

Comparison of CAN/CSA C88.1, IEEE C57.19.00/01 & IEC 60137

ITEM	CAN/CSA C88.1-96		IEEE C57.19.00/01		IEC 60137	
	Requirement	Type	Requirement	Type	Requirement	Type
Power factor (tanδ) & Capacitance Measurement	Clause 10.2. Table 2. C1 & tanδ at 10kV. The increase before and after the 1-hour low-frequency withstand voltage test to be ≤0.02	Routine /Type	Clauses 7.4.1 and 7.4.2. Table 6. C1 & tanδ to be tested at 10kV, UST	Routine	Um ≤ 36 kV: 1.05 Um /√3; Um ≥ 52 kV: 1.05 Um /√3 and Um. Measurement of C1 & tan δ to be made between 2 kV and 20 kV	Routine
	Measure C2 power factor & capacitance at 2kV	Routine	Measure C2 capacitance at 10kV,	Routine	—	—
Dry 1-minute Power frequency withstand voltage test with partial discharge measurement	Clause 10.3. Test at values specified in Table1 for 1min. PD measurements to be made before and after for OIP and RIP bushings and after for resin-bonded paper and bulk-type bushings (as per Clauses 10.4.3 and 10.4.4 Insulation Integrity)	Routine	Clause 7.4.3. Test at values specified in C57.19.01 Table 1 for 1min. Measure PD at 1.5 Um/√3 before and after.	Routine	Clause 9.3. Measure at values specified in Table 4 for 1min. Measure PD after power frequency withstand test.	Routine
Insulation integrity	Clause 10.4 PD measurements to be performed.	Routine	—	—	—	—

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Tap test	Voltage tap: 20kV for 1min	Routine	Voltage tap: 20kV for 1min	Routine	Voltage tap: twice the rated voltage of the voltage tap, at least 2kV for 1min	Routine
	Test tap: >500V for 1min		Test tap: 2kV for 1min		Test tap: 2kV for 1min	
Full-wave & Chopped-wave lightning impulse withstand voltage test	—	—	—	—	Applicable only for transformer bushings with Um equal to or greater than 245 kV. 5 FW or by agreement 1 FW, 2 CW (at 110% of FW value), 2 FW	Routine
Full-wave lightning impulse withstand voltage test	Table 1, 1.2/50µs, ±15 impulses	Type	1.2/50µs, ±15 impulses	Type	1.2/50µs, ±15 impulses. For bushings > 72.5 kV: +15 full, -1 @ 110%full, -5 @ 121% chopped, -14 @ 110%full	Type
Chopped-wave lightning impulse withstand voltage test	Table 1, ≥ -3 impulses, time to flashover 3µs	Type	≥ -3 impulses, time to flashover 3µs	Type	As described above	Type

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Switching impulse withstand voltage test	Table 1. 15 Positive Wet switching impulses. $\geq 950\text{kV}$ BIL. The front of wave shall be 200-300 microseconds and the total duration shall be 1,000-4,000 microseconds.	Type	15 Positive Wet switching impulses. Above 900kV BIL. Standard 250 x2500 μs impulse	Type	Dry (indoor) or Wet (outdoor). Transformer bushings $\geq 245\text{ kV}$ also subject to a dry test. 15 impulses of positive polarity, followed by 15 impulses of negative polarity. $\geq 950\text{kV}$ BIL. 250 /2500 μs . For transformer bushings the dry, negative polarity test shall be at 110 % of the rated SIL.	Type
Wet 1-minute Power frequency withstand voltage test	Table 1. $<950\text{kV}$ BIL, 1 minute	Type	$\leq 900\text{kV}$ BIL, 10 secs	Type	Clause 8.1. Table 4. Dry (all indoor bushings) or Wet (outdoor bushings $\leq 245\text{ kV}$), 1 minute	Type
One-hour low-frequency withstand with partial discharge measurement	Clause 8.6. Tables 1 & 2. $1.7U_y$ for 1 min and then $1.5U_y$ for 1h, $\text{PD} \leq 10\text{pC}$, the increase before and after the low-frequency withstand voltage test $\leq 5\text{pC}$. U_y - max. design voltage to ground	Type	$1.5U_m/\sqrt{3}$ for 1h, PD measurements taken every 5 minutes, $\text{PD} \leq 10\text{pC}$,	Type	Clause 8.2.2. $1.1 U_m/\sqrt{3}$ held 5 min; $1.5 U_m/\sqrt{3}$ held 5 min; U_m held 1 min; $1.5 U_m/\sqrt{3}$ held at least 60 min ($U_m \geq 300\text{kV}$) or 30 min ($U_m < 300\text{ kV}$); $1.1 U_m/\sqrt{3}$ held 5 min; 0 V; measure partial discharge every 5 minutes. $\text{PD} \leq 10\text{ pC}$ at U_m and $1.5 U_m/\sqrt{3}$; $\text{PD} \leq 5\text{ pC}$ at $1.1 U_m/\sqrt{3}$.	Type

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Temperature rise test	Hottest-spot rise $\leq 75^{\circ}\text{C}$ @ oil rise $65 \pm 2^{\circ}\text{C}$	Type	Hottest-spot rise $\leq 75^{\circ}\text{C}$ @ oil rise 65°C , in contact with temperature index 105 insulation. For insulating material with temperature index greater than 105, the hottest-spot temperature rise should be chosen accordingly and agreed between the purchaser and the manufacturer	Type	Clause 4.8 and Table 3. There is no requirement for the hottest-spot rise	Type
Thermal stability test	$1.1U_y$ (for $U_y > 108$ kV) and $\sqrt{3}U_y$ for all other bushings; conductor losses simulated; DF measured every 2 hours until equilibrium (i.e. no appreciable changes in the DF over a 5-hour period)	Type	$1.2U_m/\sqrt{3}$, rated continuous current applied or conductor losses simulated. PF measured periodically until equilibrium (i.e. PF changes no more than 0.02 over a 5-hour period)	Special	U_m for bushings of U_m equal to or less than 170 kV, $0.8 U_m$ for bushings of U_m greater than 170 kV. The conductor losses corresponding to I_r shall be simulated by appropriate means.	Type
Cantilever test	1330N for 1 minute	Type	Table 4 C57.19.01 (890N to 4000N depending on voltage and current ratings) for 1 minute	Type	Table 1 (500N to 5000N depending on voltage and current ratings), 1 minute	Type
Draw-Lead Bushing Cap Pressure	140kPa 1 hour	Type	140kPa 1 hour	Type	—	—

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Tightness test at the flange or other fixing device	—	—	—	—	Clause 9.9 1.5 bar for 15 minutes (air pressure) 1.0 bar for 12 hours (oil pressure)	Routine
Pressure Test	Clause 10.6 280 kPa for 6 hours 140 kPa for 24 hours 70 kPa for 48 hours	Routine	Clause 7.4.5 140 kPa for 1 hour and full vacuum for 1 hour	Routine	Only required on gas-filled, gas-insulated and gas-impregnated bushings	—

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