MOTOR & GENERATOR HIGH VOLTAGE TESTING

Withstand Test Voltages using *50/60 Hz. & 0.1 Hz. VLF*

Motor and Generator coils have traditionally been high voltage tested with either DC voltage or AC voltage delivered from conventional 50/60 Hz. AC Dielectric Testers, or in the case of highly capacitive, larger generator coils, from Series or Parallel Resonant Test Sets. In both AC cases, the test equipment was/is very large, heavy, expensive, difficult to transport and set-up, and consumes great amounts of line power to perform the test. Typical systems needed may be rated from 50 – 500 kVA. **Enter VLF AC Technology**.

Very Low Frequency AC Hipots offer an attractive alternative to the use of conventional power frequency test sets. Since a VLF hipot outputs a voltage of 0.10 Hz. – 0.01 Hz., rather than 50 Hz. or 60 Hz, the **capacitive charging current of the load is approximately 500x or 600x lower**, resulting in the kVA needed to perform the test also that much lower. Result: A 100 Lb. $15,000.00 VLF Hipot, that can be carried to the test, can do the job of a $100,000.00 multi-ton, power frequency AC test set. Below is the Current calculation for AC testing capacitive loads. The only variable is the frequency (f).

Amperes = $2\pi fCV$. **C = Load capacitance (Farads)** **V = Test voltage (Volts)**

VLF Technology has been used for decades worldwide for testing MV/HV cables. It is time for the apparatus world, notably rotating machinery, to also benefit from the many advantages of VLF.

IEEE 433-2009 defines the standards for using VLF to test rotating machinery. This, and other standards, define the use of VLF as a voltage source for Partial Discharge and Tan Delta testing. The test voltages required by the standard when using power frequency versus VLF are different. Dating back to the original IEEE 433-1974 standard (produced following work by GE and others using 0.1 Hz. for generator testing), states that the **sinusoidal 0.10 Hz.** VLF voltage must be 15% higher than the 50/60 Hz. voltage to be equivalent in the voltage stress applied. Since VLF hipots are measured by their **peak** output, unlike the rms measured using power frequency, this translates into a multiplier of **1.63x the power frequency rms voltage to calculate the required VLF peak voltage. RMS x 1.414 = peak. Peak x 1.15 = VLF Peak voltage.**

IEEE Std 433-2009: IEEE Recommended Practice for Insulation Testing of AC Electric Machinery with High Voltage at Very Low Frequency

Table A1: High Voltage Tests, Withstand for 1 min

	60 Hz rms	DC	0.1 Hz (crest)
Test voltage	V	1.7 V	1.63 V
End turn stress	Little of end turn stressed	Most of end turn stressed	Intermediate between 60 Hz and DC
Number of bursts of ionization (in voids)	7200	Few	12

Conversion from 50/60 Hz. RMS to 0.10 Hz. Peak VLF x 1.15 (+15%)

INPUT VOLTAGE (E)	TEST TYPE & VOLTAGE using *50/60 Hz. RMS*		
3Ø or L-L Rating	New Coil Test [2]	Acceptance Test [3]	Maintenance Test [4]
	RMS Test V **= 2E + 1kV**	**New Coil Test V x .85**	**New Coil Test V x .70**
2,300	5,600	4,760	3,920
4,000	9,000	7,650	6,300
6,600	14,200	12,070	9,940
13,200	27,400	23,290	19,180
13,800	28,600	24,310	20,020
22,000	45,000	38,250	31,500
33,640	68,280	58,038	47,796

To convert 50/60 Hz rms test voltages to the equivalent VLF peak, multiply by *1.63*

INPUT VOLTAGE (E)	TEST TYPE & VOLTAGE using *0.1 Hz VLF PEAK*		
3Ø or L-L Rating	New Coil Test [2]	Acceptance Test [3]	Maintenance Test [4]
	VLF Test V **= V rms x 1.63**	**New Coil V rms x .85**	**New Coil V rms x .70**
2,300	9,128	7,759	6,390
4,000	14,670	12,470	10,269
6,600	23,146	19,674	16,202
13,200	44,662	37,963	31,263
13,800	46,618	39,625	32,633
22,000	73,350	62,348	51,345
33,640	111,296	94,602	77,907

1 0.1 Hz VLF: Very Low Frequency testing uses 0.1 Hz. AC output instead of 50/60 Hz.
A VLF test requires 600x less AC current and kVA to perform than a 60 Hz. test.
IEEE 433 requires the VLF peak voltage to be 1.63x greater than the 50/60 Hz. RMS test voltage.

2 New Coil: This test voltage is normally used after rewind/repair at a motor shop.
Factory new coil testing voltages are generally higher.

3 Acceptance: This test performed after the coil has been installed and ready to operate.

4 Maintenance: This is an integrity check of an older but operating motor.
Usually, a diagnostic test like TD or PD is performed, not an AC Withstand test.

IEEE 433-2009 defines using VLF technology for testing rotating machinery. VLF is suitable for use as the voltage source for AC Withstand, Tan Delta, & Partial Discharge testing.

Summary: 50/60 Hz. rms test voltages converted to equivalent 0.10 Hz. VLF peak test voltages = **(50/60 Hz. rms x 1.414) x 1.15. Or (50/60 Hz. rms x 1.63)**

Call HVI for any high voltage testing application

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