Generator

High-potential Testing

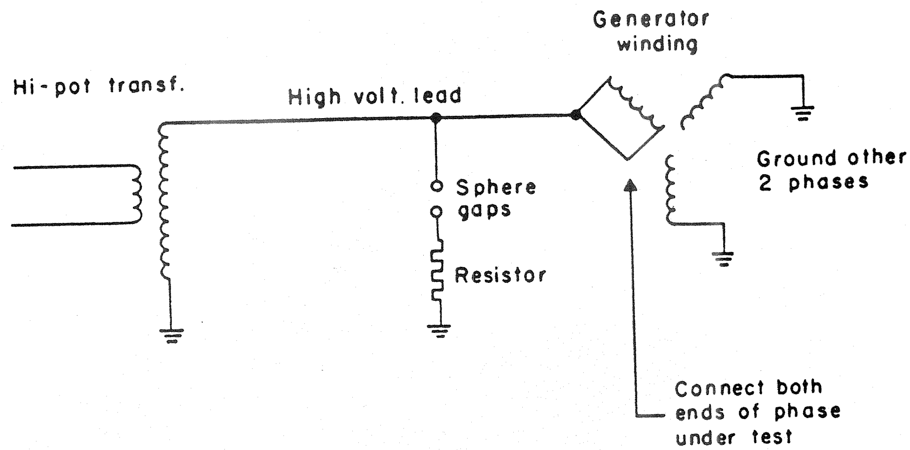

Fig. 1. High-potential test schematic circuit

I. PRECAUTIONS

a. The test set and the lead from the test set should be tested prior to applying voltage to the generator components.
The sphere gaps should be set to discharge at the desired test voltage, and the setting confirmed by raising the voltage to flashover three times. The gap should then be opened to provide an additional 10 percent voltage margin.

b. All paints, resins, putties, and any other organic materials must be thoroughly dried before conducting high-voltage testing.

c. All surfaces should be cleaned of dirt, oil, and other contaminants before conducting high-potential tests.

d. The insulation resistance should always be measured using a "megger" prior to any overpotential test. This is to make sure that no grounds, etc., have been left on the winding, and also to determine the relative integrity of the insulation before start of over-potential tests.

e. When high-potential tests are conducted on a complete phase of a winding, the line and neutral end of the winding should be connected together. This will reduce the voltage surge that will develop if the circuit is accidentally opened abruptly, or in case of flashover. Refer to Fig. 1.

f. During testing, RTD's and the remainder of the winding not being tested must be grounded at the generator.

g. Liquid-cooled Generators

Oil-cooled generators using a vacuum system must have the vacuum broken before performing high-potential tests.

Water-cooled generators should have the water circulating in the winding, or else the winding should be drained to remove water from the flexible insulating connectors. With water circulating in the winding during test, there will be losses produced in the water which must be supplied by the test equipment. The magnitude of these losses will depend on the voltage used and the resistivity of the water. For DC tests the water should be removed from the winding as outlined for megger tests (Section 3550EM).

h. For cross-compound units, when hi-pot is being conducted on one unit, personnel should be cleared from the other generator also, as a safety precaution in event of flashover to the bus or accidental feed through a sneak circuit.

SETTING OF SPHERE GAPS

Sphere gaps are used to prevent the crest voltage across which the spheres are connected from exceeding a predetermined value according to the gap between the spheres. When sparkover occurs, the protected circuit is short-circuited through the gap and current-limiting resistor, thus reducing the voltage on the protected circuit. When used for this type of service, arcing between spheres must be stopped by reducing the voltage of the protected circuit before re-establishing voltage in this circuit. This is because the ionized air that exists between spheres, once they spark, is sufficient to maintain the spark at a much lower voltage than was required to initiate the spark. The details for setting the sphere gaps are included in GEI-41580.

The calibration curve, Fig. 2 shows the relation between breakdown (spark-over) voltages and corresponding sphere-gap spacings for atmospheric conditions of 25C and barometric pressure of 760 mm of mercury for standard sizes of spheres. Values used in plotting the curves are based on sine wave voltages.

II. TECHNIQUES

a. Raising Voltage

Increase the voltage to the prescribed test value at a uniform rate in not more than one minute.

b. Testing Time

All test voltages are held for one minute, after reaching desired level.

c. Lowering Voltage

After the test interval has elapsed, reduce the voltage to 25 percent of the test value in not more than 15 seconds. Continue the reduction to zero voltage as rapidly as practical.

d. Flashovers

Care must be taken to insulate all exposed leads temporarily against the possibility of flashover to ground. Flashover during test imposes severe surge voltages on the insulation and may reduce insulation strength.

e. Bottom Bars

During a rewind, bottom bars are normally tested prior to installation of the top bars. These may be tested in small groups, particularly if corona activity is severe.

f. Top Bars

After each section of top bars are assembled, but not taped, the top bars may be tested. If, on very high-voltage generators, it proves to be difficult to hold the prescribed test voltage due to flashover from untaped parts, the top bar test should be eliminated.

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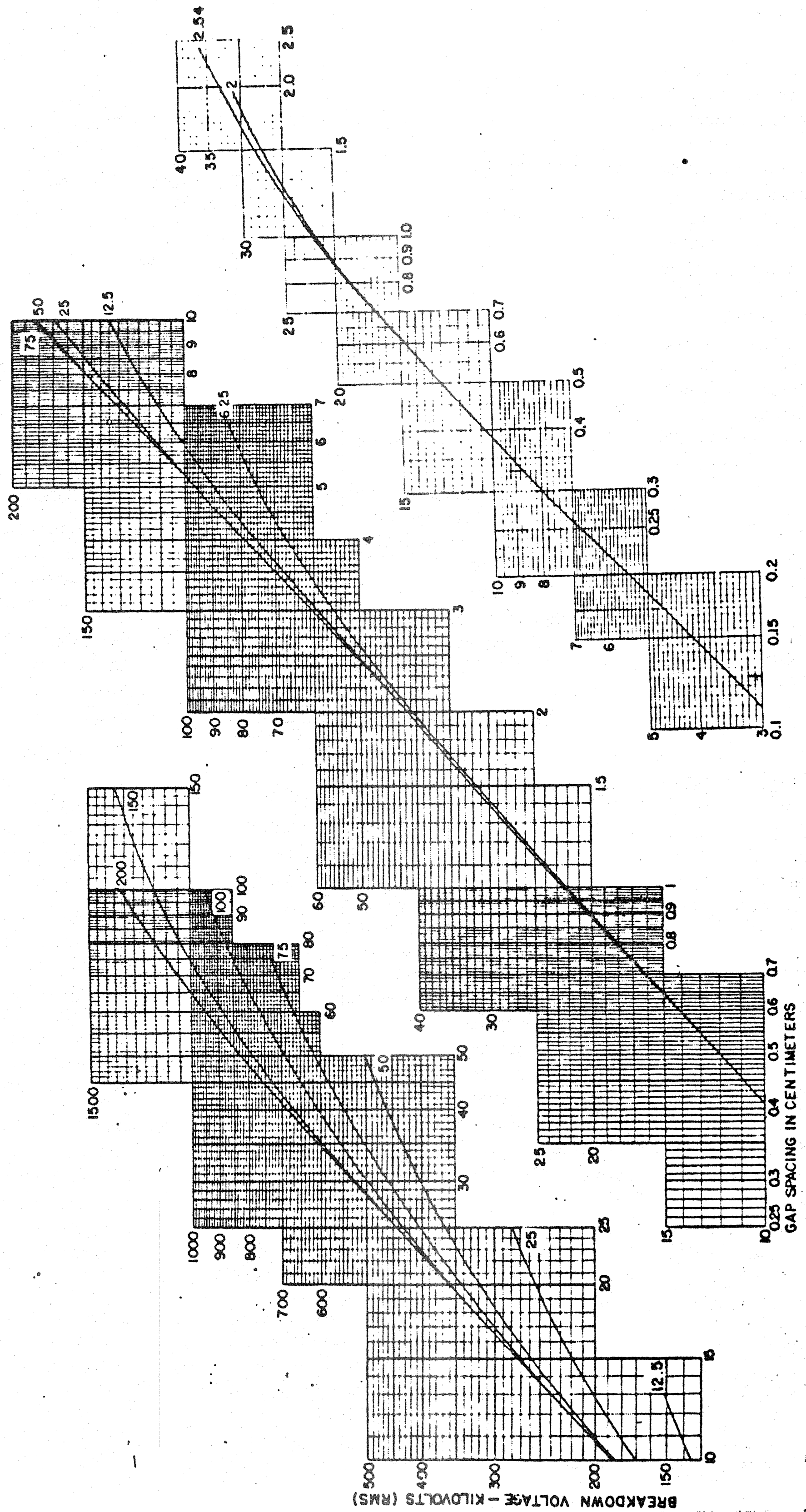

Fig. 2. Graph—sphere gap spark-over curves—60 cycles rms
(For standard sphere diameters—cm)

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g. Final Hi-pot

After the entire winding assembly is completed including blocking, tying, wedging and taping, the inner end shields are temporarily set in place and the generator is given its final high-potential test.

h. After Test

After each high-potential test the winding should be inspected for corona tracking. After the carbon areas are removed, the area should be repainted with tan pigmented paint (Chemical Div. 801–440 mixed with 801–468), or No. 7815 depending on system used. G.E. Varnish No. 237 may be substituted for No. 7815.

RTD'S

RTD's in armature slots are tested at 500 volts to ground (500-volt megger). When making this test remove the grounded lead on the RTD. Any RTD which shows less than 100,000 ohms to ground, and if the fault appears to be in the **slot** portion, must be removed prior to returning the unit to service. This test should be repeated after each high-potential test on the stator.

During a complete rewind, new **slot** RTD's may be tested at 2,000 volts after top bar hi-pot, and at 1,500 volts after final hi-pot.

III. TEST VOLTAGES

It should be recognized that any overpotential test on a piece of electrical apparatus involves a certain amount of risk of breakdown if a weak point exists in the insulation system. For tests on a generator in the purchaser's station then, the degree of reliability desired, and the amount of risk to be taken in proving the suitability for service, are decisions that must rest with the owner-operator. The following list of test values are only recommended values for various conditions, to achieve a high degree of reliability.

a. Complete Rewind, in purchaser's station, follow Table I.

b. New Generator, factory wound, if purchaser chooses to hi-pot at arrival in station, before start-up not to exceed the ASA recommendations;
85% (2E + 1000)
(E = rated rms line-to-line volts)

c. In Warranty, if work is done such as rewedging:
1. Before work (.85) (2E + 1000)
2. After work (.85) (2E − 2000)

d. Maintenance Testing (Out of Warranty)
1. Maintenance Testing: 1½E
   If any bars fail, isolate and retest remainder of winding to same level.
2. New replacement bars in station before assembly in generator, not to exceed:
   2E + 1000
3. If sound top bars are removed to permit access to a bottom bar and if they are suitable for re-use, these bars might be tested before replacement in generator at:
   (.85) (2E + 1000)
4. If bottom bars are involved, and at option of job supervision, it may be elected to test new bottom bars in place before proceeding with other work, at:
   1½E
5. After the top bars are installed, and at option of job supervision, it might be elected to test each phase prior to taping the series loops, at:
   1⅓E + 600
6. Final 1⅓E + 600

IV. DC OVERPOTENTIAL TESTS

The primary recommendations for overpotential testing of turbine-generator windings is that an alternating voltage be used. All of the voltage values quoted in the above tabulation are based on the use of AC.

It is recognized that many owners use DC for overpotential testing due to the lighter weight and portability of the equipment. It is not felt that DC provides the same level of searching that is obtained from AC. If the owner elects to use DC, a ratio of 1.7 is suggested to establish a compromise between the two types. To obtain the voltage for any particular test, multiply the appropriate value in Paragraph III (Test Voltages) by 1.7.

V. LOW FREQUENCY AC OVERPOTENTIAL TESTS

If low frequency (0.1 cps) AC tests are to be made on a generator, multiply the values tabulated in Paragraph III (Test Voltages) by 1.15 to obtain corresponding AC RMS values.

Table I—Complete Rewind High-potential Test Voltages for Generators

Rated Voltage (Line-to-line)	Test 1	Test 2	Test 3
	Bottom Bars (Kv)	Top Bars Installed (Kv) (Series Connection Uninsulated)	Final
9,001–10,000 10,001–11,000 11,001–12,000	27 29 31	24 26 28	Twice Rated + 1000 Volts
12,001–13,000 13,001–14,000 14,001–15,000	33 35 36	30 32 33	Twice Rated + 1000 Volts
15,001–16,000 16,001–17,000 17,001–18,000	37 38 40	35 36 38	Twice Rated + 1000 Volts
18,001–19,000 19,001–20,000 20,001–21,000	42 44 46	40 42 44	Twice Rated + 1000 Volts
21,001–22,000 22,001–23,000 23,001–24,000	47 49 51	46 48 50	Twice Rated + 1000 Volts
24,001–25,000	53	52	Twice Rated + 1000 Volts

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