



SERVICE PROCEDURE - GENERATOR INSULATION TESTING

PURPOSE

The purpose of this Service Procedure is to provide a guide for testing generator insulation and determining its suitability for use and/or need for preventative maintenance. All procedures and recommendations are intended to be in accordance with IEEE 43 (Ref. 1).

CAUTION: Insulation testing should only be performed when units are at standstill and all power is off. Follow all high potential test equipment manufacturer's instructions and safety precautions.

ACCURACY

In order to assure accuracy and comparability to previous test, the following test conditions should be met:

- The winding temperature should be stable.
- The winding temperature should be a minimum of 5° C. above the Dew Point.
- All insulation resistance measurements should be corrected to 40° C. (see IEEE 43, Fig. 1)
- Windings should be free of built up charge from previous tests.
- If the test result are to be compared to previous results, the windings should be clean and free of moisture.

TEST POTENTIAL

For insulation that is clean and dry, the insulation resistance should be the same regardless of the test potential used. Testing is normally done at 500 volts. In all cases the test potential must be restricted to a value appropriate to the voltage rating of the unit under test. See Table 1. Readings at higher potentials are more sensitive to surface leakage current. A drop in the insulation resistance value with an increase of test potential is a good indication that the insulation is wet and contaminated.

ISOLATION

The only way to accurately measure the generator insulation resistance is to isolate the winding from all external equipment. to expedite routine maintenance checks readings can be taken at the earliest circuit breaker, but if a questionable reading is obtained the winding must be isolated and the test retaken.

PROCEDURE

CAUTION: Be sure the regulator, and any other electronic components, metering, protective relays etc., are disconnected before performing insulation resistance testing. High voltages from the Megger or insulation tester will destroy these parts.

Determine the winding temperature. The RTDs will give a good indication of the winding temperature. A better estimate can be made by comparing the RDT temperatures with a reading taken on the surface of the insulation with a thermocouple or temperature probe. When insulation surface temperature is taken, care should be used to ensure no damage is done to the insulation by installation of the probe.

All stator leads must be isolated from ground and connected together (on most systems with grounded neutrals - the neutral can be isolated from ground and used as a rest point).

Several types of insulation testers or Meggers are available from different manufacturers. They will give direct readings in resistance (megohms), voltage and current, or all three. Any of these instruments will be satisfactory if the manufacturer recommends its use for the size of machine under test.

At this point refer to the instruction manual for the Megger or insulation tester being used. Follow all instructions and safety precautions outlined in the manual.

- To measure insulation resistance, connect the positive lead of the tester to the winding leads. Connect the negative tester lead to the generator grounding stud bolt.
- Apply the test potential for ten (10) minutes.
- Take a reading after the first minute and every minute thereafter. Voltage adjustments should not be made after the initial settings.

The one minute reading, after correction to 40° C., will be value of the insulation resistance. This value should be compared to the minimum acceptable value for the generator under test,

The minimum acceptable value (in megohms) can be calculated using the following formula.

$$\text{Minimum Insulation resistance} = (\text{Generator Voltage} / 1000) + 1$$

The ratio of the 10 minute insulation resistance reading to the 1 minute insulation reading is the Polarization Index. Since the winding temperature has little effect on the polarization index, temperature correction is not necessary.

CAUTION: After application of direct high potential, grounding of windings is important for safety as well as for accuracy of subsequent tests. The grounding time should be a minimum of four times the charging time.

INTERPRETATION OF RESULTS

Insulation resistance history of a given generator, made and kept under uniform conditions so far as controllable variables are concerned, is recognized as a useful way of monitoring the insulation condition. An estimation of the suitability of a unit for operation may be based on a

comparison of present and previous values of insulation resistance, corrected to 40° C., and polarization index.

The observed value of insulation resistance is a useful guide in evaluating the condition of a generator winding. However, it should not be considered as an exact criterion, and it does have several limitations.

- Insulation resistance of a winding is not directly related to its dielectric strength. It is impossible to specify the value of insulation resistance at which a winding will fail. (See ref 1.)
- Surface condition, moisture, temperature, test potential, duration of test, and residual charge all affect insulation resistance. (See Ref. 1 and 2.)

When the insulation resistance history is not available, recommended minimum values of the polarization index may be used to determine the winding's suitability for use. When using the polarization index as the deciding factor, the corrected insulation resistance should be at least that of the recommended minimum.

Winding condition, insulation class, and type of insulating materials used will affect the polarization index.

- If the polarization Index is reduced because of dirt or excessive moisture, it can be brought up to a satisfactory value by cleaning and drying to remove moisture Ref.1)
- Polyester or epoxy impregnated windings may have polarization index different than those stated in IEEE 43. (Ref. 1)

ACTIONS

Insulation resistance of a clean and dry winding with secure insulation will change dramatically over the life of the unit. Insulation resistance will start at a high value. drop to 10 to 100 times the minimum value over the first year of service, and then slowly decline until the end of service life is reached.

Similarly, polarization index will change over time. With the newer polyester or epoxy impregnated windings a new unit may exhibit a very low polarization index. Over the first few years of service it will develop a normal index and then slowly increase until the end of service life. With the above in mind, some recommendation for action can be made.

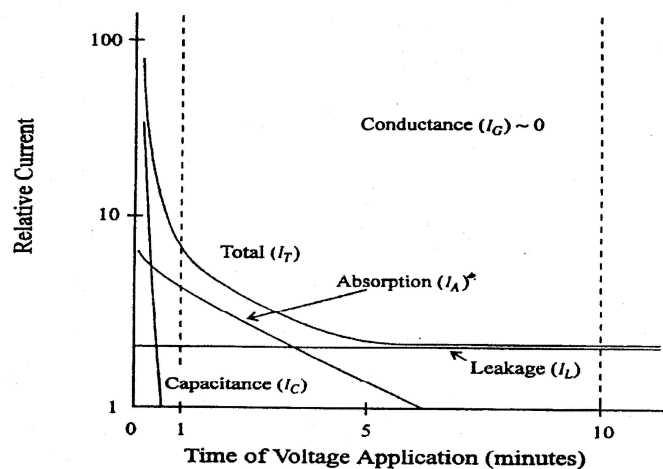
- Normal operation can proceed on any generator with an insulation resistance reading 10 times above the recommended minimum if the polarization is 1.0 or greater.
- Caution should be used with windings that have insulation resistance at or above the minimum recommended values and a polarization index less than 1.5. If, after insuring that the winding is clean and dry, the polarization and insulation resistance cannot be raised, consult the manufacturer.
- If insulation resistance values are below the recommended minimum value and cannot be brought up by the application of additional heat, the manufacturer should be consulted. If the insulation responds to the application of additional heat, the winding should be reconditioned and retested.

- It is considered to be good practice to initiate reconditioning should the insulation resistance, having been well above the recommended minimum, drop appreciably to near that level. (1)
- In any case, a polarization index of less than 1.0 indicates a conduction current increasing with time. This normally would be an unsatisfactory condition and might be due to a leakage path that has not been dried out. If the index is still less than 1.0 after cleaning and drying, the manufacturer should be consulted. (2)

Table 1. Guidelines for dc voltages to be applied during insulation resistance test. (Ref. 1)

Winding Rated Voltage (AC or DC)	Insulation Resistance Test DC Voltage
<1000	500
1000 - 2500	500 – 1000
2501 - 5000	1000 – 2500
5001 – 12000	2500 – 5000
>12000	5000 – 10000

Figure 3 Types of currents for an epoxy-mica insulation with a relatively low surface leakage current and no conduction current



REFERENCES:

- (1) IEEE std. 43 – 2000 (Revision of IEEE Std 43-1974) IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery
- (2) IEEE Std. 432 – 1992 Guide for Insulation Maintenance for Rotating Electrical Machinery.