IEEE RECOMMENDED PRACTICES FOR SAFETY IN HIGH-VOLTAGE & HIGH-POWER TESTING

1. SCOPE

Excerpts from IEEE Standard 510-1983 have been listed in this section in order to caution all personnel dealing with high voltage applications and measurements and to provide recommended safety practices with regard to electrical hazards.

Considerations of safety in electrical testing apply not only to personnel but to the test equipment and apparatus or system under test. These recommended practices deal generally with safety in connection with testing in laboratories, in the field, and of systems incorporating high voltage power supplies, etc. For the purposes of these recommended practices, a voltage of approximately 1,000 volts has been assumed as a practical minimum for these types of tests. Individual judgement is necessary to decide if the requirements of these recommended practices are applicable in cases where lower voltages or special risks are involved.

1.1 All ungrounded terminals of the test equipment or apparatus under test should be considered as energized.

1.2 Common ground connections should be solidly connected to both the test set and the test specimen. As a minimum, the current capacity of the ground leads should exceed that necessary to carry the maximum possible ground current. The effect of ground potential rise due to the resistance and reactance of the earth connection should be considered.

1.3 Precautions should be taken to prevent accidental contact of live terminals by personnel, either by shielding the live terminals or by providing barriers around the area.

1.4 The circuit should include instrumentation for indicating the test voltages.

1.5 Appropriate switching and, where appropriate, an observer should be provided for the immediate de-energization of test circuits for safety purposes. In the case of dc tests, provisions for discharging and grounding charged terminals and supporting insulation should also be included.

1.6 High Voltage and high-power tests should be performed and supervised by qualified personnel.

2. TEST AREA SAFETY PRACTICES

2.1 Appropriate warning signs, for example, DANGER – HIGH VOLTAGE, should be posted on or near the entrance gates.

2.2 Insofar as practical, automatic grounding devices should be provided to apply a visible ground on the high-voltage circuits after they are de-energized. In some high-voltage circuits, particularly those in which elements are hanged from one setup to the next, this may not be feasible. In these cases, the operator should attach a ground to the high-voltage terminal using a suitably insulated handle. In the case of several capacitors connected in series, it is not always sufficient to ground only the high-voltage terminal. The exposed intermediate terminals should also be grounded. This applies in particular to impulse generators where the capacitors should be short-circuited and grounded before and while working on the generator.

2.3 Safe grounding of instrumentation should take precedence over proper signal grounding unless other special precautions have been taken to ensure personnel safety.

3. CONTROL & MEASUREMENT CIRCUITS

3.1 Leads should not be run from a test area unless they are contained in a grounded metallic sheath and terminated in a grounded metallic enclosure, or unless other precautions have been taken to ensure personnel safety. Control wiring, meter connections, and cables running to oscilloscopes fall

into this category. Meters and other instruments with accessible terminals should normally be placed in a metal compartment with a viewing window.

3.2 Temporary Circuits

3.2.1 Temporary measuring circuits should be located completely within the test area and viewed through the fence. Alternatively, the meters may be located outside the fence, provided the meters and leads, external to the area, are enclosed in grounded metallic enclosures.

3.2.2 Temporary control circuits should be treated the same as measuring circuits and housed in a grounded box with all controls accessible to the operator at ground potential.

4. SAFETY RULES

A set of safety rules should be established and enforced for the laboratory or testing facilities. A copy of these should be given to, and discussed with, each person assigned to work in a test area. A procedure for periodic review of these rules with the operators should be established and carried out.

5. SAFETY INSPECTION

A procedure for periodic inspection of the test areas should be established and carried out. The recommendations from these inspections should be followed by corrective actions for unsafe equipment or for practices that are not in keeping with the required regulations.

NOTE: A safety committee composed of several operators appointed on a rotating basis has proven to be effective, not only from the inspection standpoint but also in making all personnel aware of safety.

6. GROUNDING & SHORTING

6.1 The routing and connections of temporary wiring should be such that they are secure against accidental interruptions that may create hazard to personnel or equipments.

6.2 Devices which rely on a solid or solid/liquid dielectric for insulation should preferably be grounded and short-circuited when not in use.

6.3 Good safety practice requires that capacitive objects be short-circuited in the following situations:

6.3.1 Any capacitive object which is not in use but may be in the influence of a dc electric field should have its exposed high-voltage terminal grounded. Failure to observe this precaution may result in a voltage included in the capacitive object by the field.

6.3.2 Capacitive objects having a solid dielectric should be short-circuited after dc proof testing. Failure to observe this precaution may result in a buildup of voltage on the object due to dielectric absorption has dissipated or until the object has been reconnected to a circuit.

NOTE: It is good practice for all capacitive devices to remain short-circuited when not in use.

6.3.3 Any open circuited capacitive device should be short-circuited and grounded before being contacted by personnel.

7. SPACING

7.1 All objects at ground potential **must** be placed away from all exposed high voltage points at a minimum distance of 1 inch (25.4 mm) for every 7,500 Volts, e.g. 50 kV requires a spacing of at least 6.7 inches (171 mm).

7.2 Allow a creepage distance of 1 inch (25.4 mm) for every 7,500 Volts for insulators placed in contact with high voltage points.

8. HIGH-POWER TESTING

8.1 High-power testing involves a special type of high-voltage measurement in that the level of current is very high. Careful consideration should be given to safety precautions for high-power testing due to this fact. The explosive nature of the test specimen also brings about special concern relating to safety in the laboratory.

8.2 Protective eye and face equipment should be worn by all personnel conducting or observing a high-power test where there is a reasonable probability that eye or face injury can be prevented by such equipment.

NOTE: Typical eye and face hazards present in high-power test areas included intense light (including ultraviolet), sparks, and molten metal.

8.3 Safety glasses containing absorptive lenses should be worn by all personnel observing a high-power test even when electric arcing is not expected. Lenses should be impact-resistant and have shade numbers consistent with the ambient illumination level of the work area but yet capable of providing protection against hazardous radiation due to any inadvertent electric arcing.

9. GENERAL

9.1 All high-voltage generating equipment should have a single obvious control to switch the equipment off under emergency conditions.

9.2 All high-voltage generating equipment should have an indicator which signals that the high-voltage output is enabled.

9.3 All high-voltage generating equipment should have provisions for external connections (interlock) which, when open, cause the high-voltage source to be switched off. These connections may be used for external safety interlocks in barriers or for a foot or hand operated safety switch.

9.4 The design of any piece of high-voltage test equipment should include a failure analysis to determine if the failure of any part of the circuit or the specimen to which it is connected will create a hazardous situation for the operator. The major failure shall be construed to include the probability of failure of items that would be overstressed as the result of the major failure. The analysis may be limited to the effect of one major failure at a time, provided that the major failure is obvious to the operator.