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IEEE Standard for 4.76 kV to 38 kV Rated Grounding and Testing Devices Used in Enclosures

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Switchgear Committee
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IEEE Power Engineering Society

Approved 20 March 1997

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Abstract: Drawout type grounding and testing (G&T) devices for use in medium-voltage metal-clad switchgear rated above 4.76 kV through 38 kV are covered. The description, design, and testing of these accessory devices that are inserted in place of drawout circuit breakers for the purpose of grounding and testing are also covered.
Keywords: electrical operation, grounding and testing (G&T) devices, locking/interlocking, manual operation, one or two terminal sets, selector switch, test port

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Introduction

(This introduction is not a part of IEEE Std C37.20.6-1997, IEEE Standard for 4.76 kV to 38 kV Rated Grounding and Testing Devices Used in Enclosures.)

Although grounding and testing devices (G&T) have been used as accessory devices in metal-clad switchgear for decades, they have never been covered by standards. This is because they are specialized accessory devices, designed and tested in accordance with applicable sections of circuit breaker standards, and based on user-unique operational requirements.

This standard complements IEEE Std C37.20.2-1993, IEEE Standard for Metal-Clad and Station-Type Cubicle Switchgear, and addresses the more popular G&T device types. This standard also clarifies that G&T devices are not required to have the interrupting and continuous current ratings of the circuit breakers they may temporarily replace for the purpose of grounding and testing medium-voltage circuits.

G&T devices are supplied in various forms and the following generally summarizes the more popular forms:

a) *Simple manual devices.* These are equipped with either one or two terminal sets for grounding through cables, manually connected to the device ground connection system. Hot stick voltage testing is possible.

b) *Simple electrical devices.* These are equipped with one terminal set connected, through a power-operated ground-making switch, to the device ground connection system. Voltage test ports may be provided.

c) *Complex electrical devices.* These are equipped with two terminal sets and a manually operated switch for selecting which terminal set is to be connected, through the power-operated ground-making switch, to the device ground connection system. Voltage test ports may be provided.

All G&T devices are equipped with necessary isolation barriers and locking or interlocking mechanisms to provide some degree of protection during handling and operation.

This standard does not cover G&T devices that are specially equipped with current and voltage transformers, glow-tubes and like components, nor those that have short-circuit current interrupting capability.

G&T devices designed before the approval of this standard may not meet all of these established requirements. The user should consult with the manufacturer if any question exists regarding the proper application of these G&T devices on the user's system.

Suggestions gained from use will be welcomed for guidance in future revisions of this standard.

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Contents

IEEE Standard for 4.76 kV to 38 kV Rated Grounding and Testing Devices Used in Enclosures

1. Scope

This standard covers drawout type, indoor medium-voltage grounding and testing (G&T) devices for use in drawout metal-clad switchgear rated above 4.76 kV through 38 kV as described in IEEE Std C37.20.2-1993. Three G&T device types are generally supplied for temporary circuit maintenance procedures for insertion in place of the circuit breaker as follows:

a) Simple manual devices
b) Simple electrical devices
c) Complex electrical devices

There may be more complex G&T devices that may include current and/or voltage transformers, glow-tubes, or other accessory components and may also have the ability to interrupt short-circuit current. These more complex devices are not covered by this standard. Due to their complexity, additional testing and interlocking are required and manufacturers should be consulted for the availability and ratings of these types of devices.

2. References

This standard shall be used in conjunction with the following publications:

ANSI C37.06-1987 (R1994), American National Standard for Switchgear—AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis—Preferred Ratings and Related Required Capabilities.[1]

IEEE Std 4-1978, IEEE Standard Techniques for High-Voltage Testing.[2]

IEEE Std C37.04-1979 (Reaff 1988), IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (ANSI/DoD).

[1]ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

[2]IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

IEEE Std C37.09-1979 (Reaff 1988), IEEE Standard Test Procedures for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (ANSI/DoD).

IEEE Std C37.20.2-1993, IEEE Standard for Metal-Clad and Station-Type Cubicle Switchgear (ANSI).

IEEE Std C37.100-1992, IEEE Standard Definitions for Power Switchgear (ANSI).

3. Definitions

The definitions of terms contained in this standard, or in other referenced standards, are not intended to embrace all legitimate meanings of the terms. They are applicable only to the subject treated in this standard.

If a term is not defined in this standard, the definition in IEEE Std C37.100-1992 applies. An asterisk (*) following a definition indicates that the definition in this standard is not in IEEE Std C37.100-1992, while a dagger (†) indicates the definition differs from that in IEEE Std C37.100-1992.

3.1 complex electrical ground and test device: A device with two terminal sets and a manually operated terminal selector switch for connecting either terminal set to the device ground connection system through a power-operated ground-making switch, complete with necessary isolation barriers and suitable interlocking. Voltage test ports may be provided.*

3.2 design tests: Tests made by the manufacturer to determine the adequacy of the design of a particular type, style, or model of equipment or its component parts to meet its assigned ratings and to operate satisfactorily under normal service conditions or under special conditions if specified, and may be used to demonstrate compliance with applicable standards of the industry.†

NOTES

1—Design tests are made on representative apparatuses or prototypes to verify the validity of design analyses and calculation methods and to substantiate the ratings assigned to all other apparatuses of basically the same design. These tests are not intended to be made on every design variation or to be used as part of normal production. The applicable portion of these design tests may also be used to evaluate modifications of a previous design and to ensure that performance has not been adversely affected. Test data from previous similar designs may also be used for current designs, where appropriate. Once made, the tests need not be repeated unless the design is changed so as to modify performance.

2—Design tests are sometimes called type tests.

3.3 ground and test device: A term applied to a switchgear assembly accessory device that can be inserted in place of a drawout circuit breaker for the purpose of grounding the main bus and/or external circuits connected to the switchgear assembly and/or primary circuit testing.*

3.4 production tests: Tests made for quality control by the manufacturer on every device or representative samples, or on parts or materials required to verify during production that the product meets the design specifications and applicable standards.† *Synonym:* **routine tests.**

NOTE—Certain quality assurance tests on identified critical parts of repetitive high-production devices may be tested on a planned statistical sampling basis.

3.5 simple electrical ground and test device: A device with one terminal set and a power-operated ground-making switch for connecting the terminal set to the device ground connection system, complete with necessary isolation barriers and suitable interlocking. Voltage test ports may be provided.*

3.6 simple manual ground and test device: A device with one or two terminal sets with provisions for connecting either terminal set through manually installed cables to the device ground connection system, complete with necessary isolation barriers and suitable interlocking.*

NOTE—Cables are synonymous with manually installed cords of any type.

3.7 terminal set: A set of three primary terminals with primary disconnecting devices typically called "upper" or "lower," "front" or "back," or "bus" or "line" depending upon design configuration.*

NOTE—In this standard, the terms "upper" and "lower" are used to identify the location of different terminal sets.

4. Service conditions

Service conditions covering G&T devices are the same as those of circuit breakers (see IEEE Std C37.04-1979).

5. Ratings

5.1 General

The designated ratings in this standard are preferred and are not considered restrictive. The ratings of G&T devices are designations of operating limits under the service conditions specified in Clause 4. Since G&T devices do not require all of the capabilities of circuit breakers, these ratings are established as the minimum required capabilities for the devices (see Clause 9).

The required rated values are to be assigned from the Tables of Preferred Ratings listed in ANSI C37.06-1987.

5.2 Rated maximum voltage and dielectric withstand voltage

5.2.1 Rated maximum voltage

The rated maximum voltage of a G&T device shall not be less than the rating of the circuit breaker it is intended to temporarily replace.

5.2.2 Rated dielectric withstand

The rated dielectric withstand of a G&T device shall not be less than the voltage withstand ratings of the circuit breaker it is intended to temporarily replace, as shown by the following:

a) Rated power frequency withstand voltage
b) Rated impulse withstand voltage

If optional functional components are supplied, they shall meet the dielectric strength requirements of the G&T device.

5.3 Rated power frequency

The rated power frequency of a G&T device is 60 Hz.

5.4 Rated short-time current

The rated short-time current of a G&T device is the rated short-time current of the switchgear assembly where the device is intended to be temporarily inserted in place of a circuit breaker; it shall be in accordance with 4.4.5 and 4.4.6 of IEEE Std C37.20.2-1993.

5.5 Rated momentary current

The rated momentary current of a G&T device is the maximum rms total current it shall be required to withstand. The symmetrical current shall be the rated short-time current (KI); the peak current value shall be 2.6 times its rated short-time current, at the major peak of the maximum cycle, and the rms total current shall be 1.55 times its rated short-time current, as determined from the envelope of the current wave. This rating shall be no less than the required close-and-latch current capability of the circuit breaker it is intended to replace.

5.6 Rated control voltage

The rated control voltage of an electrically operated G&T device is the designated voltage that is to be applied to the operating mechanism of the power-operated ground-making switch.

5.7 Close-and-latch current capability

The close-and-latch current capability of an electrically operated G&T device is the maximum rms total current that the power-operated ground-making switch shall require to close into and carry. The symmetrical current shall be the rated short-time current (KI); the peak current value shall be 2.6 times its rated short-time current, at the major peak of the maximum cycle; and the rms total current shall be 1.55 times its rated short-time current, as determined from the envelope of the current wave. This rating shall be no less than the required close-and-latch current capability of the circuit breaker it is intended to replace.

6. Functional components

The functional components required for manual and electrical ground and test devices are listed in Table 1. Additional accessory devices may be available and the manufacturer should be consulted for specific information.

6.1 Power-operated ground-making switch position indicator

Each G&T device equipped with a power-operated ground-making switch shall have an indicator visible from the front of the device when installed in the enclosure to show the closed and open position of the power-operated ground-making switch. The following colors shall be used:

a) Red background with the word CLOSED-GROUNDED in contrasting color to indicate closed contacts.

b) Green background with the word OPEN-UNGROUNDED in contrasting color to indicate open contacts.

6.2 Terminal selector switch and position indicator

The manually operated terminal selector switch provides the ability to connect the power-operated ground-making switch to either terminal set (or neutral position if provided). The terminal selector switch position

Table 1—Functional components

Functional component	Device type		
	Simple manual	Simple electrical	Complex electrical
One terminal set‡	X	X	—
Two terminal sets‡	X*	—	X
Ground cable and connectors (see 8.3)	X	—	—
Ground connection system	X	X	X
Test ports	—	X*	X*
Test probes	—	X*	X*
Power-operated ground-making switch	—	X	X
Position indicator (see 6.1)	—	X	X
Manual opening release	—	X	X
Remote electrical control (see 8.4)	—	X	X
Electrical opening release (see 8.4)	—	X*	X*
Stored energy indicator (see 6.3)	—	X†	X†
Manually operated terminal selector switch (see 6.2)	—	—	X
Position indicator (see 6.2)	—	—	X
Interlocking (see 6.4)	X	X	X
Nameplate(s) (see 6.5)	X	X	X

*Optional.
†Required on stored energy closing mechanisms when the mechanism can remain in the charged position.
‡Primary disconnecting devices as required for compartment compatibility.

shall be able to be changed only when the G&T device is fully removed from the enclosure, and means for visual verification of the terminal switch position shall be provided. A position indicator, visible from the front when the device is installed in the enclosure, shall show which terminal set has been selected (including the neutral position if provided).

6.3 Stored energy indicator

For mechanisms intended to be charged and to remain charged until released, a stored energy indicator shall be provided. The following colors shall be used:

a) Yellow background with black lettering to indicate that the closing mechanism is CHARGED.
b) White background with black lettering to indicate that the closing mechanism is DISCHARGED.

6.4 Interlocking

Interlocking for G&T devices can be very detailed depending upon the complexity of the device, especially when it is equipped with multiple functional components. The requirements given in 6.4.1 through 6.4.6 are considered the minimum interlocking requirements.

6.4.1 Insertion and withdrawal

All G&T devices shall be able to be inserted and withdrawn from the circuit breaker compartment using the same, or compatible, mechanism design as that of the circuit breakers they temporarily replace, including the drawout position indication.

6.4.2 Coordination

All G&T devices shall be equipped with a mechanical interlock, in coordination with existing provisions in the corresponding circuit breaker compartment, to block the G&T device from being inserted into a circuit breaker compartment whose ratings exceed those of the G&T device.

6.4.3 Ground-making switch closed

Every electrical G&T device shall have mechanical interlocking to prevent it from being inserted or withdrawn when the power-operated ground-making switch is closed.

6.4.4 Ports barriers

Simple and complex G&T devices equipped with voltage test ports shall have a barrier that prevents inadvertent access to each test port. Secure locking means shall be provided to prevent the barrier from being inadvertently moved to expose the ungrounded terminal set.

6.4.5 Terminal sets barriers

A simple manual G&T device equipped with two terminal sets shall have a barrier that prevents access to the ungrounded terminal set. Secure means shall be provided to prevent the barrier from being inadvertently moved to expose the ungrounded terminal set.

6.4.6 User specified interlocks

The user shall specify the interlocking required by the system operating procedures. The user shall identify any additional interlocks required on the G&T device and between the G&T device and user's devices, based on the selection of functional components. This interlocking is complex. For example, it can consist of mechanical bar types, hasps for keyed padlocks, and/or mounted key interlocks.

6.5 Nameplate(s)

The following minimum information shall be given on the device nameplate(s):

a) Manufacturer's name
b) Manufacturer's type and identification reference
c) Serial number
d) Year of manufacture
e) Rated maximum voltage (in kV)
f) Rated power frequency withstand voltage (in kV)
g) Rated impulse withstand voltage (in kV)

h) Rated power frequency (60 Hz)
i) Rated short-time current (kA symmetrical)
j) Rated momentary current (kA peak and kA rms total current)
k) Rated control voltage (in V) (for electrical G&T devices)
l) Close-and-latch current capability (kA peak and kA rms total current) (for electrical G&T devices)
m) Primary disconnecting devices compartment compatibility (in A)
n) Instruction manual number

7. Test requirements

7.1 General

This clause describes the required design and production tests.

7.2 Design tests

Design tests shall be made to determine the adequacy of a particular type of G&T device to meet its assigned ratings and to operate satisfactorily in service.

Design tests shall be made on representative G&T devices to demonstrate the ratings assigned.

All design tests shall be made with the G&T device in a test enclosure. The enclosure for a particular type of G&T device shall be either the minimum dimension, single-unit enclosure with the smallest electrical spacing as recommended by the manufacturer, including the phase and ground conductor sizes, or a production switchgear vertical section of the type and rating in which the G&T device will be used.

The conditions prevailing at the test site shall be in accordance with Clause 4 and the G&T device shall be new or reconditioned.

7.3 Schedule of design tests

Design testing of a G&T device shall be performed in accordance with 7.3.1 through 7.3.5.

7.3.1 Dielectric tests

The power frequency withstand voltage test (see 7.3.1.1) and full-wave impulse withstand voltage test (see 7.3.1.2) shall be performed on the G&T device to demonstrate the ability of the insulation system to withstand rated voltages.

The tests on the insulation system shall be made under the normal atmospheric conditions prevailing at the test laboratory. Appropriate air density correction factor shall be applied as outlined in IEEE Std 4-1978. Optional humidity correction factors, if used, shall be based on rod gaps as stated in IEEE Std 4-1978, Table 1.3.

Test voltages shall be applied between ungrounded primary terminals and the G&T device ground connection system in the following manner:

a) *Simple manual G&T device.* Individually energize each terminal (without cables, but with barriers) with the frame and device ground connection system and all other terminals grounded.

b) *Simple electrical G&T device.* With the power-operated ground-making switch open, individually energize each terminal/test port with the frame and device ground connection system and all other terminals/test ports grounded.

c) *Complex electrical G&T device.*

1) With the power-operated ground-making switch open:

—With the manually operated terminal selector switch in the "upper" position, individually energize each terminal/test port, with the frame and device ground connection system and all other terminals/test port grounded.

—With the annually operated terminal selector switch the "lower" position, individually energize each terminal/test port, with the frame and device ground connection system and all other terminals/test ports grounded.

—With the manually operated terminal selector switch (if provided) in the neutral position, individually energize each terminal/test port, with the frame and device ground connection system and all other terminals/test ports grounded.

2) With the power-operated ground-making switch closed:

—With the manually operated terminal selector switch in the "upper" position, individually energize each "lower" terminal/test port, with the frame and device ground connection system and all other terminals/test ports grounded.

—With the manually operated terminal selector switch in the "lower" position, individually energize each "upper" terminal/test port, with the frame and device ground connection system and all other terminals/test ports grounded.

—With the manually operated terminal selector in the neutral position, if provided, individually energize each terminal/test port, with the frame and device ground connection system and all other terminals/test port grounded.

NOTE—Depending on the G&T device ground-making switch design, it may be possible to eliminate the test described in item c2) above.

7.3.1.1 Power frequency withstand voltage test

A sinusoidal alternating-current voltage shall have a crest value of no less than 1.414 times the rated power frequency withstand voltage value specified, and shall be applied to each terminal as specified in 7.3.1. The frequency shall be within ± 20% of the rated power frequency. The test voltage shall be gradually increased within 30 s to 60 s from zero to the required test value and shall be held at that voltage value for 1 min without flashover.

7.3.1.2 Full-wave impulse withstand voltage test

The full-wave impulse withstand voltage, with a wave shape of 1.2 × 50 μs, shall be as described in IEEE Std 4-1978. Tests shall be applied as specified in 7.3.1, with three positive and negative impulses applied to each ungrounded terminal and test port (if provided) without flashover.

If during the first group of three consecutive impulses, one flashover occurs in the self-restoring insulation, nine additional impulses shall be applied. If the G&T device successfully withstands all nine of the second group of impulses, the flashover in the first group shall be considered as random and the G&T device shall be considered as having successfully passed the test.

NOTE—Some insulating materials retain a charge after an impulse voltage test and care should be taken when reversing polarity. To allow for the discharge of insulating materials, the use of appropriate methods is recommended such as the application of reverse polarity impulses at a lower voltage before the full voltage test is performed.

7.3.2 Short-time current test

A single-phase, short-time current withstand test shall be performed on each G&T device design to demonstrate the thermal withstand capability of all pole components, including the device ground connection system, as follows:

a) The simple manual G&T device shall have one cable connected between the individual terminal farthest from the ground disconnecting device and the ground connection system.
   1) The simple electrical G&T device shall have the power-operated ground-making switch closed, connecting the terminal set to the device ground connection system, with the test on the terminal farthest from the ground disconnecting device.
   2) Each simple G&T device shall be tested once for each terminal set.

b) The complex electrical G&T device shall have the power-operated ground-making switch closed and shall be tested as follows:
   1) With the manually operated terminal selector switch in the "upper" position.
   2) With the manually operated terminal selector switch in the "lower" position.

7.3.2.1 Single phase

The single-phase symmetrical test current shall be no less than the rated short-time current.

7.3.2.2 Test voltage

The test can be performed at any convenient voltage.

7.3.2.3 Time duration

The duration of the current flow shall be no less than 2 s (see 5.4.) The demonstrated level of thermal capability shall be determined by integration of the current envelope over the required time using the method described in IEEE Std C37.09-1979.

7.3.2.4 Connections

The G&T device shall be in the connected position in a test enclosure with the test power source connected between the selected primary terminal and the test enclosure ground bus.

7.3.2.5 Condition after tests

After testing, the G&T device shall meet the following conditions:

a) It shall be capable of being withdrawn from the enclosure and reinserted.
b) The manual G&T device cable and connections shall have no damage detrimental to the operation of the device.
c) The electrical G&T device power-operated ground-making switch shall open and close on command.
d) The terminal selector switch, if provided, shall be able to be moved to all of its positions.
e) All interlocks shall function as designed.

7.3.3 Momentary current test

A three-phase (with either the source or the shorting point grounded, but not both) and a single-phase momentary current test shall be performed on each G&T device design, to demonstrate the mechanical with-

stand capability of the device, including the device ground connection system. All G&T devices shall be tested with a three-phase current source and then again with a single-phase current source connected to the terminal nearest to the ground disconnecting device, as specified below:

a) Each simple manual G&T device terminal set shall be tested. The simple manual G&T device shall have all cables connected from a terminal set to the device ground connection system.

b) The simple electrical G&T device shall be tested with the power-operated ground-making switch closed.

c) The complex electrical G&T device shall be tested with the power-operated ground-making switch closed as follows:
   1) Once with the manually operated terminal selector switch in the "upper" position.
   2) Once with the manually operated terminal selector switch in the "lower" position.

7.3.3.1 Test current

The test current shall be as follows:

a) The peak, rms total, and rms symmetrical current values of the three-phase momentary current shall not be less than those specified in 5.5. The current shall flow through a terminal set to the device ground connection system.

   NOTE—The maximum peak value of the asymmetrical currents is required on only one of the phases.

b) The peak, rms total, and rms symmetrical current values of the single-phase momentary current shall not be less than those specified in 5.5. The current shall flow between the selected primary terminal and the test enclosure ground bus.

7.3.3.2 Test voltage

The test can be performed at any convenient voltage.

7.3.3.3 Test duration

The duration of the current flow shall not be less than 10 cycles (60 Hz basis).

7.3.3.4 Test connections

The G&T device shall be in the connected position in the test enclosure as follows:

a) For the three-phase test, the enclosure ground bus shall be connected to the test station ground.
b) For the single-phase test, the test source shall be connected between the selected primary terminal and the test enclosure ground bus.

7.3.3.5 Conditions after tests

After testing, the G&T device shall meet the following conditions:

a) It shall be capable of being withdrawn from the enclosure and reinserted.
b) The manual G&T device cables and connectors shall have no damage detrimental to the operation of the device.
c) The electrical G&T device power-operated ground-making switch shall open and close on command.
d) The terminal selector switch, if provided, shall be able to be moved to all of its positions.
e) All interlocks shall function as designed.

7.3.4 Close-and-latch current test

A three-phase close-and-latch current test shall be performed on each electrical G&T device design to demonstrate the capability of the power-operated ground-making switch to close into the required current.

7.3.4.1 Peak current values

The peak and rms symmetrical current values of the close-and-latch current capability test shall be as specified in 5.7.

7.3.4.2 Close and latch tests

The close-and-latch current tests shall be performed under the following conditions:

a) The maximum peak value of the three-phase asymmetrical currents is required on only one of the phases.

b) At a voltage no less than the rated maximum voltage divided by the rated voltage range factor K and a current no less than the peak, and rms symmetrical close-and-latch current.

c) At a voltage no less than the rated maximum voltage and a current no less than the peak, and rms symmetrical close-and-latch currents divided by the rated range factor K.

NOTE—Only one test is required if performed at the rated maximum voltage and the required close-and-latch current.

7.3.4.3 Test duration

The duration of the current flow shall be not less than 10 cycles (60 Hz basis).

7.3.4.4 Test connections

The G&T device shall be in the connected position in the grounded test enclosure with the enclosure ground bus connected to the test station ground. The power-operated ground-making switch shall be timed to close so as to meet the current requirements of 7.3.4.1.

7.3.4.5 Control voltage

The power-operated ground-making switch shall be operated at rated control voltage.

7.3.4.6 Conditions after tests

After testing, the G&T device shall meet the following conditions:

a) It shall be capable of being withdrawn from the enclosure and reinserted.
b) The electrical G&T device power-operated ground-making switch shall open and close on command.
c) The terminal selector switch, if provided, shall be able to be moved to all of its positions.
d) All interlocks shall function as designed.

NOTE—Provided that all individual test requirements are met, the tests listed in 7.3.2, 7.3.3, and 7.3.4 can be combined as desired.

7.3.5 Mechanical endurance test

A mechanical endurance test shall be conducted, in any sequence, to demonstrate the operational capability of all G&T devices, including the insertion and withdrawal mechanisms, all interlocks, power-operated ground-making switch, and the terminal selector switch on the complex design, when provided.

7.3.5.1 Enclosure insertion

One G&T device of each design shall be inserted into, and removed from, the test enclosure 250 times.

NOTE—This is a test of the G&T device only. Maintenance or replacement of the test enclosure insertion and withdrawal mechanisms is permitted at any point in the test series.

7.3.5.2 Endurance tests electrical G&T devices

Electrical G&T devices shall be tested in the test enclosure to demonstrate the mechanical endurance capability of the power-operated ground-making switch and mechanism.

a) The number of operations shall be 500 with an operation defined as a closing and opening of the switch.

b) The power-operated mechanism shall be operated at rated control voltage except for five operations each at both the minimum and maximum limits of control voltage.

c) Routine maintenance consisting of lubrication, cleaning, tightening, adjusting, and dressing of contacts is permitted at 250 operations. Replacement of parts is not permitted.

7.3.5.3 Endurance tests manual G&T devices

The test to demonstrate the operational capability of the manually operated terminal selector switch and mechanism, when provided, shall be performed outside of the enclosure. The total number of operations shall be 250 with an operation defined as moving the switch from one terminal position to the neutral position, if provided, then to the other terminal position.

Maintenance is permitted after 125 operations. Replacement of parts is not permitted.

7.3.5.4 Conditions after testing

After testing, the G&T device shall meet the following conditions:

a) The power-operated ground-making switch manually operated terminal selector switch, when provided, shall be functional.

b) All interlocks and control circuits, if provided, shall be functional.

c) The electrical resistance of the primary circuits including the power-operated ground-making switch, and both manually operated terminal selector switch positions, if provided, to the device ground bus shall not exceed 200% of the dc resistance specified by the manufacturer.

7.4 Production tests

Production tests shall be made on each G&T device at the factory after final assembly as described in 7.4.1 through 7.4.4.

7.4.1 Nameplate(s)

Nameplate(s) shall be checked for accuracy and completeness of identification and ratings as specified in 6.5.

7.4.2 Power frequency withstand voltage test

G&T devices shall be tested for the ability to withstand for 1 min, without flashover, the following power frequency sinusoidal test voltages with a crest value equal to 1.414 times the specified values. The test procedures shall be as outlined in 7.3.1.

a) Primary circuits of each G&T device shall be tested at the rated values.

b) Secondary control wiring (except spring charging motors) shall be tested at 1500 V for 1 min or 1800 V for 1 s.

c) Stored energy charging motors shall be tested at their specified dielectric withstand voltage but not less than 900 V.

7.4.3 G&T device operation tests

All G&T devices shall be tested as follows:

a) All interlocking features on the G&T device shall be checked for proper functioning.

b) All G&T devices shall be tested in an enclosure to ensure that all insertion and withdrawal mechanisms and the primary and ground disconnect devices function properly.

c) Operational tests shall be performed on electrical G&T devices as follows:

   1) *On the power-operated ground-making switch:* Five closing and five opening operations each at both the minimum and maximum limits of the control voltage range.

   2) *On the terminal selector switch, when provided:* Five operations between terminal sets, including a neutral position, if provided.

   3) *Control wiring and auxiliary devices, when provided:* These shall be checked to ensure that all connections have been correctly made. Where operation is not feasible, continuity checks are permissible.

7.4.4 Test for the electrical resistance of the current circuit

The dc resistance of the primary current circuits from each terminal of each pole unit, in each position of the terminal selector switch, when provided, to the device ground system shall be measured with at least 100 A flowing in the circuit. The dc resistances shall not exceed the limit specified by the manufacturer.

8. Construction

8.1 General

The construction, insulation materials, bushings, primary disconnects, ground disconnects, secondary disconnects, barriers, contacts, and mechanism shall be adequate to meet the assigned ratings of the G&T device.

8.2 Instructions

Due to the locking/interlocking complexities and design variations, each G&T device shall have basic instructions, warnings, and the like affixed to the front of the device that reference the manufacturer's instruction manual number.

8.3 Cable specifications

When grounding cables with terminal lugs and hardware, needed for connecting the manual G&T device terminal set to the device ground bus, are not supplied with the manual G&T device, the manufacturer shall provide the specifications for them.

8.4 Remote electrical control

For electrically operated G&T devices, a means for remote electrical control shall be provided. When an optional electrical opening release is provided, means shall be provided to prevent instantaneous opening.

9. Application

9.1 General

A G&T device is designed to be temporarily inserted into a circuit breaker compartment to test and/or ground the bus or line circuit. The user should verify that the ratings of the G&T device to be used are no less than the ratings of the circuit breaker that is being temporarily replaced. Special care should be exercised to ensure consistency between the current ratings of the circuit breaker and the G&T device, such as "peak," "rms total," or "rms symmetrical."

CAUTION—Before inserting a G&T device into a circuit breaker compartment, the user should verify that the following G&T device ratings are equal to or greater than those of the circuit breaker being temporarily replaced:

- Rated maximum voltage
- Rated impulse withstand voltage
- Rated power frequency
- Rated short-time current
- Rated momentary current
- Rated control voltage
- Close-and-latch current capability
- Primary disconnecting device compartment compatibility

9.2 Locking and interlocking equipment

It is important that the proper locking and interlocking equipment, covered in 6.4 and incorporated into the G&T device design, is properly utilized by the user to ensure that correct operating sequences are followed.

9.3 Utilization

A G&T device is used to test and/or ground the power circuit during maintenance work. It should be recognized that, due to the inherent complexity and intended use, interlocks alone cannot fully protect the operator against all potential hazards. The operator should be a fully qualified person, specifically trained by the user to completely understand the proper operating procedures of the device as well as all grounding and test procedures.

Some complex electrical G&T devices may be too large to permit the compartment door to be closed or may not operate in the "test" position and special operating procedures may be needed.

9.4 Primary disconnecting devices compartment compatibility

G&T devices do not have a continuous current rating since their only purpose is for grounding and voltage testing. However, the G&T device shall be assigned a primary disconnecting devices compartment compatibility designation (in amperes) to enable the user of the G&T device to determine which primary disconnecting devices are required for a particular compartment.

9.5 Storage and maintenance before use

Ground and test devices are used infrequently and therefore are stored for long periods of time. They should be stored in a clean, dry area, free from dust, dirt, moisture, and the like. However, even though it is assumed that the G&T device was stored properly, it should be carefully inspected and maintained before each use.

The following procedure is recommended before each use of the G&T device. The manufacturers' instruction manuals must be followed for specific guidance.

a) All insulating surfaces, including but not limited to the primary support insulation, voltage probes, and isolation barriers, should be clean and dry.

b) All primary circuits, including cables and connections, should be clean and tight.

c) All primary and ground disconnect contacts (including terminal selector switch, if provided) should be clean, with the correct contacts in place and properly lubricated.

d) The electrical G&T device mechanism(s), including terminal selector switch if provided, should be in proper mechanical and electrical operating condition.

e) All locks and interlocks should be fully functional in accordance with the instruction manual of the G&T device.

f) A 1 min power frequency voltage withstand test should be conducted on the complete G&T device in accordance with 7.4.2, except at 75% of the rated values.

NOTE—Field tests may be conducted with dc voltage sources provided that the instantaneous dc voltage is no more than 1.414 times 75% of the normal frequency withstand ac rms voltage listed in Table 1 of IEEE Std C37.20.2-1993.