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American National Standard (ANSI)

**IEEE Std C37.63-1997**  
(Revision of ANSI C37.63-1984)

# IEEE Standard Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizers for AC Systems

Sponsor

**Switchgear Committee  
of the  
IEEE Power Engineering Society**

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**Abstract:** Required definitions (for cutout type sectionalizers), ratings, procedures for performing design tests and production tests, constructional requirements, and application considerations for overhead and pad-mounted, dry-vault, and submersible automatic line sectionalizers for ac systems are specified.

**Keywords:** sectionalizers, cutout type; sectionalizers, dry-vault; sectionalizers, pad-mounted; sectionalizers, submersible

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## Introduction

(This introduction is not part of IEEE Std C37.63-1997, IEEE Standard Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizers for AC Systems.)

This standard is a revised and updated version of ANSI C37.63-1984 (Reaff 1990), which incorporates significant improvements that reflect the present state of the art in automatic line sectionalizers. These improvements include changes and additions in the following areas:

- a) New cutout type sectionalizers are applied in a distribution cutout mounting.
- b) Safety provisions are now a subclause of application considerations.
- c) The temperature rise table has been split into two tables.
- d) Rating definitions were reviewed for consistency with other standards.
- e) Table 5 was revised for consistency with other standards.

Also included is the recognition of the need for partial discharge tests for some types of sectionalizers. While the procedure and related requirements have not yet been finalized (see 6.7), an effort is under way to develop this information, and it will be published after it has been completed and has gone through the full approval process.

The preparation of IEEE Std C37.63-1997 was the cooperative work of the IEEE Switchgear Committee (Reclosers and Sectionalizer Subcommittee), the National Electrical Manufacturers Association (NEMA) Switchgear Section (SG 13—Automatic Circuit—Reclosers Technical Committee), and the C37 Subcommittee on Automatic Circuit Reclosers and Line Sectionalizers.

Upon recommendation of this latter subcommittee, the proposed American National Standard was voted on by the Standards Committee on Power Switchgear, C37, and was subsequently approved as an American National Standard.

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# IEEE Standard Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizers for AC Systems

## 1. Overview

### 1.1 Scope

This standard applies to all overhead, pad-mounted, dry-vault, and submersible single-pole or multipole alternating current automatic line sectionalizers for rated maximum voltages above 1000 Vac.

In order to simplify the vocabulary of this standard, the term *sectionalizer* has been substituted for *automatic line sectionalizer* wherever possible.

## 2. References

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

ANSI C37.85-1989 (Reaff 1995) American National Standard Safety Requirements for X-Radiation Limits for AC High-Voltage Power Vacuum Interrupters Used in Power Switchgear.<sup>1</sup>

IEEE Std 4-1995, IEEE Standard Techniques for High-Voltage Testing (ANSI).<sup>2</sup>

IEEE Std 386-1995, IEEE Standard for Separable Insulated Connectors for Power Distribution Systems Above 600 V (ANSI).

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

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

<sup>2</sup>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 C37.24-1986 (Reaff 1991), IEEE Guide for Evaluating the Effect of Solar Radiation on Outdoor Metal-Enclosed Switchgear (ANSI).

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

NEMA 107-1988 (Reaff 1993), Methods of Measurement of Radio Influence Voltage (RIV) of High-Voltage Apparatus.<sup>3</sup>

NEMA SG 13-1958, Automatic Circuit Reclosures—Automatic Line Sectionalizers and Oil-Filled Capacitor Switches for Alternating Current Systems.<sup>4</sup>

### 3. Definitions

The definitions of terms contained in this standard or in other standards referred to in this standard are not intended to embrace all legitimate meanings of the terms. They are applicable 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.

A dagger (†) following the definition indicates that while the term is defined in IEEE Std C37.100-1992, the two definitions are not identical.

An asterisk (\*) indicates that at this time this standard was approved, there were no corresponding definitions in IEEE Std C37.100-1992.

**3.1 cutout type sectionalizers:** A single-phase automatic line sectionalizer that is very similar in outward appearance to a distribution open dropout type fuse cutout and is used in a distribution cutout mounting.(\*)

### 4. Service conditions

#### 4.1 Usual service conditions

Sectionalizers conforming to this standard shall be suitable for operation at their standard rating provided that

- a) The temperature of the cooling air (ambient temperature) surrounding the enclosure is not above 40 °C or below –30 °C.
- b) The altitude does not exceed 1000 m (3300 ft).
- c) For submersible units, the water head does not exceed 3 m (10 ft) above the base of the enclosure during occasional submersion. Exposure to chemical or electrochemical reactions may be encountered in a subgrade environment.
- d) The effect of solar radiation is not significant. (The principles stated in IEEE Std C37.24-1986<sup>5</sup> may be used for guidance.)
- e) Unusual service conditions, such as those outlined in 4.2, do not prevail.

<sup>3</sup>NEMA publications are available from the National Electrical Manufacturers Association, 1300 N. 17th St., Ste. 1847, Rosslyn, VA 22209, USA.

<sup>4</sup>This standard was rescinded by the NEMA Switchgear Committee in 1962. Archive copies are available from NEMA.

<sup>5</sup>Information about references is provided in Clause 2.

## 4.2 Unusual service conditions

### 4.2.1 Abnormal ambient temperatures

Sectionalizers may be applied at higher or lower ambient temperatures than specified, but performance may be affected. Special consideration shall be given to these applications.

### 4.2.2 Altitudes above 1000 m (3300 ft)

Sectionalizers that depend on air for their insulating and cooling medium will have a higher temperature rise and lower dielectric withstand capability when operated at higher altitudes above values specified in 4.1b). The values of altitude correction factors are being studied by the Working Group on Common Clauses (Chair, L. V. MacCall) and will be incorporated after approval.

### 4.2.3 Other conditions that may affect design and applications

Where other unusual conditions exist, they should be brought to the attention of those responsible for the manufacture of the equipment.

Examples of such conditions include

- a) Abnormal vibrations, shocks, or tilting
- b) Unusual transportation or storage conditions
- c) Unusual operating duty, frequency of operation, inadequate maintenance, or special insulation requirements
- d) For overhead, pad-mounted, and dry-vault sectionalizers, exposure to damaging fumes or vapors; excessive or abrasive dust; explosive mixtures of dust or gases; salt air; or extreme humidity
- e) For submersible sectionalizers, exposure to tidal water; highly acidic water; water containing abnormal amounts of dissolved road salt or fertilizer; continuous submersion; or stray direct currents

## 5. Rating

### 5.1 Rating information

The rating shall include the following:

- a) Rated maximum voltage
- b) Rated frequency
- c) Rated continuous current
- d) Rated minimum actuating current
- e) Rated symmetrical interrupting (load current switching) current (where designed for this operation)
- f) Rated asymmetrical making current (where designed for this operation)
- g) Rated momentary current, asymmetrical
- h) Rated 1 s current
- i) Rated 10 s current
- j) Rated dielectric withstand voltage
- k) Rated control voltage (where applicable)
- l) Rated cable charging interrupting current (where designed for this application)

## 5.2 Rated maximum voltage

The rated maximum voltage of sectionalizers is the highest rms voltage for which the equipment is designed and is the upper limit for operation. The rated values are the values shown in Table 1, column (2).(\*)

**Table 1—Preferred ratings and performance characteristics of automatic line sectionalizers**

ID no.	Rated maximum voltage	Rated impulse withstand voltage	Power frequency insulation withstand voltage tests <sup>a</sup>		dc 15 min withstand	Current <sup>b</sup>	
			(kV rms)			(Amperes)	
	(kV rms)	(kV crest)	1 min dry	10 s wet	(kV)	Maximum continuous current	Symm. int. (load current switching) rms
Col. (1)	Col. (2)	Col. (3)	Col. (4)	Col. (5)	Col. (6)	Col. (7)	Col. (8)
<b>Single-Phase sectionalizers</b>							
1	15.0	95	35	30	53	200	440
2	15.0	125	42	36	53	200	200
3	15.0	125	42	36	53	200	440
4	27.0	125	60	50	78	200	—
<b>Three-Phase sectionalizers</b>							
5	15.5	110	50	45	53	200	440
6	15.5	110	50	45	53	400	880
7	15.5	110	50	45	53	600	1320
8	38.0	150	70	60	103	400	880
NOTE—For cutout type sectionalizers, the preferred ratings are the same as the distribution cutout mounting in which they are applied.							

<sup>a</sup>These are performance characteristics specified as test requirements in this standard.

<sup>b</sup>See Table 2 for data on current ratings for all continuous current ratings.

## 5.3 Rated frequency

The rated frequency of the sectionalizers is the frequency of the circuit for which the sectionalizer is designed. Ratings are based on a frequency of 60 Hz.(†)

Table 2—Preferred ratings of automatic line sectionalizers

Current ratings (Amperes) <sup>a</sup>										
Line 1 and 3 single-phase sectionalizers <sup>b</sup>			Line 2 and 4 single-phase sectionalizers Line 5 three-phase sectionalizers			Line 6, 7, and 8 three-phase sectionalizers				
Continuous current 60 Hz	Min. act. curr. rms symm. <sup>c</sup>	Momentary and making rms asymm.	1 s rms symm.	10 s rms symm.	Momentary and making rms asymm.	1 s rms symm.	10 s rms symm.	Momentary and making rms asymm.	1 s rms symm.	10 s rms symm.
Col. (1)	Col. (2)	Col. (3)	Col. (4)	Col. (5)	Col. (6)	Col. (7)	Col. (8)	Col. (9)	Col. (10)	Col. (11)
10	16	1600	400	125	1600	400	125	—	—	—
25	40	4000	1000	325	4000	1000	325	—	—	—
35	56	6000	1500	450	6000	1500	450	—	—	—
50	80	6500	2000	650	7000	2000	650	—	—	—
70	112	6500	3000	900	8000	3000	900	—	—	—
100	160	6500	4000	1250	8000	4000	1250	—	—	—
140	224	6500	4000	1800	8000	4000	1800	—	—	—
200	320	6500	4000	2500	9000	5700	2600	—	—	—
400	c	—	—	—	—	—	—	15 000	10 000	3500
600	c	—	—	—	—	—	—	15 000	10 000	3500

NOTE—For line numbers, refer to Table 1.

<sup>a</sup>Line 1, 2, 3, 4, and 5 sectionalizers are series-coil devices. Current ratings are determined by the series-coil or by the maximum rating of the contacts. Line 6, 7, and 8 sectionalizers are non-series-coil units. Current ratings for non-series-coil units and cutout type sectionalizers are determined by the ratings of the contacts only.

<sup>b</sup>For cutout-type sectionalizers, columns (3), (4), and (5) shall be the minimum values. The test will be made on the smallest and largest continuous current rating of the same design.

<sup>c</sup>The minimum actuating current of non-series-coil sectionalizers and cutout type sectionalizers is independent of the continuous current rating. For non-series-coil type sectionalizers, the minimum actuating current can be selected by means of current taps or similar means.

## 5.4 Rated continuous current

The rated continuous currents of sectionalizers is the maximum current in rms amperes at rated frequency that can be carried continuously by the primary circuit components without exceeding the temperature rise limits under the test conditions as specified in Tables 3 and 4. The values of the rated continuous currents are shown in Table 2, column (1).(\*)

**Table 3—Temperature limits for insulating materials as used in automatic line sectionalizers**

Class of insulating material	Limit of observable hottest-spot temperature rise (°C)	Total temperature (°C)
Class 90	50	90
Class 105	65	105
Class 130	90	130
Class 155	115	155
Class 180	140	180
Class 220	180	220
Series coils with over 220 class insulation or bare	No limit	No limit

### 5.4.1 Conditions of continuous current rating

- a) Sectionalizers are used under the usual service conditions defined in 4.1.
- b) Current ratings shall be based on the total temperature limits of the materials used for such parts. A temperature rise reference is given to permit testing at reduced ambient.
- c) Sectionalizers without enclosures shall have ratings based on a 40 °C ambient temperature. Sectionalizers installed in enclosures shall have their ratings based on the ventilation of such enclosures and a 40 °C ambient temperature outside the enclosure.

### 5.4.2 Limits of observable temperature rise

At rated current, the observable hottest-spot temperature rise above ambient, and the maximum temperature of each of the various parts, shall not exceed the temperatures listed in Tables 3 and 4.

**Table 4—Temperature limits for contacts, conducting joints, or bushing terminals when clean and bright as used in automatic line sectionalizers**

Sectionalizer contacts, conducting joints, and other parts <sup>a</sup>	Limits of observable hottest-spot temperature rise (°C)	Total temperature (°C)
Silver to silver in air—spring loaded	65	105
Silver to silver in air—bolted	75	115
Silver to silver in oil	50	90
Copper to copper in air	50	90
Copper to copper in oil	30	70
Copper to aluminum in air	50	90
Copper to aluminum in oil	30	70
Oil 2.5 cm (1 in) below surface (top oil)	45	85
<b>Terminal connections<sup>b</sup></b>		
Sectionalizer contacts, conducting joints and other parts	Limits of observable hottest-spot temperature rise (°C)	Total temperature (°C)
Silver to silver	65	105
Copper to copper	50	90
Copper to aluminum	50	90
<b>NOTES</b>		
<p>1—The temperature limits are being evaluated by the IEEE Switchgear Committee's Working Group on Insulating Materials. The values of the tables will be revised after their recommendations are approved by the IEEE Standards Board.</p> <p>2—Insulation is considered to be impregnated when a suitable substance provides a bond between components of the structure and also a degree of filling or surface coverage sufficient to give adequate performance under the extremes of temperature, surface contamination (moisture, dirt, etc.), and mechanical stress expected in service. The impregnant must not flow or deteriorate enough at operating temperature so as to seriously affect performance in service.</p> <p>3—The electrical and mechanical properties of the insulation must not be impaired by the prolonged application of the limiting insulation temperature permitted for the insulation class. The word <i>impaired</i> is here used in the sense of causing any change that could disqualify the insulating material from continuously performing its intended function, whether it is creepage spacing, mechanical support, or dielectric barrier action.</p> <p>4—In the preceding definitions, the words <i>accepted tests</i> are intended to refer to recognized test procedures established for the thermal evaluation of materials by themselves or in simple combinations. Experience or test data used in classifying insulating materials are distinct from the experience or test data derived for the use of materials in complete insulation systems. The thermal endurance of complete systems may be determined by test procedures specified by the responsible technical committees. A material that is classified as suitable for a given temperature in the preceding may be found suitable for a different temperature, either higher or lower, by an insulation system test procedure. For example, it has been found that some materials suitable for operation at one temperature in air may be suitable for a higher temperature when used in a system operated in an inert gas atmosphere.</p> <p>5—It is important to recognize that the other characteristics in addition to thermal endurance, such as mechanical strength and moisture resistance, are required in varying degrees in different applications for the successful use of insulating materials.</p>		

<sup>a</sup>Contacts or other parts in other than oil or air may be operated at other temperatures providing it can be shown by experience or tests that accelerated deterioration will not occur.

<sup>b</sup>If connections are made to cables, recognition must be given to possible thermal limitations of cable and appropriate measures taken.

#### 5.4.2.1 Classification of insulating materials

For the purpose of establishing temperature limits, insulating materials shall be classified as follows:

- a) *Class 90 Insulation:* Materials or combinations of materials such as cotton, silk, and paper without impregnation. Other materials or combinations of materials may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 90 °C.
- b) *Class 105 Insulation:* Materials or combinations of materials such as cotton, silk, and paper when suitable impregnated or coated or when immersed in a dielectric liquid such as oil. Other materials or combinations of materials may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 105 °C.
- c) *Class 130 Insulation:* Materials or combinations of materials such as mica, glass fiber, etc., with suitable bonding substances. Other materials or combinations of materials, not necessarily inorganic, may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 130 °C.
- d) *Class 155 Insulation:* Materials or combinations of materials such as mica, glass fiber, etc., with suitable bonding substances. Other materials or combinations of materials, not necessarily inorganic, may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 155 °C.
- e) *Class 180 Insulation:* Materials or combinations of materials such as silicone elastomer, mica, glass fiber, etc., with suitable bonding substances such as appropriate silicone resins. Other materials or combinations of materials may be included in this class if, by experience or accepted tests, they can be shown to be capable of operation at 180 °C.
- f) *Class 220 Insulation:* Materials or combinations of materials that by experience or accepted tests can be shown to be capable of operation at 220 °C.
- g) *Over Class 220 Insulation:* Insulation that consists entirely of mica, porcelain, glass, quartz, and similar inorganic materials. Other materials or combinations of materials may be included in this class if, by experience or accepted tests can be shown to be capable of operation at temperatures over 220 °C.

#### 5.5 Rated minimum actuating current

The rated minimum actuating current of sectionalizers is the minimum rms current that actuates a counting operation or an automatic operation and shall be the values shown in Table 2, column (2).(\*)

#### 5.6 Rated symmetrical interrupting (load current switching) current (manual operation only)

The rated symmetrical interrupting (load current switching) current of sectionalizers designed and rated for this operation is the rms value of the current flowing through the sectionalizer at the time of the opening and shall be the values shown in Table 1, column (8).(†)

#### 5.7 Rated making current

The rated making current of sectionalizers designed and rated for this operation is the value of the available rms asymmetrical current at the time of the closing of the sectionalizer and shall be the values shown in Table 2, columns (3), (6), and (9).(†)

NOTE—Cutout type sectionalizers do not have an interrupting mechanism like a fuse, and their close and latch capabilities depend on the skill and speed of the operator. Consult the cutout sectionalizer manufacturer for the capability and application of the device.

### 5.8 Rated momentary current

The rated momentary current of sectionalizers is the rms asymmetrical value of the current flowing through the sectionalizer at the major peak of the maximum cycle as determined from the envelope of the current wave and shall be the values shown in Table 2, columns (3), (6), and (9).(†)

### 5.9 Rated 1 s current

The rated 1 s current of sectionalizers is the value of the highest rms current for which the equipment is designed to carry for one second and shall be the values shown in Table 2, columns (4), (7), and (10).(†)

### 5.10 Rated 10 s current

The rated 10 s current of sectionalizers is the value of the highest rms current for which the equipment is designed to carry for ten seconds and shall be the values shown in Table 2, columns (5), (8), and (11).(†)

### 5.11 Rated dielectric withstand levels

The rated dielectric withstand voltage of sectionalizers comprises of power frequency withstand tests, impulse voltage withstand tests and 15 min dc withstand tests as specified in Table 1, columns (3), (4), (5), and (6). The impulse withstand voltage shall be negative or positive, depending upon which gives the lower insulation strength. The voltage wave shall reach its crest value in 1.2  $\mu$ s and decay to one-half of its crest value in 50  $\mu$ s.(†)

### 5.12 Overload rating

Sectionalizers have no standard overload rating.

NOTE—Sectionalizers are rated at the maximum rms current they can carry continuously, and since they are designed to actuate and trip at a current 1.6 times as great, they may carry an overload for which they are not self-protecting. Information as to the operation in this region should be obtained from the manufacturer.

### 5.13 Rated control voltage and ranges

When measured at the control power terminals of the operating mechanisms with the maximum operating current flowing, rated voltages and their permissible ranges for the control power supply of sectionalizers shall be as shown in Table 5.(†)

**Table 5—Rated control voltages and ranges for sectionalizers**

DC voltage ranges <sup>a, b, c</sup>			AC voltage ranges <sup>d, b, c</sup>	
Rated voltage	Closing and auxiliary functions	Tripping functions	Rated voltage (60 Hz)	Closing, tripping, and auxiliary functions
24 <sup>e</sup>	—	14–28 <sup>f</sup>	Single phase	
48 <sup>e</sup>	38–56	28–56 <sup>f</sup>	120	104–127 <sup>d</sup>
125	100–140	70–140	240	208–254 <sup>d</sup>
250	200–280	140–280	480	416–508 <sup>d</sup>
			Polyphase	
			208Y/120	180Y/104–220Y/127
			240	208–254
			480	416–508
			480Y/277	416Y/240–508Y/292

<sup>a</sup>It is recommended that the coils of closing, auxiliary, and tripping devices that are directly connected continually to one dc potential should be connected to the negative control bus so as to minimize electrolytic deterioration.

<sup>b</sup>Relays, motors, or other auxiliary equipment that functions as a part of the control for a device shall be subject to the voltage limits imposed by this standard, whether mounted at the device or at a remote location.

<sup>c</sup>Sectionalizers in some applications may be exposed to control voltages exceeding those specified here due to abnormal conditions, such as abrupt changes in line loading. Such applications require specific study, and the manufacturer should be consulted. Also, applications of sectionalizers containing solid-state control exposed continuously to control voltages approaching the upper limits of ranges specified herein require specific attention and the manufacturer should be consulted before application is made.

<sup>d</sup>Include heater circuits.

<sup>e</sup>Twenty-Four-Volt or 48 V tripping, closing, and auxiliary functions are recommended only when the device is located near the battery or where special effort is made to ensure the adequacy of conductors between battery and control terminals. Twenty-Four volts as the primary closing source is not recommended. It is suitable for operation of the auxiliary functions such as relays and contactors.

<sup>f</sup>Sectionalizers having self-contained dc control sources shall operate over the range of 85% to 115% of nominal voltage, and Table 5 shall not apply.

### 5.14 Rated cable charging interrupting current (where applicable)

The cable charging interrupting current ratings for sectionalizers having this capability are as given in Table 6.

**Table 6—Preferred cable charging interrupting current ratings**

Rated maximum line voltage (kV)	Cable charging current (rms Amperes)	
	Overhead	Pad-Mounted and submersible
15.5	2	10
27.0	5	25
38.0	5	40

## 6. Design tests

Sectionalizers shall be capable of meeting the design tests described in 6.2 through 6.13, inclusive. Once made, the design tests need not be repeated unless the design is changed so as to modify the performance characteristics of the sectionalizer.

### 6.1 General

#### 6.1.1 Condition of device to be tested

The sectionalizer shall be new and in good condition, and tests shall be applied before the device is put into commercial use.

#### 6.1.2 Mounting of device

The sectionalizer shall be mounted in a manner closely approximating the normal service conditions for which it is designed. If the sectionalizer normally requires control apparatus, the control apparatus shall be connected during the tests. The mounting bracket shall be attached to the sectionalizer during impulse tests.

#### 6.1.3 Grounding of device

All groundable parts of the sectionalizer, and control apparatus where used, shall be grounded by a lead attached to the grounding terminal and other groundable parts in a manner not to decrease the withstand voltage.

#### 6.1.4 Frequency

The frequency of the supply voltage shall be  $60 \text{ Hz} \pm 5\%$ . A sine wave of acceptable commercial standards shall be applied.

#### 6.1.5 Control voltage

The sectionalizer shall perform satisfactorily over the full range of control voltages specified in 5.13.

### 6.2 Insulation (dielectric tests)

Sectionalizers shall be capable of withstanding, without damage to the sectionalizer and associated control apparatus, if any, the following test voltages when tested in accordance with 6.1 and as follows:

#### 6.2.1 Withstand test voltages

- a) Impulse withstand test voltage shall be a  $1.2 \times 50 \mu\text{s}$  voltage impulse, with a crest value as given in Table 1, column (3). At least three positive and three negative impulses shall be applied to the test device. If flashover occurs on only one test during any group of three consecutive tests, nine more tests shall be made. If the sectionalizer successfully withstands all nine of the second group of tests, the flashover in the first group shall be considered a random flashover and the sectionalizer shall be considered as having successfully passed the test. If an additional flashover occurs the sectionalizer shall be considered to have failed. The following tolerances shall apply during these tests, unless otherwise specified.
  - 1) *Design tests.* Sectionalizers shall pass a full-wave  $1.2 \times 50 \mu\text{s}$  voltage impulse with a virtual front time based on the rated full-wave impulse voltage equal to or less than  $1.2 \mu\text{s}$  with a crest

voltage equal to or exceeding the crest value given in Table 1, column (3), and with a time to the 50% value of the crest voltage equal to or greater than 50  $\mu$ s.

- 2) *Conformance tests.* When impulse voltage tests are required for conformance tests, sectionalizers shall be capable of passing a  $1.2 \times 50 \mu$ s full-wave impulse voltage test series with values as specified by the purchaser in accordance with the following: a virtual front time, based on the rated full-wave impulse voltage, equal to or greater than 1.2  $\mu$ s; a crest voltage not exceeding the rated full-wave impulse withstand voltage; and a time to the 50% value of the crest voltage not exceeding 50  $\mu$ s.
- b) Power-Frequency withstand test voltages shall be applied with a crest value equal to 1.414 times the rated power-frequency withstand dry and wet test values given in Table 1 columns (4) and (5), with test duration of 60 s for the dry test and 10 s for the wet test. Wet tests shall be made in accordance with IEEE Std 4-1995. If bushing coordination gaps are used, they shall be retained in place during tests and shall withstand these test voltages. Wet tests shall not apply to sectionalizers utilizing submersible cables and termination.
- c) On sectionalizers using submersible cable connectors, a dc withstand test shall be used in addition to the power-frequency withstand test in b) above. When used the test voltage applied shall be the value given in Table 1, Column (6).

## 6.2.2 Electrical connections

- a) On overhead sectionalizers, electrical connections shall be made by means of bare wire, inserted in each terminal. These bare wires shall project in such a manner as not to decrease the withstand value. Any necessary bends may be made at the terminals. The test lead connections shall be made to the wires projecting from the terminals.
- b) On pad-mounted, submersible, and dry-vault sectionalizers, connections shall be made through a cable termination similar to that for which the sectionalizer was designed. If terminations capable of meeting the specified dielectric voltage are not available, other terminations (bushing or connectors, or both) may be substituted for the purpose of performing these tests.

## 6.2.3 Points of application of test voltage

Tests 1, 2, and 3 in the following subclauses shall be made on multipole sectionalizers. Tests 1 and 2 shall be made on single-pole sectionalizers.

### 6.2.3.1 Test 1

With the sectionalizer closed, and with tanks and groundable parts grounded, the test voltage shall be applied simultaneously to all of the terminals on one side of the sectionalizer.

### 6.2.3.2 Test 2

With the sectionalizer open, the test voltage shall be applied simultaneously to the terminals on one side of the sectionalizer. The other terminals, tanks, and groundable parts shall be grounded. Then, connections shall be reversed and the procedure repeated.

### 6.2.3.3 Test 3

With the sectionalizer closed, the test voltage shall be applied to the middle phase of the sectionalizer. The terminals of the other phases, all tanks and groundable parts, shall be grounded.

## 6.2.4 Temperature

Dielectric tests shall be made at the temperature attained under the conditions of commercial testing.

### 6.2.5 Dielectric test procedures and voltage measurements

The dielectric test procedures and methods of voltage measurement shall be in accordance with IEEE Std 4-1995.

## 6.3 Interrupting tests

The following test procedures shall be followed when testing sectionalizers to verify the capability to interrupt load current, cable charging current, and transformer magnetizing current.

### 6.3.1 Load current interrupting tests

If three-phase tests are made, when testing sectionalizers intended for applications on multigrounded wye system both the source and load neutrals shall be grounded for one-fourth of the unit operations specified in 6.4.1c). Otherwise, for three-phase tests, either the load neutral or the supply shall be grounded, but not both. If single-phase tests are made, a ground shall be placed on the test circuit. When single-phase testing is used for proof of three-phase performance, the test voltage shall be 87% of the corresponding phase-to-phase voltage; opening and closing speeds shall be maintained at levels comparable to those obtained during a corresponding three-phase test. Consideration shall also be given to the possibility of flashover between phases during actual three-phase operation where ionized gases can communicate. This condition could be simulated on single-phase tests with the addition of temporary grounded metal screens or barriers.

Sectionalizers, when designed for load current switching, shall be capable of nonautomatically (manually) interrupting all currents up to and including the rated interrupting currents, as shown in Table 1, column (8), when tested as specified in 6.1, 6.4.1, and as follows:

- a) At a test voltage such that the normal frequency recovery voltage is at least
  - 1) For single-phase sectionalizers, the rated maximum voltage;
  - 2) For three-phase tests on three-phase sectionalizers, the rated maximum voltage;
  - 3) For single-phase tests, to prove three-phase performance on three-phase sectionalizers, 87% of the rated maximum voltage.
- b) At the minimum control voltage for which a sectionalizer is designed.
- c) With either terminal connected to the line conductor unless the line and load terminals are identified on the device.

#### 6.3.1.1 Test conditions

The power factor of the test circuit shall be equal to or greater than 70% lagging. The test circuit shall consist of at least 10% series resistance and inductive reactance having an  $X/R$  ratio of two or more, with the remaining impedance consisting of parallel connected resistance and inductive reactance, as shown in Figure 1(a) or Figure 1(b).

#### 6.3.1.2 Test procedure

Power shall be applied to the sectionalizer in the closed position. After the closing transient has subsided, the sectionalizer shall be opened by means of the manual operating handle, or by means of the shunt-trip coil if the sectionalizer is so equipped.

Representative oscillographic records shall be obtained of the device performance on each different test circuit.

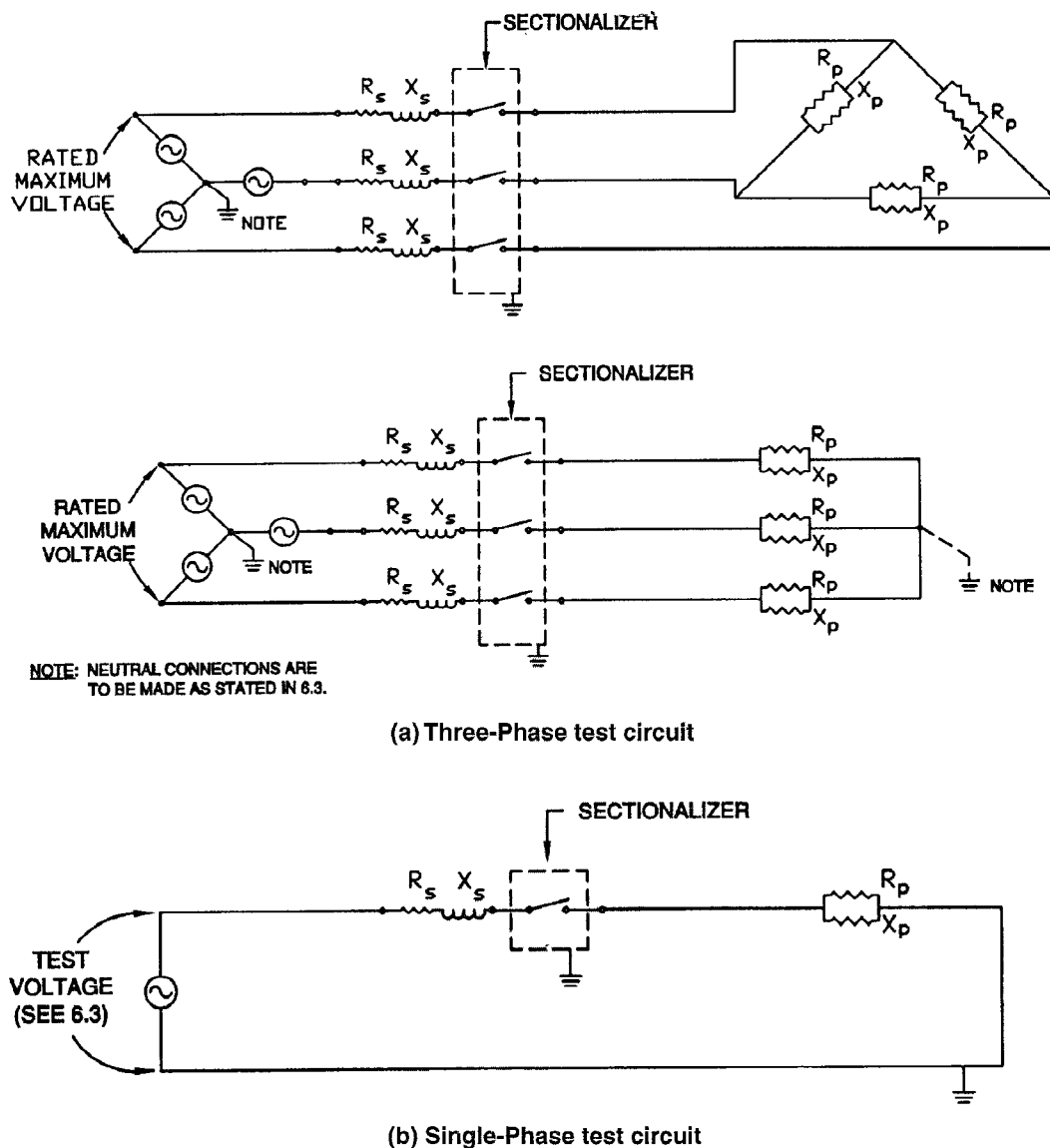


Figure 1—Load break interrupting test circuits (load current switching)

### 6.3.2 Cable charging current-interrupting test

Sectionalizers that are rated for operation on grounded wye cable circuits shall be capable of interrupting the charging current of unloaded lengths of single-phase shielded cable. (Not all sectionalizers have this capability.) The purpose of this test is to demonstrate the capability of interrupting the capacitive switching current rating of the sectionalizer.

#### 6.3.2.1 Test conditions

The test circuit for cable charging currents shall be as shown in Figure 2. This circuit will simulate an unloaded shielded cable with the shield grounded.

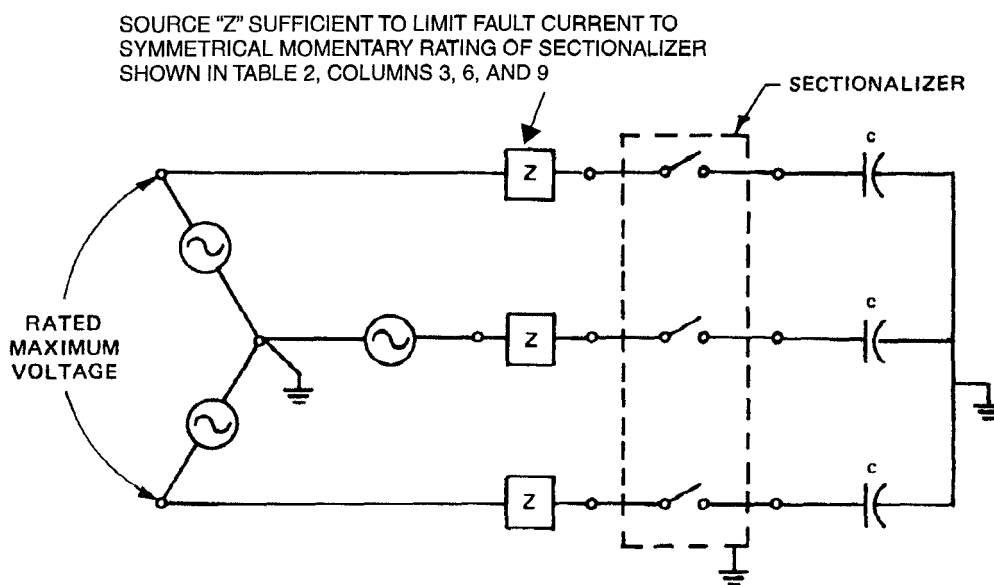


Figure 2—Cable charging current interrupting test circuit

If it can be shown that there is no phase-to-phase interaction during three-phase operation, single-phase tests may be used to demonstrate three-phase performance. If single-phase tests are run, the tests shall be made at the phase-to-neutral voltage corresponding to the rated maximum voltage, as shown in Table 1, column (2).

Tests on single-phase sectionalizers shall be made at the phase-to-neutral voltage corresponding to the rated maximum voltage, as shown in Table 1, column (2).

### 6.3.2.2 Test procedure

With the source terminal of the sectionalizer energized, the sectionalizer shall be closed. After the closing transient has subsided, the sectionalizer shall be opened by means of the manual operating handle, or by means of the shunt trip, if the sectionalizer is so equipped. At least 20 randomly timed close-open operations shall be performed, if three-phase tests are run, and at least 60 randomly timed close-open operations shall be performed if single-phase tests are run.

### 6.3.2.3 Performance

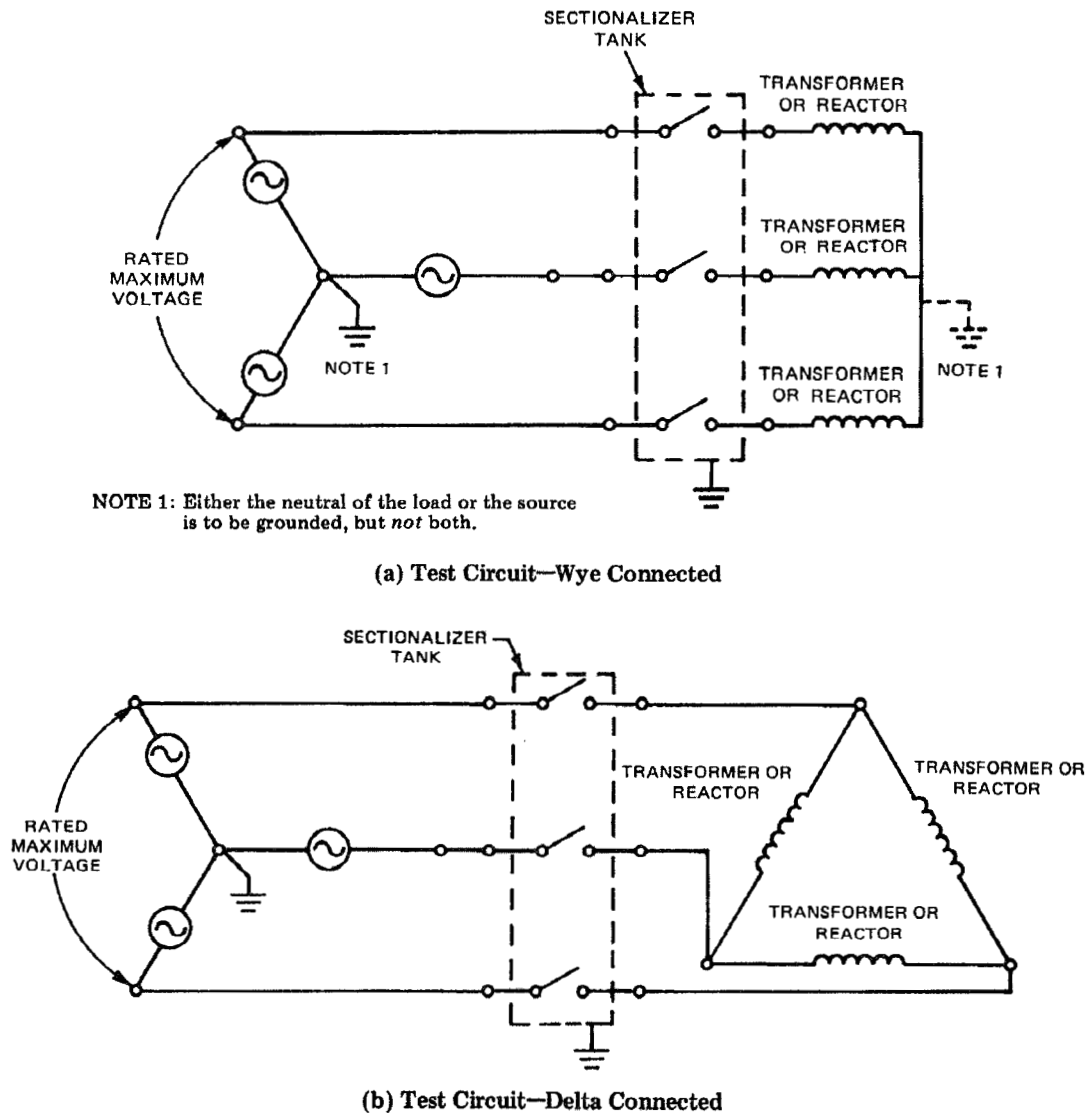
Sectionalizer performance is acceptable if it successfully interrupts the required capacitive currents. The maximum transient overvoltage produced during the tests shall not exceed 2.5 times the peak line-to-ground voltage, measured from the sectionalizer source and load terminals to ground.

## 6.3.3 Transformer magnetizing current interruption test

Sectionalizers shall be capable of interrupting magnetizing currents equal to 3.5% ( $\pm 0.5\%$ ) of the continuous current of the sectionalizer.

### 6.3.3.1 Test conditions

The test circuit for transformer magnetizing current interruption shall be as shown in Figure 3(a) or 3(b).



**Figure 3—Magnetizing current test circuits**

If it can be shown that there is no phase to phase interaction during three phase operation, single-phase tests may be used to demonstrate three-phase performance. If single-phase tests are run, the tests shall be made at 87% of the rated maximum voltage, as shown in Table 1, column (2).

Tests on single-phase sectionalizers shall be made at the rated maximum voltage of the sectionalizer.

### 6.3.3.2 Test procedure

With the source terminal of the sectionalizer energized, the sectionalizer shall be closed. After the closing transient has subsided, the sectionalizer shall be opened by means of the manual operating handle, or by means of the shunt trip, if the sectionalizer is so equipped. At least 20 randomly timed close-open operations shall be performed.

### 6.3.3.3 Performance

The performance of the sectionalizer is acceptable if it successfully interrupts the required magnetizing current.

## 6.4 Standard operating duty tests

The standard operating duty shall consist of the following tests made without maintenance in the order named on the same sectionalizer of the highest continuous current rating of a design. These tests shall prove conformance with these standards for all lower current ratings of this design.

### 6.4.1 Operating duty tests for load-interrupting sectionalizers

For sectionalizers designed to interrupt load current, the standard operating duty shall consist of the following:

- a) Twenty automatic lockout operations at rated maximum voltage and actuated by a current whose symmetric value is equal to the rated 1 s current (five operations each at one- and two-shot lockout and 10 at three-shot lockout).
- b) Eighty automatic lockout operations actuated by a current whose symmetric value is equal to the rated 1 s current supplied from a low-voltage source. The shots to lockout shall be such as to give 50% three-shot lockout. The remaining 50% may be divided between one- and two-shot lockout. Tests shall show that the isolating time from current cessation to sectionalizer contact parting does not exceed 0.25 s.
- c) Fifty nonautomatic operations at rated maximum voltage making and interrupting the rated continuous current. A sufficient time interval should be used between non-automatic operations to prevent the formation of excessive pressures. The power factor of the test circuit shall be as specified in 6.3.1.1.
- d) Sufficient nonautomatic closing operations, to obtain one operation with 90% asymmetry. This test shall be made at rated maximum voltage, with a circuit capable of a current equal to the rated momentary current. For three-phase sectionalizers this test shall be made on a three-phase basis.
- e) One nonautomatic opening operation at rated maximum voltage interrupting the rated (load current switching) interrupting current specified in 5.6. The power factor of the test circuit shall be as specified in 6.3.1.1.

### 6.4.2 Operating duty tests for nonload interrupting sectionalizers

For sectionalizers not designed to interrupt load current the standard operating duty shall consist of the following:

- a) Automatic operations as specified in 6.4.1a) and b)
- b) Nonautomatic closing operations as specified in 6.4.1d)

### 6.4.3 Operating performance

Sectionalizers shall meet the automatic and nonautomatic duties specified without emitting flame or oil.

### 6.4.4 Condition after standard operating duty tests

At the end of the standard operating duty tests, the sectionalizer shall be in the following condition:

- a) *Mechanical*. Substantially in the same mechanical condition as at the beginning except that the contacts may show some sign of arc pitting.
- b) *Electrical*. Capable of withstanding rated maximum voltage in the open position and of carrying rated continuous current at rated maximum voltage but not necessarily without exceeding rated temperature rise in the closed position.

### 6.4.5 Interpretation of standard operating duty tests

After the series of operations equivalent to the standard operating duty, it is not to be inferred that the sectionalizer can again meet its rating without being inspected, and if necessary, repaired.

## 6.5 Making and momentary current tests

The test to prove the capability to meet the rated making and momentary current as given in 5.7 and 5.8 shall be the requirement 6.4.1d). The value of momentary current shall be determined from the envelope of the current wave and shall be the rms value, including the direct-current component, if present, at the major peak of the maximum cycle. The test period shall extend for not less than 10 cycles. Determine the magnitude of current in accordance with IEEE Std C37.09-1979.

For cutout type sectionalizers, the test will be made on the smallest and largest current rating of the same design.

## 6.6 Minimum actuating current tests

Sectionalizers shall meet the rated minimum actuating current within the specified limits of  $\pm 10\%$  when tested as specified in 6.1 and as follows.

### 6.6.1 Test circuit

The sectionalizer shall be connected to a low-voltage power source of alternating current in series with a means for increasing the current and of delivering successive current impulses to cause operation of the counting mechanism.

### 6.6.2 Test procedure

The sectionalizer, set for one shot lockout, shall be subjected to sufficient current impulses to verify that it does not operate below 90% but does operate at 110% of minimum actuating current.

## 6.7 Partial discharge tests

(This section is presently being studied by committees and will be published when available.)

## 6.8 Radio influence voltage (RIV) tests

When the primary conductor insulation consists of self-restoring dielectric such as porcelain, oil, or gas (including air), the RIV test shall be made if the partial discharge test is not made. Sectionalizers shall meet the RIV limits when tested in accordance with 6.1 and as in the following subclauses.

### 6.8.1 Test voltages and limits

The test voltages and limits of conducted radio influence voltage when tested at 1000 kHz shall be as specified in Table 7.

### 6.8.2 Test conditions

#### 6.8.2.1 Proximity of other apparatus

No other grounded or ungrounded object or structure (except mounting structure when required) shall be nearer any part of the sectionalizer or its terminals undergoing test than three times the longest overall dimension of the test piece with a minimum allowable spacing of 0.9 m (3 ft).

Where space requirements under test conditions do not permit the above clearances to be maintained, the test shall be considered as satisfactory if the limits of radio influence voltage obtained are equal to or less than

**Table 7—Test voltages and limits of conducted radio influence voltage**

Rated maximum voltage (kV)	60 Hz test voltage (kV)	Limit of RIV microvolts at 1.0 MHz
15.0–15.5	9.4	500
27.0	16.4	650
38.0	23.0	650
<p>NOTES</p> <p>1—In the case of sectionalizers having voltage ratings not covered by this table, the test shall be made at 105% of the line to neutral voltage, based on the rated maximum voltage.</p> <p>2—Sectionalizers having two or more voltage ratings shall be treated on the basis of the highest voltage rating given on the nameplate.</p>		

those specified in 6.8.1. In such cases a record should be made of the object, structures, etc., and their distances from the sectionalizer under test; these data are to be kept for future use.

#### 6.8.2.2 Oil-Filled sectionalizers

The tanks of oil-filled sectionalizers shall be filled with the prescribed amount of oil.

#### 6.8.2.3 Electrical connections

Conductors of the largest size intended for use with the sectionalizer under test shall be connected to each terminal. The length of the conductors, when used, shall be equal to or greater than the longest overall dimension of the sectionalizer except that the length need not exceed 1.8 m (6 ft). The free end of any such conductor shall terminate in a sphere having a diameter of twice the diameter of the conductor  $\pm 10\%$  or shall be shielded in some other suitable manner to eliminate the effect of the end of the conductor as a source of radio influence voltage.

#### 6.8.2.4 Ambient radio noise

Tests may be made under conditions prevailing at the time and place of test. However, it is recommended that tests be avoided when the radio influence voltage of the test equipment (including the influence voltage of irrelevant electrical devices) exceeds 50% of the radio influence voltage of the sectionalizer to be tested.

#### 6.8.2.5 Atmospheric conditions

Since the effects of humidity and air density upon radio influence voltage are not definitely known, no correction factors are recommended for either at the present time. However, it is recommended that barometric pressure and dry and wet bulb thermometer readings be recorded so that, if suitable correction factors should be determined, they could be applied to previous measurements.

#### 6.8.3 Test equipment and procedure

The equipment and general method used in making radio influence voltage tests shall be in accordance with the recommendations of NEMA 107-1988.

### **6.8.3.1 Procedure**

Tests shall be made with the sectionalizer in the closed and open positions. When tests are made with the sectionalizer in the open position, the radio influence voltage shall be determined with the pole or group of poles not connected to the measuring apparatus both grounded and ungrounded.

### **6.8.3.2 Tests on multipole devices**

In the case of multipole sectionalizers, one pole or terminal or groups of the same may be tested at one time.

### **6.8.3.3 Tests on assembled apparatus**

In the case of assembled equipment, the test shall be made without removing any component part, and the test voltage shall be determined by the lowest rated voltage of any component part. The limiting radio influence voltage shall be identical with the highest value fixed for any of the component parts that determine the test voltage.

### **6.8.3.4 Precautions**

The following precautions shall be observed when making radio influence tests:

- a) The sectionalizer should be at approximately the same temperature as the room in which the tests are made.
- b) The sectionalizer should be dry and clean.
- c) The sectionalizer should not have been subjected to dielectric tests within 2 h prior to the radio influence voltage tests.
- d) In some cases it may be found that the radio influence voltage falls off after the 60 Hz voltage has been applied for a short time. In such cases, it may be desirable to pre-excite the sectionalizer at normal operating voltage for a period not exceeding 5 min before proceeding with the tests.

## **6.9 Short-Time current tests**

Sectionalizers shall carry the rated short-time currents as given in Table 2, columns (4), (5), (7), and (8) for one counting operation only.

For cutout type sectionalizers, the test will be made on the smallest and largest current rating of the same design.

### **6.9.1 Determination of 1 s and 10 s currents**

The value of current may be determined by measurement of the steady-state current with an ammeter where the circuit characteristics are such that there is no decay in current value after the initial transient. Where the current in the circuit continues to decay after the initial transient, measurement shall be made by means of an oscillograph. The device shall be considered to have been properly tested if the integrated heating equivalent of the 1 s or 10 s rating has been obtained. A specific test voltage is not required; however, the voltage must be sufficient to maintain the test current for the specified time. Single-Phase tests are acceptable for three-phase sectionalizers.

### **6.9.2 Condition after test**

There shall be no visible damage to the device after the tests have been completed. However, the tests may result in some visual evidence of the device having passed current, such as slight contact markings. When this occurs, rating shall be considered met when the device will withstand repeated mechanical operations

without cumulative damage and is capable of carrying its rated continuous current without exceeding the temperature limits specified for the device being tested.

## 6.10 Surge current test—Series coil sectionalizers

A sectionalizer shall be capable of withstanding two current surges of 65 000 A crest having a  $5 \times 10 \mu\text{s}$  wave shape.

### 6.10.1 Test conditions

If a coil bypass device is required, it shall be mounted in the sectionalizer in the same manner as furnished for normal service. The leads from the high-current impulse generator shall be connected to the same terminals of the sectionalizer.

### 6.10.2 Test procedure

Two current surges of the specified current value shall be applied.

Following this test the sectionalizer shall be tested at the minimum actuating current so as to cause it to go through one automatic operation to lockout.

### 6.10.3 Condition after test

At the end of the test the sectionalizer and the coil bypass device shall be in the following condition:

- a) *Mechanical.* Substantially in the same mechanical condition as at the beginning except for minor arc scars on any gap electrodes of the coil bypass device. There shall be no indication of external flash-over of the coil bypass device, from the terminals of the coil bypass device to any other parts of the sectionalizer or of the series coil of the sectionalizer.
- b) *Electrical.* With the coil bypass connected in its normal operating position, the sectionalizer shall be capable of withstanding rated maximum voltage in the open position and, in the closed position, of functioning correctly on overcurrent to go through its counting cycle to lockout at the minimum actuating current.

## 6.11 Temperature rise test

The sectionalizer shall meet the conditions of continuous current rating and limits of observable temperature rise as specified in 5.4.1 and 5.4.2, respectively, when tested as specified in 6.1 and as in the following sub-clauses.

### 6.11.1 Test conditions

The device shall be mounted in a closed room substantially free from air currents other than those generated by heat from the device being tested.

### 6.11.2 Electrical connections

The sectionalizer shall have a bare conductor connected to each terminal having a minimum length of 1.2 m (4 ft), specified for the sectionalizer being tested, as given in Table 8 for sectionalizers with bushings designed for connection to bare conductors. The connection shall be made to the ends of these conductors.

For sectionalizers with separable cable connection bushings, the connecting conductors shall have a minimum length of 1.2 m (4 ft) and shall be of aluminum with sizes as shown in Table 9 (or equivalent).

**Table 8—Size of bare copper leads**

Rated continuous current (Amperes)	Size of leads
Up to 50	AWG No 6 solid
70–100	AWG No 2/0 stranded
140–200	AWG No 4/0 stranded
280	125 mm <sup>2</sup> (250 000 cmil)
400	200 mm <sup>2</sup> (400 000 cmil)
560	300 mm <sup>2</sup> (600 000 cmil)
800	500 mm <sup>2</sup> (1 000 000 cmil)
1120	1000 mm <sup>2</sup> (2 000 000 cmil)

**Table 9—Size of aluminum cable leads**

Rated continuous current (Amperes)	Size of leads
200	AWG No 4/0 stranded
560	500 mm <sup>2</sup> (1 000 000 cmil)

### 6.11.3 Test procedure

The rated continuous current of a sectionalizer at rated frequency shall be applied continuously until the temperature becomes constant. The temperature shall be considered constant when three consecutive values of temperature rise taken at one-half hour intervals at all points where readings are being taken shows a maximum variation of one degree. All temperature determinations shall be made as in the following subclauses.

#### 6.11.3.1 Method of temperature determination

This method consists of the determination of the temperature by thermocouples applied to the hottest part of the apparatus.

#### 6.11.3.2 Value of ambient temperature during test

- a) The ambient temperature shall be taken as that of surrounding air, which should not be less than 10 °C nor more than 40 °C.
- b) No correction shall be applied for variations in ambient temperature within the range specified in a).
- c) Temperature tests may be made at ambient temperatures outside the range specified, if suitable and agreed upon correction factors are available.

#### 6.11.3.3 Determination of the ambient temperature

##### 6.11.3.3.1 Placing of thermocouples

The ambient temperature shall be determined by taking the average of the readings of three thermocouples (thermometers) placed 30 cm (12 in) to one side of the device and vertically located as follows:

- a) One thermocouple 30 cm (12 in) above the device,
- b) One thermocouple 30 cm (12 in) below the device, and
- c) One thermocouple midway between the above two positions.

#### 6.11.3.3.2 Use of oil cup

To avoid errors due to the time lag between the temperature of apparatus and the variations in the ambient temperature, all reasonable precautions shall be taken to reduce these variations and the errors arising therefrom. Thus, when the ambient temperature is subject to such variations that error in taking the temperature rise might result, the thermocouple for determining the ambient temperature should be immersed in a suitable liquid (such as oil) in a suitable heavy cup. A convenient form for such an oil cup consists of a metal cylinder with a hole drilled partly through it. This hole is filled with oil and the thermocouple is placed therein. The response of the thermocouple to various rates of temperature change will depend largely upon the size, kind of material, and the mass of the containing cup and may be further regulated by adjusting the amount of oil in the cup. The larger the apparatus under test, the larger the metal cylinder employed as an oil cup in the determination of the cooling temperature should be. The smallest size of oil cup employed in any case shall consist of a metal cylinder, 2.5 cm (1 in) in diameter and 5 cm (2 in) high.

### 6.12 Mechanical operation test

The sectionalizer shall meet the conditions of environment and mechanical duty when tested in accordance with 6.1 and in the following subclauses.

#### 6.12.1 Mechanical duty test

The sectionalizer shall be subjected to 500 automatic lockout operations without maintenance. The interval between operations shall be the shortest allowed by the reset time of the counting mechanism.

#### 6.12.2 Cold temperature test

A sectionalizer shall be tested for proper operation and reset at the lowest temperature for which it is designed. After the sectionalizer has come to a steady temperature, it shall be operated as in 6.6.1 with the control set for 1, 2, and 3 shots to lockout. Heater performance shall be verified during this test.

NOTE—The cutout type sectionalizer is used in a distribution cutout mounting. Consult the cutout type sectionalizer manufacturer for applications under icing conditions.

### 6.13 Control elements surge withstand capability tests

Control elements supplied with sectionalizers shall withstand, without damage, voltage surges originating in the low-voltage energy source, in the current or voltage transformers connected to the control elements, or both, or in the control leads connecting the sectionalizer and the control elements. Either of the tests described in 6.13.1 or 6.13.2 may be used to demonstrate this capability.

#### 6.13.1 Oscillatory surge tests

The test wave for this test shall be oscillatory, with a frequency of 1.0 MHz to 1.5 MHz, a crest value of 2.5 kV to 3.0 kV occurring in the first half cycle, decaying to 10% of the crest value of the first peak in not less than 6  $\mu$ s. The source impedance of the surge generator used to produce the test wave shall be 150  $\Omega$ .

#### NOTES

1—All voltage and time values refer to the open circuit condition of the surge generator.

2—Time period and repetition rate have been chosen to cover equipment which is used on 50 Hz as well as 60 Hz systems.

### **6.13.1.1 Test procedure**

The test wave shall be applied to those control element terminals used to connect the control elements to all instrument transformers, sources of energy, and any other connected element external to the control cabinet, and shall be applied between each pair of terminals and between each terminal and ground. During these tests, the sectionalizer and control elements shall be connected for normal operation and shall be energized at rated voltage.

### **6.13.2 Simulated surge arrester operation test**

This test simulates a surge arrester operation and the resulting voltage changes that appear on the sectionalizer and control elements due to the rate of current change and the impedance of the ground connection.

#### **6.13.2.1 Test procedure**

A gap connected from one source bushing terminal to the sectionalizer ground lead shall be used to simulate a surge arrester. See Figure 4(a). The gap shall be set to flashover at 80% ( $\pm 10\%$ ) of the rated impulse withstand voltage of the sectionalizer on which the control element is to be applied. The surge voltage shall rise to flashover in 1.2  $\mu\text{s}$  ( $\pm 0.5 \mu\text{s}$ ). The external surge generator current limiting resistance shall be chosen in order to provide a surge current following the gap flashover having a peak value of 7000 A ( $\pm 10\%$ ).

The sectionalizer ground lead shall be 6 m (20 ft) of AWG No 12 copper wire. The control cable shall be of equal length and spaced 15 cm (6 in) from and run parallel to the sectionalizer ground lead.

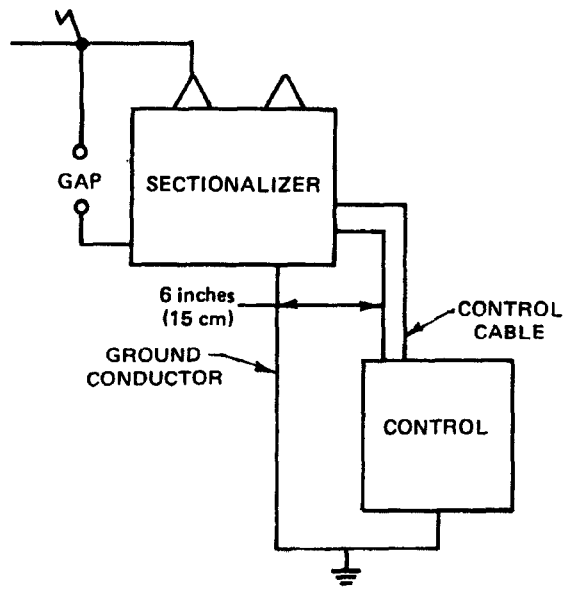
Fifteen positive and fifteen negative surges shall be applied to the source bushing with the sectionalizer open. Fifteen positive and fifteen negative surges shall be applied to the load bushing with the sectionalizer closed.

The above tests shall also be applied to a properly rated transformer connected as shown in Figure 4(b). Fifteen positive and fifteen negative surges shall be applied.

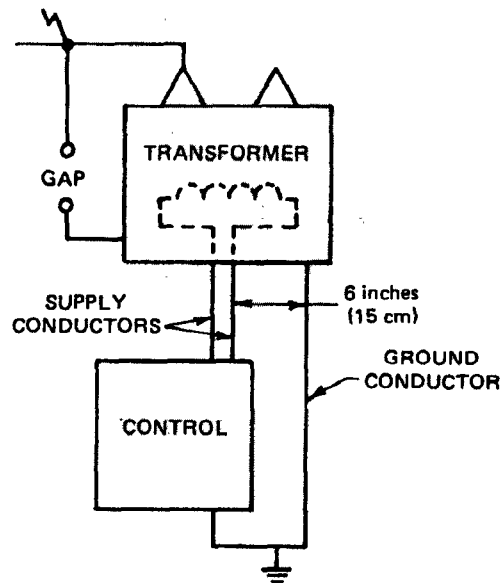
### **6.13.3 Condition of control during and after test**

The control shall not cause the sectionalizer to open or close during the application of surges.

Following the tests, the sectionalizer and control apparatus shall be capable of performing all of its normal functions without impairment.



(a) Control element with sectionalizer



(b) Control element with transformer

Figure 4—Surge withstand test circuits—Control

## 7. Production tests

All applicable production tests shall be made by the manufacturer on each sectionalizer or representative sample, at the factory after final assembly. Production tests shall include the following:

- a) Calibration
- b) Control secondary wiring, and accessory device test
- c) Dielectric withstand test—1 min dry power frequency
- d) Mechanical operation test
- e) Leak test—submersible sectionalizers only

### 7.1 Counting and overcurrent trip calibration

Sectionalizers shall be subjected to the following calibration tests. Calibration may be performed on the individual control element subassembly prior to final assembly on the sectionalizer. When the latter is done, the complete assembly shall be tested to assure that the control elements will operate the sectionalizer. Sinusoidal wave shape, 60 Hz current at a convenient voltage shall be used. The calibration may be performed in any order deemed appropriate by the manufacturer.

- a) Minimum actuating current test (6.6)
- b) Automatic operation tests to assure proper counting when set for 1, 2, or 3 counts
- c) Remote features
- d) Special features

### 7.2 Control, secondary wiring, and accessory devices check tests

Control, secondary wiring, and accessory devices shall be checked to ensure all connections have been made correctly. Devices and relays, if needed, shall be checked by actual operation where feasible. Those circuits for which operation is not feasible shall be checked for continuity.

### 7.3 Dielectric withstand test—1 min dry power frequency

The test shall be conducted in accordance with 6.2.1b). The duration of the test may be 1 s if a voltage of 20% above that specified in 6.2.1b) is used.

### 7.4 Mechanical operation tests

- a) Inspection of the external parts.
- b) Manual tripping by the tripping lever.
- c) Sufficient consecutive operational tests without trouble or malfunction, to check performance of the operating mechanism. These tests shall include electrical or manual closing and tripping of the sectionalizer, or both, as applicable.

### 7.5 Leak test

A suitable leak test shall be performed on submersible sectionalizers to ensure that these will operate under service conditions as outlined in 4.1c).

## 8. Construction requirements

### 8.1 Tank construction

- a) The tank and all appurtenances shall be made of corrosion-resistant material or provided with an impact and corrosion-resistant finish and should also be suitable for storage in uncovered areas.
- b) No external portion of the tank or accessories shall trap and hold water.
- c) Tank support rails shall extend entirely across the bottom of the tank to increase protection and to provide a firm stable support. The support shall include provision for anchoring the tank (submersible or dry-vault sectionalizers only).
- d) Lifting lugs shall be provided and so positioned that the sectionalizer will remain level when being lifted. They shall be designed and located on the tank to avoid interference between lifting slings and any attachments (bushings, operating handles, etc.) and to avoid scratching or marring the tank finish during handling.
- e) Tank construction shall be such that leaks will not occur and the sectionalizer will remain mechanically operable at the maximum operating pressure generated by the normal operation of the sectionalizer, for example, temperature rise, load interrupting, and fault closing.

### 8.2 Grounding provisions

A sectionalizer with a metal housing shall have provisions for the connection of a ground lead.

The grounding connector shall accommodate a ground conductor of a size adequate to conduct the rated 1 s current of the sectionalizer for a period of 3 s without damage to the conductor or connector.

Pad-Mounted, dry-vault, and submersible sectionalizers shall have an additional grounding connection for each three-phase set of cable entrances.

### 8.3 Insulating medium quantity indicators (submersible sectionalizers)

Where liquid or gas is used as the insulating medium, provision shall be made for personnel to determine readily the insulating liquid level or insulating gas pressure with the sectionalizer energized. Indicator markings shall show the safe operating range of levels or pressures. Procedures or devices that require exposing the insulating medium to the outside environment shall not be used.

### 8.4 Oil sampling provisions (submersible sectionalizers)

When oil is used as an insulating medium, provision shall be made to obtain a bottom oil sample.

### 8.5 Manual operating provision

Sectionalizers shall be provided with a manual operating lever that is suitable for operation with a hot line stick, or other suitable manual operating means.

#### 8.5.1 Submersible or dry-vault sectionalizer

The operating handle on a submersible sectionalizer shall be located such that one worker standing on the surface can operate it without standing directly over the sectionalizer.

### 8.5.2 Pad-Mounted sectionalizers

Pad-Mounted sectionalizers with draw-out provisions shall include an interlock that requires manual tripping of the sectionalizer before the primary connection can be disengaged.

### 8.6 Position indicator

Sectionalizers shall be provided with a position indicator, or other suitable means that clearly indicates its closed or open position, that shall be visible from the surface. For pad-mounted, submersible, or dry-vault sectionalizers viewing of the position indicator may require opening of the enclosure. If colors are used to indicate an open or closed position, red shall signify closed and green shall signify open, with the words *open* or *closed* in contrasting colors.

### 8.7 Nameplate markings

The following minimum information shall be given on the nameplate:

- a) Manufacturer's name and address
- b) Manufacturer's type or identification number to indicate the design or construction. Changes in operating characteristics, design, or construction that affect its application or service shall be accompanied by a change in the identification data.
- c) Rated maximum voltage
- d) Rated continuous current
- e) Rated minimum actuating current
- f) Rated symmetrical load switching current
- g) Rated impulse withstand voltage
- h) Rated frequency
- i) Serial number

For submersible sectionalizers, a nameplate of stainless steel or other corrosion-resistant material shall be provided. The nameplate shall be securely attached to the top of the tank by means of stainless steel screws, rivets, or other corrosion-resistant fasteners. All letters, schematics, and numbers shall be permanently stamped, embossed, or engraved on the nameplate.

### 8.8 Stored energy mechanism charge indicator

When indicators are used on stored energy operating mechanisms, the following colors should be used:

- a) Yellow background with charged in black letters for charged mechanism.
- b) White background with discharged in black letters for discharged mechanisms.

### 8.9 Separate mounting of control apparatus

Where applied, control apparatus shall be capable of being mounted separately from the sectionalizer in normal service.

### 8.10 Counters

If an operations counter is provided, it shall indicate the total number of tripping operations of the sectionalizer. The counter shall be visible with the sectionalizer in service.

### **8.11 Conductor terminal sizes**

For connection of bare conductors, bushing terminals shall accommodate conductors of a size adequate to conduct the rated continuous current of the sectionalizer without exceeding a temperature rise shown in 5.4.2.

For submersible sectionalizers, bushings shall accommodate cable terminations in accordance with IEEE Std 386-1995.

### **8.12 Vacuum interrupters**

Where vacuum interrupters are used, they shall be in accordance with ANSI C37.85-1989. X-radiation generated shall not exceed the value in Table 1 of that standard.

## **9. Application considerations**

### **9.1 Safety provisions**

(This paragraph is being studied by committee and will be published when completed.)