ANSI C119.0-2015

American National Standard for Electric Connectors— Testing Methods and Equipment Common to the ANSI C119 Family of Standards

Secretariat:

National Electrical Manufacturers Association

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Foreword (Neither this foreword nor any of the informative annexes is a part of American National Standard C119.0-2015.)

This standard describes electrical and mechanical tests that are common to the ANSI C119 family of standards, which are used to establish performance characteristics of connectors used to join aluminum-to-aluminum, aluminum-to-copper, or copper-to-copper bare and insulated conductors.

This document is the first publication of the ANSI C119.0 standard. It is not intended to be used in isolation from the other publications in the ANSI C119 family of product standards. It is intended that other ANSI C119 standards will make reference to C119.0 where a standardized test technique or procedure is required[1]. Consequently, there might be parts of ANSI C119.0 that do not fit coherently with the rest of the sections in the C119.0 document but are pertinent to the requirements of the other standards in the ANSI C119 family.

Included within the ANSI C119.0 standard:

a) Recommendations and requirements for instrumentation and equipment used for performing tests common to the ANSI C119 family of standards.

b) Two optional tests that were previously part of ANSI C119.4-2011: Optional Fault Current Test (Annex B) and Optional Corrosion Test (Annex C). The subcommittee has provided these optional performance tests as references in response to users who have requested guidance for these types of additional performance tests.

c) An alternate, accelerated current cycle test method, henceforth referred to as the current cycle submersion test (CCST). The CCST method differs from the traditional current cycle test (CCT) in that test conductors are rapidly cooled by immersion in chilled water at the beginning of the "current-OFF" cycle, and the test requires fewer total current-ON and current-OFF cycles. Comparative testing has demonstrated that the CCST method will provide essentially the same performance test results as the traditional CCT in fewer test cycles.

The techniques and methods presented in this standard were initially developed under the direction of the Transmission and Distribution Committee of the Edison Electric Institute (EEI). Tentative performance-type specifications for electrical characteristics were issued in joint report form in 1958 by a steering committee of EEI and an advisory committee of manufacturers on the aluminum conductor research project (EEI Pub. No. 59-70, *Tentative Specifications for Connectors for Aluminum Conductors*).

Experience gained from extensive trial use further confirmed the performance criteria and test conditions of the tentative specifications and led to the development of Standard TDJ 162 in October 1962 by a joint committee of EEI and the National Electrical Manufacturers Association (NEMA). TDJ 162 was subsequently superseded by ANSI C119.4.

The ANSI C119.0 Subcommittee of the Accredited Standards Committee on Connectors for Electric Utility applications, C119, in its continuing review of the publication, seeks out the views of responsible users that will contribute to the development of better standards. Suggestions for improvement of this standard are welcome. They should be sent to:

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[1] A copy of ANSI C119.0 will be provided, at no additional charge, with the purchase of any of the ANSI C119 product standards.

This standard was processed and approved for submittal to ANSI by the Accredited Standards Committee on Connectors for Electrical Utility Applications, C119. Committee approval of this standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the C119 Main Committee had the following members:

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1 Scope and Purpose

1.1 SCOPE

This standard covers methods and equipment for performing the connector qualification tests common to the ANSI C119 family of standards. Tests that are unique to only one ANSI C119 product standard are not covered in this document and are described in the applicable product standard.

1.2 PURPOSE

This standard provides guidance to organizations to perform tests required by the ANSI C119 standards and seeks to improve the inter-laboratory repeatability of the qualification of electrical connectors. Deviation from these guidelines shall be agreed upon between the purchaser and seller and documented in the test report.

1.3 DEFINITIONS

ambient temperature: Temperature in the test laboratory as measured by the temperature sensor specified in this document.

conductor: Conducting material used as a carrier of electric current.

connector: A device joining two or more conductors to provide a continuous electrical path.

control conductor: A conductor in the current cycle loop that serves as a reference for setting test current and monitoring temperature.

equalizer: A device installed in the test loop to ensure a point of equipotential in a stranded conductor.

input conductor: Conductor on the supply side of the connector.

output conductor: Conductor on the load side of the connector.

rated conductor strength: The tensile strength of a conductor determined in accordance with an applicable ASTM standard or as furnished by the conductor manufacturer for non-standard conductors.

thermal stability: A variation of not more than 2°C (3.6°F) between any two of three temperature readings taken at intervals not less than 10 minutes apart.

2 Reference Standards

This standard is used in conjunction with, but not limited to, the following standards in their latest edition:

ASTM B117 *Standard Practice for Operating Salt Spray (Fog) Apparatus*

ASTM E4-01 *Practices for Force Verification of Testing Machines*

IEEE 738 *Method for Determining the Temperature of Bare Overhead Conductor*

IEEE 837 *Standard for Qualifying Permanent Connections used in Substation Grounding*

3 Test Conditions

3.1 GENERAL

Connectors shall be installed and tested for mechanical performance in conditions meeting the following requirements:

a) Ambient temperature between 15°C (59°F) and 35°C (95°F) inclusive.

b) Humidity: non-condensing (cold metal brought into a warm lab should be allowed to stabilize before testing).

3.2 CURRENT CYCLE TESTS

Current cycle tests shall be run in enclosed spaces that are free from forced-air currents or radiated heat striking (directly or indirectly) any portion of the test loop during the current-ON period.

4 Instruments and Test Equipment

4.1 HEATING POWER SUPPLIES

4.1.1 General

A power-frequency (50 or 60 Hz) AC current supply capable of heating the control conductor to the target test temperature is required. DC power supplies and alternate-waveform power supplies are acceptable with customer acceptance. See Annex A for discussion of current power supplies.

4.1.2 Controls

Control of current within ± 3% of target current shall be provided. A manual variable autotransformer for current setting is not allowed, because there is no compensation for changes in loop impedance or variation in the voltage of the utility supply.

4.2 DC RESISTANCE MEASUREMENT EQUIPMENT

Resistance values shall be accurate to ± 1% with a resolution of 0.1 micro-Ohms. The test lab shall state the accuracy and resolution of the resistance measurement system in the test report. See Section 5.1.9.3 for specific guidance on making this measurement in a consistent manner.

4.3 TEMPERATURE MEASUREMENT EQUIPMENT

4.3.1 General

Guidelines to ensure consistent temperature measurement are provided in Section 5.1.9.1.

4.3.2 Accuracy and Resolution

Any system with certified accuracy of ± 2.2°C is acceptable. Systems with certified accuracy of ± 1°C are recommended. Temperature resolution of 0.1°C is required. The test lab shall state the accuracy and resolution of the temperature measurement system in the test report.

4.3.3 Ambient Temperature Sensor

Ambient temperature shall be measured using a thermocouple attached to a copper block approximately 50.8 mm x 50.8 mm x 6.4 mm (2 in. x 2 in. x ¼ in.). Reasonable care shall be exercised to assure the ambient temperature sensor is shielded from drafts or extraneous radiant influence. See Figure 1 for an example.

4.4 MECHANICAL LOAD TEST EQUIPMENT

4.4.1 General

Load test equipment shall provide smooth application of loads at the rates specified for the product under test. Testing machines with automatic controls and automatic data logging are preferred. Peak load capture is required for all ultimate strength tests, where the maximum load is needed to determine if the test result is acceptable.

4.4.2 Accuracy and Resolution

The measurement shall be accurate to ± 2%. Test load resolution of 4.45 N (1.0 lb) is required. The test lab shall state the accuracy and resolution of the force measurement system in the test report.

4.4.3 Torque Measurement Equipment

General

A mechanical peak-hold pointer or electronic peak capture is required for residual torque tests. Click-type wrenches are acceptable for installation of bolted connectors but are not permitted for residual torque measurement.

Accuracy and Resolution

Mechanical and electronic instruments with specified accuracy of 2% of reading are acceptable. Resolution of 1.4 N-m (1 ft-lb) is required. The test lab shall state the accuracy and resolution of the torque measurement system in the test report.

4.5 CURRENT MEASUREMENT EQUIPMENT

4.5.1 General

Electric current is reported, but it is secondary to temperature, which is the primary indicator for testing level.

4.5.2 Accuracy and Resolution

Current measuring equipment shall be accurate within ± 2% of the reading. Resolution of 1 ampere is required. The test lab shall state the accuracy and resolution of the current measurement system in the test report.

4.6 CORROSION TEST CHAMBERS

Corrosion test chambers shall meet the specifications of ASTM B 117 and a 5% salt concentration.

5 Test Procedures

5.1 CURRENT CYCLE TESTS

5.1.1 General

There are two options, the current cycle test (CCT), with the connectors cooled in air, and the current cycle submersion test (CCST), which is shorter but requires quenching the connectors in chilled water at the end of each cycle. The product standard will specify which test(s) are acceptable for that product. See Figure 2 through Figure 5 for typical layout sketches for the CCT.

CCTs shall be conducted on connectors assembled in series in a loop, and tested in a space meeting the requirements of Section 3.2. The instruments, test equipment, and controls shall meet the requirements of Section 4. Measurement procedures shall meet the requirements of Section 5.1.9. Control conductor temperature, acceptance criteria, and details not specified here shall be as specified in the standard for the product being tested. In the event of a discrepancy between this standard and the product standard, the product standard shall govern.

5.1.2 Test Conductors

Unless otherwise specified by contract, the conductors used in these tests shall be unused and unweathered. Flat bars to which terminal connectors are bolted shall be considered conductors. The flat-bar conductor shall be the nearest size that can be bolted to the terminal and have a current capacity closest to that of the maximum conductor being tested.

5.1.3 Connector Installation Procedure

Unless otherwise specified by contract, the connectors shall be installed in accordance with the manufacturer's published procedures. When clamping fasteners are used, they shall be tightened in accordance with the manufacturer's recommendations. In the absence of a recommended torque, the values specified in Table 3 or Table 4 shall be used.

5.1.4 Equalizers

5.1.4.1 General

Equalizers provide "equipotential planes" for resistance measurement and prevent the electrical or thermal influence of one connector on another. Equalizers are required on stranded conductors located on each side of all connectors in the current cycle loop. The equalizer must provide a solid-metal current electrical path. Equalizers are not required for solid conductors.

5.1.4.2 Procedure

All strands of a stranded conductor are preferably fusion welded, soldered, or brazed to the equalizer. The current path through an equalizer must be free of mechanical interfaces, except for the case where the equalizer is crimped over a continuous conductor section to provide a voltage terminal. A bolted connection between two equalizers is recommended to facilitate removal of individual samples for salt fog or fault current tests. This does not violate the "solid metal path" requirement of Section 0, as the bolted connection is between two independent equalizers. Note, however, that the bolted connection can fail during the test, and therefore the bolted connection shall be monitored for over-heating. It is suggested to use welded equalizers with cross-section of approximately 120% of the connecting conductor to minimize additional heat source or heat sink.

NOTE 1—Any form of equalizer that ensures permanent contact among all the conductor strands for the test duration may be used.

NOTE 2—A welded equalizer, made from aluminum, is recommended for aluminum conductors.

NOTE 3—If a compression sleeve is employed as an equalizer on a continuous piece of conductor, the conductor in the contact area of the equalizer should be mechanically cleaned on the outer surface of the bare conductor using a wire brush.

5.1.5 Conductor Length

The exposed length of stranded conductor between the connector and the equalizer, or between the connectors of solid conductors in the current cycle loop, shall be in accordance with Table 5 or Table 6. If a flat bus bar is used between terminal connectors, its length shall be twice that shown in Table 5 or Table 6 for the stranded conductor size being used in the terminal, or the same length of the solid conductor being used in the terminal. The conductor lengths in Table 5 and Table 6 do not include the length within the connector or equalizer. In addition, where connector design permits, the conductor end shall project 12.7 mm (½ in.) beyond the connector as shown in Figure 7. The equalizers at each end of the current cycle loop shall be joined to the power source with additional lengths of the test conductor to be not less than the lengths specified in Table 5 and Table 6.

5.1.6 Control Conductor

A control conductor, for determining test current, shall be installed in the current cycle loop (between two equalizers for stranded conductors; equalizers are not required on solid conductors). The control conductor shall be the same type and size as the conductor in the current cycle loop that would be at the highest temperature. Its length shall be twice that given in Table 5 or Table 6.

5.1.6.1 Multiple Control Conductors

If the test loop includes different conductors, and a question arises as to which conductor has the highest temperature rise, a control conductor of each type is required. The control conductor providing the higher rise in temperature for a fixed current shall be used as the reference control conductor for setting the test loop current (Section 5.1.7.4) and performing all temperature difference calculations.

5.1.6.2 Equivalent Aluminum/Copper Conductors

Where the copper and aluminum test conductors are of approximate equivalent ampacity, the size of the control conductor may be determined by selecting the conductor in the current cycle loop that has the least current for equivalent aluminum/copper conductors from Table 7 and Table 8.

5.1.7 Loop Configuration and Location

5.1.7.1 General

Test loops shall be located in a space meeting the requirements of Section 3.2. Measures shall be taken to ensure that thermal or electrical influence of adjacent loops in the lab space does not affect the measurement accuracy or stability of the data. Particularly in the case of loops operating near high-temperature loops, strong infrared radiation (IR) and hot convection plumes will significantly raise the temperature of nearby tests.

5.1.7.2 CCT Method

The current cycle loop may be of any shape, provided the location of thermocouples for the connectors and the center of the control conductor are installed at the same elevation with at least an 200 mm (8 in.) separation between adjacent conductor-connector and equalizer assemblies and located at least 305 mm (12 in.) from any exterior wall and at least 610 mm (24 in.) from the floor and the ceiling.

NOTE—This is intended to assure that the control conductor and the connectors begin the next current-ON period at the same temperature.

The CCT current shall be adjusted during the current-ON period of the first 25 cycles to result in a stable maximum temperature rise in the control conductor specified in the product standard. This current shall then be used during the remainder of the test current-ON periods, regardless of the temperature of the control conductor.

5.1.7.3 CCST Method

The control conductor shall be installed on the same horizontal plane as the test connectors. During the current-ON period, no part of the circuit shall be less than 200 mm (8 in.) above the surface of the chilled water. At the beginning of the current-OFF period, the connectors and the control conductor shall be submerged to a minimum of 100 mm (4 in.) below the water surface.

NOTE—This is intended to assure that the control conductor and the connectors begin the next current-ON period at the same temperature.

5.1.7.4 Test Current

Suggested initial test amperes during test startup are given in Table 7 and Table 8 in order to reduce the number of cycles to determine the required temperature rise in the control conductor for 100°C temperature rise above ambient. Subsequently, the actual test current might have to be adjusted from these values to achieve the required control conductor temperature rise. For conductor sizes within the range of, but not included in, those listed in Table 7 and Table 8, some experimentation, interpolation or extrapolation of the test current values will be required to achieve the required control conductor temperature rise. For conductors outside the listed range, and for temperature rise other than 100°C above ambient, refer to IEEE 738 for computation of the required current.

It shall be permissible to use a current 50% greater than the steady state current during the initial heating phase, provided there is no over-shoot above the nominal test temperature.

The CCST current shall be adjusted during the current-ON period of the first five cycles to result in a stable maximum temperature rise in the control conductor as specified in the product standard. This current shall then be used during the remainder of the test current-ON periods, regardless of the temperature of the control conductor.

NOTE—The currents in Table 7 and Table 8 are not intended to suggest conductor current ratings for actual service use.

5.1.8 Current Cycle Period

5.1.8.1 General

Each test cycle shall consist of a current-ON and a current-OFF period. The time required to make resistance and temperature measurements is not considered a part of the current-ON or current-OFF time periods.

5.1.8.2 CCT and CCST Current Cycle-ON Period

The minimum duration of the current-ON period shall be as specified in the product standard. The CCT current shall be adjusted during the current-ON period of the first 25 cycles to result in a stable maximum temperature rise in the control conductor specified in the product standard. If the control conductor and connectors being tested do not reach thermal stability within the designated ON time, the duration shall be extended until the control conductor and the connectors reach thermal stability. This current shall then be used during the remainder of the test current-ON periods, regardless of the temperature of the control conductor.

For the CCST, the current shall be adjusted during the first five cycles, and then maintained constant until the end of the test regardless of control conductor temperature.

5.1.8.3 CCT Current Cycle-OFF Period

Connectors tested by the CCT method shall cool in ambient air. The duration of the current-OFF period shall initially be the same as the current-ON period. The duration may be reduced by forced-air cooling after the first 25 cycles. With the customer's concurrence, forced-air cooling may be initiated during the current-OFF period after the first cycle. The duration for the reduced current-OFF period shall be established by adding five minutes to the time required for all connectors to reach ambient temperature within ± 2°C.

5.1.8.4 CCST Current Cycle-OFF Period

Connectors tested by the CCST method shall be immersed in still, chilled water (5°C ± 4°C) within 30 seconds of the start of the current-OFF period. The connectors shall remain immersed in the chilled water for a minimum of 15 minutes after the four connectors have reached thermal stability. The connectors shall be removed from the water before they are energized at the beginning of the next current-ON cycle.

5.1.9 Measurements

Resistance and temperature measurements shall be made as specified in the product standard. Automatic data recording is preferred. In the cases where manual readings are required, the cycle at which the reading is taken may be adjusted to ones that occur during normal working hours. In no case should this allowance be used to reduce the total number of data points, and every effort shall be taken to avoid clustering of data within a short time period.

5.1.9.1 Temperature Measurements

Unless otherwise required by the product standard, the temperature of each connector, the control conductor, and the ambient sensor shall be taken at the end of the current-ON period, immediately before the test current is turned off.

5.1.9.2 Temperature Stability

The temperature stability factor S_i for each of the specified recorded temperature measurements shall be determined by applying the following equations:

$$S_i = d_i - D$$

$$D = [d_1 + d_2 + ... + d_n)/n]$$

Where:

D is the average temperature difference

The variable "i" signifies the individual temperature measurements taken at intervals given in Table 9, and d_i is a temperature difference for an individual temperature measurement.

$d_i = (T_{cc} - T_c)_i$

$i = 1, 2, \ldots, n$

T_c is connector temperature in °C

T_{cc} is the control conductor temperature in °C

n is the total number of measurement intervals, as specified in the product standard

NOTE—For each connector, the value for d_i is determined by subtracting the connector temperature from the control conductor temperature for each of the specified data points. Next, the average temperature difference (D) is calculated and subtracted from each of the individual data points to attain specified S_i values. Each of these specified S_i values is to be within the range specified in the product standard.

5.1.9.3 Resistance Measurements

Resistance of the control and each connector shall be measured during a current-OFF period as specified in the product standard. The temperature at all points in the loop shall measure within ± 2°C of ambient, and the ambient temperature shall not have changed by more than ± 2°C within the previous 10 minutes. The ambient temperature should be as close to 20°C as practical but shall be between 10°C and 30°C.

NOTE—The resistance values obtained shall be corrected to 20°C (68°F) with the following formula:

$$R_{20} = R_m / [1 + \alpha_{20} (T_m - 20)]$$

Where:

R_m is the measured resistance

T_m is the temperature (°C) (°F) of the connector

α_{20} is the resistance variation coefficient at 20°C (68°F). This coefficient can be taken equal to:

$$\alpha_{20} = 4 \text{ X } 10^{-3}/°C\ (°F) \text{ for copper and ACSR}$$

$$\alpha_{20} = 3.6 \text{ X } 10^{-3}/°C\ (°F) \text{ for aluminum}$$

5.1.9.4 Resistance Stability

The resistance stability factor for a given connector is defined as the maximum percent variation between any resistance measurement, made at the intervals specified in Table 9, and the average of all n measurements made during the course of the test for the same connector.

5.2 STATIC HEATING STABILITY TEST

5.2.1 Procedure

The static heating stability test shall be conducted on connectors assembled in series in a loop as shown in Figure 6. This test shall be conducted in a space free of forced-air currents or radiated heat striking (directly or indirectly) any portion of the test loop during the current-ON period. The ambient temperature shall be held between 15°C (59°F) and 35°C (95°F). The ambient temperature shall not vary more than ± 5°C (± 9°F) during the entire test.

A minimum of two connector/cable systems shall be assembled in accordance with the recommendations of the connector manufacturer, on the combination of conductors that represents in number, size, and arrangement the most severe thermal condition for which the connector is designed.

The input current shall be adjusted to produce the required target temperature, as specified in the product standard, ± 5°C (± 9°F) on the hottest conductor. The temperature of the input conductor shall be measured at a point 300 mm (12 in.) from the connector. The temperature of the connector shall be measured as close as possible to the midpoint of the current path between the input and output.

The temperature measurements shall be recorded a minimum of once every 12 hours (plus or minus two hours) beginning with the 72nd hour (plus or minus two hours) and continuing through the 120th hour.

5.2.2 Static Heating Stability Calculation

Static heating stability is achieved if the following equation is satisfied over successive temperature measurements from the 72nd hour through the 120th hour:

$$|(\Delta T_{s,i} - \Delta T_{ic,i})| \leq \Delta T$$

Where:

$\Delta T_{s,i} = T_{s,i+1} - T_{s,i}$ is the change in connector temperature T_s from time interval i to i+1

$\Delta T_{ic,i} = T_{ic,i+1} - T_{ic,I}$ is the change in the input conductor temperature T_{ic} from time interval i to i+1

ΔT is the maximum allowable differential change in temperature as specified in the product standard

5.3 MECHANICAL TESTS

5.3.1 General

The applicable product standard will specify types of tests required, sample numbers, and acceptance criteria. The following guidelines apply to mechanical tests under the C119 family of standards.

5.3.2 Conductor Preparation

The conductor shall be prepared in accordance with the manufacturer's published field installation instructions.

In the absence of manufacturer's installation instructions, the portion of the conductor that is to be inserted into the connector shall be wiped with a cloth coated with particle-free petroleum jelly.

NOTE—This is to increase the severity of all mechanical tests.

5.3.3 Test Sample Preparation

The applicable product standard will specify the method required for installing connectors on the conductor. In general, the manufacturer's published instructions should be followed. Unless otherwise specified, unused and unweathered conductor shall be used for the mechanical tests. A retest shall be performed if the test failure is found to be caused by defects in the conductor, and not by poor connector performance. Termination of the free-end of the conductor shall be in accordance with a practice that ensures even loading of all strands and ensures the full strength of each strand is held for the duration of the test. Cast-resin terminations are preferred, but alternatives are allowed provided they hold the full strength of the conductor and limit birdcaging of any layer to less than 0.1% of the exposed conductor length. The length of exposed conductor shall be as specified in Table 12.

5.3.4 Pull-Out Tests and Maximum-Load Tests

Install the sample in the pulling section of the testing machine and pull out slack using tension of no greater than 8% of the acceptance criterion described in the product standard. Load shall be increased smoothly to the rated load in greater than 30 seconds but less than two minutes.

5.3.5 Sustained Load Tests

Test samples shall be taken to the target load smoothly and within five minutes of the start of loading. Sustained load shall be held within ± 2% of the target load for the minimum specified time, as found in the product standard. The load tolerance is intended to accommodate manually adjusted test machines.

5.3.6 Bolt Torque Tests

5.3.6.1 Torque Strength

The torque strength of the bolted connector shall be measured using an instrument meeting the requirements of Section 4.4.3. Torque the fastener to the value specified in the product standard. Disassemble the joint and inspect for damage.

5.3.6.2 Retained Torque

A retained torque test is performed after a bolted connection has been subjected to a thermal cycle test, and is performed to verify the connection is not prone to loosening during heat cycles. The test shall be conducted as follows:

1) Mark the relative positions of the nut, bolt head, and connector body (i.e., by making a line on each component with a scribe or felt pen).
2) Hold the bolt head stationary with a wrench, and slowly increase the torque on the nut in a tightening direction. If the nut moves before the installation torque is reached, record that value as the retained torque, then increase the torque to the original installation torque. If installation torque is reached with no movement of the nut, the retained torque is 100%, and no further tightening should be attempted.
3) Once the retained torque test is completed, back off the nut. Hold the bolt head at its original position, and retighten the nut to the specified installation torque. Record the angular movement of the mark on the nut to the nearest 5° (0.087 radians). The increased rotation from the original installed position is a measure of the relaxation in the joint during the thermal cycles.

5.3.7 Run Conductor Damage Test

A tap connector shall be installed on a run conductor whose length between gripping means is as specified in Section 5.3.4. Place the run conductor under a tensile load of 20% of its rated conductor strength. Install the tap connector and tap conductor in accordance with the manufacturer's procedure or as agreed between the buyer and the seller. Load shall be maintained within ± 2% of the target load during the installation. After the tap connector is installed, increase the tension to the breaking point, and record the maximum load from the peak load indicator.

5.4 INADVERTENT INTERRUPTION OF TESTS

It is preferred that, once started, testing continues to completion without interruption. However, unintentional interruption of a test might sometimes occur due to unforeseen circumstances.

Examples:

a) Failure of a CCT or CCST cycle to complete the nominal time or reach the nominal target temperature (usually due to interruption of the source power).

b) Loss of tension during a sustained load test.

In the case of interruption during a cycle of a CCT or CCST, the truncated cycle shall be discounted and the test shall continue from the last complete cycle. In the case of loss of tension in a sustained load test, the sample shall be re-tensioned and the testing shall continue from the point in time at which tension first dropped below 98% of the nominal target level.

The event and corrective actions shall be noted in the test report.

6 Test Report Requirements

The product standard shall specify requirements for the test report.

Table 1
Minimum Tensile Force, AWG Wire

Wire Size		Force					
AWG	mm^2	Copper		Aluminum		ACSR	
		N	lbf	N	lbf	N	lbf
16	1.3	133	30	67	15	---	---
14	2.1	222	50	111	25	---	---
12	3.3	311	70	156	35	---	---
10	5.3	356	80	178	40	---	---
8	8.4	400	90	200	45	445	100
6	13.3	445	100	222	50	445	100
4	21.1	623	140	311	70	667	150
3	26.6	712	160	356	80	667	150
2	33.6	801	180	400	90	890	200
1	42.4	890	200	445	100	890	200

Table 2
Minimum Tensile Force, mm^2 Wire

Wire Size	Force					
	Copper		Aluminum		ACSR	
mm^2	N	lbf	N	lbf	N	lbf
1.5	178	40	---	---	---	---
2.5	267	60	---	---	---	---
4	334	75	---	---	---	---
6	378	85	---	---	---	---
10	422	95	214	48	---	---
12.5	---	---	---	---	450	101
16	535	120	267	60	450	101
20	---	---	---	---	450	101
25	665	150	334	75	675	152
31.5	---	---	---	---	875	197
35	845	190	423	95	---	---
40	---	---	---	---	890	200

Table 3
Tightening Torque, Inch Size Fasteners

Size	Tightening Torque					
	Aluminum Fastener			Galvanized Steel, Stainless Steel, or Silicon Bronze Fastener		
in.	N m	lb in.	lb ft	N m	lb in.	lb ft
5/16	-	--	-	20	180	15
⅜	19	168	14	27	240	20
13/32	23	204	17	33	288	24
7/16	27	240	20	41	360	30
½	34	300	25	54	480	40
9/16	43	384	32	65	576	48
⅝	54	480	40	75	660	55
¾	73	650	54	95	840	70

Table 4
Tightening Torque, Metric Size Fasteners

Tightening Torque						
Size	Aluminum Fastener			Galvanized Steel, Stainless Steel, or Silicon Bronze Fastener		
mm	N m	lb in.	lb ft	N m	lb in.	lb ft
M8	-	--	-	25	216	18
M10	30	264	22	49	432	36
M12	50	444	37	85	756	63
M14	60	528	44	135	1200	100
M16	75	660	55	210	1860	155
M18	90	792	66	300	2652	221
M20	100	888	74	425	3756	313

Table 5
Conductor Lengths for Current Cycle Tests, AWG/kcmil Sizes

Conductor Type		Exposed Length			
Aluminum	Copper	Stranded		Solid	
		mm	in.	mm	in.
4/0 AWG and below	2/0 AWG and below	305	12	610	24
Over 4/0 AWG through 795 kcmil	Over 2/0 AWG through 500 kcmil	610	24	1220	48
Over 795 kcmil	Over 500 kcmil	914	36	1830	72

Table 6
Conductor Lengths for Current Cycle Tests, mm^2 Sizes

Conductor Type		Exposed Length			
Aluminum	Copper	Stranded		Solid	
		mm	in.	mm	in.
120 mm^2 and below	70 mm^2 and below	305	12	610	24
Over 120 mm^2 through 400 mm^2	Over 70 mm^2 through 240 mm^2	610	24	1220	48
Over 400 mm^2	Over 240 mm^2	914	36	1830	72

Table 7
Suggested Initial Test Current to Raise AWG/kcmil
Control Conductor Temperature 100°C (212°F) above Ambient

Aluminum or Aluminum Composite		Copper or Copper Composite	
Conductor Size	**Current (amperes)**	**Conductor Size**	**Current (amperes)**
6 AWG	90	8 AWG	95
4 AWG	125	6 AWG	130
2 AWG	170	4 AWG	180
1 AWG	200	2 AWG	245
1/0 AWG	230	1/0 AWG	340
2/0 AWG	270	2/0 AWG	400
3/0 AWG	320	3/0 AWG	470
4/0 AWG	380	4/0 AWG	550
250 kcmil	410	250 kcmil	615
266.8 kcmil	450	300 kcmil	700
300 kcmil	450	350 kcmil	780
336.4 kcmil	525	400 kcmil	850
350 kcmil	525	500 kcmil	990
397.5 kcmil	590	750 kcmil	1300
400 kcmil	600	1000 kcmil	1565
477 kcmil	670	-	-
500 kcmil	725	-	-
556.5 kcmil	750	-	-
636 kcmil	820	-	-
750 kcmil	950	-	-
795 kcmil	955	-	-
954 kcmil	1085	-	-
1000 kcmil	1085	-	-
1033.5 kcmil	1150	-	-
1113 kcmil	1220	-	-
1192 kcmil	1275	-	-
1250 kcmil	1330	-	-
1272 kcmil	1350	-	-
1351.5 kcmil	1390	-	-
1431 kcmil	1450	-	-
1500 kcmil	1520	-	-
1590 kcmil	1560	-	-
1750 kcmil	1715	-	-
2000 kcmil	1960	-	-

Table 8
Suggested Initial Test Current to Raise mm^2
Control Conductor Temperature 100°C (212°F) above Ambient

Aluminum or Aluminum Composite		Copper or Copper Composite	
Conductor Size (mm^2)	Current (amperes)	Conductor Size (mm^2)	Current (amperes)
-	-	10	105
16	100	16	145
25	135	25	195
35	170	35	245
50	225	50	330
70	270	70	400
95	345	95	505
120	405	120	600
150	450	150	700
185	550	185	795
240	700	240	970
300	805	300	1100
400	930	400	1300
500	1085	500	1565

Table 9
Resistance and Temperature Measurement Intervals

Data Point Number (i)	Current Cycle Test Method (CCT) (Cycles)	Current Cycle Submersion Test Method (CCST) (Cycles)
1	25 – 30	5 – 7
2	45 – 55	13 – 17
3	70 – 80	23 – 27
4	95 – 105	35 – 39
5	120 – 130	48 – 52
6	160 – 170	57 – 61
7	200 – 210	66 – 70
8	245 – 255	73 – 77
9	320 – 330	81 – 85
10	400 – 410	89 – 93
11	495 – 505	98 – 102

Table 10
Minimum Current-ON Duration for AWG/kcmil Control Conductors

Aluminum or Aluminum Composite (kcmil)	Copper or Copper Composite	Minimum Current-ON Period (Hours)
Up through 336.4 kcmil	Up through 4/0 AWG	1.0
Over 336.4 kcmil through 795 kcmil	Over 4/0 AWG through 500 kcmil	1.5
Over 795 kcmil	Over 500 kcmil	2.0

Table 11
Minimum Current-ON Duration for mm^2 Control Conductors

Aluminum	Copper	Minimum Current-ON Period (Hours)
Up through 185 mm^2	Up through 120 mm^2	1.0
Over 185 mm^2 through 400 mm^2	Over 120 mm^2 through 240 mm^2	1.5
Over 400 mm^2	Over 240 mm^2	2.0

Table 12
Length of Exposed Conductor

Connector Tension Class	Description	Length	
		m	in.
Class 1 and 1A	a) Intended for single metal or single alloy conductors with 19 strands or fewer	0.61	24
	b) Intended for single metal or single alloy conductors with more than 19 strands	3.66*	144*
	c) Intended for multiple metal or multiple alloy conductors	3.66*	144*
Class 2		0.61	24
Class 3		0.25	10

* Exception—For conductors 4/0 AWG and smaller, the length of the exposed conductor may be shortened from 3.66 m (144 in.) to 0.61 m (24 in.) if procedures ensure simultaneous loading of all strands and the manufacturer agrees.

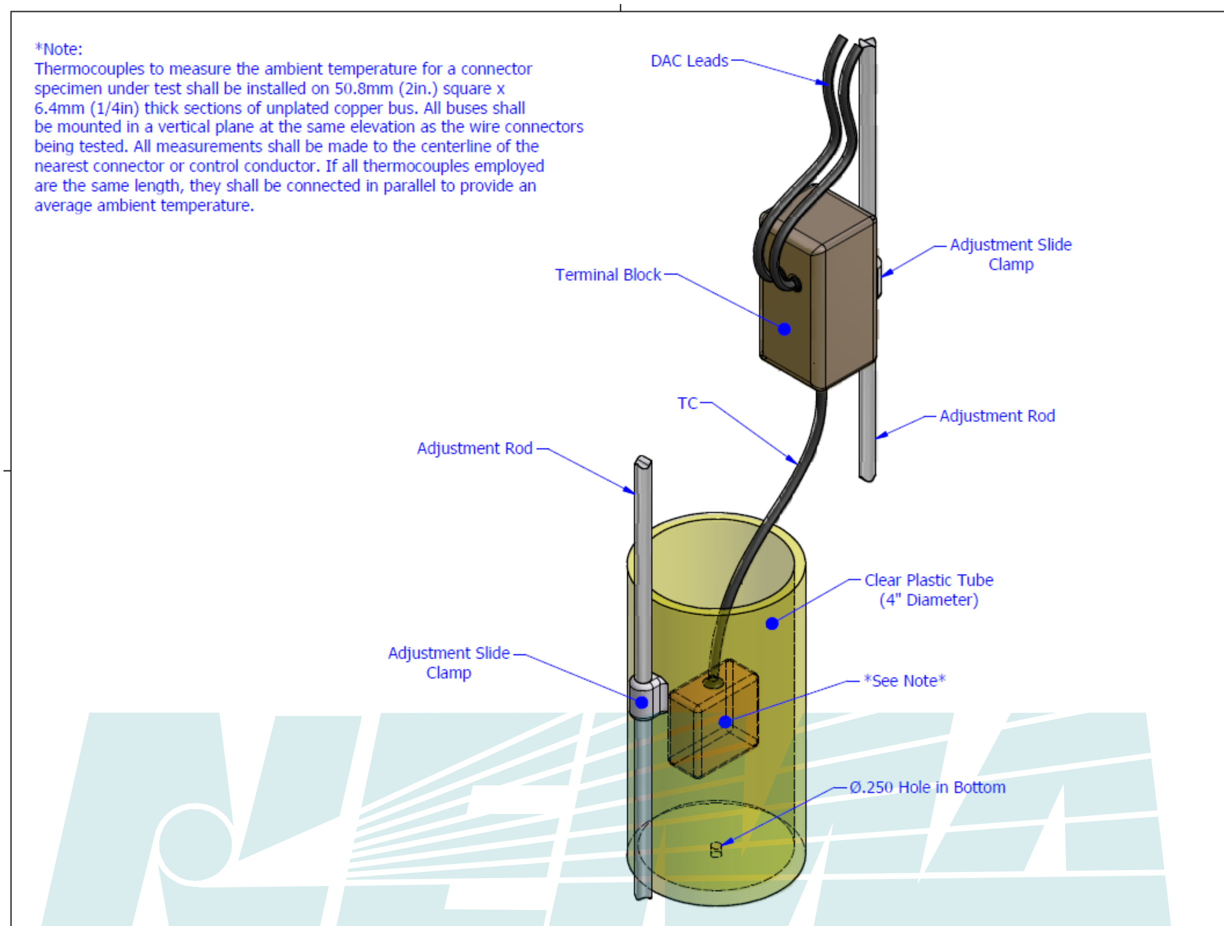
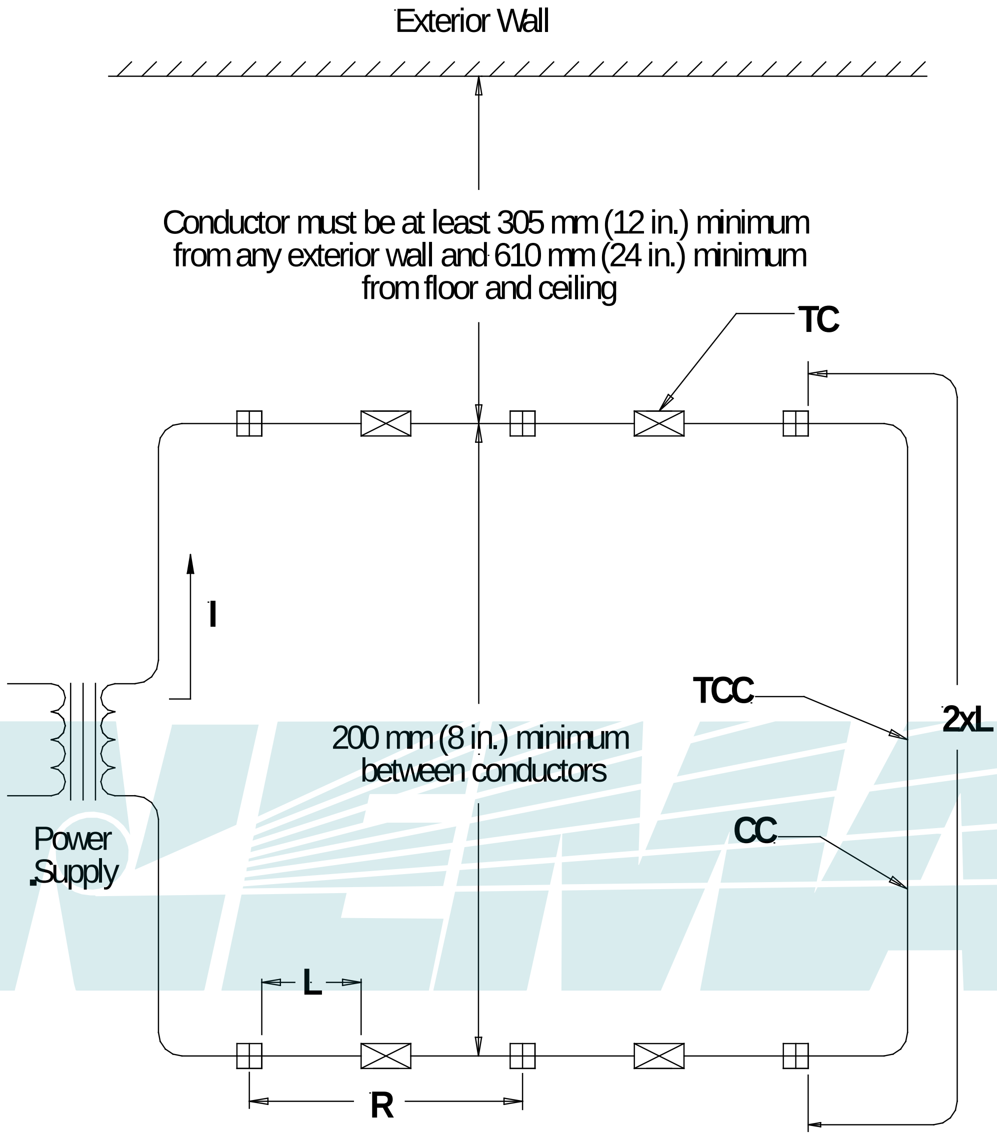


Figure 1
Example of an Ambient Temperature Sensor



- Equalizer

- Test connector

TC - Temperature measurement point. The exact temperature measurement point is selected based on the hottest point on the connector. The temperature measurement location for the control conductor and connector samples shall be located a minimum of 610 mm (24 in.) from the floor and ceiling and 305 mm (12 in.) from the exterior walls, unless a solid insulating backboard separates the test samples from the floor, ceiling, or walls. Samples shall be spaced at least 102 mm (4 in.) from the backboard.

CC - Control Conductor, length = 2 x L

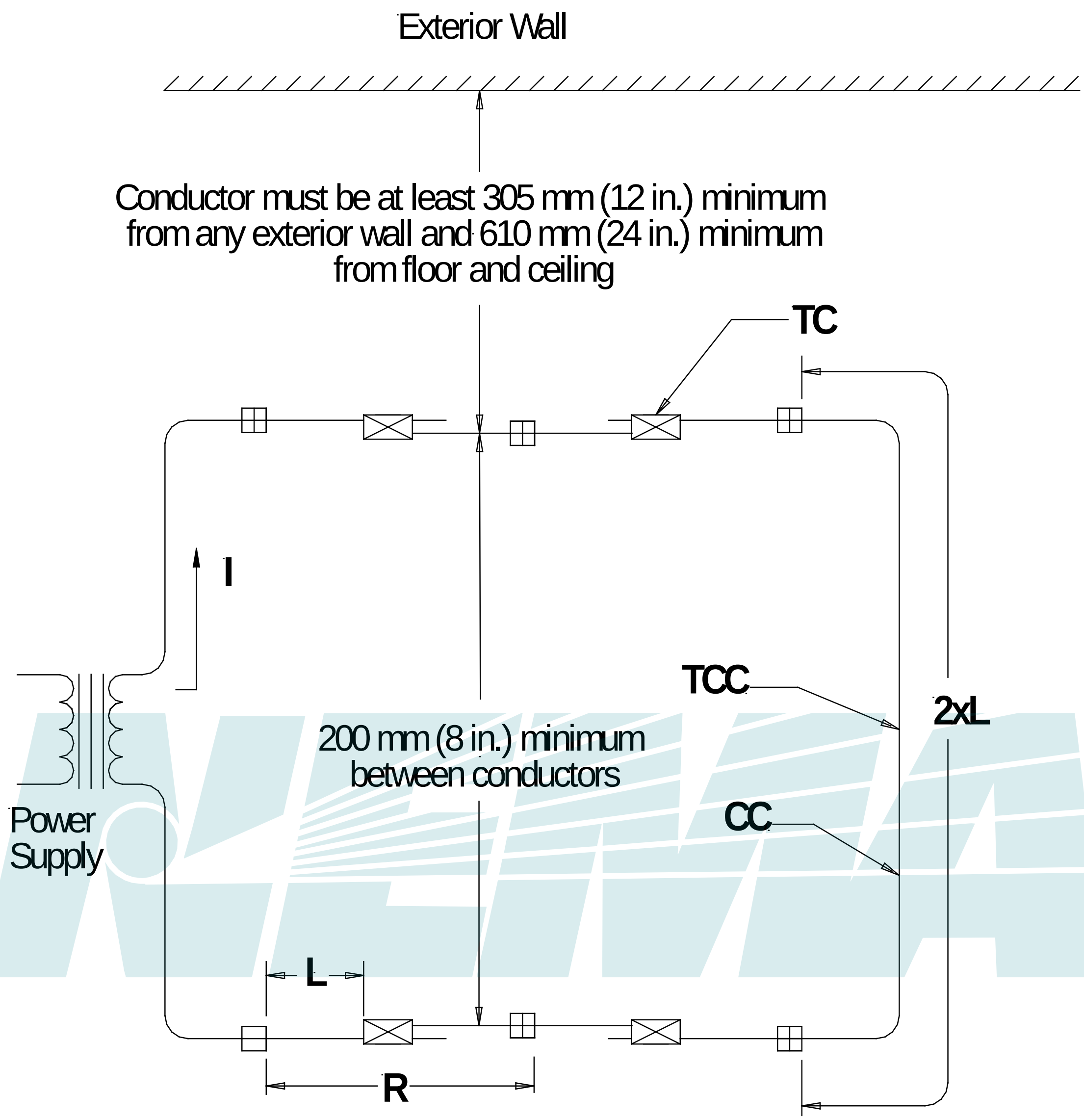
L - Exposed cable length between connector and equalizer per Table 5 or 6

R - Equalizer to equalizer resistance

I - Test current

TCC - Control Conductor temperature measurement point (midpoint of the conductor)

Figure 2
Horizontal Schematic



- Equalizer

- Test connector

TC - Temperature measurement point. The exact temperature measurement point is selected based on the hottest point on the connector. The temperature measurement location for the control conductor and connector samples shall be located a minimum of 610 mm (24 in.) from the floor and ceiling and 305 mm (12 in.) from the exterior walls, unless a solid insulating backboard separates the test samples from the floor, ceiling, or walls. Samples shall be spaced at least 102 mm (4 in.) from the backboard.

CC - Control Conductor, length = 2 x L

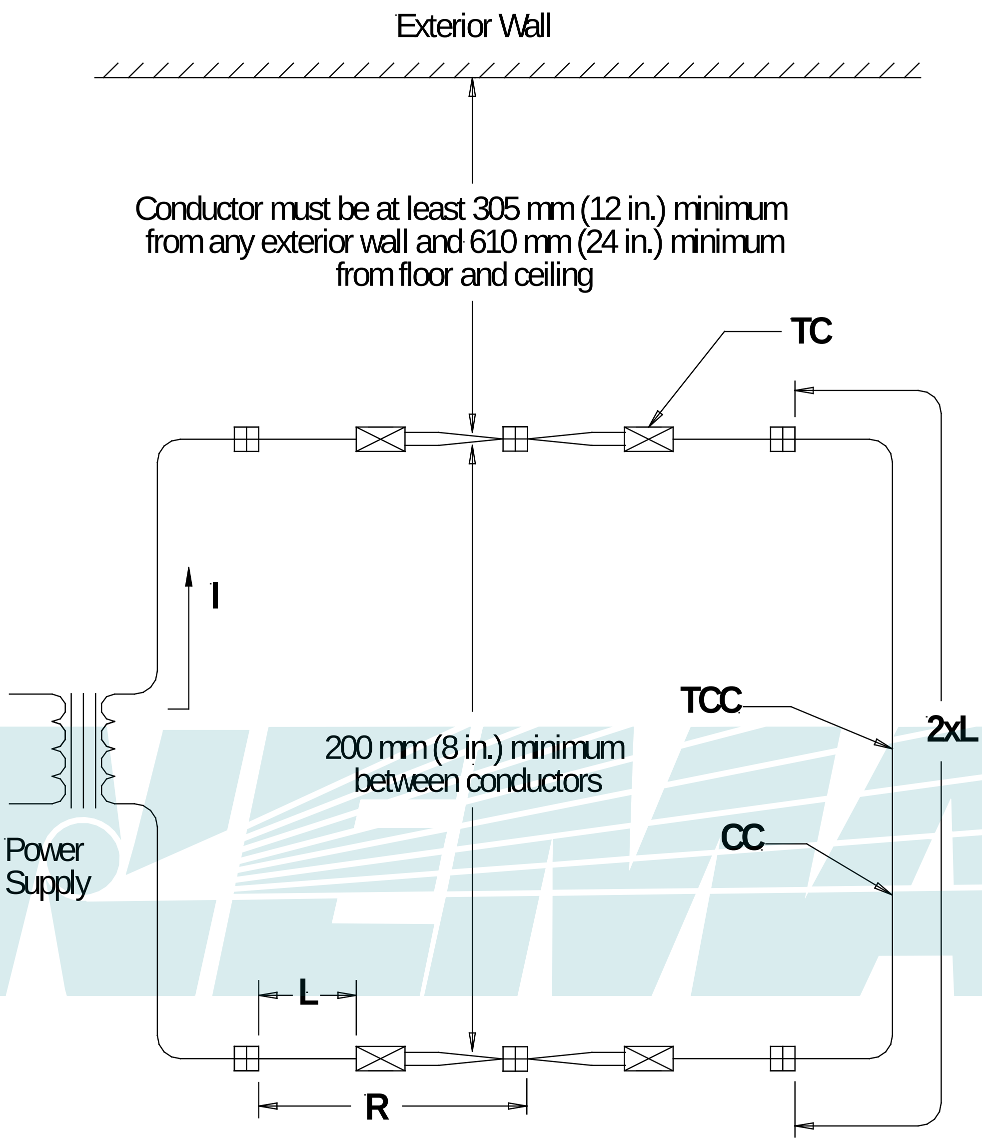
L - Exposed cable length between connector and equalizer per Table 5 or 6

R - Equalizer to equalizer resistance

I - Test current

TCC - Control Conductor temperature measurement point (midpoint of the conductor)

Figure 3
Tap Schematic



- Equalizer

- Test connector

TC - Temperature measurement point. The exact temperature measurement point is selected based on the hottest point on the connector. The temperature measurement location for the control conductor and connector samples shall be located a minimum of 610 mm (24 in.) from the floor and ceiling and 305 mm (12 in.) from the exterior walls, unless a solid insulating backboard separates the test samples from the floor, ceiling, or walls. Samples shall be spaced at least 102 mm (4 in.) from the backboard.

CC - Control Conductor, length = 2 x L

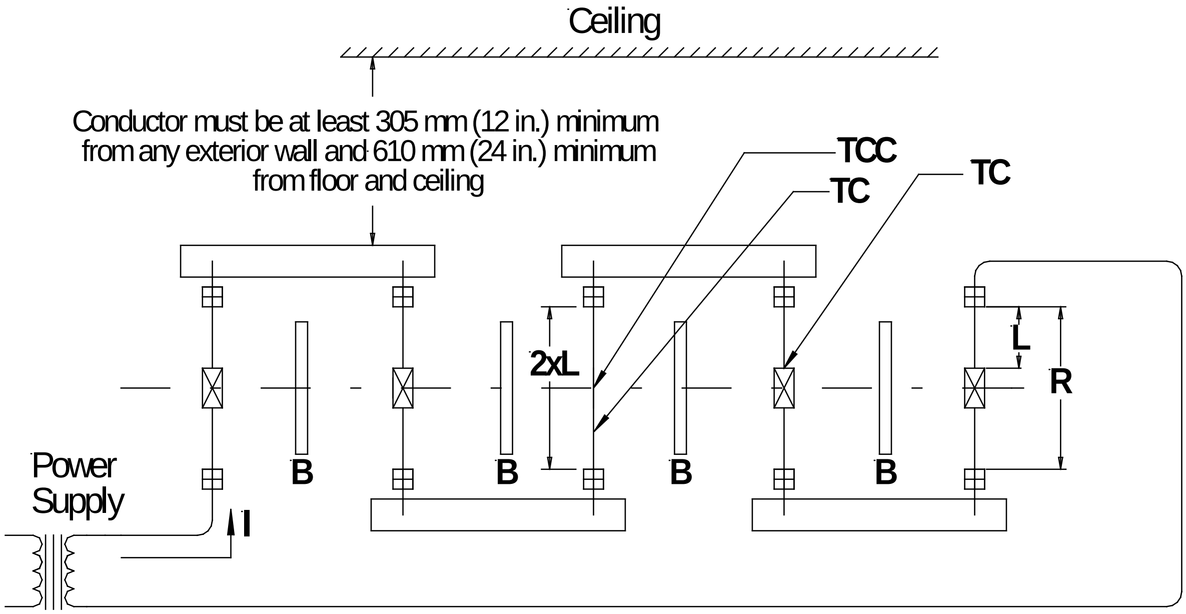
L - Exposed cable length between connector and equalizer per Table 5 or 6

R - Equalizer to equalizer resistance

I - Test current

TCC - Control Conductor temperature measurement point (midpoint of the conductor)

Figure 4
Wye Schematic



 - Equalizer

 - Test connector

TC - Temperature measurement point. The exact temperature measurement point is selected based on the hottest point on the connector. The temperature measurement location for the control conductor and connector samples shall be located a minimum of 610 mm (24 in.) from the floor and ceiling and 305 mm (12 in.) from the exterior walls, unless a solid insulating backboard separates the test samples from the floor, ceiling, or walls. Samples shall be spaced at least 102 mm (4 in.) from the backboard.

CC - Control Conductor, length = 2 x L

L - Exposed cable length between connector and equalizer per Table 5 or 6

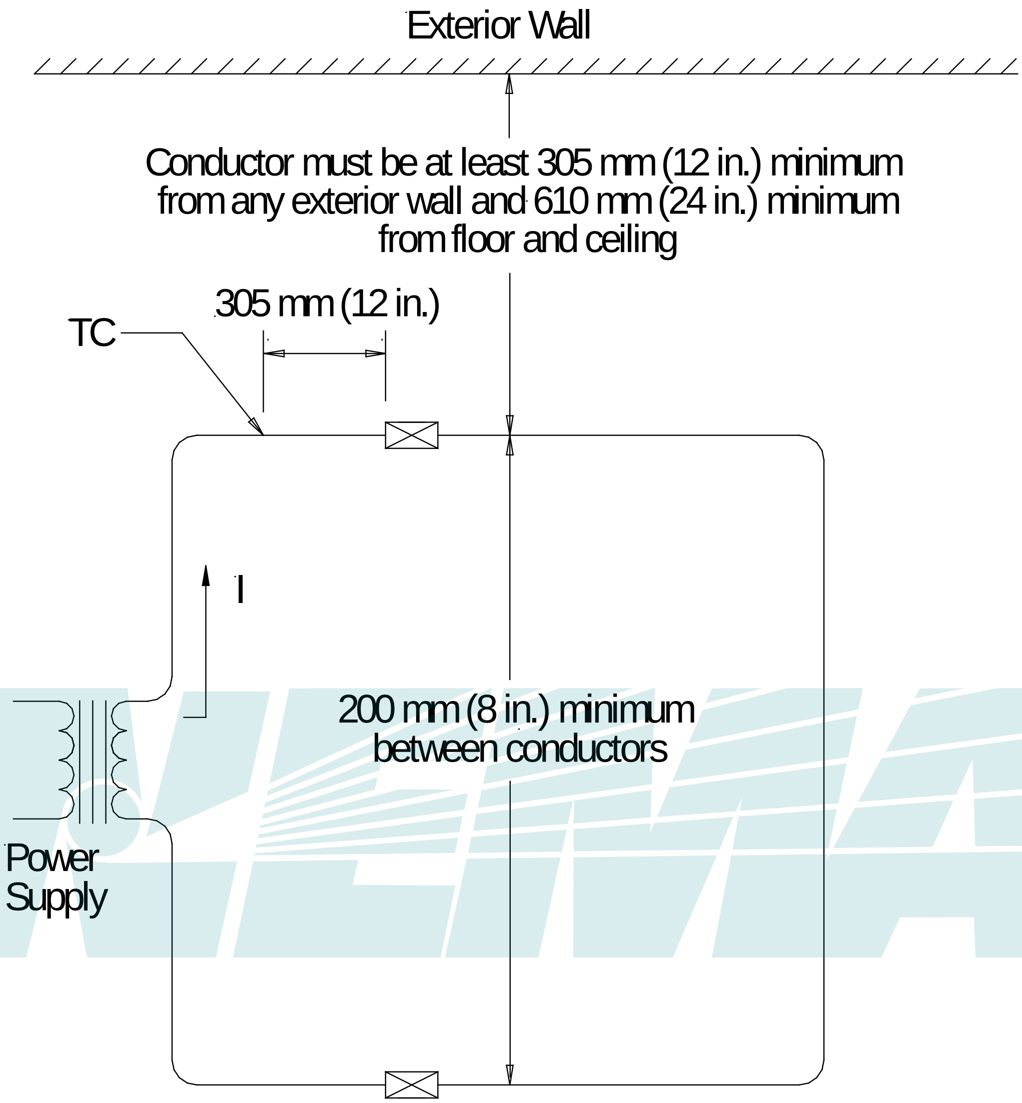
R - Equalizer to equalizer resistance

I - Test current

TCC - Control Conductor temperature measurement point (midpoint of the conductor)

B - Thermal barrier to separate test specimens. The thermal barrier is only required for a sample spacing of 152 mm (6 in.). The thermal barrier shall extend at least 152 mm (6 in.) in a vertical direction and 25.4 mm (1 in.) in a horizontal direction beyond the extremities of the sample.

Figure 5
Vertical Schematic



- Test connector

TC - Temperature measurement point

I - Test current

Figure 6
Static Heating Stability Schematic

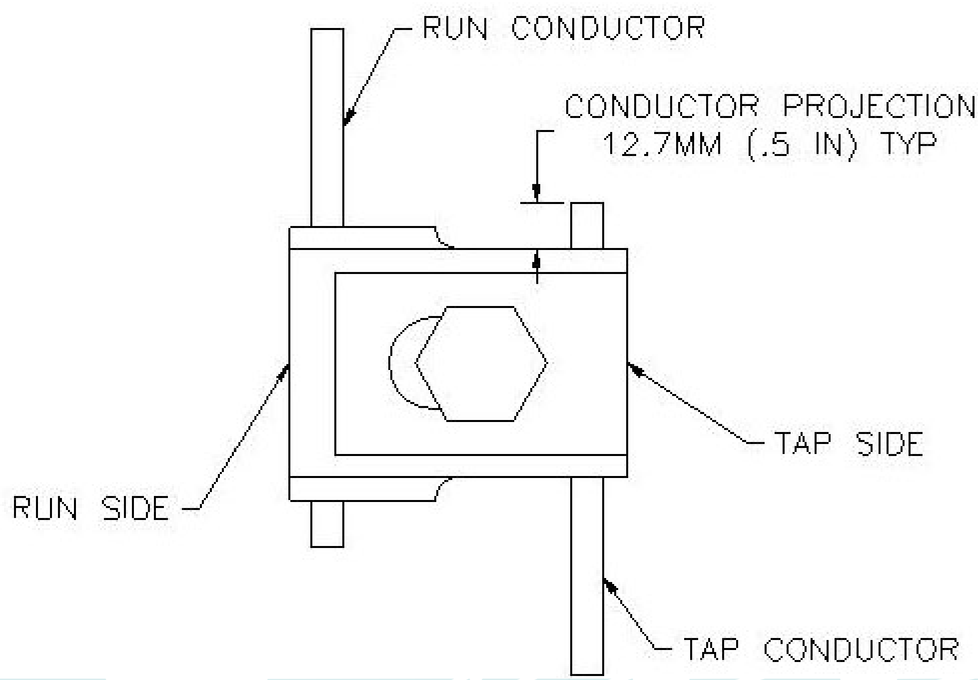


Figure 7
Length of Projected Conductor

Annex A
TESTING PRACTICES AND EQUIPMENT

(Informative)

A.1 Heating Current Power Supplies

AC power is preferred because that best represents most connector service conditions. DC power and chopped-waveform supplies are acceptable with customer acceptance.

Current cycle tests require constant current. Therefore, feedback controls are required to compensate for variation in the main supply voltage and to compensate for changes in the test loop.

A.2 Temperature Measurement

A.2.1 Equipment

Type T or J thermocouples with isolated sheaths have been used successfully for temperatures up to 250°C. Type K or J thermocouples are recommended if any expected temperature measurement exceeds the 250°C nominal limit for Type T sensors. Automatic recording equipment is recommended. Recording interval should be capable of tracking cycles in the ambient temperature.

A.2.2 Calibration

All data channels used for maximum temperature and thermal stability criteria should be calibrated from the sensor to the readout.

A.2.3 Installation

Thermocouples (or other type of temperature sensor) should be secured in place for the duration of the test. Thermocouples that inadvertently get bumped or fall out for any reason may be re-inserted, but beware: the data can show a step temperature change. Sensors that fail during the test should be replaced with the same type, but again, be aware that the data will probably show a small step change in that channel. Recommended installation practices by location are:

A.2.3.2 Stranded Conductor

Pry open two outer-layer strands, and wedge the thermocouple tip so that the contact is approximately 0.2 mm (⅛ in.) from the tip. Use electronic heat-transfer paste to couple the thermocouple to the strands and minimize the effect of air currents on the temperature reading.

A.2.3.3 Solid Conductor

Drill a hole the same diameter as the thermocouple sheath. For conductor smaller than 6 mm (¼ in.) diameter, drill the hole to the center of the strand. For larger conductors, drill a hole 3 mm (⅛ in.) deep. Use heat-transfer paste to promote thermal coupling between the strand and the thermocouple.

A.2.3.4 Connectors

Drill a hole the same diameter as the thermocouple sheath in a location expected to exhibit the highest temperature. This is generally where the conducting area is the smallest. The geometric center of the connector may be used if the conducting area is equal. Infrared imaging or a hand-held thermocouple reader may be used to locate the highest temperature. For connectors smaller than 6 mm (¼ in.) diameter, drill the hole to the center of the connector (use miniature thermocouples for connectors this small). For larger connectors, drill the hole 3 mm (⅛ in.) deep. Use heat-transfer paste to ensure thermal contact between the connector and the instrument.

A.3 Current Measurement

A.3.1 AC Current

Temperature is the property of greatest interest, but reliable current measurements are also needed to set the loop current and report reference values in the test report. Data from the AC heating power supply is typically accurate enough for connector testing. Clamp-on ammeters are convenient and reasonably accurate if they are well-maintained. The revenue metering industry provides economical wire-wound current transformers (CTs) and matching electronics that are extremely accurate and reliable. Current should be recorded on the same interval as temperature and other readings.

A.3.2 DC Current

If DC current is used for the heating power supply, the current data from the test equipment is typically accurate enough for the purpose of connector testing. Clamp-on ammeters are reliable if used and maintained with care. Current should be recorded on the same interval as temperature and other readings.

A.3.3 DC Resistance

Stable resistance is a basic requirement of the connector standards Micro-ohmmeter measurements are influenced by micro-volt changes in the loop and the test equipment. Consistent results require proper equipment and careful technique.

DC resistance is typically measured by passing 10 amperes of DC current through the test loop and measuring voltage drop across each connector using a voltmeter sensitive enough to meet the accuracy specifications. For larger conductors, a higher DC current should be used if the measurement accuracy is marginal. When determining the voltage drop of small conductors, a current lower than 10 A dc may be used to avoid heating of the test loop. To avoid heating effects, any DC test current greater than 10 amperes should be less than 0.1% of the DC current or RMS AC current used during the heating cycle. The terminals used for the current input should be remote from any terminals used for the voltage measurements, and the terminal should be bonded or welded to each conductor strand similar to requirements for an equalizer (see Section 5.1.4).

Resistance measurements on the control conductor are recommended as a cross-check on the connector resistance measurements. If the control resistance shows any significant degree of instability, the system is not suitable for determining the resistance stability of connectors. Note, however, that it is normal to see a slight negative trend in control conductor resistance because the conductor is thermally annealing at the typical test temperatures.

Best results are achieved if voltage terminals on the test subjects are not moved for the duration of the test. Semi-permanent connections using a screw and a ring terminal have produced good results. Spring-loaded “alligator” clamps are acceptable but are more prone to move or fall as the loop flexes due to temperature changes. If manual readings are taken, there should be semi-permanent jumpers fitted to the test locations to allow the removable connections to be made remote from the semi-permanent connection to the test subjects.

Battery-powered or line-harvesting–powered portable low-resistance ohmmeters intended for field work are typically not stable enough for connector testing. If portable field-grade equipment is used, it is recommended that the unit be checked against a calibrated reference shunt at each use.

Calibration-grade reference shunts (calibrated resisters with separate current and voltage terminals) are commercially-available at low cost. Reference shunts with values between

0.1X and 10X of the connector resistance values are an excellent cross-check for micro-Ohmmeters.

The test loop should be isolated from the current-loading power supply using a disconnect switch or by unbolting a connection. Resistance should be measured when any nearby tests are in the OFF cycle to minimize measurement errors caused by induced currents.

Annex B
OPTIONAL FAULT CURRENT TEST CLASS "F" CONNECTORS

(Normative)

B1 Background

B1.1 An optional fault current test may be performed by agreement between the supplier and the purchaser.

B1.2 All connectors shall first acceptably complete the CCT or CCST test applicable to that connector class.

B1.3 This optional fault current performance test shall be applied to new connectors of the same type that have been previously qualified under the product standard.

B1.4 Connectors specified for use on both copper and aluminum conductors shall be tested with both types of conductors.

B1.5 The nominal fault current levels used in the testing are specified in Tables B1 and B2. Factors to consider when specifying the fault current level may include, but are not limited to, application for the connector, fault current ratings of other equipment on the power system, expected fault current levels on the power system where the connector will be used, and protection equipment ratings.

B1.6 Connectors that acceptably pass the fault current performance test shall be designated by "F-X" (fault current tested), where "X" is the nominal fault current level to which the connector was tested (e.g., F-12.5 kA).

B1.7 IEC 61284 Section 13.5.2.1 can be substituted for fault current testing described in Annex B if agreed upon by the manufacturer and purchaser; however, a class "F-X" rating will not be designated.

B2 Sampling Requirements

B2.1 Four samples of each connector/conductor combination, of the specific class of connector being tested, shall be mounted in a test loop in a horizontal plane.

B2.2 This loop shall be assembled with separable equalizers, and with a minimum exposed conductor length that is appropriate for the conductor size, as specified in

Table 5 and Table 6.

B2.3 The connector/conductor position shall be marked prior to the test so any conductor slippage can be determined.

B3 Connector Family Sample Set

To qualify a family of connectors (group of connectors using similar design criteria), a minimum of three sizes (largest, smallest, and intermediate) shall be tested. The results of testing a single connector-conductor combination to Annex B may be extended to cover other members of a family of connectors to Annex B provided the following conditions are met.

B3.1 Mechanical Range Taking Connectors

Example—For requirements for a family of mechanical connectors, See Table B3.

B3.2 Compression Connectors

Example—For requirements for a family of compression connectors, See Table B4.

B3.3 Range Taking Connectors

Range taking connectors shall be tested at the highest fault current rating listed in Table B.1 or B.2, using the smallest conductor size for that fault current rating. For examples of how to use tables B.1 and B.2 to select the conductor size for a given fault current level, see tables B.3 through B.5

B4 Test Methods

B4.1 The test samples shall complete a minimum of 100 conditioning cycles using the CCT procedure described in Section 5.1 prior to applying a fault current, to ensure that the connector/conductor assemblies are fully conditioned and that thermal and electrical stability of the interface has been achieved. The samples shall be tested at the current and temperature levels appropriate for the connector class.

B4.2 Following conditioning, the connector/conductor samples shall be disassembled at each of the back to back connector/conductor equalizers so that each of the four connector/ conductor assemblies can be individually subjected to the fault current testing. Each connector/conductor assembly shall be physically restrained at one end by clamping the conductor near the equalizer, while the connector end is grounded and unrestrained. To limit movement of the grounding conductor, the grounding conductor may be restrained no closer than five feet away from the free end of the connector sample assembly. Suggested minimum sizes for the flexible grounding conductor are given in tables B1 and B2. Each connector sample assembly shall initially be placed with the conductor in a straight (in-line) position before the first application of fault current.

B4.3 Current surges at a suitable level for the required fault current class, as specified in tables B1 or B2, shall be applied to each connector/conductor assembly.

B4.4 Each connector/conductor assembly shall be allowed to cool to 100°C (212°F) or less after each current surge. To speed up the testing process, forced-air cooling may be applied between current surges.

B4.5 Conductor and connector surface temperature shall be measured and plotted as a function of current, I, and time, t.

B4.6 Following the test, the electrical resistance shall be recorded for each sample when samples have returned to ambient temperature.

B5 References

Aluminum Electrical Conductor Handbook, 3rd Edition, 1989; reaffirmed in 1998

IEEE 837-2002, *Standard for Qualifying Permanent Connections Used in Substation Grounding*

ANSI/IEEE C37.41-2008, *Standard Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories*

ANSI/IEEE C37.34-1994, *Standard Test Code for High-Voltage Air Switches*

Table B1
Fault Current Levels for Connectors Used in Primary (Greater than 600 V) Circuits

Nominal Fault Current Rating (kA)	12.5	15	25	38	60
Typical Continuous Current Rating (A)	100–199	200–299	300–599	600–1199	≥ 1200
RMS Current (kA)	12.5	15	25	38	60
Minimum X/R Ratio	8	10	20	20	20
Surge Duration (seconds)	0.13 sec./ 8 cycles @ 60 Hz	0.13 sec./ 8 cycles @ 60 Hz	0.3 sec./ 18 cycles @ 60 Hz	0.3 sec./ 18 cycles @ 60 Hz	0.3 sec./ 18 cycles @ 60 Hz
Number of Surges	10	10	10	10	10
Minimum Grounding Conductor Size	#2 AWG Cu	#1 AWG Cu	4/0 AWG Cu	350 kcmil Cu	500 kcmil Cu
Minimum Conductor Size for Test Samples	#4 AWG Cu #1 AWG Al	#1 AWG Cu 1/0 Al	2/0 Cu 250 kcmil Al	250 kcmil Cu 350 kcmil Al	400 kcmil Cu 556.5 kcmil Al

Table B2
Fault Current Levels for Connectors Used in Secondary (600 V or Less) Circuits

Nominal Fault Current Rating (kA)	10	20	30
Typical Continuous Current Rating (A)	100–399	400–599	≥ 600
RMS Current (kA)	10	20	30
Minimum X/R Ratio	6	12	20
Surge Duration (seconds)	0.083 sec/ 5 cycles @ 60 Hz	0.25 sec/ 15 cycles @ 60 Hz	0.25 sec/ 15 cycles @ 60 Hz
Number of Surges	10	10	10
Minimum Grounding Conductor Size	#2 AWG Cu	3/0 AWG Cu	250 kcmil Cu
Minimum Conductor Size for Test Samples	#6 AWG Cu #2 AWG Al	2/0 Cu 250 kcmil Al	250 kcmil Cu 350 kcmil Al

NOTE 1—The typical continuous current ratings (A) noted in tables B1 and B2 are representative of the relationship between the continuous current ratings of the attached conductor and fault current requirements of equipment used for electric distribution systems. These values are not specific to conductor sizing or current ratings but are used as a guide to determine the appropriate fault current test level for a connector based upon the continuous current rating of the attached conductor.

NOTE 2—Minimum conductor size for test samples in tables B1 and B2 are based on two criteria: 1) IEEE 837 with calculated temperature <60% of fusing current; 2) copper conductor must be larger than the minimum grounding conductor size specified for the next lower current rating.

Table B3
Example 1

Family of Secondary URD Mechanical Connectors					
Connector Cable Range		**Max Conductor Continuous Current (Amps)**	**Current Range (Amps)**	**Fault Current Level Table B2 (kA)**	**Test Conductor (Table B2)**
Min	**Max**				
#6 AWG Al (USE)	4/0 AWG Al (USE)	290	100 – 399	10	#2 AWG Al
#6 AWG Al (USE)	350 kcmil Al (USE)	385	100 – 399	10	Not Tested
#2 AWG Al (USE)	500 kcmil Al (USE)	465	400 – 599	20	250 kcmil Al
1/0 AWG Al (USE)	1000 kcmil Al (USE)	670	≥ 600	30	350 kcmil Al

Table B4
Example 2

Family of Compression Connectors Aluminum/Copper Rated from #4 AWG – 1000 kcmil				
Connector Conductor Size	**Max Continuous Current (Amps)**	**Current Range (Amps)**	**Fault Current Level Table B1 (kA)**	**Test Conductor**
#4 AWG AAC	185	100 – 199	12.5	#4 AWG AAC
#1 AWG AAC	214	200 – 299	15	Not Tested
3/0 AWG AAC	331	300 – 599	25	3/0 AWG AAC
500 kcmil AAC	658	600 – 1199	38	Not Tested
1000 kcmil Cu	1180	600 – 1199	38	1000 kcmil Cu

Table B5
Example 3

Range Taking Compression Connector from #4 AWG to 350 kcmil Aluminum				
Conductor Size	**Max Continuous Current (Amps)**	**Current Range (Amps)**	**Fault Current Level Table B1 (kA)**	**Test Conductor**
#4 AWG AAC	185	100 – 199	12.5	Not Tested
3/0 AWG AAC	331	300 – 599	25	3/0 AWG AAC
350 kcmil	526	300 – 599	25	Not Tested

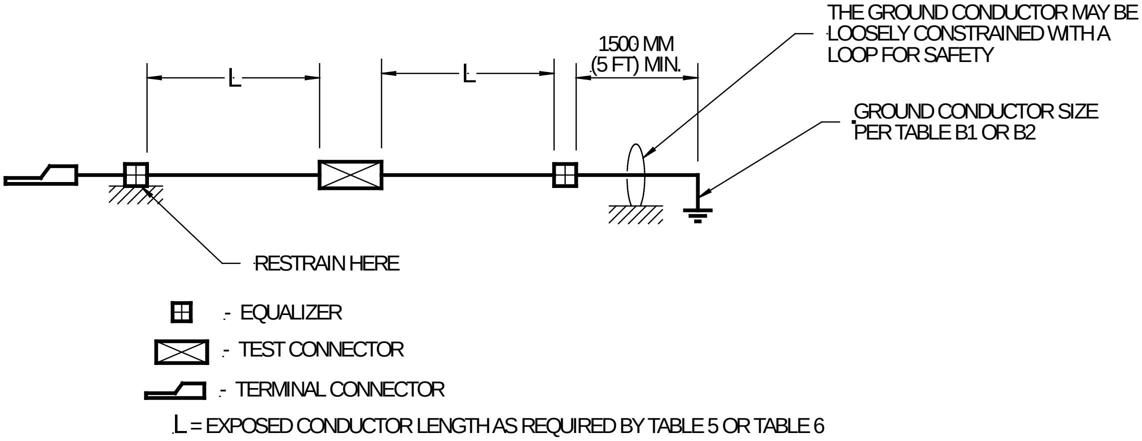


Figure B1
Typical Circuit Schematic for an Overhead Splice Fault Current Test

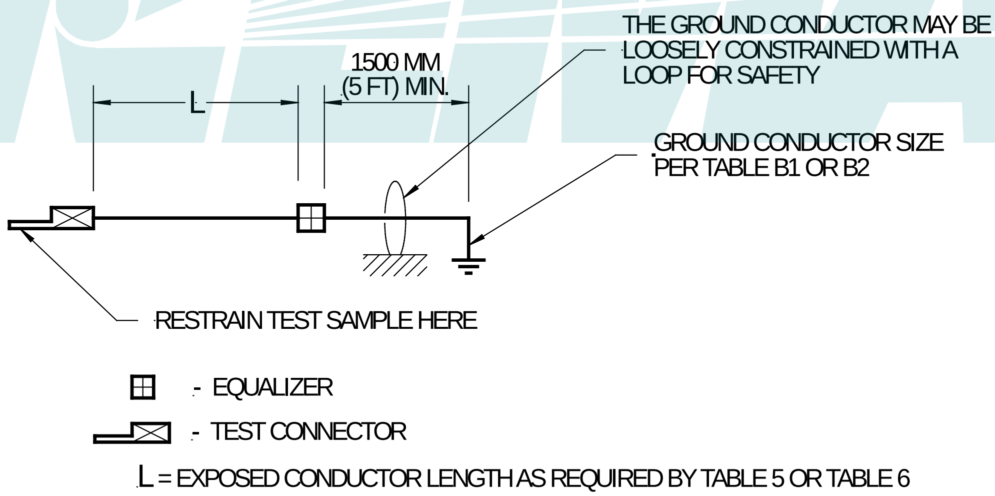


Figure B2
Typical Circuit Schematic for an Overhead Termination Fault Current Test

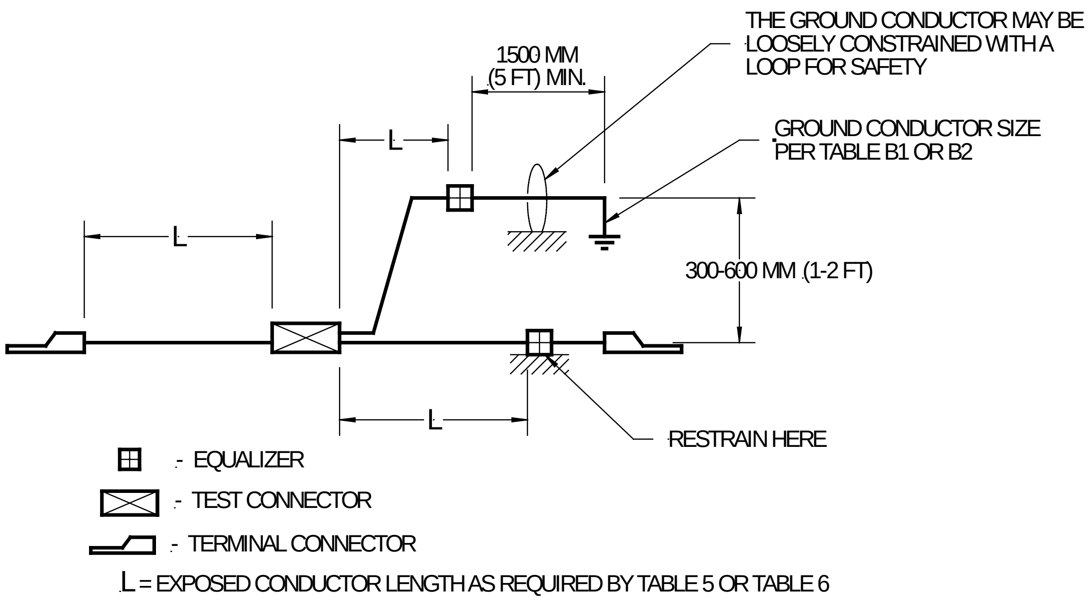


Figure B3
Typical Circuit Schematic for a Tap Connector Fault Current Test

Annex C
OPTIONAL CORROSION TEST ADDITION TO CURRENT CYCLE TEST (CCT) CLASS "S" CONNECTORS

(Normative)

C1 Scope and Purpose

C1.1 Scope

An optional corrosion test may be performed by agreement between the supplier and the purchaser. This optional test establishes the parameters and performance requirements for a corrosion test of electrical connectors. This test is conducted as a precondition for the Current Cycle Test (CCT) as described in Section 5.1. The mechanical requirements are not addressed.

C1.2 Purpose

The purpose of this optional test is to simulate a corrosive environment exposure and give reasonable assurance to the user that connectors complying with the requirements of this optional test will perform in a satisfactory manner in a corrosive environment, provided they are installed in accordance with the manufacturer's recommendations.

C2 Sample Preparation

C2.1 Four samples of each connector and conductor combination required by the CCT, as described in Section 5.1, shall be used.

C2.1.1 The CCT loop may be assembled without disconnects when a complete loop is to be exposed.

C2.1.2 The CCT loop may be assembled with disconnects between equalizers when an individual connector/conductor/equalizer sample is to be exposed.

C3 Test Procedure

C3.1 The samples shall be subjected to a 5% salt fog exposure for 1,000 hrs in accordance with ASTM B117.

C3.1.1 The complete test loop shall be exposed and later assembled into the CCT test.

C3.1.2 When disconnects are installed between equalizers, the individual samples shall be exposed and later assembled into the CCT test loop.

C3.1.2.1 When individual samples are used, the complete connector/conductor/equalizer shall be exposed.

C3.1.2.2 Additional installed parts needed to assemble the individual sample into the test loop shall be protected from the corrosion environment or designed to ensure the corrosion environment does not affect the resistance measurement of the CCT test.

C4 Marking

C4.1 In addition to the marking required by the product standard, an “S” designation shall be added for connectors that comply with the requirements of this test.

Annex D
SUGGESTED THERMOCOUPLE LOCATIONS

(Informative)

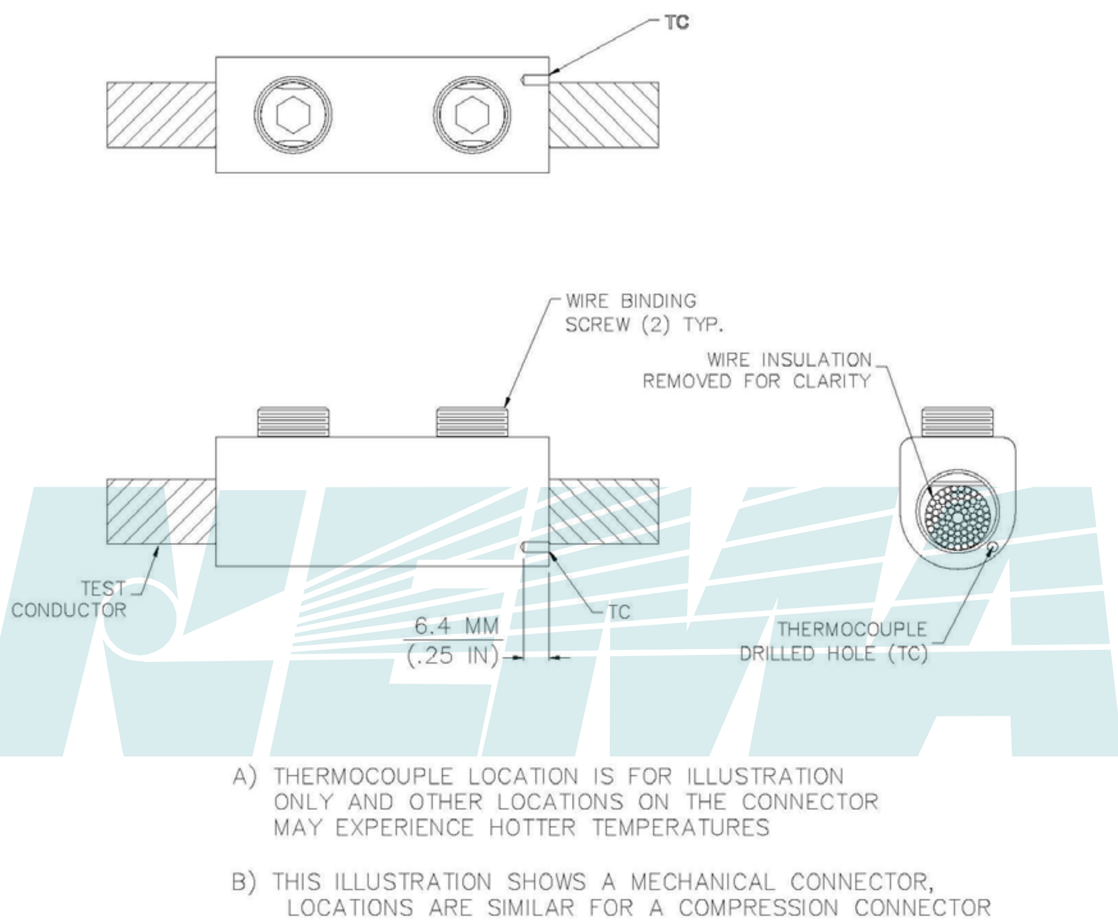


Figure D1
Suggested Thermocouple Locations

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