IEEE C37.20.1 Working Group Meeting Minutes

IEEE Standard for Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear

Meeting Date: October 10, 2023
Meeting Time: 2:00 pm – 6:00 pm
Location: Catamaran Resort Hotel – San Diego, CA

Attendance

Members:19, Guests:19, quorum met
Attendance is recorded at the end of the meeting minutes.

A. Call to Order

Meeting was called to order at 2:00 pm on October 10, 2023

B. Introductions

Participants introduced as included below.

C. Approval of Agenda and Prior Meeting Minutes

Motion to approve agenda by T. Burse, 2nd by K. Sippel. Approved by unanimous consent.
Motion to approve previous meeting minutes by Clint Carne, 2nd: Ted Burse. Approved by unanimous consent.

D. Rules and Guidelines for conducting Working Group Meetings

Slides and links to documents shared with Working Group
Verbal call for Essential Patents – None Identified

E. IEEE SA Copyright Policy

Link and Slides for SA Copyright Policy shared to WG.

F. Working Group P&P's

Link for Working Group P&P's shared to WG.

G. PAR Status Report

PAR approved by SA Standards Board 03 Dec 2020 and expires 31 Dec 2024.

H. IEEE iMeet Center Workspace

Working Group workspace location and files shared (https://ieee-sa.imeetcentral.com/c37201/home).
Any working group members that require access should contact either the Chair or Secretary.

I. WG Membership

New WG Members: A. Doroz, E. Hardy

J. Quorum Check

Quorum confirmed.

K. Ad-hoc Reports

a. **Continuous Current Testing Improvements (C37.13/C37.20.1):**
M. Lafond: Work is ongoing. Current activity focused on potential new language in PC37.13 draft.

b. **Clause 6.2.5/6.2.6 Short-time/Short-circuit:**
T. Burse: Report and proposed text shared with the WG. A copy of the report and draft text proposal attached to these meeting minutes. Motion to incorporate the proposed text in the next draft circulation by T. Hawkins; 2nd: D. Edwards. Motion approved by unanimous consent.

Ad-hoc is willing to continue work on potential improvements on the definition of a current-limiting device, trip units active during short-circuit testing, protected outgoing cable terminal testing, and primary disconnect testing. Chair asks ad-hoc to continue work on these topics with a goal to provide a recommendation by the next Spring meeting. M. Valdes and C. Schneider requests membership into the ad-hoc.

Action: T. Burse to continue leading ad-hoc as noted above.
Action: M. Lafond to address the definitions of "riser bus" and other bus terms not currently defined in the draft document.

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c. **Withdrawable/Draw-out/Removable Element Terms:**
D. Delfino: Report shared with the WG. A copy of the report is attached to these meeting minutes. WG agrees with most of ad-hoc recommendations except for the new definitions associated with the term circuit breaker. Draft 7 will incorporate the approved recommendations in the next circulation to the WG.

Action: M. Lafond will address the term use of circuit breaker to envelope the intended application of C37.13, C37.14, C37.13.1, and fuse truck components within the draft document.

d. **Copyright Permission for C37.20.09 Introduction Sentence:**
M. Lafond: Change in Introduction shared with WG and will be in next draft circulation to WG.

L. Review Draft Document & Comments
58 draft comments received from the circulated draft 6. WG resolved all technical comments and results will be documented in draft 7. New draft to be updated and re-circulated to the WG for comments prior to the Spring meeting.

Action: D. Hrncir tasked with improved language on the 600 V requirement for wiring in clause 7.1.3.3. Chair requests a recommendation prior to the next Spring meeting.

M. Adjourn
Meeting adjourned at 6:07 pm.

Recorded by:
Robert Burns
Secretary
October 10, 2023

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Attendance:

Role	First Name	Last Name	Company
Chair	Mike	Lafond	Underwriters Laboratory
Secretary	Robert	Burns	Eaton
Member	Ted	Burse	Powell Industries
Member	Clint	Carne	Schneider Electric
Member	Dan	Delfino	ABB
Member	Erik	Doroz	Eaton
Member	Doug	Edwards	Siemens Industry
Member	Sahadev	Gohil	AVAIL Switchgear Solutions
Member	Lou	Grahor	Eaton
Member	Erin	Hardy	Eaton
Member	Tom	Hawkins	Siemens Industry
Member	Jared	Hines	Eaton
Member	Dan	Hrncir	Eaton
Member	Darryl	Moser	ABB
Member	Owen	Parks	ABB
Member	Carl	Schneider	Schneider Electric
Member	Kevin	Sippel	Eaton
Member	Bryan	Tatum	Underwriters Laboratory
Member	Eddie	Wilkie	Eaton
Corresponding	Emmanuel	Ankrah	KEMA
Guest	Randy	Blake	Schneider Electric
Guest	Randall	Creach	AVAIL Switchgear Solutions
Guest	Brian	Gerzeny	Powell Industries
Guest	Ronald	Hartzel	Eaton
Guest	Terry	Hunt	Westinghouse
Guest	Shah	Jamal	Avan Grid
Guest	John	Kemlaski	Siemens Industry
Guest	Adrian	Lopez	Powell Industries
Guest	Eunhye	Park	Kepco Exc
Guest	Paul	Rakus	Eaton
Guest	Mark	Roberson	AVAIL Bus Systems
Guest	Tim	Rohrer	Exiscan
Guest	Amy	Rowell	Schneider Electric
Guest	Todd	Sauve	Rockwell Automation
Guest	Victor	Savulyak	KEMA
Guest	Christo	Thomas	Schneider Electric
Guest	Marcello	Valdez	ABB

IEEE PES Switchgear Committee
C37.20.1 WG Meeting
6.2.5 – 6.2.6 Ad Hoc Report
10 October, 2023
San Diego, California

Ted Burse

Ad Hoc Members

Emmanuel Ankrah
Ted Burse (Chair)
Paul Barnhart
Keith Flowers
Erin Hardy
Greg Harmon
Tom Hawkins
Dan Hrncir
Mike Lafond
Adrian Lopez
Victor Savulyak
Kevin Sippel
Bryan Tatum
Danish Zia

Ad Hoc Scope

Develop a recommendation for the WG at or before the Fall meeting for clauses 6.2.5 and 6.2.6.

Background:

WG comments highlight several topic areas within the test clauses of 6.2.5 and 6.2.6 that need investigative work and discussion to determine (1) if any changes were necessary, and (2) what other actions might be required to align to other sub-clauses.

6.2.5 Short-Time Test (Recap)

- Allow the use of a circuit breaker if test is performed with a 1 second duration.
  - Currently not allowed
  - Exceeds the requirements of C37.50
- Allow combination with 6.2.6 short-circuit test if current requirements of both 6.2.5 and 6.2.6 are met.

Short-Circuit Test (Recap)

- Allow a circuit breaker to be used for short-circuit tests
  - The use of a circuit breaker for the short-circuit test is currently not allowed. (Compartment “test jumpers” only)
  - Possible contradiction of combining short-time and short circuit tests if a circuit breaker is used.

Spring 2023 WG Directive

- Spring 2023 2023 WG Minutes:
  - Chair approves for continuation of work with guidance to not exceed circuit breaker C37.13/C37.50 parameters if the ad-hoc considers the inclusion of the circuit breaker in 20.1 testing.

Ad Hoc Update

- C37.51 allows combination of short-time and short-circuit tests if all parameters for both tests are met
- C37.51 allows the use of a circuit breaker for the short-circuit test
- C37.51 - -2018 does not allow the use of a circuit breaker for a 1 second short-time test

Ad Hoc Consensus

- C37.51 allows circuit breakers to be used for short-circuit tests, so 20.1 should not disallow it
- Allow combination of short-time and short-circuit tests if all parameters for both tests are met
- Allow the use of a circuit breaker for a 1 second short-time test
- “Bus in a box = full withstand”

Summary of Proposed Changes

- Short-time current withstand tests terminology alignment
- Allow combination of short-time and short circuit tests if all parameter met
- Removed uppermost compartment requirement from test arrangements
- Clarified requirement for DC resistance baseline tests (primary disconnecting devices = yes)
- Clarified calibration of prospective current
- Clarified through-current tests of dc switchgear (solid-state rectifiers)
- Corrected short-time test I^2t current requirement
- Changed greatest length of riser bus to shortest length for circuit breaker compartment tests

Summary of Proposed Changes (Cont.)

- Allow use of a circuit breaker for the short-circuit test
- Added requirement for peak current to be on outside pole
- Added ±20% tolerance to test current frequency for short circuit test
- Harmonized test connections for short-circuit test with short-time test
- Added performance criteria for short-circuit tests
- Corrected performance criteria for auxiliary equipment primary disconnecting device short-circuit current withstand test to match C37.20.2

Ad Hoc Discussion Topics, No Recommendations

- Definitions of “riser bus” and outgoing cable bus
- Current limiting device
- Direct acting trip device allowed to remain operative for short-circuit test
- “Protected” outgoing cable terminal points: fused breakers, definite-purpose switching devices
- Primary disconnecting device test requirement
- GP LV dc breaker “stacking”

Questions?

6.2.5 Short-time current withstand ~~current~~ tests

Short-time current withstand ~~current~~ tests shall be made to demonstrate the thermal and mechanical capability of the buses and connections in LV switchgear to withstand the rated short-time current of the assembly. (See 5.4.4) This test shall be conducted as a three-phase test, except for the tests of the ground bus and the neutral bus in -31681 and -31681. This test is not required for fused circuit breaker compartments.

If the test current and voltage level of the short-time and short-circuit tests are the same, and the test circuit characteristics meet the requirements for each test, this test may be combined with the short-circuit current withstand test.

Short-time current withstand~~-~~ tests shall be made using one of the following arrangements:

a) The test shall be made with a circuit breaker of a type that has previously met the design test requirements for short-time current performance as specified in ANSI C37.50 or IEEE Std C37.14~~, and shall be located in the uppermost compartment~~. The circuit breaker shall be closed and the direct acting trip device shall be removed or made inoperative.

b) If a circuit breaker compartment is not physically equivalent to the qualified circuit breaker enclosure or the switchgear stationary primary disconnecting devices and insulating supports for drawout circuit breaker are not identical to the qualified circuit breaker, the short-time current test shall include a circuit breaker of the construction used. The circuit breaker shall be closed ~~and located in the uppermost compartment,~~ and the direct acting trip device shall be removed or made inoperative.

c) If the switchgear circuit breaker compartment is physically equivalent to the qualified circuit breaker enclosure and the switchgear stationary primary disconnecting devices and insulating supports for the drawout circuit breaker are identical to the qualified circuit breaker, no additional testing of the circuit breaker, circuit breaker compartment, or associated conductors is required. In this case, the circuit breaker compartment stationary incoming primary disconnecting devices shall be connected to the circuit breaker compartment outgoing stationary primary disconnecting devices. The connections shall be within the compartment and, in so far as possible, shall not add bracing to the structure being tested. ~~The uppermost circuit breaker compartment shall be used for the test.~~

As a baseline for performance evaluation before the test with primary disconnecting devices, a dc resistance test across the circuit to be tested shall be made with a minimum of 100 A through the circuit.

6.2.5.1 Primary bus and connections

6.2.5.1.1 Test current

The prospective short-time current is determined by calibrating the test circuit with a short-circuit placed directly across the bus connection at the incoming switchgear terminals.

For LV ac switchgear, and LV dc switchgear not supplied by solid state rectifiers, the prospective current shall be the rms value calculated in accordance with IEEE Std C37.09. This test shall be conducted as a three-phase test, except for the tests of the ground bus and the neutral bus in -31681 and -31681.

Commented [BT1]: Placeholder - Out-of-scope for Ad Hoc, should refer to WG.

B. Tatum comment.

Lines 802-803:

"For the tests specified in 6.2.5 through 6.2.6 with primary disconnecting devices, the ground bus, or ground bus connections in the test current path, the circuit resistance of each phase shall be measured with a dc current of at least 100 A prior to the test as a baseline for performance evaluation."

For LV dc switchgear used with solid-state rectifiers, a dc test source is preferred. If the initial peak current applied is 1.65 times the average rms or dc sustained current value, and the test current also meets the requirements of -31681, this test may be combined with the short-circuit current withstand test. Either a dc prospective current may be used, or the test may be performed using the I^2t true rms current through the test assembly. ~~The prospective current is determined by calibrating the test circuit with a short-circuit placed directly across the bus connection at the incoming switchgear terminals.~~

6.2.5.1.2 Test voltage and frequency

For prospective current testing of LV ac switchgear, the test circuit voltage prior to the inception of current flow shall be no less than the rated maximum voltage, and the frequency of the test current shall be the rated power frequency ±20%.

For prospective current testing of LV dc switchgear, the test circuit voltage prior to the inception of current flow shall be no less than the rated maximum voltage. Through-current tests for LV dc switchgear used with solid-state rectifiers may be at any convenient voltage not exceeding rated maximum voltage.

6.2.5.1.3 Test duration

For LV ac switchgear, the test current shall continue for two periods of 0.5 s separated by a 15 s interval of zero current. At the option of the manufacturer, a single period of 1 s duration may be used ~~if circuit breakers are not included in the test current path of the assembly~~. The alternating component of the prospective short-time current at the end of each 0.5 s period (or 1 s period if manufacturer elects to use 1 s duration) shall remain constant. If ~~the~~ during test current calibration the average symmetrical ac component of the prospective short-time test current does not remain constant for the test duration, the value of the average symmetrical current squared times the actual duration of the test shall be no less than 0.5 x I^2 where I is the rated short-time ~~current~~ withstand current of the assembly (for a 0.5 second test) or 1.0 x I^2 (for a 1.0 second test). If necessary, the test duration may be extended to not more than 125% of the specified time to achieve the required value of I^2 x t.

For LV dc switchgear, the current duration shall be at least 250 ms.

6.2.5.1.4 Test connections

For LV ac switchgear, the main bus terminals shall be connected to the test circuit power source, and the ~~outgoing terminals shall be connected together at the farthest point from the circuit breaker compartment terminals.The~~ tests shall be made with a short at the following locations:

a) At the opposite end of the main bus from the terminals to cause ~~a short-time~~ current to pass through the main bus and splice.

b) At a location on the section bus (riser) so that ~~a short-time~~ current passes through the greatest possible length of the section bus (riser).

~~b)~~c) At a location on the outgoing cable terminal points so that current passes through the shortest~~greatest~~ possible length of the section bus (riser) which includes a feeder circuit breaker compartment. ~~See paragraph 6.2.5 for the circuit breaker compartment arrangement.~~

For three-phase testing, the enclosure shall be insulated from ground and shall be connected through a 30 A fuse of adequate interrupting rating to the supply side of the phase judged least likely to strike to the enclosure. As an alternate configuration, at the manufacturer's option, the 30 A fuse may be replaced by a wire no larger than no. 10 AWG copper.

For LV dc switchgear with a single bus, the test connections shall be made to the incoming main bus terminals and to the circuit breaker outgoing terminals.

For LV dc switchgear with positive and negative buses, the test connections shall be made to the incoming main bus terminals, with the outgoing circuit breaker terminals shorted.

The short-circuit connections shall be of minimum length with cross-section equal to the bus being tested.

Insofar as possible, the connections shall not add bracing to the bus structure being tested.

6.2.5.1.5 Performance

After the test, the switchgear shall have the following:

a) No breakage of insulation or structural components
b) No permanent deformation of bus or its supports
c) No separation of bus or bus connections, and no reduction in the cross-section of the bus or bus connections
d) Ground fuse or wire shall be intact

In addition, if the test is performed with a drawout circuit breaker, the switchgear shall comply with the following:

e) The removable element shall be capable of moving from the connected to the disconnected position and back to the connected position via its intended means
f) The primary disconnecting devices shall exhibit no signs of pitting or welding

If the switchgear has not met the requirements of item b) at the conclusion of the test, the dielectric tests described in **Error! Reference source not found.** shall be repeated. The switchgear shall be considered to have passed this portion of the short-time current withstand test if it successfully passes the dielectric tests.

If the switchgear has not met the requirements of item f) at the conclusion of the test, a dc resistance test across the tested circuit shall be made with a minimum of 100 A through the circuit. The switchgear shall be considered to have passed this portion of the short-time current withstand test if the dc resistance of the equipment after the short-time current withstand test does not exceed 200% of the circuit resistance of the circuit prior to the test.

6.2.5.2 Neutral bus and connections (If applicable)

6.2.5.2.1 General

A single-phase short-time current withstand test shall be made on the neutral bus. The test parameters shall be as described in -31681 through -31681, except that test voltage is to be applied between the neutral and nearest phase bus, and the voltage shall be at least rated maximum voltage divided by √3. If the test is performed with a four-pole draw out circuit ~~The~~breaker, the circuit resistance shall be measured with a dc current of at least 100 A prior to the test as a baseline for performance evaluation. The short-circuit connection shall be made between the ends of the main and neutral bus bars at the end opposite the test source connection. The phase bus and neutral bus shall be the minimum size bus furnished by the manufacturer for the short-time withstand current rating being tested. The short-circuit connection shall be made with bolted bars of minimum length, and cross-section equal to the bus being tested. Insofar as possible, the connections shall not add intentional bracing to the bus structure being tested. The enclosure shall be insulated from ground and shall be connected through a 30 A fuse of adequate interrupting rating to the supply side of the phase under test. As an alternate configuration, at the manufacturer's option, the 30 A fuse may be replaced by a wire no larger than no. 10 AWG copper.

6.2.5.2.2 Performance

After the test, the switchgear shall have the following:

a) No breakage of insulation or structural components
b) No permanent deformation of bus or its supports
c) No separation of bus or bus connections, and no reduction in cross-section of the bus or bus connections
d) Ground fuse or wire shall be intact

In addition, if the test is performed with a four-pole drawout circuit breaker, the switchgear shall comply with the following:

e) The removable element shall be capable of moving from the connected to the disconnected position and back to the connected position via its intended means
f) The primary disconnecting devices shall exhibit no signs of pitting or welding

If the switchgear has not met the requirements of item b) at the conclusion of the test, the dielectric tests described in **Error! Reference source not found.** shall be repeated. The switchgear shall be considered to have passed this portion of the short-time current withstand test if it successfully passes the dielectric tests.

If the switchgear has not met the requirements of item f) at the conclusion of the test, a dc resistance test across the tested circuit shall be made with a minimum of 100 A through the circuit. The switchgear shall be considered to have passed this portion of the short-time current withstand test if the dc resistance of the equipment after the short-time current withstand test does not exceed 200% of the circuit resistance of the circuit prior to the test.

6.2.5.3 Ground bus and connections

For LV ac switchgear and LV dc switchgear that includes a ground bus, a single-phase short-time current withstand test shall be made on the ground bus. The test parameters shall be as described in -31681 through -31681, except that the test voltage is to be applied between the ground bus and nearest phase bus, shall be at least rated maximum voltage, and only a single 0.5 second test current period is required. The circuit resistance shall be measured with a dc current of at least 100 A prior to the test as a baseline for performance evaluation. Tests for the ground bus shall be made by connecting the ground bus to one phase of the source and connecting the nearest phase bus to another phase of the source. The short-circuit connection shall be made between the ends of the main and ground bus bars at the end opposite the test source connection. The short-circuit connection shall be made with bolted bars of minimum length, and cross-section equal to the ground bus being tested. Insofar as possible, the connections shall not add intentional bracing to the bus structure being tested. The test shall be made using the smallest ground bus size furnished by the manufacturer for the short-time current rating being tested.

This test is not applicable to LV dc switchgear which is intended for ungrounded installation (without ground bus).

6.2.5.4 Performance

After the test, the ground bus, joints and connections shall have the following:

a) No breakage of insulation or structural components
b) No reduction in phase-to-ground or phase-to-phase clearance
c) No separation of bus or bus connections, and no reduction in cross-section of bus or bus connections

A dc resistance test across the tested circuit shall be made with a minimum of 100 A through the circuit. The dc resistance of the circuit after the short-time current withstand test shall not exceed 200% of the circuit resistance prior to the short-time current withstand test.

If the switchgear has not met the requirements of item b) at the conclusion of the test, the dielectric tests described in **Error! Reference source not found.** shall be repeated. The switchgear shall be considered to have passed this portion of the short-time current withstand test if it successfully passes the dielectric tests.

6.2.6 Short-circuit current withstand tests

6.2.6.1 General

Short-circuit current withstand tests shall be made to demonstrate the mechanical adequacy of the structure, buses, and connections when the bus is subjected to a high current for a specified time. The current for these tests is to be equal to the short-circuit rating of the circuit breakers intended for use in the tested switchgear. (See 5.4.5)

Short-circuit current withstand tests shall be made using one of the arrangements in accordance with 6.2.5 a), b), or c).

As a baseline for performance evaluation before the test with primary disconnecting devices, a dc resistance test across the circuit to be tested shall be made with a minimum of 100 A through the circuit.

6.2.6.2 LV ac switchgear and LV dc switchgear (not for solid-state rectifier applications)

The duration of current flow during the short-circuit current withstand test shall be for no less than four cycles on a 60 Hz basis (0.067 s), unless the bus is protected by a current-limiting device, in which case the duration shall be for the time permitted by that device.

The three-phase rms symmetrical value of prospective short-circuit current is determined by calibrating the test circuit with a short-circuit placed directly across the bus connection at the incoming switchgear terminals~~current that verifies the short-circuit withstand current rating shall be determined by calibrating the test circuit with the LV switchgear omitted~~ and shall be measured one-half cycle after the inception of the current flow in the test circuit. This current in each phase shall be calculated in accordance with IEEE Std C37.09. For three-phase circuits, the symmetrical current value shall be the average of the phase currents.

The power factor of the test circuit shall be 15% lagging or less (X/R ratio of 6.6 or greater) with X and R in series connection. The power factor shall be determined in accordance with IEEE Std C37.26. For fused circuit breaker equipment, the power factor shall be 20% lagging or less (X/R ratio of 5 or greater).

The rms value of the alternating component of the current at the end of three cycles shall be no less than 90% of the value measured at one-half cycle after initiation of the current.

The current shall be initiated in the test circuit in such a manner that the peak current available is no less than 2.3 times (2.16 for fused circuit breakers) the single-phase rms symmetrical value for the single-phase tests and 2.3 times (2.16 for fused circuit breakers) the three-phase rms symmetrical value in one phase for three-phase tests. The peak current shall be applied to an outside pole.

The test-circuit voltage prior to the inception of current flow shall be no less than the rated maximum

voltage.

The frequency of the test circuit shall be the rated power frequency +20%.

Individual single-phase tests are also to be made to prove the strength of the ground bus and the neutral conductor design with respect to the nearest phase bus during the test. Line-to-neutral voltage is to be applied between the neutral and the nearest phase bus during the test of the neutral bus. Line-to-line voltage is to be applied between the ground bus and the nearest phase bus during the test of the ground bus.

Low-voltage dc switchgear having no circuit breakers applied to solid-state rectifiers may be qualified using an ac test source as outlined in this subclause. The LV dc switchgear used in solid-state rectifier applications shall be tested in accordance with -31681.

6.2.6.3 LV dc switchgear

For LV dc switchgear used with solid-state rectifiers, a dc test source is preferred. The circuit shall produce a current peak with a value no less than the associated short-time peak current rating of the circuit breaker within 10 ms.

For LV dc switchgear assemblies, the short-circuit withstand test may be performed with either a prospective test current or with a through-peak current. The circuit breaker shall be closed and the overcurrent trip device shall be made inoperative.

For prospective current tests, the test circuit voltage prior to the inception of current flow shall be no less than the rated maximum voltage. Through-current tests may be at any convenient voltage not exceeding rated maximum voltage.

6.2.6.4 Test connections

For LV ac switchgear, the main bus terminals shall be connected to the test circuit power source, and the tests shall be made with a short at the following locations:

a) At the opposite end of the main bus from the terminals to cause ~~a short-circuit~~ current to pass through the main bus and splice.

b) At a location on the section bus (riser) so that ~~a short-circuit~~ current passes through the greatest possible length of the section bus (riser).

c) At a location on the outgoing cable terminal points so that ~~a short-circuit~~ current passes through the shortest~~greatest~~ possible length of the section bus (riser) which includes a feeder circuit breaker compartment. ~~The circuit breaker compartment stationary incoming primary disconnecting devices shall be connected to the circuit breaker compartment outgoing stationary primary disconnecting devices. The connections shall be within the compartment and, in so far as possible, shall not add bracing to the structure being tested.~~

For three-phase testing, the enclosure shall be insulated from ground and shall be connected through a 30 A fuse of adequate interrupting rating to the supply side of the phase judged least likely to strike to the enclosure. As an alternate configuration, at the manufacturer's option, the 30 A fuse may be replaced by a wire no larger than no. 10 AWG copper.

For LV dc switchgear with a single bus, the test connections shall be made to the incoming main bus terminals and to the circuit breaker outgoing terminals.

Commented [BT2]: B. Tatum comment, modified line numbers by T. Burse.

Line items 217 through 232 are limited in scope to LV ac switchgear based upon the statement in Line item 217. Line items 233 through 236 are specific to the LV dc switchgear. The specified test applications for dc switchgear are limited in scope compared to ac rated equipment.

Should a reference to the 219 through 228 lines or requirements that align with the concepts of lines 219 through 228 be considered for dc assemblies with a main and riser bus structure?

For LV dc switchgear with positive and negative buses, the test connections shall be made to the incoming main bus terminals, with the outgoing circuit breaker terminals shorted.

6.2.6.5 Performance

The performance criteria for these tests are the same as for the short-time current withstand tests, as given in 6.2.5.1.5 (phase bus), 6.2.5.2.1 (neutral bus), and 6.2.5.4 (ground bus); and the enclosure fuse or wire described in 6.2.6.5.5 shall not be open.

6.2.6.~~5~~6 Auxiliary equipment primary disconnecting device short-circuit current withstand test

6.2.6.~~5~~6.1 General

The primary disconnecting device and connecting bus or cable for voltage transformer (VT) and control power transformer (CPT) auxiliary sections shall be capable of carrying the short-circuit current from a transformer failure until the primary fuse protection can operate. The test sample shall use fuses with the maximum rated peak let-through current allowed by the design.

6.2.6.~~5~~6.2 Test current

The test current shall be a prospective value calibrated at the main bus connection point for the auxiliary section and no less than the peak and rms symmetrical values specified in **Error! Reference source not found.**.

6.2.6.~~5~~6.3 Test voltage

The test shall be performed at the rated maximum voltage of the LV switchgear.

6.2.6.~~5~~6.4 Test duration

The actual duration of current flow is limited by operating time of the primary fuse protection for the transformer. The circuit shall be calibrated for a maximum duration of four power frequency cycles.

6.2.6.~~5~~6.5 Test connections

The test circuit power source shall be connected to the incoming terminals of the auxiliary section.

The short-circuit connection shall be a bolted connection made phase-to-phase on the load side of the fuses using cable of the same size as used for the connection from the main bus to the disconnecting device.

For three-phase testing, the enclosure shall be insulated from ground and shall be connected through a 30 A fuse of adequate interrupting rating to the supply side of the phase judged least likely to strike to the enclosure. As an alternate configuration, at the manufacturer's option, the 30 A fuse may be replaced by a wire no larger than no. 10 AWG copper.

6.2.6.~~5~~.6 Performance

After the test:

a) The primary disconnecting devices shall show no signs of burning.

b) All connections shall remain effective.

c) There shall be no breakage of insulation or structural components.

d) The drawout or tilt-out component of the auxiliary section shall be capable of operation from the connected position to the disconnected position and back to the connected position via its intended means.

e) For three phase tests the enclosure fuse or wire shall not be open.

~~The performance criteria for these tests are the same as for the short-time current withstand tests, as given in 6.2.5.1.5 (phase bus), 6.2.5.2.1 (neutral bus), and 6.2.5.4 (ground bus); and the enclosure fuse or wire described in 6.2.6.5.5 shall not be open.~~

C37.20.1 Ad Hoc

Drawout vs Removable Terminology

Dan Delfino, Erin Hardy, Mike Lafond

C37.20.1 Ad Hoc

Drawout vs Removable Terminology

Ad-hoc Task: review draft document for consistent use of the terms withdrawable element, draw-out mounted device, and removable element as defined in C37.20.10 for appropriate use within C37.20.1.

C37.20.1 Ad Hoc

C37.20.10 Terms

removable element

- A withdrawable device that normally carries the current-carrying and or circuit-switching components for the main circuit, as well as primary and secondary disconnecting devices.

FOUND IN

IEEE Std C37.20.10-2016 | View Definitions

withdrawable element

- A part of a switchgear compartment that can be moved to a position in which a safe distance or segregation between the primary circuit contacts is established while the part remains mechanically attached to the enclosure.

FOUND IN

IEEE Std C37.20.10-2016 | View Definitions

stationary-mounted device

- One that cannot be removed except by the unbolting of connections and mounting supports. *Compare with:* **drawout-mounted device** and **withdrawable element**.

FOUND IN

IEEE Std C37.20.10-2016 | View Definitions

drawout-mounted device

- One having disconnecting devices and in which the removable portion may be removed from the stationary portion without the necessity of unbolting connections or mounting supports. *Compare with:* **stationary-mounted device**.

FOUND IN

IEEE Std C37.20.10-2016 | View Definitions

Term	Main Circuit	Safe Distance	Mech. Attached	Bolted	Primary Disconnects	Secondary Disconnects	Typical Devices
Stationary-mounted device	O	O	X	X	O	O	Circuit Breaker, PT, CPT, Fuse, Relay, Switch, Light, etc.
Draw-out mounted device	O	O	O		O	O	Circuit Breaker, Fuse Truck, Draw-out Relay or Module, etc.
Removable element	X	O?	O?	O?	X	X	Circuit Breaker, Fuse Truck, Switch, etc.
Withdrawable element	O	X	X	O	X	O	PT or CPT Drawer, Fuse Drawer, etc.

Proposal raised in PC37.20.10 to clarify

C37.20.1 Ad Hoc

C37.20.10 Terms

removable element

- A withdrawable device that normally carries the current-carrying and or circuit-switching components for the main circuit, as well as primary and secondary disconnecting devices.

FOUND IN

IEEE Std C37.20.10-2016 | View Definitions

withdrawable element

- A part of a switchgear compartment that can be moved to a position in which a safe distance or segregation between the primary circuit contacts is established while the part remains mechanically attached to the enclosure.

FOUND IN

IEEE Std C37.20.10-2016 | View Definitions

Accepted term in PC37.20.10 draft for ballot

Removable element: ~~a withdrawable~~ that portion of a drawout-mounted device which **may be separated from the stationary portion and** normally carries the current-carrying and or circuit-switching components for the main circuit, as well as primary and secondary disconnecting devices.

Term	Main Circuit	Safe Distance	Mech. Attached	Bolted	Primary Disconnects	Secondary Disconnects	Typical Devices
Stationary-mounted device	O	O	X	X	O	O	Circuit Breaker, PT, CPT, Fuse, Relay, Switch, Light, etc.
Draw-out mounted device	O	O	O		O	O	Circuit Breaker, Fuse Truck, Draw-out Relay or Module, etc.
Removable element	X	O			X	X	Circuit Breaker, Fuse Truck, Switch, etc.
Withdrawable element	O	X	X	O	X	O	PT or CPT Drawer, Fuse Drawer, etc.

Proposal raised in PC37.20.10 to clarify

Drawout & Removable Terms

C37.20.1 D5 term usage & recommendation summary

"Drawout-mounted device(s)"

1 time	Clause 6.2.3 a)	Term defined in C37.20.10, Stationary term correction

"Drawout circuit breaker"

10 times	See below	Term is not defined in IEEE ; Create definition , See slide 8

- clause 7.11, clause 6.2.3 b), clause 6.2.5 b), clause 6.2.5 c), clause 6.2.5.1.5 2nd paragraph, clause 6.2.5.2.2 2nd paragraph, clause 6.2.7.1 1st paragraph, clause 6.3.1 1st paragraph, clause 7.11.1, clause 7.14

"Drawout"

7 times	See below	Term is not defined in IEEE ; See slides 9~13

- abstract, keywords, metal-enclosed low-voltage power circuit breaker (LV) switchgear definition, clause 6.2.2 (2 times), clause 6.2.7.1 (2 times)

"Removable Element(s)"

28 times	See below	Term defined in C37.20.10

- C.4, clause 6.2.3 a), clause 6.2.5.1.5 e), clause 6.2.5.2.2 e), clause 6.2.7.1 c), clause 6.2.7.3 c), clause 6.3.3 1st paragraph, clause 7.1.2.1 2nd paragraph, clause 7.1.3.6 2nd paragraph, clause 7.11.3 1st paragraph, clause 7.11.4, clause 7.11.5, clause 7.11.5 1st paragraph, clause 7.11.6, clause 7.11.6 1st paragraph, clause 7.11.6 2nd paragraph, clause 7.11.6 1st paragraph, 7.11.7 2nd paragraph, 7.11.7 3rd paragraph, clause C.5 1st paragraph, clause C.5 a), clause C.6 1st paragraph

Withdrawable term is not used within C37.20.1 D5

Drawout & Removable Terms

C37.20.1 D5 term usage & recommendation summary

"Drawout-mounted device(s)"

1 time	Clause 6.2.3 a)	Term defined in C37.20.10, Stationary term correction

"Drawout circuit breaker"

10 times	See below	Term is not defined in IEEE ; Create definition , See slide 8

- clause 7.11, clause 6.2.3 b), clause 6.2.5 b), clause 6.2.5 c), clause 6.2.5.1.5 2nd paragraph, clause 6.2.5.2.2 2nd paragraph, clause 6.2.7.1 1st paragraph, clause 6.3.1 1st paragraph, clause 7.11.1, clause 7.14

"Drawout"

7 times	See below	Term is not defined in IEEE ; See slides 9~13

- abstract, keywords, metal-enclosed low-voltage power circuit breaker (LV) switchgear definition, clause 6.2.2 (2 times), clause 6.2.7.1 (2 times)

"Removable Element(s)"

28 times	See below	Term defined in C37.20.10

- C.4, clause 6.2.3 a), clause 6.2.5.1.5 e), clause 6.2.5.2.2 e), clause 6.2.7.1 c), clause 6.2.7.3 c), clause 6.3.3 1st paragraph, clause 7.1.2.1 2nd paragraph, clause 7.1.3.6 2nd paragraph, clause 7.11.3 1st paragraph, clause 7.11.4, clause 7.11.5, clause 7.11.5 1st paragraph, clause 7.11.6, clause 7.11.6 1st paragraph, clause 7.11.6 2nd paragraph, clause 7.11.6 1st paragraph, 7.11.7 2nd paragraph, 7.11.7 3rd paragraph, clause C.5 1st paragraph, clause C.5 a), clause C.6 1st paragraph

Withdrawable term is not used within C37.20.1 D5

C37.20.1 D5 Recommendation

Drawout-mounted usage

C37.20.1 D5 clause 6.2.3:

For equipment with stationary devices and for equipment with drawout-mounted devices with the removable elements in the connected position, apply the test voltage as follows:

Recommendation:

For equipment with stationary-mounted devices and for equipment with drawout-mounted devices with the removable elements in the connected position, apply the test voltage as follows:

Accepted by WG

Drawout & Removable Terms

C37.20.1 D5 term usage & recommendation summary

"Drawout-mounted device(s)"

1 time	Clause 6.2.3 a)	Term defined in C37.20.10, Stationary term correction

"Drawout circuit breaker"

10 times	See below	Term is not defined in IEEE ; Create definition , See slide 8

- clause 7.11, clause 6.2.3 b), clause 6.2.5 b), clause 6.2.5 c), clause 6.2.5.1.5 2nd paragraph, clause 6.2.5.2.2 2nd paragraph, clause 6.2.7.1 1st paragraph, clause 6.3.1 1st paragraph, clause 7.11.1, clause 7.14

"Drawout"

7 times	See below	Term is not defined in IEEE ; See slides 9~13

- abstract, keywords, metal-enclosed low-voltage power circuit breaker (LV) switchgear definition, clause 6.2.2 (2 times), clause 6.2.7.1 (2 times)

"Removable Element(s)"

28 times	See below	Term defined in C37.20.10

- C.4, clause 6.2.3 a), clause 6.2.5.1.5 e), clause 6.2.5.2.2 e), clause 6.2.7.1 c), clause 6.2.7.3 c), clause 6.3.3 1st paragraph, clause 7.1.2.1 2nd paragraph, clause 7.1.3.6 2nd paragraph, clause 7.11.3 1st paragraph, clause 7.11.4, clause 7.11.5, clause 7.11.5 1st paragraph, clause 7.11.6, clause 7.11.6 1st paragraph, clause 7.11.6 2nd paragraph, clause 7.11.6 1st paragraph, 7.11.7 2nd paragraph, 7.11.7 3rd paragraph, clause C.5 1st paragraph, clause C.5 a), clause C.6 1st paragraph

Withdrawable term is not used within C37.20.1 D5

C37.20.1 D6 Recommendation

New Drawout-circuit breaker definitions

Circuit breaker, drawout:[1]
A removable element constructed as a low-voltage power circuit breaker either fused or unfused as defined by C37.13 or C37.14 (as applicable), a definite-purpose switching device as defined by C37.13.1, or fuses on a separate removable element as defined within this document.

Circuit breaker, stationary:[2]
A stationary-mounted device constructed as a low-voltage power circuit breaker either fused or unfused as defined by C37.13 or C37.14 (as applicable), or fuses on a separate stationary-mounted device as defined within this document.

Circuit breaker:[3]
A stationary-mounted device or a removable element of a drawout-mounted device constructed as a low-voltage power circuit breaker either fused or unfused as defined by C37.13 or C37.14 (as applicable).), a definite-purpose switching device as defined by C37.13.1, or fuses included on a separate drawout-mounted device as defined within this document.

NOTE – A definite-purpose switching device, as defined by C37.13.1, is a removable element of a drawout-mounted device only.

Recommendation

Rejected by WG

1 – Term used 10 times circulated in D6 ; 2 – Term used 3 times circulated in D6 ; 3 – Term used 254 times (clean way to address term use)

Drawout & Removable Terms

C37.20.1 D5 term usage & recommendation summary

"Drawout-mounted device(s)"

1 time	Clause 6.2.3 a)	Term defined in C37.20.10, Stationary term correction

"Drawout circuit breaker"

10 times	See below	Term is not defined in IEEE ; Create definition , See slide 8

- clause 7.11, clause 6.2.3 b), clause 6.2.5 b), clause 6.2.5 c), clause 6.2.5.1.5 2nd paragraph, clause 6.2.5.2.2 2nd paragraph, clause 6.2.7.1 1st paragraph, clause 6.3.1 1st paragraph, clause 7.11.1, clause 7.14

"Drawout"

7 times	See below	Term is not defined in IEEE ; See slides 9~13

- abstract, keywords, metal-enclosed low-voltage power circuit breaker (LV) switchgear definition, clause 6.2.2 (2 times), clause 6.2.7.1 (2 times)

"Removable Element(s)"

28 times	See below	Term defined in C37.20.10

- C.4, clause 6.2.3 a), clause 6.2.5.1.5 e), clause 6.2.5.2.2 e), clause 6.2.7.1 c), clause 6.2.7.3 c), clause 6.3.3 1st paragraph, clause 7.1.2.1 2nd paragraph, clause 7.1.3.6 2nd paragraph, clause 7.11.3 1st paragraph, clause 7.11.4, clause 7.11.5, clause 7.11.5 1st paragraph, clause 7.11.6, clause 7.11.6 1st paragraph, clause 7.11.6 2nd paragraph, clause 7.11.6 1st paragraph, 7.11.7 2nd paragraph, 7.11.7 3rd paragraph, clause C.5 1st paragraph, clause C.5 a), clause C.6 1st paragraph

Withdrawable term is not used within C37.20.1 D5

C37.20.1 D5 Recommendation

Drawout term usage

C37.20.1 D5 abstract:

Metal-enclosed, low-voltage switchgear which contains either stationary or drawout, manually or electrically operated low-voltage ac or dc power circuit breakers or low-voltage ac definite-purpose switching devices in individual metal compartments, in three-pole, four-pole, two-pole, or single-pole construction is covered. Rated maximum voltage levels are 254 V, 508 V, 635 V, 730 V, or 1058 V ac; and 300/325 V, 600 V, 800 V, 1000 V, 1200 V, 1500 V, 1600 V, or 3200 Vdc. The preferred continuous current ratings of the main bus in ac designs are 1600 A, 2000 A, 3000 A, 3200 A, 4000 A, 5000 A, 6000 A, 8000 A, or 10 000 A. For dc designs, the preferred ratings are 1600 A, 2000 A, 2500 A, 3000 A, 4000 A, 5000 A, 6000 A, 8000 A, 10 000 A, or 12 000 A. The switchgear may also contain associated control, instruments, metering, protective, and regulating devices as necessary. The standard deals with service conditions, ratings, temperature limitations, and classification of insulating materials, insulation (dielectric) withstand voltage requirements, test procedures, and application.

Recommendation:

Metal-enclosed, low-voltage switchgear which contains either stationary-mounted or drawout-mounted, manually or electrically…

Accepted by WG

C37.20.1 D5 Recommendation

Drawout term usage

C37.20.1 D5 keywords:

circuit breaker, control, cumulative loading, current transformers, drawout, IEEE C37.20.1™, indoor, instrumentation, load current-carrying, metal-enclosed, metering, outdoor, protection, stationary, switchgear

Recommendation:

No change… slang use of drawout and prevalent in user base versus defined term of drawout-mounted device or stationary-mounted device

Accepted by WG

C37.20.1 D5 Recommendation

Drawout term usage

C37.20.1 D5 metal-enclosed low-voltage power circuit breaker (LV) switchgear definition:

Metal-enclosed low-voltage switchgear of multiple or individual enclosures, including the following equipment as required:

a) Low-voltage power circuit breakers (fused or unfused) in accordance with IEEE Std C37.13 or IEEE Std C37.14
b) Low-voltage definite-purpose switching devices in accordance with IEEE Std C37.13.1
c) Bare bus and connections
d) Instrument and control power transformers
e) Instruments, meters, and relays
f) Control wiring and accessory devices

The circuit breakers are contained in individual grounded metal compartments and controlled either remotely or from the front of the enclosure. The circuit breakers may be stationary or removable (drawout) type; when of removable type, mechanical interlocks are provided for proper operating sequence.

Recommendation:

…The circuit breakers may be a stationary-mounted device or the circuit breakers may be a removable element of a drawout-mounted device ~~type~~; when of removable type, mechanical interlocks are provided for proper operating sequence.

Accepted by WG

C37.20.1 D5 Recommendation

Drawout term usage

C37.20.1 D5 clause 6.2.2 last paragraph:

If the switchgear is manufactured in both stationary and drawout designs and the bus design is identical for both, the stationary design may be qualified by testing only the drawout design.

Recommendation:

If the switchgear is manufactured in both stationary-mounted and drawout-mounted designs and the bus design is identical for both, the stationary-mounted design may be qualified by testing only the drawout-mounted design.

C37.20.1 D5 clause 6.2.7.1 3rd paragraph:

Mechanical performance tests of fused circuit breakers are not required when the drawout mechanisms are of equivalent design on fused and unfused circuit breakers.

Recommendation:

Mechanical performance tests of fused circuit breakers are not required when the drawout-mounted mechanisms are of equivalent design on fused and unfused circuit breakers.

Accepted by WG

C37.20.1 D5 Recommendation

Drawout term usage

C37.20.1 D5 clause 6.2.7.1 4th paragraph:

The tests shall be performed either with an electrically operated circuit breaker or with a manually operated circuit breaker having a stored-energy closing mechanism and equipped with separable control contacts, if the design of the drawout mechanism and the interlocks are the same for both. If they are not, both manually and electrically operated designs shall be tested.

Recommendation:

The tests shall be performed either with an electrically operated circuit breaker or with a manually operated circuit breaker having a stored-energy closing mechanism and equipped with separable control contacts, if the design of the drawout-mounted mechanism and the interlocks are the same for both. If they are not, both manually and electrically operated designs shall be tested.

Accepted by WG