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(Revision of IEEE Std C37.59-1994)

IEEE Standard Requirements for Conversion of Power Switchgear Equipment

Sponsor
Switchgear Committee
of the
IEEE Power Engineering Society

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Abstract: Power switchgear equipment that is converted from the original manufacturer's designs, whether the conversion is performed in manufacturing plants or at installation sites, is covered.
Keywords: conversion, power switchgear equipment

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Introduction

(This introduction is not a part of IEEE Std C37.59-1996, IEEE Standard Requirements for Conversion of Power Switchgear Equipment.)

This revised standard is intended to cover conversions of power switchgear equipment only, and has been revised to correct some specific reference errors; to separate low-voltage and medium-voltage conversions for clarity; to include medium-voltage ground and test (G&T) devices; to clarify nameplate modification and additions; as well as to stress the importance of drawout interlocking and auxiliary functions known to have caused field problems.

Medium-voltage converted circuit breakers may or may not be interchangeable with existing non-converted circuit breakers. Where converted circuit breakers are not interchangeable it will be so indicated in the manufacturer's instruction book and the rejection system shall be changed.

Additionally, it is stressed that at least the minimum tests recommended and outlined in specific references are to be carried out as applicable on each model of a converted device.

The known lack of design verification of some conversions was the reason for the creation of this document. Previous reliance only on production tests with "ANSI tested" statements have misled users and can possibly result in field failures. The basic and fundamental criteria of this standard is that a converted product is a new design and must meet its name plate ratings as well as applicable standards. A recommended design verification form is included.

There are many forms of conversion, and this document provides the outline to cover all switchgear power equipment that may be converted, with the following examples of current areas of conversion and testing. As different additional products are converted, criteria for the new conversion products will be added in future revisions of this standard.

A conversion of power switchgear equipment reuses some portion of the original equipment in the final configuration of that equipment. If no portion of the original equipment is reused, this standard is not applicable.

Annex A, though not a required part of this standard, is provided for guidance in the design verification of the converted power switchgear equipment. It provides additional guidance regarding conversion examples and the minimum testing required for design verifications.

Typical conversions include the following:

Circuit breakers

Frame
Insulation structures
Contacts, supports, and primary disconnecting devices
High-voltage arc-interrupting structures
Low-voltage arc interrupting structures and direct-acting trip devices
Drawout parts/interlocking and auxiliary functions
Mechanism parts and control wiring

Switchgear vertical sections

Basic vertical sections
Bus, bus connections, and insulation
Drawout parts/interlocking and auxiliary functions
Instrumentation and control wiring

Ground and test devices

This standard is not intended to cover maintenance procedures when *reconditioning* power switchgear equipment in accordance with the manufacturer's instruction manuals.

This standard was prepared by a working group of the Administrative Subcommittee (ADSCOM) of the IEEE Switchgear Committee, consisting of members from the High-Voltage Circuit Breaker, Low-Voltage Switchgear Devices, and Switchgear Assemblies Subcommittees.

Suggestions for improvement gained in the use of this standard are welcome.

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CLAUSE PAGE

IEEE Standard Requirements for Conversion of Power Switchgear Equipment

1. Overview

This standard covers power switchgear equipment that is converted from the original manufacturer's designs, whether the conversion is performed in manufacturing plants or at installation sites. It provides direction and guidance in those conversions and specifies required design verification in accordance with applicable ANSI or IEEE standards.

It recognizes that production/field testing does not provide design verification. This can only be accomplished by means of design testing.

1.1 Scope

This standard cannot detail each test that must be carried out to qualify a converted circuit breaker. The specific tests shall be selected by the convertor considering exact changes made from the previously qualified design. The converter shall conduct a thorough and formal design verification for the completed circuit breaker conversion, and shall perform all additional tests determined to be necessary.

Present industry conversions involve low- and medium-voltage power circuit breakers used in metal-enclosed and metal-clad switchgear; switchgear vertical sections; and certain ratings of other high-voltage circuit breakers. This document outlines criteria for conversion of those types of equipment and it can also provide guidance in the conversions of other types of power switchgear equipment.

A vital part of the conversion process is the coordination of the mechanism-operated contact (MOC) devices with the converted circuit breaker to ensure proper operation. However, since the new, sealed interrupter, modular units may require much less mechanism power than the air magnetic circuit breakers they replace, they may not necessarily have the ability to operate all existing, installed MOCs. Accordingly, this may necessitate substantial revision to or replacement of the MOCs and their operating linkage in the existing vertical sections to assure proper operation.

NOTE — At present, there is no known modular interrupter unit type of power switchgear equipment available with sufficient interrupting capacity to meet low-voltage circuit breaker rating requirements. If a low-voltage circuit breaker is converted with a vacuum contactor modular unit, the National Electrical Manufacturers Association (NEMA) ICS series and Underwriters Laboratory (UL) standards for such contactors should be utilized. However, since fused contactors on low-voltage power circuit breaker frames are similar to fused circuit breakers, following the test procedures of ANSI

C37.50-1989 [1], but at lower ratings, can provide a creditable test program. If medium-voltage circuit breakers are converted to medium-voltage starters utilizing lower rated vacuum contactor units, the same concept applies as with low-voltage circuit breakers.

Any conversions and all work performed on third party labeled or listed or involved in Nuclear Regulatory Commission required conformance equipment may void the label, listing, or certification of the equipment. It will be necessary to reapply to the third party for continued certification of the equipment under any and all requirements of the third party for such conversions. For instance, if a UL listed low-voltage switchgear assembly, using UL listed power circuit breakers, is converted to use UL listed molded case circuit breakers, the converted switchgear assembly must be submitted to the UL for evaluation for continued coverage. UL may elect to use this or any other standard as a guide for continued acceptance.

1.2 Other conversions

The conversion and testing processes outlined in this standard are based on known examples and are outlined for general guidance and direction. However, alterations can be made to other equipment, such as load-break switches, fuses, and/or fuse mounts or reclosers, not specifically outlined in detail, that will require design verification in accordance with appropriate standards. Whenever there is any question, the manufacturer/converter should be consulted.

Additionally, while this standard specifically does not cover reconditioning of power switchgear equipment, it does recognize the process and the fact that appropriate production/field testing is necessary.

2. References

The following standards are referred to in this document and are the most recently published editions of the standards. When a standard is superseded by an approved revision, the revision shall apply.

However, when conversions are made to older total current rated circuit breakers, it is essential that the converted device ratings are correlated to at least meet the applicable ratings and design requirements of the original circuit breaker designs described in the appropriate edition of the standard.

2.1 Low-voltage equipment

ANSI C37.16-1988, American National Standard for Switchgear—Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors—Preferred Ratings, Related Requirements, and Application Recommendations.[2]

ANSI C37.17-1979 (Reaff 1988), American National Standard for Trip Devices for AC and General Purpose DC Low-Voltage Power Circuit Breakers.

ANSI C37.50-1989, American National Standard for Switchgear—Low-Voltage AC Power Circuit Breakers Used in Enclosures—Test Procedures.

IEEE Std C37.13-1990, IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures (ANSI).[3]

IEEE Std C37.14-1992, IEEE Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures (ANSI).

[1]Information on references can be found in Clause 2.
[2]ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.
[3]IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

IEEE Std C37.20.1-1993 IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear (ANSI).

2.2 Medium- and high-voltage equipment

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

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

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

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

IEEE Std PC37.20.6, Draft Standard for Medium-Voltage Ground and Test Devices Used in Enclosures.[4]

2.3 Miscellaneous

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

3. Definitions

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

If a term is not defined in this standard, the definition in IEEE Std C37.100-1992 applies. The following definitions differ from that in IEEE Std C37.100-1992.

3.1 conversion: The process of altering existing power switchgear equipment from the original manufacturers design.

3.2 design verification: The process of overall qualification, in accordance with all appropriate standards, of any conversion by means of design testing and/or evaluation, supported by justified technical evaluation and documentation.

3.3 modular assembly: A circuit breaker element consisting of sealed interrupters, mechanism, and connecting terminals.

3.4 reconditioning: The process of maintaining existing power switchgear equipment in operating condition as recommended by the manufacturer's instructions, using only the original manufacturer's designed parts.

NOTE — Reverse engineered parts (designs copied from existing parts by other manufacturers) are not considered to be the original manufacturer's design or recommended replacement parts.

4. Service conditions

The service conditions specified in the standards listed in the references apply (see Clause 2.) to newer equipment. Older equipment shall meet the service conditions in the standards that were in effect at the date of manufacture unless

[4]Numbers preceded by P are IEEE authorized standards projects that were not approved by the IEEE Standards Board at the time this publication went to press. For information about obtaining drafts, contact the IEEE.

the specified conversion process alters the equipment to meet the service conditions in the referenced standards. Any new and/or unusual service conditions shall be specified by the user.

5. Ratings

The ratings of newer equipment are covered by the standards listed in Clause 2. The ratings of older equipment are covered by the standards that were in effect at the time of manufacture as noted in Clause 2. Converted equipment shall continue to meet the original ratings unless different ratings are specified or accepted by the user. When a circuit breaker is converted to a higher rating, the existing switchgear must be evaluated for capability at this higher rating.

6. Conversion and testing

The conversion process can involve as little as a minor frame change to replacing main or arcing contact tips with other than the original design material, or replacing the entire arc-interrupting structure and mechanism. This clause outlines known, specific examples of conversion, with the minimum testing required to verify the conversion. When multiple alterations are made, design tests may be combined for overall effectiveness.

Design testing is required in accordance with the applicable standards listed in Clause 2., with metal-enclosed devices to be tested in their applicable switchgear enclosures when required by the referenced standards. Since alterations can affect the overall operation of the equipment, design verification of conversions is necessary. All interlocking and mechanism operated contacts (MOC) functions are critical to proper operation and shall be design verified in an actual enclosure. Additional design testing may be necessary when converted circuit breakers are required to be interchangeable with existing non-converted circuit breakers. Applicable portions of required, referenced design tests can be utilized, with justified technical evaluation of the design alterations, to ensure that performance has not been adversely affected. Test data from previous similar designs can be used for current designs, if clearly technically applicable.

Design verification data and the justified technical evaluation shall be available to the user, on request, to ensure that the converted equipment has been tested in accordance with this standard for continued service under installation conditions.

6.1 Circuit breakers

6.1.1 Frames

Any alterations to the circuit breaker frame require design verification in accordance with ANSI C37.50-1989 or IEEE Std C37.09-1979.

To ensure that all interlocking and auxiliary functions have been retained, racking tests shall be made in a switchgear enclosure in accordance with IEEE Std C37.20.1-1993 or IEEE Std C37.20.2-1993 for design verification. All metal-enclosed, dead-front characteristics present in the original design, shall be retained.

6.1.2 Insulation structures

The insulation structure provided to mount current-carrying parts, or that of connecting bushings is specifically designed for mechanical strength as well as electrical and thermal life. Any alteration shall require design verification in accordance with ANSI C37.50-1989 or IEEE Std C37.09-1979.

6.1.3 Contacts, supports, and primary disconnecting devices

Any alteration in the original design or manufacturing process of contacts, contact structures, contact supports, arc chutes or arc runners and primary disconnecting devices, including material composition, brazing or plating, can affect overall performance and shall require design verification in accordance with ANSI C37.50-1989, IEEE Std C37.09-1979, IEEE Std C37.20.1-1993, or IEEE Std C37.20.2-1993.

6.1.4 Medium- and high-voltage arc-interrupting structures

The arc-interrupting structures are designed to control and extinguish arcs. Several conversion possibilities are given in the examples in 6.1.4.1 and 6.1.4.2.

6.1.4.1 Retaining the original structure (air-magnetic, air-blast, oil, etc.)

The original manufacturer's recommended replacement parts or other design-verified replacement parts shall be used.

For example, air-magnetic circuit breaker arc-chute splitter plates and liner plates are critical to proper operation and they shall not be replaced with different material or coated (plated) with different material without a complete series of short-circuit current rating design tests.

When medium-voltage circuit breaker air-magnetic arc chute materials are altered and/or replaced, a complete series of short-circuit rating design tests shall be conducted in accordance with IEEE Std C37.09-1979.

6.1.4.2 Conversion of original structure (air-magnetic, air-blast, oil, etc.)

When an interrupter conversion is made to a circuit breaker, there are several alternatives that vary in complexity as outlined in the following examples:

a) Conversions utilizing individual sealed interrupters to replace only the interrupting structure and contacts require basic circuit breaker design changes such as the insulating structures for mounting and/or mechanism parts to modify stroke and force.
   This type of conversion shall be subjected to the complete series of design tests in accordance with IEEE Std C37.09-1979 to verify the circuit breaker for the ratings assigned.

b) Conversions utilizing a complete modular assembly, consisting of sealed interrupters, mechanism, and connecting terminals, may require alterations to the original circuit breaker frame to mount the modular assembly as well as to provide connections to the existing or new primary bushings, and may require new, additional insulation.
   The modular assembly shall be subjected to the complete series of design tests in accordance with IEEE Std C37.09-1979. The design test data from the modular assembly tests may be utilized for design verification, if clearly applicable. Additional design tests shall be made on the complete conversion and shall include a dielectric withstand, momentary current, short-time current, continuous current, interlock, and other operational tests including MOCs, if applicable (see IEEE Std C37.20.2-1993).
   Mechanical endurance testing of the converted circuit breaker is required to at least the "between servicing" operational level requirements listed in ANSI C37.06-1987, Table 8. If the circuit breaker has no MOC operator, it may be tested separately but if an MOC operator is involved, it must be tested in the connected position in a switchgear vertical section to the same level.
   In certain cases, the orientation/proximity of the bus connections between the modular units and the connection bushings can magnetically affect the short-circuit current capability of the sealed interrupters. Sufficient short-circuit current testing shall be conducted for verification unless all configurations have been evaluated and documented by previous testing.

6.1.5 Low-voltage

Conversion of low-voltage circuit breakers can include alteration of the arc-interrupting structure to eliminate asbestos; the replacement of an earlier design circuit breaker with a new design mounted on the same drawout structure; the replacement of electro-mechanical trip devices with an electronic trip system; the addition of fuses to an unfused circuit breaker; or substitution of current limiting fuses on a fused circuit breaker.

6.1.5.1 Arc-interrupting structure

When ac or dc low-voltage circuit breaker arc chute designs are altered in any way, a complete series of short-circuit current design tests shall be conducted in accordance with ANSI C37.50-1989 for ac types and IEEE Std C37.14-1992 for dc types.

6.1.5.2 Fuse addition or substitution

When fused low-voltage circuit breaker current limiting fuses are changed from the exact model and rating initially qualified in the configuration, design verification shall be required in accordance with ANSI C37.50-1989. Dielectric withstand, continuous current, and short-circuit current tests shall be performed as appropriate to prove suitability of the application. When current limiting fuses are added to an original, unfused circuit breaker, design verification to prove the mechanical design of the modified circuit breaker is required as well as the dielectric withstand, continuous current and short-circuit current tests, regardless of the fuse rating.

6.1.5.3 Direct acting ac overcurrent trip devices

The conversion of low-voltage circuit breakers from electro-mechanical direct acting trip devices to electronic trip systems may require alteration of the current-carrying structure, the sensor mounting, and the operating mechanism to adapt the new latch-tripping device, as well as the mechanical mounting of the electronic trip logic unit.

Design verification is required for each application of a trip system, unless they are the qualified parts for the original design. All trip systems shall have design verification performed and installed on the circuit breaker frames for which they are intended to be applied. Upon successful design verification, production testing shall be performed in order to verify subsequent application of that same design, given that the design is being applied on circuit breakers that are identical to those in which the design verification has been successfully performed. Both design and production testing shall be performed in accordance with ANSI C37.50-1989.

6.1.6 Mechanism parts and control wiring

When mechanism parts are replaced with other than the manufacturer’s recommended replacement parts, design verification is required in accordance with ANSI C37.50-1989 or IEEE Std C37.09-1979.

Control wiring replacements shall be in compliance with IEEE Std C37.20.1-1993 and IEEE Std C37.20.2-1993. The replacement wiring shall be at least the same ampacity, dielectric withstand capability, and flexibility as the original, or as required by the converted control system design. It is specifically noted that, for medium-voltage circuit breakers, the wiring shall be isolated from primary elements by grounded metal barriers with the exception of short lengths of wire at terminals, such as those of secondary disconnect devices or auxiliary switches, if provided on the circuit breaker.

Wiring changes shall undergo the necessary continuity checks and a dielectric withstand test in accordance with ANSI C37.50-1989 and IEEE Std C37.20.1-1993, or IEEE Std C37.09-1979, and IEEE Std C37.20.2-1993 for design verification.

6.1.7 Drawout parts/interlocking and other operational functions

Drawout interlocking and auxiliary functions as outlined in IEEE Std C37.20.1-1993 and IEEE Std C37.20.2 -1993 are critical for the operation of the circuit breaker and shall be design verified [see item b) in 6.1.4.2.]

To ensure the proper operation of all interlocking and other operational functions, testing, including mechanical endurance, shall be conducted in the proper switchgear vertical section or duplicate circuit breaker test compartment.

If interchangeability is required with other existing circuit breakers, then additional alteration of existing vertical sections may be necessary, and design verification is then required. Mechanical and electrical interchangeability of converted circuit breakers with non-converted circuit breakers in a switchgear assembly may not be possible, for instance, due to changes in control schemes. In this situation, new blocking interlock features are required. When there is any lack of interchangeability, the blocking interlock features shall prevent the racking of either mechanically or electrically non-interchangeable circuit breakers.

6.1.7.1 Racking interlocking functions

When the conversions covered in item b) in 6.1.4.2 are made and racking interlocking redesign is necessary, design verification is required in accordance with IEEE Std C37.20.2-1993. It is essential that the racking interlocking functions of the converted circuit breaker properly operate in the existing switchgear vertical section. For instance, solenoid type circuit breaker racking interlocking shall be mechanically matched (electrical interlocking alone is not acceptable) with the new stored energy mechanism to meet the requirements of IEEE Std C37.20.2-1993. During the racking procedure, the circuit breaker shall be open, and closing shall be prevented unless the primary disconnecting devices are in full contact or are separated by a safe distance.

6.1.7.2 MOC or truck-operated contacts (TOC) devices

If MOC (auxiliary switches) or truck-operated contacts (TOC) devices are mounted in the vertical section, whether altered or not, design verification of the assembly is required in accordance with IEEE Std C37.20.1-1993, IEEE Std C37.20.2-1993 , and item b) in 6.1.4.2.

A vital part of the conversion process is the coordination of the MOC devices with the converted circuit breaker to ensure proper operation. However, since the new, sealed interrupter, modular units may require much less mechanism power than the air magnetic circuit breakers they replace, they may not necessarily have the ability to operate all existing, installed MOCs. Accordingly, this may necessitate substantial revision to or replacement of the MOCs and their operating linkage in the existing vertical sections to assure proper operation.

The converted circuit breaker shall satisfactorily operate with the maximum number of MOC contacts and spring return mechanisms that are recommended by the converter to be installed. Any deviation shall be accepted with blocking interlock features changed and other provisions complied with as outlined in this standard.

Substantial alterations with specific attention to MOC devices may be needed in each vertical section to assure satisfactory operation of conversions.

If MOC operation is limited, a prominent warning label shall be affixed to the circuit breaker indicating the limitation, i.e., “This converted circuit breaker was not designed to operate a separate external auxiliary switch (MOC).” The instruction book and nameplate must also state limitations. The blocking interlock (rejection) shall be changed.

The MOC functionality shall be addressed as part of the conversion by both the converter and the user.

6.1.8 Control circuit coordination

The modular units used in conversions may have operators with significantly different operating current than the original circuit breaker operators. This must be taken into consideration, in cooperation with the user, to ensure total

control and indication coordination and may require alteration or replacement of certain switchgear control circuit components.

6.1.9 Medium-voltage ground and test devices

Conversions of ground and test devices shall conform to all the requirements of IEEE PC37.20.6 to ensure that the devices have ratings and compartment capabilities no less than the circuit breaker they are intended to temporarily replace.

6.2 Switchgear vertical sections

6.2.1 Basic vertical section

All design alterations to a switchgear vertical section require design verification. The following are examples:

a) Replacement of old medium-voltage circuit breakers with newer technology circuit breakers that are completely tested to IEEE Std C37.09-1979 but do not fully coordinate with the vertical section interlocks and MOC switches. The resulting configuration shall be design verified including mechanical evaluation and testing.
b) Insertion of an assembly of a medium-voltage circuit breaker in its own compartment, completely tested to IEEE Std C37.09-1979 and IEEE Std C37.20.2-1993, to replace another design of circuit breaker but requiring bussing design alterations to properly connect the new assembly. The resulting configuration shall be design verified. Complete dielectric withstand, momentary current, short-time current, and continuous current tests for this major switchgear conversion shall be performed unless clearly applicable test data for similar conversions is available.
c) Construction of a complete, newly fabricated vertical section for expansion of the switchgear or as a replacement for a damaged section, may require alteration and design verification from the original design.

6.2.2 Bus, bus connections, and insulation

The switchgear bus, bus connections, current transformers, and insulation structure design are a balanced mechanical, electrical, and thermal system as initially designed. However, if a converted circuit breaker short-circuit current rating is increased above the original switchgear design capability, technical evaluation or test is required to verify that the bus system is capable of withstanding this increased rating or additional bus bracing shall be added and design verified.

When a complete, newly fabricated vertical section is constructed for expansion of the switchgear or as a replacement for a damaged section, any alteration from the original design shall require design verification. The design verification for these alterations shall be in accordance with IEEE Std C37.20.1-1993 or IEEE Std C37.20.2-1993.

6.2.3 Drawout parts/interlocking and other operational functions

These basic functions shall be retained in the converted equipment and any alterations to the existing or converted circuit breakers require design verification in accordance with ANSI C37.50-1989, IEEE Std C37.04-1979, IEEE Std C37.20.1-1993, and IEEE Std C37.20.2-1993. When interchangability between vertical sections is required, then modification/alignment of all circuit breaker interfaces shall be performed. Interchangeability is not always possible with existing, non-converted circuit breakers and may require changes in the blocking interlock features.

Any replacement of moving parts by other than the original design parts of the above equipment will require mechanical endurance tests as well as continuity checks and dielectric withstand tests in accordance with IEEE Std C37.20.1-1993, or IEEE Std C37.20.2-1993 for design verification.

If the primary disconnecting device design is altered, testing shall be correlated with the circuit breaker testing (see 6.1.3) in accordance with IEEE Std C37.09-1979 and IEEE Std C37.20.2-1993 for design verification.

6.2.4 Instrumentation and control wiring

When current/voltage transformers, MOC/TOC switches, or similar components are replaced or additions are made, they should be a duplicate of the original design wherever practical. Replacement MOC/TOC switches shall have electrical ratings (interrupting, current carrying, and mechanical endurance) equal to or greater than those they replace unless lower capabilities are accepted by the user and qualified for the application. Replacement wiring should be as described in IEEE Std C37.20.1-1993 and IEEE Std C37.20.2-1993, and of at least the same ampacity, dielectric withstand capability, and flexibility as the original. For metal-clad switchgear, the control wiring shall be isolated from primary circuit elements by grounded metal barriers, with the exception of short lengths of wire at secondary disconnect and current transformer terminals.

All control wiring, terminal blocks, and terminal connections shall be in accordance with IEEE Std C37.20.1-1993 or IEEE Std C37.20.2-1993.

Any replacement of moving parts by other than the original design parts of the above equipment will require mechanical endurance tests as well as continuity checks and dielectric withstand tests in accordance with IEEE Std C37.20.1-1993 or IEEE Std C37.20.2-1993 for design verification.

7. Production testing

Production testing of all conversions shall be in accordance with the applicable referenced standards ANSI C37.50-1989 , IEEE Std C37.20.1-1993, IEEE Std C37.09-1979; or IEEE Std C37.20.2-1993.

8. Nameplates

In order to ensure that the converted equipment performance ratings and responsibility for design are properly established, additional nameplates are necessary. Regardless of the complexity of the conversions, the original manufacturer’s nameplate shall be retained on the equipment for traceability (safety recall and/or renewal parts).

Each type of conversion shall be treated as follows:

- For high-voltage circuit breakers or ground and test device conversion covered by 6.1.4.2 and 6.1.9 the original manufacturer’s ratings shall be marked “Converted” as shown in 8.1 and 8.2, if the ratings of the conversion are not changed.
- For low-voltage circuit breaker conversions covered by 6.1.5, the original nameplate shall be marked “Converted” as shown in 8.1 and 8.2, if the ratings of the conversion are not changed.
- For switchgear conversions covered by 6.2, the original nameplate remains valid with requirements in 8.3 also followed. Additionally, when only individual vertical sections are converted in any multiple switchgear line up, the additional nameplate shall list the frame(s) that were converted, if the ratings of the conversion are not changed.

The nameplate shall state the nature of the conversion and any limitations in interchangeability.

The instruction book number will be stamped on the nameplate.

8.1 Individual interrupters

For conversions utilizing individual interrupters, such as in item a) in 6.1.4.2, a new nameplate(s) shall be added near or adjacent to the original nameplate, including the words “Converted by” with the name, address, identification number, date, and all rating information in accordance with the nameplate requirements of IEEE Std C37.04-1979.

8.2 Modular assemblies

For conversions utilizing modular assemblies, such as in item b) in 6.1.4.2, the nameplate of the modular assembly manufacturer shall be provided on the unit, including the name, address, identification number, date, and all rating information, with an additional nameplate added to the circuit breaker near or adjacent to the original nameplate, including the words “Converted by” with name, address, identification number, and date, in accordance with the requirements of IEEE Std C37.13-1990, IEEE Std C37.14-1992, or IEEE Std C37.04-1979.

8.3 Others

For any other conversions, such as in 6.1.5, an additional nameplate shall be added nearby or adjacent to the original nameplate, including the words “Converted by” with the name, address, identification number, new instruction book number, date, and nature of the conversion in accordance with the requirements of IEEE Std C37.13-1990, IEEE Std C37.14-1992, IEEE Std C37.04-1979, IEEE Std C37.20.1-1993, or IEEE Std C37.20.2-1993.

9. Manuals

Installation, field test, maintenance, and renewal parts instruction manuals complete with drawings that cover the assembly/equipment installed or revised in the conversion process shall be provided. The manual shall include the expected electrical and mechanical interfaces between the converted circuit breaker and the compartment components including the component mounting inside the cubicle and the adjustments to ensure that they function together. This will include appropriate servicing and test methods and acceptance criteria of circuit breaker compartment mounted equipment such as interlocks and MOC devices to assure proper operation.

The conversion circuit breaker instruction manual shall state any limitations in driven MOC or TOC devices.

The instruction manual shall state whether the converted circuit breaker is or is not interchangeable with non-converted circuit breakers. Where converted circuit breakers are not interchangeable with non-converted circuit breakers, the instruction manual shall indicate, “This circuit breaker is not interchangeable with *Manufacturer, type XXX* circuit breakers. Contact the *Converter (name)* for circuit breaker interchangeability limitations.”

10. Recommended conversion design verification form

The organization verifying that the conversion conforms to this standard shall

a) Generate a tabulation of specific design qualification tests required as if this were a newly designed or developed circuit breaker.
b) For each required test, either reference a specific test that was completed or indicate that it was not required, with technical evaluation provided.
c) Supply an appropriate heading that identifies the product and indicates the engineering approval of the conformance. It shall be issued in a permanently available form with an assigned number.
d) Make a copy of this form for availability upon request.

Figure 1 appears as an example of the form content of this design verification, with arrangement left to the designer of the conversion converter.

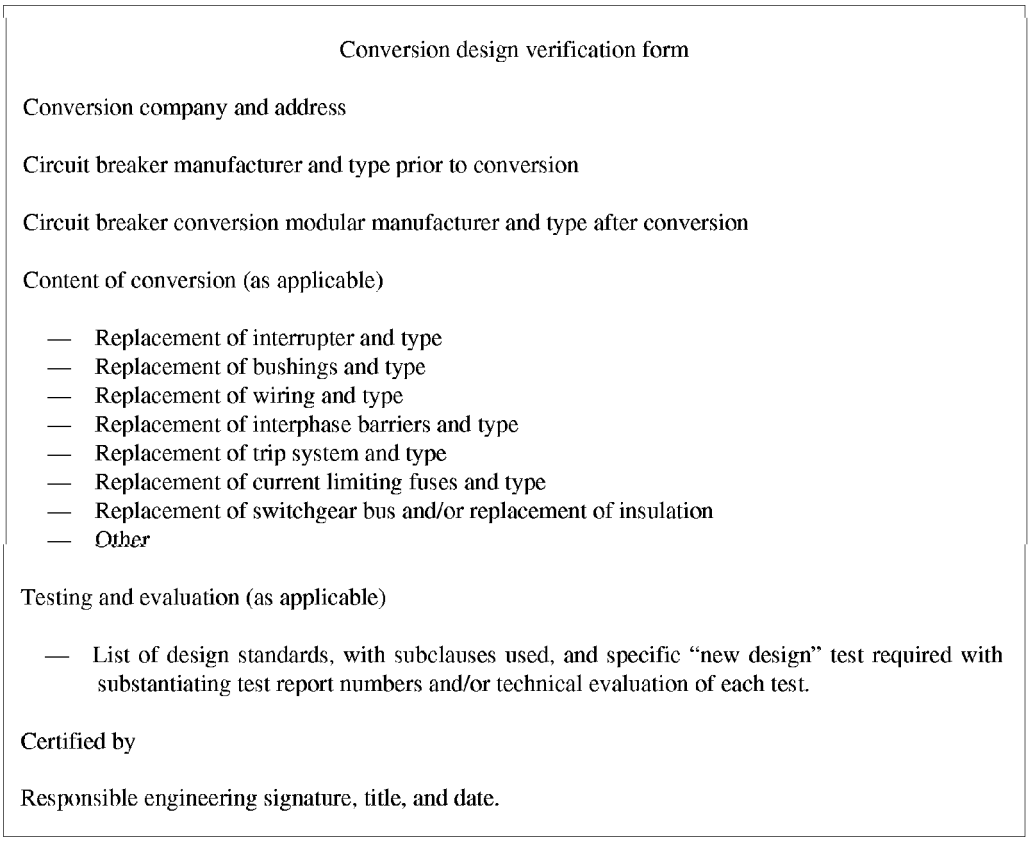

Figure 1— Recommended conversion design verification form

Annex A Clarification of conversion processes

(Informative)

A.1 Introduction

This annex is provided for guidance in the design verification of the converted power switchgear equipment. It provides additional guidance regarding conversion examples and the minimum testing required for design verifications.

It is important to recognize that production/field tests do not provide design verification, which can only be accomplished by design testing and technical evaluation.

A.2 Scope

This annex covers the switchgear equipment conversions outlined in the basic standard. Clauses 1., 2., 3., 4., and 7. are sufficiently explained in the basic standard. However, Clause 6. has been expanded as a guide to ensure that conversions are design-verified as intended. Details included will be helpful regarding different conversion possibilities and in performing the test verification. However, the design tests specifically listed should not be interpreted to be the only tests necessary for the design verification.

A.3 Circuit breakers

A.3.1 Frames (see 6.1.1)

The circuit breaker frame, if retained, should be carefully inspected. Some minor drilling and cutting is permissible, followed by repainting as necessary. However, since other parts will probably be converted, the modified (converted) frame should be tested as part of the total conversion. Design testing shall include partial mechanical endurance tests and momentary tests to ensure that the mechanical durability of the altered frame has not been reduced. Interlocking and auxiliary functions shall be proven by racking tests and mechanical endurance tests in a switchgear enclosure.

A.3.2 Insulation structure (see 6.1.2)

The insulation structure is critical and any changes such as substitution of different materials or a different configuration requires material qualification for flame resistance and tracking, with design testing to include, at least, momentary, dielectric withstand, and mechanical endurance tests. It should be noted that insulation testing to determine long time endurance in practical field environments requires evaluation beyond simple dielectric withstand tests.

A.3.3 Contacts, supports, and primary disconnecting devices (see 6.1.3)

Any alteration in the original design of the contacts, contact structures, contact supports, primary disconnecting devices, or in material content or plating can affect overall performance and requires design verification. Design testing should include close-and-latch, short-circuit current interrupting, and mechanical endurance tests. A continuous-current test shall be performed if the alteration increases the electrical resistance of the current path (as compared to the original design value) or reduces the effective cooling air flow.

A.3.4 Medium- and high-voltage arc-interrupting structures (see 6.1.4)

This subclause is sufficiently outlined in the standard. However, it is stressed that conversions of arc-interrupting structures create a new design and complete design testing is required.

A.3.5 Low-voltage arc interrupting structures (see 6.1.5.1)

This subclause is also sufficiently outlined in the standard. And again, it is stressed that conversions of arc-interrupting structures create a new design and complete design testing is required.

A.3.6 Fuse replacement (see 6.1.5.2)

Replacing fused, low-voltage power-circuit breaker current-limiting fuses with a different design fuse, though mechanically the same dimensions, should not be done without design testing. There are mechanical blocking means, thermal, peak-current let-through, and crossover current differences. Design testing should be conducted to include, at the least, a continuous-current test and short-circuit current close-open interrupting tests at both the maximum short-circuit current rating and at the 600 V short-circuit current rating of the circuit breaker.

When adding current limiting fuses to a previously unfused circuit breaker to increase its short-circuit current capability, the proper mechanical mounting needs to be developed with design verification of the mechanical alterations and to prove the dielectric withstand, continuous and short-circuit current capabilities, regardless of the fuse continuous current rating.

A.3.7 Direct-acting ac trip devices (see 6.1.5.3)

Design verification is required in accordance with IEEE Std C37.13-1990 and ANSI C37.17-1979 for basic design parameters, and in ANSI C37.50-1989 for basic test parameters. Each frame size converted circuit breaker, unfused and fused, shall be design tested in accordance with the concepts in 3.9.4.3 and 3.9.4.4 of ANSI C37.50-1989, but at both the minimum and maximum sensor ratings at the energy input level corresponding to the actual system voltage on which the converted circuit breaker is applied. The corresponding short-circuit current should be listed in ANSI C37.16-1988 for that voltage. For fused circuit breakers, this is in addition to the testing required in 6.1.5.3.

All electronic trip systems used shall be adapted, mounted, and design tested on the circuit breaker. Production tests shall be carried out on each converted breaker.

A.3.8 Mechanism parts and control wiring (see 6.1.6)

When mechanism parts are replaced with parts different in material, material hardness, or bearing design, for example, a mechanical endurance test should be conducted. Closing and tripping speeds and forces can also be affected and should be checked.

A.3.9 Drawout parts/interlocking and other operational functions (see 6.1.7)

When worn or broken parts are replaced, for example, with parts different in material, material hardness, or bearing design, design testing should be conducted. A major alteration to the drawout system could affect the hold-in capability of the circuit breaker under maximum short-circuit current conditions and should be tested.

When the conversions covered in item b) in 6.1.4.2 are made and redesign of the interlocking is necessary, design testing shall be conducted in an enclosure to ensure interchangeability of the converted circuit breaker in its own vertical section, as well as in other sections as necessary (see 6.1.7.1).

Operating functions for mechanism-operated cell switches (MOC) (auxiliary switches) or truck-operated contacts (TOC) shall be provided. The 6.1.4.2 a) conversions generally utilize existing functions. However, for 6.1.4.2 b) conversions, it may be necessary to increase the number of auxiliary switches and/or the means to operate the existing off-breaker switches and would require changes to the blocking interlocks and also design verification (see 6.1.7.2).

A.4 Switchgear vertical sections

A.4.1 Basic vertical section (see 6.2.1)

The basic vertical section, if retained, should not have the materials and weldments changed. Some minor drilling and cutting is permissible, followed by repainting as necessary. However, any major alteration should be tested as part of the total conversion with design testing coordinated with the circuit breaker changes. Testing shall include mechanical endurance, short-time, and momentary tests to ensure suitability of the altered section. This should include the circuit breaker hold-in mechanism if altered. Interlocking and auxiliary functions should be proven by the racking tests.

If the design of the primary disconnect is altered, testing should be correlated with the circuit breaker testing in A.3.3.

A.4.2 Bus, bus connections, and insulation (see 6.2.2)

The switchgear bus, bus connections, and insulation structure design are a balanced mechanical, electrical, and thermal system, and any replacements that are not of the same design and materials, including the bus-joint covers and secondary disconnects, may require design testing.

When a complete, newly fabricated vertical section is constructed for expansion of switchgear or as a replacement for a damaged section, any alteration from the original design should be design tested.

NOTE — Depending on the alterations made, the design testing conducted should include the following: insulation material properties; mechanical drawout functions and alignment; momentary current; continuous current; and dielectric withstand capability.

If the design of the primary disconnect device is altered, or the basic circuit breaker rating is increased, a dielectric withstand, momentary current, short-time current, and possibly continuous-current test shall be made in a switchgear enclosure.

A.4.3 Drawout parts/interlocking and other operational functions (see 6.2.3)

These basic functions shall be retained and matched to the existing or converted circuit breaker with interchangeability and design testing conducted.