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IOGP S-743, Supplementary Specification to IEEE Std C37.20.2 for Metal-Clad Switchgear, First Edition, January 2024

ADDENDUM 1

This addendum (Version 1.01) replaces Edition 1.0 published in January 2024.

List of updates

Clause/subclause	Update
3.2	New acronym "IED"
7.3.1	New subclauses f) and g)
7.3.4.2	Subclause replaced
7.3.4.6	Subclauses 7.3.4.6 * and 7.3.4.7 * replaced with single clause 7.3.4.6
7.3.12.1	New NOTE
7.3.12.2	"7.3.12.2.5" * replaced with "7.3.12.2.6" (to reflect the addition of subclause 7.3.12.2.6)
7.3.12.2.6	New subclause
7.3.12.8	"7.3.12.8.8" * replaced with "7.3.12.8.9" (to reflect the addition of subclause 7.3.12.8.9)
7.3.12.8.9	New subclause
7.17.5	Subclause amended (addition of "If provided" and deletion of "cable" *)
7.17.7	Subclause amended (addition of "If provided" and deletion of "cable" *)
Bibliography	Reference [B19] "IEC 62439-3" added (and subsequent numbering updated)
* Clause/subclause number from Edition 1.0.	

International Association of Oil & Gas Producers

SPECIFICATION
IOGP S-743J

May 2025
Version 1.01

ADDENDUM 1 TO FIRST EDITION (JANUARY 2024)

Supplementary Specification to IEEE Std C37.20.2 for Metal-Clad Switchgear

NOTE This version (S-743J) of the specification document provides the justification statements for each technical requirement, but is otherwise identical in content to S-743.

JIP33
JOINT INDUSTRY PROGRAMME

Revision history

VERSION	DATE	PURPOSE
1.01	May 2025	Addendum 1
1.0	January 2024	First Edition

Acknowledgements

This IOGP Specification was prepared by a Joint Industry Programme 33 Standardization of Equipment Specifications for Procurement organized by IOGP with support by the World Economic Forum (WEF).

Foreword

This specification was prepared under Joint Industry Programme 33 (JIP33) "Standardization of Equipment Specifications for Procurement" organized by the International Oil & Gas Producers Association (IOGP) with the support from the World Economic Forum (WEF). Companies from the IOGP membership participated in developing this specification to leverage and improve industry level standardization globally in the oil and gas sector. The work has developed a minimized set of supplementary requirements for procurement, with life cycle cost in mind, resulting in a common and jointly agreed specification, building on recognized industry and international standards.

Recent trends in oil and gas projects have demonstrated substantial budget and schedule overruns. The Oil and Gas Community within the World Economic Forum (WEF) has implemented a Capital Project Complexity (CPC) initiative which seeks to drive a structural reduction in upstream project costs with a focus on industry-wide, non-competitive collaboration and standardization. The CPC vision is to standardize specifications for global procurement for equipment and packages. JIP33 provides the oil and gas sector with the opportunity to move from internally to externally focused standardization initiatives and provide step change benefits in the sector's capital projects performance.

This specification has been developed in consultation with a broad user and supplier base to realize benefits from standardization and achieve significant project and schedule cost reductions.

The JIP33 work groups performed their activities in accordance with IOGP's Competition Law Guidelines (November 2020).

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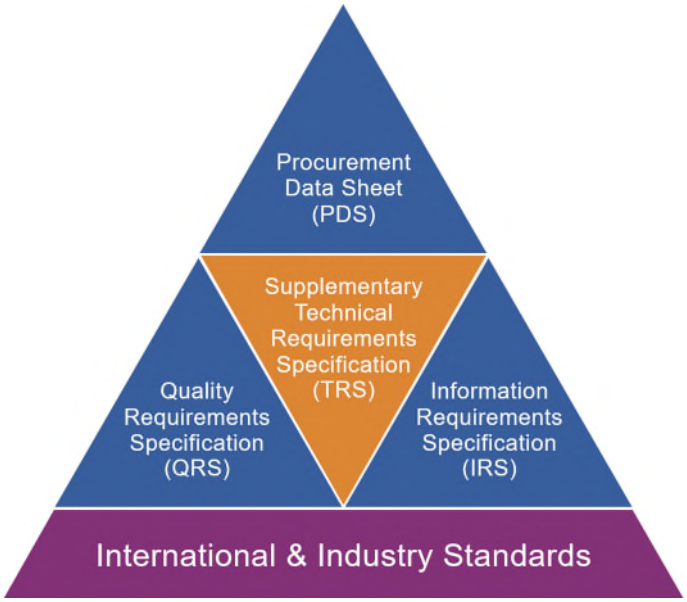
Introduction

The purpose of the IOGP S-743 specification documents is to define a minimum common set of requirements for the procurement of metal-clad switchgear in accordance with IEEE Std C37.20.2, published January 2023, IEEE Standard for Metal-Clad Switchgear for application in the petroleum and natural gas industries.

The IOGP S-743 specification documents follow a common structure (as shown below) comprising a specification, also known as a technical requirements specification (TRS), a procurement data sheet (PDS), an information requirements specification (IRS) and a quality requirements specification (QRS). These four specification documents, together with the purchase order, define the overall technical specification for procurement.



JIP33 Specification for Procurement Documents
Supplementary Technical Requirements Specification (TRS)

This specification is to be applied in conjunction with the supporting PDS, IRS and QRS as follows.

IOGP S-743: Supplementary Specification to IEEE Std C37.20.2 for Metal-Clad Switchgear

This specification defines technical requirements for the supply of the equipment and is written as an overlay to IEEE Std C37.20.2, following the IEEE Std C37.20.2 clause structure. Clauses from IEEE Std C37.20.2 not amended by this specification apply as written. Modifications to IEEE Std C37.20.2 defined in this specification are introduced by a description that includes the type of modification (i.e. *Add*, *Replace* or *Delete*) and the position of the modification within the clause.

NOTE Lists, notes, tables, figures, equations, examples and warnings are not counted as paragraphs.

IOGP S-743D: Procurement Data Sheet for Metal-Clad Switchgear (IEEE)

The PDS defines application-specific requirements. The PDS is applied during the procurement cycle only and does not replace the equipment data sheet. The PDS may also include fields for supplier-provided information required as part of the purchaser's technical evaluation. Additional purchaser-supplied documents may also be incorporated or referenced in the PDS to define scope and technical requirements for enquiry and purchase of the equipment.

IOGP S-743L: Information Requirements for Metal-Clad Switchgear (IEEE)

The IRS defines information requirements for the scope of supply. The IRS includes information content, format, timing and purpose to be provided by the supplier, and may also define specific conditions that invoke the information requirements.

IOGP S-743Q: Quality Requirements for Metal-Clad Switchgear (IEEE)

The QRS defines quality management system requirements and the proposed extent of purchaser conformity assessment activities for the scope of supply. Purchaser conformity assessment activities are defined through the selection of one of four generic conformity assessment system (CAS) levels on the basis of evaluation of the associated service and supply chain risks. The applicable CAS level is specified by the purchaser in the PDS or in the purchase order.

The specification documents follow the editorial format of IEEE Std C37.20.2 and, where appropriate, the drafting principles and rules of ISO/IEC Directives Part 2.

The PDS and IRS are published as editable documents for the purchaser to specify application-specific requirements. The TRS and QRS are fixed documents.

The order of precedence of documents applicable to the supply of the equipment, with the highest authority listed first, shall be as follows:

a) regulatory requirements;

b) contract documentation (e.g. purchase order);

c) purchaser-defined requirements (e.g. PDS, IRS and QRS);

d) this specification;

e) IEEE Std C37.20.2.

1. Overview

1.1 Scope

Replace first sentence of second paragraph with

This standard applies to enclosed, indoor and outdoor MC switchgear assemblies rated above 1 kV ac and below 52 kV ac.

Justification

IEEE Std C37.20.2 is a performance standard, and this subclause identifies the scope and boundaries of this overlay. This addition defines this boundary in line with the agreed framing proposal.

Add to subclause

This specification defines minimum technical requirements for the purchase of metal-clad (MC) switchgear equipment, including design features, fabrication quality, inspection, testing, shipment and documentation.

Justification

IEEE Std C37.20.2 is a performance standard, and this clause identifies the scope and boundaries of this overlay. This addition defines this boundary in line with the agreed framing proposal.

2. Normative references

Add to first paragraph

The following publications are referred to in this document, the PDS (IOGP S-743D) or the IRS (IOGP S-743L) in such a way that some or all of their content constitutes requirements of this specification.

Add to clause

46 CFR 111, *Title 46 – Shipping, Chapter I - Department of Coast Guard, Subchapter J - Electrical Engineering, Part 111 - Electrical Systems - General Requirements*

ABS MODU, Publication Number 6 Part 4, *Rules for Building and Classing Mobile Offshore Drilling Units - Part 4 Machinery and Systems*

ANSI/NEMA CC 1, *Electric Power Connection for Substations*

API Recommended Practice 14F, *Recommended Practice for Design, Installation, and Maintenance of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Division 1, and Division 2 Locations*

API Recommended Practice 14FZ, *Recommended Practice for Design, Installation, and Maintenance of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Zone 0, Zone 1, and Zone 2 Locations*

ASCE/SEI 7-16, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*

ASME B30.26, *Rigging Hardware—Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings*

ASTM F855:2023, *Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment*

IEC 61850 (all parts), *Communication networks and systems for power utility automation*

IEC/IEEE 62271-37-013, *High-voltage switchgear and controlgear – Part 37-013: Alternating current generator circuit-breakers*

IEEE Std C37.04-2018, *IEEE Standard for Ratings and Requirements for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000 V*

IEEE Std C37.012, *IEEE Guide for the Application of Capacitive Current Switching for AC High-Voltage Circuit Breakers above 1000 V*

IEEE Std C37.20.7-2017, *IEEE Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*

IEEE Std C37.90, *IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus*

IEEE Std C62.11, *IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV)*

NEMA ICS 5, *Industrial Control and Systems: Control-Circuit and Pilot Devices*

UL DLAH, *GuideInformation - Circuit Breakers and Metal-clad Switchgear Over 1000 Volts*

Replace Clause 3 title with

3. Definitions and abbreviated terms

Add subclause 3.1 heading before first definition

3.1 Definitions

Add new definition

arc-resistant accessibility Type 2: An enclosure or assembly equipment with arc-resistant designs or features at the freely accessible exterior (front, back and sides).

Add new definition

arc-resistant accessibility Type 2B: An enclosure or assembly with arc-resistant designs or features at the freely accessible exterior (front, back and sides) and in the walls isolating the low-voltage control or instrument compartment(s).

NOTE—Suffix B for accessibility type indicates the equipment is arc-resistant even with the instrument or control compartment doors open. See IEEE Std C37.20.7 for additional details.

Add new definition

arc-resistant equipment: An equipment designed to withstand the effects of an internal arcing fault.

NOTE—This equipment is type tested as per the tests described in IEEE Std C37.20.7.

Add new definition

fault making rating: A rating intended for a grounding (earthing) switch installed on the load terminals of a controller, connected to a circuit that may contain stored electrical energy or have the possibility to close into an energized circuit.

Add new definition

grounding (earthing) switch: A permanently installed mechanical three-pole switching device used to connect the load side of a de-energized MV circuit breaker to ground (earth) for maintenance purposes.

Add new definition

internal arcing fault: An unintentional discharge of electrical energy in air or insulating gas within the confines of a switchgear enclosure.

Add new definition

main horizontal ground bus: The ground bus that provides common bonding between vertical sections throughout the entire length of the MC switchgear assembly.

Add new definition

manufacturer: An organization manufacturing and/or supplying equipment or services.

NOTE—Also referred to as "vendor", "seller" or "supplier".

Add new definition

short-circuit making current: The maximum value of prospective peak current of the circuit that the grounding (earthing) switch could be closed into at rated voltage.

Add new definition

touch safe: Protected from inadvertent contact by a finger using covers, recessing of terminals or the size of openings.

NOTE—"Touch safe" and similar terms, such as finger safe, are widely used to describe products but are not defined by industry standards. "Touch safe" is generally equivalent to IP 2X as per ANSI/IEC 60529, but most products are not tested to a particular IP rating.

Add new subclause

3.2 Abbreviated terms

ACO accredited certification organization

AHJ authority having jurisdiction

BIL basic impulse level

CBM condition-based monitoring

CPT control power transformers (or control power transformer assembly)

CT current transformer

FAT factory acceptance test

FLC full load current

GFCI ground fault current interrupter

IED intelligent electronic device

IRS information requirements specification

LED light emitting diode

LOTO	lock-out-tag-out
LV	low-voltage
MC	metal-clad
MV	medium-voltage
NC	normally closed
NO	normally open
NRTL	nationally recognized testing laboratory
PDS	procurement data sheet
PF	power factor
PPE *	personnel protective equipment
PT	power transformer
QRS	quality requirements specification
VT	voltage transformer (or voltage transformer assembly)

* Cited in IOGP S-743J only.

4. Service conditions

Add new subclause

4.1 Dependability of materials and parts

4.1.1

The MC switchgear, excluding protection and control devices, shall have a minimum design life of 25 years at the rated current and under usual (normal) service conditions.

Justification

This requirement ensures that the equipment has a design life and operates for 25 years or more. The normal design life of a facility ranges between 20 to 30 years.

4.1.2

The electronic components (e.g., protection and control devices) shall have a minimum design life of 14 years under usual (normal) service conditions.

Justification

This requirement ensures that the electronic components have a design life and operate for two turnaround cycles that are typically seven years each.

4.1.3

The MC switchgear shall be capable of operating continuously under the specified service conditions for a minimum of five years without requiring de-energization of the bus bars.

Justification

This requirement ensures that the complete assembly does not need major maintenance or de-energization before the first scheduled turnaround.

Add new subclause

4.2 Technology readiness and obsolescence

4.2.1

The MC switchgear, excluding electronic devices, shall be supported for a minimum of 25 years after delivery.

Justification

This requirement ensures that replacement components are available within the 25-year design life.

4.2.2

The obsolescence management plan shall be made available for MC switchgear components excluding devices that are required by procurement documents and that are not part of the manufacturer's standard offering.

Justification

This requirement ensures that replacement components are available within the 25-year design life.

NOTE—IEC 62402 is an example of an obsolescence management guide.

4.2.3

The manufacturer's proposal shall indicate whether the MC switchgear or any sub-component individually denoted has less than three years of proven operational service.

Justification

This requirement ensures that the proposed materials are proven, and have successful operational history or have been identified to the user prior to contract award. This is a standard requirement within operating companies' specifications, but it is not included in IEEE Std C37.20.2.

5. Ratings

5.6 Current transformer ratings

5.6.1 Current transformer mechanical rating

Replace third sentence with

CTs shall withstand the same short-circuit mechanical stresses as the associated circuit breaker short-time withstand current rating for a minimum of 2 s.

Justification

This requirement ensures that ratings for CTs are compatible with the short-time withstand rating of the MC switchgear. Potential damage and electrical fires can result if a lesser rated CT is subjected to a long-duration electrical fault event.

5.6.2 Current transformer thermal ratings

Replace third sentence with

CTs shall withstand the same short-circuit thermal stresses as the associated circuit breaker short-time withstand current rating for a minimum of 2 s.

Justification

This requirement ensures that ratings for CTs are compatible with the short-time withstand rating of the MC switchgear. Potential damage and electrical fires can result if a lesser rated CT is subjected to a long-duration electrical fault event.

5.7 Current transformer accuracies

Table 4—Standard accuracy ratings[a] for current transformers in MC switchgear

Replace seventh column "Relaying accuracy" with

Ratio	Relaying accuracy [c]
50:5	C or T10
75:5	C or T10
100:5	C or T10
150:5	C or T20
200:5	C or T20
300:5	C or T20
400:5	C100
600:5	C100
800:5	C100
1200:5	C100
1500:5	C100
2000:5	C100
3000:5	C100
4000:5	C100
5000:5	C100

Justification

For modern relaying protective devices, a minimum of C100 accuracy class ensures the required precision relay operation.

7. Construction

7.1 Buses and primary connections

7.1.3 Cable terminations

Add new subclause

7.1.3.1

Cable terminations shall be provided with a NEMA two-hole pattern (i.e., ANSI/NEMA CC 1).

Justification

This requirement ensures a compatible and robust termination location for incoming conductors. The use of single-hole lugs can result in loosening electrical connections due to vibration or cable movement, potentially leading to an electrical fire.

Add new subclause

7.1.3.2

Cable termination lugs shall be of compression type.

Justification

The use of mechanical-type lugs can result in loosening electrical connections due to vibration or cable movement, leading to a possible electrical fire or protection system misoperation.

Add new subclause

7.1.3.3 Field cable termination area sizing

The field cable termination area shall be sized to provide space in accordance with the requirements given in 7.1.3.3.1 through 7.1.3.3.3.

Justification

MV incoming cables are normally of shielded type and have terminators to provide stress control for cable terminations. The requirement for ample spacing allows for proper installation clearances, which eliminates electrical stress on the shielded terminator or cable. Improper installation has resulted in past failures that have evolved into an arc-flash or short-circuit event. MV power cables are supported before the termination point on the load side of the contactor to prevent undue stress on the shielded terminator, which can result in premature failure.

7.1.3.3.1

Cable supports shall be provided with spacing no greater than 450 mm (18 in) from the cable termination point.

Justification

MV incoming cables are normally of shielded type and have terminators to provide stress control for cable terminations. The requirement for ample spacing allows for proper installation clearances, which eliminates electrical stress on the shielded terminator or cable. Improper installation has resulted in past failures that have evolved into an arc-flash or short-circuit event. MV power cables are supported before the termination point on the load side of the contactor to prevent undue stress on the shielded terminator, which can result in premature failure.

7.1.3.3.2

The field cable termination area shall provide space for conductor separation that allows for the installation of shielded cable terminations.

Justification

MV incoming cables are normally of shielded type and have terminators to provide stress control for cable terminations. The requirement for ample spacing allows for proper installation clearances, which eliminate electrical and thermal stress on the shielded terminator or cable. Improper installation has resulted in past failures that have evolved into an arc-flash or short-circuit event. MV power cables are supported before the termination point on the load side of the contactor to prevent undue stress on the shielded terminator, which can result in premature failure.

NOTE—Specific details for field cable sizes are typically detailed in the project drawings and documentation.

7.1.3.3.3

The field cable termination area shall provide space for the minimum bending radius for the cable installation.

Justification

MV incoming cables are normally of shielded type and have terminators to provide stress control for cable terminations. The requirement for ample spacing allows for proper installation clearances, which eliminates electrical stress on the shielded terminator and mechanical damage due to exceeding the minimum bend radius for the cable. Improper installation has resulted in past failures that have evolved into an arc-flash or short-circuit event. MV power cables are supported before the termination point on the load side of the contactor to prevent undue stress on the shielded terminator, which can result in premature failure.

NOTE—Specific details for field cable sizes are typically detailed in the project drawings and documentation.

7.1.5 Main bus splices

Add new subclause

7.1.5.1

Bolted power bus connections shall be secured with corrosion-resistant steel hardware (e.g., bolts, locking washers, flat washers, nuts, pressed threaded inserts).

Justification

This requirement ensures that the bus bar joint hardware is resistant to corrosion for connection reliability and prevents hot spots.

Add new subclause

7.1.5.2

Cables shall not be used for main power buses inside the MC switchgear assembly.

Justification

The use of cables negatively impacts the switchgear short-circuit ratings, resulting in unnecessary supports and bracing.

Add new subclause

7.1.6

The main bus shall be pre-drilled on each end of the assembly for connecting adjacent sections without the need for additional bus supports or bracing.

Justification

Drilling the existing bus for additional sections results in extended downtime and potential safety issues with metal shavings from drilling.

Add new subclause

7.1.7

The current-carrying bus bars shall be tin-plated copper or silver-plated copper, as specified.

Justification

Plated copper bus systems can be operated with a temperature rise of 65 °C above ambient temperature. Otherwise, non-plated copper is restricted to a 30 °C rise, resulting in larger bus bar sizes for similar ampacity.

7.2 Grounding and bonding

Add new subclause

7.2.1

The dimensions of the main horizontal ground bus shall be a minimum of 6.35 mm ($^1/_4$ in) x 50.8 mm (2 in).

Justification

It is not practical to have proper mechanical connection with a two-hole type lug to a bus bar size any smaller. To drive safety and standardization, a minimum horizontal ground bussing is standardized at 6.35 mm ($^1/_4$ in) x 50.8 mm (2 in) minimum.

Add new subclause

7.2.2

The main horizontal ground bus shall be pre-drilled for connection of additional sections at each end without the need for additional bus supports or bracing.

Justification

Drilling the existing bus for additional sections results in extended downtime and potential safety issues associated with metal shavings from drilling.

Add new subclause

7.2.3

The main horizontal ground bus shall be drilled at each end for a NEMA two-hole lug (i.e., ANSI/NEMA CC 1) for field connections.

Justification

Drilling holes into the bus requires metal shaving and hole diameter management in the field. To drive safety and standardization, the main horizontal ground bus is pre-drilled on all MC switchgears. This also saves time by minimizing and making field work efficient.

Add new subclause

7.2.4

Removable side sheet(s) or cover plate(s) attached with bolts or screws shall be provided on each end to allow connection of the main horizontal ground bus to additional sections.

Justification

This requirement allows for easy extension of the switchgear assembly with the addition of vertical sections.

Add new subclause

7.2.5

Ground bus joints shall be of through-bolt type (i.e., using a bolt that is secured with a hex nut or a pressed threaded insert).

Justification

Ground bus bolted connections safely clear electrical faults and prevent fires that are associated with loose connections. Being of through-bolt type ensures that the connections do not easily become loose over time.

Add new subclause

7.2.6

The ground bus shall be made of plated copper.

Justification

The use of plated copper is necessary to prevent oxidation and maintain surface conductivity. Field connections of additional ground conductors on oxidized or surface corroded bare copper bus require significant surface preparation and result in conductive filings, particles and/or dust within the assembly.

NOTE—Tin or silver plating is acceptable.

Add new subclause

7.2.7

The main horizontal ground bus shall be of uniform dimensions and continuous across the entire length of the MC switchgear assembly.

Justification

This requirement ensures the integrity of the grounding system for the entire MC switchgear assembly.

Add new subclause

7.2.8

The ground bus shall include provisions to connect a portable safety grounding clamp device in every circuit breaker compartment.

Justification

This requirement provides protection for personnel against accidental contact with energized parts.

NOTE—The provisions for a portable safety grounding clamp device are not a substitution for a factory-installed grounding (earthing) switch.

Add new subclause

7.2.9

The ground bus in cable compartments shall be pre-drilled for connection of the field cable termination shield wire.

Justification

Drilling holes into the bus in the field is time consuming, produces metal shavings that introduce integrity issues, and requires hole diameter management in the field. This requirement ensures that the ground bus is pre-drilled to drive safety and standardization.

Add new subclause

7.2.10

The main horizontal ground bus shall be supplied with NEMA two-hole copper compression lugs for field connections at each end.

Justification

Drilling holes into the bus in the field is time consuming, produces metal shavings that introduce integrity issues, and requires hole diameter management in the field. This requirement ensures that the horizontal ground bus is pre-drilled to drive safety and standardization.

Add new subclause

7.2.11

Cable terminations on each phase bus bar shall be provided with a grounding ball stud with a removable, reusable insulating cover.

Justification

When personnel are working on MV equipment, this requirement provides them with protection against incidental contact with live parts using these types of devices that can provide a safe and short-circuit rated grounding facility. This requirement is found in the electrical safety programs of the operating companies.

Add new subclause

7.2.12

Grounding ball studs shall be in accordance with ASTM F855.

Justification

The grounding facility for MV equipment is short-circuit rated to ensure withstand capability during fault conditions. These requirements are defined in ASTM F855.

NOTE—The selection guidance provided in ASTM F855:2023, Table 1 and Table 2 accounts for fault current level, duration and dc offset.

Add new subclause

7.2.13

The main horizontal ground bus shall be extended to the incoming power cable section.

Justification

This requirement allows for easy access for the incoming cable(s) with multiple grounding conductors and provides reasonable termination lengths.

Add new subclause

7.2.14

Hinged doors and panels equipped with powered devices shall be bonded to the enclosure with a flexible copper conductor connected between the hinged doors or panels and the MC switchgear ground bus or metallic structure.

Justification

This requirement minimizes the electric shock risk to personnel if electrical continuity (i.e., bonding) across the metallic panels or doors to the MC switchgear ground bus or assembly structure is solely dependent on the rotating metal-to-metal contact surface made by the hinge itself.

7.3 Control and secondary circuits and devices

7.3.1 General

Add new subclause f)

f) Each branch circuit that is utilized for protection, control or monitoring devices shall be individually protected.

Justification

When separate branch circuits are utilized in the MC switchgear for control and relaying functions, the failure of the circuit needs to be isolated from the main control circuit so the reliability of the complete lineup will not be compromised.

Add new subclause g)

g) Control power circuits that are sourced from the switchgear for a device or system external to the switchgear (e.g., transformer rapid pressure rise relays, motor start/stop circuits, device status) shall be individually protected.

Justification

When control power is utilized outside of the in the MC switchgear for control and relaying interfaces with external devices, the circuit needs to be isolated from the external control circuit so the reliability of the complete lineup will not be compromised.

7.3.2 Voltage and transformer fusing

Delete list subclause b)

Justification

The use of current-limiting fuses on VT secondary circuits provides protection from short circuits and prevents electrical fires. This requirement allows for other devices that are not of current-limiting type to be utilized for protection. These types of devices are of disconnecting type to allow for electrical isolation of the circuit to prevent electric shock during troubleshooting or maintenance activities.

Delete EXCEPTION

Justification

Fuse protection minimizes the likelihood of electrical shock to personnel during troubleshooting activities. Fuse protection also protects electrical instruments with independent power supplies from damage due to internal short circuits or inadvertent contact with live parts.

7.3.3 Control, secondary, and logic-level wiring

7.3.3.2 Wire size

Delete first paragraph

Justification

The minimum internal control wiring size varies between operators. However, to help drive standardization and alignment across other JIP33 electrical specifications, the essential minimum is No.14 AWG or 1.3 mm² and No.12 AWG for CTs to allow for prolonged fault current durations without any equipment damage.

Delete embedded table

Justification

The minimum internal control wiring size varies between operators. However, to help drive standardization and alignment across other JIP33 electrical specifications, the essential minimum is No.14 AWG or 1.3 mm² and No.12 AWG for CTs to allow for prolonged fault current durations without any equipment damage.

Delete EXCEPTION

Justification

The minimum internal control wiring size varies between operators. However, to help drive standardization and alignment across other JIP33 electrical specifications, the essential minimum is No.14 AWG or 1.3 mm² and No.12 AWG for CTs to allow for prolonged fault current durations without any equipment damage.

Delete third paragraph (Wiring for current transformer...)

Justification

The minimum internal control wiring size varies between operators. However, to help drive standardization and alignment across other JIP33 electrical specifications, the essential minimum is No.14 AWG or 1.3 mm² and No.12 AWG for CTs to allow for prolonged fault current durations without any equipment damage.

Add new subclause

7.3.3.2.1

Minimum conductor sizes for CT secondary wiring shall be No.12 AWG.

Justification

The minimum internal control wiring size varies between operators. However, to help drive standardization, the workgroup agreed on behalf of the operating companies to standardize on No.12 AWG for all CT circuits to allow for prolonged fault current duration to minimize the risk of equipment damage.

Add new subclause

7.3.3.2.2

Minimum conductor sizes for control wiring and auxiliary power circuits, except communication cabling, shall be No. 14 AWG.

Justification

The minimum internal control wiring size varies between operators. However, to help drive standardization, the workgroup agreed on behalf of the operating companies to standardize on No.14 AWG for all general control circuits. This also allows for standard fuse sizes for protection of control circuits.

Add new subclause

7.3.3.2.3

Minimum conductor sizes for analog and digital signals shall be No. 16 AWG shielded.

Justification

The minimum internal control wiring size for analog and digital signals varies between operators. However, to help drive standardization and to ensure the integrity of internal signals, the workgroup agreed on behalf of the operating companies to standardize on No.16 AWG shielded for analog and digital signals. These types of signals are normally utilized to remotely operate the power circuit breakers and provide diagnostic, alarms and status that are used in the DCS and other types of process control systems.

7.3.3.3 Wire protection and support

Add new subclause

7.3.3.3.1

Internal wiring shall be installed in a single continuous run from termination point to termination point, free of splices and taps.

Justification

For quality control, performance and maintenance reasons, the internal wiring should be continuous and not have any splices or taps.

Add new subclause

7.3.3.3.2

Wire and cable supports shall be permanently attached to the enclosure or the assembly (e.g., with screws or non-adhesive fasteners).

Justification

Permanently attached supports secure wiring consistent with the expected reliability and lifetime of the equipment. Adhesive-type supports are notorious for coming off, causing delays in maintenance, troubleshooting, repair and operating tasks, and leading to rework.

7.3.3.4 Wire type

Delete second list item from EXCEPTION

Justification

This requirement has been replaced with a new requirement in 7.3.3.4.2. These low-energy signal communication cables are installed throughout the assembly and in various compartments.

Delete sixth list item from EXCEPTION

Justification

This requirement has been replaced with a new requirement in 7.3.3.4.2. These low-energy signal communication cables are installed throughout the assembly and in various compartments.

Delete seventh list item from EXCEPTION

Justification

This requirement has been replaced with a new requirement in 7.3.3.4.2. These low-energy signal communication cables are installed throughout the assembly and in various compartments.

Add new subclause

7.3.3.4.1

Control wiring within the MC switchgear assembly shall be stranded tinned copper wire.

Justification

There are similar requirements for control wiring throughout IEEE Std C37.20.2, which can result in unclear instructions. This specification reorganizes all requirements for control wiring in this section and provides additional clarity. This specification also harmonizes with the requirements for control wiring in IOGP S-727 and IOGP S-742.

Add new subclause

7.3.3.4.2

If MC switchgear data communications are specified, the cabling and connections to the devices intended to be monitored and controlled shall be provided in accordance with the requirements given in 7.3.3.4.2.1 through 7.3.3.4.2.3.

Justification

This requirement ensures the integrity of internal signals as these types of systems are utilized to remotely operate the power circuit breakers and provide diagnostic, alarms and status that are used in the DCS and other types of process control systems.

7.3.3.4.2.1

The cabling and connection to the devices intended to be monitored and controlled shall be compatible with the specified communication protocol or combination of protocols.

Justification

This requirement ensures the integrity of internal signals as these types of systems are utilized to remotely operate the power circuit breakers and provide diagnostic, alarms and status that are used in the DCS and other types of process control systems.

7.3.3.4.2.2

The cabling and connection to the devices intended to be monitored and controlled shall be secured with a mechanical connecting means (e.g., screw-type connectors, RJ45 connectors).

Justification

This requirement prevents unintended separation of the communication network cable connections made in wireways and between vertical sections. In addition, this ensures the integrity of internal signals. These types of systems are utilized to remotely operate power circuit breakers and provide diagnostic, alarms and status that are used in the DCS and other types of process control systems.

7.3.3.4.2.3

The cabling to the devices intended to be monitored and controlled shall be rated for 600 V ac.

Justification

This 600 V ac rating requirement ensures the integrity of internal signals as these types of systems are utilized to remotely operate power circuit breakers and provide diagnostic, alarms and status that are used in the DCS and other types of process control systems. This also eliminates the requirement to segregate and separate different wiring classes.

7.3.4 Secondary-wiring terminals

Add new subclause

7.3.4.1

Control wiring terminated on screw-type terminals shall use insulated, compression, locking fork tongue-type lugs.

Justification

This requirement promotes standardization and reduces the probability of inadvertent disconnection due to vibration or maintenance and troubleshooting activities.

Add new subclause

7.3.4.2

Control wiring terminated on intelligent electronic devices (IEDs) (e.g., microprocessor-based multifunction protective relays and meters) that do not have screw-type terminals shall be terminated with crimp-type ferrules or pin lugs.

Justification

This requirement promotes standardization and provides an alternate method of control wiring termination for devices utilizing European-style type terminals.

Add new subclause

7.3.4.3

Internal wire terminations shall be marked with heat shrink-type wire markers or permanently marked.

Justification

Double-ended 360° slip-on or heat-shrink wire markers drive standardization, increase quality control and improve safety and maintainability. Adhesive-type markers are well-known for coming off, causing delays in maintenance, troubleshooting, repair and operating tasks, and leading to rework. This requirement facilitates the tracing of circuits and troubleshooting.

Add new subclause

7.3.4.4

Internal wire termination markers shall be visible at the termination point without disassembling the cable bundle.

Justification

Double-ended 360° slip-on or heat-shrink wire markers drive standardization, increase quality control and improve safety and maintainability. Alternatively, printed wire designations appearing on the wire at intervals can have the wire marker further back into the wiring bundle and not visible at the location where the circuit is being diagnosed. Adhesive-type markers are well-known for coming off, causing delays in maintenance, troubleshooting, repair and operating tasks, and leading to rework. This requirement facilitates the tracing of circuits and troubleshooting.

Add new subclause

7.3.4.5

Adhesive-type wire markers, labels and wire holders shall not be used for internal wire marking.

Justification

Double-ended 360° slip-on or heat-shrink wire markers drive standardization, increase quality control and improve safety and maintainability. Adhesive-type markers are well-known for coming off, causing delays in maintenance, troubleshooting, repair and operating tasks, and leading to rework.

Add new subclause

7.3.4.6

Internal wiring shall be identified at both ends within 25.4 mm (1 in) of the termination, using one of the following methods:

a) machine-printed 360° slip-on wire markers;

b) heat-shrink wire markers;

c) permanent stenciling per wire with a unique tag or wire number.

Justification

To drive standardization, increase quality control, improve safety and maintainability, the operators agreed to the use of doubled ended 360° slip-on wire markers, heat-shrink wire markers, or permanent stenciling per wire with a unique tag or wire number. This requirement also ensures that the wiring identification is visible in close proximity to the termination point.

7.3.5 Terminal blocks

Add new subclause

7.3.5.1

Terminal blocks shall be provided for external connections to the MC switchgear assembly.

Justification

This requirement ensures safe repair and troubleshooting activities.

Add new subclause

7.3.5.2

Exposed energized terminals of LV components (e.g., relays, terminal blocks, fuse holders) shall be provided as touch safe or covered by an insulating barrier.

Justification

This requirement protects electrical personnel from incidental contact and shock exposure during electrical troubleshooting or maintenance activities.

Add new subclause

7.3.5.3

The MC switchgear internal wiring shall be connected to only one side of the field wiring terminal blocks.

Justification

This requirement allows safe repair and minimizes confusion during troubleshooting activities. Having all internal wiring terminated on the same side of the terminal blocks provides a clear demarcation of the field interface wiring.

Add new subclause

7.3.5.4

A maximum of two wires shall be terminated on an individual terminal.

Justification

This requirement allows safe repair and troubleshooting activities. More than two lugs on one terminal are more likely to result in loose connections. Terminal screws can be too short to sufficiently connect more than two lugs.

Add new subclause

7.3.5.5

Terminal blocks and the associated wiring between shipping sections shall be permanently marked with identification matching the drawings.

Justification

IEEE Std C37.20.2 does not require wire marking for interconnection of shipping splits. Poor identification has been proven to be a source of improper wire connections resulting in equipment malfunction, electrical fire and breakers not tripping.

Add new subclause

7.3.5.6

Individual MV circuit breaker compartments shall be provided with a minimum of 10 % spare terminals on the control wiring terminal blocks in the LV compartment.

Justification

The operating companies all had requirements of 10 % to 20 % spare terminal strips. It has been determined that the minimum essential appropriate for most applications and standardization is 10 %.

Add new subclause

7.3.5.7

Terminal blocks shall be numbered and identified as designated on the approved schematic and wiring diagrams.

Justification

IEEE Std C37.20.2 does not include requirements for identification of terminal blocks for maintenance and troubleshooting. Poor identification has been proven to be a source of improper wire connections resulting in equipment malfunction, electrical fire and breakers not tripping.

Add new subclause

7.3.5.8

All wiring entering or leaving a compartment connected to a device shall be terminated on terminal blocks in that compartment.

Justification

IEEE Std C37.20.2 does not fully address capability for troubleshooting interconnecting wiring between compartments. This requirement facilitates maintenance and repairs.

Add new subclause

7.3.12 Instruments, meters, and control devices

7.3.12.1 General

Control devices, meters and protective relays shall be installed between 0.61 m and 1.8 m (2 ft and 6 ft) from the bottom of the MC switchgear assembly.

Justification

This human factor design requirement ensures that electrical personnel do not require the use of height extension devices to operate the equipment. This is necessary to ensure the safety of personnel during operations, maintenance and troubleshooting activities and it reduces the likelihood of misoperation by operators.

NOTE—Control devices should be arranged so as to minimize misoperation of the circuit breaker (e.g., prevent placing the ammeter selector switch directly adjacent to the circuit breaker operation switch).

Justification

This recommendation is from human factors engineering where operability and interaction with the equipment is needed for operators of varying height.

7.3.12.2 Microprocessor-based multifunction meters

If specified, power quality or microprocessor-based multifunction meters shall be provided in accordance with the requirements given in 7.3.12.2.1 through 7.3.12.2.6.

Justification

Microprocessor or power quality metering devices are selected for their ability to offer advanced monitoring and power metering functions. The functions required are typically provided in these relays and promote reliable operation of motors and analysis of power quality conditions.

7.3.12.2.1

Power quality or microprocessor-based multifunction meters shall be provided with digital communication capability.

Justification

Microprocessor metering devices are selected for their ability to offer advanced monitoring and communications capability. The use of this feature can significantly reduce the auxiliary wiring used to bring monitored variables into the facility-wide control system.

7.3.12.2.2

Power quality or microprocessor-based multifunction meters shall have a minimum accuracy of 0.5 %.

Justification

Microprocessor metering devices are selected for their ability to offer advanced monitoring and power metering functions. This level of accuracy in these meters provides reliable operation of motors and analysis of power quality conditions.

7.3.12.2.3

Power quality or microprocessor-based multifunction meters shall display the current and voltage for each phase.

Justification

Microprocessor metering devices are selected for their ability to offer advanced monitoring and power metering functions. Monitoring all phase voltage and currents allows the operator to accurately monitor the electrical parameters of the power distribution system.

7.3.12.2.4

Power quality or microprocessor-based multifunction meters shall display Hz, kVA, kW, kVAR and PF.

Justification

Microprocessor metering devices are selected for their ability to offer advanced monitoring and power metering functions. Monitoring these parameters allows the operator to accurately monitor the health and characteristics of the power distribution system.

7.3.12.2.5

Power quality or microprocessor-based multifunction meters shall display harmonic order measurements.

Justification

Microprocessor metering devices are selected for their ability to offer advanced monitoring and power metering functions. Monitoring these parameters allows the operator to accurately monitor the level of distortion (both voltage and current) of the power distribution system.

7.3.12.2.6

Current coils of power monitoring equipment shall be capable of withstanding momentary CT secondary currents of 20 times the CT rating without sustaining damage.

Justification

This requirement is based on previous experience where metering is connected to relay class CTs capable of outputting 20 times the rating as opposed to metering class CTs with a limited overload rating. This is required in this applications to prevent thermal overloads which can result in explosion or fire.

7.3.12.3 Analog-type metering

If specified, analog-type metering shall be provided in accordance with the requirements given in 7.3.12.3.1 through 7.3.12.3.6.

Justification

In cases where incoming metering is required, the analog type offers a minimum essential alternative and provides the required basic functionality.

7.3.12.3.1

Analog-type metering shall have a circular 250-degree-scale switchboard type.

Justification

Analog-type metering for switchgear applications is normally this type of meter that allows for rapid visual recognition of critical power system parameters.

7.3.12.3.2

Analog-type metering shall have a minimum accuracy of 1 %.

Justification

This level of accuracy provides the operator with the ability to accurately monitor the condition of the power distribution system.

7.3.12.3.3

Analog-type metering shall be 115 mm (4.5 in) square.

Justification

Analog-type metering for switchgear applications is normally this type of meter that allows for rapid visual recognition of critical power system parameters.

7.3.12.3.4

Analog-type metering shall be flush mounted.

Justification

Analog-type metering for switchgear applications is normally mounted using a through-the-door construction method. Surface-mounted analog metering can interfere with the operation of the switchgear door.

7.3.12.3.5

Analog-type ammeters shall be provided with a four-position rotary-type switch.

Justification

The use of a meter switch allows for the use of one ammeter for all phases to be displayed in one meter on the switchgear door to manage the number of devices on the front of the cubical.

7.3.12.3.6

Analog-type voltmeters shall be provided with a four-position rotary-type switch for open-delta connected VTs or a seven-position switch for wye-connected VTs.

Justification

The use of a meter switch allows for the use of one voltmeter to monitor all phases to be displayed in one meter on the switchgear door to minimize the number of devices on the door.

7.3.12.4 Protective relays

If protective relays are indicated on the single line or project drawings, these relays shall be provided in accordance with the requirements given in 7.3.12.4.1 through 7.3.12.4.8.

Justification

Microprocessor relays are selected for their ability to offer advanced monitoring and diagnostic functions. The functions required are typically provided in these relays and promote reliable operation of circuit breakers and analysis of trip/fault conditions. These types of devices allow for remote monitoring of switchgear parameters and integrate the MC switchgear into the digitalization strategy of the facility.

7.3.12.4.1

Protective relays shall be in accordance with the service conditions, ratings and testing requirements specified in IEEE Std C37.90.

Justification

This requirement ensures that microprocessor relays are selected based on IEEE Std C37.90 to ensure that they detect and operate reliably during electrical fault conditions, otherwise a misoperation can result in catastrophic equipment damage, electrical fires or both.

7.3.12.4.2

Protective relays shall be multifunctional microprocessor based.

Justification

Microprocessor relays are selected for their ability to offer advanced monitoring and diagnostic functions. These types of devices allow for remote monitoring of switchgear parameters and integrate the MC switchgear into the digitalization strategy of the facility.

7.3.12.4.3

Protective relays shall have a trip indication with a manual reset function.

Justification

This requirement ensures that microprocessor relays that provide protective functions supply the operator with the necessary information concerning the trip that has occurred and a means to reset the relay such that the breaker can be placed back into service without the need for a separate lock-out relay.

7.3.12.4.4

Protective relays shall provide an indication for each type of fault.

Justification

Microprocessor-based multifunctional relays identify the nature of the electrical fault condition to provide the operator with the information to enable him to correct the situation and/or restore the electrical circuit back into service.

7.3.12.4.5

Protective relays shall have a digital communication capability.

Justification

These types of devices allow for remote monitoring and control of the MC switchgear and integrate it into the digitalization strategy of the facility.

7.3.12.4.6

Protective relays shall be provided with a minimum of two digital inputs and two digital outputs.

Justification

These types of devices allow for remote monitoring and control of the MC switchgear and integrate it into the digitalization strategy of the facility.

7.3.12.4.7

Protective relays shall be capable of performing the protective functions indicated on the single line or project drawings.

Justification

Microprocessor relays are selected for their ability to offer advanced monitoring and diagnostic functions. These types of devices allow for remote monitoring of the MC switchgear parameters and integrate it into the digitalization strategy of the facility.

7.3.12.4.8

Protective relays shall be installed on the circuit breaker LV compartment door.

Justification

Locating the protective relays near the circuit breaker or device protected prevents confusion, mistakes, and spurious trips from occurring during testing and maintenance activities.

7.3.12.5 Selector switches

If MC switchgear style selector switches are indicated in the project drawings, these selector switches shall be provided in accordance with the requirements given in 7.3.12.5.1 through 7.3.12.5.3.

Justification

These types of switchboard selection devices ergonomically provide accurate and repeated operations. The pushbutton types can lead to possible misoperation and spurious circuit breaker trips.

7.3.12.5.1

Selector switches shall be of rotary-cam type.

Justification

These types of switchboard selection devices ergonomically provide accurate and repeated operations. The pushbutton types can lead to possible misoperation and spurious circuit breaker trips.

7.3.12.5.2

Selector switches shall have engraved escutcheon plates.

Justification

Selector switches with engraved plates provide clear identification and prevent confusion between devices. They also prevent misoperation that can lead to spurious circuit breaker trips.

7.3.12.5.3

Selector switches shall have oval handles.

Justification

These types of switchboard selection devices ergonomically provide accurate and repeated operations.

7.3.12.6 Circuit breaker control switches

If MC switchgear style circuit breaker control switches are indicated in the project drawings, these switches shall be provided in accordance with the requirements given in 7.3.12.6.1 through 7.3.12.6.3.

Justification

These types of switchboard selection devices ergonomically provide accurate and repeated operations. The pushbutton types can lead to possible misoperation and spurious circuit breaker trips.

7.3.12.6.1

Circuit breaker control switches shall have pistol grip handles.

Justification

These types of circuit breaker control switches ergonomically provide accurate and repeated operations. The pushbutton types can lead to possible misoperation and spurious circuit breaker trips.

7.3.12.6.2

Circuit breaker control switches shall have momentary contact and spring return-to-center functionality.

Justification

These types of circuit breaker control switches prevent misoperation of the circuit breaker. This functionality requirement eliminates the potential for fast repetitive operations of the breaker.

7.3.12.6.3

Circuit breaker control switches shall have red for "closed" and green for "open" mechanical indication.

Justification

These types of circuit breaker control switches provide a backup indication for the circuit breaker position in the unlikely event that the circuit breaker indicating lights fail.

7.3.12.7 Lock-out relays

If door-mounted lock-out relays (i.e., IEEE Device 86) are indicated on the project drawings, these relays shall be provided in accordance with the requirements given in 7.3.12.7.1 through 7.3.12.7.5.

Justification

A door-mounted external lock-out relay provides a positive manual lock-out function and an interface with external control systems. A physical door-mounted relay is typically used in critical equipment (e.g., compressor, generator or transformer) applications.

7.3.12.7.1

Lock-out relays shall have a manual reset type handle.

Justification

A door-mounted lock-out relay is needed to provide a positive manual lock-out function and to ensure that an accidental reclosure into a fault condition does not occur.

7.3.12.7.2

Lock-out relays shall operate in less than one cycle.

Justification

A fast-acting lock-out relay ensures that the circuit breaker interrupts the fault in a timely fashion.

7.3.12.7.3

Lock-out relays shall have two positions, "Reset" and "Tripped".

Justification

Two positions display the "Reset" and "Tripped" positions for easy identification of the status of the lock-out relay.

7.3.12.7.4

Lock-out relays shall have the coil health monitored with a white indicating light.

Justification

The monitoring of the lock-out relay trip coil ensures that the lock-out relay trips the circuit breaker after an electrical fault condition is detected.

7.3.12.7.5

If test switches are specified, the lock-out relay trip contacts shall be routed through separate test switch contacts.

Justification

The use of a test switch contact provides the capability for testing the lock-out relay without actuating the final element (e.g., circuit breaker trip, generator shutdown, compressor shutdown).

7.3.12.8 Test switches

If specified, test switches shall be provided in accordance with the requirements given in 7.3.12.8.1 through 7.3.12.8.9.

Justification

Test switches permit measurement and testing of relays, meters and other associated equipment from the front of the switchgear without taking devices out of service and without accessing wiring at the rear of the devices.

7.3.12.8.1

Test switches shall be installed on the circuit breaker or the associated instrument compartment door.

Justification

Locating the test switches near the circuit breaker or the device being tested prevents confusion, mistakes and spurious trips from occurring during testing and maintenance activities.

7.3.12.8.2

Test switches shall allow for isolation of power monitoring and protective relay equipment inputs and outputs.

Justification

This requirement enables online maintenance, testing and repairs of protective relays and breaker trip and close circuits without adversely affecting adjacent circuits.

7.3.12.8.3

Test switches shall be of FT-1 type.

Justification

FT-1 test switches allow for testing of the protective relay without removing the relay under test or making temporary wiring modifications.

7.3.12.8.4

Test switches shall be wired to provide three-phase bus voltages and three-phase line currents.

Justification

This requirement allows for full three-phase testing of metering and protection relays.

7.3.12.8.5

Individual test switches shall be wired in series on each side of protective relay trip output contacts.

Justification

This requirement allows for the full testing of protective relays without removing the wiring or bypassing the trip output. Experience has shown that modifications made to the protective circuit during routine maintenance and testing are sometimes not restored and have led to electrical fires due to the circuit breaker not tripping upon detection of an electrical fault.

7.3.12.8.6

A dedicated test switch per circuit breaker shall be provided for each lock-out device tripping more than one breaker.

Justification

This requirement enables online maintenance, testing and repairs of protective relays and breaker trip and close circuits. This requirement also ensures continuity of service and safeguards electrical personnel from exposure to hazardous voltages during these types of operations. This requirement also prevents the spurious trip of multiple circuit breakers and the possibility of a complete bus blackout.

7.3.12.8.7

If test switches are applied to CT circuits, the test switches shall be of shorting type.

Justification

This requirement prevents dangerous over-voltages that can exist when a CT circuit is open circuited under load. Experience has shown that open circuiting of CTs during routine maintenance and testing has led to electrical shock incidents or electrical fires.

7.3.12.8.8

Test switches shall be wired such that the voltage blades are de-energized when open.

Justification

This requirement prevents exposure to hazardous voltages that can exist when the test switch is operated. Experience has shown that operating an improperly wired test switch has led to electrical shock incidents.

7.3.12.8.9

Test switches shall be provided with a nameplate that identifies the function or service of each switch pole, with the text aligned directly above the associated pole.

Justification

Labeling of test switch pole function can reduce the likelihood of human error leading to an unintended trip.

7.3.12.9 Indication devices

If status indicator lights are specified or indicated on the project drawings, these lights shall be provided in accordance with the requirements given in 7.3.12.9.1 through 7.3.12.9.6.

Justification

Status indicators are utilized to locally determine the status of the circuit breaker and associated devices.

7.3.12.9.1

Status indicator lights shall be installed on the circuit breaker LV compartment door.

Justification

Status indicators are LV devices installed in the LV compartment. They are utilized to locally determine the status of the circuit breaker and associated devices.

7.3.12.9.2

Status indicating light colors shall depend on the status of the circuit breaker in accordance with the following:

— red for breaker closed or motor running;

— green for breaker open or motor stopped;

— amber for tripped;

— white for breaker trip coil health and lock-out relay health.

Justification

This requirement provides a standard color scheme for operating status of different devices.

7.3.12.9.3

Status indicating lights shall be of clear LED type.

Justification

Long-life LED bulbs for status indicators typically eliminate the need for complex push-to-test functions in the control circuits. This type improves efficiency and reliability and reduces the maintenance effort to support the equipment.

7.3.12.9.4

LED status indicating lights shall have a minimum illumination life of 100 000 hours.

Justification

Long-life LED bulbs for status indicators typically eliminate the need for complex push-to-test functions in the control circuits. This type improves efficiency and reliability and reduces the maintenance effort to support the equipment.

7.3.12.9.5

Status indicating lights shall be replaceable.

Justification

Replaceable status indicators provide a safe and efficient means to replace defective indicators without rewiring.

7.3.12.9.6

Replacement of indicator lights shall not result in circuit breaker operation.

Justification

The close indicating light is sometimes wired into the circuit breaker close circuit to indicate a trip coil healthy indication and, depending on the type of lamp used, can result in sufficient voltage being applied to the trip coil when the new lamp is inserted into the base.

7.3.12.10 Auxiliary relays

If auxiliary relays are required, these relays shall be provided in accordance with the requirements given in 7.3.12.10.1 through 7.3.12.10.4.

Justification

IEEE Std C37.20.2 does not address requirements for auxiliary relays. These types of devices are necessary to interface the MC switchgear with other control systems.

7.3.12.10.1

Control relay output contacts and auxiliary (interposing) control-circuit device contacts for field wiring to external equipment shall have a contact ampacity performance rating for the intended switching application in accordance with NEMA ICS 5.

Justification

This requirement provides a standardized interface device specification and quality level using a widely used industry standard, NEMA ICS 5, to provide safe and reliable unit controls.

7.3.12.10.2

Surge suppressors shall be installed across control relay coils, except for electronic relays that include internal surge suppression.

Justification

Surge suppressors protect electronic components from voltage irregularities that may exist during normal operation or fault conditions. Surge suppressors provide an economic method to prevent failure or replacement of more valuable items.

7.3.12.10.3

Plug-in-type relays shall be provided with retaining clips.

Justification

Natural vibration from the environment and circuit breaker operation can result in plug-in-type relays loosening over time. Retaining clips are an economical means to increase reliability.

7.3.12.10.4

Surface-mounted control and auxiliary relays shall not be mounted on the interior surface of the LV compartment door.

Justification

Surface-mounted relays installed on the rear of the LV compartment door are subject to vibration and inadvertent contact during door opening that can result in misoperation or reliability issues.

7.3.12.11 E-stop pushbutton

If specified, an emergency stop button (E-stop) function shall be provided for circuit breakers in accordance with the requirements given in 7.3.12.11.1 through 7.3.12.11.4.

Justification

The emergency stop button function allows personnel to shut down the circuit in case of emergency. This requirement standardizes design and functionality to provide commonality between all electrical switching equipment.

7.3.12.11.1

The color of the emergency stop button shall be red.

Justification

The emergency stop button function allows personnel to shut down the circuit in case of emergency. This requirement standardizes design and functionality to provide commonality between all electrical switching equipment.

7.3.12.11.2

The emergency stop button shall be of mushroom-head type.

Justification

The emergency stop button function allows personnel to shut down the circuit in case of emergency. This requirement standardizes design and functionality to provide commonality between all electrical switching equipment.

7.3.12.11.3

The emergency stop button shall be of maintained push-to-operate type.

Justification

The emergency stop button function allows personnel to shut down the circuit in case of emergency. This requirement standardizes design and functionality to provide commonality between all electrical switching equipment.

7.3.12.11.4

The emergency stop button shall be provided with a protective guard or shroud.

Justification

The protective guard on the emergency stop button prevents inadvertent activation of the emergency stop function. The emergency stop button function allows personnel to shut down the circuit in case of emergency. This requirement standardizes design and functionality to provide commonality between all electrical switching equipment.

7.3.12.12 Motor protection relay

If motor protection relays are indicated on the single line or project drawings, these relays shall include the following functions:

a) Percentage of motor FLC

b) Percentage of thermal capacity utilized

c) Motor bearing temperature

d) Running time (cumulative) in hours

e) Operation count

f) Number of remaining starts

g) Motor start lock out

h) Motor stator winding temperature

i) Protective functions including thermal overload, underload, locked rotor, current imbalance, differential, short circuit, ground fault, under-voltage, under-frequency, phase imbalance and stall

Justification

Microprocessor relays are selected for their ability to offer advanced monitoring and diagnostic functions. Advanced monitoring and diagnostic functions are typically provided in these relays and promote reliable operation of motors and analysis of trip/fault conditions. These types of devices allow for remote monitoring of switchgear parameters and integrate the MV motor data into the digitalization strategy of the facility.

7.4 Miscellaneous

7.4.1 Nameplate marking

Add new list item k)

k) Purchase order number

Justification

This nameplate is required for the end user to be able to identify the assembly for installation. It is also needed for maintenance support when contacting the manufacturer for assistance.

Add new list item l)

l) MC switchgear designation (i.e., tag number)

Justification

This nameplate is required for the end user to be able to identify the assembly for installation. It is also needed for maintenance support when contacting the manufacturer for assistance.

Add new subclause

7.4.1.1

Nameplates on compartment doors or panels shall be mounted with stainless steel screws.

Justification

Nameplate requirements are lacking in IEEE Std C37.20.2. This requirement has been added to be in line with operating companies' minimal requirements and promote standardization. The use of non-stainless steel hardware for these important identifiers may result in illegibility due to corrosion or loss of the nameplate altogether. Nameplate details may seem trivial, but the lack/illegibility of nameplates has been responsible for several electrical-related deaths in various operating companies.

Add new subclause

7.4.1.2

Nameplates shall be of engravable type with black letters on a white background.

Justification

Nameplate requirements are lacking in IEEE Std C37.20.2. This requirement has been added to be in line with operating companies' minimal requirements and promote standardization. Nameplate details may seem trivial, but the lack/illegibility of nameplates has been responsible for several electrical-related deaths in various operating companies. This requirement replaces all the different colors in operating companies' specifications and standardizes on color.

Add new subclause

7.4.1.3

Circuit breaker compartment nameplates shall be a minimum of 25.4 mm (1 in) high x 63.5 mm (2.5 in) wide.

Justification

Nameplate requirements are lacking in IEEE Std C37.20.2. This requirement has been added to be in line with operating companies' minimal requirements and promote standardization. Nameplate details may seem trivial, but the lack/illegibility of nameplates has been responsible for several electrical-related deaths in various operating companies. This requirement replaces all the different nameplate sizes in operating companies' specifications and promotes standardization.

Add new subclause

7.4.1.4

The characters on the circuit breaker compartment nameplate shall be a minimum of 4.8 mm (0.1875 in) high.

Justification

Nameplate requirements are lacking in IEEE Std C37.20.2. This requirement has been added to be in line with operating companies' minimal requirements and promote standardization. Nameplate details may seem trivial, but the lack/illegibility of nameplates has been responsible for several electrical-related deaths in various operating companies. This requirement replaces all the different nameplate sizes in operating companies' specifications and promotes standardization.

Add new subclause

7.4.1.5

Individual nameplates shall identify door-mounted items (e.g., meters, switches, indicating lights and protective relays).

Justification

Nameplate requirements are lacking in IEEE Std C37.20.2. This requirement has been added to be in line with operating companies' minimal requirements and promote standardization. Nameplate details may seem trivial, but the lack/illegibility of nameplates has been responsible for several electrical-related deaths in various operating companies.

Add new subclause

7.4.1.6

Individual device labels shall identify the individual components within each compartment (e.g., terminals, relays, switches, fuse blocks).

Justification

Nameplate requirements are lacking in IEEE Std C37.20.2. This requirement has been added to be in line with operating companies' minimal requirements and promote standardization. Nameplate details may seem trivial, but the lack/illegibility of nameplates has been responsible for several electrical-related deaths in various operating companies.

Add new subclause

7.4.1.7

MC switchgear individual front and rear compartment doors or covers shall be provided with externally mounted nameplates.

Justification

Nameplate requirements are lacking in IEEE Std C37.20.2. This requirement has been added to be in line with operating companies' minimal requirements and promote standardization. Nameplate details may seem trivial, but the lack/illegibility of nameplates has been responsible for several electrical-related deaths in various operating companies.

Add new subclause

7.4.1.8

Nameplates on individual MC switchgear front and rear compartment doors or covers shall identify the equipment tag number, description and other information detailed in the project nameplate schedule or single line drawings.

Justification

Nameplate requirements are lacking in IEEE Std C37.20.2. This requirement has been added to be in line with operating companies' minimal requirements and promote standardization. Nameplate details may seem trivial, but the lack/illegibility of nameplates has been responsible for several electrical-related deaths in various operating companies.

Add new subclause

7.4.1.9

Cable compartment doors shall be provided with nameplates that identify the circuit breaker or circuit designation.

Justification

Nameplate requirements are lacking in IEEE Std C37.20.2. This requirement has been added to be in line with operating companies' minimal requirements and promote standardization. Nameplate details may seem trivial, but the lack/illegibility of nameplates has been responsible for several electrical-related deaths in various operating companies.

Add new subclause

7.4.1.10 Mimic bus representation

If specified, a mimic bus representation shall be installed on the front of the MC switchgear assembly in accordance with the requirements given in 7.4.1.10.1 through 7.4.1.10.5.

Justification

Mimic bus representations have proved to be helpful in the execution of switching procedures and assisting in troubleshooting activities. Experience has shown that a mimic bus representation results in a facilitation of power system restoration.

7.4.1.10.1

The mimic bus representation shall include current-carrying buswork within the MC switchgear.

Justification

Mimic bus representations have proved to be helpful in the execution of switching procedures and assisting in troubleshooting activities. Experience has shown that a mimic bus representation results in a facilitation of power system restoration.

7.4.1.10.2

The mimic bus representation shall include MV circuit breakers.

Justification

Mimic bus representations have proved to be helpful in the execution of switching procedures and assisting in troubleshooting activities. Experience has shown that a mimic bus representation results in a facilitation of power system restoration.

7.4.1.10.3

The mimic bus representation shall include MV supply sources.

Justification

Mimic bus representations have proved to be helpful in the execution of switching procedures and assisting in troubleshooting activities. Experience has shown that a mimic bus representation results in a facilitation of power system restoration.

7.4.1.10.4

The mimic bus representation shall include load designations.

Justification

Mimic bus representations have proved to be helpful in the execution of switching procedures and assisting in troubleshooting activities. Experience has shown that a mimic bus representation results in a facilitation of power system restoration.

7.4.1.10.5

The mimic bus representation shall include MV VTs.

Justification

Mimic bus representations have proved to be helpful in the execution of switching procedures and assisting in troubleshooting activities. Experience has shown that a mimic bus representation results in a facilitation of power system restoration.

Add new subclause

7.4.1.11

If an interlock system (e.g., key type, secondary selective, electrical, mechanical) is used, nameplates containing operational instructions shall be affixed on the front of the MC switchgear near the point of operation.

Justification

Readily available instructions for proper operation of interlock systems enhance comprehension of operation and prevent incidents due to improper operation of the safety interlock system from occurring.

Add new subclause

7.4.1.12

Interior warning labels and device nameplates shall not be obscured by wiring and other components.

Justification

Proper placement of warning labels ensures that maintenance personnel can easily identify hazards and specific devices as detailed in the schematic drawings.

Add new subclause

7.4.1.13

Fuse holders shall be labeled to indicate the fuse size, type and identification matching the drawings.

Justification

This requirement ensures standardization and commonality, and reduces problems during maintenance and troubleshooting activities.

7.4.3 Viewing panes

Add new subclause

7.4.3.1

If specified, a circuit breaker viewing window that allows for an unobscured view of the circuit breaker position during closed-door racking shall be provided.

Justification

The task of racking an MV circuit breaker in or out of the circuit breaker's compartment is considered an activity with a very high likelihood of creating an arc-flash event or an unanticipated exposure to energized circuit parts if the racking mechanism fails to operate as designed. The requirement of an MV circuit breaker position viewing window provides an additional means to visually confirm the actual position of the MV circuit breaker with the compartment door closed, ensuring personnel safety during maintenance activities or switching procedures.

Add new subclause

7.4.3.2

If specified, a viewing window that allows for an unobscured view of the circuit breaker mechanical open/closed status indicator shall be provided for each compartment containing an MV circuit breaker to view the circuit breaker mechanical open/closed status indicator with the door closed.

Justification

The task of racking an MV circuit breaker in or out of the circuit breaker's compartment is considered an activity with a very high likelihood of creating an arc-flash event or an unanticipated exposure to energized circuit parts if the racking mechanism fails to operate as designed. The requirement of an MV circuit breaker position viewing window provides an additional means to visually confirm the actual position of the MV circuit breaker with the compartment door closed, ensuring personnel safety during maintenance activities or switching procedures.

7.4.6 Service disconnecting means

Add new subclause

7.4.6.1

If a service entrance application is specified, the service entrance compartment shall have provisions for utility instrument transformers and meters as indicated on the project drawings and in the project documentation.

Justification

Service entrance applications are special services and are not addressed in IEEE Std C37.20.2.

Add new subclause

7.4.6.2

If a service entrance application is specified, the service entrance compartment(s) shall be in accordance with local utility and AHJ requirements.

Justification

Service entrance applications are special services and are not addressed in IEEE Std C37.20.2.

7.6 Precautionary labels

Add new subclause

7.6.1

Caution labels shall be provided on doors of compartments with an external ac voltage source.

Justification

This requirement provides a safe and easily identifiable means of accessing and maintaining the circuits supplied from an external source. Additionally, caution labels reduce the risk of electrical shock to personnel.

Add new subclause

7.6.2

Caution labels shall be provided on doors of compartments with external powered space heaters to identify the space heater circuit panel and breaker information as detailed in the project drawings.

Justification

This requirement provides a safe and easily identifiable means of accessing and maintaining the circuits supplied from an external source.

7.8 Shutters

Add new subclause

7.8.1

Shutters for MC switchgear circuit breaker compartments shall be equipped with provisions to padlock the shutters in the closed position.

Justification

The LOTO of shutter mechanisms prevents exposure to the energized bus during switchgear maintenance and commissioning activities.

Add new subclause

7.8.2

The padlock provisions for the shutter assembly for MC switchgear circuit breaker compartments shall be front accessible.

Justification

The LOTO of shutter mechanisms prevents exposure to the energized bus during switchgear maintenance and commissioning activities. Front accessibility allows operating personnel to implement LOTO in a safe manner.

Add new subclause

7.8.3

Shutters for MC switchgear circuit breaker compartments shall be marked with a label indicating "Line" (for incoming feeders), "Main Bus" (for the main bus), or "Load" (for outgoing feeders).

Justification

The shutter assembly identification differentiates between the line and load bus connections during switchgear maintenance and commissioning activities. Numerous incidents in the industry have occurred involving exposure to energized parts due to improper or lack of identification of shutters.

NOTE—For switchgear with tie-breakers, the shutters are typically labeled with the corresponding main bus equipment or tag number as indicated in the project drawings.

Add new subclause

7.8.4

Shutters for MC switchgear circuit breaker compartments shall be identified using a label with a minimum character height of 50 mm (2 in).

Justification

Clearly legible identification of the shutter mechanism warns personnel and prevents exposure to energized circuits.

7.9 Insulating materials for covering buses and connections

Delete third paragraph

Justification

IEEE Std C37.20.2 requirements for the insulated bus are not sufficient for oil and gas applications. They are more appropriate for commercial installations.

Add new subclause

7.9.1 Bus bar insulation

The MC switchgear shall be provided with a fully insulated bus in accordance with the requirements given in 7.9.1.1 through 7.9.1.8.

Justification

This requirement provides additional details for an insulated bus for the MC switchgear.

7.9.1.1

The bus bar insulating material shall be non-hygroscopic.

Justification

Without non-hygroscopic insulation, bussing can absorb moisture and become wet, resulting in dielectric failure.

7.9.1.2

The bus bar insulating material shall be flame retardant and track resistant.

Justification

The use of flame-retardant and track-resistant insulation materials reduces failures associated with partial discharge, and helps improve safety and prevents fires.

7.9.1.3

MC switchgear assembly bus joints shall be covered with formed insulating boots.

Justification

This requirement provides a standard method for insulating bus joints in a maintainable manner.

7.9.1.4

Bolted joints shall not be insulated using tape in lieu of formed bus bar joint boots.

Justification

A taped joint material that is capable of handling temperature rise requirements of the bus is difficult and time consuming to remove/replace.

7.9.1.5

Bus joint insulating boots shall be attached with non-metallic hardware.

Justification

The use of metallic hardware for the securement of bus insulating boots can result in premature dielectric failure at the cable termination location.

7.9.1.6

MC switchgear assembly bus joints at shipping splits shall be supplied with boots, attachment hardware and installation instructions.

Justification

This is necessary for the insulation evaluation as required for the main bus power frequency withstand test.

7.9.1.7

MC switchgear bus bar insulation, except at the joints, shall be bonded to the bus bar and be of heat-shrink, liquid-dipped or fluidized-bed epoxy type.

Justification

Partial discharge can lead to early dielectric failure in the main bus compartment. This requirement prevents partial discharge by directly adhering the insulation to the bus bar surface.

7.9.1.8

Incoming supply and outgoing feeder connections (e.g., cable or bus) shall be covered with formed insulating boots.

Justification

This requirement provides a standard method for insulating bus joints in a maintainable manner. It also provides a means for reducing exposure of personnel to energized parts and shock hazards.

Add new subclause

7.9.2 Bus bar supports

Supports for the main and current-carrying buses for the MC switchgear shall be provided in accordance with the requirements given in 7.9.2.1 through 7.9.2.3.

Justification

IEEE Std C37.20.2 does not limit the materials used for support of insulated current-carrying parts of the main circuit.

7.9.2.1

The material for the support of an insulated energized part shall be porcelain, cycloaliphatic epoxy or glass polyester.

Justification

IEEE Std C37.20.2 does not limit the materials used for support of insulated current-carrying parts of the main circuit.

7.9.2.2

The bus bar support material shall be non-hygroscopic.

Justification

IEEE Std C37.20.2 does not limit the materials used for support of insulated current-carrying parts of the main circuit.

7.9.2.3

The bus bar support material shall be flame retardant and track resistant.

Justification

IEEE Std C37.20.2 does not limit the materials used for support of insulated current-carrying parts of the main circuit.

7.17 Indoor MC switchgear, access, and ventilation

Add new subclause

7.17.1

MC switchgear enclosures shall be provided as Category B in accordance with Appendix B.

Justification

Category B enclosures are used in installations not subject to deliberate unauthorized acts by members of the unsupervised general public, primarily to provide a degree of protection to unauthorized and untrained personnel against incidental contact with enclosed equipment. Most oil and gas facilities can be categorized as such because general access to those facilities is restricted.

Add new subclause

7.17.2

The front doors of the MC switchgear shall be secured with latches or handles (i.e., cam or twist type) with less than one full rotational turn.

Justification

This requirement protects electrical personnel during operation and maintenance procedures associated with the equipment.

Add new subclause

7.17.3

Special tools shall not be required to open or close compartment doors.

Justification

This requirement protects electrical personnel during operation and maintenance procedures associated with the equipment.

Add new subclause

7.17.4

Hinged doors exceeding a height of 1143 mm (45 in) or a width of 610 mm (24 in) shall be provided with door keepers or positioners.

Justification

This requirement facilitates safe installation, inspection and maintenance. It also prevents the door from accidentally closing while the technician is performing maintenance or troubleshooting.

Add new subclause

7.17.5

If provided, rear compartment doors shall be removable or capable of being opened more than 90°.

Justification

IEEE Std C37.20.2 does not require a minimum opening of compartment doors. This requirement facilitates safe installation, inspection, maintenance and egress.

Add new subclause

7.17.6

Full-height compartment doors shall be provided with a full-length hinge or with a minimum of three separate hinges.

Justification

IEEE Std C37.20.2 does not require doors and removable covers to be attached in this rigid fashion. This requirement facilitates safe installation, inspection and maintenance.

Add new subclause

7.17.7

If provided, rear compartment doors shall be equipped with padlock provisions.

Justification

IEEE Std C37.20.2 requires doors to be lockable but not padlockable. This requirement provides LOTO capability to ensure safe inspection and maintenance activities.

Add new subclause

7.17.8

The front doors of the MC assembly shall be capable of being opened more than 120°.

Justification

Front doors that open more than 120° allow sufficient space for clearance between the equipment mounted on the door and a circuit breaker or potential transformer being removed from its compartment.

Add new subclause

7.17.9

The MC switchgear assembly shall be extendable on each end for the addition of vertical sections.

Justification

This requirement allows the MC switchgear to accept additional sections on either end with no sheet metal or bus work. Performing sheet metal fabrication or drilling holes in main bus sections can increase the risk of metal or copper particles present in the interior of the MC switchgear. This type of debris inside the bus or primary connection area can lead to premature dielectric breakdown or result in an arc fault event. This also promotes standardization and eliminates customization.

Add new subclause

7.17.10

Circuit breaker compartment doors shall be equipped with padlock provisions.

Justification

IEEE Std C37.20.2 requires doors to be lockable but not padlockable. This requirement provides LOTO capability to ensure safe inspection and maintenance activities.

Add new subclause

7.17.11

A removable side sheet or cover plate attached with bolts or screws shall be provided on each end of the assembly, allowing access to the predrilled main and ground bus bars and interconnecting LV wiring.

Justification

This requirement ensures that the user has access to the main and ground bus bars in the field to accommodate the installation of additional sections in the field.

Add new subclause

7.17.12

Removable panels weighing more than 16 kg (35 lbs) shall have two lifting handles.

Justification

Safety in design practices limits excessive lifting of weight by personnel. This requirement ensures that these removable panels for maintenance access do not require any overhead lift devices to be installed.

7.18 Outdoor MC switchgear, access, and ventilation

Add new subclause

7.18.1

The roof shall be sloped to allow for drainage away from the front of the assembly.

Justification

This requirement for outdoor applications ensures that the roof drains water away from personnel for safe and reliable operation.

Add new subclause

7.18.2

External joints shall be seal welded for the full length of the joint or bolted with gaskets.

Justification

This enclosure requirement for outdoor applications prevents the entry of water or other contaminates, ensuring reliable performance.

Add new subclause

7.18.3

External gasketed joints shall be covered with a metal cap.

Justification

This enclosure requirement for outdoor applications prevents the entry of dust, rain, snow or other contaminates, ensuring reliable performance.

Add new subclause

7.18.4

Gaskets shall be held in metal retainers, channels or other means to prevent the gasket from being misaligned or dislodged during operation.

Justification

This enclosure requirement for outdoor applications keeps the gasket in place during assembly to prevent the entry of water or other contaminates, ensuring reliable performance.

Add new subclause

7.18.5

Outdoor MC switchgear assemblies of three or fewer vertical sections shall have at least one 120-volt GFCI-protected receptacle located inside an exterior door.

Justification

This receptacle requirement for the outdoor enclosure provides electrical shock protection and a means of providing local power for test equipment and maintenance operations.

Add new subclause

7.18.6

Outdoor MC switchgear assemblies of four or more vertical sections shall have at least one 120-volt GFCI-protected receptacle located on each end and inside an exterior door.

Justification

This receptacle requirement for the outdoor enclosure provides electrical shock protection and a means of providing local power for test equipment and maintenance operations.

Add new subclause

7.18.7

The distance between the 120-volt GFCI-protected receptacles of an outdoor MC switchgear assembly consisting of four or more vertical sections shall not be more than 7.5 m (25 ft).

Justification

This distance requirement between receptacles for outdoor enclosures allows for the use of standard extension cords most often used by electrical maintenance personnel.

Add new subclause

7.18.8

Outdoor MC switchgear enclosures shall have one LED-type light fixture per vertical section located inside the exterior door.

Justification

This requirement ensures adequate lighting for safe operations and maintenance of the equipment.

Add new subclause

7.18.9

The nameplates located on exterior surfaces of outdoor MC switchgear shall be made of stainless steel.

Justification

This enclosure requirement for outdoor applications including corrosion-resistant materials ensures safe operations and maintenance of the equipment.

7.19 Circuit breaker open/close position indication

Add new subclause

Circuit breaker open and closed positions shall be indicated by a color-coded mechanical means visible with the compartment door closed.

Justification

The mechanical indication of circuit breaker status provides a visual indication if the electrical status of the circuit breaker is not functional (loss of control power). This provides a means of safely identifying the operating status of circuit breakers without opening the unit door, preventing exposure of the worker to energized conductors or circuit parts.

Add new subclause

7.24 Instrument and control power transformers

7.24.1 Voltage transformers

7.24.1.1

The secondary voltage shall be 120 V with the primary voltage indicated on the single line diagram.

Justification

IEEE Std C37.20.2 does not include requirements for the design and performance of VTs. This requirement promotes standardization and commonality and reduces shock hazards associated with higher control voltage levels.

7.24.1.2

VTs shall be protected by current-limiting primary fuses.

Justification

IEEE Std C37.20.2 does not include requirements for the design and performance of VTs. This requirement promotes standardization and commonality and reduces shock hazards during maintenance and troubleshooting activities.

7.24.1.3

VTs shall be withdrawable.

Justification

IEEE Std C37.20.2 does not include requirements for the design and performance of VTs. This requirement promotes standardization and commonality and reduces shock hazards during maintenance and troubleshooting activities.

7.24.1.4

VTs shall have the secondary winding protected by disconnecting-type current-limiting fuses or circuit breakers with one leg of the secondary winding grounded.

Justification

IEEE Std C37.20.2 does not include requirements for the design and performance of VTs. This requirement promotes standardization and commonality and reduces shock hazards during maintenance and troubleshooting activities.

7.24.1.5

The VT BIL rating shall be at a minimum equal to the MC switchgear assembly BIL rating.

Justification

This requirement ensures that all devices connected to the main bus have insulation levels to minimize flashover and arc-flash events.

7.24.1.6

Secondary protective devices for VTs shall be located in the LV control compartment.

Justification

This requirement promotes standardization and commonality and reduces shock hazards during maintenance and troubleshooting activities.

7.24.1.7

Fuse holders shall be labeled to indicate fuse size, fuse type and identification matching the drawings.

Justification

This requirement promotes standardization and commonality and reduces shock hazards during maintenance and troubleshooting activities.

7.24.1.8

Provisions to padlock VTs in the disconnect or withdrawn position shall be provided.

Justification

This requirement promotes standardization and commonality and reduces shock hazards during maintenance and troubleshooting activities.

7.24.2 Control power transformers

7.24.2.1

The kVA rating of the CPT shall include the MC switchgear loads in addition to the external loads indicated on the project drawings.

Justification

In some applications, accessories for the MC switchgear are also supplied from the CPT, thereby increasing the overall load on the CPT.

7.24.2.2

The kVA rating of the CPT shall include the larger of either the simultaneous tripping or charging of all the circuit breakers for 120 V ac control power applications.

Justification

In some applications when 120 V ac control power is specified, accessories for the MC switchgear are also supplied from the CPT. This is required for reliable operation.

7.24.2.3

The kVA rating of the CPT shall include a minimum of 15 % additional VA capacity.

Justification

In most applications, field-installed accessories are also supplied from the MC switchgear CPT, resulting in an extra capacity CPT. Retrofitting the CPT to the next size up is uneconomical versus adding additional capacity in the CPT sizing.

7.24.2.4

The CPT BIL rating shall be at a minimum equal to the MC switchgear assembly BIL rating.

Justification

This requirement ensures the overall reliability of the assembly by requiring the same withstand capabilities as the main bus assembly, preventing premature failures due to transient overvoltage events.

7.24.2.5

If internal ac control power is required, one CPT shall be provided for each incoming power source feeding the MC switchgear.

Justification

This requirement ensures operability for MC switchgear assemblies that utilize multiple power sources for the reliability of electrical power to the facility.

7.24.2.6

If multiple CPTs are provided internal to one MC switchgear assembly, an automatic control power transfer scheme shall be provided such that the control power is normally supplied from one control power source and transferred to one of the others in the event a control power source becomes unavailable.

Justification

This requirement ensures operability for MC switchgear assemblies that utilize multiple power sources for the reliability of electrical power to the facility.

7.24.2.7

The secondary voltage of an internal CPT shall be 240/120 V or 120 V, with the primary voltage as indicated on the single line diagram.

Justification

This requirement promotes standardization and commonality and reduces shock hazards during maintenance and troubleshooting activities.

7.24.2.8

Primary windings for CPTs shall be protected by current-limiting fuses.

Justification

This requirement promotes standardization and commonality, and minimizes damage to the equipment during short-circuit events.

7.24.2.9

Secondary windings for CPTs shall be protected by disconnecting-type current-limiting fuses or molded-case circuit breakers with the neutral of the secondary winding grounded.

Justification

This requirement promotes standardization and commonality, and minimizes damage to the equipment during short-circuit events.

7.24.2.10

The CPT compartment door shall be equipped with provisions to be padlocked in the disconnected position.

Justification

This requirement promotes standardization and commonality, and reduces shock hazards during maintenance and troubleshooting activities.

7.24.2.11

CPT current-limiting primary fuses shall be coordinated with the magnetizing inrush current.

Justification

This requirement ensures the overall reliability of the assembly by requiring properly sized fuses and minimizes spurious trips during energization events.

7.24.2.12

A control relay with a dry-type, Form C contact shall be provided for remote alarming of any loss of each control power source.

Justification

A control relay with a dry-type, Form C contact provides alarm functions even during loss of power. Given the criticality of alarming for the operation of electrical equipment, a Form C contact is necessary to maintain alarming function during loss of power. This provides a minimum essential status and alarming discrete dry contact which can be used as the interface to a remote-control system or other annunciating panel if facility networking capability is not available.

7.24.3 Current transformers

7.24.3.1

CT secondary connections, including taps from multi-ratio CTs, shall be directly wired out to accessible short-circuiting terminal strips.

Justification

This requirement promotes standardization and commonality, and reduces shock hazards during maintenance and troubleshooting activities.

7.24.3.2

CTs with the same rating and application shall be identical and interchangeable.

Justification

This requirement promotes standardization and commonality, and reduces shock hazards during maintenance and troubleshooting activities.

7.24.3.3

CT polarity shall be visible (e.g., CT markings are visible or a label is provided).

Justification

This requirement promotes standardization and commonality, and reduces shock hazards during maintenance and troubleshooting activities.

7.24.3.4

Phase CTs installed on stationary circuit breaker stabs shall be front accessible.

Justification

This requirement promotes standardization and commonality, and reduces shock hazards during maintenance and troubleshooting activities.

7.24.3.5

Wiring for CT secondary leads shall be terminated with insulated, compression ring-type lugs.

Justification

This requirement promotes standardization and commonality, and reduces shock and fire hazards during maintenance and troubleshooting activities.

7.24.3.6

One direct connection shall be made from the CT short-circuiting terminal block to the ground bus, without intermediate terminations or splices.

Justification

This requirement prevents loop currents and ensures that the CT remains with a grounded reference during short-circuit conditions.

7.24.3.7

The grounding conductor insulation color for CT grounding circuits shall be green or green with a yellow stripe.

Justification

This requirement clearly identifies the CT grounding circuit which can be a shock hazard when current is flowing through the CT.

7.24.3.8

The grounding wires shall be marked "CT Ground" at the short-circuiting terminal block and at the ground bus termination point.

Justification

This requirement clearly identifies the CT grounding circuit which can be a shock hazard when current is flowing through the CT.

Add new subclause

7.25 Circuit breakers

7.25.1

Power circuit breakers shall be rated, manufactured, tested and provided in accordance with IEEE Std C37.04, IEEE Std C37.09 and IEEE Std C37.20.2.

Justification

As various types of MV circuit breakers can be provided in an MC switchgear assembly, these industry standards are common to all operating companies, provide standardization, limit the selection of breakers and deliver expected operability.

7.25.2

MV circuit breakers provided in the MC switchgear shall be provided in accordance with the requirements given in 7.25.2.1 through 7.25.2.11.

Justification

The specific requirements for MV circuit breakers are not included in IEEE Std C37.20.2. The requirements in 7.25.2 are common to all operating companies, provide standardization, limit the selection of breakers and deliver expected operability.

7.25.2.1

Circuit breakers provided in the MC switchgear shall be of three-pole type.

Justification

Single-pole applications are rare in MV applications. Three-pole circuit breakers interrupt all three poles with a single mechanical device, therefore preventing misoperation (e.g., poor synchronization between single-pole devices resulting in single-phasing overvoltage incidents).

7.25.2.2

Circuit breakers provided in the MC switchgear shall be of vacuum-interrupter type.

Justification

Vacuum-type circuit breakers are highly reliable, require low maintenance, and are an economical and sustainable solution when considering MVA interrupting capacity and footprint.

7.25.2.3

Circuit breakers provided in the MC switchgear shall be of mechanical stored-energy type.

Justification

High fault currents present in MV systems result in significant voltage drops resulting in insufficient energy available to operate the shunt trip in an MV circuit breaker. A mechanical means to operate the circuit breaker when no control power is available is required.

7.25.2.4

Circuit breakers provided in the MC switchgear shall be electrically operated.

Justification

Electrically operated circuit breakers enable the digitalization strategy at all locations. This requirement enables a safer operation of the switchgear by removing personnel from the line of fire.

7.25.2.5

Circuit breakers provided in the MC switchgear shall have provisions for manual open/trip without opening the compartment door.

Justification

This requirement enables a safer operation of the switchgear by removing personnel from the line of fire.

7.25.2.6

Circuit breakers provided in the MC switchgear shall have provisions for manual charging of the spring mechanism.

Justification

This requirement provides a means to operate the circuit breaker when control power is not available.

7.25.2.7

Circuit breakers provided in the MC switchgear shall have an anti-pump operating mechanism.

Justification

This requirement prevents circuit breaker misoperation (e.g., contact chatter) due to miscoordination between the open and close signals.

7.25.2.8

Circuit breakers provided in the MC switchgear shall be provided with padlocking provisions for the test and withdrawn positions.

Justification

Padlocking provisions ensure that the unit is in the "off" position when inserting or removing the circuit breaker. This requirement increases safety through design, eliminating the need to rely solely on-site procedures and individual practices. The padlock provision supports a LOTO program.

7.25.2.9

Circuit breakers provided in the MC switchgear shall be provided with padlocking provisions for keeping the breaker in the open position when connected to the main circuit.

Justification

This requirement allows operators to perform a LOTO operation without calling out an electrician to perform a rack out operation. Padlocking provisions support the LOTO program.

7.25.2.10

MV circuit breakers in the MC switchgear shall have an operation counter.

Justification

Operation counters enable a condition-based instead of periodic time-based maintenance strategy, which increases maintenance efficiency.

7.25.2.11

Circuit breakers provided in the MC switchgear shall have a vacuum interrupter wear indicator.

Justification

A vacuum interrupter wear indicator enables condition-based maintenance which reduces maintenance hours relative to time-based maintenance and reduces the likelihood of vacuum interrupter catastrophic failure.

NOTE—An alternative method of vacuum interrupter wear indication is a software algorithm-based vacuum interrupter condition monitoring.

7.25.3

Drawout circuit breakers shall be provided with a manual racking mechanism that allows for the connected, test and disconnected positions.

Justification

This requirement provides flexibility and operability when control power is not available.

7.25.4

Circuit breaker compartment doors shall be able to be closed when the drawout breaker is in the test or disconnected position.

Justification

This assembly requirement increases safety as the breaker can be placed in the disconnected position with the door closed without exposure to live or energized parts.

7.25.5

Mechanical indicators for charged or discharged spring conditions shall be visible when the circuit breaker is in the connected position with the door closed.

Justification

This assembly requirement increases safety as the spring charge mechanism status of the breaker can be viewed with the door closed without exposure to live or energized parts.

7.25.6

Circuit breakers shall be provided with a mechanical means to indicate breaker closed (red) and open (green) positions with the compartment door closed.

Justification

This assembly requirement increases safety as the position status of the breaker can be viewed with the door closed without exposure to live or energized parts.

7.25.7

The close circuit and trip circuit(s) for each MV breaker shall be individually fused or protected by lockable molded-case circuit breakers in each breaker LV compartment.

Justification

This requirement ensures independent functionality for each circuit breaker to prevent a complete switchgear outage on a control circuit fault.

7.25.8

A means to prevent overtravel of the circuit breaker during the racking operation shall be provided.

Justification

This requirement prevents damage to the stationary mechanism and prevents misalignment of the withdrawable element and possible damage to the main bus connections.

7.25.9

For generator applications of 10 MVA and larger, a generator circuit breaker meeting the requirements of IEC/IEEE 62271-37-013 shall be provided.

Justification

This requirement ensures that large generator applications use circuit breakers with increased interrupting capability with higher X/R ratios. Standard distribution-type circuit breakers are not capable of interrupting fault current from large machines and can result in breaker failure and electrical fires within the MC switchgear assembly. 10 MVA and larger sizes align with the recommendations of IEC/IEEE 62271-37-013.

7.25.10

Circuit breaker trip circuits shall be monitored for loss of control voltage on the load side of the protective device with a dry, fail-safe contact for alarm provisions.

Justification

This requirement alerts operations to the loss of control power which would result in the inability of the circuit breaker to interrupt a fault, resulting in an electrical fire.

NOTE—One method of meeting this requirement is wiring a protective relay digital input to the load side of the protective device trip contact, providing trip circuit supervision logic in the protective relay and an alarm via a digital output contact from the protective relay.

7.25.11

In addition to contacts required for circuit breaker operations and indication, contacts shall be supplied in accordance with the requirements given in 7.25.11.1 through 7.25.11.4.

Justification

This requirement ensures expansion / additional control capabilities. Providing two NO and two NC contacts drives standardization and compatibility with typical applications.

7.25.11.1

Two NO and two NC MOC contacts shall be wired out to terminal blocks.

Justification

Spare auxiliary contacts wired to terminal blocks allow for expansion / additional control capabilities. Providing two NO and two NC contacts for typical applications drives standardization.

7.25.11.2

Two NO and two NC TOC contacts shall be wired out to terminal blocks.

Justification

Spare auxiliary contacts wired to terminal blocks allow for expansion / additional control capabilities. Providing two NO and two NC contacts for typical applications drives standardization.

7.25.11.3

Two NO auxiliary contacts, device 52a, shall be wired out to terminal blocks.

Justification

Spare auxiliary contacts wired to terminal blocks allow for expansion / additional control capabilities. Providing two NO and two NC contacts for typical applications drives standardization.

7.25.11.4

Two NC auxiliary contacts, device 52b, shall be wired out to terminal blocks.

Justification

Spare auxiliary contacts wired to terminal blocks allow for expansion / additional control capabilities. Providing two NO and two NC contacts for typical applications drives standardization.

7.25.12

For capacitive current switching applications (i.e., capacitor banks, no-load cables, no-load transmission lines, and filter banks), circuit breakers shall be in accordance with IEEE Std C37.012.

Justification

In capacitive current switching applications, the interruption of capacitive currents is generally considered light duty for a circuit breaker because currents are normally a few hundred amperes or less. However, there is a high probability that restrikes will occur. Restrikes can lead to undesirable overvoltages or high frequency transients affecting power quality in the network or adversely impacting MV loads. Restrikes can also cause damage to the circuit breaker itself and result in spurious trips of the other circuit breakers that are connected to the same bus.

NOTE — Depending on the magnitude of capacitive current, some derating of the MV circuit breaker may be required.

7.25.13

If 120 V ac control power is specified for circuit breaker control, a capacitive trip device with a dry-type, Form C alarm contact shall be provided for each circuit breaker.

Justification

This requirement ensures that the necessary energy required to operate the trip coil of an MV circuit breaker during an electrical fault is available when using 120 V ac control power that is derived from the ac power system using a CPT or other transformer applications.

NOTE — For external 120 V ac control power supply using a UPS, a capacitive trip device for each circuit breaker is not necessary.

Add new subclause

7.26 Arc-resistant design and construction

7.26.1

Arc-resistant assemblies shall be tested in accordance with IEEE Std C37.20.7-2017, for not less than 0.5 s, based on the prospective current of the highest rated circuit breaker without insertion of any current-limiting device in the test circuit.

Justification

This is needed to adequately protect electrical personnel during operation and maintenance procedures associated with the equipment.

7.26.2

Arc-resistant enclosures shall be tested at the rated maximum voltage of the equipment.

Justification

This is needed to adequately protect electrical personnel during operation and maintenance procedures associated with the equipment.

7.26.3

Where current-limiting or duration-limiting devices are used to achieve the arc resistant certification, the details of these devices shall be provided with the proposal.

Justification

The device details are important information that is typically not disclosed by manufacturers and that is for proper protection setting and system coordination.

7.26.4

Installation requirements for the arc-resistant MC switchgear (e.g., minimum room dimensions, room volume, requirements for plenums, clearance for arc vents) required for the performance of the arc-resistant MC switchgear shall be provided.

Justification

These installation requirements ensure the performance of the MC switchgear, building integrity and personnel safety.

7.26.5

The circuit breaker and instrument compartment front doors of the MC switchgear shall be secured with latches (i.e., cam or twist type) with less than one rotational turn.

Justification

This requirement ensures the integrity of the arc resistance functionality after doors and panels are opened for routine maintenance and resecured in an efficient and expedited manner.

7.26.6

Special tools shall not be required to latch the circuit breaker or instrument doors.

Justification

This requirement facilitates the opening and closing of the arc-resistant doors and panels after routine maintenance and troubleshooting activities.

7.26.7

Provisions for penetrating the LV compartment for field wiring within the controller shall not compromise the arc-resistant integrity of the compartment.

Justification

This requirement minimizes the damage to the control devices installed in the LV compartment after all the field cables are installed. The arc fault evaluation testing does not require the installation of field cables into the LV compartment prior to testing.

7.26.8

The arc-resistant design shall have provisions for the expansion of the MC switchgear.

Justification

This requirement allows for expansion without modifying the existing structures, as modification can result in loss of the arc resistant functionality of the equipment.

7.26.9

The MC switchgear shall be provided with an interlock to prevent opening of the circuit breaker compartment door except for the following:

— the circuit breaker is in the disconnected position and the safety shutters are closed;

— the circuit breaker is in the test position and the safety shutters are closed.

Justification

This requirement ensures personnel safety during maintenance and troubleshooting activities.

7.26.10

The arc-resistant rating of the MC switchgear shall be maintained during closed-door racking of the withdrawable elements.

Justification

This requirement ensures operator safety during racking operations.

7.26.11

Circuit breakers shall be provided with a means to manually (i.e., mechanically) trip the circuit breaker with the door closed without compromising the integrity of the arc-resistant construction.

Justification

When control power is not available, this requirement ensures operator safety during mechanical operations.

7.26.12

If an arc-resistant MC switchgear is specified, an additional nameplate shall be provided to identify the arc-resistant ratings of the MC switchgear in accordance with IEEE Std C37.20.7-2017, 6.3.

Justification

This requirement ensures that all the requirements of IEEE Std C37.20.7-2017 are verified in the arc resistant evaluation.

7.26.13

If a plenum is required, the plenum assembly shall be fully rated to withstand the forces associated with an arc fault within the MC switchgear assembly.

Justification

This requirement ensures the integrity of all sections of the plenum assembly during an arcing event.

7.26.14

If a plenum with an outdoor exhaust is specified, the plenum assembly shall be provided with a wall penetration kit and exterior exhaust outlet equipped with environmental-type seals.

Justification

This requirement protects electrical personnel during operation and maintenance procedures associated with the equipment. The manufacturer can simply supply an exhaust transit frame with a wind/rain louver or deflector shield and insect screen. Cold weather climates can be adversely affected by icing due to condensation and icing resulting in failure to open the exhaust louver. A sealing method limits the free transfer of cold air into the plenum space that comes in contact with the warm air as a result of normal operation.

7.26.15

A tool-operated provision for deactivating the circuit breaker compartment door interlock while the circuit breaker is not in the test or withdrawn positions shall be provided.

Justification

This requirement allows for access to the circuit breaker stationary mechanism to facilitate repair or troubleshooting activities upon a racking failure event or loss of control power. This requirement ensures the safety of the operations staff during maintenance and troubleshooting activities and does not require cubical damage to facilitate stationary mechanism repairs.

Add new subclause

7.27 MC switchgear configuration

7.27.1

Incoming circuit breakers and tie circuit breakers shall be limited to one-high construction within the MC switchgear assembly.

Justification

This requirement provides for increased safety, reliability and shorter recovery times from arc fault events in Type 2b enclosure designs where the damage propagates within a vertical section. If the incomer or tie breaker is included in the same vertical section with a feeder, an arc event results in the de-energization of the entire assembly until all repairs are complete. This arrangement requirement minimizes operator and human factor related incidents as all incomer or tie operational controls, relaying, metering and monitoring are installed in the same vertical section.

7.27.2

Provisions shall be made for the addition of vertical sections at both ends of the MC switchgear assembly.

Justification

This requirement allows for easy addition of vertical sections.

7.27.3

Provisions for additional vertical sections shall include the necessary hardware such as removable plates or side sheets furnished at the end of vertical sections, terminal blocks for vertical section interconnect wiring, pre-drilled main bus and pre-drilled ground bus.

Justification

This requirement allows for easy addition of vertical sections.

7.27.4 Equipped and unequipped spaces

7.27.4.1

Equipped and unequipped spaces shall be capable of being modified to add circuit breakers of the same ampere rating, as indicated on the project drawings or single-line diagram, without a shutdown of the MC switchgear.

Justification

This requirement allows for easy addition of circuit breakers without de-energizing the complete MC switchgear assembly.

7.27.4.2

Equipped spaces shall be furnished with hardware, wiring, doors and ancillary equipment including CTs and monitoring devices.

Justification

This requirement allows for easy addition of new units without the de-energization of the entire switchgear assembly, ensuring service continuity.

NOTE—Only the addition of an MV circuit breaker is needed to complete an equipped space compartment.

7.27.4.3 Provisions for unequipped spaces

Unequipped spaces shall be provided in accordance with the requirements given in 7.27.4.3.1 through 7.27.4.3.3.

Justification

This requirement simplifies the addition of new units with minimal service disruption.

7.27.4.3.1

Unequipped spaces shall be provided with doors.

Justification

This requirement simplifies the addition of new units with minimal service disruption.

7.27.4.3.2

Unequipped spaces shall be provided with line and load side power stabs.

Justification

This requirement simplifies the addition of new units with minimal service disruption.

7.27.4.3.3

Unequipped spaces shall be provided with line and load side power stab covers or shutters.

Justification

This requirement simplifies the addition of new units with minimal service disruption.

7.27.4.4

Unequipped spaces shall not be used for mounting instrumentation, control devices or auxiliary equipment.

Justification

This requirement allows for easy addition of new units without the de-energization of the entire switchgear assembly. This requirement ensures service continuity.

7.27.5

Cable entry provisions shall include removable gland plates for every vertical section.

Justification

This requirement allows for cable compartments to accommodate incoming and outgoing cable installation and termination. Conductors subjected to inadequate space and tight radius bends have resulted in electrical incidents.

7.27.6

If a cable bus or a bus duct is specified for the incoming line section, the necessary components (e.g., interface flange, bus extensions, supports, hardware, gaskets) for the MC switchgear to accept the cable bus or bus duct shall be provided.

Justification

The components required for cable bus or bus duct installations are vendor dependent and are often more difficult to manage in the field. Operating companies agreed that supplying these components with the MC switchgear drives standardization and increases quality control.

7.27.7 Breaker interlocking or transfer scheme

If specified, an MV circuit breaker interlocking or transfer scheme shall be arranged in accordance with the requirements given in 7.27.7.1 through 7.27.7.3.

Justification

This requirement ensures service continuity during maintenance or faulted conditions.

7.27.7.1

The transfer scheme shall be disabled if one or more transfer breakers are in the test or disconnected position.

Justification

This requirement ensures service continuity under maintenance and faulted conditions.

7.27.7.2

Manual transfer schemes that do not have electrical interlocks (e.g., sync checks or transfer logic controls) shall have a key-type interlock to achieve mechanical interlocking between circuit breaker operations.

Justification

This requirement ensures service continuity under maintenance and faulted conditions. This requirement also provides a level of protection from misoperation and spurious trips.

7.27.7.3

The transfer scheme shall operate as indicated in the supplementary descriptions provided with the project drawings.

Justification

Operational functionality of transfer schemes can vary depending on the application. The MC switchgear transfer scheme functionally operates as described by the project documentation supplied by the purchaser.

7.27.8

The MC switchgear point of access to initiate withdrawal of removable elements (e.g., VT, CPT, fuse drawer, circuit breaker) shall be located no more than 1.88 m (74 in) above floor level.

Justification

This human factor requirement ensures that personnel do not require the use of height extension devices to operate the equipment. This is necessary to ensure the safety of operations personnel during maintenance and troubleshooting activities.

Add new subclause

7.28 Space heaters

7.28.1 Enclosure space heaters

7.28.1.1

Enclosure space heaters shall be wired to an accessible terminal block provided for connection to a single external power source for the MC switchgear assembly.

Justification

This requirement provides a safe and easily identifiable means of accessing and maintaining the space heater circuit supplied from an external source.

7.28.1.2

Enclosure space heaters shall be guarded by an expanded metal cage around the heaters.

Justification

This requirement provides protection to prevent burns due to incidental contact with the space heater.

7.28.1.3

Enclosure space heaters shall be operated at 120 V ac.

Justification

Low voltage reduces the risk associated with shock and arc flash.

7.28.1.4

Enclosure space heaters shall be sized to provide a 5 K rise over the site ambient air temperature upper limit to prevent condensation.

Justification

Space heaters within MC switchgear sections ensure the prevention of moisture that results in an arc-flash event or failure of components within the vertical sections.

7.28.1.5

Each enclosure space heater circuit shall be protected by a disconnect device with lock-out provisions (i.e., fuse or molded case circuit breaker).

Justification

This requirement provides a required means of locking out the disconnection device to establish a safe work condition when troubleshooting or exposure to energized conductors or circuit parts.

7.28.1.6

Each enclosure space heater circuit shall be provided with an ammeter.

Justification

The use of an ammeter demonstrates that there is current in the space heater circuit. The common failure mode results in open circuiting the space heater element.

7.28.1.7

The ammeter for each enclosure space heater circuit shall have an appropriately sized scale such that failure of a single space heater element results in a discernible change in ammeter reading.

Justification

The use of an ammeter demonstrates that there is current in the space heater circuit. The common failure mode results in open circuiting the space heater element.

7.28.1.8

The normal operating ampacity of the enclosure space heater circuit shall be inscribed on the ammeter nameplate.

Justification

The use of an ammeter with the normal expected current indication demonstrates that the space heater circuit is operating normally.

7.28.1.9

If specified, enclosure space heaters shall be installed in the MV circuit breaker and cable compartments.

Justification

The location of space heater devices is not addressed in IEEE Std C37.20.2. In order to provide adequate protection from moisture condensation, this requirement allows for installation of separate space heater devices in all circuit breaker and cable compartments.

7.28.1.10 Enclosure space heater automatic control

7.28.1.10.1

If enclosure space heater automatic control is specified, a control unit shall be provided in accordance with 7.28.1.10.2 and 7.28.1.10.3.

Justification

Automatic control of vertical section space heaters is not addressed in IEEE Std C37.20.2. These requirements define the system.

7.28.1.10.2

The control unit shall have a control circuit that includes a momentary test pushbutton.

Justification

Thermostat control of section space heaters can be specified to control cycling of the space heaters on and off to increase power usage efficiency in certain applications. This additional function allows for testing of the enclosure space heaters.

7.28.1.10.3

The control unit momentary pushbutton (i.e., test pushbutton) shall energize the space heaters and bypass the space heater controls.

Justification

The test pushbutton for the thermostat control of enclosure space heaters provides a means to verify the functionality of the space heater system without exposing maintenance personnel to energized work.

7.28.2 Motor space heaters

7.28.2.1

The MV circuit breakers identified for motor applications on the project drawings shall be provided with a normally closed contact (e.g., 52b with TOC, MOC) wired in series with an external power source such that the motor space heater is energized when the circuit breaker is open.

Justification

The operation of motor space heaters is dependent on the status of the MC switchgear circuit breaker. An external power source allows the space heaters to operate when the circuit breaker is in the open position (i.e., LOTO).

7.28.2.2

The supply power for motor space heaters shall be wired to an accessible terminal block provided for connection to an external power source.

Justification

Dedicated terminal blocks allow for safe installation of the field interconnection cabling for the motor space heater.

7.28.2.3

Motor space heater circuits shall have a fused disconnect or lockable molded case circuit breaker located within the respective LV compartment of the MV circuit breaker.

Justification

The local isolation of the power feed for the motor space prevents shock hazard electrical incidents during maintenance and troubleshooting activities.

7.28.2.4

Motor space heater circuits shall be supplied with an ammeter with an appropriately sized scale such that failure of the motor heater element results in a discernible change in the ammeter reading.

Justification

This requirement ensures that the ammeter reading can indicate a failure of the motor heater element.

7.28.2.5

The external power supply for motor space heaters shall remain energized when the MV circuit breaker is open, in the test or disconnect positions.

Justification

This requirement ensures that the operation of the motor space heater remains energized in all cases when the motor is not running to ensure the integrity of the motor.

7.28.2.6

A momentary pushbutton shall be provided to test the motor space heater and the ammeter circuit.

Justification

A momentary push button facilitates testing of the space heater during maintenance activities. Without the pushbutton, verification is problematic due to the automatic controls for the space heater circuit.

Add new subclause

7.29 MC switchgear accessories

7.29.1

A hand crank or handle shall be provided for moving the circuit breaker into the connected, test and disconnected positions.

Justification

This requirement provides the mechanical means to manually rack the circuit breaker into its three positions for service and isolation during maintenance or troubleshooting activities.

7.29.2

A device for manually charging the stored energy mechanism of electrically operated circuit breakers shall be provided.

Justification

This requirement provides a means of manually charging the stored energy mechanism if the electrical charging motor is not functional or control power is not available.

7.29.3 Remote electrical racking device

If specified, a remote electrical racking device shall be supplied and operate in accordance with the requirements given in 7.29.3.1 through 7.29.3.5.

Justification

A remote racking capability without human interaction directly in the vicinity of the MC switchgear minimizes exposure of personnel and increases reliability. Removing and reinserting circuit breakers can require personnel to be in the arc-flash boundary and can require the use of a higher level of electrical PPE. This accessory is often specified in applications with increased levels of incident energy.

7.29.3.1

The racking device shall move the circuit breaker in all positions (i.e., withdrawn, test, connected).

Justification

A remote racking capability without human interaction directly in the vicinity of the MC switchgear minimizes exposure of personnel and increases reliability. Removing and reinserting circuit breakers can require personnel to be in the arc-flash boundary and can require the use of a higher level of electrical PPE. This accessory is often specified in applications with increased levels of incident energy.

7.29.3.2

The racking device shall be operable with the door closed.

Justification

A remote racking capability without human interaction directly in the vicinity of the MC switchgear minimizes exposure of personnel and increases reliability. Removing and reinserting circuit breakers can require personnel to be in the arc-flash boundary and can require the use of a higher level of electrical PPE. This accessory is often specified in applications with increased levels of incident energy.

7.29.3.3

The racking device shall be operable at a distance of 6 m (20 ft) from the MV circuit breaker compartment.

Justification

A remote racking capability without human interaction directly in the vicinity of the MC switchgear minimizes exposure of personnel and increases reliability. Removing and reinserting circuit breakers can require personnel to be in the arc-flash boundary and can require the use of a higher level of electrical PPE. This accessory is often specified in applications with increased levels of incident energy.

7.29.3.4

The racking device shall automatically shut off when the breaker is in the connected position.

Justification

A remote racking capability without human interaction directly in the vicinity of the MC switchgear minimizes exposure of personnel and increases reliability. Removing and reinserting circuit breakers can require personnel to be in the arc-flash boundary and can require the use of a higher level of electrical PPE. This accessory is often specified in applications with increased levels of incident energy.

7.29.3.5

If an integral remote circuit breaker racking device is incorporated into the circuit breaker stationary housing, the power supply shall be wired to an accessible terminal block provided for connection to a single external power source for the MC switchgear assembly.

Justification

This requirement provides a safe and easily identifiable means of accessing and maintaining the remote racking mechanism circuit supplied from an external source.

7.29.4

A lifting apparatus (e.g., lifting yoke) shall be provided to allow each size of circuit breaker in the assembly to be safely lifted off the compartment rails.

Justification

For maintenance or troubleshooting purposes, this requirement ensures that the circuit breaker is lifted off the compartment rails with the appropriately sized lifting apparatus.

7.29.5

If not part of the circuit breaker compartment, one set of extension rails for each circuit breaker frame size shall be provided.

Justification

This requirement allows for the circuit breaker to be inserted or withdrawn from the switchgear compartment for maintenance or troubleshooting.

7.29.6

If specified, portable lift trucks for raising and lowering the circuit breakers from MC switchgear compartment rails shall be provided to accommodate each frame size contained within the complete MC switchgear assembly.

Justification

This requirement prevents personnel injury and damage to the switchgear by using a mechanical lifting device to raise or lower the circuit breaker into position for either insertion or removal into the switchgear compartment.

7.29.7 Remote handheld control station

If specified, a remote handheld control station shall be provided to operate the individual circuit breakers of the MC switchgear assembly in accordance with the requirements given in 7.29.7.1 through 7.29.7.5.

Justification

A remote control station allows for the operation of the circuit breaker without human interaction directly in the vicinity of the MC switchgear to minimize exposure of personnel and increase safety. Operating circuit breakers directly in front of the MC switchgear can require personnel to be in the arc-flash boundary and can require the use of a higher level of electrical PPE. This accessory is often specified in applications with increased levels of incident energy.

7.29.7.1

The control station shall operate the circuit breaker types and sizes provided in the assembly.

Justification

A remote control station allows for the operation of the circuit breaker without human interaction directly in the vicinity of the MC switchgear to minimize exposure of personnel and increase safety. Operating circuit breakers directly in front of the MC switchgear can require personnel to be in the arc-flash boundary and can require the use of a higher level of electrical PPE. This accessory is often specified in applications with increased levels of incident energy.

7.29.7.2

The control station shall perform the open and close functions for the circuit breaker.

Justification

A remote control station allows for the operation of the circuit breaker without human interaction directly in the vicinity of the MC switchgear to minimize exposure of personnel and increase safety. Operating circuit breakers directly in front of the MC switchgear can require personnel to be in the arc-flash boundary and can require the use of a higher level of electrical PPE. This accessory is often specified in applications with increased levels of incident energy.

7.29.7.3

The control station shall indicate the circuit breaker positions (i.e., open and closed).

Justification

A remote control station allows for the operation of the circuit breaker without human interaction directly in the vicinity of the MC switchgear to minimize exposure of personnel and increase safety. Operating circuit breakers directly in front of the MC switchgear can require personnel to be in the arc-flash boundary and can require the use of a higher level of electrical PPE. This accessory is often specified in applications with increased levels of incident energy.

7.29.7.4

The control station shall be provided with a minimum of 6 m (20 ft) of control cable.

Justification

A remote control station allows for the operation of the circuit breaker without human interaction directly in the vicinity of the MC switchgear to minimize exposure of personnel and increase safety. Operating circuit breakers directly in front of the MC switchgear can require personnel to be in the arc-flash boundary and can require the use of a higher level of electrical PPE. This accessory is often specified in applications with increased levels of incident energy.

7.29.7.5

In order to facilitate the interface of the handheld control station to the circuit breaker, a connection port shall be provided on each circuit breaker compartment door.

Justification

A remote control station allows for the operation of the circuit breaker without human interaction directly in the vicinity of the MC switchgear to minimize exposure of personnel and increase safety. Operating circuit breakers directly in front of the MC switchgear can require personnel to be in the arc-flash boundary and can also require the use of a higher level of electrical PPE. This accessory is often specified in applications with increased levels of incident energy.

7.29.8

If specified, an accessory cabinet that is separate, key lockable and suitable for storage of supplied accessories shall be provided.

Justification

This requirement keeps accessories (e.g., tools) readily available and in good operating condition to facilitate MC switchgear maintenance and troubleshooting activities.

7.29.9 Thermal scanning inspection windows

If specified, thermal scanning inspection windows for infrared scanning of the equipment shall be provided in accordance with the requirements given in 7.29.9.1 through 7.29.9.3.

Justification

This requirement allows for safe inspection of potential hotspots without being exposed to energized parts within the circuit breaker or the cable compartment.

7.29.9.1

The thermal scanning inspection windows shall be provided for locations where external thermal scanning can detect hot spots in the MC switchgear assembly.

Justification

This requirement allows for safe inspection of potential hotspots without being exposed to energized parts within the circuit breaker or the cable compartment.

7.29.9.2

Thermal scanning inspection windows shall be NRTL or ACO approved.

Justification

This requirement ensures that all components installed within the assembly are approved or recognized by an appropriate NRTL for the assembly to meet the certification requirement in this specification (DLAH certified).

7.29.9.3

Thermal scanning windows provided in arc-resistant MC switchgear shall be included in the type testing program for the qualification of the arc-resistant MC switchgear.

Justification

This requirement ensures that the arc-resistance construction and testing are not compromised by the addition of thermal scanning windows.

Add new subclause

7.29.10 Condition-based monitoring

7.29.10.1 Continuous thermal monitoring

If specified, a continuous thermal monitoring system shall be provided in accordance with the requirements given in 7.29.10.1.1 through 7.29.10.1.3.

Justification

Condition-based thermal monitoring (analytics) is not included in IEEE Std C37.20.2. Continuous thermal monitoring of the MC switchgear increases safety and reliability without opening the unit doors for visual or thermographic-type inspections to detect abnormal operating temperature conditions, hot spots created by loose wiring terminations, or other overheating devices within the MC switchgear compartments or sections.

7.29.10.1.1

The continuous thermal monitoring system shall be factory integrated.

Justification

Condition-based thermal monitoring (analytics) is not included in IEEE Std C37.20.2. Continuous thermal monitoring of the MC switchgear increases safety and reliability without opening the unit doors for visual or thermographic-type inspections to detect abnormal operating temperature conditions, hot spots created by loose wiring terminations, or other overheating devices within the MC switchgear compartments or sections.

7.29.10.1.2

The thermal monitoring system shall include hotspot detection sensors for areas of concern (e.g., cable connections, fuse clips, drawout connections and shipping split connections).

Justification

Condition-based thermal monitoring (analytics) is not included in IEEE Std C37.20.2. Continuous thermal monitoring of the MC switchgear increases safety and reliability without opening the unit doors for visual or thermographic-type inspections to detect abnormal operating temperature conditions, hot spots created by loose wiring terminations, or other overheating devices within the MC switchgear compartments or sections.

7.29.10.1.3

The continuous thermal monitoring system shall include communications to convey temperature data, status and alarming for every monitored point.

Justification

Condition-based thermal monitoring (analytics) has been shown to generate beneficial results when analyzed over a period of time. The ability to collect this data at a central location for analysis purposes is facilitated by communication capability and enables considerable value to be extracted from this investment.

7.29.10.2 Local motor condition monitoring

If specified, a local motor condition monitoring system using manual data collection shall be provided in accordance with the requirements given in 7.29.10.2.1 through 7.29.10.2.4.

Justification

Motor condition monitoring (analytics) is not included in IEEE Std C37.20.2. Local condition monitoring of large MV motors increases safety and reliability without opening the compartment doors for signal collection activity to detect abnormal operating conditions.

7.29.10.2.1

The local motor condition monitoring system shall be equipped with factory-integrated components within the MC switchgear assembly.

Justification

A factory-integrated motor condition monitoring (analytics) system eliminates the need for field modifications to the MC switchgear assembly and provides for a simplified and more reliable installation.

7.29.10.2.2

Connections to internal CT and VT circuits shall be through a test port located on the front door of the MC switchgear or at a remote interface panel.

Justification

Door-mounted testing facilities that allow the local condition monitoring of large MV motors increases safety and reliability without opening the compartment door and exposing technicians to energized parts.

7.29.10.2.3

Voltage at the test port shall be touch safe.

Justification

Door-mounted testing facilities provided at non-hazardous voltage levels that allow the local condition monitoring of large MV motors increases safety and reliability without opening the compartment door and exposing technicians to energized parts.

7.29.10.2.4

Voltage at the test port shall be less than 50 V.

Justification

Door-mounted testing facilities provided at non-hazardous voltage levels that allow the local condition monitoring of large MV motors increases safety and reliability without opening the compartment door and exposing technicians to energized parts.

7.29.10.3 Continuous motor condition monitoring

If specified, a continuous motor condition monitoring system shall be provided in accordance with the requirements given in 7.29.10.3.1 through 7.29.10.3.4.

Justification

Continuous motor condition monitoring (analytics) is not included in IEEE Std C37.20.2. Continuous monitoring of large MV motors increases safety and reliability without manual data collection. This requirement allows data collection to detect abnormal operating conditions without opening compartment doors and exposing electrical personnel to energized parts. This requirement also provides for trending analysis to identify gradual degradation in motor performance.

7.29.10.3.1

The continuous motor condition monitoring system shall be factory integrated into the MC switchgear assembly.

Justification

Continuous motor condition monitoring (analytics) is not included in IEEE Std C37.20.2. Continuous monitoring of large MV motors increases safety and reliability without manual data collection. This requirement allows data collection to detect abnormal operating conditions without opening compartment doors and exposing electrical personnel to energized parts. This requirement also provides for trending analysis to identify gradual degradation in motor performance.

7.29.10.3.2

The continuous motor condition monitoring system shall be capable of continuous monitoring and sensing as detailed in the project documentation.

Justification

Continuous motor condition monitoring (analytics) is not included in IEEE Std C37.20.2. Continuous monitoring of large MV motors increases safety and reliability without manual data collection. This requirement allows data collection to detect abnormal operating conditions without opening compartment doors and exposing electrical personnel to energized parts. This requirement also provides for trending analysis to identify gradual degradation in motor performance

7.29.10.3.3

The continuous motor condition monitoring system shall include communications to convey status and alarming for every monitored point.

Justification

Continuous motor condition monitoring (analytics) is not included in IEEE Std C37.20.2. Continuous monitoring of large MV motors increases safety and reliability without manual data collection. This requirement allows data collection to detect abnormal operating conditions without opening compartment doors and exposing electrical personnel to energized parts. This requirement also provides for trending analysis to identify gradual degradation in motor performance

7.29.10.3.4

The continuous motor condition monitoring system shall provide a methodology for the real-time analysis of rotor flux, rotor cage current signature analysis, end winding vibration, shaft voltage and shaft current.

Justification

Continuous motor condition monitoring (analytics) is not included in IEEE Std C37.20.2. Continuous monitoring of large MV motors increases safety and reliability without manual data collection. This requirement allows data collection to detect abnormal operating conditions without opening compartment doors and exposing electrical personnel to energized parts. This requirement also provides for trending analysis to identify gradual degradation in motor performance

7.29.10.4 Continuous partial discharge monitoring

If specified, a continuous partial discharge monitoring system shall be provided in accordance with the requirements given in 7.29.10.4.1 through 7.29.10.4.3.

Justification

Continuous partial discharge monitoring (analytics) is not included in IEEE Std C37.20.2. Continuous partial discharge monitoring of the MC switchgear assembly increases safety and reliability by early detection of impending dielectric breakdown. Early detection prevents premature ground faults and arcing events. Continuous partial discharge monitoring improves the data quality and analytical results versus local data collection. Additionally, this system identifies gradual trends in degradation of dielectric performance of the insulation system.

7.29.10.4.1

The continuous partial discharge monitoring system shall be factory integrated into the MC switchgear assembly.

Justification

Continuous partial discharge monitoring (analytics) is not included in IEEE Std C37.20.2. Continuous partial discharge monitoring of the MC switchgear assembly increases safety and reliability by early detection of impending dielectric breakdown. Early detection prevents premature ground faults and arcing events. Continuous partial discharge monitoring is recommended versus local data collection to improve the data quality and analytical results. Additionally, this system can identify gradual trends in degradation of dielectric performance of the insulation system.

7.29.10.4.2

Partial discharge systems shall be capable of continuous sensing and monitoring of the MC switchgear assembly and connected equipment.

Justification

Continuous partial discharge monitoring (analytics) is not included in IEEE Std C37.20.2. Continuous partial discharge monitoring of the MC switchgear assembly increases safety and reliability by early detection of impending dielectric breakdown. Early detection prevents premature ground faults and arcing events. Continuous partial discharge monitoring improves the data quality and analytical results versus local data collection. Additionally, this system identifies gradual trends in degradation of dielectric performance of the insulation system.

7.29.10.4.3

The continuous partial discharge monitoring system shall include communications to convey partial discharge data, status and alarming for each monitored point.

Justification

Continuous partial discharge monitoring (analytics) has been shown to generate beneficial results when analyzed over a period of time. The ability to collect this data at a central location for analysis purposes is facilitated by communication capability and enables considerable value to be extracted from this investment. Additionally, this system can identify gradual trends in degradation of dielectric performance of the insulation system.

Add new subclause

7.30 Certifications

7.30.1

The MC switchgear shall be listed or certified by a NRTL for the United States or an ACO for Canada.

Justification

NRTL certification of the MC switchgear assembly ensures compliance with UL DLAH. NRTL certification also satisfies local electrical inspectors and AHJs that have approval authority to operate the electrical system.

NOTE—Applications for the MC switchgear assembly in other countries may have additional requirements for certification (e.g., UL DLAH for US applications).

7.30.2

If specified, MC switchgear assemblies installed on floating offshore installations in United States Coast Guard (USCG) and American Bureau of Shipping (ABS) jurisdictions shall comply with 46 CFR 111 and ABS MODU, Publication Number 6 Part 4, respectively.

Justification

46 CFR 111 and ABS MODU, Publication Number 6 Part 4 provide requirements for MC switchgear equipment used in floating marine applications in the outer continental shelf (OCS).

NOTE—Additional guidance and information for USCG and ABS requirements for the MC switchgear installed on floating facilities in US territorial waters can be found in API Recommended Practice 14F or API Recommended Practice 14FZ.

Add new subclause

7.31 Grounding (earthing) switch

7.31.1 General

If specified, grounding (earthing) switches shall be provided in accordance with the requirements given in 7.31.1.1 through 7.31.1.10.

Justification

The grounding (earthing) switch provides a factory-integrated means to safely ground the load side terminals of the circuit breaker after the isolation switch has been opened. This requirement provides a safety-by-design approach to isolating hazardous electrical energy from maintenance personnel. This requirement also ensures an electrical safe working condition within the circuit breaker without the use of temporary grounding cables.

7.31.1.1

The grounding (earthing) switch shall be permanently installed in the cable compartment and connected to the load side of the individual circuit breaker.

Justification

The grounding (earthing) switch provides a factory-integrated means to safely ground the load side terminals of the circuit breaker after the circuit breaker has been opened. This requirement provides a safety-by-design approach to isolating hazardous electrical energy from maintenance personnel. This requirement also ensures an electrical safe working condition within the circuit breaker without the use of temporary grounding cables.

7.31.1.2

The grounding (earthing) switch shall be of three-pole type.

Justification

The grounding (earthing) switch provides a factory-integrated means to safely ground the load side terminals of the circuit breaker after the isolation switch has been opened. This requirement provides a safety-by-design approach to isolating hazardous electrical energy from maintenance personnel. A three-pole design ensures all phases of the load are grounded at the same time.

7.31.1.3

The grounding (earthing) switch position shall be visually verifiable without opening the compartment door.

Justification

This requirement allows the operations personnel to verify open or closed position as part of LOTO and switching activities. This requirement also provides safety to operations personnel and reduces the likelihood of human factor related events.

7.31.1.4

A vacuum interrupter or device with equivalent functionality shall not satisfy the grounding (earthing) switch position verification in 7.31.1.3.

Justification

This requirement allows operations personnel to verify open or closed position as part of LOTO and switching activities. The visual confirmation of the position of each pole of a vacuum contactor or interrupter is impractical and marginally detectable.

7.31.1.5

The grounding (earthing) switch shall be operated manually.

Justification

The grounding (earthing) switch provides a factory-integrated means to safely ground the load side terminals of the circuit breaker after the isolation switch has been opened. This requirement provides a safety-by-design approach to isolating hazardous electrical energy from maintenance personnel. The operation of this device is part of the electrical safety LOTO program and provides a positive means for grounding the load.

7.31.1.6

The grounding (earthing) switch shall be mechanically interlocked with the circuit breaker in the open and withdrawn positions.

Justification

The grounding (earthing) switch provides a factory-integrated means to safely ground the load side terminals of the circuit breaker after the isolation switch has been opened. This requirement provides a safety-by-design approach to isolating hazardous electrical energy from maintenance personnel. A mechanically interlocked switch provides reasonable assurance that the switch will not be closed on an energized circuit.

7.31.1.7

In the open position, the grounding (earthing) switch shall have a rated maximum voltage for the line side terminals greater than or equal to the circuit breaker ratings.

Justification

The grounding (earthing) switch provides a factory-integrated means to safely ground the load side terminals of the circuit breaker after the isolation switch has been opened. This requirement provides a safety-by-design approach to isolating hazardous electrical energy from maintenance personnel. This rating is necessary to minimize the risk of flashover during operation.

7.31.1.8

In the open position, the grounding (earthing) switch shall have a rated insulation level for the line side terminals greater than or equal to the circuit breaker ratings.

Justification

The grounding (earthing) switch provides a factory-integrated means to safely ground the load side terminals of the circuit breaker after the isolation switch has been opened. This requirement provides a safety-by-design approach to isolating hazardous electrical energy from maintenance personnel. This rating is necessary to minimize the risk of flashover during operation.

7.31.1.9

The grounding (earthing) switch shall have a short-time withstand current rating greater than or equal to that of the circuit breaker for a minimum of 0.1 s.

Justification

The grounding (earthing) switch provides a factory-integrated means to safely ground the load side terminals of the circuit breaker after the isolation switch has been opened. This requirement provides a safety-by-design approach to isolating hazardous electrical energy from maintenance personnel. This rating is necessary to prevent an arc flash in the unlikely event the switch is closed on an energized circuit. The duration was based on circuit breaker opening time (five cycles) and protective relay pickup time (one cycle).

7.31.1.10

The grounding (earthing) switch shall perform a minimum of 1000 de-energized operations with zero current flow through the circuit.

Justification

The grounding (earthing) switch provides a factory-integrated means to safely ground the load side terminals of the circuit breaker after the isolation switch has been opened. This requirement provides a safety-by-design approach to isolating hazardous electrical energy from maintenance personnel. This requirement demonstrates a minimal mechanical endurance functionality and is in alignment with IEC-62271-102 requirements.

7.31.2 Grounding (earthing) switches with a fault close rating

If specified, grounding (earthing) switches with a fault close rating shall be provided in accordance with the requirements given in 7.31.1, 7.31.2.1 and 7.31.2.2.

Justification

The grounding (earthing) switch provides a factory-integrated means to safely ground the load side terminals of the circuit breaker after the isolation switch has been opened. The switch with a fault close rating has demonstrated that it can close into an energized circuit for a minimum of two operations and maintain full operational integrity.

7.31.2.1

The grounding (earthing) switch shall be provided with a short-circuit making current rating.

Justification

The grounding (earthing) switch provides a factory-integrated means to safely ground the load side terminals of the circuit breaker after the isolation switch has been opened. The switch with a fault close rating has demonstrated that it can close into an energized circuit in accordance with the manufacturer's type test for short-circuit making current.

NOTE—The short-circuit making current rating for the grounding (earthing) switch can be equivalent to or less than the short-circuit making current rating of the associated circuit breaker. This rating is commonly selected based on the potential for stored energy associated with the load (e.g., capacitor bank, power factor correction equipment, long feeder cables, harmonic filters, rotating equipment).

7.31.2.2

The grounding (earthing) switch shall provide a minimum of two closing operations at the short-circuit making current rating.

Justification

The grounding (earthing) switch provides a factory-integrated means to safely ground the load side terminals of the circuit breaker after the isolation switch has been opened. The switch with a fault close rating has demonstrated that it can close into an energized circuit for a minimum of two operations and maintain full operational integrity.

8. Application guide for MC switchgear

Add to start of clause

The recommendations in this clause shall be considered normative requirements.

Justification

Clause 8 includes content applicable to this specification. This requirement specifies that Clause 8 is normative (i.e., not informative) and provides guidance on its application.

8.1 Unusual service conditions

8.1.4 Modification of equipment for unusual environments

8.1.4.1 Exposure to damaging fumes, vapors, steam, salt air, and oil vapors

Add new list subclause f)

f) The equipment shall be protected against deterioration from the specified corrosive gases using compatible coatings or material selection.

Justification

Corrosive environments affect equipment reliability without appropriate protection or compatible materials.

Add new list subclause g)

g) Silver-plated copper shall not be used for stationary current-carrying parts when in the presence of the specified corrosive gases.

Justification

The use of silver-plated bus bars in MC switchgear in corrosive environments (e.g., H2S) affects equipment reliability.

NOTE—Stationary current-carrying parts do not include sliding contacts (e.g., breaker grounding shoe, primary disconnects). These types of current-carrying parts are silver plated to withstand wear.

8.1.4.6 Exposure to seismic shock

Replace second paragraph with

If seismic requirements are specified, the MC switchgear shall be provided in accordance with ASCE/SEI 7-16.

Justification

Requirements for seismic impacted installations are not provided in IEEE Std C37.20.2. Many installations have regulatory requirements for seismic withstand capability that are defined here for standardization.

8.4 Continuous current rating and overload capability

8.4.3 Special continuous current ratings

Delete list subclause b)

Justification

The use of forced air cooling or fan cooling of main bus assemblies or MV circuit breakers is inherently unreliable, requires additional redundancy, and decreases the long-term integrity of the equipment.

8.7 Associated devices often used in MC switchgear

Add new subclause

8.7.2.5

If specified, surge protection devices (i.e., arresters and capacitors) shall be of single-phase station-class type.

Justification

These devices are used to mitigate the damage to downstream electrical equipment due to transient overvoltages and switching surges that can occur in the electrical distribution system. Station class is used for safety and reliability to reduce the likelihood of catastrophic failure within the MC switchgear assembly.

Add new NOTE

NOTE—These devices are typically installed in primary service, overhead feeder and large motor feeder applications.

Add new subclause

8.7.2.6

If specified, the surge protection voltage rating of the arrester and capacitor shall be selected based on the system voltage and the grounding method used.

Justification

The selection of these devices is dependent on the relationship between the L-L and L-N system voltage. The incorrect selection results in premature failure of these devices and subsequent spurious trips from the upstream circuit breaker.

Add new subclause

8.7.2.7

If specified, surge protection connection leads to each phase and ground of the surge devices shall be a minimum length to their respective termination points.

Justification

A high impedance connection due to a long grounding path from the ground connection results in misoperation of the surge protection device, which can result in equipment damage.

Add new subclause

8.7.2.8

If surge protection is specified, wiring to surge protection devices shall be at least #6 AWG.

Justification

A #6 AWG or larger grounding conductor provides a low-impedance connection necessary for the proper operation of the surge protection device.

Add new subclause

8.7.2.9

If specified, surge arresters shall be in accordance with IEEE Std C62.11.

Justification

Surge arresters mitigate the damage to downstream electrical equipment due to transient overvoltages and switching surges that can occur in the electrical distribution system.

9. Guide for handling, storage, and installation

Add to start of clause

The recommendations in this clause shall be considered normative requirements.

Justification

Clause 9 includes content applicable to this specification. This requirement provides clarity that Clause 9 is normative (i.e., not informative) and provides guidance on its application.

9.2 Handling

9.2.2 Rigging

Add new subclause

9.2.2.1

Assembly design shall allow the MC switchgear shipping section to be rolled across the floor on pipes without causing the structure to deform or otherwise be damaged.

Justification

This requirement provides a means of safely handling the MC switchgear without damage when an overhead lifting means is not available.

Add new subclause

9.2.2.2

Shipping sections of stationary structures shall be furnished with removable lifting angles, lugs or plates engineered in accordance with ASME B30.26.

Justification

IEEE Std C37.20.2 is a performance standard and does not include requirements to address lifting means. These lifting accessories prevent damage to equipment or injuries to personnel during installation and repair activities.

Add new subclause

9.7 Shipping and preservation

9.7.1

Shipping splits comprised of multiple vertical sections shall be furnished with removable lifting angles, lugs or plates engineered for use with crane hooks or slings.

Justification

This requirement is focused on the lifting and handling requirements for each shipping split. These details are used for installation and repair activities.

9.7.2

Items shipped separately from the MC switchgear, including removed circuit breakers, shall be clearly identified with the item description and the location of installation.

Justification

This requirement ensures that the packing and preservation method is not compromised during storage and shipping. The requirement also provides additional information to assist with reassembly during installation.

9.7.3 Shipping identification labels

9.7.3.1

Shipping splits of multiple vertical sections shall be provided with individual identification labels.

Justification

This requirement ensures that the packing and preservation method is not compromised during storage and shipping. The requirement also provides additional information to assist with reassembly during installation.

9.7.3.2

The identification labels of shipping splits of multiple vertical sections shall display the equipment number of the assembly of which these vertical sections are components.

Justification

This requirement ensures that the packing and preservation method is not compromised during storage and shipping. The requirement also provides additional information to assist with reassembly during installation.

9.7.3.3

The identification labels of shipping splits shall be visible and use a means of permanent attachment.

Justification

This requirement ensures that the packing and preservation method is not compromised during storage and shipping. The requirement also provides additional information to assist with reassembly during installation.

9.7.4

Shipping restraints (e.g., blocking, bracing) that require removal before energizing the equipment shall be clearly identified with tags, signs or markings.

Justification

This requirement is focused on the lifting, handling and storage requirements for each shipping split. The requirement also provides additional information to assist with reassembly during installation. Significant damage to the switchgear assembly can occur if these shipping restraint materials are not removed prior to energization.

9.7.5

Equipment and removable items shall be protected from dust, water, humidity and vibration during shipping and storage.

Justification

This requirement ensures that the packing and preservation methods prevent corrosion and damage to the switchgear assembly and associated components during shipping and storage.

9.7.6

Instruments, relays, switches and meters installed on the MC switchgear doors shall be protected, blocked and braced to prevent damage during shipment.

Justification

This requirement minimizes damage to door-mounted components during shipping and lifting operations. These devices are sometimes installed in a cantilever orientation and are subject to impact damage when exposed to higher-than-normal g-forces.

9.7.7

Individual shipment packages shall be identified with the purchase order number, job number and equipment number.

Justification

This requirement ensures that the packaging is properly labeled and identified to facilitate installation and commissioning. The misidentification of shipping splits leads to installation and commissioning delays.

9.7.8

Equipment release for shipment shall be approved by the user's identified authority (e.g., third-party inspector).

Justification

This requirement ensures that the equipment is inspected and accepted in accordance with project specifications prior to shipment. Equipment release requires official sign off to ensure all quality punchlists have been addressed/agreed to be closed after shipping and all shipment requirements have been met.

9.7.9 Space heater operation for storage

The electrical connection point for the space heaters in each shipping section shall be in accordance with the requirements given in 9.7.9.1 through 9.7.9.3.

Justification

This requirement ensures that the packing and preservation method is not compromised during storage when the space heaters are connected.

9.7.9.1

The connection point shall be available without uncrating the equipment.

Justification

This requirement ensures that the packing and preservation method is not compromised during storage when the space heaters are connected.

9.7.9.2

The connection point shall be labeled.

Justification

This requirement ensures that the packing and preservation method is not compromised during storage when the space heaters are connected.

9.7.9.3

The connection point shall indicate the electrical service required.

Justification

This requirement ensures that the packing and preservation method is not compromised during storage when the space heaters are connected.

Annex A

(informative)

Bibliography

Add to first paragraph

The following documents are informatively cited in the text of this document, IEEE Std C37.20.2, the PDS (IOGP S-743D) or the IRS (IOGP S-743L).

Add to annex

[B15] ANSI/IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

[B16] API Specification Q1, *Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry*

[B17] API Specification Q2, *Specification for Quality Management System Requirements for Service Supply Organizations for the Petroleum and Natural Gas Industries*

[B18] IEC 62402, *Obsolescence management*

[B19] IEC 62439-3, *Industrial communication networks – High availability automation networks – Part 3: Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR)*

[B20] IEEE 1584, *IEEE Guide for Performing Arc-Flash Hazard Calculations*

[B21] IOGP S-727, *Supplementary Specification to IEEE Std C37.20.1 Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear*

[B22] IOGP S-742, *Supplementary Specification to UL 347 Standard for Safety for Medium-Voltage AC Contactors, Controllers, and Control Centers*

[B23] ISO 9001, *Quality management systems — Requirements*

[B24] ISO 10005, *Quality management — Guidelines for quality plans*

[B25] ISO/IEC Directives, Part 2, *Principles and rules for the structure and drafting of ISO and IEC documents*

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