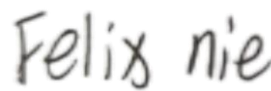
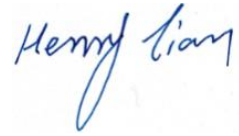


TEST REPORT IEC 61439 Low-voltage switchgear and controlgear assemblies -Part 1: General rules	
Report Reference No.	ATJC25072380005800S
Tested by (+ signature)	Felix nie 
Approved by (+ signature)	Henry Tian 
Date of issue	Oct. 25, 2025
Testing Laboratory	Shenzhen Anteng Testing Technology Co., Ltd.
Address	Floor 5, No. 11, Floor 5, No. 11, Hebei Industrial Zone, Hualian Community, Longhua Street, Longhua District, Shenzhen, China.
Testing location/ address	Same as above
Applicant's name	Riches hardware Co., Ltd
Address	Building 168 Guangren Road,Xintian Group,Dongya Village Committee,Ruhu Town,Huicheng District,Huizhou City,Guangdong Province, China
Test specification:	
Standard	IEC 61439-1:2020
Type of test	Consignment test
Non-standard test method	N/A
Test item description	
Trademark	N/A
Model/Type reference	MNS, GCK, GCS, VFD, ATS, ACC, ACP, AP, AL, AF, APE, ALE, AD, AS, AR, AW, JXF, XM, XL-21, GGD, GGJ, DB, PDU, ODC, OSG, ODB, OTC, AH, AM, AA, AJ
Rating	Input:1000V~, 50/60Hz, 4000kW Max
Manufacturer	Same as applicant
Address	Same as applicant

Possible test case verdicts:	
- test case does not apply to the test object.....:	N/A
- test object does meet the requirement.....:	P (Pass)
- test object does not meet the requirement.....:	F (Fail)
Testing:	
Date of receipt of test item.....:	Oct. 13, 2025
Date (s) of performance of tests.....:	Oct. 13 - Oct. 25, 2025
General remarks:	
The test results presented in this report relate only to the object tested. This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory. “(see remark #)” refers to a remark appended to the report. “(see Appendix #)” refers to an appendix appended to the report. Throughout this report a comma (point) is used as the decimal separator.	
General disclaimer:	
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General product information:	
- Model differences: The only difference is the model name.	

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Clause	Requirement + Test	Result - Remark	Verdict
5	Interface characteristics		--
5.1	General		--
	The characteristics of the assembly shall ensure compatibility with the ratings of the circuits to which they are connected plus the installation conditions and shall be declared by the assembly manufacturer using the criteria identified in 5.2 to 5.6.		P
5.2	Voltage ratings		P
5.2.1	Rated voltage (U_n)(of the assembly)		P
	The rated voltage shall be at least equal to the nominal voltage of the eLEctrical system.		P
5.2.2	Rated operational voltage(U_e)(of a circuit of an assembly)		P
	The rated operational voltage of any circuit shall not be less than the nominal voltage of the eLEctrical system to which it is to be connected. If the nominal voltage is given for a three.phase system, the rated operational voltage of single-phase circuits shall not be less than the nominal voltage divided by $\sqrt{3}$.		P
	If different from the rated voltage of the assembly, the appropriate rated operational voltage of the circuit shall be stated.		P
5.2.3	Rated insulation voltage (U_i) (of a circuit of an assembly)		P
	The rated insulation voltage of a circuit of an assembly is the voltage value to which dieLEctric test voltages and creepage distances are referred.		P
	The rated insulation voltage of a circuit shall be equal to or higher than the values stated for U_n and for U_e for the same circuit.		P
	For single-phase circuits derived from IT systems (see IEC 60364-5-52:2009), the rated insulation voltage shall be at least equal to the voltage between the line conductors of the supply.		P
5.2.4	Rated impulse withstand voltage (U_{imp}) (of the assembly)		P
	The rated impulse voltage of an assembly is the voltage value to which clearance distances and solid insulation withstand to transient overvoltage are referred.		P
	The rated impulse withstand voltage shall be equal to or higher than the values stated for the transient overvoltages occurring in the eLEctrical system(s)		P

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Clause	Requirement + Test	Result - Remark	Verdict
	to which the circuit is designed to be connected.		
	The preferred values of rated impulse withstand voltage are those given in Table G.1.		P
5.3	Current ratings		P
5.3.1	Rated current of an assembly (I_{nA})		P
	The rated current of an assembly is the lowest value of.		P
	-the total group rated current I_{ng} of the incoming circuit(s), which is either the group rated current of the single incoming circuit or the sum of the group rated currents of the incoming circuits operated in parallel and simultaneously within the assembly;		P
	-the total current that the main busbar can distribute in the particular assembly arrangement.		P
	This current shall be carried without the temperature-rise of the individual parts exceeding the limits specified in 9.2.		P
5.3.2	Rated current of a main outgoing circuit (I_{nc})		P
	The rated current of a main outgoing circuit is the current that can be carried by the outgoing circuit when all other outgoing main circuits in the same section are not carrying current (see 10.10). This current shall be carried without the temperature-rise of the various parts of the assembly exceeding the limits specified in 9.2.		P
	Declaration of the rated current of a circuit I_{nc} is voluntary if the group rated current I_{ng} of the circuit is declared. If I_{nc} is stated, the maximum permissible continuous load current on an individual circuit in a lightly loaded section can be assessed and the load on the individual circuit possibly allowed to exceed I_{ng} , but it is never allowed to exceed I_{nc}		P
5.3.3	Group rated current of a main circuit (I_{ng})		P
	The group rated current of a main circuit is the current that can be carried by this circuit when it is loaded continuously and simultaneously together with at least one other circuit in the same assembly or section of the assembly, in a specific arrangement as defined by the original manufacturer. It shall be carried without the temperature-rise of the various parts of the assembly exceeding the limits specified in 9.2.		P
	If I_{ng} is declared, the original manufacturer shall state the specific arrangements which are covered		P

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Clause	Requirement + Test	Result - Remark	Verdict
	by the group rated current in terms of: - type(s), ratings and maximum number of circuits/functional units allowed to be installed in the same assembly or section, and - arrangement(s) of functional units within the sections and/or assemblies		
	The group rated current of the main circuits, which are continuously and simultaneously loaded, shall be equal to or higher than the assumed loading of the outgoing circuits (equal to the design current I_B , according to IEC 60364-1). The group rated current of the main circuits which are continuously and simultaneously loaded, shall be equal to or higher than the assumed loading of the outgoing circuits (equal to the design current of the circuit, I_B , according to IEC 60364-1).		P
	The assumed loading of outgoing circuits shall be addressed by the relevant assembly standard.		P
	I_{ng} is obtained by a test according to 10.10.2.3.5 or 10.10.2.3.6 or 10.10.2.3.7. or by calculation according to 10.10.4. Using method 10.10.2.3.6 or 10.10.2.3.7, I_{ng} values are required to calculate the RDF.		P
	An alternative to declaring I_{ng} for each type of main circuit is to declare I_{nc} for each type of main circuit and the appropriate RDF		P
5.3.4	Rated peak withstand current (I_{pk})		P
	The rated peak withstand current shall be equal to or higher than the values stated for the peak value of the prospective short-circuit current of the supply system(s) to which the circuit(s) is(are) designed to be connected (see also 9.3.3).		P
5.3.5	Rated short-time withstand current (I_{cw}) (of a main circuit of an assembly)		P
	The rated short-time withstand current of a main circuit of an assembly shall be equal to or higher than the prospective value of the short-circuit current I_{cp} at each point of connection to the supply (see also 3.8.10.3).		P
	Different values of I_{cw} for different durations (e.g. 0,2 s; 1 s; 3 s) may be assigned to an assembly. Maximum duration normally does not exceed 1 s.		P
	For AC, the value of the current is the RMS value of the AC component. For DC, the value of the current is the arithmetic mean value.		P
5.3.6	Rated conditional short-circuit current (I_{cc}) (of an		P

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Clause	Requirement + Test	Result - Remark	Verdict
	assembly or a circuit of an assembly)		
	The rated conditional short-circuit current of an assembly or a circuit of an assembly, declared by the assembly manufacturer, is the maximum short-circuit current which that circuit when protected by a SCPD, as specified by the manufacturer, can satisfactorily withstand for the operating time of the device under the test conditions specified in 10.11.		P
	The rated conditional short-circuit current of an assembly or a circuit of an assembly shall be equal to or higher than the prospective value of the short-circuit current I_{cp} for a duration limited by the operation of the short-circuit protective device that protects the circuit or assembly, The assembly manufacturer shall declare the breaking capacity, current limitation characteristics, I^2t and I_{lt} , of the specified short-circuit protective device, taking into consideration the data given by the device manufacturer.		P
5.4	Rated diversity factor(RDF)		N/A
	As an alternative to declaring the group rated currents I_{ng} of each main outgoing circuit, their current carrying capacity under conditions of simultaneous operation can be stated in terms of the rated currents I_{nc} , and the rated diversity factor.		N/A
	The rated diversity factor is the per unit value of I_{nc} , to which outgoing circuits can be continuously and simultaneously loaded in the same section of the assembly in the specific arrangement(s) as defined by the original manufacturer, taking into account the mutual thermal influences. For further details on the specific arrangements, see 5.3.3.		N/A
	The rated diversity factor multiplied by the rated current I_{nc} of the circuits shall be equal to or higher than the assumed loading of the outgoing circuits, where the assumed load current is equal to the design current I_B for continuously and simultaneously loaded circuits. If the design current I_B is not provided then the assumed loading of outgoing circuits shall be as given in the relevant assembly standard of IEC 61439 and is subject to agreement between user and manufacturer.		N/A
5.5	Rated frequency(f_n)		P
	The rated frequency of a circuit is the value of frequency to which the operating conditions are referred. Where the circuits of an assembly are designed for different values of frequency, the rated frequency of each circuit shall be given.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	The frequency should be within the limits specified in the relevant IEC standards for the incorporated components. Unless otherwise stated by the assembly manufacturer, the limits are assumed to be 98 % and 102 % of the rated frequency.		P
5.6	Other characteristics		P
	The following characteristics shall be declared:		P
	a) additional requirements depending on the use of a functional unit (e.g. type of coordination, overload characteristics); b) pollution degree of the macro-environment (see 3.6.10.2); c) types of earthing system for which the Assembly is designed; d) indoor and/or outdoor installation (see 3.5.1 and 3.5.2); e) stationary or movable (see 3.5.3 and 3.5.4); f) degree of protection against contact with hazardous live parts, ingress of solid foreign bodies and water, IP code (see 8.2.2); g) intended for use by ordinary or authorized persons (see 3.7.1 6 and 3.7.1 7); h) electromagnetic compatibility (EMC) classification (see Annex J); i) special service conditions, if applicable (see 7.2); j) external design (see 3.3); k) degree of protection against mechanical impact, IK code, if applicable (see 8.2.1); l) type of construction – fixed or removable parts (see 8.5.1 and 8.5.2); m) type of short-circuit protective device(s) (see 9.3.2); n) measures for protection against electric shock; o) overall dimensions (including projections e.g. handles, covers, doors), if required; p) weight, if required.		P
6	Information		P
6.1	Assembly designation marking		P
	The assembly manufacturer shall provide each assembly with one or more labels, marked in a durable manner and located in a place such that they are visible and legible when the assembly is installed and in operation. Compliance is checked		P

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Clause	Requirement + Test	Result - Remark	Verdict
	according to the test of 10.2.7 and by inspection.		
	The following information regarding the assembly shall be provided on the designation label(s): a) assembly manufacturer's name or trade mark (see 3.10.2); b) type designation or identification number or any other means of identification, making it possible to obtain relevant information from the assembly manufacturer; c) means of identifying date of manufacture; d) rated current of the assembly I_{nA} (see 3.8.10.7 and 5.3.1); e) rated voltage of the assembly U_n (see 3.8.9.1 and 5.2.1); f) rated frequency of the assembly f_n (see 3.8.1 2 and 5.5); g) IEC 61 439-X (the specific part “X” shall be identified).		P
6.2	Documentation		P
6.2.1	Information relating to the assembly		P
	All interface characteristics according to Clause 5, where applicable, shall be provided in the assembly manufacturer's technical documentation supplied with the assembly.		P
6.2.2	Instructions for handling, installation, operation and maintenance		P
	The assembly manufacturer shall provide in documents or catalogues the conditions, if any, for the handling, installation, operation and maintenance of the assembly and the equipment contained therein. Where appropriate, instructions shall state that the assembly manufacturer is to be consulted when repair of an assembly is required.		P
	If necessary, the instructions shall indicate the measures that are of particular importance for the safe, proper and correct transport, handling, installation and operation of the assembly. The provision of weight details is of particular importance in connection with the transport and handling of transport units . In addition, installation instructions shall provide sufficient details for the installer to adequately secure the assembly in service.		P
	The correct location and installation of lifting means and the thread size of lifting attachments, if applicable, shall be given in the assembly		P

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Clause	Requirement + Test	Result - Remark	Verdict
	manufacturer's documentation or the instructions on how the transport unit has to be handled.P		
	The measures to be taken, if any, with regard to EMC associated with the installation, operation and maintenance of the assembly shall be specified (see Annex J).		P
	Where necessary, the above-mentioned documents shall indicate the recommended extent and frequency of maintenance.		P
	If the circuitry within the assembly is not obvious, for example, there are connections from several incoming power-supplies such as photovoltaic supplies, generators, batteries, information detailing the circuit arrangements shall be supplied.		P
	When fuses are installed, the assembly manufacturer shall state the type and rating of the fuse-links to be used.		P
6.3	Device and/or component identification		P
	Inside the assembly, it shall be possible to identify individual circuits and their protective devices. Identification tags shall be legible, permanent and appropriate for the physical environment. Any designations used shall be in compliance with IEC 81 346-1 :2009 and IEC 81 346-2:201 9 and identical to those used in the wiring diagrams, which shall be in accordance with IEC 61082-1 :201 4.		P

7	Service conditions		P
7.1	Normal service conditions		P
7.1 .1	Climatic conditions		P
	Assemblies conforming to this document are intended for use under the normal service conditions detailed in Table 1 5.		P
	If components, for example relays, electronic equipment, are used which are not designed for these conditions, the environment provided within the assembly shall be suitable for the components.		P
7.1 .2	Pollution degree		P
	The pollution degree referred to in Annex C is the macro-environmental condition for which the assembly is intended.		P
	For switching devices and components inside an enclosure, the pollution degree of the environmental conditions inside the enclosure, the		P

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Clause	Requirement + Test	Result - Remark	Verdict
	micro-environment, is applicable.		
	For the purpose of evaluating clearances and creepage distances, the following four degrees of pollution in the micro-environment are established.		P
	• Pollution degree 1 : No pollution or only dry, non-conductive pollution occurs. The pollution has no influence. • Pollution degree 2: Only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is to be expected. • Pollution degree 3: Conductive pollution occurs, or dry, non-conductive pollution occurs which is expected to become conductive due to condensation. • Pollution degree 4: Continuous conductivity occurs due to conductive dust, rain or other wet conditions. Pollution degree 4 is not applicable to this document for a micro-environment inside the assembly.	PD2	P
	The micro-environment within the assembly can be different from the macro-environment outside the enclosure. The pollution degree for a particular type of assembly is given in the relevant assembly standard.		P
7.2	Special service conditions		N/A
	Where any special service conditions exist, the applicable particular requirements shall be complied with or special agreements shall be made between the assembly manufacturer and the user. The user shall inform the assembly manufacturer if such exceptional service conditions exist.		N/A
	Special service conditions include, for example: a) values of temperature, relative humidity and/or altitude differing from those specified in 7.1 ; b) applications where variations in climatic conditions are likely to result in exceptional condensation inside the assembly ; c) heavy pollution of the air by dust, smoke, corrosive or radioactive particles, vapours or salt; d) exposure to strong electric or magnetic fields; e) exposure to extreme climatic conditions; f) attack by fungus or small creatures;		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	g) installation in locations where fire or explosion hazards exist; h) exposure to heavy vibration, shocks, seismic occurrences; i) installation in such a manner that the current-carrying capacity is affected, for example equipment built into machines or recessed into walls; j) exposure to conducted and radiated disturbances other than electromagnetic, and electromagnetic disturbances in environments other than those described in 9.4; k) exceptional overvoltage conditions or voltage fluctuations; l) excessive harmonics in the supply voltage or load current; m) exposure to radiation (for example, X-rays, microwave, ultraviolet other than solar, lasers).		
7.3	Conditions during transport, storage and installation		P
	A special agreement shall be made between the assembly manufacturer and the user if the conditions during transport, storage and installation, for example temperature and humidity conditions, differ from those defined in 7.1 .		P

8	Constructional requirements		--
8.1	Strength of materials and parts		P
8.1 .1	General		P
	Under the responsibility of the original manufacturer, all design activities shall be carried out or supervised by a competent person.		P
	The external shape of the assembly enclosure, if any, can vary to suit the application and use. Some examples are;		P
	• cubicle-type assembly (see 3.3.4); • multi-cubicle-type assembly (see 3.3.5); • desk-type assembly (see 3.3.6); • box-type assembly (see 3.3.7); • multi-box-type assembly (see 3.3.8); • wall-mounted surface type assembly (see 3.3.9); • wall-mounted recessed type assembly (see 3.3.10); and • floor-standing type assembly (3.3.1 1).		P

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Clause	Requirement + Test	Result - Remark	Verdict
	These enclosures may be constructed from various materials, e.g. insulating, metallic or a combination of these.		P
	Assemblies shall be constructed of materials capable of withstanding the mechanical, electrical, thermal and environmental stresses that are likely to be encountered in specified service conditions.		P
	In the case of special service conditions that can be present in the physical environment in which the assembly is to be installed (for example, dust, acids, corrosive gases, salts), the assemblies shall be adequately protected against contaminants (see Annex C). When the assembly is subject to radiation (for example, X-rays, microwave, ultraviolet, lasers), additional measures shall be taken to avoid malfunctioning of the assembly and accelerated deterioration of the insulation. When such measures are necessary, an agreement is required between the assembly manufacturer and the user.		P
	When the assembly is subject to undesirable effects of vibration or shock, e.g. caused by a machine and its associated equipment, the selection of suitable equipment, or mounting it away from the source of the vibration, or the provision of anti-vibration mountings shall be considered.		P
8.1.2	Protection against corrosion		P
	Protection against corrosion shall be ensured by the use of suitable materials or by protective coatings to the exposed surface, taking account of the normal service conditions (see 7.1). Compliance with this requirement is checked by the test in 10.2.2.		P
8.1.3	Properties of insulating materials		P
8.1.3.1	Thermal stability		N/A
	Enclosures or parts of enclosures made of insulating material(s), not already certified to their own product standard, e.g. louvers, meshes, shall be capable of operation at temperatures of at least 70 °C. Thermal stability shall be verified according to 10.2.3.1 .		P
8.1.3.2	Resistance of insulating materials to heat and fire		P
8.1.3.2.1	General		P

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Clause	Requirement + Test	Result - Remark	Verdict
	Parts of insulating materials, which can be exposed to thermal stresses due to internal electrical effects, and the deterioration of which can impair the safety of the assembly, shall not be adversely affected by normal (operational) heat, and abnormal heat or fire.		P
8.1.3.2.2	Resistance of insulating materials to normal heat		P
	The original manufacturer shall select insulating materials which are suitable for the maximum temperatures to which they are exposed in normal operation, in accordance with 9.2 and Table 6. The applied temperature-rise limit (see 9.2) for parts of insulating materials shall be justified based on, for example, the methods of IEC 6021 6 (all parts), or thermal class identified in accordance with IEC 60085:2007.		P
8.1.3.2.3	Resistance of insulating materials to abnormal heat and fire due to internal electric effects		P
	Insulating materials used for parts necessary to retain current carrying parts in position and parts which can be exposed to thermal stresses due to internal electrical effects, of which the deterioration can impair the safety of the assembly , shall not be adversely affected by abnormal heat and fire and shall be verified by the glow-wire test in 10.2.3.2. For the purpose of this test, a protective conductor (PE) is not considered as a current-carrying part.		P
8.1.4	Resistance to ultra-violet (UV) radiation		N/A
	External surfaces made of insulating material(s) and coated metal enclosures which are intended to be used outdoor exposed to ultra-violet radiation shall not crack nor deteriorate such that it impairs the safety of the assembly. Resistance to ultra-violet radiation shall be verified according to 10.2.4.		N/A
8.1.5	Mechanical strength		P
	All enclosures or partitions, including locking means and hinges for doors, shall be of a mechanical strength sufficient to withstand the stresses to which they may be subjected in normal service, (see also 10.2.8) and during short-circuit conditions (see also 10.1 1).		P
	The mechanical operation of removable parts, including any insertion interlock, shall be verified by test according to 10.2.8.		P
8.1.6	Lifting provision		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	Where lifting, other than by manual means is recommended by the manufacturer, e.g. by crane or fork lift truck, transport units shall be provided with the appropriate provision for lifting. Compliance is verified according to 10.2.5.		N/A
8.2	Degree of protection provided by an assembly enclosure		P
8.2.1	Protection against mechanical impact (IK code)		P
	The minimum degree of protection provided by an assembly enclosure against mechanical impact, if necessary, shall be defined by the relevant assembly standards.		P
	Compliance is verified according to 10.2.6.		P
8.2.2	Protection against contact with live parts, ingress of solid foreign bodies and water (IP code)		N/A
	The degree of protection provided by any assembly against contact with live parts, ingress of solid foreign bodies and water is indicated by the IP code according to IEC 60529:1 989, IEC 60529:1989/AMD1 :1 999 and IEC 60529:1 989/AMD2:201 3; and verified according to 10.3.		N/A
	After installation in accordance with the assembly manufacturer's instructions, the degree of protection of an enclosed assembly shall be at least IP2X. The degree of protection provided from the front of a dead-front assembly shall be at least IPXXB.		N/A
	For assemblies for outdoor use having no supplementary protection, the second characteristic numeral shall be at least 3.		N/A
	Unless otherwise specified, the degree of protection indicated by the assembly manufacturer applies to the complete assembly when installed in accordance with the assembly manufacturer's instructions, for example sealing of the open mounting surface of an assembly, etc.		N/A
	Where the assembly does not have the same IP rating throughout, the assembly manufacturer shall declare the IP rating for the separate parts.		N/A
	Different IP ratings shall not impair the intended use of the assembly .		N/A
	IP codes shall not be declared by the assembly manufacturer unless the appropriate verifications have been made according to 10.3.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	Enclosed assemblies , for outdoor and indoor installation, intended for use in locations with high humidity and temperatures varying within wide limits, shall be provided with suitable arrangements (ventilation and/or internal heating, drain holes, etc.) to prevent harmful condensation within the assembly. However, the specified degree of protection shall at the same time be maintained.		N/A
8.2.3	Assembly with removable parts		N/A
	The degree of protection (IP) indicated for assemblies normally applies to the connected position (see 3.2.3) of the removable parts.		N/A
	If, after the removal of a removable part, it is not possible to maintain the original degree of protection (e.g. by closing a door), the assembly manufacturer shall make available covers or similar to restore the original degree of protection. If these measures are not available, the IP tests shall be carried out without the removable part in place.		N/A
	When shutters are used to provide adequate protection to live parts, they shall be secured to prevent unintentional removal.		N/A
8.3	Clearances and creepage distances		P
8.3.1	General		P
	The requirements for clearances and creepage distances are based on the principles of IEC 60664-1 :2007 and are intended to provide insulation coordination within the installation.		P
	The clearances and creepage distances of equipment that form part of the assembly shall comply with the requirements of the relevant product standard.		P
	When incorporating equipment into the assembly, the specified clearances and creepage distances shall be maintained during normal service conditions.		P
	For dimensioning clearances and creepage distances between separate circuits, the highest voltage ratings shall be used (rated impulse withstand voltage for clearances and rated insulation voltage for creepage distances).		P
	The clearances and creepage distances apply to line to line, line to neutral, and, except where a conductor is connected directly to earth, line to earth and neutral to earth.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	For bare live conductors and terminations, the clearances and creepage distances shall at least be equivalent to those specified for the equipment with which they are directly associated.		P
	The effect of a short-circuit up to and including the declared rating(s) of the assembly shall not reduce permanently the clearances or creepage distances between busbars and/or connections below the values specified for the assembly. Deformation of parts of the enclosure or of the internal partitions, barriers and obstacles due to a short-circuit shall not reduce permanently the clearances or creepage distances below those specified in 8.3.2 and 8.3.3 (see also 10.1 1 .5.5).		P
8.3.2	Clearances		P
	The clearances shall be sufficient to enable the declared rated impulse withstand voltage (U_{imp}) of a circuit to be achieved. The clearances shall be at least as specified in Table 1 ; if not, a design verification test and a routine impulse withstand voltage test are carried out in accordance with 10.9.3 and 1 1 .3, respectively.		P
	The method of determining clearances by measurement is given in Annex F.		P
8.3.3	Creepage distances		P
	The original manufacturer shall select a rated insulation voltage(s) (U_i) for the circuits of the assembly from which the creepage distance(s) shall be determined. For any given circuit, the rated insulation voltage shall not be less than the rated operational voltage (U_e).		P
	The creepage distances shall not, in any case, be less than the associated minimum clearances.		P
	Creepage distances shall correspond to a pollution degree as specified in 7.1 .2 and to the corresponding material group at the rated insulation voltage given in Table 2.		P
	The method of determining creepage distances by measurement is given in Annex F.		P
	For inorganic insulating materials, e.g. glass or ceramics, which do not track, creepage distances need not be greater than their associated clearances. However, the risk of disruptive discharge should be considered.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	By using ribs of a minimum height of 2 mm, the creepage distance may be reduced but, irrespective of the number of ribs, shall be not less than 0,8 times the value of Table 2 and not less than the associated minimum clearance. The minimum base of the rib is determined by mechanical requirements (see Clause F.2).		P
8.4	Protection against electric shock		P
8.4.1	General		P
	The apparatus and circuits in the assembly shall be so arranged as to facilitate their operation and maintenance with the required protection against electric shock.		P
	The following requirements are intended to ensure that the required protective measures are obtained when an assembly is installed in an electrical system conforming to the IEC 60364 series.		N/A
	Those protective measures, which are of particular importance for an assembly , are reproduced in 8.4.2 to 8.4.6.		N/A
8.4.2	Basic protection		P
8.4.2.1	General		P
	Basic protection is intended to provide protection against electric shock under normal conditions, preventing direct contact with hazardous live parts.		P
	Basic protection can be achieved either by appropriate constructional measures on the assembly itself or by additional measures to be taken during installation; this may require information to be given by the assembly manufacturer.		P
	An example of additional measures to be taken is the installation of an open-type assembly without further provisions in a location where access is only permitted for authorized person(s).		P
	Where basic protection is achieved by constructional measures, one or more of the protective measures given in 8.4.2.2 and 8.4.2.3 may be selected. The choice of the protective measure shall be declared by the assembly manufacturer if not specified within the relevant assembly standard.		P
8.4.2.2	Basic insulation provided by insulating material		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Hazardous live parts shall be completely covered with insulation that can only be removed by destruction or by the use of a tool.		P
	The insulation shall be made of suitable materials capable of durably withstanding the mechanical, electrical and thermal stresses to which the insulation may be subjected in service.		P
	Paints, varnishes and lacquers alone are generally not considered to satisfy the requirements for basic insulation. This does not preclude the use of specifically designed insulating coatings that fulfil the dielectric requirements specified in 10.9.6.		P
8.4.2.3	Barriers or enclosures		N/A
	Air-insulated live parts shall be inside enclosures or behind barriers. The enclosures or barriers shall provide a degree of protection of at least IPXXB.		N/A
	Horizontal top surfaces of accessible enclosures having a height equal to or lower than 1,6 m above the standing area shall provide a degree of protection of at least IPXXD.		N/A
	Barriers and enclosures shall be firmly secured in place and have sufficient stability and durability to maintain the required degrees of protection and appropriate separation from live parts under normal service conditions, taking account of relevant external influences. The distance between a conductive barrier or enclosure and the live parts they protect shall not be less than the values specified for the clearances and creepage distances in 8.3.		N/A
	Where it is necessary to remove barriers or open enclosures or to remove parts of enclosures (see 8.4.6), this shall be possible only if one of the conditions a) to c) is fulfilled.		N/A

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	a) By the use of a key or tool, i.e. any mechanical aid, to open the door, cover or override an interlock. b) After isolation of the supply to live parts, against which the barriers or enclosures afford basic protection, restoration of the supply being possible only after replacement or reclosure of the barriers or enclosures. In TN-C and TN-C-S systems, the PEL, PEM or PEN conductor shall not be isolated or switched. In TN-S and TN-C-S systems, the mid-point and neutral conductors need not be isolated or switched (see IEC 60364-5-53:2001 , 536.1 .2). c) Where an intermediate barrier providing a degree of protection of at least IPXXB prevents contact with live parts, such a barrier being removable only by the use of a key or tool.		N/A
8.4.3	Fault protection		P
8.4.3.1	Installation conditions		P
	The assembly shall include protective measures and be suitable for installations designed to be in accordance with IEC 60364-4-41 :2005 and IEC 60364-4-41 :2005/AMD1 :201 7.		P
	When a TT earthing system is being used in the electrical network, one of the following protective measures shall be applied in the assembly: a) double or reinforced insulation of all conductors (incoming cables, extension terminals, etc.) upto the supply side of the first RCD(s) in the system (this is not a requirement when a Class II assembly is used); or b) residual current device (RCD) protecting the incoming circuit.		P
	Such provisions are subject to agreement between the user and the manufacturer.		P
8.4.3.2	Requirements for the protective conductor to facilitate automatic disconnection of the supply		P
8.4.3.2.1	General		P
	Each assembly shall have a protective conductor to facilitate automatic disconnection of the supply for: a) protection against the consequences of earth faults within the class I assembly; b) protection against the consequences of earth faults in external circuits supplied through the class I and class II assembly. In the case of a class II assembly, the protective conductor may or may not be incorporated within the assembly: it is permissible for it to pass the assembly externally.		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	The requirements to be complied with are given in 8.4.3.2.2 and 8.4.3.2.3.		P
	Requirements for identification of the protective conductor (PE, PEN, PEM, PEL) are given in 8.6.6.		P
8.4.3.2.2	Requirements for earth continuity providing protection against the consequences of faults within the class I assembly		P
	All exposed-conductive-parts of the assembly shall be interconnected together and to the protective conductor of the supply or via an earthing conductor to the earthing arrangement.		P
	These interconnections may be achieved either by metal screwed connections, welding or other conductive connections, or by a separate conductor providing earth continuity.		P
	With metal parts of the assembly where abrasion-resistant finishes are used (e.g. gland plates with powder coatings), interconnections providing earth continuity requires the removal or the penetration of the coating.		P
	The method to verify the earth continuity between the exposed-conductive-parts of the assembly and the protective conductor is given in 10.5.2.		P
	For the continuity of these connections, the following shall apply: a) When a part of the assembly is removed, for example for routine maintenance, the earth continuity for the remainder of the assembly shall not be interrupted. Means used for assembling the various metal parts of an assembly are considered sufficient for ensuring earth continuity if the precautions taken guarantee permanent good conductivity. Flexible or pliable metal conduits shall not be used as protective conductors unless they are designed for that purpose. b) For lids, doors, cover plates and the like, the usual metal screwed connections and metal hinges are considered sufficient to ensure continuity provided that no electrical equipment is attached to them except equipment which is part of a PELV or SELV system.		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	If devices with a voltage exceeding the limits of PELV or SELV systems, as appropriate, are attached to lids, doors, or cover plates, additional measures shall be taken to ensure earth continuity. These parts (lids, doors or covers) shall be fitted with a protective conductor (PE) whose cross-sectional area is in accordance with Table 3 depending on the highest rated operational current I _e of the devices attached. Alternatively, if the rated operational current of the attached devices is less than or equal to 16 A an equivalent electrical connection specifically designed and verified for this purpose shall be provided (e.g. sliding contact, hinges protected against corrosion).		P
	Exposed conductive parts of a device that cannot be interconnected for earthing continuity by the fixing means of the device shall be connected to the earthing arrangement of the assembly by a conductor whose cross-sectional area is chosen according to Table 3.		P
	Certain exposed-conductive-parts of an assembly that do not constitute a danger need not be connected to the earthing arrangement, either; - because they cannot be touched on large surfaces or grasped with the hand; or - because they are of small size (approximately 50 mm by 50 mm) or so located as to exclude any contact with live parts.		P
	This applies to screws, rivets and nameplates. It also applies to electromagnets of contactors or relays, magnetic cores of transformers, certain parts of releases, or similar, irrespective of their size.		P
	When removable parts are equipped with a metal supporting surface, these surfaces shall be considered sufficient for ensuring earth continuity provided that the pressure exerted on them is sufficiently high.		P
8.4.3.2.3	Requirements for protective conductors providing protection against the consequences of earth faults in external circuits supplied through the class I or class II assemblies		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	A protective conductor within the assembly shall be designed so that it can withstand the highest thermal and dynamic stresses arising from earth fault currents in external circuits supplied through the assembly in its installed location. Conductive structural parts may be used as a protective conductor or a part of it. Additional requirements for protective conductors for class II assemblies are given in 8.4.4 c).		P
	Except where verification of the short-circuit withstand strength is not required in accordance with 10.1 1 .2, verification shall be made in accordance with 10.5.3.		P
	In principle, with the exception of the cases mentioned below, protective conductors within an assembly shall not include a disconnecting device (switch, disconnector, etc.).		P
	- In the run of protective conductors, links shall be permitted which are removable by means of a tool and accessible only to authorized person(s) (these links may be required for certain tests). - Where continuity can be interrupted by means of connectors or plug-and-socket devices, the protective circuit shall be interrupted only after the live conductors have been interrupted and continuity shall be established before the live conductors are reconnected.		P
	In the case of an assembly containing structural parts, frameworks, enclosures, etc. made of conducting materials, a protective conductor, if provided, need not be insulated from these parts. Conductors to voltage-operated fault detection devices, including the conductors connecting them to a separate earth electrode, shall be insulated when specified by their manufacturer. This can also apply to the earth connection of the transformer neutral.		P
	The cross-sectional area of protective conductors (PE, PEL, PEM, PEN) in an assembly to which external conductors are intended to be connected shall be not less than the value calculated with the aid of the formula indicated in Annex B using the highest earth fault current and fault duration that may occur and taking into account the limitation of the SCPDs that protect the corresponding live conductors. The short-circuit withstand strength is verified according to 10.5.3.		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	For PEL, PEM and PEN conductors, the following additional requirements apply.		P
	- The minimum cross-sectional area shall be 10 mm² for copper or 16 mm² for aluminium. - The PEN and PEM conductor shall have a cross-sectional area not less than that required for a neutral and mid-point conductor (see 8.6.1). - The PEN, PEL and PEM conductors need not be insulated within a class I assembly. - Structural parts shall not be used as a PEN, PEL and PEM conductor; however, mounting rails according to IEC 60947-7-2:2009, Annex A, made of copper or aluminium may be used.		P
	For details of requirements for terminals for external protective conductors, see 8.8.		P
8.4.3.3	Electrical separation		P
	Electrical separation of individual circuits is intended to prevent electrical shock through contact with exposed-conductive-parts, which can become live when basic insulation of the circuit fails.		P
	For this type of protection, see IEC 60364-4-41 :2005 and IEC 60364-4-41 :2005/AMD1 :201 7.		P
8.4.4	Additional requirements for class II assemblies		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	a) For basic and fault protection, by double or reinforced insulation, the following additional requirements shall be met. The electrical equipment shall be enclosed in insulating material which is equivalent of double or reinforced insulation. The enclosure shall carry the symbol which shall be visible from the outside of the protected space. b) The enclosure shall at no point be pierced by conducting parts in such a manner that there is the possibility of a fault voltage being brought out of the enclosure. This means that metal parts, such as actuator shafts that, for constructional reasons, have to be brought through the enclosure, shall be insulated on the inside or the outside of the enclosure from the live parts for the maximum rated insulation voltage and the maximum rated impulse withstand voltage of all circuits in the assembly . If an actuator, or similar, is made of metal (whether covered by insulating material or not), it shall be provided with insulation rated for the maximum rated insulation voltage and the maximum impulse withstand voltage of all circuits in the assembly. c) If an actuator, or similar, is principally made of insulating material, any of its metal parts which may become accessible in the event of insulation failure shall also be insulated from live parts for the maximum rated insulation voltage and the maximum rated impulse withstand voltage of all circuits in the assembly . The enclosure or protected space, when the class II assembly is ready for operation and connected to the supply, shall enclose all live parts, exposed-conductive-parts and parts belonging to a protective circuit in such a manner that they cannot be touched. The enclosure shall give at least the degree of protection IP2XC (see IEC 60529:1 989, IEC 60529:1 989/AMD1 :1 999 and IEC 60529:1 989/AMD2:201 3). If an external protective PEL, PEM or PEN conductor is passed through the class II assembly, the assembly should be provided with a suitably identified terminal.		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	d) Inside the enclosure or protected space of a class II assembly, the protective conductor, (PE, PEL, PEM or PEN conductor) and its terminal shall be insulated from the live parts and the exposed-conductive-parts. Exposed-conductive-parts within the assembly shall not be connected to the protective conductor. This applies also to built-in apparatus, even if they have a connecting terminal for a protective conductor. e) If doors or covers of the enclosure can be opened without the use of a key or tool, a barrier of insulating material shall be provided that will afford protection of at least IPXXB against unintentional contact not only with the accessible live parts, but also with the exposed-conductive-parts that are only accessible after the door or cover has been opened; this barrier, however, shall not be removable except with the use of a tool.		P
8.4.5	Limitation of steady-state touch currents and charge		N/A
	If the assembly contains items of equipment that may retain charges after they have been switched off (capacitors banks without internal basic protection, etc.), a warning label is required.		N/A
	Small capacitors such as those used for arc extinction, for delaying the response of relays, etc., shall not be considered dangerous.		N/A
	Unintentional contact is not considered dangerous if the voltages resulting from static charges fall below a DC voltage of 60 V in less than 5 s after disconnection from the power supply.		N/A
	Touch currents are limited by ensuring exposed-conductive-parts are effectively connected to the protective conductor. See 10.5.2.		N/A
8.4.6	Operating and servicing conditions		N/A
8.4.6.1	Devices to be operated or components to be replaced by ordinary persons		N/A
	Protection against any contact with live parts shall be maintained when operating devices or when replacing components.		N/A
	The minimum degree of protection shall be IPXXC. During the replacement of certain lamps or fuselinks, openings larger than those defined by the degree of protection IPXXC are allowed.		N/A
8.4.6.2	Requirements related to accessibility in service by authorized persons		N/A

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
8.4.6.2.1	General		N/A
	Depending on the application and accessibility necessary in service, by authorized person(s), one or more of the following requirements in 8.4.6.2.2 to 8.4.6.2.4 shall be fulfilled. These requirements shall be complementary to the basic protection specified in 8.4.2.		N/A
	If doors or covers of the assembly can be opened by authorized persons by overriding an interlock to obtain access to live parts, then the interlock shall automatically be restored on reclosing the door(s) or replacing the cover(s).		N/A
	Obstacles can be used to prevent either: - unintentional bodily approach to live parts; or - unintentional contact with live parts during the operation of live equipment in normal service.		N/A
	Obstacles may be removed without using a key or tool but shall be so secured as to prevent unintentional removal. The distance between a conductive obstacle and the live parts they protect shall not be less than the values specified for the clearances and creepage distances in 8.3.		N/A
	Where a conductive obstacle is separated from hazardous live parts by basic protection only, it is an exposed-conductive-part, and measures for fault protection shall also be applied.		N/A
8.4.6.2.2	Requirements related to accessibility for inspection and similar operations		N/A
	The assembly shall be constructed in such a way that certain operations can be performed when the assembly is in service and energized.		N/A
	Such operations may consist of: - visual inspections of; • switching devices and other apparatus; • settings and indicators of relays and releases; • conductor connections and marking; - adjusting and resetting of relays, releases and electronic devices; - replacement of fuse-links; - replacement of indicating lamps; - certain fault location operations, for example voltage and current measuring with suitably designed and insulated devices.		N/A

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
8.4.6.2.3	Requirements related to accessibility for maintenance		N/A
	To enable maintenance on an isolated functional unit or isolated group of functional units in the assembly, with adjacent functional units or groups still energized, necessary measures shall be taken. The choice depends on such factors as service conditions, frequency of maintenance, competence of the authorized person, as well as local installation rules. Such measures may include the following: - sufficient space between the actual functional unit or group and adjacent functional units or groups. It is recommended that parts likely to be removed for maintenance have, as far as possible, retainable fastening means; - use of barriers or obstacles designed and arranged to protect against direct contact with equipment in adjacent functional units or groups; - use of terminal shields; - use of compartments for each functional unit or group; - insertion of additional protective means provided or specified by the assembly manufacturer.		N/A
8.4.6.2.4	Requirements related to accessibility for extension when energized		N/A
	When it is required to enable future extension of an assembly with additional functional units or groups, with the rest of the assembly still energized, the requirements specified in 8.4.6.2.3 shall apply, subject to agreement between the assembly manufacturer and the user. These requirements also apply for the insertion and connection of additional outgoing cables when the existing cables are energized.		N/A
	The extension of busbars and connection of additional units to their incoming supply shall not be made when energized, unless the assembly is designed for this purpose.		N/A
8.5	Incorporation of switching devices and components		P
8.5.1	Fixed parts		P
	For fixed parts (see 3.2.1), the connections of the main circuits (see 3.1 .3) shall only be connected or disconnected when the assembly is not energized. Removal and installation of fixed parts requires the use of a tool.		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	The disconnection of a fixed part shall require the isolation of the complete assembly or part of it.		P
	In order to prevent unauthorized operation, the switching device may be provided with means to secure it in one or more of its positions.		P
8.5.2	Removable parts		N/A
	The removable parts shall be so constructed that their electrical equipment can be safely removed from, or connected to, the main circuit even if this circuit is live. The removable parts may be provided with an insertion interlock (see 3.2.5).		N/A
	Clearances and creepage distances (see 8.3) shall be complied with during transfer from one position to another.		N/A
	A removable part shall be fitted with a device that ensures that it can only be removed and inserted after its main circuit has been switched off from the load.		N/A
	If unauthorized operation, can occur, then the removable parts shall be provided with a locking means to secure them in one or more of their positions.		N/A
8.5.3	Selection of switching devices and components		P
	Switching devices and components incorporated in assemblies shall comply with the relevant IEC standards.		P
	The switching devices and components shall be suitable for the particular application with respect to the external design of the assembly (e.g. open type or enclosed), their rated voltages, rated currents, rated frequency, service life, making and breaking capacities, short-circuit withstand strength, etc.		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	The rated insulation voltage, and rated impulse withstand voltage of the devices installed in the circuit shall be equal or higher than the corresponding value assigned to that circuit. In some cases, overvoltage protection may be necessary (e.g. for equipment fulfilling overvoltage category II (see 3.6.1 1)). The switching devices and components having a short-circuit withstand strength and/or a breaking capacity which is insufficient to withstand the stresses likely to occur at the place of installation, shall be protected by means of protective devices with suitable current-limiting characteristics, for example fuses or current-limiting circuit-breakers. When selecting current-limiting protective devices for built-in switching devices, the maximum permissible values specified by the device manufacturer shall be taken into account with due regard to coordination (see 9.3.4).		P
	Coordination of switching devices and components shall comply with the relevant IEC standards. Coordination of motor starters with short-circuit protective devices shall comply with IEC 60947-4-1 :201 8. See also 9.3.4.		P
8.5.4	Installation of switching devices and components		P
	Switching devices and components shall be installed and wired in the assembly in accordance with instructions provided by their manufacturers and in such a manner that their proper functioning is not impaired by interaction, such as heat, switching emissions, vibrations, electromagnetic fields, which are present in normal operation. In the case of electronic equipment, this may necessitate the separation or screening of all electronic signal processing circuits.		P
	When fuses are installed, the original manufacturer shall state the type and rating of the fuse-links to be used.		P
8.5.5	Accessibility		P
	Adjusting and resetting devices, that have to be operated inside the assembly , shall be easily accessible.		P
	Functional units mounted on the same support (mounting plate, mounting frame) and their terminals for external conductors shall be so arranged as to be accessible for mounting, wiring, maintenance and replacement.		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Assuming the base of the assembly and the normal standing area for operational personnel are at the same level, the following accessibility requirements associated with floor-standing assemblies shall apply.		P
	- The terminals, excluding terminals for protective conductors, shall be situated at least 0,2 m above the base of the assembly and, moreover, be so placed that the cables can be easily connected to them with their respective bending radii respected. - Indicating instruments that need to be read by the operator shall be located within a zone between 0,2 m and 2,2 m above the base of the assembly. - Operating devices such as handles, push buttons, or similar shall be located at such a height that they can easily be operated; this means that their centreline shall be located within a zone between 0,2 m and 2 m above the base of the assembly. Devices which are infrequently operated (e.g. less than once per month) may be installed at a height up to 2,2 m. - Actuators for emergency switching devices (see 536.4.2 of IEC 60364-5-53:2001) shall be accessible within a zone between 0,8 m and 1 ,6 m above the base of the assembly .		P
8.5.6	Barriers		N/A
	Barriers for manual switching devices shall be so designed that the switching emissions do not present a danger to the operator.		N/A
	To minimize danger when replacing fuse-links, interphase barriers shall be applied, unless the design and location of the fuses makes this unnecessary.		N/A
8.5.7	Direction of operation and indication of switching positions		N/A
	The operational positions of components and devices shall be clearly identified. Operational positions are the "on" and the "off" position (see 8.1 .6 of IEC 60947-1 :2020). A tripped position is not considered as an operational position and need not to be indicated. If the direction of operation is not in accordance with IEC 60447:2004, then the direction of operation shall be clearly identified.		N/A
8.5.8	Indicator lights and push-buttons		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Unless otherwise specified in the relevant product standard, the colours of indicator lights and push-buttons shall be in accordance with IEC 60073:2002.		P
8.5.9	Power factor correction banks		P
	For power factor correction banks incorporated in assemblies , the requirements of IEC 61 921 :201 7 shall be met.		P
8.6	Internal electrical circuits and connections		P
8.6.1	Main circuits		P
	The busbars (bare or insulated, see 3.1 .5) shall be arranged in such a manner that an internal short-circuit is not to be expected. They shall be rated at least in accordance with the requirements concerning the short-circuit withstand strength (see 9.3) and designed to withstand at least the short-circuit stresses limited by the protective device(s) on the supply side of the busbars.		P
	Within one section, the conductors (including distribution busbars) between the main busbars and the supply side of functional units – or in the case of a single section assembly, between the load terminals of the incoming device and the supply terminals of each outgoing SCPD – as well as the components included in these units, may be rated on the basis of the reduced short-circuit stresses occurring on the load side of the respective short-circuit protective device within each unit. This is provided that these conductors are arranged so that under normal operation, an internal short-circuit between live parts and/or between live parts and earth is not to be expected (see 8.6.4).		P
	The minimum cross-sectional area of the neutral conductor within a three-phase and neutral circuit shall be: – for circuits with a line conductor cross-sectional area up to and including 1 6 mm² , 100 % of that of the corresponding lines; – for circuits with a line conductor cross-sectional area above 1 6 mm² , 50 % of that of the corresponding lines with a minimum of 1 6 mm² .		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	It is assumed that the neutral: a) current does not exceed 50 % of the line currents; b) conductor is made of the same material as the line conductors. Where this is not the case, the neutral conductor shall have at least the same conductance or current carrying capacity as that provided when the neutral conductor is of the same material as the line conductors.		P
	For certain applications, which lead to high values of zero sequence harmonics (e.g. third order harmonics), higher cross-sections of the neutral conductor may be required as these harmonics of the lines are added in the neutral conductor and lead to high current load at higher frequencies. This is subject to special agreement between the assembly manufacturer and the user.		P
	The PEL, PEM and PEN conductors shall be dimensioned as specified in 8.4.3.2.3.		P
8.6.2	Auxiliary circuits		P
	The design of the auxiliary circuits shall take into account the auxiliary circuit(s) earthing and ensure that an earth fault shall not cause unintentional dangerous operation.		P
	In general, auxiliary circuits shall be protected against the effects of short-circuits. However, a short-circuit protective device shall not be provided if its operation is liable to cause a danger. In such a case, the conductors of auxiliary circuits shall be arranged in such a manner that a short-circuit is not to be expected (see 8.6.4).		P
8.6.3	Bare and insulated conductors		P
	The connections of current-carrying parts shall not suffer undue alteration as a result of normal temperature-rise, ageing of the insulating materials and vibrations occurring in normal operation. The effects of thermal expansion, electrolytic action in the case of dissimilar metals, and the ageing due to the temperatures attained shall be taken into consideration.		P
	Connections to devices mounted on doors or to other movable parts shall be made using flexible conductors, e.g. Class 5 or Class 6 according to IEC 60228:2004, to allow the movement of the part. The conductors shall be anchored to the fixed part and to the movable part independent of the electrical connection terminals.		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Connections between current-carrying parts shall be established by means that ensure a sufficient and durable contact pressure.		P
	If the verification of temperature-rise is carried out on the basis of tests (see 10.10.2), the selection of conductors and their cross-sections used inside the assembly shall be the responsibility of the original manufacturer. If verification of temperature-rise is made following the assessment rules of 10.10.4, the conductors shall have a minimum cross-section according to IEC 60364-5-52:2009. Examples on how to use this document for conditions inside an assembly are given in Tables H.1 and H.2. In addition to the current-carrying capacity of the conductors, the selection is governed by: - the mechanical stresses to which the assembly may be subjected; - the method used to lay and secure the conductors; - the type of insulation; - the type of components being connected (e.g. switchgear and controlgear in accordance with IEC 60947 series; electronic devices or equipment).		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	In the case of insulated solid or flexible conductors, the following criteria apply: - They shall be rated for at least the rated insulation voltage (see 5.2.3) of the circuit concerned. - Conductors connecting two termination points shall have no intermediate joint, e.g. spliced or soldered. - Conductors with only basic insulation shall be prevented from coming into contact with bare live parts at different potentials. - Contact of conductors with sharp edges shall be prevented. - Supply conductors to apparatus and measuring instruments in covers or doors shall be so installed that no mechanical damage can occur to the conductors as a result of movement of these covers or doors. - Soldered connections to apparatus shall be permitted in assemblies only in cases where provision is made for this type of connection on the apparatus and the specified type of conductor is used. - For apparatus other than those mentioned above, soldering cable lugs or soldered ends of stranded conductors are not acceptable under conditions of heavy vibration. In locations where, heavy vibrations exist during normal operation, for example in the case of dredger and crane operation, operation on board ships, lifting equipment and locomotives, attention should be given to the support of conductors. - Generally, only one conductor should be connected to a terminal clamping unit; the connection of two or more conductors to one terminal clamping unit is permissible only in those cases where the terminal clamping units are designed for this purpose.		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	– Conductors of different circuits may be laid side by side, may occupy the same duct (for example conduit, trunking system), or may be in the same multiconductor cable if the arrangement does not impair the proper functioning of the respective circuits. Where those circuits operate at different voltages, the conductors shall be separated by suitable barriers. Alternatively, all conductors within the same duct or any conductors in multicore cables shall be insulated for the highest voltage to which any conductor within the same duct can be subjected, for example line to line voltage for unearthed systems and line to earth voltage for earthed systems.		P
8.6.4	Selection and installation of non-protected live conductors to reduce the possibility of short-circuits		P
	Live conductors in an assembly that are not protected by short-circuit protective devices (see 8.6.1 and 8.6.2) shall be selected and installed throughout the entire assembly in accordance with Table 4. Non-protected live conductors selected and installed as in Table 4 shall have a total length not exceeding 3 m between the main busbar and each respective SCPD or, in the case of a single section assembly, between the load terminals of the incoming device and the supply terminals of each outgoing SCPD.		P
8.6.5	Identification of the conductors of main and auxiliary circuits		P
	Except for the cases mentioned in 8.6.6, the method and the extent of identification of conductors, for example by arrangement, colours or symbols, on the terminals to which they are connected or on the end(s) of the conductors themselves, is the responsibility of the assembly manufacturer and shall be in agreement with the indications on the wiring diagrams and drawings. Where appropriate, identification according to IEC 60445:201 7 shall be applied.		P
8.6.6	Identification of the protective conductor (PE, PEL, PEM, PEN) and of the neutral conductor (N) and the mid-point conductor (M) of the main circuits		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	The protective conductor (PE, PEL, PEM or PEN) shall be readily distinguishable by location and/or marking or colour. If identification by colour or marking is used it shall be in accordance with IEC 60445:201 7. When the protective conductor is an insulated single-core cable, this colour identification shall be used, preferably throughout the whole length.		P
	Any neutral or mid-point conductor of the main circuit shall be readily distinguishable by location and/or marking or colour (see IEC 60445:201 7 where blue is required).		P
8.6.7	Conductors in AC circuits passing through ferromagnetic enclosures or plates		P
	Where conductors in AC circuits with a current rating exceeding 200 A pass through ferromagnetic enclosures, sections or plates, they shall: - be arranged such that the conductors are only collectively surrounded by ferromagnetic material, e.g. pass through the same hole; or - arrangements where conductors pass through separate holes shall have been verified by temperature-rise test(s).		P
	It is permitted for an additional protective conductor to enter the ferrous enclosure individually.		P
8.7	Cooling		N/A
	If special precautions are required at the place of installation to ensure proper cooling, the assembly manufacturer shall furnish the necessary information (for instance indication of the need for spacing with respect to parts that are liable to impede the dissipation of heat or produce heat themselves).		N/A
8.8	Terminals for external cables		N/A
	Based on information from the original manufacturer, the assembly manufacturer shall indicate whether the terminals are suitable for connection of copper or aluminium conductors, or both. The terminals shall be such that the external conductors may be connected by a means (screws, connectors, etc.) that ensures that the necessary contact pressure corresponding to the current rating and the short-circuit strength of the apparatus and the circuit is maintained.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	In the absence of a specific information that larger cables are to be used, which require larger terminals, the terminals shall be capable of accommodating copper conductors from the smallest to the largest cross-sectional areas corresponding to the rated current of the circuit protective device I_n , (see Annex A). For adjustable protective devices, the rated current is the current setting selected.		N/A
	Where aluminium conductors are to be terminated, the type, size and termination method of the conductors shall be as agreed between the assembly manufacturer and the user.		N/A
	In the case where external conductors for electronic circuits with low-level currents and voltages (less than 1 A and less than 50 V AC or 1 20 V DC) have to be connected to an assembly, Table A.1 does not apply.		N/A
	The available wiring space shall permit proper connection of the external conductors of the indicated material and, in the case of multicore cables, spreading of the cores.		N/A
	The conductors shall not be subjected to stresses which are likely to reduce their normal life expectancy. In the absence of a specific information that larger cables are to be used, which require larger terminals, on three-phase and neutral circuits, terminals for the neutral conductor shall allow the connection of copper conductors having a minimum cross-sectional area: - equal to half the cross-sectional area of the line conductor, with a minimum of 16mm², if the size of the line conductor exceeds 16mm²; - equal to the full cross-sectional area of the line conductor, if the size of the latter is less than or equal to 16mm².		N/A
	For conductors, other than copper conductors, the above cross-sections should be replaced by cross-sections of equivalent conductance, which may require larger terminals.		N/A
	For certain applications, which lead to high values of zero sequence harmonics (e.g. third order harmonics), higher cross-sections of the neutral conductor may be required as these harmonics of the lines are added in the neutral conductor and lead to high current load at higher frequencies. This is subject to special agreement between the assembly manufacturer and the user.		N/A

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	If connecting facilities for incoming and outgoing neutral, mid-point, protective, PEL, PEM and PEN conductors are provided, they shall be arranged near the associated line conductor terminals.		N/A
	Openings in cable entries, cover plates, etc. shall be so designed that, when the cables are properly installed, the stated protective measures against contact and degree of protection shall be obtained. This implies the selection of means of entry suitable for the application as stated by the assembly manufacturer.		N/A
	The terminals for external protective conductors shall be marked according to IEC 60445:201 7. As an example, see graphical symbol  IEC 6041 7-501 9:2006-08-25. This symbol is not required where the external protective conductor is intended to be connected to an internal protective conductor that is clearly identified with the colours green and yellow.		P
	The terminals for external protective conductors (PE, PEL, PEM, PEN) and metal sheathing of connecting cables (steel conduit, lead sheath, etc.) shall, where required, be bare and, unless otherwise specified, suitable for the connection of copper conductors. A separate terminal of adequate size shall be provided for the outgoing protective conductor(s) of each circuit.		P
	In the absence of a specific information that larger cables are to be used, which require larger terminals, terminals for protective conductors shall allow the connection of copper conductors having a cross-section depending on the cross-section of the corresponding line conductors according to Table 5. Terminals for PEN conductors shall be the same as for neutral conductors.		P
	In the case of enclosures and conductors of aluminium or aluminium alloys, particular consideration shall be given to the danger of electrolytic corrosion. The connecting means to ensure the continuity of the conductive parts with external protective conductors shall have no other function.		N/A
	Special precautions can be necessary with metal parts of the assembly, particularly gland plates, where abrasion-resistant finishes, for example powder coatings, are used.		N/A

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Identification of terminals shall comply with IEC 60445:201 7 unless otherwise stated.		N/A
9	Performance requirements		P
9.1	Dielectric properties		P
9.1 .1	General		P
	Each circuit of the assembly shall be capable of withstanding: - temporary overvoltages; - transient overvoltages.		P
	The ability to withstand temporary overvoltages, and the integrity of solid insulation, is verified by the power-frequency withstand voltage and the ability to withstand transient overvoltages is verified by the impulse withstand voltage.		P
	In the case of variable frequency drives or converters, reflected voltage waves, recurring peak voltages and frequency can require special attention.		P
9.1.2	Power-frequency withstand voltage		P
	The circuits of the assembly shall be capable of withstanding the appropriate power-frequency withstand voltages given in Table 8 and Table 9 (see 10.9.2). The rated insulation voltage of any circuit of the assembly shall be equal to or higher than its maximum rated operational voltage.		P
	Enclosures and external operating handles manufactured from or covered with insulating materials shall be capable of withstanding the power frequency dielectric tests as given in 10.9.4 and 10.9.5.		P
	Conductors covered with insulating material to provide protection against electric shock shall be capable of withstanding the power frequency dielectric test as given in 10.9.6. This test is not required for insulated conductors which are verified to be suitably insulated according to their product standard (e.g. cables).		P
9.1.3	Impulse withstand voltage		P
9.1.3.1	Impulse withstand voltages of main circuits		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Clearances from live parts to exposed-conductive-parts and between live parts of different potential shall be capable of withstanding the test voltage given in Table 10 as appropriate for the rated impulse withstand voltage.		P
	The rated impulse withstand voltage for a given rated operational voltage shall not be less than that corresponding in Annex G to the type of supply system and the nominal voltage of the supply system of the circuit at the point where the assembly is to be used and the appropriate overvoltage category.		P
9.1.3.2	Impulse withstand voltages of auxiliary circuits		P
	a) Auxiliary circuits that are connected to the main circuit and operate at the rated operational voltage without any means for reduction of overvoltage shall comply with the requirements of 9.1 .3.1 .		P
	b) Auxiliary circuits that are not connected to the main circuit may have an overvoltage withstand capacity different from that of the main circuit. The clearances of such circuits - AC or DC - shall be capable of withstanding the appropriate impulse withstand voltage in accordance with Annex G.		P
9.1.4	Protection of surge protective devices		P
	When overvoltage conditions require surge protective devices (SPDs) to be connected to the main circuit, such SPDs shall be protected to prevent uncontrolled short-circuit conditions as specified by the SPD manufacturer.		P
	The installation of the SPD needs to respect the instructions of the SPD manufacturer, for example, the total length of conductors between the terminals of the SPD to the line and earth, as applicable.		P
9.2	Temperature-rise limits		P
9.2.1	General		P
	The assembly and its circuits shall be able to carry their rated currents under specified conditions (see 5.3.1 , 5.3.2, 5.3.3 and 5.4), taking into consideration the ratings of the components, their disposition and application, without exceeding the limits given in Table 6 when verified in accordance with 10.10. The temperature-rise limits given in Table 6 apply for a daily average ambient air temperature of 35 ° C.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	The temperature-rise of an element or part is the difference between the temperature of this element or part measured in accordance with 10.10.2.3.3 and the ambient air temperature outside the assembly. If the mean ambient air temperature is higher than 35 ° C, then the temperature-rise limits shall be adapted for this special service condition, so that the sum of the ambient air temperature and the individual temperature-rise limit remains the same. If the daily average ambient air temperature is lower than 35 ° C, the same adaptation of the temperature-rise limits is allowed subject to agreement between the user and the assembly manufacturer.		P
	In some cases, for example, manual operating means, accessible external covers and enclosures, higher temperatures are permitted, but not higher than maximum limits from Table 6. See Table 6, footnote h.		P
	The temperature-rise shall not cause damage to current-carrying parts or adjacent parts of the assembly. In particular, for insulating materials, the original manufacturer shall demonstrate compliance either by reference to the temperature index, for example, by the methods of IEC 6021 6 (all parts) or in accordance with IEC 60085:2007.		P
9.2.2	Adjustment of rated currents for alternative ambient air temperatures		P
	If the temperature-rise limits have been changed to cover a different ambient air temperature, then the rated currents of all busbars, functional units, etc. may need to be changed accordingly. The original manufacturer shall state the measures to be taken, if any, to ensure compliance with the temperature limits. If an adaptation for lower ambient air temperatures is made, then the rated currents of the devices published by the device manufacturers shall not be exceeded.		P
	If a temperature-rise test has been previously carried out applying the temperature-rise limits for a daily average ambient air temperature of 35 ° C, then, up to a daily average ambient air temperature of 50 ° C, the rated currents verified by test can be adjusted by calculation as given in 10.10.3.6.		P
9.3	Short-circuit protection and short-circuit withstand strength		P
9.3.1	General		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Assemblies shall be capable of withstanding the thermal and dynamic stresses resulting from short-circuit currents not exceeding the rated values.		P
	Assemblies shall be protected against short-circuit currents by means of, for example, circuit-breakers, fuses or combinations of both, which may either be incorporated in the assembly or arranged outside of it.		P
	For assemblies intended for use in IT systems, the short-circuit protective device should have a sufficient breaking capacity on each single pole at line-to-line voltage to clear a double earth fault. (See IEC 60364-5-53:2001 , IEC 60364-5-53:2001 /AMD1 :2002 and IEC 60364-5-53:2001 /AMD2:2015).		P
	Unless otherwise specified in the assembly manufacturer's operating and maintenance instructions, assemblies that have been subjected to a short-circuit may not be suitable for future service without inspection and/or maintenance by skilled person(s).		P
9.3.2	Information concerning short-circuit withstand strength		N/A
	For assemblies with a SCPD incorporated in the incoming unit, the assembly manufacturer shall declare the maximum allowable value of the prospective short-circuit current at the input terminals of the assembly. This value shall not exceed the appropriate rating(s) (see 5.3.4, 5.3.5, and 5.3.6). The corresponding power factor and peak values shall be those shown in 9.3.3.		N/A
	If a circuit-breaker with a time-delay release is used as the short-circuit protective device, the assembly manufacturer shall state the maximum time-delay and the current setting corresponding to the indicated prospective short-circuit current.		N/A
	For assemblies where the short-circuit protective device is not incorporated in the incoming unit, the assembly manufacturer shall indicate the short-circuit withstand strength in one or both of the following ways: a) rated short-time withstand current (I_{cw}) together with the associated duration (see 5.3.5) and rated peak withstand current (I_{pk}) (see 5.3.4); b) rated conditional short-circuit current (I_{cc}) including the current-limiting characteristics of the upstream SCPD (see 3.1.11).		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	For times up to a maximum of 3 s, the relationship between the rated short-time current and the associated duration is given by the formula $I^2t = \text{constant}$, provided that the peak value does not exceed the rated peak withstand current.		N/A
	For an assembly having several incoming units which are unlikely to be in operation simultaneously, the short-circuit withstand strength can be indicated for each of the incoming units in accordance with the above.		N/A
	For an assembly having several incoming units which are likely to be in operation simultaneously, and for an assembly having one incoming unit and one or more outgoing high-power units likely to contribute to the short-circuit current, it is necessary to determine the values of the prospective short-circuit current, considering all operating modes, in each incoming unit, in each outgoing unit and in the busbars. The prospective short-circuit currents determined shall be based on data provided by the user.		N/A
9.3.3	Relationship between peak current and short-time current		N/A
	For determining the electrodynamic stresses, the value of peak current shall be obtained by multiplying the RMS value for AC applications and mean value for DC applications of the short-circuit current by the factor n. The values for the factor n and the corresponding power factor for AC applications are given in Table 7. The peak factor for DC applications is subject to agreement between the manufacturer and the user.		N/A
9.3.4	Coordination of protective devices		N/A
	The coordination of protective devices within the Assembly with those to be used externally to The assembly shall be the subject of an agreement between the assembly manufacturer and the user. Information given in the assembly manufacturer's catalogue may take the place of such an agreement.		N/A
	If the operating conditions require maximum continuity of supply, the settings or selection of the short-circuit protective devices within the assembly should, where possible, be so coordinated that a short-circuit occurring in any outgoing circuit is cleared by the SCPD installed in the circuit without affecting the other outgoing circuits, thus ensuring selectivity of the protective system.		N/A

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Where short-circuit protective devices are connected in series and are intended to operate simultaneously to reach the required short-circuit switching capability (i.e. back-up protection), the assembly manufacturer shall inform the user (e.g. by a warning label in the assembly or in the operating instructions, see 6.2) that none of the protective devices are allowed to be replaced by another device which is not of identical type and rating, unless the device is tested and approved in combination with the back-up device since the switching capability of the whole combination can otherwise be compromised.		N/A
	Further guidance is given in IEC TR 61 91 2-1 :2007 and IEC TR 61 91 2-2:2009. See also 8.5.3.		N/A
9.4	Electromagnetic compatibility (EMC)		N/A
	For EMC-related performance requirements, see J.9.4.		N/A

10	Design verification		P
10.1	General		P
	Under the responsibility of the original manufacturer, all design verifications shall be carried out or supervised by a competent person.		P
	Design verification is intended to verify compliance of the design of an assembly or assembly system with the requirements of the IEC 61 439 series.		P
	Design verifications shall cover all declared mounting orientations.		P
	Where tests on the assembly have been conducted in accordance with the IEC 60439 series (withdrawn) or previous editions of the IEC 61 439 series, and the test results fulfil the requirements of the current edition of the relevant part of IEC 61 439 series, the verification of these requirements need not be repeated.		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Repetition of verifications in the product standards of switching devices or components including conductors incorporated in the assembly, which have been selected in accordance with 8.5.3 and installed in accordance with the instructions of their manufacturer is not required. Tests on individual devices and components including conductors to their respective product standards are not an alternative to the design verifications in this document for the assembly .		P
	If modifications are made to a verified assembly, Clause 10 shall be used to check if these modifications affect the performance of the assembly. New verifications shall be carried out if an adverse effect is likely.		P
	The various methods include: - verification testing; - verification comparison with a reference design(s); - verification assessment, i.e. confirmation of the correct application of calculations and design rules, including use of appropriate safety margins.		N/A
	See Annex D for the full list of design verifications to be covered.		N/A
	When there is more than one method for the same verification, they are considered equivalent and the selection of the appropriate method is the responsibility of the original manufacturer.		N/A
	The tests shall be performed on a representative sample of an assembly in a clean and new condition.		N/A
	The performance of the assembly may be affected by the verification tests (e.g. short-circuit test). These tests should not be performed on an assembly that is intended to be placed in service.		N/A

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	An assembly which is verified in accordance with this document by an original manufacturer (see 3.10.1) and manufactured or assembled by another does not require the original design verifications to be repeated if all the requirements and instructions specified and provided by the original manufacturer are met in full. Where the assembly manufacturer incorporates their own arrangements not included in the original manufacturer's verification, the assembly manufacturer is deemed to be the original manufacturer in respect of these arrangements and is responsible for verification of these alternate arrangements.		P
	a) Construction: 10.2 Strength of materials and parts; 10.3 Degree of protection of assemblies (IP Code); 10.4 Clearances and creepage distances; 10.5 Protection against electric shock and integrity of protective circuits; 10.6 Incorporation of switching devices and components; 10.7 Internal electrical circuits and connections; 10.8 Terminals for external conductors. b) Performance: 10.9 Dielectric properties; 10.10 Temperature-rise; 10.11 Short-circuit withstand strength; 10.12 Electromagnetic compatibility.		P
	The reference designs, the number of assemblies or parts thereof used for verification, the selection of the verification method when applicable, and the order in which the verification is carried out shall be at the discretion of the original manufacturer.		N/A
	The data used, calculations made, and comparisons undertaken for the verification of assemblies shall be recorded in verification reports.		N/A
1 0.2	Strength of materials and parts		N/A
1 0.2.1	General		P
	The mechanical, electrical and thermal capability of constructional materials and parts of the assembly shall be deemed to be proven by verification of construction and performance characteristics.		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Where an empty enclosure in accordance with IEC 62208:201 1 is used, and it has not been modified so as to degrade the performance of the enclosure, no repetition of the enclosure testing to 1 0.2 is required.		P
10.2.2	Resistance to corrosion		P
10.2.2.1	Verification by test		P
	The resistance to corrosion of representative samples of ferrous metallic enclosures, including internal and external ferrous metallic constructional parts of the assembly , shall be verified.		P
	The test shall be carried out on: - an enclosure or representative sample enclosure with representative internal parts in place and door(s) closed as in normal use, or - representative enclosure parts and internal parts separately.		P
	In all cases, hinges, locks and fastenings shall also be tested unless they have previously been subjected to an equivalent test and their resistance to corrosion has not been compromised by their application.		P
	Where the enclosure is subjected to the test, it shall be mounted as in normal use according to the original manufacturer's instructions.		P
	The test specimens shall be new and in a clean condition and shall be subjected to severity test A or B, as detailed in 1 0.2.2.2 and 1 0.2.2.3.		P
10.2.2.2	Severity test A		N/A
	This test is applicable to: - ferrous metallic indoor enclosures; - external ferrous metallic parts of indoor assemblies ; - internal ferrous metallic parts of indoor and outdoor assemblies upon which intended mechanical operation may depend.		N/A

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	The test consists of: six cycles of 24 h each to damp heat cycling test according to IEC 60068-2-30:2005 (Test Db) at $(40 \pm 2) ^\circ \text{C}$. Variant 1 or 2 to be selected as recommended by Annex A of IEC 60068-2-30:2005, followed by, two cycles of 24 h each to salt mist test according to IEC 60068-2-1 1 :1 981 (Test Ka: Salt mist) at a temperature of $(35 \pm 2) ^\circ \text{C}$.		N/A
10.2.2.3	Severity test B		N/A
	This test is applicable to: - ferrous metallic outdoor enclosures; - external ferrous metallic parts of outdoor assemblies		N/A
	The test comprises two identical 1 2-day periods.		N/A
	Each 1 2-day period comprises: five cycles of 24 h each to damp heat cycling test according to IEC 60068-2-30:2005 (Test Db) at $(40 \pm 2) ^\circ \text{C}$. Variant 1 or 2 to be selected as recommended by Annex A of IEC 60068-2-30:2005, followed by: seven cycles of 24 h each to salt mist test according to IEC 60068-2-1 1 :1 981 (Test Ka: Salt mist) at a temperature of $(35 \pm 2) ^\circ \text{C}$.		N/A
10.2.2.4	Results to be obtained		N/A
	After the test, the enclosure or samples shall be washed in running tap water for 5 min, rinsed in distilled or demineralized water, then shaken or subjected to an air blast to remove water droplets. The specimen under test shall then be stored under normal service conditions for 2h.		N/A

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Compliance is checked by visual inspection to determine that: - there is no evidence of cracking or other deterioration other than iron oxide as allowed by ISO 4628-3:201 6 for a degree of rusting Ri1 (considering the sample as a whole). However, surface deterioration of the protective coating is allowed. In case of doubt associated with paints and varnishes, reference shall be made to ISO 4628-3:201 6 to verify that the samples conform to the specimen Ri1 ; - the mechanical integrity is not impaired; - seals are not damaged; - doors, hinges, locks, and fastenings work without abnormal effort.		N/A
10.2.2.5	Verification by comparison to reference design		N/A
	Similar enclosures, enclosure parts and internal ferrous metallic parts, irrespective of their shape and size, are covered by the corrosion test on the representative samples if they are manufactured from the same materials and with the same surface treatments, using the same manufacturing process.		N/A
10.2.3	Properties of insulating materials		N/A
10.2.3.1	Thermal stability		N/A
1 0.2.3.1.1	Verification of thermal stability of enclosures by test		N/A
	The thermal stability of enclosures manufactured from insulating material shall be verified by the dry heat test. The test shall be carried out according to IEC 60068-2-2:2007 (Test Bb), at a temperature of 70 ° C, with natural air circulation, for a duration of 1 68 h and with a recovery of 96 h.		N/A
	Parts intended for decorative purposes that have no technical significance shall not be considered for the purpose of this test.		N/A
	The enclosure, mounted as in normal use, is subjected to a test in a heating cabinet with an atmosphere having the composition and pressure of the ambient air and ventilated by natural circulation. If the dimensions of the enclosure are too large for the available heating cabinet, the test may be carried out on a representative sample of the enclosure.		N/A
	The use of an electrically heated cabinet is recommended.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	Natural circulation may be provided by holes in the walls of the cabinet.		N/A
	The enclosure or sample shall show no crack visible to normal or corrected vision without additional magnification nor shall the material have become sticky or greasy, this being judged as follows: - With the forefinger wrapped in a dry piece of rough cloth, the sample is pressed with a force of 5 N.		N/A
	No traces of the cloth shall remain on the sample, and the material of the enclosure or the sample shall not stick to the cloth.		N/A
10.2.3.1.2	Verification of thermal stability of enclosures by comparison		N/A
	Enclosures or parts attached to the enclosure of same materials, same colour, same or greater thickness of the walls and same general construction, but with, for example, other dimensions, are covered by the test on the representative samples.		N/A
10.2.3.2	Verification of resistance of insulating materials to abnormal heat and fire due to internal electric effects		N/A
10.2.3.2.1	Verification by test		N/A
	The glow-wire test principles of IEC 60695-2-10:201 3 and the details given in IEC 60695-2-11 :201 4 shall be used to verify the suitability of the materials used: a) on parts of assemblies, or b) on specimens taken from these parts.		N/A
	The test shall be carried out on material with the minimum thickness used for the parts in a) or b).		N/A
	For a description of the test, see Clause 8 of IEC 60695-2-1 1 :201 4. The apparatus to be used shall be as described in Clause 5 of IEC 60695-2-11: 201 4.		N/A

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	The temperature of the tip of the glow-wire shall be as follows: - 960 ° C for parts necessary to retain current-carrying parts in position; - 850 ° C for enclosures to be installed in hollow walls; - 650 ° C for all other parts, including parts necessary to retain the protective conductor and enclosure parts intended to be embedded in and mounted on walls which are combustion-resistant.		N/A
	For small parts having surface dimensions not exceeding 14 mm × 14 mm, an alternative test may be used (e.g. needle flame test, according to IEC 60695-1 1 -5:2016). The same procedure may be applicable for other practical reasons where the metal material of a part is large compared to the insulating material.		N/A
10.2.3.2.2	Verification by comparison to a reference design		N/A
	If a part made from an identical material, having the same or greater thickness than the reference part that has already satisfied the requirements of 8.1.3.2.3, then the test need not be performed. It is the same for all parts which have been previously tested according to their own specifications.		N/A
10.2.3.2.3	Verification by assessment		N/A
	As an alternative, the original manufacturer shall provide data on the suitability of materials from the insulating material manufacturer to demonstrate compliance with IEC 60695-2-1 2 for the materials used and applicable temperature according to 10.2.3.2.1.		N/A
10.2.4	Resistance to ultraviolet (UV) radiation		N/A
10.2.4.1	Verification by test		N/A
	This test applies only to enclosures and external parts of assemblies intended to be installed outdoors and which are constructed of insulating materials or enclosures that are entirely coated by synthetic material. Representative samples of such parts shall be subjected to the following test.		N/A
10.2.4.1.1	Verification for enclosures and external parts of assemblies constructed of insulating materials		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	Test samples: – six test specimens of standard size according to ISO 1 78:201 0; and – six test specimens of standard size according to ISO 1 79-1 :201 0, ISO 1 79-2:1 997 and ISO 1 79-2:1 997/AMD:201 1 , shall be prepared. The test specimens shall be made under the same conditions as those used for the manufacture of the enclosure being considered.		N/A
	Test sequence: a) UV test on all twelve samples according to ISO 4892-2:201 3, Method A, Cycle 1 providing a total test period of 500 h. b) Verification of the flexural strength in accordance with ISO 1 78 (method A) with six of the samples. The surface of the sample exposed to UV radiation shall be turned face down and the pressure applied to the non-exposed surface. c) Verification of the Charpy impact in accordance with ISO 179 on the other six samples. No notches shall be cut into the sample and the impact shall be applied to the exposed surface.		N/A
	Results to be obtained: i) Samples shall not show cracks or deterioration visible to normal or corrected vision without additional magnification. ii) The flexural strength according to ISO 1 78 shall have 70 % minimum retention. iii) The Charpy impact according to ISO 1 79 shall have 70 % minimum retention. For materials whose impact bending strength cannot be determined prior to exposure because no rupture has occurred, not more than three of the exposed test specimens shall be allowed to break.		N/A
10.2.4.1 .2	Verification for enclosures and external parts of assemblies coated on their exposed surface(s) by synthetic material		N/A
	Test sample: Three representative samples of suitable size shall be tested. The test specimens shall be made under the same conditions as those used for the manufacture of the enclosure being considered.		N/A

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Test sequence: a) UV test on all three samples according to ISO 4892-2:2013, Method A, Cycle 1 providing a total test period of 500 h. b) Verification of the retention of the coating according to ISO 2409. Results to be obtained: The adherence of the synthetic material shall have a minimum retention of category 3 according to ISO 2409.		N/A
10.2.4.2	Verification by comparison to a reference design		N/A
	Enclosures and external parts made of the same insulating materials, irrespective of their shape and size, are covered by the test on the representative samples.		N/A
10.2.4.3	Verification by assessment		N/A
	As an alternative, the original manufacturer shall provide data on the suitability of materials of the same type and thickness or thinner from the insulating material supplier to demonstrate compliance with the requirements of 8.1.4.		N/A
10.2.5	Lifting		N/A
10.2.5.1	Verification by test		N/A
	If the original manufacturer makes provision for lifting other than by manual means, compliance is verified with the following tests.		N/A
	The maximum number of sections allowed by the original manufacturer to be lifted together shall be equipped with components and/or weights to achieve a weight of 1,25 times its maximum shipping weight. With doors closed, it shall be lifted with the specified lifting means and, in the manner, defined by the original manufacturer.		N/A
	From a standstill position, the transport unit shall be raised smoothly without jerking in a vertical plane to a height ≥ 1 m and lowered in the same manner to a standstill position. This test is repeated a further two times after which the transport unit is raised up and suspended clear of the floor for 30 min without any movement.		N/A

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Following the above test and using the same transport unit, the transport unit shall be raised smoothly without jerking from a standstill position to a height ≥ 1 m and moved (1.0 ± 0.5) m horizontally, then lowered to a standstill position. This sequence shall be carried out three times at uniform speed, each sequence being carried out within 1 min.		N/A
	After the test, with the test weights in place, the transport unit shall show no cracks or permanent distortions, visible to normal or corrected vision without additional magnification, that could impair any of its characteristics.		N/A
10.2.5.2	Verification by comparison to a reference design		P
	Enclosures with the same or equal constructional design and arrangements for lifting are verified if having an equal or lower weight than that tested as the representative sample.		P
10.2.6	Verification of protection against mechanical impact (IK code)		P
	Mechanical impact tests, where required by the specific assembly standard, are to be carried out in accordance with the test requirements of the specific assembly standard.		P
10.2.7	Marking		P
10.2.7.1	Verification by test		P
	Marking made by moulding, pressing, engraving or similar, including labels with a laminated plastic covering, shall not be submitted to the following test.		P
	The test is made by rubbing the marking by hand for 15 s with a piece of cloth soaked in water and then for 15 s with a piece of cloth soaked with petroleum spirit.		P
	After the test, the marking shall be legible to normal or corrected vision without additional magnification.		P
10.2.7.2	Verification by comparison to a reference design		P
	Markings of a same material and method of printing are covered by the tests completed on the reference samples.		P
10.2.8	Mechanical operation		P
10.2.8.1	Verification by test		P

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Clause	Requirement + Test	Result - Remark	Verdict
	This verification test shall not be made on such devices of the assembly which have already been type tested according to their relevant product standard (e.g. withdrawable circuit-breaker) unless their mechanical operation has been modified by their mounting arrangements differing from those given in the device manufacturer's instructions.		P
	For parts that need to be verified through testing (see 8.1 .5), intended mechanical operation shall be verified after installation in the assembly. The number of operating cycles shall be 200. Where a device has been tested in accordance with its own product standard, but the mounting arrangement is not in accordance with the manufacturer's instructions, the number of operations shall be in accordance with the product standard.		P
	At the same time, the operation of the mechanical interlocks associated with these movements shall be checked. The test is passed if the operating conditions of the apparatus, interlocks, the specified degree of protection and position indication, if any, have not been impaired and if the effort required for operation is practically the same as before the test. For devices that have specific operational criteria the device product standard and/or the manufacturer's instructions should be consulted.		P
1 0.2.8.2	Verification by comparison to a reference design		N/A
	Enclosures with the same or equal constructional solution for mechanical operation are covered by tests completed on the reference samples.		N/A
10.3	Degree of protection of assemblies (IP Code)		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	The degree of protection provided in accordance with 8.2.2, 8.2.3 and 8.4.2.3 shall be verified in accordance with IEC 60529:1 989, IEC 60529:1 989/AMD1 :1 999 and IEC 60529:1 989/AMD2:201 3; the test may be carried out on one representative equipped assembly in a condition stated by the original manufacturer . Where an empty enclosure in accordance with IEC 62208:201 1 or an assembly enclosure tested in accordance with the IEC 61 439 series is used, a verification assessment shall be performed to ensure that any external modification that has been carried out does not result in a deterioration of the degree of protection. Such an assessment can, for example, be a visual check to confirm that a device with a suitable degree of protection (IP code) has been installed in an opening in an enclosure in accordance with the device manufacturer's installation instructions. In this case, no further testing is required.		N/A
	Degree of protection (IP code) tests shall be carried out: - with all covers and doors in place and closed as in normal service, irrespective of whether they can be opened or removed, with or without the use of key or tool; - in a de-energized state (main and auxiliary circuits); - where the assembly is made up of multiple sections or is described as extendable, joined sections shall be included.		N/A
	Assemblies having a degree of protection of IP5X shall be tested according to category 2 in 13.4 of IEC 60529:1 989 and IEC 60529:1 989/AMD1 :1 999;		N/A
	Assemblies having a degree of protection of IP6X shall be tested according to category 1 in 13.4 of IEC 60529:1 989 and IEC 60529:1 989/AMD1 :1 999;		N/A
	The test device for IPX3 and IPX4 as well as the type of support for the enclosure during the IPX4 test shall be stated in the test report.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	The IPX1 test may be carried out by moving the drip box instead of rotating the assembly. If the dimensions of the surface of the assembly to be tested are larger than the dimensions of the drip box, the test shall be repeated as often as necessary to cover all relevant surfaces of the assembly. Each separate test shall take 1 0 min.		N/A
	Ingress of water in the IPX1 to IPX6 tests on an assembly is permissible only if its route of entry is obvious and the water is only in contact with the enclosure at a location where it will not reduce the clearance and creepage distances. If clearances and creepage distances are reduced, they shall not be below the minimum specified in Table 1 and Table 2, respectively.		N/A
	The IP5X test is deemed to be a failure if dust is visible on creepage paths housed within the enclosure and creepage distances are reduced below the minimum specified in Table 2, see IEC 60529:1989, 1 3.5.2.		N/A
10.4	Clearances and creepage distances		P
	It shall be verified that the clearances and creepage distances comply with the requirements of 8.3.		P
	The creepage distances shall be measured in accordance with Annex F.		P
	Clearances are verified by measurement according to Annex F or by test according to 1 0.9.3.		P
10.5	Protection against electric shock and integrity of protective circuits		P
10.5.1	General		P
	The effectiveness of the earth continuity and the protective circuit is verified for the following functions: 1) protection against the consequences of a fault within the class I assembly (internal faults) as outlined in 1 0.5.2; and 2) protection against the consequences of faults in external circuits supplied through the assembly (external faults) as outlined in 1 0.5.3.		P
10.5.2	Effective earth continuity between the exposed-conductive-parts of the class I assembly and the protective circuit		P

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Clause	Requirement + Test	Result - Remark	Verdict
	It shall be verified that the different exposed-conductive-parts of the assembly are effectively connected to the terminal for the incoming external protective conductor.		P
	Verification shall be made using a resistance-measuring instrument that is capable of driving a current of at least 10 A (AC or DC). The current is passed between each exposed-conductive-part and the terminal for the external protective conductor. The resistance shall not exceed 0,1 Ω .		P
	It is recommended to limit the duration of the test where low-current equipment is used; otherwise it can be adversely affected by the test.		P
10.5.3	Short-circuit withstand strength of the protective circuit		P
10.5.3.1	General		N/A
	The rated short-circuit withstand strength shall be verified. Verification may be carried out by a comparison to a reference design(s) (see 10.5.3.3 or 10.5.3.4) or with a test as detailed in 10.5.3.5.		N/A
	The original manufacturer shall determine the reference design(s) that will be used in 10.5.3.3 and 10.5.3.4.		N/A
10.5.3.2	Protective circuits that are exempted from short-circuit withstand verification		N/A
	Where a separate protective conductor is provided in accordance with 8.4.3.2.3, short-circuit testing is not required if one of the conditions of 10.1.1.2 is fulfilled.		N/A
10.5.3.3	Verification by comparison with reference designs - Using a checklist		N/A
	Verification is achieved when the comparison of the assembly to be verified with already tested designs using items 1 to 6 and 8 to 10 of the checklist given in Table 13 shows no deviations.		N/A
	To ensure the same current-carrying capacity for that portion of the fault current that flows through the exposed-conductive-parts, the design, number and arrangement of the parts that provide contact between the protective conductor and the exposed-conductive-parts shall be the same as in the reference design.		N/A
10.5.3.4	Verification by comparison with reference designs - Using calculation		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	Verification by comparison with reference designs based on calculation is to be carried out in accordance with 1 0.1 1 .4.		P
	To ensure the same current-carrying capacity for that portion of the fault current that flows through the exposed-conductive-parts, the design, number and arrangement of the parts that provide contact between the protective conductor and the exposed-conductive-parts shall be the same as in the reference design.		P
10.5.3.5	Verification by test		P
	Subclause 1 0.1 1 .5.6 applies.		P
10.6	Incorporation of switching devices and components		P
10.6.1	General		P
	Compliance with the design requirements of 8.5 for the incorporation of switching devices and components shall be confirmed by the original manufacturer's inspection.		P
10.6.2	Electromagnetic compatibility		N/A
	The performance requirements of J.9.4 for electromagnetic compatibility shall be confirmed by inspection or, where necessary, by testing (see 1 0.1 2).		N/A
10.7	Internal electrical circuits and connections		N/A
	Compliance with the design requirements of 8.6 for internal electrical circuits and connections shall be confirmed by the original manufacturer's inspection.		N/A
10.8	Terminals for external conductors		P
	Compliance with the design requirements of 8.8 for terminals for external conductors shall be confirmed by the original manufacturer's inspection.		P
10.9	Dielectric properties		P
10.9.1	General		P

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Clause	Requirement + Test	Result - Remark	Verdict
	For this test, all the electrical equipment of the assembly shall be connected, except those items of apparatus which, according to the relevant specifications, are designed for a lower test voltage; current-consuming apparatus (e.g. windings, measuring instruments, voltage surge suppression devices) in which the application of the test voltage would cause the flow of a current, shall be disconnected. Such apparatus shall be disconnected at one of their terminals unless they are not designed to withstand the full test voltage, in which case all terminals may be disconnected.		P
	For test voltage tolerances and the selection of test equipment, see IEC 61 1 80:201 6.		P
10.9.2	Power-frequency withstand voltage		P
10.9.2.1	Main and auxiliary circuits		P
	Main circuits and auxiliary circuits that are connected to the main circuit shall be subjected to the test voltage according to Table 8.		P
	Auxiliary circuits, whether AC or DC, that are not connected to the main circuit shall be subjected to the test voltage according to Table 9. This test is not carried out on auxiliary circuits: - which contain only insulated conductors with the appropriate insulation strength as stated by their manufacturers; and - which are protected by short-circuit protective devices with the rating not exceeding 1 6 A; and - if an electrical function test has been carried out previously at the rated operational voltage for which the auxiliary circuits are designed.		P
10.9.2.2	Test voltage		P
	Circuits intended for AC applications shall preferably be tested with an AC test voltage. Substitution of an AC voltage test by a DC voltage test should only be considered when the specimen does not allow testing with AC, e.g. in the case of filters, capacitors and similar, (see IEC 60664-1 :2007, 6.1 .3.4.1 , fifth paragraph).		P
	Circuits for DC applications shall be tested with AC or DC test voltages corresponding to the rated insulation voltage U _i .		P

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Clause	Requirement + Test	Result - Remark	Verdict
	Where an AC test voltage is used, it shall have a substantially sinusoidal waveform and a frequency equal to the rated frequency of the assembly with a tolerance of $\pm 25\%$. A DC test voltage shall have negligible ripple.		P
	The high-voltage source used for the test shall be so designed that, when the output terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current is sufficient to trip the overcurrent relay and it is greater than 100 mA.		P
	The overcurrent relay shall not trip when the output current is less than 100 mA.		P
	The value of the test voltage shall be that specified in Table 8 or Table 9 as appropriate with a permitted tolerance of $\pm 3\%$.		P
10.9.2.3	Application of the test voltage		P
	The test voltage at the moment of application shall not exceed 50 % of the full test value. It shall then be increased progressively to this full value and maintained for 60_{-0}^{+2} s as follows: a) between all live parts of the main circuit connected together (including the auxiliary circuits connected to the main circuit) and exposed-conductive-parts, with the main contacts of all switching devices in the closed position or bridged by a suitable low resistance link; b) between each live part of different potential of the main circuit and, the other live parts of different potential and exposed-conductive-parts connected together, with the main contacts of all switching devices in the closed position or bridged by a suitable low resistance link; c) between each auxiliary circuit not normally connected to the main circuit and the - main circuit; - other circuits; - exposed-conductive-parts.		P
10.9.2.4	Acceptance criteria		P
	The overcurrent relay shall not operate and there shall be no disruptive discharge (see 3.6.1 7) during the tests.		P
10.9.3	Impulse withstand voltage		P
10.9.3.1	General		P

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Clause	Requirement + Test	Result - Remark	Verdict
	Verification shall be made by test or by assessment.		P
	In place of the impulse withstand voltage test of 1 0.9.3.2, the original manufacturer may perform, at their discretion, an equivalent AC or DC voltage test, in accordance with 1 0.9.3.3 or 1 0.9.3.4.		P
10.9.3.2	Impulse withstand voltage test		P
	The impulse voltage generator shall be adjusted to the required impulse voltage with the assembly connected. The value of the test voltage shall be that specified in 9.1 .3. The tolerance of the applied peak voltage shall be $\pm 3\%$. When the manufacturer agrees, the positive tolerance of the test voltage may be exceeded.		P
	Auxiliary circuits not connected to main circuits shall be connected to the earth for the tests a) and b) below. The 1 ,2/50 μ s impulse voltage shall be applied to the assembly five times for each polarity at intervals of 1 s minimum as follows: a) between all the live parts of different potential of the main circuit connected together (including the auxiliary circuits connected to the main circuit) and exposed-conductive-parts, with the main contacts of all switching devices in the closed position or bridged by a suitable low-resistance link; b) between each live part of different potential of the main circuit and the other live parts of different potential and exposed-conductive-parts connected together, with the main contacts of all switching devices in the closed position or bridged by a suitable low-resistance link; c) between each auxiliary circuit not normally connected to the main circuit and the - main circuit; - other circuits; - exposed-conductive-parts.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	This test is not carried out on auxiliary circuits: - which contain only insulated conductors with the appropriate insulation strength as stated by their manufacturers; and - which are protected by short-circuit protective devices with a rating not exceeding 16 A; and - if an electrical function test has been made previously at the rated operational voltage for which the auxiliary circuits are designed.		P
	For an acceptable result, there shall be no disruptive discharge during the impulse voltage tests.		P
	Some conductor arrangements retain a considerable charge after an impulse test, and for these cases care should be taken when reversing the polarity. To allow the arrangement to discharge, the use of appropriate methods, such as the application of three impulses at about 80 % of the test voltage in the reverse polarity before the test, is recommended.		P
10.9.3.3	Alternative power-frequency voltage test		P
	The test voltage shall have a substantially sinusoidal waveform at the rated frequency with a tolerance of $\pm 25\%$.		P
	The high-voltage source used for the test shall be so designed that, when the output terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current is sufficient to trip the overcurrent relay and it is greater than 100 mA.		P
	The overcurrent relay shall not trip when the output current is less than 100 mA.		P
	The value of the test voltage shall be that specified in 9.1.3 and Table 10 as appropriate with a permitted tolerance of $\pm 3\%$.		P
	The power-frequency voltage shall be applied once, at full value, for three cycles (see IEC 60664-1:2007, 6.1.2.2.2.2). It shall be applied to the assembly in the manner described in 10.9.3.2 a), b) and c) above.		P
	For an acceptable result, the overcurrent relay shall not operate and there shall be no disruptive discharge during the tests.		P
10.9.3.4	Alternative DC voltage test		P

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Clause	Requirement + Test	Result - Remark	Verdict
	The test voltage shall have negligible ripple.		P
	The high-voltage source used for the test shall be so designed that, when the output terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current is sufficient to trip the overcurrent relay and it is greater than 1 00 mA.		P
	The overcurrent relay shall not trip when the output current is less than 1 00 mA.		P
	The value of the test voltage shall be that specified in 9.1 .3 and Table 1 0 as appropriate with a permitted tolerance of $\pm 3 \%$.		P
	The DC voltage shall be applied three times for each polarity for a duration of 1 0 ms (see IEC 60664-1 :2007, 6.1 .2.2.2.3).		P
	It shall be applied to the assembly in the manner described in 1 0.9.3.2 a) and b) above.		P
	For an acceptable result the overcurrent relay shall not operate and there shall be no disruptive discharge during the tests.		P
10.9.3.5	Verification assessment		P
	Clearances shall be verified by measurement, or verification of measurements on design drawings, employing the measurement methods stated in Annex F. The clearances shall be at least 1 ,5 times the values specified in Table 1 .		P
	It shall be verified by assessment of the device manufacturer's data that all incorporated devices are suitable for the specified rated impulse withstand voltage (U_{imp}).		P
10.9.4	Testing of enclosures made of insulating material		P
	For assemblies with enclosures made of insulating material, an additional dielectric test shall be carried out by applying an AC test voltage between a metal foil laid on the outside of the enclosure over openings and joints, and the interconnected live and exposed-conductive-parts within the assembly located next to the openings and joints. For this additional test, the test voltage shall be equal to 1 ,5 times the values indicated in Table 8.		P
10.9.5	External door or cover mounted operating handles of insulating material		P

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Clause	Requirement + Test	Result - Remark	Verdict
	In the case of handles made of or covered by insulating material, a power-frequency withstand voltage test shall be carried out by applying a test voltage equal to 1,5 times the test voltage indicated in Table 8 between the live parts and a metal foil wrapped round the whole surface of the representative handle. During this test, the exposed-conductive-parts shall not be earthed or connected to any other circuit.		P
10.9.6	Testing of conductors and hazardous live parts covered by insulating material to provide protection against electric shock		P
	Conductors and hazardous live parts covered by insulating material in direct contact with the conductor so as to provide protection against electric shock, excluding those previously verified to their own product standard (e.g. cables), shall be subjected to an additional dielectric test. This test shall be carried out by applying an AC test voltage between a metal foil laid on the outside of the conductor insulation including openings and joints in the insulation, and the interconnected conductive parts within the insulation. For this additional test, the test voltage shall be equal to 1,5 times the values indicated in Table 8.		P
10.10	Temperature-rise		P
10.10.1	General		P
	It shall be verified that the temperature-rise limits specified in 9.2 for the different parts of the assembly or assembly system will not be exceeded.		P
	Verification shall be made with one or more of the following methods (see Annex L for guidance): a) testing (10.1.0.2); b) comparison with a reference design (10.1.0.3); c) assessment (calculation) (10.1.0.4).		P
	In assemblies rated for frequencies above 60 Hz verification of temperature-rise by test (10.1.0.2) or by derivation from a similar design tested at the same intended frequency (10.1.0.3) is always required.		P
	The current-carrying capacity of the circuits to be verified is determined by;		P

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Clause	Requirement + Test	Result - Remark	Verdict
	- the group rated current of a main circuit I_{ng} (see 5.3.3); or - the rated current of the main circuit I_{nc} (see 5.3.2) and the RDF (see 5.4).		N/A
	For assemblies incorporating power factor correction banks, verification of temperature-rise shall meet the additional requirements of IEC 61921 :2017.		N/A
10.10.2	Verification by testing		N/A
10.10.2.1	General		N/A
	Verification through testing consists of the following.		N/A
	a) If the assembly system to be verified comprises a number of variants, the most onerous arrangement(s) for the assembly system shall be selected according to 10.10.2.2. b) The assembly variant(s) selected shall be verified by one of the following methods (see Annex L): 1) considering individual functional units, the main and distribution busbars and the assembly collectively according to 10.10.2.3.5; 2) considering individual functional units separately, and the complete assembly including the main and distribution busbars according to 10.10.2.3.6; 3) considering individual functional units and the main and distribution busbars separately as well as the complete assembly according to 10.10.2.3.7. c) When the assembly variant(s) tested are the most onerous variants of an assembly system, then the test results can be used to establish the ratings of similar variants without further testing. Comparison rules for such derivations are given in 10.10.3.		N/A
10.10.2.2	Selection of the representative arrangement		N/A
10.10.2.2.1	General		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	The test shall be made on one or more representative arrangements loaded with one or more representative load combinations chosen to determine with reasonable accuracy the maximum temperature-rise under normal operating and installation conditions. The selection of the representative arrangements to be tested is given in 1 0.1 0.2.2.2 and 1 0.1 0.2.2.3 and is the responsibility of the original manufacturer. The original manufacturer shall take into consideration in the selection for testing the configurations to be derived from the tested arrangements according to 1 0.1 0.3.		N/A
10.10.2.2.2	Busbars		N/A
	For busbar systems consisting of single or multiple rectangular sections of conductor, where the variants differ only in the reduction of one or more of; - height, - thickness, - quantity of bars per conductor, and have the same; - geometric arrangement of bars, - centre line spacing of conductors, - enclosure, and - busbar compartment (if any), the busbars with the greatest cross-sectional area shall be selected as the representative arrangement as a minimum for the test. For ratings of smaller busbar size variants or other materials, see 1 0.1 0.3.3.		N/A
10.10.2.2.3	Functional units		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	a) Selection of comparable functional unit groups Functional units intended to be used at different rated currents can be considered to have a similar thermal behaviour and form a comparable range of units if they fulfil the following conditions: 1) the function and basic wiring diagram of the main circuit is the same (e.g. incoming unit, reversing starter, cable feeder); 2) the devices are of the same frame size and belong to the same series; 3) the mounting structure is of the same type; 4) the mutual arrangement of the devices is the same; 5) the type and arrangement of conductors is the same; 6) the cross-section of the main circuit conductors within a functional unit shall have a rating at least equal to that of the lowest rated device in the circuit. Selection of cables shall be as tested or in accordance with IEC 60364-5-5:2009. Examples on how to adapt this document for conditions inside an assembly are given in Table H.1 and Table H.2. The cross-section of bars shall be as tested or as given in Annex K.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	b) Selection of a critical variant out of each comparable group as a specimen for test The maximum possible current rating for each variant of functional unit is established. For functional units containing only one device, this is the rated current of the device. For functional units with several devices, it is that of the device with the lowest rated current. For each functional unit, the power loss is calculated at the maximum possible current using the data given by the device manufacturer for each device together with the power losses of the associated conductors. For functional units with currents up to and including 630 A, the critical unit in each range is the functional unit with the highest total power loss. For functional units with currents above 630 A, the critical unit in each range is that which has the highest rated current. This ensures that additional thermal effects relating to eddy currents and current displacement are taken into consideration. The critical functional unit shall at least be tested: - inside the smallest compartment (if any) which is intended for this functional unit; and - with the worst variant of internal separation (if any) with respect to size of ventilation openings; and - with the enclosure with the highest installed power loss per volume; and - with the worst variant of ventilation of the enclosure with respect to the kind of ventilation (natural or forced convection) and size of ventilation openings.		N/A
	If the functional unit can be arranged in different orientations (horizontal, vertical), then the most onerous arrangement shall be tested.		N/A
	Additional tests may be made at the discretion of the original manufacturer for less critical arrangements and variants of functional units, if any.		N/A
10.10.2.3	Methods of test		P
10.10.2.3.1	General		P

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Clause	Requirement + Test	Result - Remark	Verdict
	In 1 0.1 0.2.3.5 to 1 0.1 0.2.3.7, three methods of testing are given, which differ in the number of tests needed and in the range of applicability of the test results. 1 0.1 0.2.3.5 provides a means of testing a complete assembly where the group rated current I_{ng} is the test result. 1 0.1 0.2.3.6 provides a means of testing an assembly where additionally the rated current I_{nc} of the outgoing circuits is determined with fewer tests than specified in 1 0.1 0.2.3.7. An explanation is provided in Annex L.		P
	The temperature-rise test on the individual circuits shall be made with the type of current for which they are intended, and at the design frequency. Any convenient value of the test voltage may be used to produce the desired current. Current consuming items such as, electronic components, coils of relays, contactors, releases, etc. shall be supplied with their rated operational voltages.		P
	For assemblies with active cooling, the cooling equipment shall be operational, as in normal service.		P
	The assembly shall be mounted as in normal use, with all covers including bottom cover plates, etc. in place.		P
	If the assembly includes fuses, it shall be fitted for the test with fuse-links as specified by the manufacturer.		P
	Details of the fuse-links used for the test, i.e. the manufacturer's name and reference, the rated current, the power loss of the fuse-link, and the breaking capacity, shall be given in the test report. The type test with the specified fuse-links shall be deemed to cover the use of any other fuse-link having a power loss, at the conventional thermal current of the combination unit, not exceeding the power loss of the fuse-link used for the test.		P
	The size and the disposition of external conductors used for the test shall be stated in the test report.		P
	The test shall be carried out for a time sufficient for the temperature-rise to reach a constant value. In practice, this condition is reached when the variation at all measured points (including the ambient air temperature) does not exceed 1 K/h.		P
	To shorten the test, if the devices allow it, the current may be increased during the first part of the test, with it being reduced to the specified test current afterwards.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	When a control electro-magnet is energized during the test, the temperature is measured when thermal equilibrium is reached in both the main circuit and the control electro-magnet.		P
	The average value of the actual incoming test currents shall be between 1 00 % and 1 03 % of the intended value. Each phase shall be within ± 5 % of the intended value.		P
	Tests on an individual section of the assembly are acceptable. To make the test representative, the external surfaces at which additional sections may be connected shall be thermally insulated with a covering to prevent any undue cooling.		P
	When the performance of a single functional unit in one compartment is being tested as part of a complete assembly (or part of an assembly) as required by 1 0.1 0.2.3.7 d) taking into account the influence of other functional units in their own compartments, these other functional units can be replaced by heating resistors if the rating of each does not exceed 630 A and their rating is not to be verified with this test.		P
	In assemblies where there is a possibility that additional auxiliary circuits or devices may be incorporated, heating resistors shall simulate the power dissipation of these additional items.		P
	To reduce the testing required to determine the rated current of a circuit I 1 at the maximum permissible temperature-rise $\Delta T 1$, the current rating may be calculated from the actual test current I 2 if the measured temperature-rise $\Delta T 2$ of the current carrying parts (e.g. busbars and terminals) deviates from the permissible value by not more than ± 5 K		P
	The formula can only be applied if the power loss of the devices and conductors is substantially proportional to I^2 .		P
	Care shall be taken to ensure that all other measurement points will not reach their maximum temperature at this higher current. Any adjusted current ratings shall be clearly identified in the test documentation by the recording of results obtained during the test. Care is required when determining the number of points where this calculation is applied so as to ensure the effects of changing several currents having an influence on other measuring points (including internal air temperature) due to the changed power loss.		P

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Clause	Requirement + Test	Result - Remark	Verdict
10.10.2.3.2	Test conductors		P
	n the absence of detailed information concerning the external conductors and the service conditions, the cross-section of the external test conductors shall be chosen considering the rated current of each circuit as follows:		P
	a) For values of rated current up to and including 400 A: 1) The conductors shall be single-core, copper cables or insulated wires with cross-sectional areas as given in Table 1 1 ; 2) As far as practicable, the conductors shall be in free air; 3) The minimum length of each temporary connection from terminal to terminal shall be: - 1 m for cross-sections up to and including 35 mm ² ; - 2 m for cross-sections larger than 35 mm ² .		P
	b) For values of rated current higher than 400 A but not exceeding 1 600 A: 1) The conductors shall be single-core copper cables with cross-sectional areas as given in Table 1 2, or the equivalent copper bars given in Table 1 2 as specified by the original manufacturer. 2) Cables or copper bars shall be spaced at approximately the distance between terminals. Multiple parallel cables per terminal shall be bunched together and arranged with approximately 10 mm of air space between each other. Multiple copper bars per terminal shall be spaced at a distance approximately equal to the bar thickness. If the sizes stated for the bars are not suitable for the terminals or are not available, it is permissible to use other bars having the same cross-sectional dimensions $\pm 10\%$ and the same or smaller cooling surfaces. Cables or copper bars shall not be interleaved. 3) For single-phase or multi-phase tests, the minimum length of any temporary connection to the test supply shall be 2 m. The minimum length to a star point may be reduced to 1,2 m where agreed by the original manufacturer.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	c) For values of rated current higher than 1 600 A but not exceeding 7000 A: 1) The conductors shall be copper bars of the sizes stated in Table 1 2 unless the assembly is designed only for cable connection. In this case, the size and arrangement of the cables shall be as specified by the original manufacturer. 2) Copper bars shall be spaced at approximately the distance between terminals. Multiple copper bars per terminal shall be spaced at a distance approximately equal to the bar thickness. If the sizes stated for the bars are not suitable for the terminals or are not available, it is permissible to use other bars having the same cross-sectional dimensions $\pm 10\%$ and the same or smaller cooling surfaces. Copper bars shall not be interleaved. 3) For single-phase or multi-phase tests, the minimum length of any temporary connection to the test supply shall be 3 m, but this can be reduced to 2 m provided that the temperature-rise at the supply end of the connection is not more than 5 K below the temperature-rise in the middle of the connection length. The minimum length to a star point shall be 2 m.		P
	d) For values of rated current higher than 7000 A: The original manufacturer shall determine all relevant items of the test, such as type of supply, number of lines and frequency (where applicable), cross-sections of test conductors, etc. This information shall form part of the test report.		P
10.10.2.3.3	Measurement of temperatures		P
	Thermocouples or thermometers shall be used for temperature measurements. For windings, the method of measuring the temperature by resistance variation shall generally be used. In cases where this is not practical, thermocouples may be used to determine the temperature-rise on the surface of the coil.		P
	The thermometers or thermocouples shall be protected against air currents and heat radiation.		P
	The temperature shall be measured at all points where a temperature-rise limit (see 9.2) shall be observed. Particular attention shall be given to joints in conductors and terminals within the main circuits. For measurement of the temperature of the air inside an assembly, several measuring devices shall be arranged in convenient places.		P

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Clause	Requirement + Test	Result - Remark	Verdict
10.10.2.3.4	Ambient air temperature		P
	The ambient air temperature shall be measured by means of at least two thermometers or thermocouples equally distributed around the assembly at approximately half its height and at a distance of approximately 1 m from the assembly. The thermometers or thermocouples shall be protected against air currents and heat radiation.		P
	The ambient air temperature during the test shall be between +10 °C and +40 °C.		P
10.10.2.3.5	Verification of the complete assembly		P
	The main circuits of the assembly shall be loaded with their estimated group rated currents, I_{ng} , (see 5.3.3) (see Annex L).		P
	If the group rated current, I_{ng} , of the incoming circuit or distribution busbar system is less than the sum of the group rated currents, I_{ng} , of all outgoing circuits, then the outgoing circuits shall be split into test sets corresponding to the group rated current of the incoming circuit or distribution busbar system. The test sets shall be formed in a manner so that the highest possible temperature-rise is obtained. Enough test sets shall be formed and tests undertaken to include all different variants of functional units in at least one test set.		P
	Where the fully-loaded circuits do not distribute exactly the total incoming current, the remaining current shall be distributed via any other appropriate circuit. This test shall be repeated until all types of outgoing circuit have been verified at their group rated currents.		P
	Change in the arrangement of functional units within a verified assembly, or section of an assembly, may necessitate additional tests as the thermal influence of the adjacent units may differ significantly.		P
10.10.2.3.6	Verification considering individual functional units separately and the complete assembly		P

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Clause	Requirement + Test	Result - Remark	Verdict
	The group rated currents, I_{ng}, according to 5.3.3 and the rated currents, I_{nc}, of the outgoing main circuits according to 5.3.2 shall be verified in two stages: - The rated current, I_{nc}, of each critical variant of outgoing functional unit as defined in 1 0.1 0.2.2.3 b) shall be verified separately in accordance with 1 0.1 0.2.3.7 c). - The assembly is verified by loading the incoming circuit and all outgoing functional units collectively to their estimated group rated currents, I_{ng}.		P
	If the group rated current, I_{ng}, of the incoming circuit or distribution busbar system is less than the sum of the currents, I_{ng}, of all outgoing circuits, then the outgoing circuits shall be split into test sets corresponding to the group rated current of the incoming circuit or distribution busbar system. The test sets shall be formed in a manner so that the highest possible temperature-rise is obtained. Sufficient test sets shall be formed and tests undertaken to include all different variants of functional units in at least one test set.		P
	Where the fully loaded circuits do not distribute exactly the total incoming current, the remaining current shall be distributed via any other appropriate circuit. This test shall be repeated until all types of outgoing circuit have been verified at their test current.		P
	Change in the arrangement of functional units within a verified assembly, or section of an assembly, may necessitate additional tests as the thermal influence of the adjacent units may differ significantly.		P
	If I_{nc} and I_{ng} are verified, the RDF is calculated by dividing I_{ng} by I_{nc} for the individual circuits being considered.		P
10.10.2.3.7	Verification considering functional units and the main and distribution busbars separately as well as the complete assembly		P
	Assemblies shall be verified by separate verification of standard elements a) to c) as selected in accordance with 1 0.1 0.2.2.2 and 1 0.1 0.2.2.3, and verification of a complete assembly d) under worst case conditions as detailed below.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	a) Main busbars shall be tested separately. They shall be mounted in the assembly enclosure as in normal use with all covers and all partitions that separate the main busbars from other compartments in place. If the main busbar has joints, then they shall be included in the test. The test shall be carried out at the rated current. The test current shall pass through the full length of the busbars. Where the design of the assembly permits, and, to minimize the influence of the external test conductors on the temperature-rise, the length of the main busbar within the enclosure for the test shall be a minimum of 2 m and include a minimum of one joint when the busbars are extendable.		P
	b) Each distribution busbar shall be tested separately from the outgoing units. They shall be mounted in the enclosure as in normal use with all covers and all partitions that separate the busbar from other compartments in place. Distribution busbars shall be connected to the main busbar. No other conductors (e.g. connections to functional units) shall be connected to the distribution busbar. In order to consider the most onerous condition, the test shall be carried out at the rated current, and the test current shall pass through the full length of the distribution busbar. If the rated current of the main busbar is higher than the test current, it shall be fed with additional current so that it carries its rated current to its junction with the distribution busbar.		P
	c) If the manufacturer declares I_{nc} , the relevant functional units shall be tested individually. The functional unit shall be mounted in the enclosure as in normal use with all covers and all internal partitions in place. If it can be mounted at different places, the most unfavourable place shall be used. It shall be connected to the main or the distribution busbar as in normal use. If the main busbar and/or the distribution busbar (if any) are intended to supply other circuits and they are rated for a higher current, they shall be fed with additional currents so that they carry their individual rated currents to the respective junction points. The test shall be carried out at the estimated rated current I_{nc} for the functional unit.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	d) The complete assembly shall be verified by temperature-rise testing of the most onerous arrangement(s) possible in service and as defined by the original manufacturer. For this test the incoming circuit and each outgoing functional unit are loaded to their group rated current I_{ng} where I_{ng} is equal to I_{nc} multiplied by RDF when I_{nc} is declared. If the group rated current of the incoming circuit or distribution busbar system is less than the sum of the test currents of all outgoing circuits (i.e. their group rated currents), then the outgoing circuits shall be split into test sets corresponding to the rated current of the incoming circuit or distribution busbar system. If the main busbar and/or the distribution busbar (if any) are rated for a higher current, they shall be fed with additional currents so as to maintain the rating achieved in a) and b). The test sets shall be formed in a manner so that the highest possible temperature-rise is obtained. Enough test sets shall be formed and tests undertaken to include all different variants of functional units in at least one test set.		P
	If I_{nc} and I_{ng} , are verified the RDF is calculated by dividing I_{ng} by I_{nc} for the individual circuits being considered.		P
10.10.2.3.8	Results to be obtained		P
	The estimated rated currents in 1 0.1 0.2.3.5, 1 0.1 0.2.3.6 and 1 0.1 0.2.3.7, as verified by test(s), determine the final I_{nc} and/or I_{ng} , as applicable.		P
	At the end of the test, the temperature-rise shall not exceed the values specified in Table 6.		P
	If tests according to 1 0.1 0.2.3.6 or 1 0.1 0.2.3.7 have been carried out to verify I_{nc} in addition to I_{ng} , for the outgoing circuits, then the rated diversity factor may be calculated (see 3.8.1 1 and 5.4).		P
10.10.3	Verification by comparison		P
10.10.3.1	General		P
	The following subclauses define how the rated currents of variants can be verified by derivation from similar arrangements verified by testing.		P
	Tests carried out at a particular frequency are applicable at the same current rating to lower frequencies including DC.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	Temperature-rise tests on the circuit(s) carried out at 50 Hz are applicable to 60 Hz for rated currents up to and including 800 A. In the absence of tests at 60 Hz for currents above 800 A, the rated current at 60 Hz shall be reduced to 95 % of that at 50 Hz. Alternatively, where the maximum temperature-rise at 50 Hz does not exceed 90 % of the permissible value, then de-rating for 60 Hz is not required.		P
10.10.3.2	Assemblies		N/A
	Assemblies verified by derivation from a similar tested arrangement shall comply with the following: a) the functional units shall belong to the same group(s) as the functional unit(s) selected for test (see 1 0.1 0.2.2.3); b) the same type of construction as used for the test; c) the same or increased overall dimensions as used for the test; d) the same or increased cooling conditions as used for the test (forced or natural convection, same or larger ventilation openings); e) the same or reduced internal separation as used for the test (if any); f) the same or reduced power losses in the same section as used for the test.		N/A
	The assembly being verified may comprise all or only part of the electrical circuits of the assembly previously verified. Alternative arrangement(s) of functional units within the assembly or section compared to the tested variant is allowed as long as the thermal influences of the adjacent units are not more severe.		N/A
	Thermal tests performed on 3-phase, 3-wire assemblies are considered as representing 3-phase, 4-wire and single-phase, 2-wire or 3-wire assemblies, provided that the neutral conductor is sized equal to or greater than the line conductors and arranged in the same manner.		N/A
1 0.10.3.3	Busbars		N/A
	Ratings established for aluminium busbars are valid for copper busbars with the same cross-sectional dimensions and configuration. However, ratings established for copper busbars shall not be used to establish ratings of aluminium busbars.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	The ratings of variants not selected for test according to 1 0.1 0.2.2.2 shall be determined by multiplying their cross-section with the current density of a larger cross-section busbar of the same design that has been verified by testing.		N/A
	If, additionally, a smaller cross-section than the one to be derived has been tested, which also fulfils the conditions of 1 0.1 0.2.2.2, then the rating of the intermediate variants may be established by interpolation.		N/A
	Modification of the connection between main and distribution busbar is permissible if the modification is verified by a test in which the temperature-rise in the new arrangement is not higher than in a comparable test on the reference design.		N/A
10.1 0.3.4	Functional units		N/A
	After the critical variant of each group of comparable functional units (see 1 0.1 0.2.2.3 a)) has been subjected to a test for verification of temperature-rise, the actual rated currents I_{ng} , and if determined, I_{nc} , of all other functional units in the group shall be calculated using the results of these tests.		N/A
	For each functional unit tested, a de-rating factor (rated current, I_{nc} or I_{ng} , resulting from the test divided by the maximum possible current of this functional unit, see 1 0.1 0.2.2.3 b)) shall be calculated.		N/A
	The rated current, I_{nc} or I_{ng} , of each non-tested functional unit in the range shall be the maximum possible current of the functional unit multiplied by the de-rating factor established for the variant tested in the range.		N/A
	Modification of the connection between functional unit and the main or distribution busbar is permissible if the modification is verified by a test in which the temperature-rise in the new arrangement is not higher than in a comparable test on the reference design.		N/A
10.10.3.5	Functional units – Temperature-rise considerations for device substitution		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	A device with a rated current I_n not exceeding 1 600 A may be substituted with a similar device from another series from the same or a different device manufacturer to that used in the original verification, provided that the power loss and terminal temperature-rise of the substituting device is the same as or lower than the device used in the original verification, when both are tested in accordance with the devices' product standard.		N/A
	Alternatively, and without a limit on current rating, when the original device and the substituting device are from the same device manufacturer, the device manufacturer may issue a declaration of temperature-rise performance. The declaration shall confirm that the substituting device can replace the original device with no further need for verification in respect of temperature-rise. The declaration shall include statements indicating that the power loss for the substituting device is the same or lower than the original device.		N/A
	In addition, for both the above options the physical arrangement within the functional unit shall be maintained. The rating of a functional unit shall not be increased.		N/A
	The physical arrangements shall include terminal shields, conductor type, material, and connection sizes, mounting orientation, clearances to other parts, ventilation arrangements and terminal arrangement.		N/A
	The performance data on terminal temperatures and power loss may be obtained from the device manufacturer or from comparison tests undertaken by those responsible for the substitution. Any test shall be conducted on new samples.		N/A
	Refer to Table D.1 for other design characteristics, including short-circuit withstand (see Table 1 3, Item 6), that require consideration when substituting devices.		N/A
10.10.3.6	Calculation of currents based on adjustment of ambient air temperature		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	Once a temperature-rise test has been carried out applying the temperature-rise limits for a daily average ambient air temperature of 35 ° C, the rated currents confirmed by testing for a daily average ambient air temperature of 35 ° C can be adjusted by calculation to determine rated current for daily average ambient air temperatures between 20 ° C and 50 ° C, assuming that the temperature-rise of each component or device is proportional to the power loss generated in this component.		N/A
	Caution should be taken to ensure the devices being assessed have a power loss substantially proportional to I^2 and not applied to devices that have substantially fixed or linear losses. By agreement between the user and the manufacturer, in assemblies where the power loss of conductors and devices is substantially proportional to I^2 , the circuits at ambient air temperatures (outside the enclosure) between 20 ° C and 50 ° C		N/A
	where I_1 is the current at which the temperature-rise test is carried out; I_2 is the current rating to be determined at the specific ambient air temperature between 20 ° C and 50 ° C; ΔT_1 is the temperature-rise measured by test with a current of I_1 ; ΔT_2 is maximum permissible temperature-rise at the specific ambient air temperature between 20 ° C and 50 ° C. I_2 cannot exceed the rated current of any device, (e.g. I_n for a circuit-breaker), within the circuit being considered, e.g. a circuit including a 1 600 A circuit-breaker cannot be assigned a current rating of 1 750 A in an ambient air temperature of 20 ° C.		N/A
10.10.4	Verification assessment		N/A
10.10.4.1	General		N/A
	The following calculation methods are provided, which have differing ranges of applicability: 1) single compartment assembly with natural cooling and rated current I_{nA} not exceeding 630 A (1 0.1 0.4.2); 2) assembly with natural cooling and rated current I_{nA} not exceeding 1 600 A (1 0.1 0.4.3).		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	These methods determine the approximate air temperature-rise inside the enclosure, which is caused by the power losses of all circuits, and compares this temperature with the limits for the installed equipment. The methods differ only in the way the relationship between the delivered power loss and the air temperature-rise inside the enclosure is ascertained.		N/A
	Due to the actual local temperatures of the current-carrying parts, which cannot be calculated by these methods, some limits and safety margins are necessary and included. Verification of the temperature-rise may be made by calculation if all the following general conditions and the additional conditions for the selected calculation method are fulfilled.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	a) The rated frequency is up to and including 60 Hz. b) The power loss data for all built-in electrical components is available from the component manufacturer. c) There is an approximately even distribution of power losses inside the enclosure. d) The mechanical parts and the installed equipment are so arranged that air circulation is not significantly impeded. e) The group rated current of the circuits, (I_{ng}), of the assembly to be verified shall not exceed 80 % of the rated conventional free air thermal current (I_{th}) if known, or when I_{th} is not available, 80 % of the rated current (I_n) of the switching devices and electrical components included in the circuit. Circuit-protection devices shall be selected to ensure adequate protection to outgoing circuits, e.g. thermal motor protection devices at the calculated temperature in the assembly. The limitation to 80 % of the rated current I_{th} or I_n does not apply to electronic devices which incorporate means for forced ventilation when they are installed according to the device anufacturer's instructions. f) All conductors directly connected to a device shall have a minimum cross-sectional area based on 1 25 % of the group rated current, I_{ng}, of the associated circuit. Selection of cables shall be in accordance with IEC 60364-5-52:2009. Examples of how to adapt this document for conditions inside an assembly are given in Annex H. The cross-section of bare copper bars shall be as tested or as given in Annex K. Where the device manufacturer specifies a conductor with a larger cross-sectional area, this shall be used. g) Conductors carrying currents in excess of 200 A and the adjacent structural parts are so arranged that eddy-current and hysteresis losses are minimized.		N/A
	The effective power losses of all circuits including interconnecting conductors shall be calculated assuming the circuits are operating at their group rated current, I_{ng}. The total power loss of the assembly is calculated by adding the power losses of the circuits taking additionally into account that the total load current is limited to the rated current of the assembly , I_{nA}. The power losses of the conductors are determined by calculation (see Annex H and Annex K).		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
10.10.4.2	Single compartment assembly with natural cooling and rated current (I_{nA}) not exceeding 630 A		N/A
10.10.4.2.1	Verification method		N/A
	Verification of the temperature-rise may be made by calculation if all the general conditions listed in 1 0.1 0.4.1 are fulfilled, and using the following: a) The air temperature-rise within the enclosure at a given power loss in the enclosure, for the applicable installation method being considered (e.g. flush mounting, surface mounting) is: - available from the enclosure manufacturer, or - determined in accordance with 1 0.1 0.4.2.2. b) The total power loss within the enclosure is calculated as detailed in 1 0.1 0.4.1 . The maximum permissible air temperature-rise within the enclosure is determined by the device with the lowest maximum operating air temperature and is taken as the maximum operating temperature of that device minus the daily average ambient air temperature (outside the enclosure). When electronic devices with integral forced ventilation are incorporated, the enclosure shall be considered as having no natural ventilation, irrespective of whether or not openings exist in the enclosure.		N/A
10.10.4.2.2	Determination of the power loss capability of an enclosure by test		N/A
	The power loss shall be simulated by means of heating resistors that produce heat equivalent to the intended power loss capability of the enclosure. The heating resistors shall be distributed evenly over the height of the enclosure and installed in suitable places inside the enclosure.		N/A
	The cross-section of the leads to these resistors shall be such that no appreciable amount of heat is conducted away from the enclosure.		N/A
	The test shall be carried out in accordance with 10.1 0.2.3.1 to 1 0.1 0.2.3.4 and the air temperature-rise shall be measured in the top of the enclosure. Enclosure temperatures shall not exceed the values given in Table 6.		N/A
10.10.4.2.3	Results to be obtained		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	The assembly is verified if: - the enclosure is capable of dissipating power losses equal to or greater than those generated by the assembly at the maximum permissible air temperature-rise within the enclosure; - all conductors within the assembly have been selected to operate at the maximum permitted air temperature within the assembly.		N/A
10.10.4.3	Assembly with natural cooling and rated current (I_{nA}) not exceeding 1600 A		N/A
10.10.4.3.1	Verification method		N/A
	Verification of the temperature-rise may be made by calculation in accordance with the method of IEC TR 60890:201 4 providing the additional requirements of 1 0.1 0.4.1 are fulfilled.		N/A
	The air temperature-rise within the assembly is then determined from the total power loss using the method of IEC TR 60890:201 4.		N/A
	The air temperature within the assembly is calculated by adding this air temperature-rise and the daily average ambient air temperature of the assembly. When electronic devices with integral forced ventilation are incorporated, the enclosure shall be considered as having no natural ventilation, irrespective of whether or not openings exist in the enclosure.		N/A
10.10.4.3.2	Results to be obtained		N/A
	The assembly is verified if the calculated air temperature at the mounting height of any built-in component (devices, conductors, etc.) does not exceed the permissible operating air temperatures of the built-in components as declared by their manufacturers.		N/A
10.11	Short-circuit withstand strength		N/A
10.11 .1	General		N/A
	The short-circuit current ratings declared shall be verified except where exempt, see 1 0.1 1 .2. Verification may be made by comparison with a reference design(s) (1 0.1 1 .3 and 1 0.1 1 .4) or by testing (1 0.1 1 .5). For verification, the following apply.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	a) If the assembly system to be verified comprises a number of variants, the most onerous arrangement(s) of the assembly shall be selected, taking into account the rules in 10.11 .3 and 10.11.4. b) The assembly variants selected for test shall be verified according to 1 0.1 1 .5. c) When the assemblies tested are the most onerous variants of the larger product range of an assembly system, then the test results can be used to establish the ratings of similar variants without further testing. Rules for such derivations are given in 1 0.1 1 .3 and 1 0.1 1 .4.		N/A
10.11 .2	Circuits of assemblies which are exempted from the verification of the short-circuit withstand strength		N/A
	A verification of the short-circuit withstand strength is not required for the following: a) assemblies having a rated short-time withstand current (see 5.3.5) or rated conditional short-circuit current (see 5.3.6) not exceeding 1 0 kA RMS for AC and 1 0 kA mean average for DC; b) assemblies , or circuits of assemblies , protected by current-limiting devices having a cut-off current not exceeding 1 7 kA with the maximum allowable prospective short-circuit current at the terminals of the incoming circuit of the assembly; c) auxiliary circuits of assemblies intended to be connected to transformers whose rated power does not exceed 1 0 kVA for a rated secondary voltage of not less than 1 1 0 V, or 1 ,6 kVA for a rated secondary voltage less than 1 1 0 V, and whose short-circuit impedance is not less than 4 %; d) circuits protected by frequency converters where the outputs are provided with electronic short-circuit protection that limits the cut-off current to not more than 1 7 kA, as declared by the manufacturer. All other circuits shall be verified.		N/A
1 0.11 .3	Verification by comparison with a reference design - Using a checklist		N/A
	The verifications are undertaken by comparison of the assembly to be verified with a reference design(s) using the checklist provided in Table 1 3.		N/A
	Should any elements identified in the checklist not comply with the requirements of the checklist and be marked 'NO', one of the following means of verification shall be used (see 10.1 .4 and 10.11.5).		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	A fuse link used in the reference design can be replaced by a fuse link of another make or series without any further testing if: - the rating of the fuse links shall be the same; - the utilization category is the same (e.g. gG); - the fuse system is the same (e.g. NH); and - power loss is the same or lower.		N/A
1 0.11 .4	Verification by comparison with a reference design(s) - Using calculation		N/A
	Assessment of the rated short-time withstand current of an assembly and its circuits, by calculation, shall be undertaken by a comparison of the assembly to be assessed with an assembly already verified by testing. The assessment to verify the main circuits of an assembly shall be in accordance with Annex M. In addition, each of the circuits of the assembly to be assessed shall meet the requirements of items 6,8,9 and 10 in Table 13.		N/A
	The data used, calculations made and the comparison undertaken shall be stated in the verification documentation.		N/A
	If the assessment in accordance with Annex M does not pass or any of the items listed above are not fulfilled, then the assembly and its circuits shall be verified by test in accordance with 1 0.1 1 .5.		N/A
10.11 .5	Verification by test		N/A
10.11 .5.1	Test arrangements		N/A
	The assembly or its parts as necessary to complete the test shall be mounted as in normal use. It is sufficient to test a single functional unit if the remaining functional units are of the same construction. Similarly, it is sufficient to test a single busbar configuration if the remaining busbar configurations are of the same construction. Table 1 3 provides clarification on items not requiring additional tests.		N/A
1 0.11 .5.2	Performance of the test		N/A
	If the test circuit incorporates fuses, fuse-links with the maximum let-through current and, if required, of the type indicated by the original manufacturer as being acceptable, shall be used.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	The supply conductors and the short-circuit connections required for testing the assembly shall have sufficient strength to withstand short-circuits and be so arranged that they do not introduce any additional stresses on the assembly.		N/A
	Unless otherwise agreed, the test circuit shall be connected to the input terminals of the assembly. Three-phase assemblies shall be connected on a three-phase basis.		N/A
	All parts of the equipment intended to be connected to the protective conductor in service, including the enclosure, shall be connected as follows: a) for assemblies suitable for use on three-phase four-wire systems with an earthed star point and marked accordingly, to the neutral point of supply or to a substantially inductive artificial neutral permitting a prospective fault current of at least 1 500 A; b) for assemblies also suitable for use in three-phase three-wire as well as on three-phase four-wire systems and marked accordingly, to the line conductor least likely to arc to earth.		N/A
	Except for assemblies according to 8.4.4, the connection mentioned in a) and b) shall include a fusible element consisting of a copper wire of 0,8 mm diameter and at least 50 mm long, or of an equivalent fusible element for the detection of a fault current. The prospective fault current in the fusible element circuit shall be $1\,500\text{ A} \pm 1\,50\text{ A}$, except as stated in Notes 2 and 3. If necessary, a resistor limiting the current to that value shall be used.		N/A
10.11.5.3	Testing of main circuits		P
10.11.5.3.1	General		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Circuits shall be tested with the highest thermal and dynamic stresses that may result from short-circuit currents up to the rated values for one or more of the following conditions as declared by the original manufacturer. a) Not dependent upon a SCPD: the assembly shall be tested with the rated peak withstand current and the rated short-time withstand current for the specified duration (see 5.3 and 9.3.2 a)). b) Dependent upon an incoming SCPD included within the assembly: the assembly shall be tested with an incoming prospective short-circuit current for a period of time that is limited by the incoming SCPD. c) Dependent upon an upstream SCPD: the assembly shall be tested to the let-through values permitted by the upstream SCPD as defined by the original manufacturer.		P
	Where an incoming or outgoing circuit includes a SCPD that reduces the peak and/or duration of the fault current, then the circuit shall be tested allowing the SCPD to operate and interrupt the fault current (see 5.3.6 rated conditional short-circuit current I_{cc}). If the SCPD contains an adjustable short-circuit release, then this shall be set to the maximum allowed value (see 9.3.2, second paragraph).		P
	One of each type of circuit shall be subject to a short-circuit test as described in 10.11.5.3.2 to 10.11.5.3.5.		P
10.11.5.3.2	Outgoing circuits		P
	The outgoing terminals of outgoing circuits shall be provided with a bolted short-circuit connection. When the protective device in the outgoing circuit is a circuit-breaker, the test circuit may include a shunting resistor in accordance with 9.3.4.1 .2 b) of IEC 60947-1 :2020 in parallel with the reactor used to adjust the short-circuit current.		P
	For circuit-breakers having a rated current up to and including 630 A, a conductor 0,75 m in length having a cross-sectional area corresponding to the rated current (see Table 1 1 and Table 1 2) shall be included in the test circuit. At the original Manufacturer's discretion, a shorter connection than 0,75 m may be used.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	The switching device shall be closed and held closed in the manner normally used in service. The test voltage shall then be applied once for a magnitude and duration as given in 1 0.1 1 .5.4. In the case of outgoing circuits which do not include an SCPD, the magnitude and duration shall be as specified for the main busbars by the original manufacturer. Testing of outgoing circuits may also result in the operation of the incoming SCPD.		P
10.11.5.3.3	Incoming circuit and main busbars		P
	Assemblies containing main busbars shall be tested to prove the short-circuit withstand strength of the main busbars and the incoming circuit including at least one joint where the busbars are intended to be extendable. The short-circuit shall be placed such that the length of main busbar included in the test is $(2 \pm 0,4)$ m. For the verification of rated short-time withstand current (see 5.3.5) and rated peak withstand current (see 5.3.4), this distance may be increased and the test conducted at any convenient voltage providing the test current is the rated value (see 1 0.1 1 .5.4 b)). Where the design of the assembly is such that the length of the busbars to be tested is less than 1,6m and the assembly is not intended to be extended, then the complete length of busbar shall be tested, the short-circuit being established at the end of these busbars. If a set of busbars consists of different sections (as regards cross-sections, centre line spacing of the conductors, type and number of supports per metre), each section shall be tested separately or concurrently, provided that the above conditions are met.		P
10.11.5.3.4	Connections to the supply side of outgoing units		P
	Where an assembly contains conductors, including any distribution busbars, between a main busbar and the supply side of outgoing functional units that do not fulfil the requirements of 8.6.4, one circuit of each type shall be subjected to an additional test.		P
	A short-circuit is obtained by bolted connections on the conductors connecting the busbars to a single outgoing unit, as near as practicable to the terminals on the busbar side of the outgoing unit. The value and duration of the short-circuit current shall be the same as that for the main busbars.		P
10.11.5.3.5	Neutral or mid-point conductor		P
10.11.5.3.5.1	Neutral conductor		P

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Clause	Requirement + Test	Result - Remark	Verdict
	If a neutral conductor exists within a circuit, it shall be subjected to one test to prove its short-circuit withstand strength in relation to the nearest line conductor of the circuit under test including any joints. Line to neutral short-circuit connections shall be applied as specified in 10.11.5.3.3.		P
	Unless otherwise agreed between the original manufacturer and the user, the value of the test current in the neutral conductor shall be at least 60 % of the line current during the three-phase test.		P
	The test need not be executed if the test is intended to be made with a current of 60 % of the line current and if the neutral conductor is: – the same shape and cross-section as the line conductors; – supported in an identical manner as the line conductors and with support centres along the length of the conductor not greater than that of the phases; – spaced at a distance from the nearest phase(s) not less than that between phases; – spaced at a distance from earthed metalwork not less than the line conductors.		N/A
	If a 4-pole busbar system is sectioned by a three pole device, the short-time withstand current test including the neutral need not be executed if the test is intended to be made with a current of 60 % of the line current and: a) the criteria listed above are met; and b) the neutral pole is part of a 4-pole busbar system that includes a 3-pole device, and c) the 3-pole device does not result in any changes to the support system that would be necessary to support the line and neutral conductors if the 3-pole device were not present.		N/A
10.11.5.3.5.2	Mid-point conductor		N/A
	The mid-point conductor shall be subjected to one test to prove its short-circuit withstand strength in relation to the line conductor of the circuit under test including any joints. Mid-point to line short-circuit connections shall be applied as specified in 10.11.5.3.3.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	Unless otherwise agreed between the original manufacturer and the user, the value of the test current in the mid-point conductor shall be 1 00 % of the line to line test current.		N/A
	The test need not be executed if the mid-point conductor is not positioned between the line conductors if the following are fulfilled: - it is the same shape and cross-section as the line conductors; - it is supported in an identical manner as the line conductors and with support centres along the length of the conductor not greater than that of the line conductors; - it is spaced at an equal or greater distance than the distance between the line conductor(s).		N/A
	In the case of a short-time withstand current, the test need not be executed if: a) the criteria listed above are met; and b) the mid-point pole is part of a 3-pole busbar system that includes a device; and c) the device does not result in any changes to the support system that would be necessary to support the line and mid-point conductors if the device were not present.		N/A
10.1 1 .5.4	Value and duration of the short-circuit current		N/A
	For all short-circuit withstand ratings, the dynamic and thermal stresses shall be verified with a prospective current at the supply side of the specified protective device, if any, equal to the value of the rated short-time withstand current, rated peak withstand current or rated conditional short-circuit current.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	For the verification of all the short-circuit withstand ratings (see 5.3.4 to 5.3.6 inclusive), the value of the prospective short-circuit current shall be within a tolerance of 0 % to +5 % at a test voltage equal to 1,05 times the rated operational voltage U_e of the circuit . The value of the short-circuit current shall be determined from a calibration oscillogram, which is taken with the supply conductors to the assembly short-circuited by a connection of negligible impedance placed as near as possible to the input supply of the assembly. The oscillogram shall show that there is a constant flow of current such that it is measurable at a time equivalent to the operation of the protective device incorporated in the assembly or for the specified duration (see 9.3.2 a)).		N/A
	The value of current during the calibration is: – for a test with AC, the RMS value of the AC component and the average of currents of all phases in a poly-phase system; or – for a test with DC, the mean value in sustained conditions.		N/A
	When making the tests at maximum operational voltage, the calibration current shall be equal to the rated short-circuit current with a tolerance of 0 % to +5 %. In poly-phase systems, this tolerance applies to the average of all line currents, while each individual line current may have a tolerance of ± 5 % of the rated value. For AC tests, the power factor shall be within a tolerance of 0,00 and $-0,05$.		N/A
	The peak current and power factor in the case of an AC test shall be in accordance with 9.3.3. All tests for AC applications shall be carried out at the rated frequency of the assembly with a tolerance of ± 25 %. With the following exception, tests for DC applications shall be carried out with DC.		N/A
	An AC short-time current test may be used to verify a rated DC short-time withstand current and a rated DC peak withstand current providing the test with AC has a peak current equal to the rated DC peak withstand current and the RMS value of the short-time current is at least equal to the rated DC short-time withstand current. When substituting a DC test by an AC test, it should be recognized that the thermal and dynamic stresses of the AC test are higher than those of the equivalent DC test.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	a) For a test at the rated conditional short-circuit current I_{cc}, whether the protective devices are in the incoming circuit of the assembly or elsewhere, the test voltage shall be applied for a time sufficiently long to enable the short-circuit protective devices to operate to clear the fault and, in any case, for not less than 10 cycles for AC and 200 ms for DC. The test shall be conducted at 1.05 times the rated operational voltage with prospective short-circuit currents, at the supply side of the specified protective device, equal to the value of the rated conditional short-circuit current. Tests at lower voltages are not permitted. b) For a test at the rated short-time withstand current and at the rated peak withstand current, the dynamic and thermal stresses shall be verified with a prospective current equal to the value of rated short-time withstand current and rated peak withstand current declared. The current shall be applied for the specified time during which the RMS value of its AC component in the case of a test with AC, or the DC value in the case of a test with DC, shall remain constant.		N/A
	In the event of difficulties in carrying out the short-time or peak withstand tests at the maximum operational voltage with the test station, the tests according to 10.11.5.3.3, 10.11.5.3.4 and 10.11.5.3.5 may be carried out at any convenient voltage with the original manufacturer's agreement, the actual test current being in this case equal to the rated short-time current or peak withstand current. This shall be stated in the test report. If, however, any momentary contact separation occurs in a contact arrangement (e.g. within a switching device or a plug-in contact), during the test, the test shall be repeated at the maximum operational voltage.		N/A
	If necessary, due to test limitations, a different test period is permissible; in such a case, the test current should be modified in accordance with the formula $I^2 t = \text{constant}$, provided that the peak value does not exceed the rated peak withstand current without the original manufacturer's consent and that the RMS value in the case of a test with AC, or DC value in the case of a test with DC, of the short-time current is not less than the rated value in at least one phase for at least 0.1 s after current initiation.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	The peak current withstand test and the short-time current test may be separated. In this case, the time during which the short-circuit is applied for the peak current withstand test shall be such that the value $I_2 t$ is not larger than the equivalent value for the short-time current test, but it shall be not less than 60 ms.		N/A
	Where the required test current in each phase cannot be achieved, the positive tolerance may be exceeded with the agreement of the original manufacturer.		N/A
10.11 .5.5	Results to be obtained		P
	After the test, deformation of busbars and conductors is acceptable provided that the clearances and creepage distances specified in 8.3 are still complied with. In case of any doubt, clearances and creepage distances shall be measured (see 1 0.4).		P
	The characteristics of the insulation shall remain such that the mechanical and dielectric properties of the equipment satisfy the requirements of the relevant assembly standard. A busbar support or cable restraint shall not have separated into two or more pieces. Also, there shall be no cracks appearing on opposite sides of a support and no cracks, including surface cracks, running the full length or width of the support. In case of any doubt that the insulation properties of the assembly are not maintained, an additional power frequency test at two times U_e with a minimum of 1 000 V shall be performed in accordance with 1 0.9.2.		P
	There shall be no loosening of parts used for the connection of conductors and the conductors shall not separate from the outgoing terminals.		P
	Distortion of the busbars or supporting structure of the assembly that impairs its normal use shall be deemed a failure.		P
	Any distortion of the busbars or supporting structure of the assembly that impairs normal insertion or removal of the removable parts shall be deemed a failure.		P
	Deformation of the enclosure or of the internal partitions, barriers and obstacles due to the short-circuit current is permissible to the extent that the degree of protection is not apparently impaired and the clearances or creepage distances are not reduced to values that are less than those specified in 8.3.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	Additionally, after the tests of 1 0.1 1 .5.3 incorporating short-circuit protective devices, the tested equipment shall be capable of withstanding the power-frequency withstand voltage test of 1 0.9.2 at a voltage value for the "after-test" condition prescribed in the relevant short-circuit protective device standard for the appropriate short-circuit test, as follows: a) between all live parts and the exposed-conductive-parts of the assembly, and b) between each pole and all other poles connected to the exposed-conductive-parts of the assembly.		P
	If tests a) and b) above are conducted, they shall be carried out with any fuses replaced and with any switching device closed.		P
	In case of any doubt, it shall be checked that the equipment incorporated in the assembly is in a condition as prescribed in the relevant product standards and/or device manufacturer's information, e.g. can be manually opened and closed. The fusible element (see 1 0.1 1 .5.2), if any, shall not indicate a fault current. There shall be neither arcing nor flashover between poles of the protective device, or between poles and enclosure.		P
1 0.1 1 .5.6	Testing of the protective circuit		P
10.11.5.6.1	General		P
	This test does not apply for circuits according to 1 0.1 1 .2.		P
	A single-phase test supply shall be connected to the incoming terminal of one phase and to the terminal for the incoming protective conductor. When the assembly is provided with a separate protective conductor, the nearest line conductor shall be used. Where the assembly is extendable, the protective circuit tested shall include at least one joint. For each representative outgoing unit, a separate test shall be carried out with a bolted short-circuit connection between the corresponding outgoing phase terminal of the unit and the terminal for the relevant outgoing protective conductor.		P
	Each outgoing unit on test shall be fitted with its intended protective device. Where alternative protective devices can be incorporated in the outgoing unit, the protective device which lets through the maximum values of peak current and I 2 t shall be used.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	For this test, the frame of the assembly shall be insulated from the earth. The test voltage shall be equal to 1,05 times the single-phase value of the rated operational voltage. Unless otherwise agreed between the original manufacturer and the user, the value of the test current in the protective conductor shall be at least 60 % of the line current during the three-phase test of the assembly.		P
	All other conditions of this test shall be analogous to 10.11.5.2 to 10.11.5.4 inclusive.		P
10.11.5.6.2	Results to be obtained		P
	The continuity and the short-circuit withstand strength of the protective circuit, whether it consists of a separate conductor or the frame or enclosure of the assembly, shall not be significantly impaired. Besides visual inspection, this may be verified by measurements with a current of the order of the rated current of the relevant outgoing unit. The earth continuity between the exposed-conductive-parts of a class I assembly and the protective circuit shall remain effective. If in doubt, measurements according to 10.5.2 shall be carried out. Deformation of the enclosure or of the internal partitions, barriers and obstacles due to the short-circuit current is permissible to the extent that the degree of protection is not apparently impaired and the clearances or creepage distances are not reduced to values that are less than those specified in 8.3.		P
	Where the frame or enclosure of the assembly is used as a protective conductor, sparks and localized heating at joints are permitted, provided they do not impair the electrical continuity and provided that adjacent flammable parts are not ignited.		P
10.12	Electromagnetic compatibility (EMC)		N/A
	For EMC tests, see J.10.1.2.		N/A
11	Routine verification		P
11.1	General		P
	Under the responsibility of the assembly manufacturer, all routine verification including testing, installation and commissioning shall be carried out or supervised by a competent person.		P

IEC 61439-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Routine verification is intended to detect faults in materials and workmanship and to ascertain proper functioning of the manufactured assembly. It is made on every assembly . The assembly manufacturer shall determine if routine verification is carried out during and/or after manufacture. Routine verification shall confirm that the assembly manufacturing instructions have been adhered to.		P
	Routine verification is not required to be carried out on devices and self-contained components incorporated in the assembly when they have been selected in accordance with 8.5.3 and installed in accordance with 8.5.4.		P
	Verification shall comprise the following categories: a) Construction (see 1 1 .2 to 1 1 .8): 1) degree of protection against contact with hazardous live parts, ingress of solid foreign bodies and water of enclosures; 2) clearances and creepage distances; 3) protection against electric shock and integrity of protective circuits; 4) incorporation of built-in components; 5) internal electrical circuits and connections; 6) terminals for external conductors; 7) mechanical operation. b) Performance (see 1 1 .9 to 1 1 .1 0): 1) dielectric properties; 2)wiring, operational performance and function. c) Confirmation that documents that are intended to be supplied with the assembly are provided and include those required in 6.2.1 .		P
11.2	Degree of protection against contact with hazardous live parts, ingress of solid foreign bodies and water of enclosures		P
	A visual inspection is necessary to confirm that the assembly meets the prescribed measures to achieve the designated degree of protection.		P
11.3	Clearances and creepage distances		P

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Clause	Requirement + Test	Result - Remark	Verdict
	Where the clearances are: - less than the values given in Table 1 , an impulse voltage withstand test in accordance with 10.9.3 shall be carried out; - not evident by visual inspection to be larger than the values given in Table 1 (see 10.9.3.5), verification shall be by physical measurement or by an impulse voltage withstand test in accordance with 10.9.3; - evidently larger by visual inspection than the values given in Table 1 , verification may be carried out only by visual inspection.		P
	The prescribed measures with regard to creepage distances (see 8.3.3) shall be subject to a visual inspection. Where it is not evident by visual inspection, verification shall be by physical measurement. No reduction on the values given in Table 2 is acceptable.		P
11.4	Protection against electric shock and integrity of protective circuits		P
	The prescribed protective measures with regard to basic protection and fault protection (see 8.4.2 and 8.4.3) shall be subject to a visual inspection.		P
	The protective circuits shall be checked by inspection to ascertain that the measures prescribed in the manufacturer's instructions are adhered to and verified. When it is not obvious by inspection that the earth continuity of the protective circuits meets the requirement of 8.4.3.2, a continuity test according to 10.5.2 shall be made.		P
	Screwed and bolted connections shall be checked for the correct tightness on a random basis.		P
11.5	Incorporation of built-in components		P
	The installation and identification of built-in components shall be in accordance with the assembly's manufacturing instructions.		P
11.6	Internal electrical circuits and connections		P
	The connections, especially screwed and bolted connections, shall be checked for the correct tightness on a random basis.		P
	Conductors shall be checked in accordance with the assembly's manufacturing instructions.		P
11.7	Terminals for external conductors		P

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Clause	Requirement + Test	Result - Remark	Verdict
	The number, type and identification of terminals shall be checked in accordance with the Assembly's manufacturing instructions.		P
11.8	Mechanical operation		P
	The effectiveness of mechanical actuating elements, interlocks and locks, including those associated with removable parts, shall be checked.		P
	Where a device's operating handle is used to indicate the switching position of the device, and it detaches from the device when the door is open, it shall be confirmed that, when the door is closed, the handle provides positive and unambiguous indication of the device's open and closed positions.		P
11.9	Dielectric properties		P
	A power-frequency withstand test shall be performed on all circuits in accordance with 1 0.9.1 and 1 0.9.2 but for a duration of 1 s and with a tripping current not less than 3,5 mA.		P
	This test need not be made on auxiliary circuits: - that are protected by a short-circuit protective device with a rating not exceeding 1 6 A; - if an electrical function test has been made previously at the rated operational voltage for which the auxiliary circuits are designed.		P
	As an alternative for assemblies with incoming protection rated up to 630 A and a rated voltage U_n not exceeding 500 V, the verification of insulation resistance may be by measurement using an insulation measuring device at a voltage of at least 500 V DC.		P
	In this case, the test is satisfactory if the insulation resistance between circuits and exposed-conductive-parts is at least 1 M Ω .		P
11.10	Wiring, operational performance and function		P
	It shall be verified that the information and markings specified in Clause 6 are complete.		P
	Depending on the complexity of the assembly, it may be necessary to inspect the wiring and to carry out an electrical function test. The test procedure and the number of tests depend on whether or not the assembly includes complicated interlocks, sequence control facilities, etc.		P

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Clause	Requirement + Test	Result - Remark	Verdict
	By agreement between the user and the assembly manufacturer, communicating devices that are included and connected in a system within the assembly may need to be checked for basic operation and functionality.		P
	In some cases, it may be necessary to make or repeat this test on site before putting the installation into operation.		P

Photo 1



Photo 2



Photo 3



Photo 4



Photo 5



Photo 6



Photo 7



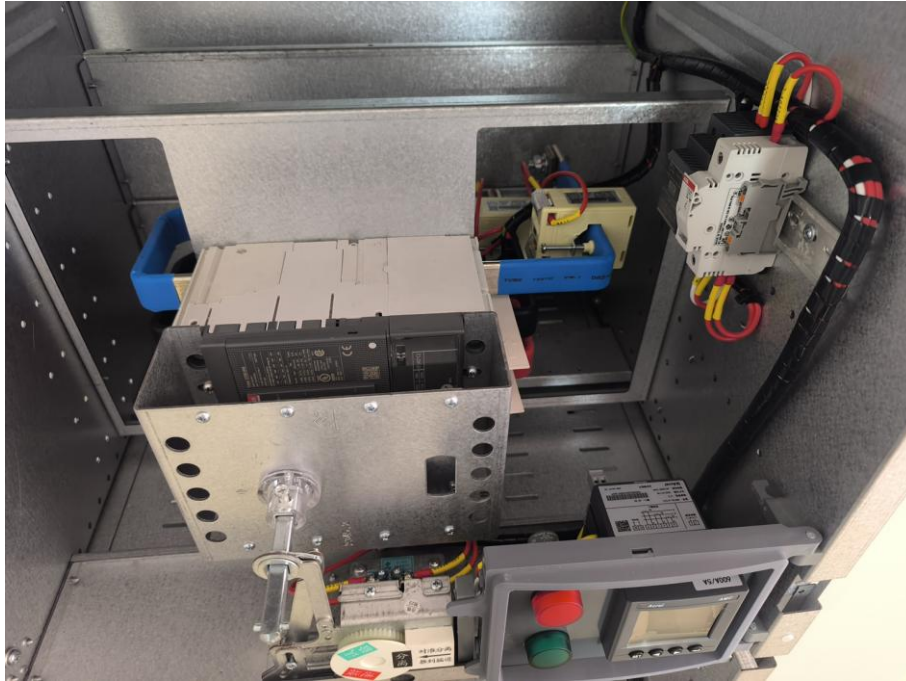
Photo 8



Photo 9



Photo 10



----- End of Report -----