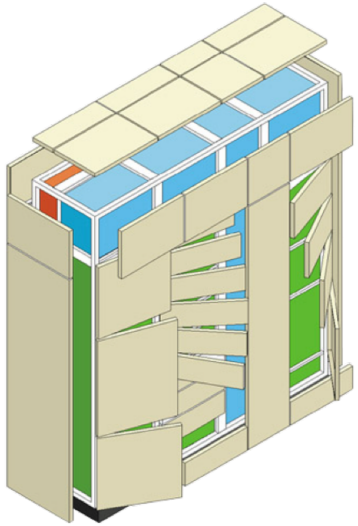
MODUTEC

Switchboard Testing as per IEC 61439 Part 1 & 2





LV Assemblies Standard

IEC 61439 Series

- Part 0: Guide
- Part 1 : General Rule
- Part 2 to 7: Relevant Assembly Standard

Design Verification Methods by IEC 61439

Verification made on a sample of an ASSEMBLY or on parts of ASSEMBLIES to show that design meets the requirements of the relevant ASSEMBLY standard

Verification by test:

Test made on a sample of an ASSEMBLY or on parts of ASSEMBLIES to verify that the design meets the requirements of the relevant assembly standards.

Verification by comparison:

Structured comparison of a proposed design of an assembly or parts of an assembly with a reference design verified by test.

Verification by assessment:

Design verification of strict design rules or calculations applied to a sample of an ASSEMBLY or on parts of ASSEMBLIES to verify that the design meets the requirements of the relevant assembly standards

List of Tests for Complete Design Verification

Construction Requirement:

1) Strength of material and parts
2) Degree of protection of enclosures
3) Clearances
4) Creepage distances
5) Protection against electric shock and integrity of protective circuits
6) Incorporation of switching devices and components
7) Internal electrical circuits and connections
8) Terminals for external conductors

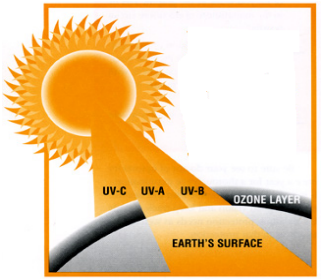
Performance Requirement:

9) Di-electric properties
10) Verification of temperature rise
11) Short circuit withstand strength
12) Electromagnetic compatibility
13) Mechanical operations

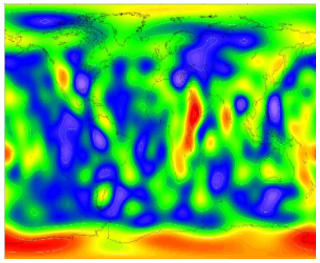
1. Strength of material and parts

Resistance to Corrosion

Resistance to UV radiation



Thermal Stability of Enclosure



Lifting & Marking

Mechanical Impact

Resistance to heat and fire

1.1 Resistance to Corrosion

Testing (10.4)	Comparison	Assessment
✓	✕	✕

Test objective:

To ensure that deterioration of metallic component caused by corrosion shall not impair the mechanical strength of switchboard.

- Severity A: Metallic indoor enclosures, external metallic parts of indoor, and internal metallic parts of indoor/ outdoor assemblies.
- Severity B: Metallic Outdoor enclosures, external metallic parts of outdoor assemblies.

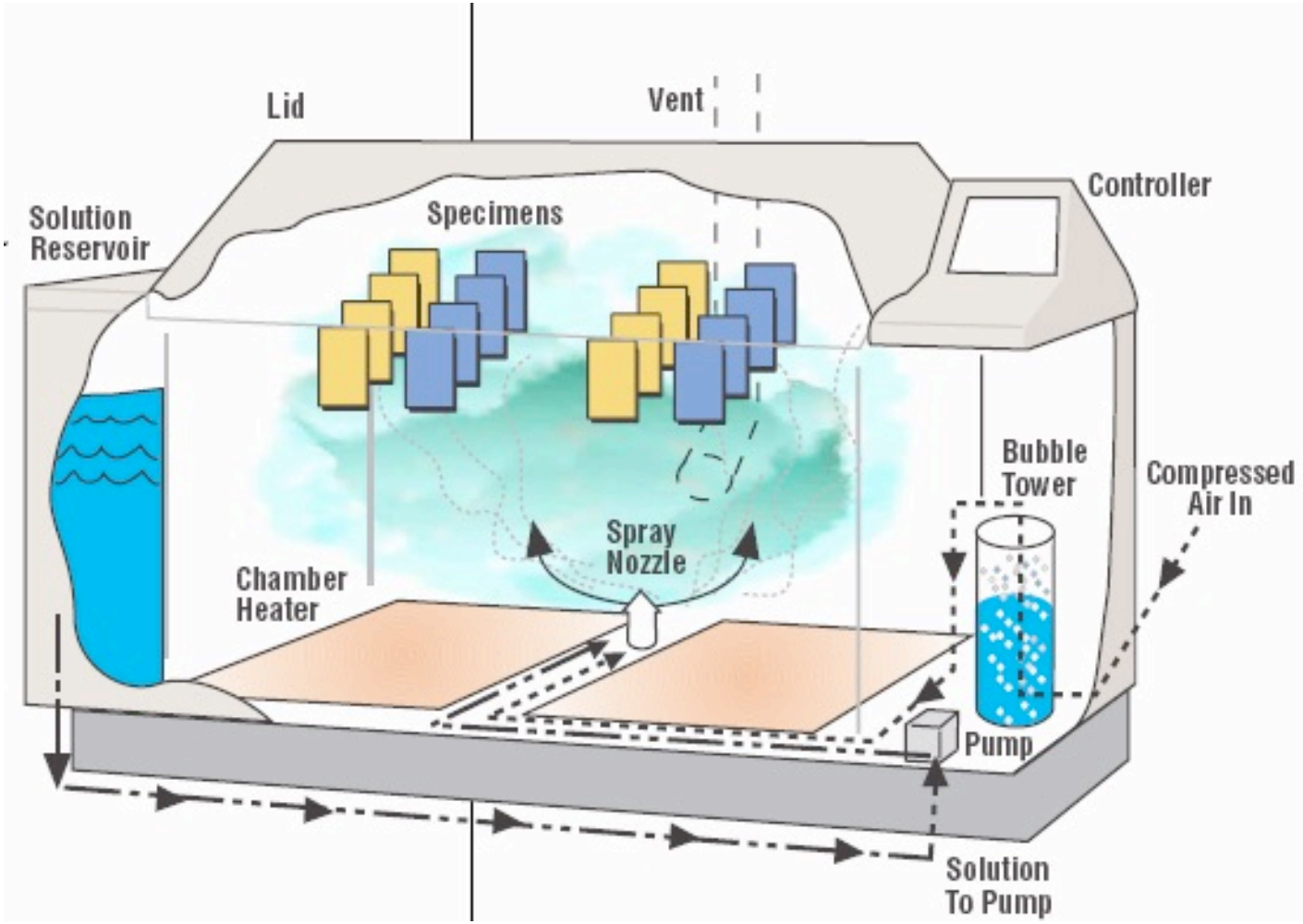
The specimen has to undergo following test:

	Severity A	Severity B
24 hr damp heat cycle	6 cycles	5 cycles
24 hr Salt mist cycle	2 cycles	7 cycles

Severity B: 2 identical cycles

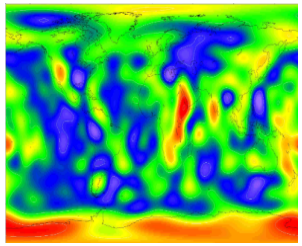
- Sample shall shows no evidence of iron oxide, cracking etc.
- Doors, Hinges, Locks and fastenings works without abnormal effort

Typical Salt mist chamber



1.2 Verification of Thermal stability

Testing (10.4)	Comparison	Assessment
✓	✕	✕



Test objective:

To verify the thermal properties of the enclosure made up of insulating material.

- The specimen is kept in a heating chamber at 70°C for 7 days. After that the sample is kept at ambient temperature for 4 days.
- The sample shall show no cracks nor the material has become sticky or greasy, to test, sample is pressed with the forefinger wrapped in a dry cloth with a force of 5N.
- No traces of cloth shall remain on the sample or vice-versa.

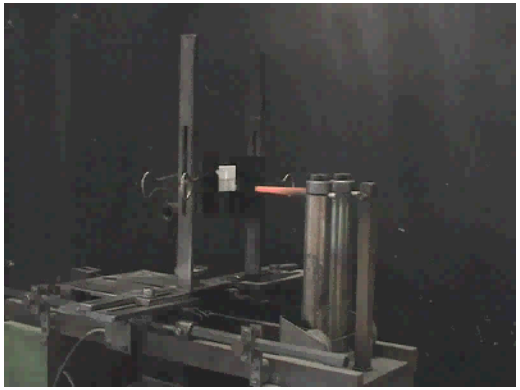
1.3 Resistance to Abnormal heat and fire (Glow wire)

Testing (10.4)	Comparison	Assessment
✓	✕	✓

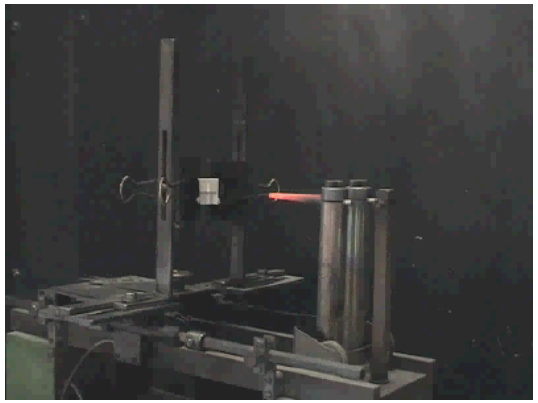
Test objective:

To checks the capability of insulation material to handle thermal stresses produced by sources of heat or ignition.

- Tests as per IEC 60695-2-10 & 60695-2-11
- The test at different temperature are mandatory for insulating materials.
  - 960°C - for parts supporting conducting parts
  - 650°C - for all other parts



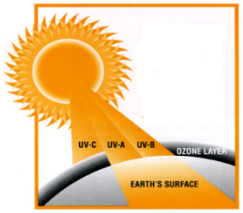
Fail



Pass

1.4 Resistance to UV radiation

Testing (10.4)	Comparison	Assessment
✓	✕	✓



- The test applies only to enclosures and external parts of ASSEMBLIES intended to be installed outdoors.
- **Not applicable for INDOOR USE**
- UV Test according to ISO 4892 – 2 method A; 1000 cycles of 5 min of watering and 25 min. of dry period with xenon lamp providing a total test period of 500hrs.

1.5 Lifting

Testing (10.4)	Comparison	Assessment
✓	✕	✕

Test objective:

To ensure that there should be no damage to the panel during transportation & installation. The test is carried out on a sample having weight 1.25 times its maximum shipping weight.

- The specimen is raised vertically to a height of 1 m before returning to its normal position. This test is repeated twice and then the specimen is raised up and suspended at a height of 1 m for 30 min.
- After this the specimen is raised up at a height of 1 m and moved horizontally (10 m), then returned to its normal position. This is repeated 3 times.
- After the test the specimen shall show no cracks or permanent distortion

1.6 Protection against mechanical impact

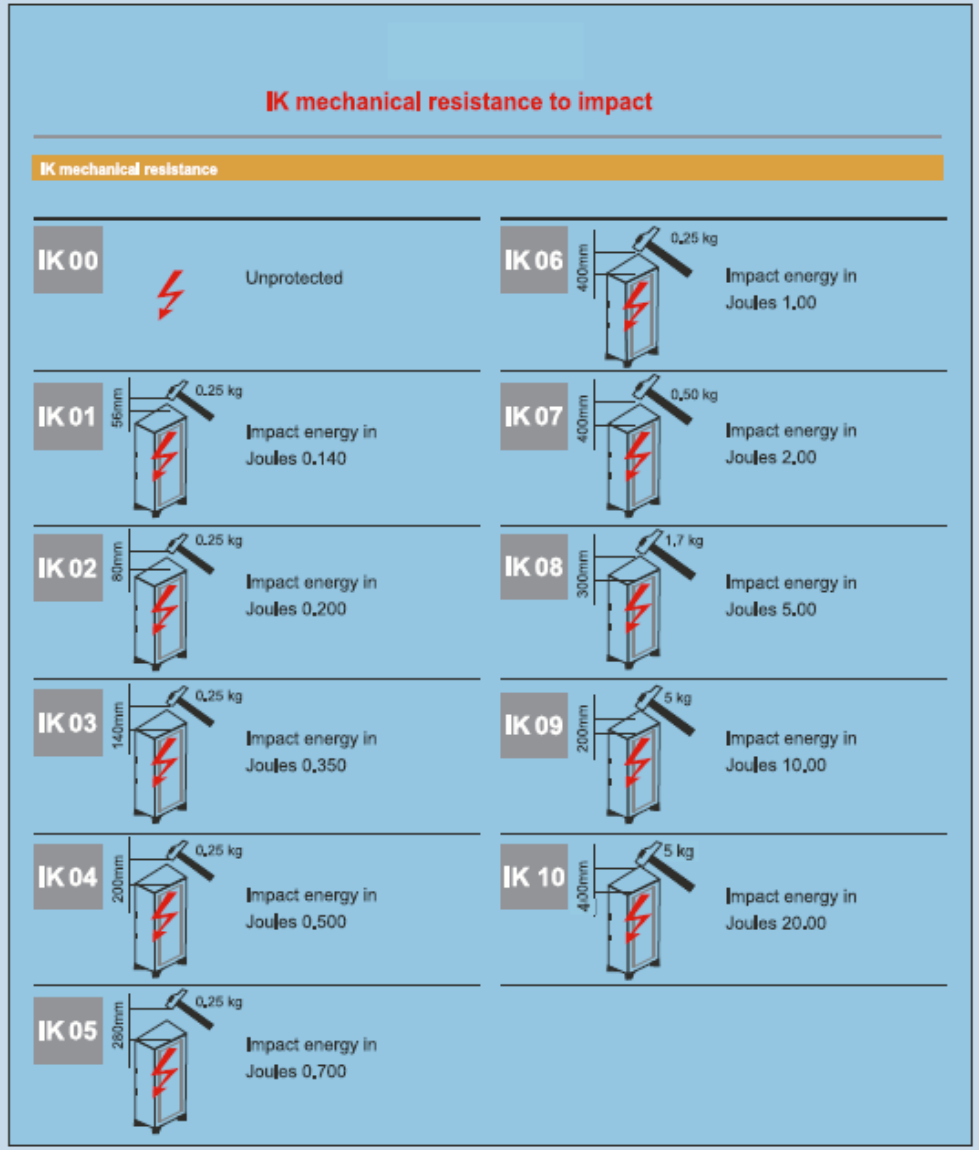
Testing (10.4)	Comparison	Assessment
✓	✕	✕

Test objective:

To verify a resistance of enclosure against external impact forces.

- Verified in accordance with IEC 62262
- The degree of protection provided by an enclosure against impacts is indicated by the IK code.

Protection against mechanical impact



IK code	Impact Energy J
IK 00	*
IK 01	0.14
IK 02	0.2
IK 03	0.35
IK 04	0.5
IK 05	0.7
IK 06	1
IK 07	2
IK 08	5
IK 09	10
IK 10	20

1.7 Marking

Testing (10.4)	Comparison	Assessment
✓	✕	✕

Test objective:

To ensure that the markings are legible.

- Markings made by molding, pressing, engraving or similar shall not be submitted to this test.
- This test is made by rubbing the marking by hand for 15 sec with a piece of cloth soaked in water and then for 15 sec with petroleum spirit.
- After the test the marking shall be easily legible.

2. Degree of Protection (IP)

Testing (10.4)	Comparison	Assessment
✓	✗	✓

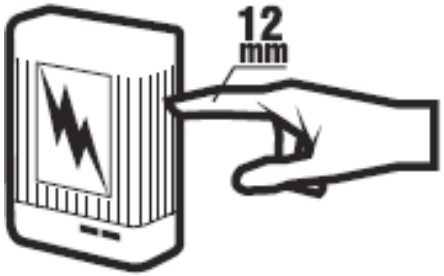
- Test as per IEC-60529
- IP code: ***IP XX***

First characteristic numeral: Protection against ingress of solid foreign material

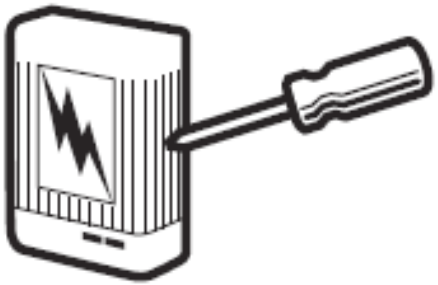
Second characteristic numeral: Protection against ingress of Liquid

IP – First digit (Solids)

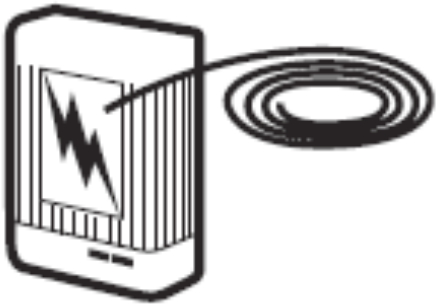
IP1X



IP2X



IP3X



IP4X

IP5X

IP6X

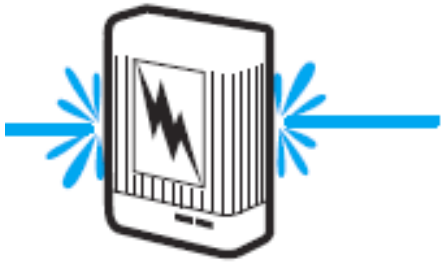
IP – Second digit (Liquids)

IPX1

IPX2

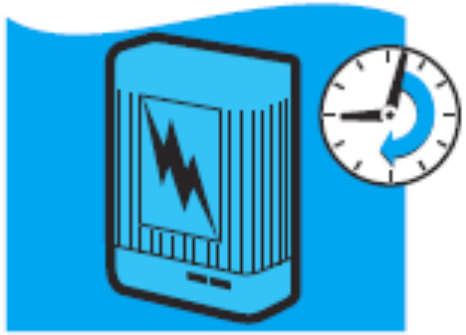
IPX3

IPX4



IPX5

IPX6



IPX7

IPX8

Degree of protection of enclosures

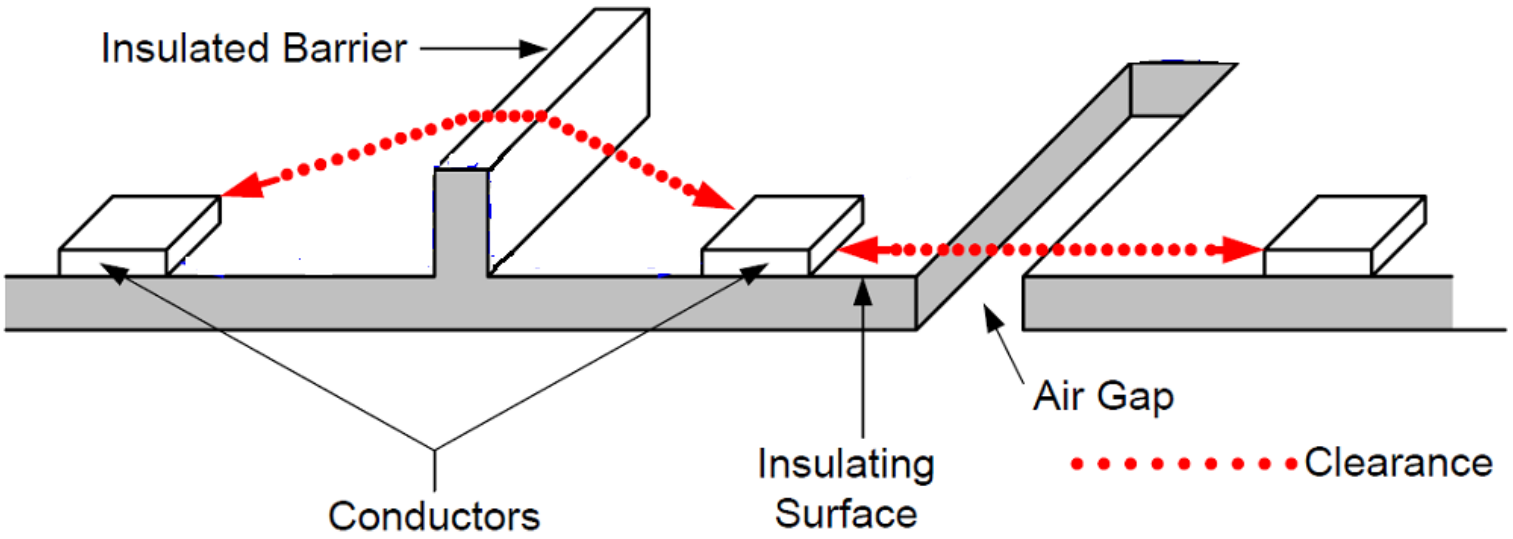
Dust Test

liquid test

3. Verification of Clearance distance

Testing (10.4)	Comparison	Assessment
✓	✕	✕

Clearance: Distance of the shortest string stretched between two conductive paths



Verification of Clearance distance

Minimum clearance value should be as per table 1

Table 1 – Minimum clearances in air [a] (8.3.2)

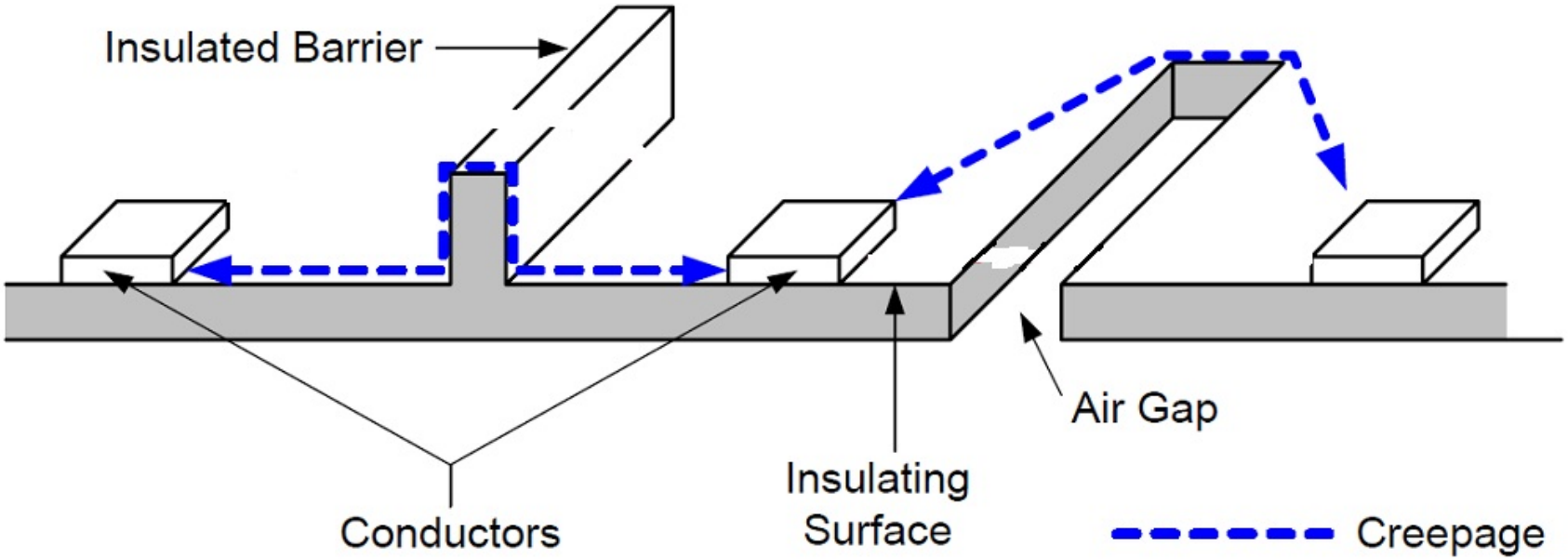
Rated impulse withstand voltage U_{imp} kV	Minimum clearance mm
≤ 2,5	1,5
4,0	3,0
6,0	5,5
8,0	8,0
12,0	14,0

[a] Based on inhomogeneous field conditions and pollution degree 3.

4. Verification of Creepage distance

Testing (10.4)	Comparison	Assessment
✓	×	×

Creepage: Shortest distance along the surface of an insulator between two conductive paths



Verification of Creepage distance

Creepage value depends upon:

1) Rated insulation voltage of the assembly
2) Pollution degree
3) Material group
4) Material group are classified based on CTI value of insulating material.

Pollution degree 1 : No pollution or non conductive pollution occurs. The pollution has no influences

Pollution degree 2 : Non conductive pollution occur except that occasionally a temporary conductivity caused by condensation is to be expected.

Pollution degree 3 : Conductive pollution occur, nonconductive pollution occurs which is expected to become conductive due to condensation.

Pollution degree 4 : Continuous conductivity occurs due to conductive dust, rain or wet conditions.

Verification of Creepage distance

Table 2 – Minimum creepage distances (8.3.3)

Rated insulation voltage U_i	Minimum creepage distance mm							
	Pollution degree							
	1	2			3			
	Material group[c]	Material group[c]			Material group[c]			
V[b]	I	I	II	IIIa and IIIb	I	II	IIIa	IIIb
32	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5
40	1,5	1,5	1,5	1,5	1,5	1,6	1,8	1,8
50	1,5	1,5	1,5	1,5	1,5	1,7	1,9	1,9
63	1,5	1,5	1,5	1,5	1,6	1,8	2	2
80	1,5	1,5	1,5	1,5	1,7	1,9	2,1	2,1
100	1,5	1,5	1,5	1,5	1,8	2	2,2	2,2
125	1,5	1,5	1,5	1,5	1,9	2,1	2,4	2,4
160	1,5	1,5	1,5	1,6	2	2,2	2,5	2,5
200	1,5	1,5	1,5	2	2,5	2,8	3,2	3,2
250	1,5	1,5	1,8	2,5	3,2	3,6	4	4
320	1,5	1,6	2,2	3,2	4	4,5	5	5
400	1,5	2	2,8	4	5	5,6	6,3	6,3
500	1,5	2,5	3,6	5	6,3	7,1	8,0	8,0
630	1,8	3,2	4,5	6,3	8	9	10	10
800	2,4	4	5,6	8	10	11	12,5	a)
1 000	3,2	5	7,1	10	12,5	14	16	
1 250	4,2	6,3	9	12,5	16	18	20	
1 600	5,6	8	11	16	20	22	25	

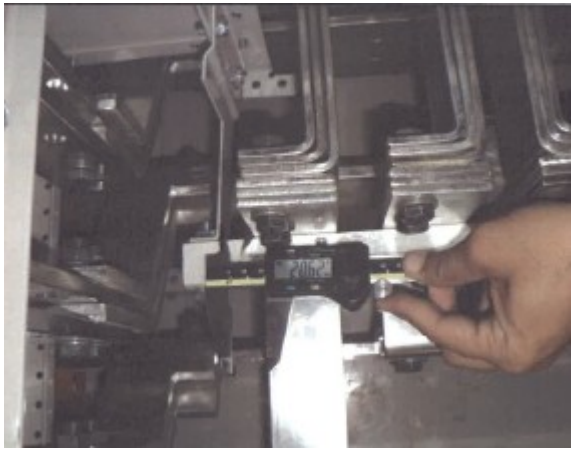
a) Insulation of material group IIIb is not recommended for use in polluton degree 3 above 630 V.

b) As an exception, for rated insulation voltages 127, 208, 415, 440, 660/690 and 830 V, creepage distances corresponding to the lower values 125, 200, 400, 630 and 800 V may be used.

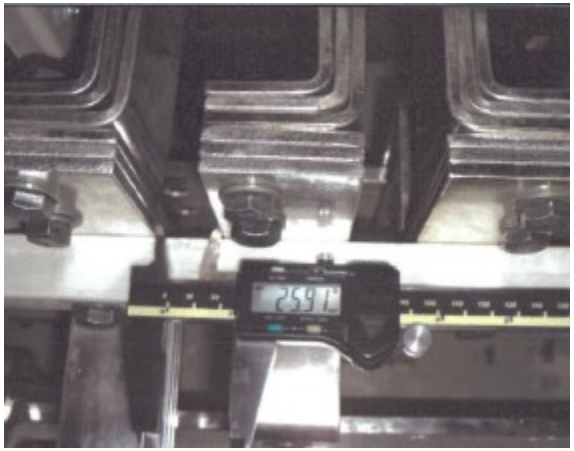
c) Material groups are classified as follows, according to the range of values of the comparative tracking index (CTI) (see 3.6.17):

- Material group I 600 ≤ CTI
- Material group II 400 ≤ CTI < 600
- Material group IIIa 175 ≤ CTI < 400
- Material group IIIb 100 ≤ CTI < 175

Clearance & Creepage distances



Clearance distance



Creepage distance

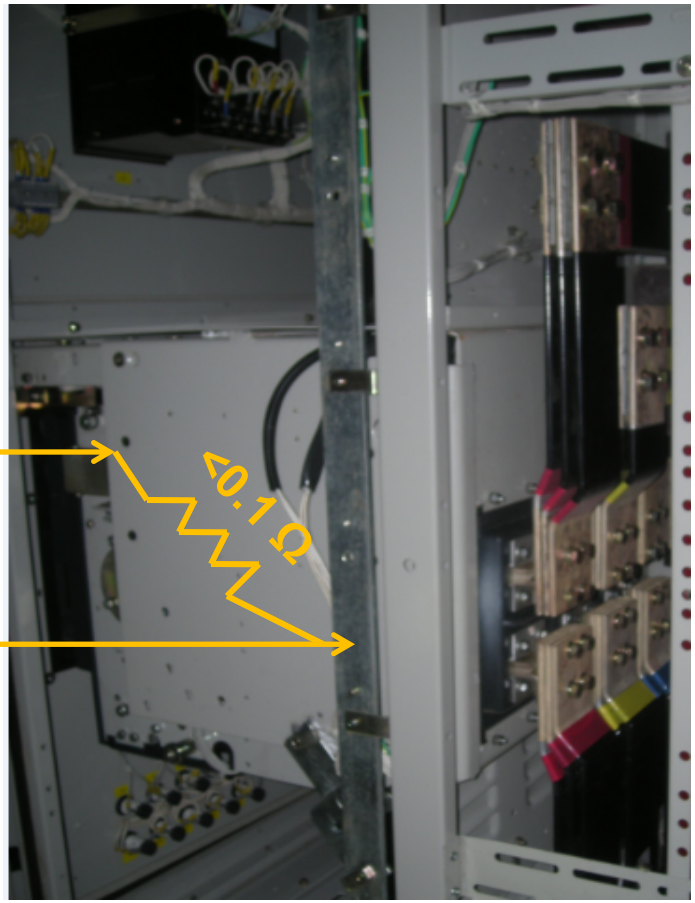
5. Protection against electric shock & integrity of circuit

Testing (10.5)	Comparison	Assessment
✓	✕	✕

Test objective :

Check for effectiveness of the protective circuit

Driving current (≥10A DC) is passed between exposed conductive path and the terminal of protective conductor



Exposed Conductive part

Protective Conductor (Earth Bar)

Performance Requirement

9. Dielectric Properties

Di electric test is carried out to check the insulation performance level of assembly for maximum voltage

Each circuit of the assembly shall be capable of withstanding

1) Power frequency withstand voltage
2) Impulse withstand voltage

9.1 Power frequency withstand voltage

Testing (10.9.2)	Comparison	Assessment
✓	✕	✕

- System having temporary over-voltages (Duration: Several seconds)
- Conducted for Main Circuits and Auxiliary Circuits.
- Test Voltage depends upon Rated Insulation Voltage
- Duration of Application of Test Voltage: 5 sec (leakage current < 100mA)

Rated insulation voltage (Ui) (line to line a.c or d.c) V	Dielectric test voltage (a.c) r.m.s V	Dielectric test voltage (d.c) V
Ui ≤ 60	1000	1415
60< Ui ≤ 300	1500	2120
300< Ui ≤ 690	1890	2670
690< Ui ≤ 800	2000	2830
800< Ui ≤ 1000	2200 (3500V/60s)	3110
1000< Ui ≤ 1500*	--	3820

9.2 Impulse withstand voltage test

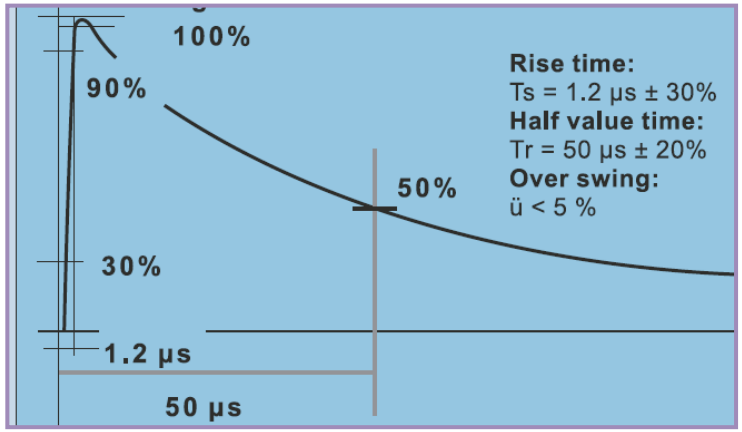
Testing (10.9.3)	Comparison	Assessment (10.9.3.5)
✓	✗	✓
		Test is not required when clearances in assembly is more than 1.5 times than specified.

- Test Voltage depends on nominal voltage of supply and the overvoltage category
- Application of Test Voltage: 5 times for each polarity at intervals of 1sec

Rated impulse withstand voltage Uimp (kV)	Minimum clearance mm
≤ 2.5	1.5
4.0	3.0
6.0	5.5
8.0	8.0
12.0	14.0

Impulse withstand voltage test

Rated Impulse Withstand Voltage U_{imp} kV	Test voltage and corresponding altitudes				
	$U_{1.2/50}$ a.c. peak and d.c. kV				
	Sea Level	200 m	500 m	1000 m	2000 m
0.33	0.36	0.36	0.35	0.34	0.33
0.5	0.54	0.54	0.53	0.52	0.5
0.8	0.95	0.9	0.9	0.85	0.8
1.5	1.8	1.7	1.7	1.6	1.5
2.5	2.9	2.8	2.8	2.7	2.5
4	4.9	4.8	4.7	4.4	4
6	7.4	7.2	7	6.7	6
8	9.8	9.6	9.3	9	8
12	14.8	14.5	14	13.3	12



10. Verification of temperature rise

Temperature-rise test is carried out to check the assembly characteristic at maximum operating condition for

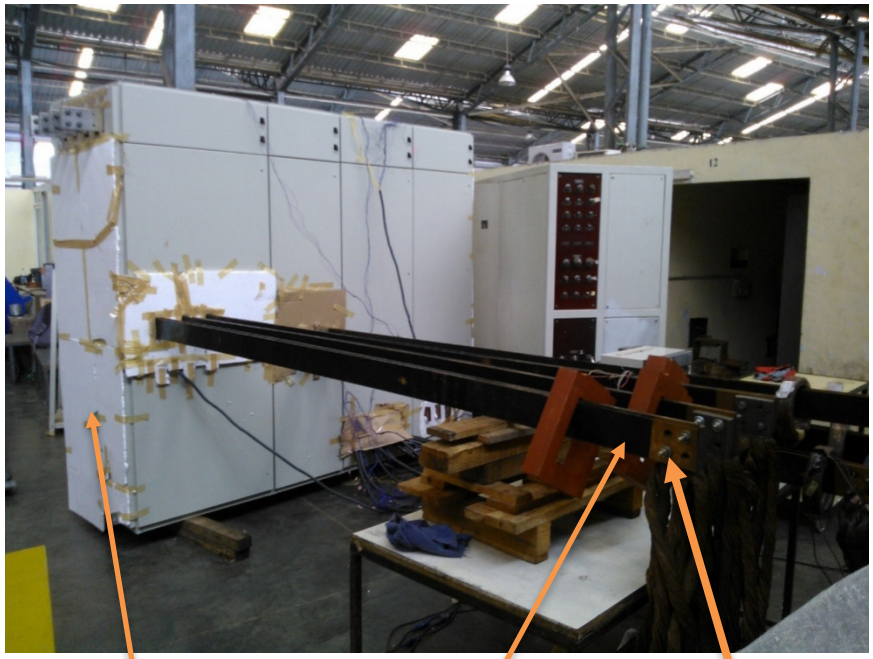
1) Rated current
2) For given feeders
3) Volume of enclosure

Temperature Rise = Temperature of the current carrying part – Ambient Air temperature

Verification of temperature rise

Testing (10.10.2)	Comparison (10.10.3)	Assessment (10.10.4)
✓	✓	✓
Complete ASSEMBLY	1) Functional units shall belong to the same group as selected for test 2) Same type of construction 3) Same or increased overall dimensions 4) Same or reduced internal separation 5) Same or reduced power losses 6) Same or reduced number of o/g circuits	Single compartment ASSEMBLY with rated current not exceeding 630 A
Individual functional units separately and the complete ASSEMBLY		Multiple compartment ASSEMBLY with rated current not exceeding 1600 A
Individual functional units and the main and distribution busbar separately as well as the complete ASSEMBLY		In accordance with the method of IEC 60890. Calculation of Power loss, Enclosure constant, temperature distribution factor is required.

Verification of temperature rise test



Thermocol

Star point

3 meter Test conductor

Verification of temperature rise

Table 6 – Temperature-rise limits (9.2)

Parts of ASSEMBLIES	Temperature rise K
Built-in components [a]	In accordance with the relevant product standard requirements for the individual components or, in

Limited by :

- mechanical strength of conducting material ;
- possible effect on adjacent equipment;
- permissible temperature limit of the insulating materials in contact with the conductor;
- effect of the temperature of the conductor on the apparatus connected to it;
- for plug-in contacts, nature and surface treatment of the contact material

Discrete arrangements of plug and socket-type connections	Determined by the limit for those components of the related equipment of which they form part [e]

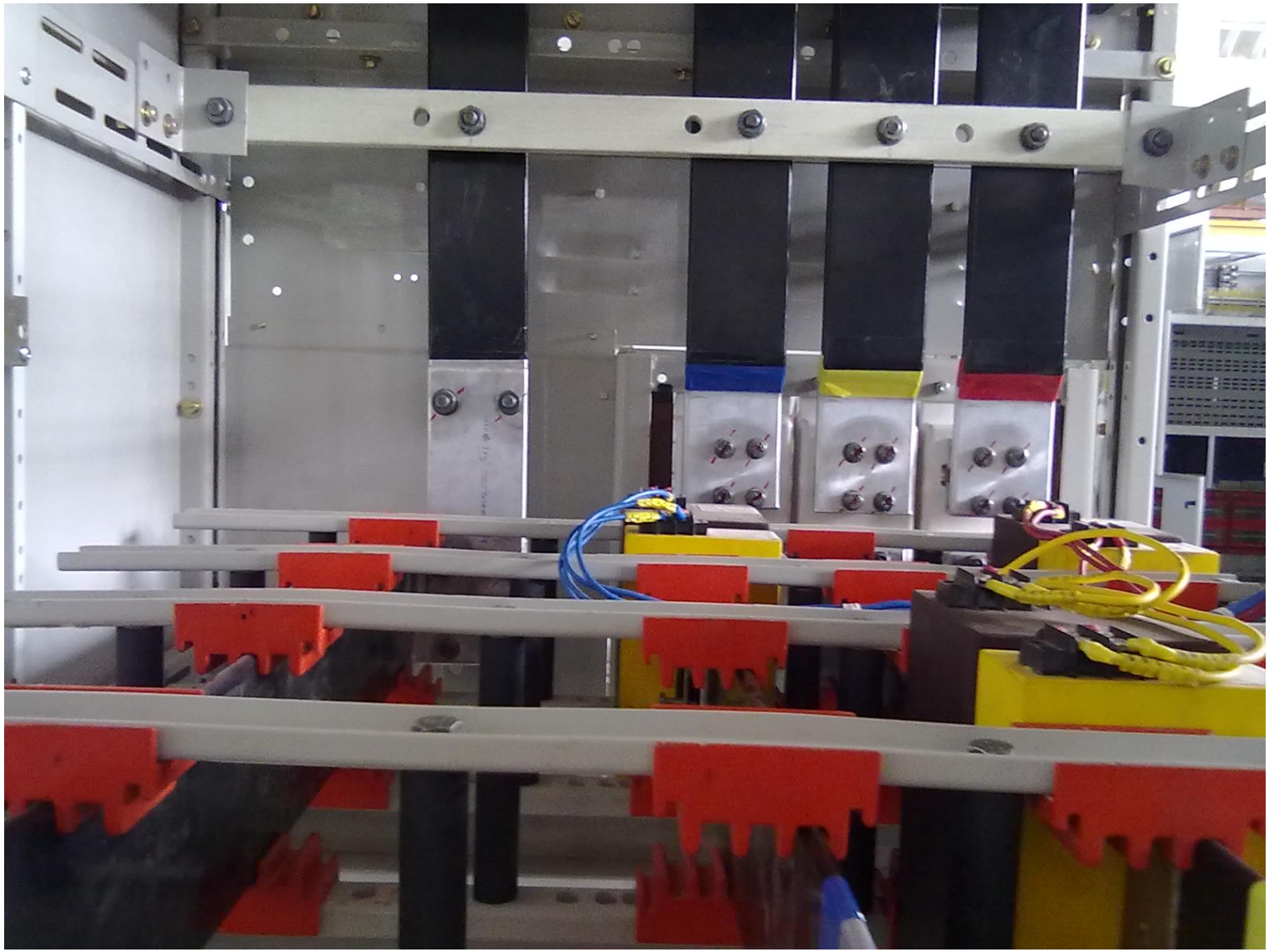
11. Short-circuit withstand strength

Testing (10.11.5)	Comparison (10.11.3)	Assessment (10.11.4)
✓	✓	✗
	1) requirements are greater or equal to reference design – Cross-sectional dimensions of the busbar and connections – Spacing of the busbar and connections – SCPDs are equivalent, 2) requirements are less or equal to reference design – Short circuit rating of each circuit – Busbar supports spacing 3) requirements are same as that of reference design – Conductor material and its properties – Enclosure design, type and dimensions – Compartment mechanical design and dimensions	

Short circuit withstand test

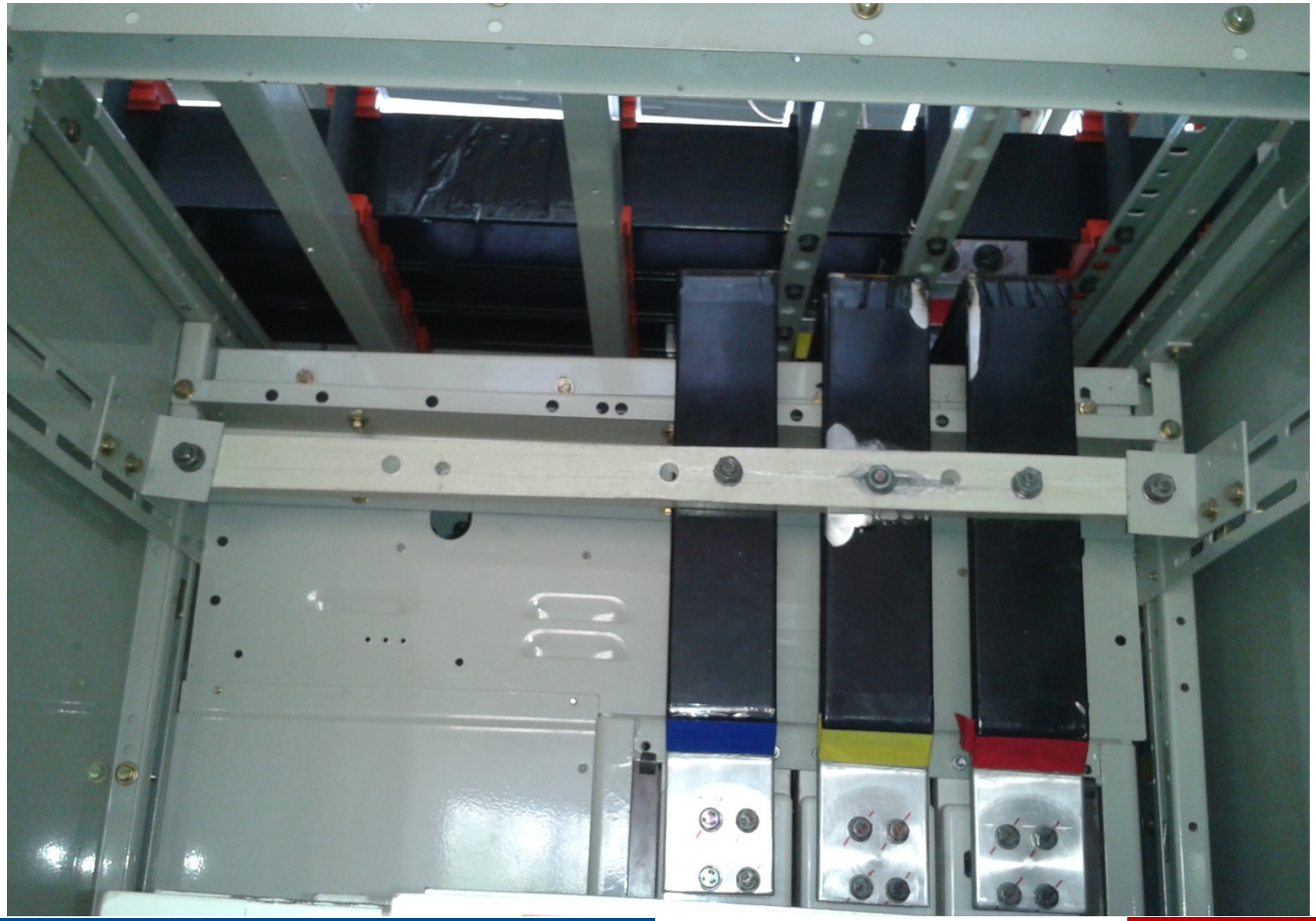
Short circuit test board

Short-circuit withstand strength



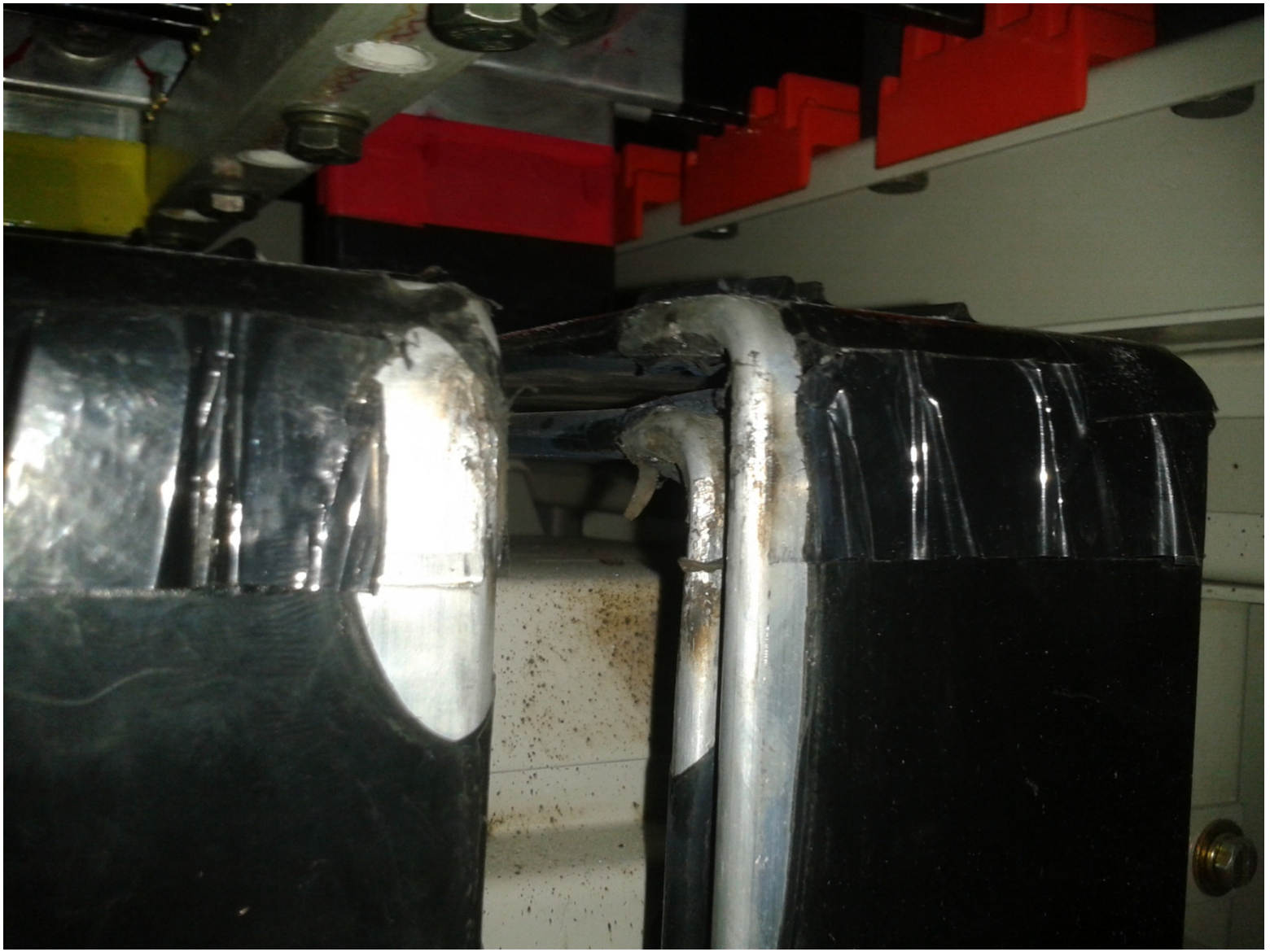
Before Test

Short-circuit withstand strength



After Test

Short-circuit withstand strength



After Test

Min cross section for short duration Thermal stress

Annex B
(normative)

Method of calculating the cross-sectional area of protective conductors with regard to thermal stresses due to currents of short duration

The following formula shall be used to calculate the cross-section of the protective conductors necessary to withstand the thermal stresses due to currents with a duration of the order of 0,2 s to 5 s.

$$S_p = \frac{\sqrt{I^2 t}}{k}$$

where

S_p is the cross-sectional area, in square millimetres;

I is the value (r.m.s.) of a.c. fault current for a fault of negligible impedance which can flow through the protective device, in amperes;

t is the operating time of the disconnecting device, in seconds;

NOTE Account should be taken of the current-limiting effect of the circuit impedances and the limiting capability (Joule integral) of the protective device.

k is the factor dependent on the material of the protective conductor, the insulation and other parts and the initial and final temperatures, see Table B.1.

Table B.1 – Values of k for insulated protective conductors not incorporated in cables, or bare protective conductors in contact with cable covering

	Insulation of protective conductor or cable covering		
	Thermo-plastic (PVC)	XLPE EPR Bare conductors	Butyl rubber
Final temperature	160 °C	250 °C	220 °C
	Factor k		
Material of conductor:			
Copper	143	176	166
Aluminium	95	116	110
Steel	52	64	60
The initial temperature of the conductor is assumed to be 30 °C.			

More detailed information is to be found in IEC 60364-5-54.

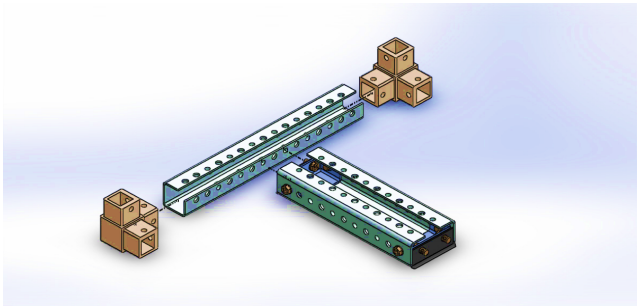
13. Verification of mechanical operation

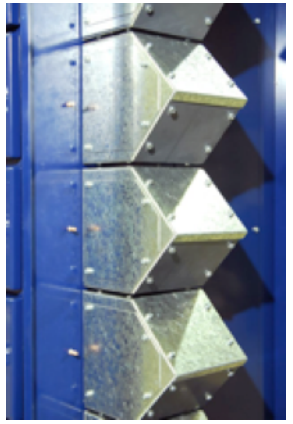
Testing (10.13)	Comparison	Assessment
✓	✕	✕
Rated number of operating cycles are 200 (50)		

Test objective:

The functional unit mounted inside the assembly should be closed and opened for 200 times.

No difference should noticeable in the effort required for operation at the start and end of the test.





Thank You