Introduction:

IEC 60439, the standard for low-voltage switchgear and controlgear assemblies, was under restructuring from the last decade. The new series of IEC 61439 standards were published in January 2009. This standard has brought considerable clarity in technical interpretation.

The new standard follows the philosophy of IEC 60947 series i.e. IEC 61439-1 is 'General Rules' standard to be referred to by subsidiary product parts of IEC 61439 series. (Refer Table 1)

The IEC 60439 standards were ambiguous about how to assess compliance of partially type tested assemblies. As a result manufacturers and testing bodies often treated partially type-tested assemblies differently. One of the main features of IEC 61439-1 is that the discrimination between Type Tested Assemblies (TTA) and Partially Type Tested Assemblies (PTTA) has been eliminated by the verification approach.

The three different but equivalent types of verification methods are introduced and these are;

a) Verification by Testing.

b) Verification by Calculation/Measurement.

c) Verification by Design rules.

The requirements regarding short circuit performance, temperature rise, dielectric properties and rated diversity factor have been covered in more detail.

Verification of Requirements:

Verification Table 2 gives the characteristics to be verified and options available for verification.

Salient features of IEC 61439

1. Verification of temperature rise

   - For multiple compartment assembly, verification by calculation can be done up to rated current of 1600 A only.

   - Assemblies, verified by design rule from a similar tested assembly, should comply with the following:
     - Functional units shall belong to the same group as functional unit selected for test.
     - Same type of construction.
     - Same or increased overall dimensions.
     - Same or reduced internal separation.
     - Same or reduced power losses in the same section of assembly.
     - Same or reduced number of outgoing circuit for every section.

   - Rated diversity factor (RDF) is elaborated in more details with incoming and outgoing circuit diagrams.

   - The average ambient temperature for the duration of test shall not exceed 35°C.

<table>
<thead>
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<th>Table 1: Parts of IEC 61439 series</th>
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<tbody>
<tr>
<td>IEC 61439-1</td>
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<td>IEC 61439-4</td>
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<td>IEC 61439-5</td>
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<td>IEC 61439-6</td>
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2. Short circuit withstand test
Verification of assembly by design rules is permitted, if:

- Following requirements are greater than or equal to reference design
  - Cross-sectional dimensions of the busbars and connections
  - Spacing of the busbars and connections
  - SCPDs are equivalent, i.e. of the same make with the same or better I²t based on the device manufacturer’s data

- Following requirements are less than or equal to reference design
  - Short circuit rating of each circuit
  - Busbar supports spacing

- Following requirements are same as that of reference design
  - Conductor material and its properties
  - Enclosure design, type and dimensions
  - Compartment mechanical design and dimensions

If all the above requirements are satisfied, then further verification by calculation or actual testing is not required.

3. Power frequency withstand voltage
The values of dielectric test voltage are reduced corresponding to rated insulation voltage (Refer Table 3)

4. Impulse voltage withstand test
- Verification is mandatory either by test or by design rules.
- Test is not required when clearances in the assembly are 1.5 times the specified value in Table - 4.

5. Degree of protection
- The IPX1 to IPX6 tests on an assembly are deemed to be failure if water comes into contact with electrical equipment housed within the enclosure.
- Requirements for ‘empty enclosures for assemblies (IEC 62208)’ have been incorporated in the standard.

6. Mechanical operation
- Rated numbers of operating cycles have been increased from 50 to 200.

7. Protection provided by barriers
The protection provided by horizontal top surfaces of easily accessible barriers is changed from IPXXB (the protection of person against access to hazardous parts with finger) to IPXXD (the protection of person against access to hazardous parts with wire).

8. Cross-section area of neutral
- 100% - for phase cross section area upto 16 mm²
- 50% - for phase cross section area above 16 mm², with a minimum of 16 mm²
- For conductor other than copper, the cross section should be greater than equivalent copper conductor

9. Additional Tests in IEC 61439
- Resistance to corrosion Test
  - Purpose:
    To ensure that deterioration of metallic component caused by corrosion shall not impair the mechanical strength of switchboard.
  - Procedure:
    The test is carried out on a typical switchboard enclosure or on a representative sample showing the same constructional details.
    - 6 cycles of 24 hr each to Damp Heat Cycling Test according to IEC 60068-2-30 at (40±3)°C & relative humidity of 95%.
2 cycles of 24 hr each to Salt Mist test according to IEC 60068-2-11 at temperature of (35±2)°C.

**Assessment Criteria:**
- The mechanical integrity shall not be impaired.
- Doors, hinges, locks, etc. shall work without abnormal effects.
- Seals shall not damage.
- There shall be no iron-oxide, cracking or other deterioration more than that allowed by ISO 4628-3 for degree of rusting Ri1.

**Verification of Thermal stability**

**Purpose:**
To check the thermal properties of the enclosure

**Procedure:**
- 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.

**Assessment criteria:**
- The sample shall show no cracks nor shall the material become sticky or greasy
- Sample is pressed with the forefinger wrapped in a dry cloth with a force of 5 N; no traces of cloth shall remain on the sample.

**Resistance to abnormal heat & fire (Glow Wire Test)**

**Purpose:**
Glow wire test checks the capability of insulation material to handle thermal stresses produced by sources of heat or ignition.

**Procedure:**
- Sample: Thinnest wall thickness of the completed application.
- Pre-treatment: 24 hours at 23°C at 50% RH.
- Temperatures of glow wire: 550, 650, 750, 850 or 960 degrees C (depending on the relevant specification).
- Force: 1 N
- Contact time: 30 s

**Assessment criteria:**
- There is no flame and glowing on the sample or flames/glowing of the sample extinguish within 30 s.
- The cotton or the paper underlay doesn’t ignite or burn.

**Resistance to UV radiation**

**Purpose:**
The UV radiation causes deterioration of synthetic material use for enclosures.

**Procedure:**
- 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 500 hrs.
- The value of temperature and humidity for the test are (65±3)°C and (65±5) %.

**Assessment criteria:**
- Adherence of synthetic material (according to ISO 2409) shall have minimum 50% retention.
- Sample shall not show cracks or deterioration visible to normal or corrected vision without any additional magnification.

This test is not required if synthetic material supplier demonstrates that materials of same thickness or thinner comply with this requirement.

**NOTE:** This test is applicable only for enclosures and external parts of ASSEMBLIES intended to be installed outdoors.
Mechanical Impact Test

Purpose:
This test measures resistance of an enclosure towards external Mechanical Impact.

Procedure:
- The test is carried out on a sample having weight 1.25 times its maximum shipping weight.
- From a standstill position, the ASSEMBLY shall be raised smoothly without jerking in a vertical plane to a height of (1±0.1) m and lowered in the same manner to a standstill position. This test is repeated a further two times.
- After this the ASSEMBLY is raised up and suspended for 30 min at a height of (1±0.1) m without any movement.
- Following this test the ASSEMBLY shall be raised smoothly without jerking from a standstill position to a height of (1±0.1) m and moved (10±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.

Assessment criteria:
- During the test, with the test weights in place, the ASSEMBLY shall show no deflections and after the test show no cracks or permanent distortions visible to normal or corrected vision without additional magnification, which could impair any of its characteristics.

Validity of certificates as per IEC 60439:
Where tests on the ASSEMBLY have been conducted in accordance with the IEC 60439 series, prior to the publication of relevant product standard in the IEC 61439 series, and the test results fulfill the requirements of the relevant part of IEC 61439, the verification of these requirements need not be repeated.

Conclusion:
The 4th edition of IEC 60439-1 was published in 1999 with a subsequent amendment in 2004. This standard did not mandate compliance to stringent safety requirements (such as impulse withstand and resistance to abnormal heat and fire i.e. glow wire) which are present in other LV product standards.
In the new standard (IEC 61439-1) these safety requirements have been included in addition to others pertaining to satisfactory performance under applicable environmental conditions.
Hence, with these additions IEC 61439 series becomes the most updated document from a technological perspective.

Relation between IK code & Impact energy.

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NOTE: Mechanical Impact test is not applicable to low voltage power switchgear and controlgear (PSC) assemblies.

Marking:

Purpose:
To ensure that the markings are legible.

Procedure:
- Marking made by moulding, pressing, engraving or similar shall not be submitted to the following test.
- The test is made by rubbing the marking by hand for 15 s with a piece of cloth soaked in petroleum spirit.