Power Arc Testing on Insulator Sets

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Power arc tests on insulator sets (IEC 61467:2008)

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Power arc testing according to IEC 61467:2008
Choosing the test arrangement: the set’s position in the line

Choose arc current level according to where in the line the set will be used

1. \( I = I_{sys} \)
2. \( I = 0.5 \ I_{sys} \)
3. \( I = 0.2 \ I_{sys} \)

For current level \( I = I_{sys} \):
unbalanced supply circuit, \( IS1 = I, IS2 = 0 \)

For current levels \( I = 0.5 \ I_{sys} \) and \( I = 0.2 \ I_{sys} \):
balanced supply circuit, \( IS1 = I/2, IS2 = I/2 \)
Choosing the test arrangement: type of tower

- Balanced return circuit (centre phase window) = test series X
- Unbalanced return circuit = test series Y

<table>
<thead>
<tr>
<th>Test series</th>
<th>Test circuit (see Table 1)</th>
<th>Short-circuit current</th>
<th>Number and duration of tests (test sequence)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>A</td>
<td>$I_n = 0.2 I_{sys}$</td>
<td>Two of $t_n = 0.2$ s and one of $t_n = 1$ s</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>$I_n = 0.5 I_{sys}$</td>
<td>Two of $t_n = 0.2$ s and one of $t_n = 1$ s</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>$I_n = I_{sys}$</td>
<td>Two of $t_n = 0.2$ s and one of $t_n = 0.5$ s</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>$I_n = 0.2 I_{sys}$</td>
<td>Two of $t_n = 0.2$ s and one of $t_n = 1$ s</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>$I_n = 0.5 I_{sys}$</td>
<td>Two of $t_n = 0.2$ s and one of $t_n = 1$ s</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>$I_n = I_{sys}$</td>
<td>Two of $t_n = 0.2$ s and one of $t_n = 0.5$ s</td>
</tr>
</tbody>
</table>
Typical test arrangement
Verification tests

- MFLT - mechanical failing load tests (insulator units only).

- DPFF - dry power frequency flashover to check the puncture.

- Additional electrical tests to verify the withstand characteristics (if more than 1/3 of sheds broke).
Typical test arrangements - examples
Statistical overview of five years of testing
Insulator set types and materials

### Material of sets

- Composite (81x) - 17%
- Glass cap and pin (34x) - 50%
- Long rod (porcelain) (27x) - 21%
- Glass cap and pin - short string (12x) - 7%
- Porcelain cap and pin (8x) - 5%

### Insulator sets

- Suspension (92x) - 57%
- Tension (49x) - 30%
- "V" (17x) - 11%
- Cross-arm (4x) - 2%
Successful tests and failures

- 22% Successful test (109x)
- 6% No DPFF (36x), incl. 4x failing mech. load (fittings) → not evaluated
- 6% No mech. Load tests (insulator units) (10x) → not evaluated
- 4% Failure during DPFF (0x)
- 2% Falling mech. load (fittings) < specification (4x)
- 0.6% Falling mech. load (insulator units) < specification (6x)
- 0% Seperation during arc test (1x)
MFLT results on insulator units

- Not required by customer (10x) → not evaluated
- Failed (6x)
- Successful mechanical tests (145x)
Results of mechanical tests on fittings and conductors

- Tests on conductors (0x)
- Failed (4x)
- Successful tests (32x)
- Not required by customer (106x) → not evaluated
Critical parts of insulator sets
Long-rod insulator sets

- Melting of metallic insulator unit components
- Breaking of sheds near to metallic parts
- Arc puddling of metal (metal evaporation of the protective fittings)
Composite insulator sets

- Silicone rubber has high resistance to power arc tests
- Critical point is the connection between fibre-glass core and metal end fittings
Cap and pin insulator sets (glass and porcelain)

- High mechanical resistance after power arc tests.
- Breaking of sheds, cooling down of glass cap and pin units.
Load-bearing fitting protection and arc direction fittings

- Mechanical strength & thermal strength (much higher than short-circuit test).
- Danger of material melting on to insulator units.
- Movement / falling down -> arc root sits on the load-bearing fittings.
Protective fittings: corona rings, grading rings, etc.

- Primarily not designated for arc current.
- Influence the arc root position and movement.
- Danger of material melting on to insulator units.
- Movement / falling down.
- Contour changes – excessive corona and radio noise.
Power arc behaviour during tests
Behaviour 1: intended behaviour

Suspension

Tension

- Arc runs between the protective fittings (arching horns, arcing rings, etc.)
  - Limited impact on insulator set.
  - Stress on protective fittings and insulator units.
  - Low impact on the tower and conductor.
Behaviour 2: unintended behaviour

- Arc travels along the line conductor or tower
  - Reduced impact on insulator set.
  - Less stress on protective fittings and insulator units.
  - Much greater negative impact on the tower and conductor.
Power arc behaviour during the tests

- Video No. 1 – Power arc between the protective fittings.
- Video No. 2 – Arc moving on the line conductor or tower.

What is the preferred behaviour of the power arc?