Coordination of Surge protection devices

Design guide
Surge arresters for commercial and industrial buildings
Coordination between the surge protective device and its disconnect circuit breaker

An external disconnecting device must be coordinated with a surge protective device in order to achieve:
- continuity of service:
  - do not trip due to surge current,
  - do not increase (Up) voltage protection level.
- effective protection against all types of overcurrents:
  - overload due to SPD aging,
  - short circuit of low intensity (impedant) due to temporary overvoltages,
  - short circuit of high intensity due to SPD degradation.

The disconnecting device must be coordinated with the surge protective device. It is designed to meet the following two constraints:

**Resistance to lightning current**
The resistance to lightning current is an essential characteristic of the surge protective device’s external disconnecting device.
The device must be capable of passing the following standardized tests: not trip upon 15 successive impulse currents at In.

**Resistance to short-circuit current**
The breaking capacity is determined by the installation rules (IEC 60364 standard):
- the external disconnecting device must have a breaking capacity equal to or greater than the presumed short-circuit current Isc at the point of installation.
- when this device is integrated into the surge protective device, conformity with product standard IEC 61643-11 naturally ensures protection.
Main reasons why the disconnecting device recommended by the manufacturer should be used:
- if the disconnecting device’s rating is lower than the recommended rating: risk of the disconnecting device opening in normal operation.
- If the disconnecting device’s rating is higher than the recommended rating: risk of non-disconnection during a temporary voltage surge.

### Surge protective device coordination (cont.)

**Protection Load protection**

- **External disconnecting device**
- **Fuse protection combined with the SPD**
- **Circuit breaker protection combined with the SPD**
- **Circuit breaker protection integrated into the SPD**

<table>
<thead>
<tr>
<th>Lightning protection of equipment</th>
<th>Protection of installation (at end of the surge protective device’s life)</th>
<th>Continuity of service (at end of the surge protective device’s life)</th>
<th>Maintenance (at end of the surge protective device’s life)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
<td><img src="image3" alt="Image" /></td>
<td><img src="image4" alt="Image" /></td>
</tr>
<tr>
<td>*= All types of disconnecting devices protect the equipment satisfactorily</td>
<td><strong>Achieved if compliance with the MCB/SPD coordination table</strong></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Protection from (impedant) short circuits of low intensity not well ensured</td>
<td>Protection against (impedant) short circuits of low intensity</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><img src="image5" alt="Image" /></td>
<td><img src="image6" alt="Image" /></td>
<td><img src="image7" alt="Image" /></td>
<td><img src="image8" alt="Image" /></td>
</tr>
<tr>
<td>Only the surge protective device circuit is shut down</td>
<td>Change of fuses</td>
<td>Immediate resetting</td>
<td></td>
</tr>
</tbody>
</table>

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**Protection of installation (at end of the surge protective device’s life)**
- Achieved if compliance with the MCB/SPD coordination table
- Protection against (impedant) short circuits of low intensity

**Continuity of service (at end of the surge protective device’s life)**
- Only the surge protective device circuit is shut down

**Maintenance (at end of the surge protective device’s life)**
- Change of fuses
- Immediate resetting
Coordination between the surge protective device and its disconnect circuit breaker in the event of a short circuit

This table shows: the rating, curve and short circuit current level of the disconnector coordinated with the surge protective device.

(\#) For lightning impulse current withstand
Coordination between the surge protective device and its disconnect fuse in the event of a short circuit.
Surge protective device coordination (cont.)

Coordination between two surge protective devices, upstream/downstream

When two surge protective devices are installed in an electrical installation, coordination is needed according to IEC 61643-12 to obtain an acceptable stress distribution between the two surge protective devices according to their permissible energy "E".

![Diagram of Surge Protective Devices]

L and Zd represent the cable length and impedance respectively between the 2 surge protective devices.

Up2: level of protection of surge protective device SPD2.

Uw: impulse withstand voltage of the equipment to be protected.

Imax: maximum discharge current.

I2: lightning current: 

\[ I_2 < I_{max} SPD2 = I_1 + I_2 \]

E: permissible energy.

MCB: modular circuit breaker.

SPD: surge protective device.

For coordination between two surge protective devices, a minimum cable length between these 2 surge protective devices is needed to ensure that:

- \( I_2 < I_{max} SPD2 \).
- \( U_{p2} < Uw \).
- \( E_2 < E_{max} SPD2 \).
Minimum distance between two surge protective devices, upstream/downstream

For a cable section of 16 mm² and an impulse current equal to the maximum discharge current (Imax) of the upstream surge protective device.

Example
If iPRD65r is installed in the incoming panelboard, the second SPD iPRD8r must be installed at a cable length of 8 meters from the first one.

<table>
<thead>
<tr>
<th>Upstream surge protective device</th>
<th>Type 2</th>
<th>Type 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>iQuick PRD 20r</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iQuick PRD 40r</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iPRD 20r</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iPRD 40r</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iPRD 65r</td>
<td>0m</td>
<td>10m</td>
</tr>
<tr>
<td>iPRD 40r</td>
<td>0m</td>
<td>10m</td>
</tr>
<tr>
<td>iPRD 20r</td>
<td>2m</td>
<td>10m</td>
</tr>
<tr>
<td>iQuick PRD 40r</td>
<td>3m</td>
<td>10m</td>
</tr>
<tr>
<td>iQuick PRD 20r</td>
<td>2m</td>
<td>10m</td>
</tr>
<tr>
<td>iPRD 8r</td>
<td>9m</td>
<td>10m</td>
</tr>
<tr>
<td>iPRD 8r</td>
<td>8m</td>
<td>10m</td>
</tr>
</tbody>
</table>
Cascading in the event of a short circuit between the surge protective device disconnector and the upstream circuit breaker

What is cascading?

Cascading means using the circuit breakers’ limiting power, which allows circuit breakers of lower performance to be installed downstream.

The upstream circuit breakers then act as a barrier for major short-circuit currents. They thus enable circuit breakers of breaking capacity lower than the presumed short-circuit current (at their point of installation) to be loaded in their normal breaking conditions.

Since current limiting takes place all along the circuit controlled by the upstream current-limiting circuit breaker, cascading concerns all the devices located downstream of that circuit breaker.

It is not restricted to two consecutive devices.

Case 1

Disconnect circuit breaker not integrated into the surge protective device.

For this type of study, refer to the existing coordination tables.

MCCB = Molded-case circuit breaker.
MCB = Modular circuit breaker.
SPD = Surge protective device.
Case 2
Disconnect circuit breaker integrated into the surge protective device.

**MCCB** = Molded-case circuit breaker.

**MCB** = Modular circuit breaker.

**SPD** = Surge protective device.

**Type 3**

<table>
<thead>
<tr>
<th>Imax (kA)</th>
<th>In (kA)</th>
<th>Low risk</th>
<th>Medium risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Type 2**

- **NG125L C25 A** + **iQuick PRD 8r**
- **NG125L C63 A** + **iQuick PRD 20r**
- **NG125L C63 A** + **iQuick PRD 40r**

- **NG125H C25 A** + **iQuick PRD 8r**
- **NG125H C63 A** + **iQuick PRD 20r**
- **NG125H C63 A** + **iQuick PRD 40r**

- **iQuick PF 10**
- **iQuick PF 10**
- **iQuick PF 10**

- **IC60H C20 A** + **iQuick PF 10**
- **iQuick PRD 20r**
- **iQuick PRD 40r**

Uoc: 10 kV.