FIRE PREVENTION FOR CABLES,
CABLE TRAYS AND CONDUITS

1. INTRODUCTION

The objective of this Safety Instruction is to minimise fire risks in cabling and associated equipment.

2. HAZARDS

Intrinsic hazards associated with cables, cable trays and conduits include overheating, arcing, corrosion, micro-sparking, insulation destruction of any kind, vibrations, thermal stresses and movements.

Extrinsic hazards include depositions or overheating by near-by equipment or activities, mechanical or radiation damage, acid gases.

3. MINIMISING THE FIRE RISK

3.a) Conduits

Wall plugging, fire resistance

Conduits used for passing cables through walls, ceilings, etc., must be plugged with a material that meets or exceeds the fire rating of the original barrier.

Non-metallic cable trays or conduits shall consist of halogen-free flame-retardant material.

3.b) Cable Trays

Installation, load

Cable trays shall be engineered and properly installed according to the technical description of the supplier so as to preclude mechanical failure.

The maximum admissible mechanical load per unit length of a cable tray shall be respected.
Access

Access to cable trays must be kept free at all times, in particular maintenance access to connection points. A vertical space of 30 cm and an unilateral space of 45 cm shall be kept free at all times.

One must not walk on cable trays. Appropriate guidance shall be sign-posted at strategic locations where the cable tray could easily be confused with an access path or where the cable tray obstructs access to other equipment.

Earthing

Metallic cable trays, conduits or enclosures containing electrical equipment shall be earthed in such a way as to handle the maximum earth current. Metallic sections of cable trays shall be interconnected electrically by earth straps designed to withstand the maximum earth current.

Tray abuse

Electrical or other equipment shall not be located on cable trays. Cable trays shall not be utilised for storage. No combustible materials other than cables or cable ties shall be present.

Cleanliness

Cleanliness of cable trays is a prerequisite for fire prevention. Any debris deposition resulting from finished work shall be removed painstakingly, in particular metallic particles and combustible rubbish.

3.c) Cables and Connectors

Supplier rules

Rules issued by cable suppliers for cable usage, handling and laying have to be strictly followed.

The force that vertical cable sections put on connectors must be limited and be within the connectors’ specification.

The maximum length of freely hanging cable shall not exceed the length given by the cable’s specification.

The minimum bending radius as defined for each type of cable shall be respected.

Tying

Cables shall be tied to the cable trays. Mechanical damage to the cables during laying and tying shall be prevented. The use of properly set tie-tools is recommended.

Cable Connections to Printed Circuit Boards

Particular attention must be given to cables connected directly to printed circuit boards. Printed circuit boards shall neither be bent nor pulled out of their foreseen position by mechanical forces originating from cables.

Unused cables

It is recommended that all unused cables be removed from cable trays and conduits. If unused cables remain on the cable trays all leads and screens shall be earthed on both ends.
High Current Connectors and Connections

High current connectors shall not be corroded or mechanically damaged. Insertion type connectors shall be fully inserted prior to applying power. Connectors shall be mechanically coded to prevent false or reversed insertion. Power systems shall be interlocked to shut off when high current connectors are removed or partially removed.

Bolted high current leads shall be tightened with the correct torque required for the necessary contact pressure.

It is forbidden to bolt soldered cable ends.

Voltage monitoring leads shall be fused or connected via a current limiting resistor.

3.d) **Electrical Equipment**

Protection of User Specific Circuits

Protective devices for HV, LV and ELV power systems not belonging to the standard electricity distribution network maintained by ST division shall provide full protection against accidental earthing, shorting, or partial opening of any live conductor.

Cables using additional cooling

Cooled low voltage and extra low voltage power cables in underground areas shall have a minimum of two separate interlocks. At least one interlock shall react on over-temperature. The inter-lock system shall be of the fail-safe\(^1\) design.

Insulated circuits

Circuits using insulated HV, LV or ELV are permitted. Insulated circuits shall be equipped with earth impedance monitoring and earth fault interlock\(^2\).

Insulated LV and ELV electrical networks linked to other electrical circuits or earth via undefined cross sections\(^3\) shall undergo a risk evaluation assessing the consequences of accidental earth contact, opening or shorting anywhere on the system's live conductors.

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\(^1\) Loss of power, interruptions, component failure in any part of the system automatically puts the system in a safe state.

\(^2\) Excepted: safety sources for ELV or ELV and LV circuits with double insulation.

\(^3\) Applies mainly to physics experiments; their power circuits are often earthed via particle detector electronics or sensors. In consequence, the systems cannot be considered insulated in the sense of IEC-364.
Radiation

Electrical cables exposed to radiation may suffer from increased likelihood of corrosion and premature insulation ageing. Prevention of micro-sparking and arcing shall be part of the system design.

3.e) Routing and Geometry

Re-routing

Re-routing or addition of cables onto trays, tray parts or conduits already occupied by electrical cables of a different kind may violate an existing segregation philosophy and therefore jeopardise fire prevention measures. Any such type of re-routing or addition shall be subject to a risk evaluation.

Routing and Interference

Cable routing shall be such as to minimise or cancel the magnetic field exposure which suggests power return on the same tray or twisted line configurations. The magnetic forces due to ambient magnetic fields and due to possible fault currents must be taken into account. Such practice will also minimise electromagnetic interference.

Existing segregations

New cable installations must respect any existing segregation philosophy.

Adding new cables

Caution must be exercised when adding cables or other services to existing trays to make sure that already installed cables are not crushed, abraded, or otherwise damaged.

3.f) Vicinity

Water Condensation

Cable trays must not be placed underneath water condensation sources.

Hazardous services

Cable trays must not interfere with or suffer interference from other cable trays in the vicinity, or from conduits for hot air, water, smoke, heated gases, gas pipes or heating ducts.

Gas lines or any other lines, pipes, etc. must not be installed on cable trays. Conforming to the Flammable Gas Safety (Code G), electrical cables must be routed at least 0.5 m from piping systems carrying flammable gases.

Fire proofing

Fire-proof wrapping of cables, casing, coating and other means of preventing oxygen supply to cable trays are recommended provided the cable cooling remains adequate.
4. LEGAL MATTERS

4.a) General remark

The most recent European decrees, IEC\textsuperscript{4} or CENELEC\textsuperscript{5} standards and recommendations constitute the basic regulations governing electrical equipment and installations at CERN. The present Safety Instruction is based on the French Norm NF C 15-100 (Low voltage electrical installations), which corresponds to IEC norm of the series 364, and to the CENELEC harmonisation document of the series HD 384.

The requirements of this Safety Instruction do not preclude the more detailed requirements of the relevant standards.

4.b) Legal basis

This Safety Document is published by TIS Division under the procedure set out in the CERN Safety Policy Document SAPOCO/42 and pursuant to the CERN Staff Rules and Regulations.

Applicable Safety Documents:

- C1 Electrical Safety Code
- E Fire Protection
- G Flammable Gas Safety Code
- IS 23 Criteria and Standard Test Methods for the Selection of Electric Cables, Wires and Insulated Parts with Respect to Fire Safety and Radiation Resistance
- IS 24 Regulations applicable to Electrical Installations
- IS 28 Dangers due to Electricity
- IS 33 Voltage domains according to IEC
- IS 36 Safety rules for the Use of Static Magnetic Fields at CERN
- IS 40 Purchase and Installation of Uninterruptable Power Supplies
- IS 41 The Use of Plastic and other non-metallic materials at CERN with respect to Fire Safety and Radiation Resistance
- NS 13 Explosion Protection of Electrical Apparatus in Experimental Areas
- NS 24 Procedure for Dismantling Unused Electrical Cables

\textsuperscript{4} International Electrotechnical Commission
\textsuperscript{5} European Committee for Electrical Standardisation
**GLOSSARY**

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<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
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<tr>
<td>CENELEC</td>
<td>European Committee for Electrical Standardisation</td>
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<tr>
<td>EN</td>
<td>European Standard</td>
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<td>HD</td>
<td>Harmonised Document</td>
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<tr>
<td>NF C 15-100</td>
<td>French Standard: Low Voltage Electrical Installations</td>
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<td>SAPOCO</td>
<td>Safety Policy Committee</td>
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<td>ELV</td>
<td>Extra Low Voltage (U $\leq$ 50 VAC, U $\leq$ 120 VDC)</td>
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<td>LV</td>
<td>Low Voltage (50 VAC $&lt;$ U $\leq$ 1000 VAC, 120 VDC $&lt;$ U $\leq$ 1500 VDC)</td>
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<td>HV</td>
<td>High Voltage (U $&gt;$ 1000 VAC, U $&gt;$ 1500 VDC)</td>
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