

Mitigating the risks and the consequences of a fire

Marc Tavlet

European Organization for Nuclear Research

CERN, TIS Division

1211 Geneva 23, Switzerland

Marc.Tavlet @ cern.ch

Fire risk

Three steps in a fire :

- **The initiating phase** : Heat is generated at one point of a component, allowing more material to be involved, materials decompose, gas are generated, temperature rises **Flash-over**
- **The fully developed fire** ; fire spreads rapidly !
- **The decreasing fire**

Fire risk

Three components to have a fire :

- A combustible material (fuel)
e.g. plastics, rubbers, wood, composites...
- A combustive (oxygen in air)
- A heat source or ignition
e.g. a flame, an electrical over-load...

Fire prevention

During the design phase :

- Avoid “combustible” materials :
 - Metals and ceramics
 - Fire-retardant polymers
- Avoid oxygen ; inert atmosphere (?)
- Avoid heat and ignition source
 - Proper electr(on)ic design, and proper mounting !

Fire prevention by proper choice of materials

- Insulations of electrical cables :
High LOI (or TI) thermoplastics and rubbers
(Standards = ISO-4589, BS-2782/1, ...)
- Flame-retardant cables :
(Standards = CEI 60331, 60332...)
- Halogen-free, low-smoke materials !!
= avoid toxic and corrosive gases, reduce smoke density

Law at CERN = Safety Instruction 23 :

http://cern.web.cern.ch/CERN/Divisions/TIS/safdoc/IS/is23/is23_en.html

Fire prevention by proper choice of materials

- Fire-retardant rigid plastics and composites ;
V-0 (UL-94) or M-1 (NF P 50x...) rating

Problem with **CFRP**

- Halogen-free, low-smoke materials !!

to avoid toxic and corrosive gases, reduce smoke density

Problem with **FR-4** for PCBs

Law at CERN = Safety Instruction 41 :

http://cern.web.cern.ch/CERN/Divisions/TIS/safdoc/IS/is41/is41_en.html

Fire prevention by proper choice of materials

Other fire-retardant polymers to be used as

- Thin electrical insulators, problem with **films**
 - Liquid electrical insulators = **oils**
 - Thermal insulations, problem with **foams**
 - Flexible hoses and pipes = rubbers and plastics / prefer metals
 - Glazing, **Plexiglas, polycarbonate** / prefer mineral glass
- Always try to use halogen-free, low-smoke components to avoid toxic and corrosive gases, and reduce smoke density

Same CERN law : Safety Instruction 41

Fire detection

During the initiating phase !!

- Detect heat, temperature increase
(temperature sensors)
- Detect gas or fumes (“sniffers”)

! After flash-over ; TOO LATE !

Fire fighting

Ideally, during the initiating phase !

- Cut the heat source (electricity)
- Spread inert gas (not halon !)

Automatically or manually ?

If manually, avoid dense and toxic smoke.

- Others ...

After flash-over ; usually much water !

Remind

The consequences of a (contained) fire,
to the material and components,
as well as to the personnel,
as well as to the environment,
result more from the released products
(toxic gases, corrosive fumes and soiled
water) than from the fire itself !