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FIRE SAFETY CONCEPT

HI-ECN3 – Surface Building

In the context of the HI-ECN3 project, a code-compliant fire safety concept has been proposed for the new Service Building (BB85) that is intended to support the activities of the target area.

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Modifications

Versions	Date	Pages	Description
0.1	20.12.2024	17	Preliminary prescriptive fire safety concept report

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1 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to propose a fully code compliant fire safety solution for the service building (BB85) that meets the following safety objectives:

1. *Life Safety of occupants*
2. *Firefighter intervention*
3. *Environmental protection*
4. *Property protection and operation continuity*

1.2 REGULATORY FRAMEWORK

The requirements described in this document are obtained from the following regulatory frameworks:

1. *Ordonnance du DFI sur l'utilisation des matières radioactives ([OUMR](#))*
2. *Ordonnance sur la radioprotection ([ORaP](#))*
3. *[Code E](#) – Fire Protection*
4. *Code du Travail ([CdT](#))*

1.3 PROJECT DESCRIPTION

The HI-ECN3 project refers to the fire safety assessment for the proposed High Intensity ECN3 (HI-ECN3) Facility on the Prévessin campus of CERN (FR) which aims to provide unique capabilities for delivering a high intensity 400 GeV proton beam for fixed target physics at CERN SPS's North Area. The underground project scope includes the dismantling of TCC8 and ECN3, TT7 shielding recovery, a new Target Complex in TCC8 and a revised Experimental Area in ECN3. At the surface level, Buildings 911 and 918 will have new service and access buildings with the installation of a new access shaft to the underground areas, and a modified access road.

The scope of the FIRIA project for Hi-ECN3 consists of three activity areas: 1. Service Building 2. Target Area and 3. Experimental area and Access Shafts which spans across the following physical areas: the new service building BB85, a part of the tunnel 901 (TCC8), tunnel 900 (ECN3), Access shafts (TA851, TA852, TA853, TA854) and the Access areas of building 918 and 911.

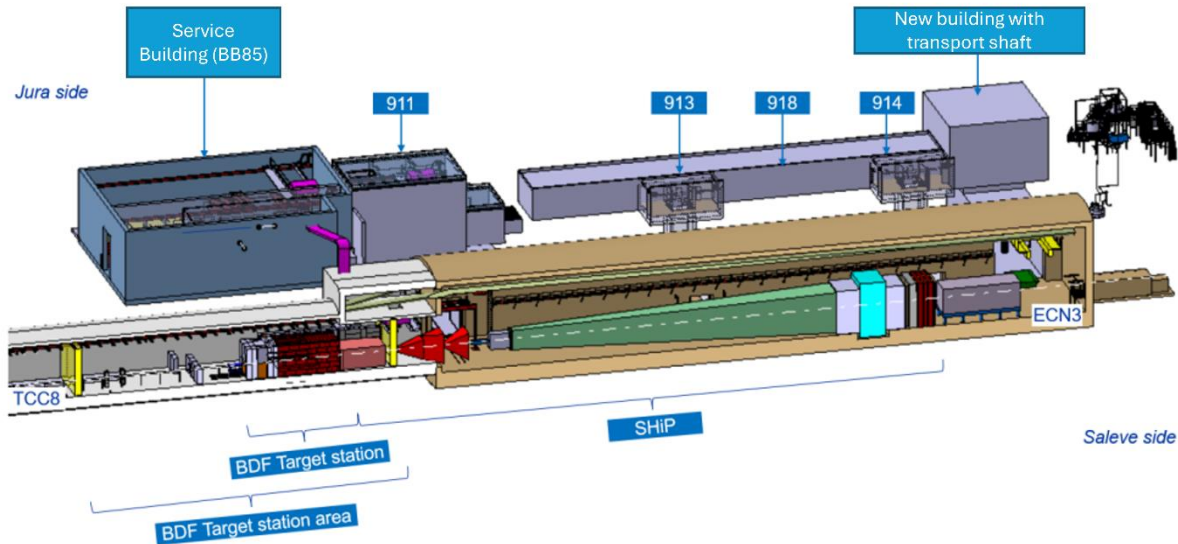


Figure 1: The Hi-ECN3 project scope consists of the service building, target station area, SHiP area, the transport shaft and the access shafts in buildings 911, 913 and 914.

1.4 SCOPE AND BOUNDARIES

The aim of this prescriptive report is to provide the fire safety requirements for the new service building based on the applicable regulatory framework such that the structure is full code-compliant for fire safety.

The scope of this report pertains solely to the to-be constructed Service Building denominated also as BB85. This report does not provide any requirements for the building 911 except prescribing the required fire partitioning between BB85 and B911. This document also provides the regulatory requirements to ensure a safe and effective firefighter intervention.

The ECN3 and TCC8 galleries that connect to the service building by evacuation and transport shafts will also be consolidated as per the specific safety requirements to aid occupant evacuation and firefighter intervention. However, these requirements are not within the scope of this document.

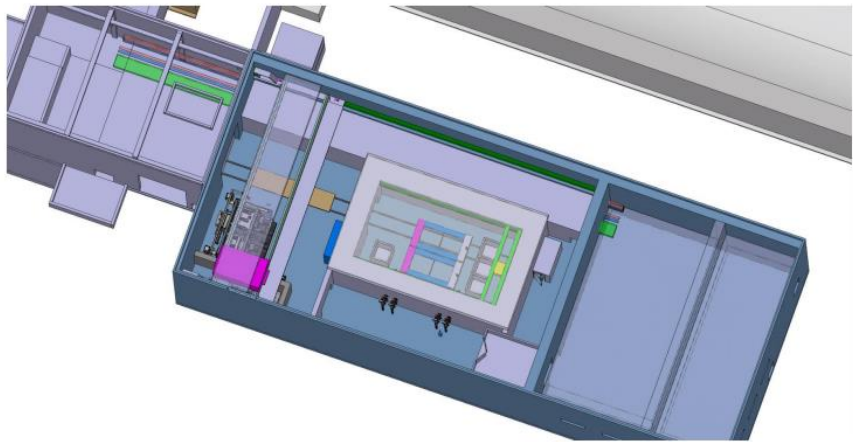


Figure 2: The tentative illustration of the service building and the different activities contained within it.

1.5 QUALITY ASSURANCE

The documentation for all the fire safety systems must be correctly archived in EDMS and made available along with the maintenance plan for safety systems (preferably in EAM).

2 GENERAL CONDITIONS

2.1 BUILDING BB85

The purpose of the building BB85 is to service the target area which includes preparing, mounting and dismantling the targets along with analysing the results produced by the ECN3 experimental area. The building is expected to have a shielded buffer zone for transport of activated material and access for a transport lorry. The building would also be used for manipulating and storing of activated materials and is thus classified as a “Type A” lab according to the Swiss regulations. The technical specifications of the surface building are described in Table 1.

Table 1: Technical specifications

Dimensions	46.5 m x 19.0 m x 11.0 m
Surface area	833
Floors	2
Construction material	Concrete

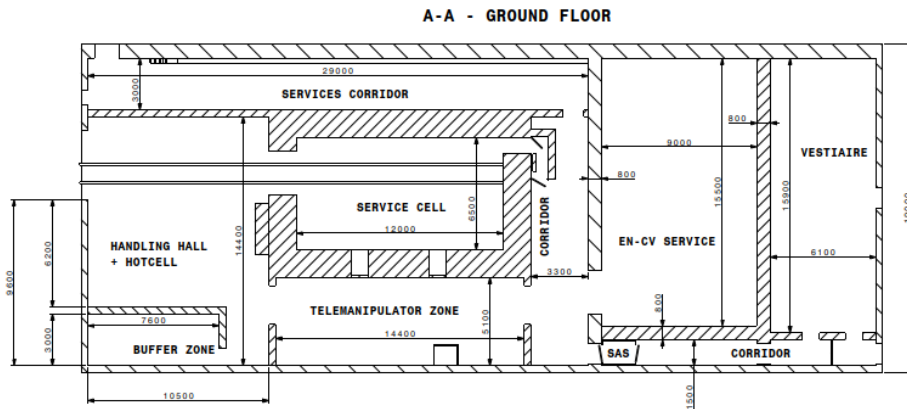


Figure 3: The layout of the service building indicating the various activities (preliminary design)

The main activities of the lab involving radioactive material manipulation is located at the ground level. The upper floors of the structure will house the cooling-ventilation room (EN-CV room) and the control room.

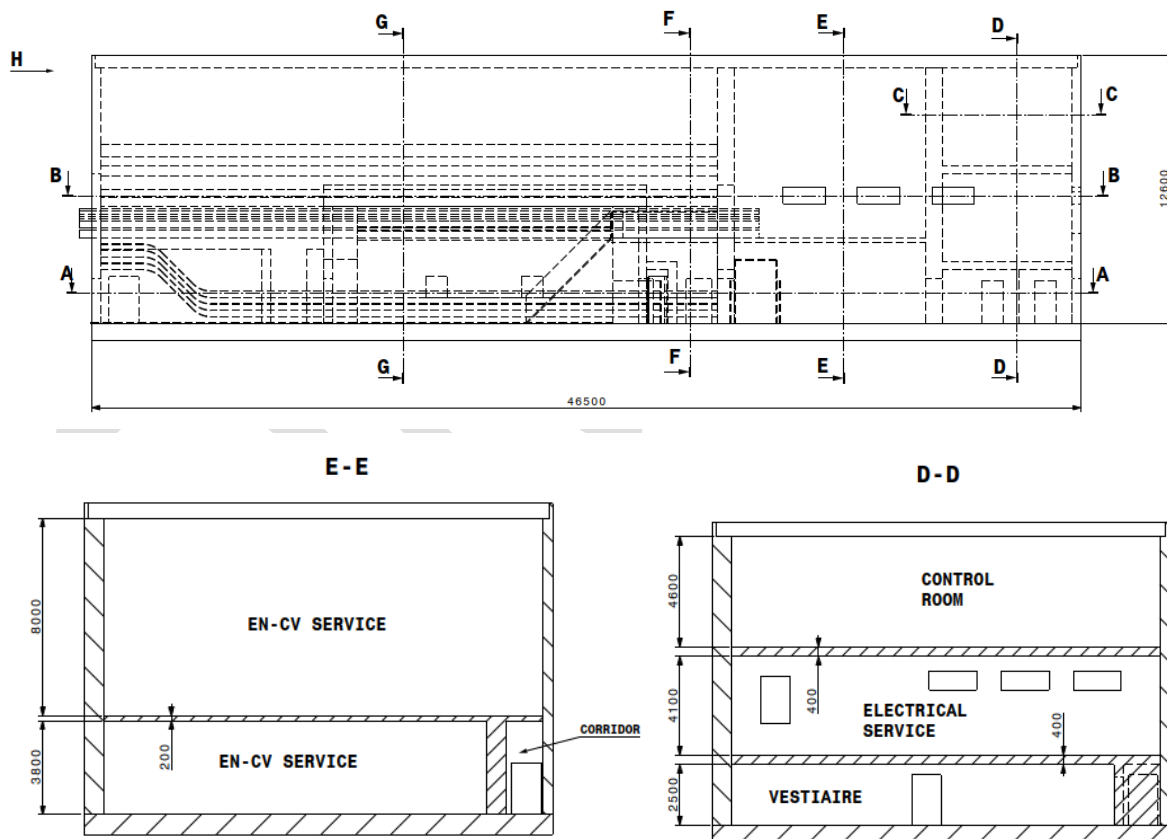


Figure 4: The sectional view of the service building illustrating the other activities contained in the building

3 INPUT DATA TO FIRE DESIGN

3.1 BUILDING AND ACTIVITY REGULATORY CLASSIFICATION

The building is expected to host the following activity types within it:

1. Type A lab according to the Swiss Radiation Protection Regulations
2. Technical rooms (electrical, cooling etc)
3. Changing rooms
4. Transport area

3.2 OCCUPANCY

The building occupants are personnel aware of the risks and trained to act appropriately during emergencies. The maximum number of occupants of the building are expected to be less than 50 people.

3.3 PRESENCE OF COMBUSTIBLE MATERIAL

The combustible with the highest risk of fire in the service building is expected to be the Hadron stopper coil. A detailed combustible inventory will be provided by the radiation protection group and EN-CV

Zone	Fire load
Handling hall	Hot cell equipment
Service cell	Hadron stopper coil
EN-CV room	Filters and other electrical equipment
Vestiaire	Clothes, miscellaneous plastic items

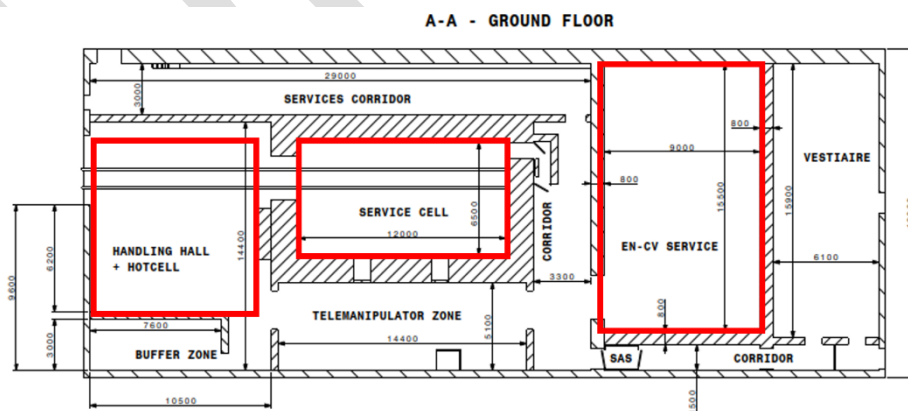


Figure 5: The zones that contain combustible materials

4 FIRE PROTECTION BETWEEN BUILDINGS

The exterior walls of the building must be at least EI90 (for Type A lab) and the roof of the structure must be EI90 as per Article 9, [OUMR](#). The building is compartmentalised from the adjacent structure and there are no other buildings around it. If there are doors connecting the building with another structure, the fire rating of the door must also be EI90.

5 FIRE PROTECTION IN BUILDINGS

5.1 FIRE RESISTANCE

5.1.1 Compartments

The various activities of the building must be compartmentalised among themselves. The part of the building classified as the “Type A laboratory” must be a fire compartment separated from the other activities by decontamination zones.

The fire resistance requirements (EI for non-load bearing and REI for load-bearing elements) for the building as per [Article 9-11, OUMR](#) are described in Table 2.

Table 2: The fire resistance requirements for the “Type A laboratory” part of the service building.

Component	Fire Resistance Required
Floor, walls, roof	(R)EI 90
Doors and interior windows	EI 90
Passages through walls, floors and ceilings	EI 90
Fire dampers – Supply and Exhaust	EI 90

The cooling and ventilation room must also conform to the requirements in Table 2 as it is also expected to contain activated materials. Depending on the level of radioactivity in this room, the fire resistance requirement can be adjusted.

- *Services: The fire resistance rating of the duct depends on the duct layout and needs to be analysed as required.*
- *Technical Rooms (HVAC, HV and LV distribution, UPS, AFD and Alarm Central, etc.) must be compartmentalised.*
- *Other rooms such as storages (flammables, oxidizers, combustibles, etc) need to be compartmentalised*
- *Safety systems room shall also be a standalone fire compartment*

5.2 CABLES FIRE RESISTANCE (MAINTAIN OF FUNCTION)

All new cables required for the safety systems must be rated for a fire resistance of 90 minutes according to EN 50200 or IEC 60331 according to the SSI-FS-2-1 and SG-FS-2-1-1.



5.3 REACTION TO FIRE OF BUILDING MATERIAL

5.3.1 Surface layers and cladding materials

All the walls (load bearing and non-load bearing) must be made from non-combustible materials.

5.3.2 Cables

The service building is considered to be a high-risk installation and hence the fire reaction of the cables must be at least C_{ca} s2, d1, a2 as per [SG-FS-2-1-1](#)¹.

5.3.3 Furniture

The fire reaction classes of the furniture used in the "Type A lab" zones must not be lower than M1/M2 or A1/A2. The use of flexible foams in furniture upholstery is not allowed as per IS41².

5.3.4 Other non-metallic

According to Table 3 of IS41, all non-metallic material used shall be halogen free (as per EN/IEC-60754-2) and show small contribution to fire

6 ACTIVE FIRE SAFETY SYSTEMS

6.1 DETECTION

According to the Code E, a multi-storey building which houses special hazards requires a fire detection system. In this case, fire detection would be required in all the compartments of the service building. The systems must be interlocked with ventilation and trigger a level 3 alarm (as per [IS37](#)³). The systems shall be supplemented by manual pushbutton close to exists. In case of detection ventilation modes shall be assessed to keep dynamic confinement.

7 VENTILATION SYSTEMS

The building must be ventilated the following conditions apply:

- The building must be mechanically ventilated
- At least 5 air changes per hour must be guaranteed

¹ See SG-FS-2-1-1

² IS41 - The Use of Plastic* and other Non-Metallic Materials at CERN with respect to Fire Safety and Radiation Resistance

³ IS37 – Level 3 Safety alarms and Alarm systems

- All the rooms with radioactive materials must be maintained in under-pressure of not less than -50 Pa as per Article 15, OUMR.
- Under-pressure must be guaranteed even in case of loss of power as per Annex 5 of OUMR
- The exhaust air must not be allowed to re-enter the supply air system i.e. the inlet air must not be obtained from the same location where air is exhausted as per Article 17, OUMR. The filter used in the ducts will be specified by the RP group.

7.1.1 Interlock to fire detection

The interlock between the fire detectors and the smoke extraction system is crucial for ensuring occupant evacuation and firefighter intervention. It is proposed that the ventilation system follows similar approach to the Nanolab ventilation logic described Figure 1 of the document - EDMS [2535657](#).

7.2 SMOKE EXTRACTION SYSTEM

The smoke extraction systems are required as per Article R4216-13, Code du Travail to aid occupant evacuation and firefighters' intervention. According to the French fire regulations, compartments with floor area greater than 100 m² (for *blind* facilities without any opening) would require a smoke extraction system. If certain individual compartments are less than 100 m², smoke extraction is not required.

Due to the specificities of this facility, the smoke extraction system shall be aimed at ensuring dynamic confinement (also during fire) and support the CFRS intervention. It shall be designed with this objective for the areas concerned.

The smoke extraction system (fans, ducts and sealings) must have a fire resistance rating equivalent to the fire resistance of the compartment. All parts of the smoke extraction system must have an autonomy of at least 2 hours. The extraction fan must be able to withstand gas temperatures of at least 400 °C.

The smoke extraction will be done through the filters and the number of filters required are provided by the radiation protection group.

Table 3: The smoke extraction logic for the service building

Detection	Ventilation	Evacuation
Fire detection in non-radioactive areas	No action on ventilation	Evacuation alarm triggered. All the users are evacuated
Fire detection in the handling hall or buffer zone	Supply maintained until the end of evacuation.	All users evacuated. Level 3 fire alarm to CFRS

Fire detection in the service cell	Extraction continues. Supply shut-off to service cell.	All user evacuated. No users in the service cell. Level 3 fire alarm to CFRS
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7.2.1 Fire-Fighting cubicle (coffret pompier)

The requirement for the firefighting cubicle is based on the Safety Request Form EDMS [2682509](#).

The cubicle shall be located at the emergency access level outside the building. As per the fire concept and the layout configuration, a single box serving several buildings (i.e. forming a connected complex) might be accepted or required. The cubicle must have the following characteristics:

- Colour: Orange (Code RAL 2000-2011)
- Front panel: Breakable glass. The entire synoptic schema shall be visible.
- Lock: KABA 8.2 key2
- Installation height: Between 90 cm and 1 m from the ground

The interior of the firefighter's cubicle must provide the following:

1. "Coffret pompier" with the building name must be inscribed
2. Control buttons: AUTO, OFF, DESENFUMAGE
3. Synoptic plan of the smoke extraction area. Fire compartments must be identified with bold red dotted lines.
4. Status lights: Red (system ON), GREEN (system ON), ORANGE (system FAULT)

The cubicle must also have fire detection indication lights (RED indicates fire detection system triggered, and NO LIGHT indicates fire detection system not triggered) for each zone.

8 POSSIBILITY OF EVACUATION

8.1 ESCAPE ROUTES (SIZE, QUANTITY AND EVACUATION DISTANCE)

The escape routes from a building have several requirements as described below:

1. According to article R4227-5 of Code du Travail, the minimum free width of the emergency evacuation paths must be at least 0.80 m. This can change depending on the maximum number of users of the building.
2. As per articles 4216-5 to 4216-12: the exit width required is 0.90 m for less than 20 occupants. The total exit width required is 1.40 m for less than 50 occupants.
3. The maximum distance to the open-air exit or a staircase is 40 m. From the staircase at ground floor to the outside is 20 m.
4. The maximum dead-end travel distance (cul-de-sac) is 10 m in evacuation paths.
5. The doors must open by a simple manoeuvre and in the direction of the exit.



6. Evacuation plans which indicate normal, and emergency exits must be displayed in the building areas where personnel have access.

8.2 EMERGENCY LIGHTING

The Article 4227-14 of Code du Travail requires all establishments to have safety lighting. The emergency lighting must be provided as per the requirements mentioned in [SG-EL-0-0-1](#).

8.3 SAFE WAITING AREAS (EAS - ESPACE D'ATTENTE SECURISÉ)

No safe waiting areas will be required as there are no higher floors with lifts.

8.4 LIFTS

No lifts exist in this building. The technical rooms on the upper floors are connected by stairs.

8.5 MEETING POINT

The officer responsible of evacuation (S. Hansen) will decide the assembly point for the occupants later in the project

9 EMERGENCY PREPAREDNESS INSTALLATIONS AND EQUIPMENT

9.1 EVACUATION PLANS

According to Article R4227-13, evacuation plans must be prepared and displayed across the facility. Signage indicating the path to the nearest exit as well as the path to the nearest secure waiting space or equivalent space must be provided. These spaces must also be identified using the appropriate sign.

The emergency exits must be marked with "EXIT" or "EMERGENCY EXIT" signs.

9.2 HANDHELD FIRE EXTINGUISHER

As per the Article R4227-29 of the Code du Travail, in case of premises with particular fire hazards, including electrical hazards, the premises must be equipped with at least one appropriate type of fire extinguisher must be available for every 200 m^2 ; and each floor must have at least one extinguisher.

Compressed Air Foam systems (CAFs) maybe requested by the fire brigade and the locations will be specified later.



9.3 SIRENS AND PUSHBUTTONS REQUIREMENT AND LOCATION

Sirens are requested and must be situated at multiple points such that it is clearly audible in all the compartments of the building.

The norm NF-S 32-001 "Signal sonore d'évacuation d'urgence" is used as a reference. According to this standard: "In each location of the building or premises that can be occupied, the overall A-weighted level produced by the signal must be higher than the overall A-weighted level of the usual ambient noise by at least 10 dB (A) without however exceeding 120 dB (A)"

As per Code E, manual push buttons must be provided in the corridors or near the emergency exits that sounds an alarm in the building and sends a Level 3 alarm to the fire brigade.

9.4 EMERGENCY COMMUNICATION MEANS

A bi-directional communication system that enables rapid communication with the CFRS shall be present near the exits.

10 FIRE AND RESCUE OPERATION

10.1 TACTICAL PLAN

CFRS shall decide if a dedicated intervention plan is needed for this area. In such case, all information shall be made available.

10.2 FIRE HYDRANT NETWORK

At least one fire hydrant system must be installed, and it must be within 100 m from any side of the building.

10.3 DRY RISER

An independent dry riser must be provided for the service building to allow by-passing fire compartment without losing the compartmentalization (open doors). The exact positioning of the dry risers and its inlets and outlets must be discussed with the CFRS. and shall be designed according to the norm NF-S 61-759.

10.4 MANAGEMENT OF FIREFIGHTING WASTE WATER

As per Article 14 and 24-26 of OUMR, Type A labs are required to have a dedicated drainage, retention and treatment system for the liquid waste that is produced.

Activated firefighting water might be required to be transported to the retention basins for treatment.



10.5 EMERGENCY STOPS SYSTEMS, AUG, AUL

According to the Cern Code [IS 5](#), systems that can cut the power for the entire building (AUG) or individual zones (AUL) are required. The AUGs must send a Level 3 alarm to the fire service.

AULs must be placed:

1. inside and at all points of entry to the area concerned.
2. barracks and areas considered as particularly exposed shall also have alarm triggers outside.
3. Any point dictated by local conditions

AUGs must be placed:

1. close to every entrance to buildings or areas
2. at access gates to areas where beams operate
3. elsewhere, at positions dictated by local conditions (e.g., on each floor)

11 CONTROL AND MAINTENANCE PLAN

The owners and users of buildings shall ensure that safety systems are properly maintained in accordance with the regulations and always guarantee their functioning.

11.1 GENERAL

Safety System	Department responsible	Type of control / maintenance
Smoke extraction	EN-CV or SCE-SAM	VI + FT + DOC??
Fire Detection (Including pushbuttons and sirens)	EN-AA	VI + FT + DOC ??
Portable fire extinguishers	HSE-FRS	VI + replacement
Fire extinguishing systems	TBC if present (in hotcell)	VI + FT + DOC??
Emergency lighting	EN-EL or SCE-SAM (TBC)	VI + FT + DOC??
Fire doors	TBC	VI + FT + DOC??
Fire partitions	TBC	VI + FT + DOC??
Actions/interlocks	<i>(depending on which system is affected)</i>	VI + FT + DOC??



Fire dampers	EN-CV or SCE-SAM, TBC	VI + FT + DOC??
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VI: visual inspection. FT: Functional test. DOC: documentation.

12 QUALITY ASSURANCE AND DOCUMENTATION

Upon reception of the project, the project leader shall ensure that as-built documentation as well as the necessary certificates will be provided to CERN and this documentation shall be uploaded to the dedicated MTF page of the facility, under subsection **Fire and Rescue Service Intervention Plans** (to be reached through <https://edms.cern.ch/ui/#!master/portal/tab?buildings>). Specific care shall be taken that a technical fire safety drawing, in accordance with at least the simple fire technical drawings as prescribed by AEAI guideline 2003-15 or equivalent, is provided to CERN and uploaded to the dedicated MTF page. The plans shall at least clearly indicate:

- Fire compartmentation and their rating indicated per wall by colour code,
- Fire doors, their opening direction and rating indicated per door by colour code,
- Evacuation routes,
- Presence and extent of fixed extinguishing systems and their type,
- Fire brigade intervention means, such as:
 - o Access road requirements
 - o Fire brigade parking space
 - o Access point(s) for fire brigade
 - o Presence of and position of firefighter cubicles (see [EDMS 2682509](#))

Furthermore, any new or consolidated fire doors shall be registered or updated to [InforEAM](#) to ensure correct inspection and maintenance of these doors.