



TECHNICAL STANDARDS OF ANWIL S.A.

**GUIDELINES ON FIRE PROTECTIONS OF SUPPORTING CONSTRUCTIONS OF  
APPARATUSES AND PIPELINES**

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Włocławek, September 2021

<b>Company Fire Brigade - TF</b> <b>Director for Prevention and OHS - DT</b>  <b>Director for Maintenance - SS</b>	<b>GUIDELINES ON FIRE PROTECTIONS OF SUPPORTING CONSTRUCTIONS OF APPARATUSES AND PIPELINES</b> .....	Copy number: <b>A</b>
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## 1. INTRODUCTION

Pursuant to the Act of 7 July 1994 Construction Law, the building object together with the related construction equipment, taking into account the expected useful life, must be designed and constructed in the manner specified in the regulations, including technical and construction regulations, and in accordance with the principles of technical knowledge, ensuring compliance with the basic requirements concerning:

- a) safety of load-bearing capacity and stability of the construction,
- b) fire safety,
- c) safety of using and accessibility of objects.

The basic objective of fire protections of load-bearing steel constructions and apparatuses is to ensure appropriate time in which a load-bearing element or apparatus exposed to fire temperature will retain its features designed.

Since in the Polish legal system there are no regulations on fire protections, supporting constructions of apparatuses and pipelines in industrial plants, enterprises prepare their own standards and guidelines within this scope.

## 2. OBJECTIVE AND SCOPE OF APPLICATION OF THE GUIDELINES

These Guidelines on fire protections are applicable to newly-designed and modernized installations in ANWIL S.A. They also form the basis for repairs of existing fire protections of supporting constructions of apparatuses and pipelines.

## 3. BASES FOR PREPARATION OF THE GUIDELINES

- Act of 7 July 1994 Construction Law (consolidated text: Journal of Laws 2020, item 1333, as amended)
- Regulation of the Minister of the Interior and Administration of 7 June 2010 on fire protection of buildings, other building objects and areas (Journal of Laws, No. 109, item 719, as amended).
- Regulation of the Minister of the Interior and Administration of 24 July 2009 on water supply for fire fighting and fire escape routes (Journal of Laws No. 124, item 1030).
- Regulation of the Minister of Economy of 21 November 2005 on the technical conditions to be met by liquid fuel bases and stations, long-distance transmission pipelines for the transport of crude oil and petroleum products and their location (Journal of Laws of 2014, item 1853).
- Regulation of the Minister of Infrastructure of 12 April 2002 on the technical conditions to be met by buildings and their location (consolidated text: Journal of Laws 2019, item 1065, as amended).
- Regulation of the Minister of Labour and Social Policy of 26 September 1997 on general occupational health and safety regulations (Journal of Laws of 2003., No. 169, item 1650, as amended).
- API 2218 – *Fireproofing Practices in Petroleum and Petrochemical Processing Plants (3rd Edition, July 2013)*.
- API 2510 – *Design and Construction of LPG Installations (8th Edition, May 2001)*.
- Guidelines for design of fire protections for new and modernized production installations - preparation: OCCUPATIONAL HEALTH AND SAFETY OFFICE OF PKN ORLEN S.A., OHS AND FIRE PROTECTION PREVENTION COORDINATION DEPARTMENT IN REGIONS AND ORLEN GROUP.

## 4. DEFINITIONS

**Passive protection of construction** - protection of construction ensured by means of insulation coatings or claddings ensuring that a steel construction achieves a desired fire resistance class.

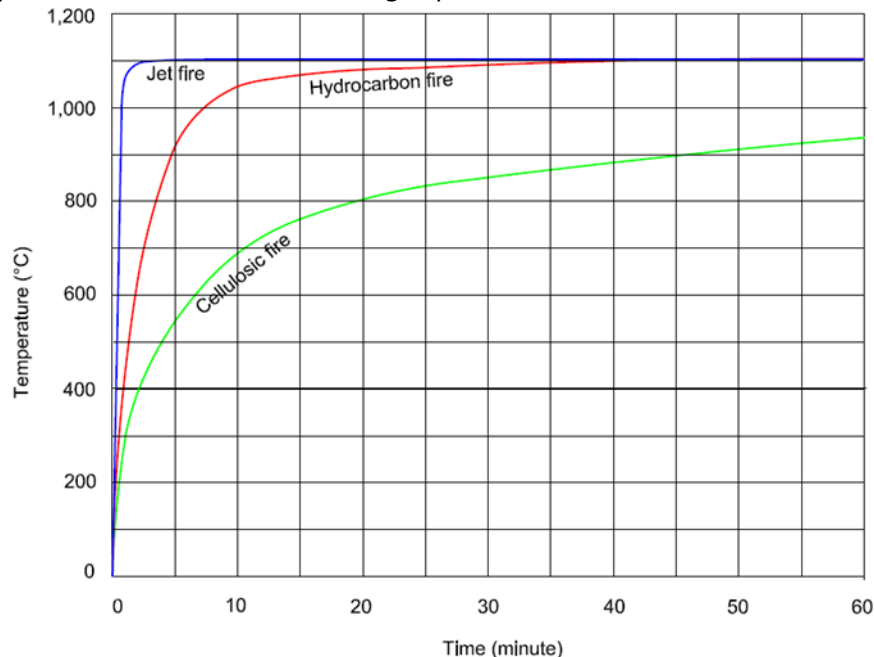
**Load-bearing element** - a construction element bearing loads, responsible for stability of an object construction in case of fire.

**Standard curve** - a curve presenting a temperature rise in time, characteristic of cellulosic fire. In literature, this curve is called a "cellulosic curve".

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**Hydrocarbon curve** - a curve presenting a very fast temperature rise from  $1093 \pm 56$  °C within 5 minutes with total heat flux of  $204 \pm 16$  kW/m<sup>2</sup> derived from combustion of hydrocarbons.

**Jet fire curve** - turbulent combustion of gas, aerosol or pure fuel flowing out under pressure into a particular direction from a damaged place on the installation.



**Fire resistance** - capacity of a construction element, determined by time, to meet designed requirements for a building element. Time expressed in minutes by the time an element achieves one of three limit states is the measure of fire resistance:

- fire load capacity - R
- fire integrity - E
- thermal insulation - I

**Potential source of leakage** - a point in the installation where leakage may occur. The basic sources of leakage may be: flange connections of pipelines and installations, valves, latches, sealings and throttles of pumps, compressors, probes for connection of pipelines, devices and instruments etc.

**Design fire zone / fire danger area** - three dimensional space in which outflow of combustible substances and pool fire or spatial fire may occur which lasts long enough and is sufficiently intense, potentially leading to considerable losses.

**Section massivity factor** -  $U/A$  [m<sup>-1</sup>] (or in English-language literature  $H_p/A$ ) – relation of heated perimeter  $U$  [m] to cross section area of an element  $A$  [m<sup>2</sup>].

## 5. FIRE RISK ANALYSIS

The most significant role to be fulfilled by fire protections is protection of particular elements of steel constructions in the first stage of fire when other safety systems / protection layers have not managed to effectively start working yet.

Within this critical time when the construction is deprived of fire protections and temperature, in line with the hydrocarbon curve, reaches the yield point of steel already after 2÷3 minutes, an unprotected steel element is destroyed leading to escalation of fire and damage.

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Therefore, it is important to properly design and make fire protections which will give required time needed to locate and extinguish fire before fire causes considerable losses.

Thus, it is necessary to carry out a fire risk analysis which should include, at least the following stages:

- selection of the method for review and estimation of risk (e.g.: *Risk Matrices*);
- identification of potential sources of fire along with working parameters and determination of estimated quantities of combustible utilities, their type, fire characteristics and possible sources of ignition;
- marking of identified sources of potential fire on plans with location of apparatuses and devices;
- determination of possible fire scenarios considering, where applicable, respectively for: pool fire, jet fire, flash fire, fire of vessel, BLEVE type explosion etc.;
- development of each fire scenario includes answers to the following questions:
  - ☐ What are the potential causes of fire?
  - ☐ What type of fire may it be (pool fire, jet fire etc.)?
  - ☐ What is the estimated quantity of combustible material in the fire zone before cutting it off?
  - ☐ How fast does the material flow out (temperature, pressure, state of aggregation, size of opening)?
  - ☐ Will the material gather directly under the leakage place?
  - ☐ How long may fire last before its extinguishing starts and without extinguishing?
  - ☐ Are there any technological protections in case of fire (ESD, EIV/EBV, PSV, pressure relieve system EDP etc.)?
  - ☐ Are there any fire protection installations (what and how are they controlled)?
  - ☐ Does the Company Fire Brigade have sufficient forces and measures to carry out an extinguishing action? etc.;
- determination of consequences of a particular fire scenario;
- determination of preventive measures;
- determination of how simultaneity of application and completeness of all available safety systems / protection layers influence the possibility of changes adopted in these Guidelines of fire load capacity parameters and scope of protections of steel constructions.

Optimally, depending on an adopted realization path, the analysis needs to be carried out after the Hazard and Operability Study before issuing a Building Project so that recommendations from the fire risk analysis can be considered in issued projects. For modernized installations the analysis should additionally consider exploitation experience from operation of the installation and limitations arising from adopted and already applied construction/building, installation and technological solutions.

The Team for conducting the risk analysis is appointed by the Business Owner from resources of ANWIL S.A. and EPC contractor (project, delivery, performance). It should be composed of people with large experience, holding construction/installation and fire protection entitlements. The Team should comprise specialists/designers from the following fields of operation:

- ☐ technological;
- ☐ construction/building;
- ☐ installation;
- ☐ fire protection specialist from the Company Fire Brigade of ANWIL S.A.;
- ☐ fire protection appraiser.

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The Team's works should be managed by an experienced Process Engineer.

The team's works based on the elements of the analysis included in this point or guidelines included in global standards (e.g.: API 2218) should end with a formal Report determining the scope of required fire protections. Results from the team's analysis are in force and should be included in a detailed design.

## 6. GUIDELINES ON DESIGN OF FIRE PROTECTIONS

Criteria for selection of sources of potential fire.

Devices, apparatuses containing utilities (of class I, II, and III) with flashpoint up to 100 °C or working at a temperature over an auto ignition temperature are considered as a potential source of fire.

Three categories of fire danger from apparatuses, devices, objects have been adopted (in line with API 2218):

The first (highest) category includes:

- furnaces using liquid hydrocarbons or their phas-mixture;
- pumps with capacity from 45 m<sup>3</sup>/h with temperature of combustible products over flashpoint;
- pressure reactors or such in which spontaneous exothermic reactions may occur;
- pressure vessels and air coolers containing combustible products of class I and II;
- storage spheres and cylindrical containers (not covered with earth) with LPG or another combustible gas;
- flyovers and single supports of pipelines inside a defined fire zone from another source with:
  - collector for flares, neutralization system or release line with a safety valve;
  - pipeline containing a toxic product;
  - pipeline with flange connections;
  - pipelines of fire water and foam generating agents;
  - line of instrument air, measurement hydraulic systems, controlling the process and enabling stoppage of the installation or its part.

The second (medium) category includes:

- air coolers with work temperature over an auto ignition temperature if they are not protected by an automatic sprinkler system;
- compressors;
- pressure columns and vessels whose weight of combustible utility exceeds 2 tons or whose total weight in the fire zone from another source exceeds 10 tons or containing toxic utilities.

The third (lowest) category includes:

- heat exchangers;
- pumps using utilities of class III when flashpoint is exceeded but not more than by 100 °C or working at a temperature over an auto ignition temperature;
- air coolers only with combustible gas products;
- valve stations, flange connections, fittings on pipelines on the border of the installation.

## 7. SCOPE OF PROTECTIONS REQUIRED

A steel construction should be designed in consideration of work in fire conditions with the use of fireproof materials in accordance with PN EN 1993-1-2

### Technological etageres

All elements forming a part of the main load-bearing construction of an etagere are subject to fire protection i.e.: pillars, beams and bracings (if they are not calculated only for wind) within a radius

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of 9 m from a potential source of fire to height of 8 m in fire resistance class R60 to R120 depending on results from the conducted fire risk analysis.

When construction of an etagere has a tight slab making it possible to create a pool of combustible products which may lead to pool fire, then the stated height of 8 m is calculated from the level of this slab.

The upper surface of beam where pipelines and passageways/service ways are supported (along with their supports) do not require fire protections. Constructions of staircases/escape staircases and service platforms are not subject to fire protections either.

#### **Flyovers and supports of pipes**

All elements forming a part of the main load-bearing construction of flyovers, single supports of pipeline i.e.: pillars, beams and bracings are subject to fire protection (if they are not calculated only for wind or earthquake), within a radius of 9 m from a potential source of fire to height of 8 m in fire resistance class - minimum R60 depending on results from the conducted fire risk analysis.

The upper surface of beam where pipelines are supported may not require fire protection.

#### **Skirts, supports of vessels, columns, reactors and other vertical apparatuses**

All steel skirts of vertical apparatuses being within a radius of 9 m from a potential source of fire must be protected up to their complete height. Skirts with diameter larger than or equal to 1.2 m must be protected both from internal side and external side.

With regard to skirts with diameter smaller than 1.2 m fire protection can be made only from the external side when inside the skirt there are no flange connections or valves and there is one uncovered hatch with substitute diameter up to 600 mm. Fire resistance class - minimum R60 depending on results from the conducted fire risk analysis.

#### **Supports of air coolers**

All elements forming a part of the main load-bearing construction of coolers of the first and second category of fire danger are subject to fire protection i.e.: pillars, beams and bracings (if they are not calculated only for wind) within a radius of 9 m from a potential source of fire to height of 8 m if weight of the cooler with combustible products exceeds 2.5 tons.

When the cooler of the first category of fire danger is on top of an etagere, then the main load-bearing construction must be protected to the complete height, whereas with regard to coolers of the second category of fire danger protections must be made when the coolers are not protected with a permanent automatic sprinkler installation.

An analogous situation applies to location of coolers on flyovers. Fire resistance class - minimum R60 depending on results from the conducted fire risk analysis.

#### **Vessels, horizontal apparatuses beds**

Vessels, horizontal apparatuses beds with diameter larger than 750 mm or with capacity of combustible products exceeding 2 tons, height in the lowest point - minimum 300 mm, set within a radius of 9 m from a potential source of fire to height of 8 m must be protected on the entire surface in fire resistance class - minimum R60 depending on results from the conducted fire risk analysis.

#### **Supply and automation installations**

Supply cables and cables controlling devices which should work in case of fire (ESD systems, emergency pumps, control valves, emergency stoppage and emergency release devices) should have fire resistance envisaged for the work time of these devices, but not less than 30 minutes. This requirement also refers to load-bearing constructions of these installations.

#### **Flares and neutralization systems**

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Supports of flares and neutralization systems should be protected up to height of 9 m. Supports of release collectors should be protected up to complete height and at a distance of 9 m from the flare and neutralization system.

#### Other steel construction elements

The following steel constructions should be protected against fire irrespectively of their location in relation to the fire danger zone:

- furnace's supporting pillars - from the level of foot to complete height. All construction elements introduced to decrease length of effective buckling of these pillars should also be protected against fire in fire resistance class R120;
- compressor's supports should be protected against fire in fire resistance class R120, whereas load-bearing construction of roofing above the compressor should have fire resistance R60. If the compressor is not in a shed surrounded by walls, fire protection must be made within a radius of 6 m from fire source to height of 8 m in fire resistance class - minimum R60 depending on results from the conducted fire risk analysis;
- supports of storage spheres and cylindrical containers (LPG) with height in the lowest point - minimum 300 mm should protected against fire in fire resistance class R120;
- load-bearing construction of unloading and loading fronts of railway tankers and tank trucks should be protected in fire resistance class R60 unless the conducted fire risk analysis allows replacement solutions;
- supports of all pipelines being in capacitive trays of warehouse and treatment containers on their entire height should be protected in fire resistance class R120;
- if jet fire danger is identified, the steel construction that is spherically closest to the outflow place is subject to fire protections within a radius of 3 m from the outflow source in fire resistance class R120. Where possible, it is necessary to ensure safe distances from such a source of fire danger. If impossible, technological protections must be ensured.

#### Systems of technological protections

Power supply systems, control systems, valve control pneumatic and hydraulic lines, insulation valves (EIV/EBV), valves of the emergency pressure release system (EDP) etc. being in a fire zone should be able to work for 30 minutes in fire conditions.

#### NOTE!

- When determined protection range includes a part of the element (e.g. beam), the protection range must be increased to the closest construction connection (+ 30 cm beyond this connection).
- Also struts, bracing beams carrying all loads are subject to protection.
- Supports of pipelines placed beyond the main flyover are subject to protection - small posts, crosswise flyovers connected with the main flyover, columns with supports, etc.

### 8. MATERIALS/SYSTEMS - SELECTION AND CONSTRUCTION

Materials admitted to use on production installations of ANWIL S.A. are:

- ready-made fire protection systems (e.g. made on the basis of light concretes or thermally activated materials - intumescent paints), insulation materials etc.;
- concrete made in accordance with PN-EN-206:2013.



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With regard to ready-made materials for fire protections they must be admitted to use and be positively assessed in terms of the product conformity to the technical specification in which:

- their usefulness and effectiveness in hydrocarbon fires have been determined;
- asbestos content is excluded;
- durability of at least 15 years is required;
- resistance to rapid changes of temperature is required, caused by water stream while extinguishing potential fire;
- initiation and sustaining of processes harmful to durability of construction are excluded (e.g. corrosion processes);
- resistance to external weather conditions and specific chemical impact is required.

Conformity to the technical specification must be confirmed by the Certificate of Conformity and CE mark or construction product marking in accordance with the Act of 16 April 2004 on construction products (Journal of Laws No. 92, item 881, as amended)

The technical specification can include only:

- pursuant to the European system for CE marking - harmonized standard, European technical approval or national technical specification of product of the Member State of the European Union or European Economic Area, considered by the European Commission as consistent with the basic requirements;
- pursuant to the national system with regard to construction product marking - binding Polish Standard of product or national technical approval carried out by an authorized organizational unit.

The method of encasing beams and pillars of class not lower than C20/25 with concrete in accordance with PN EN 1992-1-1 can be used only for single-storeyed constructions of flyovers and etageres with maximum height up to 6m intended for apparatuses and devices of the third category of fire danger and fronts of railway tankers and tank trucks. The casing should be full and additionally reinforced with net of galvanized wire, permanently fixed to elements of the construction with the use of galvanized couplers. Thickness of the cover should be checked calculationally in the project and should be minimum 50 mm.

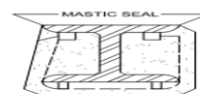
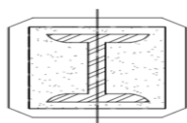


Fig. 1 Construction of concrete lining

## 9. REQUIREMENTS FOR DOCUMENTATION

The documentation should include the following items:

- report of the Team from conducted risk analysis;
- fire protection design based on an analysis, relevant calculations and guidelines, agreed with the licensed fire protection expert appraiser, containing at least the following information:
  - name of construction or element;
  - description of applied fire protections;

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- tabular compilation of sources of potential fire along with name of combustible products, compilation of protected equipment not being a source of danger, levels of setting, fire resistance class, size of protected surfaces;
  - drawings with marked sources of potential fire and marked fire zone from them and drawings of facades of etageres and flyovers;
  - information on the fire protection system used, Technical Specification and Certificate of Conformity;
  - template of the plate placed on protected surfaces;
  - information on the manner and conditions of making protections;
  - requirements concerning warranty, control of quality of the workmanship and acceptance;
  - requirements concerning the way of repairing, maintaining and preserving the covering used.
- As-built drawings of protections made (permissible so-called “red-marks”).

## 10. EXAMPLES OF FIRE PROTECTIONS OF APPARATUSES AND CONSTRUCTIONS

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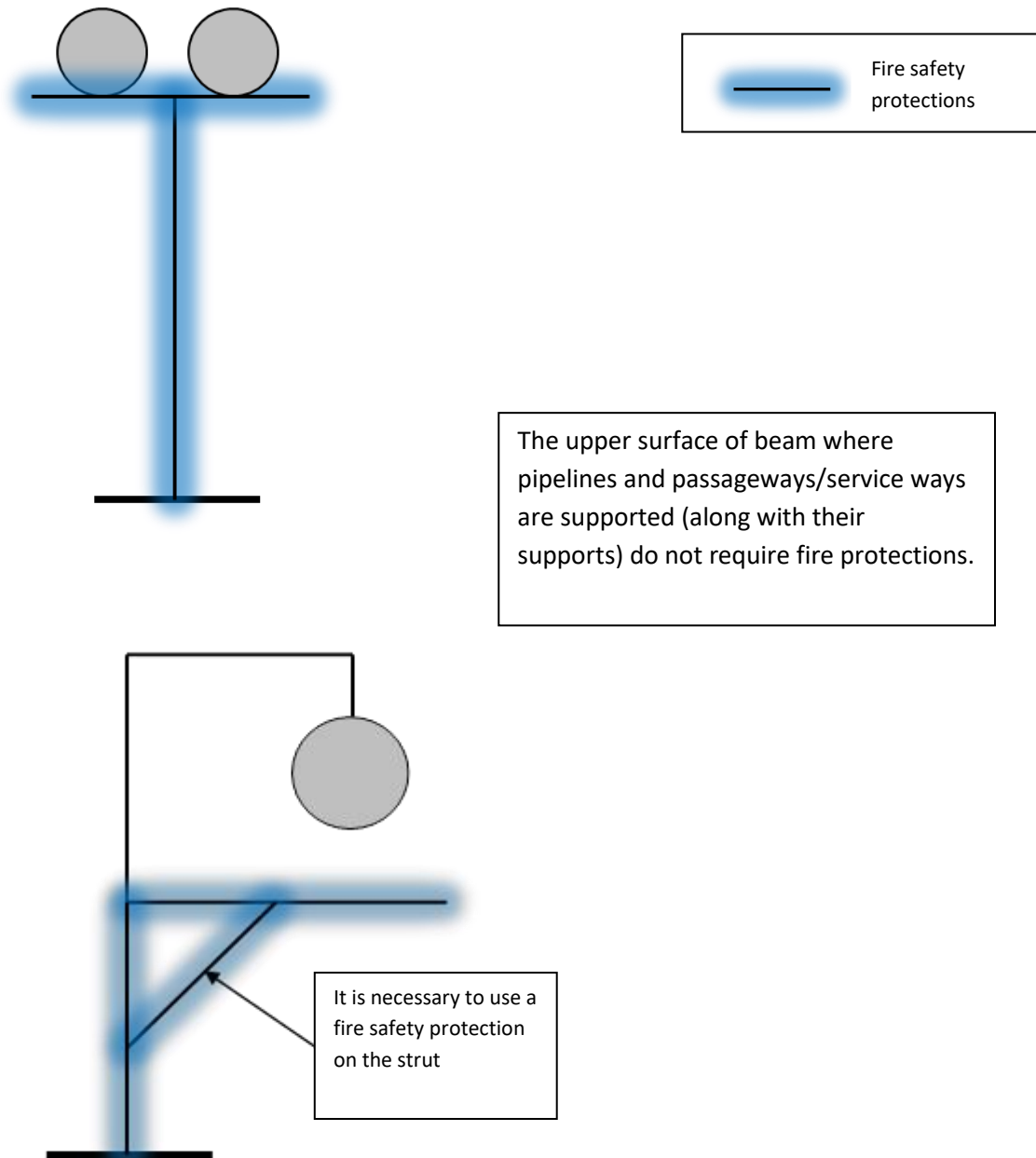


Fig. 2. Flyovers of pipelines in the fire scenario area

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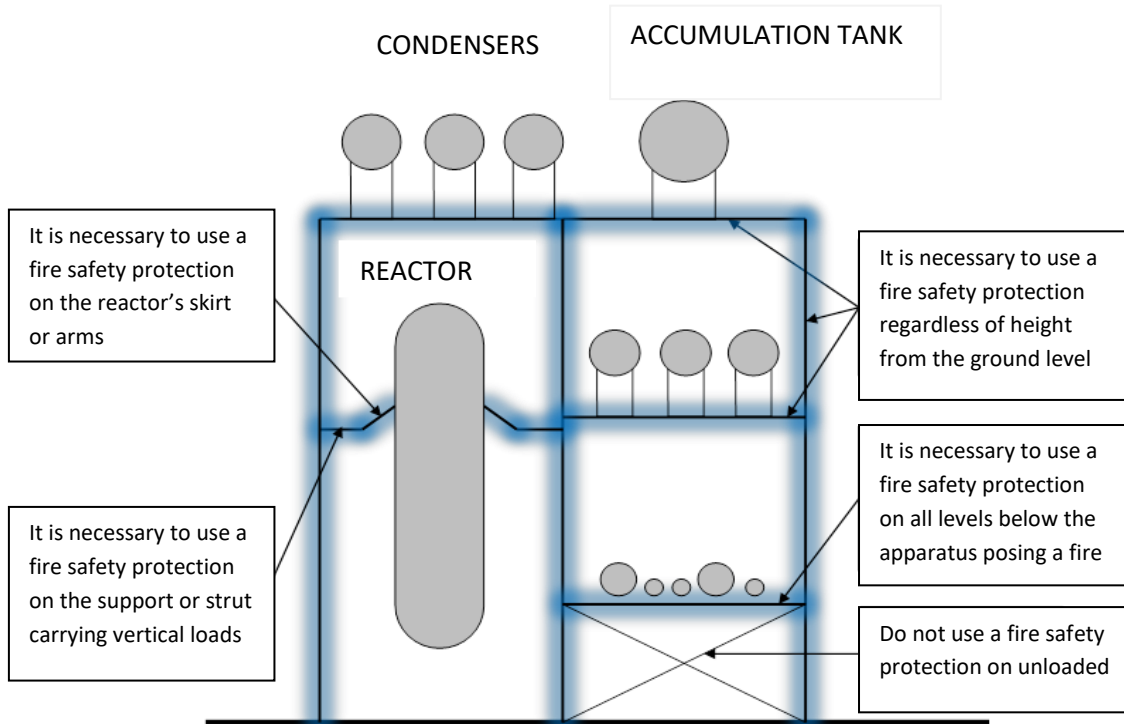
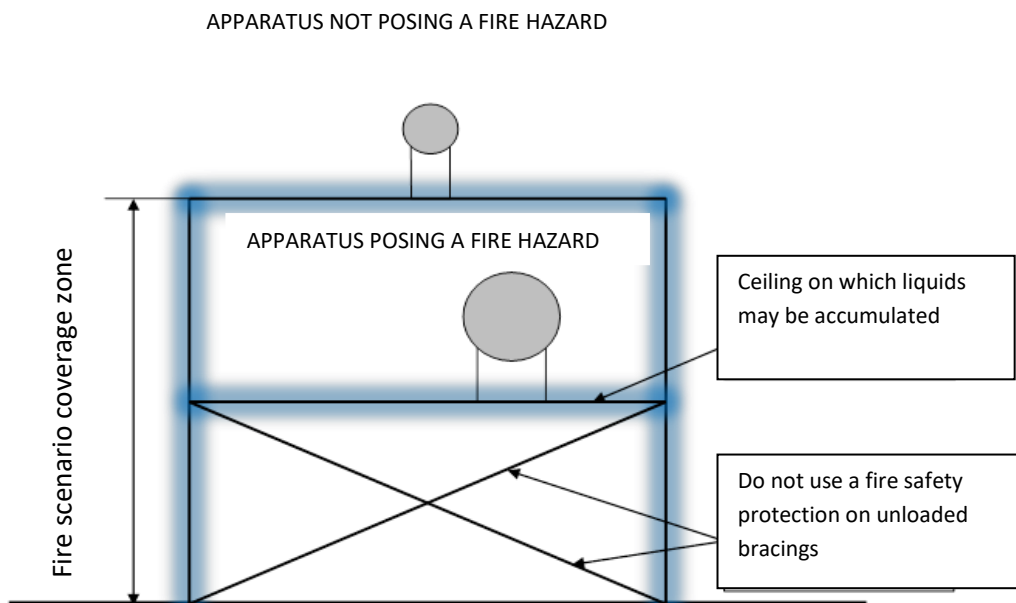


Fig. 3. Protections of load-bearing construction of etageres / flyovers within reach of the fire scenario



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Fig. 4. Protections of load-bearing construction of etageres / flyovers within reach of the fire scenario - continuation

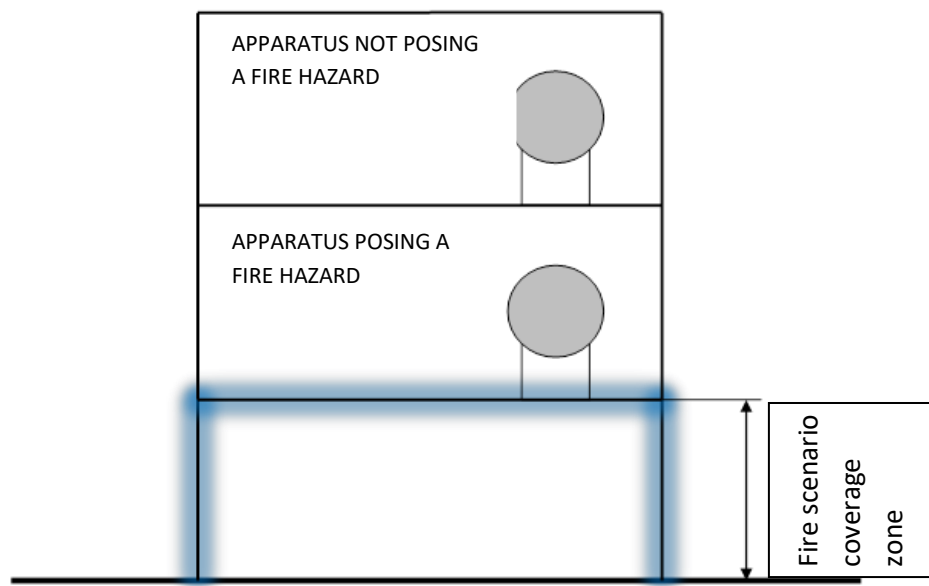


Fig. 5. Protections of load-bearing construction of etageres

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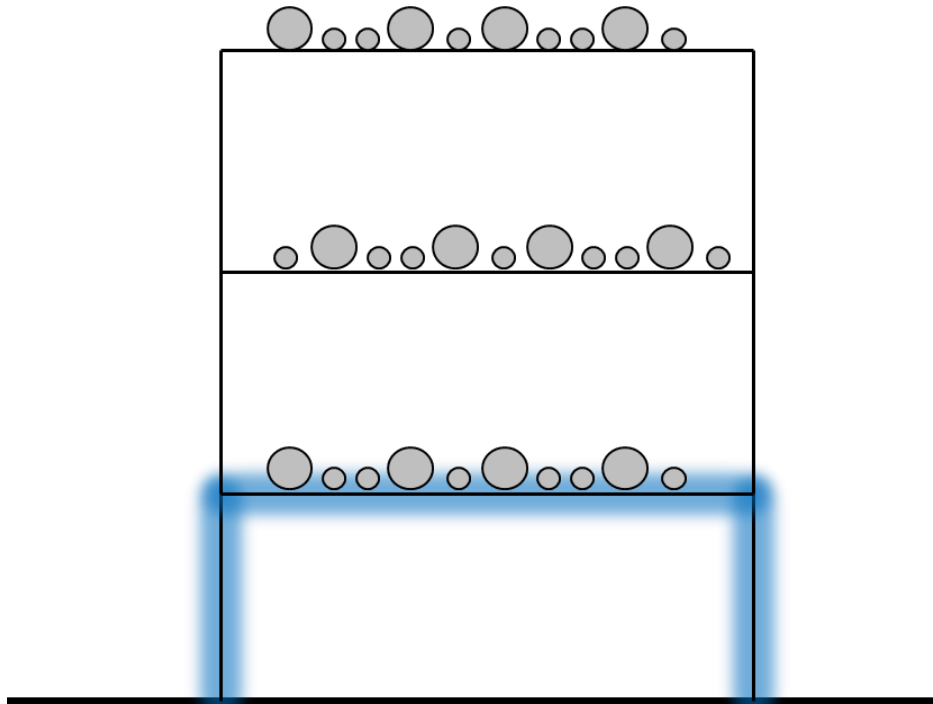


Fig. 6. Protections of load-bearing construction of flyovers when there are no pumps in the fire scenario area

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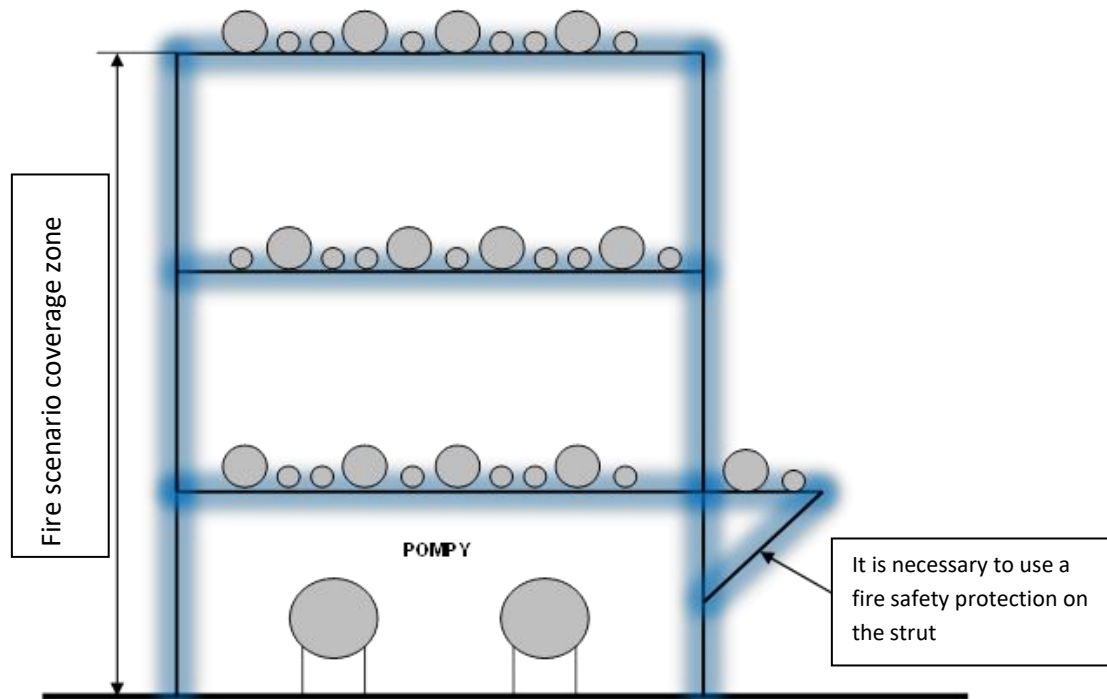
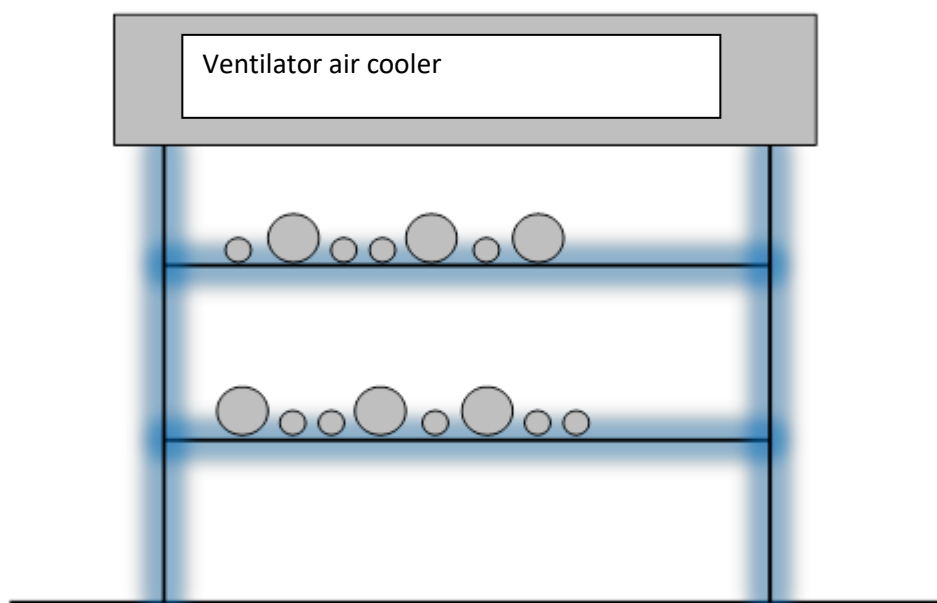


Fig. 7. Protections of load-bearing construction of etageres / flyovers where there are pumps in the fire scenario area



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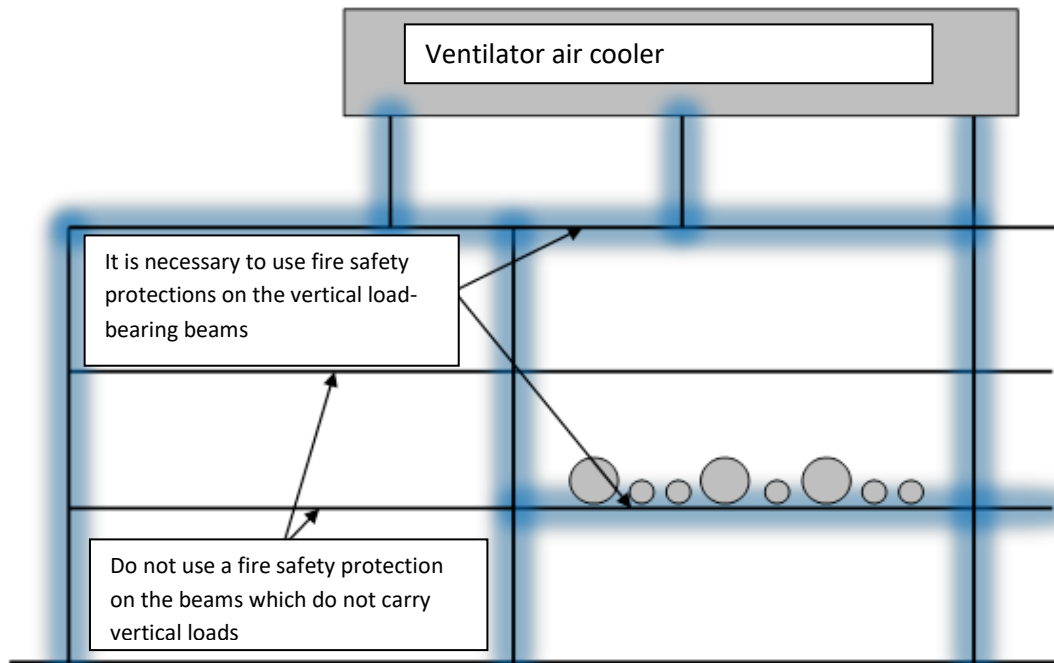


Fig. 8. Protections of load-bearing construction of coolers