



Exploration & Production

GENERAL SPECIFICATION

SAFETY

GS EP SAF 337

Passive fire protection: Basis of design

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1. Scope

1.1 Purpose

The purpose of this General Specification is to set out COMPANY's philosophy and requirements for the design, selection and use of Passive Fire Protection (PFP) systems for onshore and offshore installations.

This specification also sets out COMPANY's requirements for the qualification of Passive Fire Protection (PFP) systems.

1.2 Applicability

This General Specification is not retroactive. It applies to new facilities and major modifications or extensions of the existing installations.

This specification applies to onshore and offshore installations, in particular to:

- primary structure members and indoor structure members;
- enclosures involved in Emergency Response or Escape, Evacuation and Rescue;
- enclosed process areas and outdoor partitions (living quarter external faces, external fire walls, etc.);
- process and storage, vessels and tanks;
- pipes, risers and top ESDVs, valves and local instrumentation.

The present document does not cover the fire rating requirements for internal partitions in buildings (refer to [GS EP SAF 221](#)).

For Quality Assurance and Quality Control refer to [GS EP COR 353](#).

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Standards

Reference	Title
ISO 834-1:1999	Fire-resistance tests - Elements of building construction – Part I: General requirements
ISO 13702:1999	Petroleum and Natural Gas Industries - Control and Mitigation of Fires and Explosion on Offshore Production Installations – Requirements and Guidelines
ISO 14692-2:2002	Petroleum and natural gas industries – Glass-reinforced plastics (GRP) piping – Part 2: Qualification and manufacture
ISO 22899-1:2007	Determination to the resistance to jet fires of passive fire protection materials – Part 1: General requirements
UL 1709	UL Standard for Safety Rapid Rise Fire Tests of Protection Materials for Structural Steel, third edition (including revision of 2007)

Professional Documents

Reference	Title
API PUBL 2218	Fireproofing Practices in Petroleum and Petrochemical Processing Plant, second edition, 1999
API PUBL 2510A	Fire Protection considerations for the Design and Operation of Liquefied Petroleum Gas (LPG) Storage Facilities, second edition
API RP 14G:2007	Recommended Practice for Fire Prevention and Control on Fixed Open-type Offshore Production Platforms
API STD 2510	Design and construction of LPG Installations, eighth edition
IMO Resolution A.753 (18)	Guidelines for the application of plastic pipes on ships, adopted on 4 November 1993
IMO Resolution A.754 (18)	Recommendation on fire resistance tests for "A", "B" and "F" class divisions, adopted on 4 November 1993
IMO SOLAS	International Convention for the Safety Of Life At Sea (SOLAS), 1974 and subsequent amendments
NFPA 33	Standard for Spray Application Using Flammable or Combustible Materials, 2007
OTI 95634	Offshore Technology Report – Health and Safety Executive - Jet-fire resistance test of passive fire protection materials, 1996
UKOOA	United Kingdom Offshore Operators Association – Fire and Explosion Hazard Management Guidelines, March 1995

Regulations

Reference	Title
Arrêté du 21 novembre 2002 (French Legislation)	Arrêté relatif à la réaction au feu des produits de construction et d'aménagement (modifié par les arrêtés du 13 août 2003 et du 18 septembre 2006)

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS EP COR 230	External laminated glass fibre/resin based coating for risers of sea line
GS EP COR 353	Design and application of passive fire protection coatings
GS EP PLR 100	Submarine pipeline systems
GS EP SAF 221	Safety rules for buildings
GS EP SAF 253	Impacted area, restricted area and fire zones
GS EP SAF 261	Emergency Shut-Down and Emergency De-Pressurisation (ESD & EDP)
GS EP STR 102	Design of offshore topside structure

3. Terms and definitions

There are three types of statements in this specification: "shall", "should" and "may". They shall be understood as follows:

Shall Is to be understood as mandatory. Any deviation from a "shall" statement requires a derogation approved by the COMPANY.

Should Is to be understood as strongly recommended to comply with the requirements of the specification. Alternatives shall provide a similar level of protection and this shall be documented.

May Is used where alternatives are equally acceptable.

For the purpose of this document, only the following terms and definitions apply:

Boiling Liquid Expanding Vapour Explosion (BLEVE)	Sudden rupture due to fire impingement of a vessel and/or system containing liquefied flammable gas under pressure. The pressure burst and the flashing of the liquid to vapour creates a blast wave and potential missile damage, and immediate ignition of the expanding fuel-air mixture leads to intense combustion creating a fireball (UKOOA :1995).
Emergency De-Pressurization (EDP)	Control actions undertaken to depressurize equipment or process down to a pre-defined threshold (generally 7 barg or 50% of design pressure) in a given period of time (generally 15 minutes) in response to a hazardous situation (COMPANY from ISO 13702:1999).
Emergency Response (ER)	Action taken by personnel on or off the installation to control and/or mitigate a hazardous event (ISO 13702:1999).
Escape, Evacuation and Rescue (EER)	General term used to describe the range of possible actions including escape, muster refuge, evacuation, escape to the sea and rescue/recovery (ISO 13702:1999).
Fire rating	Time during which a structure or component will provide prescribed resistance to transmission of heat, passage of flame, smoke and toxic gases and structural failure (COMPANY).
Glass-fibre-reinforced epoxy (GRE)	Epoxy resin-based composite that is reinforced with glass fibre (COMPANY from ISO 14692-2:2002).
Glass-fibre-reinforced plastic (GRP)	Polymeric resin-based composite that is reinforced with glass fibre. (COMPANY from ISO 14692-2:2002).
Passive Fire Protection (PFP)	Coating, cladding arrangements or a free standing system which in the event of fire will provide thermal protection to the substrate to which it is attached or to the protected area and does so independently of a requirement for human, mechanical or other intervention to initiate a response (COMPANY from ISO 13702:1999).
Pool fire	Combustion of flammable or combustible liquid spilled and retained on a surface (ISO 13702:1999).

4. General requirements for Passive Fire Protection

4.1 Objectives

The aim of PFP is to minimize the spread of fire, its duration, the damage caused, and more specifically:

Safety to life:

- to protect personnel on the installation against hydrocarbon fire and jet fire;
- to protect part of the escape routes, evacuation and rescue means, as necessary.

Mitigation:

- to protect equipment, critical components and structure members;
- to prevent any explosion or delaying the event of BLEVE on pressure vessels;
- to minimize fire escalation;
- to provide a degree of protection to assist the Emergency Response (ER) activity.

PFP shall also be considered for the protection of equipment whose failure in case of a local fire could cause extensive damage to the environment and assets.

Additional PFP requirements shall be implemented, as follows:

- Non-flammable materials shall always be used in new facilities.
- Particular attention shall be paid when selecting cables within continuously, permanently and normally manned rooms/enclosures. Cables shall be "Zero Halogen" type.
- Electrical overload protection systems shall be carefully adjusted in order to limit the risk of fire by cable overheating.
- Potential fire areas shall be segregated into volumes as small as possible: cable floors from the cabinets, cable floors and cabinets from the room, etc.

4.2 Functional requirements

4.2.1 General

The performance of PFP (in terms of fire resistance), is the period of time (in minutes) during which the PFP protects the structure or the equipment before the first critical behavior is observed. Attention shall also be paid to other criteria such as pre-fire-durability, reaction in a fire, installation requisites, weight, and certifications of PFP materials.

4.2.2 Performance criteria

PFP systems shall be certified. A list of laboratories and certifying authorities agreed by the COMPANY is given in **appendix 1**. No PFP material shall be used without certificates.

In terms of fire rating, structures, partitions and equipment, PFP systems shall satisfy three main criteria throughout a prescribed time of exposure to heat:

- Stability:** the structure shall fulfill its load-bearing capacity throughout the fire exposure period.
- Integrity:** the partitions shall prevent spread of flames and hot fumes throughout the fire exposure period.
- Insulation:** the unexposed side of the partitions shall not reach surface temperatures in excess of a certain level throughout the fire exposure period.

4.2.3 Standard fires

Three standard fires shall be considered.

4.2.3.1 Cellulosic-Fire (CF)

A CF has a slow flame temperature rise after ignition. The standard CF temperature vs. time curve shall be that of the reference documents [IMO Resolution A.754 \(18\)](#), [ISO 834-1:1999](#) and [IMO SOLAS](#). With $T_0 = 20^{\circ}\text{C}$

Table 1: temperature rise

t (min)	0	5	10	20	30	60	120
T ($^{\circ}\text{C}$)	20	576	678	781	841	945	1049

Typical radiation value 5 minutes after ignition is 50kW/m^2 .

4.2.3.2 Hydrocarbon-Fire (HF)

A HF has a rapid flame temperature rise after ignition. The standard HF temperature vs. time curve shall be taken from [UL 1709](#) or [ISO 834-1:1999](#) or an equivalent procedure approved by the COMPANY (DGEP/HSE/SEI).

The heat flux is $205\text{kW/m}^2 \pm 15\text{ kW/m}^2$ after 5 minutes. The typical temperature value 5 minutes after ignition is between 1037°C and 1149°C .

4.2.3.3 Jet-Fire (JF)

A JF is a turbulent diffusing flame, resulting from the combustion of a steady release of pressurized liquid or gaseous fuel. They are the most severe fire scenarios that PFP materials could be required to withstand, considering the effect of erosion and also the significantly higher rate of burning due to turbulent fuel/air mixing.

The Jet Fire test shall be conducted as described in [OTI 95634](#) or [ISO 22899-1:2007](#) or similar COMPANY approved procedure.

In particular, the jet fire test shall deliver $0.3\text{ kg/s} \pm 0.05\text{ kg/s}$ flow rate of propane fuel under controlled condition, as described in [OTI 95634](#) and [ISO 22899-1:2007](#).

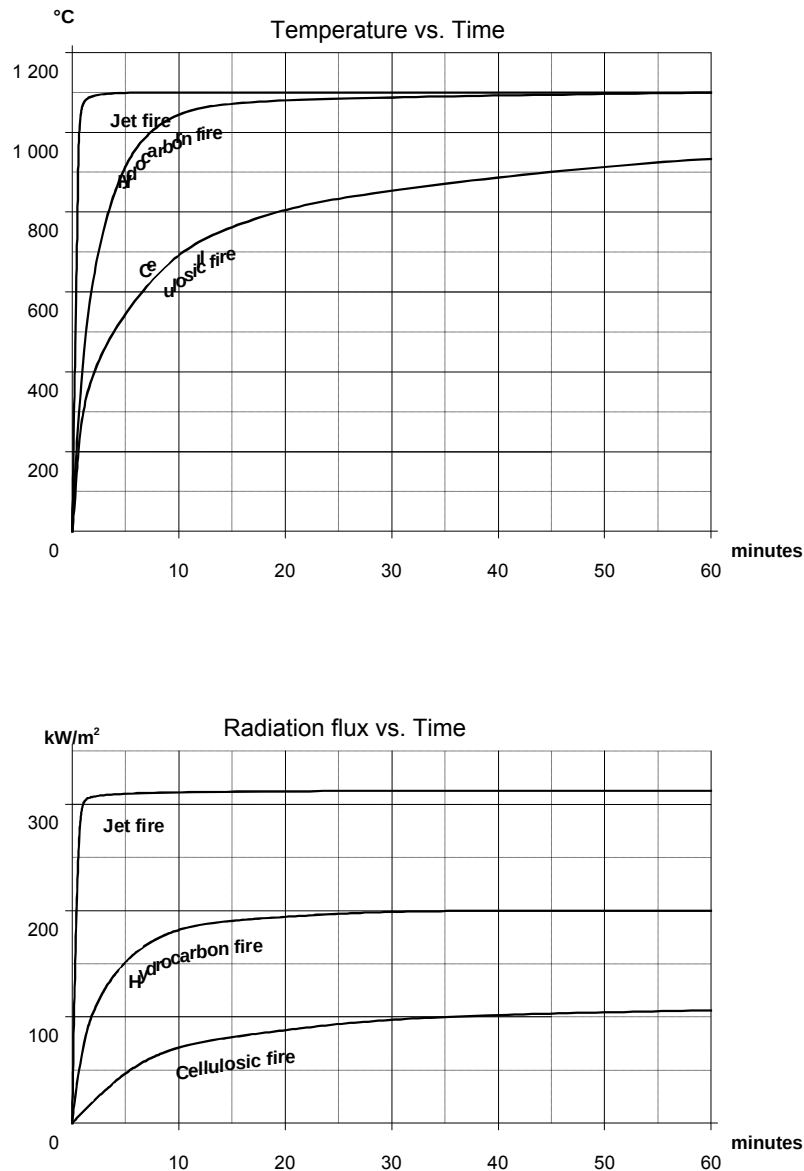


Fig 1: standard fire curves (Temperature and radiation flux vs Time)

4.2.4 Maximum allowable temperatures

4.2.4.1 Reinforced concrete structures

The mechanic resistance of reinforced concrete structures is appreciably weakened (due to dilatation of bar iron) at 400°C. At 800°C, concrete risks complete destruction. The critical temperature shall be assumed at 450°C.

4.2.4.2 Steel structures

The critical temperature for steel shall be specified as 800°F giving 427°C, at which the steel departs from linear elastic behavior to plastic deformation in a standard tensile test.

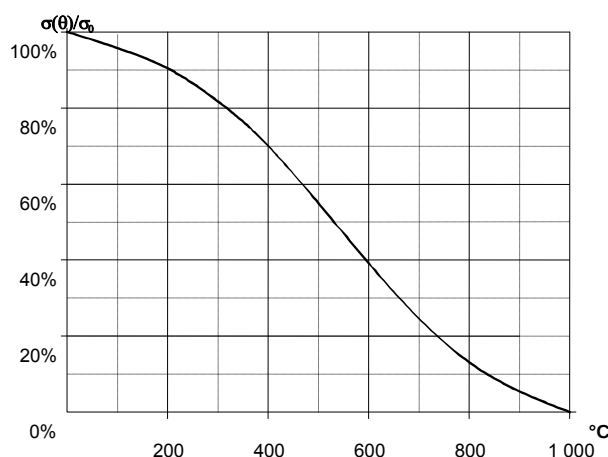


Fig 2: resistance of steel vs Temperature

4.2.4.3 Other materials (structure)

The critical temperature for other materials than steel is specified as the temperature at which yield strength is reduced to the maximum allowable stress under operating loading conditions.

4.2.4.4 Equipment

The maximum surface temperatures given in the following table shall be used as default values in determining the PFP requirements for critical equipment, which may require a protection in order to allow it to fulfill its function in an emergency. The PFP requirements shall be listed in the Safety Concept.

Table 2: maximum surface temperatures

Equipment	Maximum surface temperature (°C)
Steel processing equipment and piping (vessels, columns, exchangers, etc.) likely to contain gaseous, liquid or liquefied hydrocarbon	< 350
Riser sections, pipelines and ESDV's	< 200
Riser supports	< 400
Fire pumps, essential generator	< 200

4.2.5 Duration of the protection

The PFP system shall provide protection for a specified period of time, given in minutes, during which it has been continuously exposed to fire. Unless otherwise specified in the Safety Concept, the default values shall be such so as to provide the following protection: