



Exploration & Production

GENERAL SPECIFICATION

CORROSION

GS COR 353

Design and application of passive fire protection coatings

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1. Scope

This specification defines the technical requirements for the design and application of fireproof coatings to provide structures, buildings and equipment with passive fire protection.

The document does not cover:

- Definition of the equipment and structures to be protected
- Protection of cable and piping entries
- Definition of fire classifications of bulkheads and floors.

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	Fire resistance tests
ISO 8421- 1	Fire protection - Glossary of terms
ISO 1182	Incombustibility
ISO 1716	Building materials - Determination of calorific potential
ISO 5660- Part1	Fire tests - Reaction to fire - Rate of heat release from building products

Professional Documents

Reference	Title
UL 1709 (Underwriters laboratories Inc)	Rapid rise fire tests of protection materials for structural steels
UL 263 (Underwriters laboratories Inc)	Fire test of building construction/material
ASTM E 119	
ASTM E 1354-90	Standard test method for heat and visible smoke. Release rates for materials and products using an oxygen consumption calorimeter
NS-INSTA 412	Fire testing building products heat development, smoke development

Regulations

Reference	Title
NPD (Norwegian Petroleum Directorate)	Fire test standard

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS SAF 337	Passive fire protection
GS PVV 771	Thermal insulation (hot service)
GS PVV 772	Thermal insulation (cold service)
GS PVV 773	Thermal insulation (cyclic service)
GS COR 350	External protection of offshore and related structures and equipment by painting

3. Design hypotheses

3.1 Critical temperature

The stability of a steel element ceases to be guaranteed when, because of a rise in temperature, the mechanical strength of the component falls until it is equal to the stresses to which it is subjected.

The temperature reached by this structural element at this point in time is defined as the "critical temperature".

The contractual critical temperature levels to be applied in fire stability calculations are set in the design code applicable to the structural element or equipment to be protected.

3.2 Fire protection time

The fireproof protection time to be taken into account shall be decided on the basis of the conclusions of the studies of risk or danger conducted for the site concerned, and all applicable

regulations. For onshore metallic or concrete structures, it shall average two hours unless otherwise stipulated in the project documentation.

The fire effectiveness time of the fireproof materials shall be determined from calculations ratified by tests carried out by approved laboratories (see section 5.2).

3.3 Temperature rise curves

3.3.1 Cellulose fire

In the case of public buildings, the fire stability of the protected elements must be justified by supporting documentation. It shall be established with reference to a temperature rise curve of the standardized "building fire" furnace ([ISO 834](#) or [UL 263](#)). This represents a cellulose fire that is inconsistent with an environment in which hydrocarbons are handled.

3.3.2 Hydrocarbon fire

In the case of a hydrocarbon fire, the temperature rise is very much quicker.

To characterize all the tests for determining and verifying the thicknesses of the passive fireproof protection system, the temperature rise curve used shall be that defined by [ISO 834](#) (hydrocarbon), or [NPD](#) (Norwegian Petroleum Directory) or [UL 1709](#) (Underwriters laboratories Inc).

3.3.3 Jet fire

The ability of the fireproofing product to withstand attack from jet fire can be justified only by experimental methods. The resulting abrasive effect, and the thermal shock and flux depend on the nature and pressure of the combustible products carried.

3.4 Degree of fire stability of reinforced concrete structures

There are contractual methods for dimensioning reinforced concrete structures exposed to the risk of fire. These methods shall be defined in the design codes.

3.5 Degree of fire stability of metallic structures

The thickness of the fireproofing products on the framework elements must be designed on the basis of tests carried out by simulating the temperature rise curve or by a jet fire test. These tests shall be validated by a certificate of conformity issued by an approved authority.

3.6 Limit design temperature of equipment and vessels

3.6.1 Equipment operating with no thermal insulation

The critical temperature of the steel used for non thermally insulated structures and equipment shall be determined according to the maximum service pressure and the grade of steel.

The critical temperature of the steel used for the equipment supports shall also be defined.

These values shall be used to calculate the thickness of fireproofing products to be applied on each area of the structure.

In cases where a jet fire is the only risk, protection applied to a reduced area of the equipment may be considered.

3.6.2 Thermally insulated equipment

The fireproofing/thermal insulation complex shall be designed as a whole. The temperature used to calculate the thickness of the fireproofing product shall be:

- The limit design temperature defined above in cases where the thermal insulation covers the fireproofing product
- When the fireproofing product covers the thermal insulation, it shall be dimensioned in such a way as to comply with the lowest temperature taken between the limit temperature recommended by the insulation SUPPLIER and the limit design temperature defined in section 5.4.1. The purpose of this is to guarantee the mechanical strength of the thermal insulation throughout the fire effectiveness time of the fireproofing product.

4. Types of structures and equipment to be protected

The term structure is used to mean main load bearing elements of the structure, the mechanical characteristics of which need to be maintained in the event of fire to maintain the integrity of the construction.

4.1 Concrete structures

The degrees of fire stability may be uprated by the application of products to the structures. Preference shall be given to mineral fireproofing products which afford good cohesion of all the system. The materials shall then be the same as those recommended to increase the degree of fire stability of the metallic elements.

Note: Retention ponds may be involved when stipulated by application regulations.

4.2 Metallic structures

4.2.1 Onshore structure

The fire stability time of the structures may vary according to risks and applicable regulations. The studies of risks or dangers must be taken into account to determine the equipment and structures to be protected and the required protection time.

4.2.2 Offshore structures

The structures to be protected shall be determined on the basis of the studies of risk or dangers, and all applicable regulations.

4.3 Equipment and vessels

4.3.1 Onshore equipment

Equipment that is not thermally insulated:

The list of equipment requiring protection by a fireproof coating is derived from the study of dangers or risks. Such equipment represents a potential risk of aggravating the situation in the event of a fire, or a toxic risk.

Below is a non-exhaustive list of examples:

- **Skirts of columns or vertical vessels**, as a general rule theoretically containing more than one cubic metre of flammable liquid

- **Furnaces**, other than those superheating steam: supports from the ground to the level of the operation floor
- **Storage facilities** for liquefied hydrocarbons or spherical storage vessels containing liquid hydrocarbons that may present a risk of spreading fire, with the protection extending from the hardstanding to the tangency line of the vessel, including the bolts
- The supports of free-standing vertical or horizontal vessels on the ground located within plants that include liquid, liquefied or similar hydrocarbons shall be protected
- **If necessary, all safety or blowdown equipment**, if its vulnerability is such that it may compromise safety of the installation in the event of a fire. Such equipment shall be covered by full protection.

Valves, instrumentation and fittings connected to equipment are generally not protected against the risk of fire except in cases where they are safety devices that are essential to the containment of the product inside the vessel (fire safety valve, automatic check valve, valve flanges, etc). In such cases, the fireproofing protection shall comprise removable boxes offering the same fire resistance tie as that required for the equipment.

4.3.2 Offshore equipment

The equipment shall be determined on the basis of the studies of risks or dangers, and all applicable regulations.

4.4 Buildings

- Buildings with a risk of enveloping fire onshore
- Living quarters, cabins, plant rooms, temporary shelters (TSR) and control rooms offshore
- Other buildings (including administrative).

The materials used to protect the outside this type of construction shall be chosen according to the surrounding risk.

The materials used inside this type of construction shall comply with applicable regulations. No specific test of hydrocarbon fire resistance shall be required apart from of any exposed walls. The temperature rise curves shall be those defined for cellulose fire ([ISO 834](#) or [UL 263](#)).

5. Application of fireproofing materials

Only the products fire tested by approved laboratories shall be allowed. The use of fireproofing products containing asbestos is prohibited.

5.1 Types of fireproofing material

The protection systems and materials that can be used are:

- Concrete materials with vaporization stages. The heat release energy is initially absorbed to vaporize the constituent water; consequently, the structure does not heat up during this time. Once the water has vaporized, the protection layer serves as a thermal screen to prevent the transmission of heat flux
- Intumescent products: these are products which, under the action of a high rise of in temperature, swell to form a very thick "meringue" to form an insulating barrier protecting against flames

- Caissons: possibility of construction by rigid or semi-rigid panels.

In all cases, the materials used shall satisfy the following minimal requirements:

- The protection product must withstand attack from the environment over time
- Ease of application and repair shall be considered as an important factor
- The chemical resistance of product to anything liable to pollute it shall be examined
- The hardness of the products shall be at least equal to 40 (Shore D scale) for passive protection against hydrocarbon fires.

The behaviour of the product with respect to its support structure shall be examined. Products developing a non-passivating pH level when they become damp shall require a watertight corrosion protection treatment of the structure to which they are applied. Such corrosion protection shall be approved by the SUPPLIER of the fireproofing product for compatibility between the products. The application of such corrosion protection shall be carried out in accordance with the SUPPLIER's instructions and **GS COR 350**.

In the event of deterioration, repairs must be easy to carry out and adhere fully to the old part.

A reinforcement may be incorporated in the fireproofing product in accordance with the SUPPLIER's recommendations to improve its mechanical strength.

When joints are provided to take account of differential thermal expansion in the equipment, the protection shall be implemented in such a way as to allow for and not be damaged by such expansion.

The upper parts of beams supporting gratings or piping shall not be protected.

5.2 Composition of the systems

The compliance of a protection system with its classification must be guaranteed by a report or certificate issued by an inspection authority for standardized tests (**ISO 834**, **UL 263**, **NPD**, **UL 1709**) carried out by an approved laboratory.

5.2.1 Approved laboratories

CTICM	(F)	Centre Technique Industriel de la Construction Métallique (Technical and Industrial Centre for Metallic Construction)
CSTB	(F)	Centre Scientifique et Technique du Bâtiment (Scientific and Technical Centre for Building)
SINTEF	(N)	The Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology
FIRTO	(NL)	Fire Insurer's Research and Testing Organisation
UL	(USA)	Underwriters Laboratories
BG	(UK)	British Gas
WARRINGTON	(UK)	
WARNOCK	(USA)	

5.2.2 Verifying authorities

- TUV (D)
- LLOYD'S REGISTER OF SHIPPING (UK)
- DET NORSKE VERITAS (N)
- BUREAU VERITAS (F)

Note: Other laboratories and inspection organizations may be proposed subject to the approval of the OWNER, subject to the submission of a duly justified document pack.

The applier must strictly comply with the rules of application defined by the SUPPLIER.

The applier shall be approved by the SUPPLIER.

Employees responsible for applying these products must be individually qualified by the SUPPLIER; in particular, employees occupying the following posts:

- Site supervisor
- Qualified applier
- Reinforcement fitter

must have received training specific to their particular activities.

The applier is responsible for surveying the materials and heads, to which he applies the treatment appropriate to their type.

5.3 Application on structures

5.3.1 Concrete structure

The fireproof protection of reinforced concrete structures shall be provided by a covering of reinforcements corresponding to the thickness established by the approved laboratories.

5.3.2 Metallic structure

Fireproof protection for metallic framework structures shall be provided by different systems of fireproof protection.

For offshore structures, the weight of the coatings for passive fire protection may be a decisive selection factor.

5.3.2.1 Reinforced concrete materials

In all cases, it is essential to provide the following fireproofing protection complex:

- Anticorrosion treatment of the base metal material using a coating compatible with the fireproofing product (see section 5.1, above). The anticorrosion system may be different from the system used to treat the rest of the framework
- Application of a reinforcement, positioned and fixed according to the SUPPLIER's instructions
- Application of the material according to the SUPPLIER's recommendations and in such a way that there are no air pockets between the framework and the fireproofing material. Such pockets may cause condensation at the interface resulting in corrosion of the base metal in the event of a seal defect. These materials may be sprayed on or applied by

trowel. The finished appearance must be smooth for steel members > 300 mm and equipment supports

- Application of a surface paint coating compatible with the fireproofing product.

Note: Materials causing acid hydrolysis in the presence of moisture (particularly those containing magnesium oxychloride based products) shall be prohibited on offshore structures, including inside the rooms.

5.3.2.2 Intumescent products

These types of products are particularly well suited to very corrosive atmospheres (offshore structures, for example).

If such products are used, the procedure is as follows:

- Surface preparation of the base metal followed by application of a primary coat compatible with the intumescent epoxy resin (see section 5.1, above)
- Application of the fireproofing product according to the SUPPLIER's recommendations
- Application of a reinforcement. With thin fireproofing products (less than 9 mm), this can be eliminated if the fire certification permits.

Any external paint not recommended by the SUPPLIER shall be formally proscribed, because, in the event of a fire, it may prevent expansion of the fireproofing material.

The thickness of the fireproofing protection shall be measured using a wet gauge.

5.3.2.3 Other products

Other fireproofing products that satisfy the conditions of exposure and resistance to fire defined for the project may, if necessary, be proposed by the CONTRACTOR.

5.4 Application on equipment and vessels

5.4.1 Support structures

Metal elements supporting equipment and vessels shall be protected against the risk of fire in the same way as the structures described in the previous section. The fireproofing product used may differ from that used to protect the jacket. In this case, seal tightness at the point of change of material must be guaranteed.

5.4.2 Jacket

5.4.2.1 Jacket without thermal insulation

The jacket protection shall be implemented in the same way as a framework element described in section 5.3.2. The reinforcement fixing principle shall be defined by the product SUPPLIER.

The allowable service temperature for use of fireproofing products shall be that defined by the product SUPPLIER. The following may be used as a general rule:

- 85°C for reinforced concrete type mineral products. This prevents evaporation of the crystallized water
- 65°C for intumescent organic products.

If the wall temperature is higher than the temperature allowed for the product, thermal insulation shall be provided.

5.4.2.2 Jacket with thermal insulation

The fireproof protection system may be applied under the thermal insulation (cold service insulation only), or outside the thermal insulation.

5.4.2.2.1 Fireproofing product (intumescent epoxy resin) under the thermal insulation

In this case, the fireproofing protection complex is as follows:

- Surface preparation of the base metal and application of a primary coat compatible with the intumescent epoxy resin (see section 5.1, above)
- Application of the fireproofing product with incorporation of the reinforcement according to the SUPPLIER's recommendations
- Bonding of the thermal insulation after checking its compatibility with the fireproofing products
- Application of the insulation which may be a polyurethane foam with a minimum density of 50 kg/m³ and with a fire reaction class in the difficult to ignite category or, in the case of offshore structures, an incombustible material
- Application of the vapour barrier.

The advantage of this solution is that it avoids any cracking of the fireproofing product because its flexibility is greater than that of the steel used for the jacket and provides an excellent quality anticorrosion protection because of the nature of the product.

5.4.2.2.2 Fireproofing product outside the thermal insulation

In this case, the fireproofing protection complex is as follows:

- Surface preparation and anticorrosion protection according to **GS COR 350**
- Thermal insulation according to **GS PVV 771**, **GS PVV 772**, **GS PV 773**
- Application of the vapour barrier
- Application of the fireproofing product in accordance with the SUPPLIER's recommendations, with incorporation of a reinforcement separated from the vapour barrier. This operation must be carried out with care to avoid puncturing the vapour barrier
- Application of a surface paint coating to enhance the resistance to outdoor conditions and/or to facilitate maintenance and/or enhance appearance.

6. Fireproof coating performance

Guaranteed good resistance and performance of the thermal insulation and fireproofing products is required of both SUPPLIERS and applier; this guarantee of a minimum ten year life applies to all of the complex, as follows:

- Anticorrosion coating
- Fireproofing product

- Thermal insulation
- Seal coating.

The guarantee applies to the mechanical strength of the complex and to the ongoing performance of the fireproofing product.

Also, three specimen samples of the complex shall be taken during the work and used to check the strength of the system by testing before the end of the warranty period.

7. Technical content of bids

The CONTRACTOR's bid shall include the following information:

- The SUPPLIER of the selected fireproofing product and his reference information
- The minimum thickness of fireproofing products to satisfy the protection hypotheses
- The fireproofing complex application procedure approved by the SUPPLIER
- Data sheets of the materials that make up the fireproofing complex
- Product safety sheets
- Test certificates issued by approved laboratories and certified by authorities as to the performance levels
- The applier's quality assurance plan with an operational flow diagram complete with names
- The resources provided to protect against unfavourable climatic conditions
- Schedule of the work.

8. Quality assurance provisions

Before the start of application, a Quality Plan must be drawn up, detailing all of the procurement, fabrication, inspection and repair operations.

These shall be covered by detailed procedures.

The OWNER shall reserve the right to define specific inspection points, for example:

- Qualification of personnel
- Inspection of the compliance of the products used, material certificates
- Inspection of surface preparation
- Inspection of the anticorrosion system
- Inspection of the reinforcement supports
- Inspection of the type of reinforcement and its application
- Climatic conditions
- Inspection of fireproofing application conditions (including drying times)
- Inspection of thickness



- Inspection of adhesion
- Inspection of finished product and sealing system.

The inspection methods may vary from one product to the next according to type. The inspection methods and values shall be specified in the quality control manuals specific to each product.