Certificate No: LR2003996SF
Issue Date: 24/02/2020
Expiry Date: 23/02/2025

Certificate Of Fire Approval

This is to certify that the product(s) detailed below will be accepted for compliance with the applicable Lloyd's Register Rules and Regulations for use on offshore units classed with Lloyd's Register, and for use on offshore units and onshore facilities when authorised by contracting governments to issue the relevant certificates, licences, permits etc.

Manufacturer	**Carboline Company**
Address	350 Hanley Industrial Court St. Louis Missouri 63144 United States of America (USA)
Type	STRUCTURAL STEEL JET FIRE PROTECTION SYSTEM
Description	Structural Steel Jet Fire Protection System for I-Sections protected with "Pyrocrete 241 HD" reinforced with Steel Wire Mesh, for Jet Fire Exposures up to 240 minutes
Trade Name	Pyrocrete 241 HD
Specified Standard	International Standard ISO 22899-1:2007 "Determination of the resistance to jet fires of passive fire protection materials – Part 1 General Requirements"

The attached Design Appraisal Document forms part of this certificate.
This certificate remains valid unless cancelled or revoked, provided the conditions in the attached Design Appraisal Document are complied with and the equipment remains satisfactory in service.

This certificate is not valid for equipment, the design or manufacture of which has been varied or modified from the specimen tested. The manufacturer should notify Lloyd's Register of any modification or changes to the equipment in order to obtain a valid Certificate.

Keith Taylor

Keith Taylor

Team Lead Fire & Safety to Lloyd's Register EMEA
A member of the Lloyd's Register Group

71 Fenchurch Street, London, EC3M 4BS, United Kingdom

ATTACHMENT TO CERTIFICATE OF TYPE APPROVAL No.LR2003996SF

This Design Appraisal Document forms part of the Certificate.

This Certificate is a replacement of previous Lloyd's Register EMEA Certificate of Fire Approval No: SAS F150065.

TEST REPORTS

1. Intertek, Elmendorf, Texas, United States of America, Fire Test Report No. 101464945SAT-001A, dated 29 April 2014.
2. Intertek, Elmendorf, Texas, United States of America, Fire Test Report No. 101464945SAT-001B, dated 29 April 2014.

CONDITIONS OF CERTIFICATION

1. Application in each case to be approved by Lloyd's Register at the design stage
2. Consisting of: 29mm to 39mm thick coating of 'Pyrocrete 241 HD' (1089kg/m^3 or 68lb/ft^3 nominal density) reinforced with plastic coated steel wire mesh (17 gauge) and retained to steel substrate with welded stainless steel pins (3mm diameter x 25mm long) spaced at 355mm, subjected to jet fire exposure up to 240 minutes
3. Insulated face of the member to be exposed to the high risk side in all cases
4. Thickness of the 'Pyrocrete 241 HD' for individual I- Sections applications is to be determined by considering the Hp/A or A/V value at 100m^{-1} for the web, the maximum allowable core temperature and by comparing jet fire performance data with suitable hydrocarbon fire performance data. No hydrocarbon data has been submitted or considered for this certificate. The "Jet Fire Test Results" Section of this Certificate details the construction make-up and the performance achieved from the protection system during the jet fire testing
5. Production items are to be manufactured in accordance with a quality control system which shall be maintained to ensure that items are of the same standard as the approved prototype
6. The Certificate holder is solely responsible for the products supplied under this Certificate and to ensure that their products, whether manufactured by themselves or their licensee manufacturers, if agreed by Lloyd's Register, are fully compliant with the relevant statutory regulations and Lloyd's Register Class Rules as applicable and designed and manufactured to the same quality and specifications as the prototype tested, including components that are designed and manufactured by third parties

NOTES

1. Alternative pins of copper coated mild steel (3mm diameter x 25mm long) and a galvanised diamond mesh lathe (1.85kg/m^2) may be considered as an alternative to the as-tested stainless steel pins (3mm diameter x 25mm long) and plastic coated steel wire mesh (17 gauge), on the basis that the mesh used in the test was not exposed to the jet fire and improved welding would be possible when using the mild steel pins for carbon steel substrates.
2. Linear interpolation between the two thickness values for the web at 400°C gives a minimum jet fire thickness for I-Sections with an Hp/A of 100m^{-1} at 120 mins of **28.9mm**, to give a **Jet Fire Classification** based on ISO 22899-1:2007(E), Section 15 and ISO 22899-2:2013 [Type of Fire/Type of Application/Critical Temperature Rise (°C)/Period of Resistance (Mins)], depending on type of application, particular construction make-up of the insulation system and maximum core temperatures specified, in accordance with ISO 22899-1:2007 Section 15.4 and ISO 22899-2:2013 Section 8.4 Critical Temperature Rise as follows: "**JF/Structural Steel I-Section/400/120**".
3. The "Classification" listed on Note 2 above depend on the particular application and maximum allowable core temperature required, in accordance with ISO 22899-1:2007(E) "Section 15.4 Critical Temperature Rise" for load bearing

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steel structures this is normally 400°C, however, different projects and regions of the world may have significantly lower temperature limitations which should be taken into consideration at the design stage.

4. No additional hydrocarbon fire tests were submitted by the manufacturer to demonstrate the relationship between hydrocarbon and jet fire test results, to enable variations in time/temperature criteria, 'Pyrocrete 241 HD' thickness or Hp/A values to be assessed.

JET FIRE TEST RESULTS

Test Results for Structural Panel Specimen (28.1mm thick Coating of 'Pyrocrete 241 HD') [Intertek Test Report No: 101464945SAT-001A, dated 29 April 2014]:

Test Description: A jet fire test was performed on a structural panel specimen in accordance with ISO 22899-1:2007.

Integrity: 240 minutes (protection remained generally intact for the duration of the test).

Insulation: The following maximum temperature rises were recorded on the specimen in line with ISO 22899-1:2007:

Exposure Time (Minutes)	Maximum Temperature Rise of Backplate (°C / °F) & TC No. ( )		Maximum Temperature Rise of Web (°C / °F) & TC No. ( )	
30	78.9 / 174.0	(4)	77.3 / 171.1	(14)
60	132.7 / 270.9	(8)	189.0 / 372.2	(13)
90	266.6 / 511.9	(8)	320.1 / 608.2	(14)
120	282.2 / 540.0	(8)	420.6 / 789.1	(14)
150	295.0 / 563.0	(8)	494.5 / 922.1	(14)
180	298.3 / 568.9	(8)	543.4 / 1,010.1	(14)
210	298.3 / 568.9	(8)	577.3 / 1,071.1	(14)
240	298.3 / 568.9	(8)	601.1 / 1,114.0	(14)

Classification:

JF/Structural Steel I-Section/200/60
JF/Structural Steel I-Section/250/70
JF/Structural Steel I-Section/300/85
JF/Structural Steel I-Section/350/95
JF/Structural Steel I-Section/400/110
JF/Structural Steel I-Section/427/120
JF/Structural Steel I-Section/450/130
JF/Structural Steel I-Section/500/150
JF/Structural Steel I-Section/538/175
JF/Structural Steel I-Section/550/185
JF/Structural Steel I-Section/600/235
JF/Structural Steel I-Section/620/240

Notes:

- Ambient temperature: 23°C/73.4°F (The thermocouples starting temperatures have deducted from actual temperature readings to calculate the maximum temperature rises).
- Thermocouple start temperature: 26.7°C/80.1°F on Backplate & 26.6°C/79.9°F on Web.

Description of Test Specimen: Structural Jet Fire Test specimen consisting of: 10mm thick mild steel open-fronted box 1.50m square x 0.50m deep, with a 20mm thick central web running its entire height and 0.25m deep. Stainless steel pins (3mm diameter, 25mm long) were welded to all inner surfaces at approximately

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330mm spacing and bent over to retain a 17 gauge, PVC coated steel wire mesh with 38mm hexagonal openings at the nominal centre of the coating.
The specimen consisted of a 28.1mm coating of 'Pyrocrete 241 HD'. A primer coating of 'Carboguard 888' (98 microns thick) was applied to all internal surfaces prior to coating of 'Pyrocrete 241 HD'. The joint areas of the wire mesh reinforcement had minimal overlap.

Test Results for Structural Panel Specimen (39.1mm thick Coating of 'Pyrocrete 241 HD') [Intertek Test Report No: 101464945SAT-001B, dated 29 April 2014]:

Test Description: A jet fire test was performed on a structural panel specimen in accordance with ISO 22899-1:2007.

Integrity: 240 minutes (protection remained generally intact for the duration of the test).

Insulation: The following maximum temperature rises were recorded on the specimen in line with ISO 22899-1:2007:

Exposure Time (Minutes)	Maximum Temperature Rise of Backplate (°C / °F) & TC No. ( )		Maximum Temperature Rise of Web (°C / °F) & TC No. ( )	
30	61.6 / 142.9	(5)	72.3 / 162.1	(16)
60	80.0 / 176.0	(5)	79.0 / 174.2	(15)
90	81.6 / 178.9	(5)	105.9 / 222.6	(15)
120	107.7 / 225.9	(2)	181.8 / 359.2	(15)
150	154.4 / 309.9	(2)	262.3 / 504.1	(14)
180	181.6 / 358.9	(2)	331.8 / 629.2	(14)
210	197.2 / 387.0	(2)	390.1 / 734.2	(14)
240	206.6 / 403.9	(2)	437.3 / 819.1	(14)

Classification:

JF/Structural Steel I-Section/200/125
JF/Structural Steel I-Section/250/145
JF/Structural Steel I-Section/300/165
JF/Structural Steel I-Section/350/185
JF/Structural Steel I-Section/400/215
JF/Structural Steel I-Section/427/230
JF/Structural Steel I-Section/450/240

Note:

- Ambient temperature: 25°C/77°F (The thermocouples starting temperatures have deducted from actual temperature readings to calculate the maximum temperature rises).
- Thermocouple start temperature: 25.6°C/78.1°F on Backplate & 23.8°C/74.8° F on Web.

Description of Test Specimen: Structural Jet Fire Test specimen consisting of: 10mm thick mild steel open-fronted box 1.50m square x 0.50m deep, with a 20mm thick central web running its entire height and 0.25m deep. Stainless steel pins (3mm diameter, 25mm long) were welded to all inner surfaces at approximately 330mm spacing and bent over to retain a 17 gauge, PVC coated steel wire mesh with 38mm hexagonal openings at the nominal centre of the coating.

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The specimen consisted of a 39.2mm coating of 'Pyrocrete 241 HD'. A primer coating of 'Carboguard 888' (119 microns thick) was applied to all internal surfaces prior to coating of 'Pyrocrete 241 HD'. The joint areas of the wire mesh reinforcement had minimal overlap.

SCOPE

The test described in the procedure ISO 22899: Part 1 is one in which some of the properties of passive fire protection materials can be determined and is designed to give an indication of how passive fire protection materials will perform in a jet fire. The dimensions of the test specimen may be smaller than typical items of structure and plant and the release of gas may be substantially less than that which might occur in a credible event. However, individual thermal and mechanical loads imparted to the passive fire protection material, from the jet fire defined in the procedure described in ISO 22899: Part 1, have been shown to be similar to those by large-scale jet fires resulting from high pressure releases of natural gas.

Although the test method has been designed to simulate some of the conditions that occur in an actual jet fire, it cannot reproduce them all exactly and the thermal and mechanical loads do not necessarily coincide. The results of this test do not guarantee safety but may be used as elements of a fire risk assessment for structures or plant. This should also take into account all the other factors that are pertinent to an assessment of the fire hazard for a particular end use. This test is not intended to replace the hydrocarbon fire resistance test (ISO/TR 834-3/EN 1363-2 or equivalent) but is seen as a complimentary test.

PLACE OF PRODUCTION

Carboline AD
321 Duke Street
Louisa,VA 23093
United States of America (USA)

Keith Taylor
Team Lead, Fire & Safety
Statutory Discipline Team
UK&I Technical Support Office, Marine & Offshore
Lloyd's Register

Supplementary Type Approval Terms and Conditions

This certificate and Design Appraisal Document relates to type approval, it certifies that the prototype(s) of the product(s) referred to herein has/have been found to meet the applicable design criteria for the use specified herein, it does not mean or imply approval for any other use, nor approval of any products designed or manufactured otherwise than in strict conformity with the said prototype(s).