

# 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.

<b>Manufacturer</b>	<b>Morgan Advanced Materials</b>
<b>Address</b>	Thermal Ceramics, Tebay Road, Bromborough, Wirral, Merseyside, CH62 3PH, United Kingdom (UK).
<b>Type</b>	Cryogenic (Jet Release) and Jet Fire Resisting Protection Systems
<b>Description</b>	Cryogenic (Jet Release) and Jet Fire Protection System: "FireMaster Marine Plus Blanket" Protection System, for Cryogenic (Jet Release) Exposures of up to 60 minutes followed by Jet Fire Exposures of up to 65 minutes, for tubular steel sections, pipes or cylindrical vessels with an O.D. <500mm
<b>Trade Name</b>	FireMaster Marine Plus Blanket
<b>Specified Standard</b>	ISO 20088-3:2016 "Determination of the resistance to Cryogenic Spillage of Insulation Materials – Part 3: Jet Release"; ISO 22899-1:2007 "Determination of the resistance to Jet Fires of Passive Fire Protection Materials – Part 1: General Requirements"

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 EMEA of any modification or changes to the equipment in order to obtain a valid Certificate.

The Design Appraisal Document and its supplementary Type Approval Terms and Conditions form 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.

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

**Keith Taylor**

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

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**ATTACHMENT TO CERTIFICATE OF FIRE APPROVAL No. LR2135713SF**

This Design Appraisal Document forms part of the Certificate.

**APPROVAL DOCUMENTATION**

1. DNV-GL, Spadeadam Test Site, Cumbria, United Kingdom, Fire Test Report No. 10179348, Rev. 1, dated 22 July 2020.
2. Lloyd's Register, Independent Witness Statement, Reference No. PRJ11100265101, dated 20 August 2020.

**CONDITIONS OF CERTIFICATION**

1. Application in each case to be approved by Lloyd's Register at the design stage.
2. The "FireMaster Marine Plus Blanket" Protection System for cryogenic jet release protection followed by jet fire may be considered for applications for tubular sections, pipes or cylindrical vessels of up to 500mm diameter, but not with corners or edge features and not exceeding an Hp/A section factor of  $170\text{m}^{-1}$  (where 'Hp' is the outside circumference and 'A' is the cross-sectional area). The "FireMaster Marine Plus Blanket" system tested (88mm nominal thickness) comprised of the following construction composition:

<b><u>Thickness</u></b>	<b><u>Layer / Component Description</u></b>
38mm	Morgan FireMaster Marine Plus Blanket (Density: 128 kg/m <sup>3</sup> )
0.049mm	VaporStop™ Foil 12/25/12
50mm	Morgan FireMaster Marine Plus Blanket (Density: 128 kg/m <sup>3</sup> )
0.7mm	316 Stainless Steel Sheet Outer Cladding

Further details of this system and the performance achieved during testing is outlined in the 'Conditions of Certification' and 'Sequential Cryogenic Jet Release followed by Jet Fire Test Results' Section of this Certificate.

3. The "FireMaster Marine Plus Blankets" shall be held in place utilising stainless steel tie wire with a spacing of approximately 125mm centres. All joints between the "FireMaster Marine Plus Blankets" shall be installed with compressed butt joints. The first and second layers of "FireMaster Marine Plus Blankets" shall also be offset to reduce heat transfer.
4. A cryogenic vapour protection barrier shall be incorporated into this "FireMaster Marine Plus Blanket" Protection System and is composed of 1 layer of 0.049mm thick "VaporStop™ Foil 12/25/12" Manufactured by Temati, installed over the first 38mm thick layer of Morgan FireMaster Marine Plus Blanket (Density: 128 kg/m<sup>3</sup>). All joints in the "VaporStop™ Foil 12/25/12" shall be overlapped by 75mm and sealed with "VaporStop™ Foil 12/25/12" Adhesive Tape Manufactured by Temati.
5. The 0.7mm thick 316 stainless steel sheet outer cladding shall be overlapped by 75mm longitudinally and circumferentially and shall incorporate the application of "DOWSIL™ Firestop 700 Sealant" Manufactured by Dow Chemical Company Ltd. in the overlapping joints. The 316 stainless steel sheet outer cladding shall be secured in position with stainless steel rivets (Ø10mm) at a maximum spacing of 100mm centres. The 0.7mm thick 316 stainless steel sheet outer cladding shall be held in place by stainless steel banding (20mm wide) with tightening securing clasps at a maximum spacing of 200mm centres.

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6. Suitable approved insulation shall be applied to any other part of the protected exposed surfaces not covered by the insulation system, in all cases. In particular, attention is to be paid to means of securing boundaries and the prevention of heat bridging; an overlap of at least 150mm should be provided between the two systems where the insulation arrangements on the adjacent areas are the same or equivalent to the as-tested arrangements.
7. Composition and application of insulation material to be maintained in production and use in accordance with originally tested composition formula and method of application, and manufacturer's instructions.
8. 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.
9. 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, manufactured and installed to the same quality and specifications as the prototype tested, including components that are designed and manufactured by third parties.

**NOTES**

1. It should be noted that the cryogenic jet release testing outlined in this Certificate, conducted to ISO 20088-3:2018 was followed by sequential jet fire testing to ISO 22899-1: 2007 to allow the specimen protected with a "FireMaster Marine Plus Blanket" Protection System to be exposed to liquid nitrogen (-196°C) jet release exposure for cryogenic cooling immediately before jet fire testing, in order to demonstrate the effects of an LNG release / exposure (-162°C) followed by a jet fire.
2. Following the cryogenic jet release testing exposure and sequential jet fire testing exposure there was no visual change to the "FireMaster Marine Plus Blanket" Protection System and the protection system had remained intact. The integrity of the coating system was considered to have been achieved for 60 minutes for cryogenic jet release exposure and 65 minutes for jet fire exposure.
3. The "FireMaster Marine Plus Blanket" Protection System, may be assigned a **Cryogenic Jet Release Classification** based on **ISO 20088-3: 2018, Annex C** (Exposure Type / Protected Equipment / Critical Temperature Drop (Average Temperature Drop) / Minutes), or **Jet Fire Exposure Classifications** based on ISO 22899-1:2007, Section 15 (Exposure Type / Protected Equipment / Critical Core Temperature Rise / Minutes), depending on type of application, particular construction make-up of the insulation system and minimum / maximum core temperatures as specified in the 'Sequential Cryogenic Jet Release followed by Jet Fire Test Results' Section of this Certificate.
4. The "Classifications" listed in the 'Sequential Cryogenic Jet Release followed by Jet Fire Test Results' Section of this Certificate, depend on the particular application, type of cryogenic fluid anticipated, Hp/A Section Factor, insulation thickness and the limiting critical core temperature required, in accordance with ISO 20088-3:2018 & ISO 22899-1:2007.

**ATTACHMENT TO CERTIFICATE OF FIRE APPROVAL No. LR2135713SF****SEQUENTIAL CRYOGENIC JET RELEASE FOLLOWED BY JET FIRE TEST RESULTS**

**Test Description:** A 60 minute cryogenic jet release test in line with ISO 20088-3:2018, followed sequentially by a 67 minute, 47 second jet fire exposure test in line with ISO 22899-1:2007.

**Description of the Test Specimen:** The test specimen consisted of a tubular specimen comprising of a 4" SCH 40 seamless pipe (114.3mm O.D. x 6.3mm thick) 3 meters in length and an Hp/A section factor of  $170\text{m}^{-1}$ . The specimen incorporated one longitudinal joint facing the cryogenic jet / jet fire impingement location and two circumferential joints on the specimen in line with the testing standards to facilitate testing in the most onerous conditions.

The specimen was protected with "FireMaster Marine Plus Blanket" system (88mm nominal thickness) which comprised of the following construction composition:

- 38mm thick Morgan FireMaster Marine Plus Blanket (Density:  $128\text{ kg/m}^3$ )
- 0.049mm thick VaporStop™ Foil 12/25/12
- 50mm thick Morgan FireMaster Marine Plus Blanket (Density:  $128\text{ kg/m}^3$ )
- 0.7mm thick 316 Stainless Steel Sheet Outer Cladding

The "FireMaster Marine Plus Blankets" were held in place utilising stainless steel tie wire at 125mm centres and all joints between the "FireMaster Marine Plus Blankets" were installed with compressed butt joints. The first and second layers of "FireMaster Marine Plus Blankets" were also offset 300 mm on circumferential joints and opposite sides of the tubular section to reduce heat transfer.

A cryogenic vapour protection barrier was incorporated into this "FireMaster Marine Plus Blanket" Protection System and composed of 1 layer of 0.049mm thick "VaporStop™ Foil 12/25/12" Manufactured by Temati, installed over the first 38mm thick layer of Morgan FireMaster Marine Plus Blanket (Density:  $128\text{ kg/m}^3$ ). All joints in the "VaporStop™ Foil 12/25/12" were overlapped by 75mm and sealed with "VaporStop™ Foil 12/25/12" Adhesive Tape Manufactured by Temati.

The 0.7mm thick 316 stainless steel sheet outer cladding was overlapped by 75mm longitudinally and circumferentially and incorporated the application of "DOWSIL™ Firestop 700 Sealant" Manufactured by Dow Chemical Company Ltd. in the overlapping joints. The 316 stainless steel sheet outer cladding was secured in position with stainless steel rivets ( $\text{Ø}10\text{mm}$ ) at 100mm centres longitudinally and 88mm centres circumferentially. The 0.7mm thick 316 stainless steel sheet outer cladding was held in place by stainless steel banding (20mm wide) with tightening securing clasps at 200mm centres.

**Integrity:** **60 minutes for cryogenic jet release exposure**  
"FireMaster Marine Plus Blanket" Protection System remained in place for full duration of the cryogenic jet release exposure, with no deteriorated fixation arrangements or openings observed.

**65 minutes for jet fire exposure**  
"FireMaster Marine Plus Blanket" Protection System remained in place for full duration of the cryogenic jet release exposure, with no deteriorated fixation arrangements or openings observed.

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**Insulation:**

The following maximum average temperature drops<sup>(1)</sup> for **cryogenic jet release exposure** were recorded on the tubular specimen (Hp/A of 170m<sup>-1</sup>) in line with ISO 20088-3:2018:

after 15 minutes of exposure	-0.1°C	after 45 minutes of exposure	-2.6°C
after 30 minutes of exposure	-0.8°C	after 60 minutes of exposure	-5.2°C

<sup>(1)</sup> The maximum temperature drops were calculated based on the specimen's average temperature at the start of test (25.6°C) and the average temperature from the central band of thermocouples (cryogenic jet impingement location) reached at specific durations. For example, at 60 minutes of exposure the specimen's average temperature had reduced from 25.6°C to 20.4°C.

The following maximum temperature rises for **jet fire exposure** where exposed to cryogenic jet release exposure first were recorded on the tubular specimen (Hp/A of 173m<sup>-1</sup>) in line with ISO 22899-1:2007:

after 15 minutes of exposure	41.0°C	after 60 minutes of exposure	359.1°C
after 30 minutes of exposure	157.6°C	after 65 minutes of exposure	388.9°C
after 45 minutes of exposure	264.8°C		

**Classification:**

The "FireMaster Marine Plus Blanket" tubular specimen (Hp/A of 170m<sup>-1</sup>) protection system may be assigned a **Cryogenic Jet Release Exposure Classification**<sup>(2)</sup> (Exposure Type / Protected Equipment / Critical Temperature Drop (Average Temperature Drop) / Minutes) in line with ISO 20088-3:2018 of: **CJ/Tubular Sections/-10/60**<sup>(3)</sup>

<sup>(2)</sup> The Cryogenic jet Release Exposure Classification durations are based on the time period when the specimen core temperature dropped from the specimen's average temperature at the start of test (25.6°C) and reached the relevant limiting temperatures [Critical Temperature Drop as defined in ISO 20088-3:2018, Annex C], as determined by the average temperature from the central band of thermocouples (cryogenic jet impingement location).

<sup>(3)</sup> This result is limited by the Cryogenic Jet Release Exposure test duration. The "FireMaster Marine Plus Blanket" Protection System may be able to achieve a better result at this limiting temperature, however the test evidence does not facilitate any assessment of this.

The "FireMaster Marine Plus Blanket" tubular specimen (Hp/A of 170m<sup>-1</sup>) protection system may be assigned the following **Jet Fire Exposure Classifications**<sup>(4)</sup> (Exposure Type / Protected Equipment / Critical Temperature Rise / Minutes) in line with ISO 22899-1:2007 where a Cryogenic Jet Release Exposure has occurred first:

<b>JF/Tubular Sections/100/20</b>	<b>JF/Tubular Sections/250/40</b>	<b>JF/Tubular Sections/400/65</b> <sup>(5)</sup>
<b>JF/Tubular Sections/150/25</b>	<b>JF/Tubular Sections/300/50</b>	
<b>JF/Tubular Sections/200/35</b>	<b>JF/Tubular Sections/350/55</b>	

<sup>(4)</sup> The Jet Fire Exposure Classification Durations are based on the mean steel core temperature at the start of the jet fire test (12.6°C), and the time period when the temperature rise measured by individual thermocouples reached the relevant Critical Core Temperature.

<sup>(5)</sup> This result is limited by the Jet Fire Exposure test duration. "FireMaster Marine Plus Blanket" protection system may be able to achieve a better result at this critical temperature rise, however the test evidence does not facilitate any assessment of this.

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**SCOPE**

The tests in ISO 20088-3:2018 and ISO 22899-1: 2007 have been designed to give an indication of how cryogenic jet release protection materials will perform at a sudden exposure to cryogenic liquids and how passive fire protection materials will perform in a jet fire respectively. However, both these tests cannot guarantee a specific degree of protection from the myriad of possible exposures to cryogenic liquids or jet fires.

The Jet Fire Resistance Test, or indeed large-scale demonstrations, cannot also be used to confer a universal fire resistance rating for a specific time in the way that a standard furnace test confers a hydrocarbon rating. Hence this test is not intended to replace the hydrocarbon fire resistance test but is seen as a complementary test.

Although the test methods in these standards have been designed to simulate some of the conditions which occur in an actual cryogenic jet release or jet fire, it cannot reproduce them all exactly and the thermal and mechanical loads do not necessarily coincide. The results of these tests do not guarantee safety but may be used as elements of a cryogenic and/or 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 cryogenic or fire hazard for a particular end use.

**PLACES OF PRODUCTION**

Thermal Ceramics Lieu-dit Les Plantées St. Marcellin-en-Forez F-42680 France	Thermal Ceramics 2102 Old Savannah Road Augusta GA 30906 United States of America (USA)	Thermal Ceramics 1-31 Bookdong, Non Gong Eup Dal Sung-Gun, Dae Gui-Shi 711 855 Republic of Korea
Thermal Ceramics Cerrada de la Paz No. 101 Zona Industrial la Paz CP. 4218 Mineral de la Reforma Hidalgo México	M/S Murugappa Morgan Thermal Ceramics Ltd. Plot No. 26 & 27 SIPCOT Industrial Complex Ranipet 632 403 Vellore District Tamil Nadu India	Murugappa Morgan Thermal Ceramics Ltd. Plots No. 681 Village Moti Bhoyan Kalol-sanand Road Dist. Gandhinagar Pin 382 721, Gujarat India
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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).*