

## Certificate Of Cryogenic 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) PROTECTION SYSTEM   |
| <b>Description</b>        | Cryogenic (Jet Release) Protection System: "FireMaster® MarineFlex HY" Protection System, for Cryogenic (Jet Release) Exposures of up to 70 minutes, for tubular steel sections, pipes or cylindrical vessels with an O.D. <500mm |
| <b>Trade Name</b>         | FireMaster® MarineFlex HY   |
| <b>Specified Standard</b> | ISO 20088-3:2018 "Determination of the resistance to Cryogenic Spillage of Insulation Materials – Part 3: Jet Release "   |

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.

**ATTACHMENT TO CERTIFICATE OF CRYOGENIC APPROVAL No. LR22191726SF**

This Design Appraisal Document forms part of the Certificate.

**APPROVAL DOCUMENTATION**

1. DNV-GL, Spadeadam Test Site, Cumbria, United Kingdom, Fire Test Report No. 10179348-2, Rev. 0, dated 16 July 2020.
2. Lloyd's Register, Independent Witness Statement, Reference No. PRJ11100265101, dated 04 June 2020.

**CONDITIONS OF CERTIFICATION**

1. Application in each case to be approved by Lloyd's Register at the design stage.
2. The "FireMaster® MarineFlex HY" Protection System for cryogenic (jet) release protection 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  $160\text{m}^{-1}$  (where 'Hp' is the outside circumference and 'A' is the cross-sectional area). The "FireMaster® MarineFlex HY" Protection System tested (24mm nominal thickness) comprised of the following construction composition:

| <b>Thickness</b> | <b>Layer / Component Description</b>   |
|------------------|--|
| 10mm             | "FireMaster® MarineFlex HY" Blanket (Density: 270 kg/m <sup>3</sup> )  |
| 0.049mm          | VaporStop™ Foil 12/25/12   |
| 13mm             | "FireMaster® Marine Plus" Blanket (Density: 128 kg/m <sup>3</sup> , 50mm wide) at circumferential joints of the Outer Cladding |
| 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 'Cryogenic (Jet) Release Test Results' Section of this Certificate.

3. The "FireMaster® MarineFlex HY" blankets shall be held in place utilising stainless steel tie wire with a spacing of approximately 300mm centres and 100mm from edges. All joints between the "FireMaster® MarineFlex HY" blankets shall be installed with compressed butt joints.
4. A cryogenic vapour protection barrier shall be incorporated into this "FireMaster® MarineFlex HY" Protection System and is composed of 1 layer of 0.049mm thick "VaporStop™ Foil 12/25/12" Manufactured by Temati, installed over the 10mm thick layer of Morgan "FireMaster® MarineFlex HY" Blanket (Density: 270 kg/m<sup>3</sup>). All joints in the "VaporStop™ Foil 12/25/12" shall be overlapped by 75mm and sealed with "VaporStop™ 12/25/12" Adhesive Tape Manufactured by Temati. A 13mm thick, 50mm wide strip of "FireMaster® Marine Plus" Blanket (Density: 128 kg/m<sup>3</sup>) shall be installed at all circumferential joints to prevent rivets from penetrating the VaporStop™ Foil 12/25/12.
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.

**ATTACHMENT TO CERTIFICATE OF CRYOGENIC APPROVAL No. LR22191726SF**

6. Suitable approved insulation shall be applied to any other part of the protected cryogenic (jet) release 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 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. This Certificate only approves the cryogenic (jet) release protection performance of the product in line with the testing standards. All other performance requirements, including durability, environmental exposure (UV, salt spray exposure, high humidity, condensation, corrosion, corrosion under PFP system) etc. are outside the scope of this Certificate.
2. The "FireMaster® MarineFlex HY" Protection System, may be assigned a **Cryogenic (Jet) Release Classification<sup>(1)</sup>** based on **ISO 20088-3: 2018, Annex C** (Exposure Type / Protected Equipment / Critical Temperature Drop (Average Temperature Drop) / Minutes), depending on type of application, particular construction make-up of the insulation system and minimum core temperatures specified as follows:
  - **CJ/Tubular Sections/-5/5**
  - **CJ/Tubular Sections/-10/15**
  - **CJ/Tubular Sections/-15/20**
  - **CJ/Tubular Sections/-20/30**
  - **CJ/Tubular Sections/-25/35**
  - **CJ/Tubular Sections/-29/40**
  - **CJ/Tubular Sections/-30/45**
  - **CJ/Tubular Sections/-35/50**
  - **CJ/Tubular Sections/-40/60**
  - **CJ/Tubular Sections/-45/70<sup>(2)</sup>**
- <sup>(1)</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 (25.8°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>(2)</sup> *This result is limited by the Cryogenic (Jet) Release Exposure test duration. The "FireMaster® MarineFlex HY" 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].*
3. The "Classifications" listed in the 'Cryogenic (Jet) Release 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.

### **ATTACHMENT TO CERTIFICATE OF CRYOGENIC APPROVAL No. LR22191726SF**

4. In relation to cryogenic (jet) release exposure, this Certificate may not be suitable for applications where the ambient temperature conditions and steel thickness are different as this could change the time period when the actual temperature on the specimen reaches the limiting temperature. The ratings for individual applications must be separately verified by the design Project Approval Authority, taking into consideration as a minimum, the ambient temperature conditions, steel type and grade, type of cryogenic fluid release anticipated, rate of temperature drop demonstrated in testing, type of application, and critical temperature drop (defined in ISO 20088-3:2018) as the difference between the ambient temperature and the limiting temperature for the steel).

### **CRYOGENIC (JET) RELEASE TEST RESULTS**

**Test Description:** A 70 minute, 24 second cryogenic (jet) release exposure test in line with ISO 20088-3:2018.

**Description of the Test Specimen:** The test specimen consisted of a tubular specimen comprising of a 10" SCH 20 seamless pipe (273mm O.D. x 6.35mm thick) 3 meters in length and an Hp/A section factor of  $160\text{m}^{-1}$ . The specimen incorporated one longitudinal joint facing the cryogenic (jet) release 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® MarineFlex HY" protection system (24mm nominal thickness) which comprised of the following construction composition:

- 10mm thick "FireMaster® MarineFlex HY" Blanket (Density:  $270\text{ kg/m}^3$ )
- 0.049mm thick VaporStop™ Foil 12/25/12
- 13mm thick "FireMaster® Marine Plus" Blanket (Density:  $128\text{ kg/m}^3$ , 50mm wide) at circumferential joints of the Outer Cladding
- 0.7mm thick 316 Stainless Steel Sheet Outer Cladding

The "FireMaster® MarineFlex HY" blankets were held in place utilising stainless steel tie wire with a spacing of approximately 300mm centres and 100mm from edges and all joints between the "FireMaster® MarineFlex HY" blankets were installed with compressed butt joints.

A cryogenic vapour protection barrier was incorporated into this "FireMaster® MarineFlex HY" Protection System and composed of 1 layer of 0.049mm thick "VaporStop™ Foil 12/25/12" Manufactured by Temati, installed over the 10mm thick layer of Morgan "FireMaster® MarineFlex HY" Blanket (Density:  $270\text{ kg/m}^3$ ). All joints in the "VaporStop™ Foil 12/25/12" were overlapped by 75mm and sealed with "VaporStop™ 12/25/12" Adhesive Tape Manufactured by Temati. A 13mm thick, 50mm wide strip of "FireMaster® Marine Plus" Blanket (Density:  $128\text{ kg/m}^3$ ) was installed at all circumferential joints to prevent rivets from penetrating the VaporStop™ Foil 12/25/12.

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 a maximum spacing of 100mm centres. The 0.7mm thick 316 stainless steel sheet outer cladding was also held in place by stainless steel banding (20mm wide) with tightening securing clasps at a maximum spacing of 200mm centres.

**ATTACHMENT TO CERTIFICATE OF CRYOGENIC APPROVAL No. LR22191726SF**

**Integrity:** **70 minutes for cryogenic (jet) release exposure**  
 “FireMaster® MarineFlex HY” Protection System remained in place for full duration of the cryogenic (jet) release exposure, with no deteriorated fixation arrangements or openings observed.

**Insulation:** The following maximum average temperature drops<sup>(3)</sup> for **cryogenic (jet) release exposure** were recorded on the tubular specimen (Hp/A of 160m<sup>-1</sup>) in line with ISO 20088-3:2018:

|                              |         |                              |         |
|------------------------------|---------|------------------------------|---------|
| after 5 minutes of exposure  | -0.9°C  | after 40 minutes of exposure | -25.3°C |
| after 10 minutes of exposure | -5.9°C  | after 45 minutes of exposure | -28.3°C |
| after 15 minutes of exposure | -8.9°C  | after 50 minutes of exposure | -31.3°C |
| after 20 minutes of exposure | -12.4°C | after 55 minutes of exposure | -34.1°C |
| after 25 minutes of exposure | -15.6°C | after 60 minutes of exposure | -36.8°C |
| after 30 minutes of exposure | -18.8°C | after 65 minutes of exposure | -39.6°C |
| after 35 minutes of exposure | -22.1°C | after 70 minutes of exposure | -42.1°C |

**Classification:** The “FireMaster® MarineFlex HY” tubular specimen (Hp/A of 160m<sup>-1</sup>) protection system may be assigned a **Cryogenic (Jet) Release Exposure Classification**<sup>(4)</sup> (Exposure Type / Protected Equipment / Critical Temperature Drop (Average Temperature Drop) / Minutes) in line with ISO 20088-3:2018 of:

|                                   |                                   |   |
|-----------------------------------|-----------------------------------|---|
| <b>CJ/Tubular Sections/-5/5</b>   | <b>CJ/Tubular Sections/-25/35</b> | <b>CJ/Tubular Sections/-40/60</b>               |
| <b>CJ/Tubular Sections/-10/15</b> | <b>CJ/Tubular Sections/-29/40</b> | <b>CJ/Tubular Sections/-45/70<sup>(5)</sup></b> |
| <b>CJ/Tubular Sections/-15/20</b> | <b>CJ/Tubular Sections/-30/45</b> |   |
| <b>CJ/Tubular Sections/-20/30</b> | <b>CJ/Tubular Sections/-35/50</b> |   |

**Notes:**

<sup>(3)</sup> The maximum temperature drops were calculated based on the specimen’s average temperature at the start of test (25.8°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 25.8°C to -11.0°C.

<sup>(4)</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 (25.8°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>(5)</sup> This result is limited by the Cryogenic (Jet) Release Exposure test duration. The “FireMaster® MarineFlex HY” 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.

**ATTACHMENT TO CERTIFICATE OF CRYOGENIC APPROVAL No. LR22191726SF**

**SCOPE**

The test in ISO 20088-3:2018 has been designed to give an indication of how cryogenic (jet) release materials will perform at a sudden exposure to cryogenic liquids. However, this test cannot guarantee a specific degree of protection from the myriad of possible exposures to cryogenic liquids.

Although the test methods in these standards have been designed to simulate some of the conditions which occur in an actual cryogenic (jet) release, 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 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 hazard for a particular end use.

**PLACES OF PRODUCTION**

Thermal Ceramics Korea (Daegu)  
1-31 Bookri, Nongong-Eup,  
Dalsung-Gun, Daegu-shi 711 855,  
Republic of Korea

Porextherm Dämmstoffe GmbH  
Heisinger Straße 8/10  
87437 Kempten  
Germany

Thermal Ceramics Inc.  
2730 Industrial Parkway  
Elkhart, Indiana  
46516  
United States of America



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).*