Certificate No: LR2135765SF
Issue Date: 14/01/2021
Expiry Date: 13/01/2022

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	**Morgan Advanced Materials**
Address	Thermal Ceramics, Tebay Road, Bromborough, Wirral, Merseyside, CH62 3PH, United Kingdom (UK)
Type	Structural Steel Jet Fire Protection System
Description	Structural Tubular Steel Sections, Cylindrical Vessels or Pipes protected with – Type: "FIREMASTER TUBULAR STRUCTURAL PROTECTION SYSTEM", for Jet Fire Exposures up to 180 minutes
Trade Name	FIREMASTER TUBULAR STRUCTURAL PROTECTION SYSTEM
Specified Standard	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.

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 FIRE APPROVAL No. LR2135765SF

This Design Appraisal Document forms part of the Certificate.

This Certificate is a replacement of previous Lloyd's Register Certificate of Fire Approval No: SAS F150026/M1.

APPROVAL DOCUMENTATION

1. HSL – Health & Safety Laboratory, Buxton, Derbyshire, United Kingdom, Fire Test Report No. MH/14/137, dated 18 November 2014 for a Tubular Jet Fire Test.
   Note: *A Surveyor from Lloyd's Register witnessed this jet fire test.*
2. Manufacturers Document No. FM/FT/Tubular Construction 2014-1, for Protection System General Arrangement."
3. DNV-GL, Spadeadam Test Site, Cumbria, United Kingdom, Fire Test Report No. 16569, Rev. 0, dated 21 May 2015.
   Note: *A Surveyor from DNV-GL witnessed this jet fire test.*
4. DNV-GL, Spadeadam Test Site, Cumbria, United Kingdom, Fire Test Report No. 1MFA0YQ-3, Rev. 0, dated 13 July 2015.
   Note: *A Surveyor from DNV-GL witnessed this jet fire test.*
5. HSL – Health & Safety Laboratory, Buxton, Derbyshire, United Kingdom, Fire Test Report No. MH/15/18, dated 09 March 2015.
   Note: *A Surveyor from Lloyd's Register's Liverpool Office witnessed this jet fire test.*
6. HSL – Health & Safety Laboratory, Buxton, Derbyshire, United Kingdom, Fire Test Report No. MH/15/19, dated 09 March 2015.
   Note: *A Surveyor from Lloyd's Register's Liverpool Office witnessed this jet fire test.*

CONDITIONS OF CERTIFICATION

1. Applications to be based on the following jet fire tests performed:
   - **90mm Thick System and Section Factor Hp/A = 120m^{-1} [Approval Document Ref. 1]:**

     A 180 minute jet fire exposure test performed on a 4.5" Schedule 80 steel pipe, 127mm OD, 9.0mm thick tubular section (Hp/A of 120m^{-1}), fitted with a "FireMaster Tubular Structural Protection System" (90mm nominal thickness). The system insulation consists of four layers of 10mm thick "BTU Block Flexible" insulation (220kg/m^3) and two layers of 25mm thick "FireMaster Marine Plus" insulation (128kg/m^3), with staggered overlap joints, all covered with 0.6mm thick stainless steel cladding secured with stainless steel securing bands and rivets.
   - **78mm Thick System and Section Factor Hp/A = 345m^{-1} [Approval Document Ref. 3]:**

     105 minute jet fire exposure test performed on a 3" Schedule 10 steel pipe, 88.8mm O.D., 3.0mm thick, tubular section (Hp/A of 345m^{-1}), fitted with a "FireMaster Tubular Structural Protection System" (78mm nominal thickness). The system insulation consists of four layers of 10mm thick "BTU Block Flexible" insulation (220kg/m^3) and one layer of 38mm thick "FireMaster Marine Plus" insulation (128kg/m^3), with staggered overlap joints, all covered with 0.6mm thick stainless steel cladding secured with stainless steel securing bands and rivets.
   - **80mm Thick System and Section Factor Hp/A = 113m^{-1} [Approval Document Ref. 4]:**

     180 minute jet fire exposure test performed on a 5" Schedule 80 steel pipe, 141.3mm O.D., 9.56mm thick, tubular section (Hp/A of 113m^{-1}), fitted with a "FireMaster Tubular Structural Protection System" (80mm nominal thickness). The system insulation consists of three layers of 10mm thick "BTU Block Flexible" insulation (220kg/m^3) and one layer of 50mm thick "FireMaster Marine Plus" insulation (128kg/m^3), with staggered overlap joints, all covered with 0.6mm thick stainless steel cladding secured with stainless steel securing bands and rivets.

ATTACHMENT TO CERTIFICATE OF FIRE APPROVAL No. LR2135765SF

AND ALSO INCLUDES:

70mm Thick Branch Pipe/Drain detail Section Factor Hp/A = 254m^{-1}

¾" Schedule 160 steel tube/drain detail, 26.7mm O.D., 5.6mm thick, welded to the above pipe substrate at 90° and orientated towards the jet fire nozzle representing a drain pipe detail was also tested. This was protected by seven layers of 10mm thick "BTU Block Flexible" insulation (220kg/m^3) with staggered overlap joints, all covered with 0.6mm thick stainless steel cladding secured with stainless steel securing bands and rivets. Only the temperature of the main pipe connection was recorded.

- **70mm Thick System and Section Factor Hp/A = 115m^{-1} [Approval Document Ref. 5]:**

  120 minute jet fire exposure test performed on a 5" Schedule 80 steel pipe, 141mm O.D., 9.5mm thick tubular section (Hp/A of 115m^{-1}), fitted with a "FireMaster Tubular Structural Protection System" (70mm nominal thickness). The system insulation consists of two layers of 10mm thick "BTU Block Flexible" insulation (220kg/m^3) and one layer of 50mm thick "FireMaster Marine Plus" insulation (128kg/m^3), with staggered overlap joints, all covered with 0.6mm thick stainless steel cladding secured with stainless steel securing bands and rivets.

- **108mm Thick System and Section Factor Hp/A = 206m^{-1} [Approval Document Ref. 6]:**

  180 minute jet fire exposure test performed on a 3" Schedule 40 steel pipe, 88.9mm O.D., 5.16mm thick, tubular section (Hp/A of 206m^{-1}), fitted with a "FireMaster Tubular Structural Protection System" (108mm nominal thickness). The system insulation consists of seven layers of 10mm thick "BTU Block Flexible" insulation (220kg/m^3) and one layer of 38mm thick "FireMaster Marine Plus" insulation (128kg/m^3), with staggered overlap joints, all covered with 0.6mm thick stainless steel cladding secured with stainless steel securing bands and rivets.

2. Suitably approved insulation is to be applied to any other part of the protected fire exposed surfaces not covered by this system, in all cases. In particular, attention is to be paid to means of securing jacket boundaries and the prevention of heat bridging; an overlap of at least 150mm should be provided between the two systems. Other overlaps may be approved where suitable test evidence is provided.
3. May be considered for applications on tubular steel sections, pipes or cylindrical vessels not exceeding an Hp/A factor of 345 m^{-1}. (Where 'Hp' is the outside circumference and 'A' is the cross-sectional area).
4. Application in each case to be approved by Lloyd's Register at the design stage.
5. 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.
6. 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.
7. 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.

ATTACHMENT TO CERTIFICATE OF FIRE APPROVAL No. LR2135765SF

NOTES

1. The "FireMaster Tubular Structural Protection System" insulation system may be assigned **Jet Fire Classifications** based on ISO 22899-1: 2007, Section 15 (Jet Fire/Structural Tubular Steel/Critical Core Temperature/Minutes) depending on type of application, particular construction composition of the insulation system and maximum core temperatures specified, in accordance with ISO 22899-1:2007, Section 15.4, Critical Temperature Rise as follows:

90mm Thick System and Section Factor Hp/A = 120m^{-1} [Approval Document Ref. 1]:

- **JF/Structural Tubular Steel/5/30**
- **JF/Structural Tubular Steel/40/60**
- **JF/Structural Tubular Steel/90/90**
- **JF/Structural Tubular Steel/165/120**
- **JF/Structural Tubular Steel/240/150**
- **JF/Structural Tubular Steel/305/180**

78mm Thick System and Section Factor Hp/A = 345m^{-1} [Approval Document Ref. 3]:

- **JF/Structural Tubular Steel/45/30**
- **JF/Structural Tubular Steel/155/60**
- **JF/Structural Tubular Steel/310/90**
- **JF/Structural Tubular Steel/395/105**

80mm Thick System and Section Factor Hp/A = 113m^{-1} [Approval Document Ref. 4]:

- **JF/Structural Tubular Steel/40/30**
- **JF/Structural Tubular Steel/115/60**
- **JF/Structural Tubular Steel/200/90**
- **JF/Structural Tubular Steel/280/120**
- **JF/Structural Tubular Steel/345/150**
- **JF/Structural Tubular Steel/405/180**

INCLUDED IN SAME TEST AS ABOVE:

70mm Thick System Pipe/Drain Detail, Section Factor Hp/A = 254m^{-1} [Approval Document Ref. 4]:

- **JF/Structural Tubular Steel/55/30**
- **JF/Structural Tubular Steel/145/60**
- **JF/Structural Tubular Steel/230/90**
- **JF/Structural Tubular Steel/300/120**
- **JF/Structural Tubular Steel/360/150**
- **JF/Structural Tubular Steel/415/180**

70mm Thick System and Section Factor Hp/A = 115m^{-1} [Approval Document Ref. 5]:

- **JF/Structural Tubular Steel/45/30**
- **JF/Structural Tubular Steel/155/60**
- **JF/Structural Tubular Steel/265/90**
- **JF/Structural Tubular Steel/365/120**

108mm Thick System and Section Factor Hp/A = 206m^{-1} [Approval Document Ref. 6]:

- **JF/Structural Tubular Steel/5/30**
- **JF/Structural Tubular Steel/20/60**
- **JF/Structural Tubular Steel/50/90**
- **JF/Structural Tubular Steel/90/120**
- **JF/Structural Tubular Steel/155/150**
- **JF/Structural Tubular Steel/220/180**

2. The "Classifications" listed above depend on the particular application, Hp/A Section Factor, insulation thickness and the maximum core temperature required, in accordance with ISO 22899-1:2007, Section 15.4. The Critical Temperature Rise for load bearing steel structures is typically 400°C, however some protected items may have significantly lower temperature limitations which should be taken into consideration at the design stage.

ATTACHMENT TO CERTIFICATE OF FIRE APPROVAL No. LR2135765SF

JET FIRE TEST RESULTS

Test Results for 90mm Thick System and Section Factor Hp/A = 120m^{-1} [Approval Document Ref. 1]:

Test Description: A jet fire tubular test was performed in accordance with ISO 22899-1:2007.

Description of Test Specimen: Tubular test specimen– 3 metre long circular steel hollow section 127mm OD, wall thickness: 9.0mm and a Section Factor (Hp/A) of 120m^{-1}; fitted with a "FireMaster Tubular Structural Protection System" jet fire resistant insulation system with both circumferential and longitudinal joints of the 0.6mm thick Grade 304 stainless steel outer cladding sheets, all secured by stainless steel securing bands 19mm wide x 0.5mm thick with screw fasteners, all fitted around the insulation at 200mm centres. All longitudinal and circumferential joints secured with stainless steel rivets spaced at 100mm, the cladding sheets were overlapped for 75mm at all joints.

The specimen insulation consisted of: four layers of "BTU Block Flexible" insulation with staggered overlap joints (all 10mm thick, 220 kg/m^3 density) and covered by two layers of "FireMaster Marine Plus Blanket" with staggered overlap joints (both 25mm thick, 128 kg/m^3 density), with a total nominal insulation thickness of 90mm and a total measured diameter of 338mm, including the stainless steel cladding.

Integrity: 180 minutes (protection remained intact for duration of test)

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

after 30 minutes of exposure:	42.8°C	after 120 minutes of exposure:	397.3°C
after 60 minutes of exposure:	142.1°C	after 150 minutes of exposure:	471.1°C
after 90 minutes of exposure:	233.8°C	after 180 minutes of exposure:	556.5°C

Classification:

JF/Structural Tubular Steel/5/30
JF/Structural Tubular Steel/40/60
JF/Structural Tubular Steel/90/90
JF/Structural Tubular Steel/165/120
JF/Structural Tubular Steel/240/150
JF/Structural Tubular Steel/305/180

Test Results for 78mm Thick System and Section Factor Hp/A = 345m^{-1} [Approval Document Ref. 3]:

Test Description: A jet fire tubular test was performed in accordance with ISO 22899-1:2007.

Description of Test Specimen: Tubular test specimen– 3 metre long circular steel hollow section 3" NB, Schedule 10 steel pipe, 88.8mm O.D., 3.0mm wall thickness and a Section Factor (Hp/A) of 345m^{-1}; fitted with a "FireMaster Tubular Structural Protection System" jet fire resistant insulation system with both circumferential and longitudinal joints of the 0.6mm thick Grade 304 stainless steel outer cladding sheets, all secured by stainless steel securing bands 19mm wide x 0.5mm thick with screw fasteners, all fitted around the insulation at 200mm centres. All longitudinal and circumferential joints secured with stainless steel rivets spaced at 100mm, the cladding sheets were overlapped for 75mm at all joints.

ATTACHMENT TO CERTIFICATE OF FIRE APPROVAL No. LR2135765SF

The specimen insulation consisted of: four layers of "BTU Block Flexible" insulation with staggered overlap joints (all 10mm thick, 220 kg/m^3 density) and covered by one layer of "FireMaster Marine Plus Blanket" with staggered overlap joints (38mm thick, 128 kg/m^3 density), with a total nominal insulation thickness of 78mm.

Integrity: 105 minutes (protection remained intact for duration of test)

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

after 30 minutes of exposure:	46.5°C	after 90 minutes of exposure:	313.1°C
after 60 minutes of exposure:	159.1°C	after 120 minutes of exposure:	399.4°C

Classification: **JF/Structural Tubular Steel/45/30** **JF/Structural Tubular Steel/310/90**
JF/Structural Tubular Steel/155/60 **JF/Structural Tubular Steel/395/105**

Test Results for 80mm Thick System (Section Factor Hp/A = 113m^{-1}) and 70mm Thick Branch Pipe/Drain Detail (Section Factor Hp/A = 254m^{-1}) [Approval Document Ref. 4]:

Test Description: A jet fire tubular test was performed in accordance with ISO 22899-1:2007.

Description of Test Specimen: Tubular test specimen– 3 metre long circular steel hollow section 5" NB, 141.3mm O.D., 9.535mm wall thickness and a Section Factor (Hp/A) of 113m^{-1}; fitted with a "FireMaster Tubular Structural Protection System" jet fire resistant insulation system with both circumferential and longitudinal joints of the 0.6mm thick Grade 304 stainless steel outer cladding sheets, all secured by stainless steel securing bands 19mm wide x 0.5mm thick with screw fasteners, all fitted around the insulation at 200mm centres. All longitudinal and circumferential joints secured with stainless steel rivets spaced at 100mm, the cladding sheets were overlapped for 75mm at all joints.

The specimen insulation consisted of: three layers of "BTU Block Flexible" insulation with staggered overlap joints (all 10mm thick, 220 kg/m^3 density) and covered by one layer of "FireMaster Marine Plus Blanket" with staggered overlap joints (50mm thick, 128 kg/m^3 density), with a total nominal insulation thickness of 80mm.

A ¾" NB Schedule 160 pipe with a Section Factor (Hp/A) of 254 m^{-1}; 26.7mm O.D., 5.6mm wall thickness, was welded to the above pipe substrate at 90° and orientated towards the jet fire nozzle representing a drain pipe detail was included in test. This was protected by seven layers of 10mm thick "BTU Block Flexible" insulation (220kg/m^3) with staggered overlap joints, all covered with 0.6mm thick stainless steel cladding secured with stainless steel securing bands and rivets, with a total nominal insulation thickness of 70mm (only the temperature of the main pipe above, next to branch was recorded).

Integrity: 180 minutes (protection remained intact for duration of test)

ATTACHMENT TO CERTIFICATE OF FIRE APPROVAL No. LR2135765SF

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

after 30 minutes of exposure:	40.2°C	after 120 minutes of exposure:	280.5°C
after 60 minutes of exposure:	119.4°C	after 150 minutes of exposure:	346.3°C
after 90 minutes of exposure:	204.1°C	after 180 minutes of exposure:	408.9°C

The following maximum temperature rises were recorded on the branch pipe/drain detail specimen (only the temperature of the main pipe above, next to branch was recorded TK21):

after 30 minutes of exposure:	59.7°C	after 120 minutes of exposure:	300.8°C
after 60 minutes of exposure:	146.0°C	after 150 minutes of exposure:	362.6°C
after 90 minutes of exposure:	230.5°C	after 180 minutes of exposure:	417.5°C

Classification:

Tubular Specimen:

JF/Structural Tubular Steel/40/30
JF/Structural Tubular Steel/115/60
JF/Structural Tubular Steel/200/90
JF/Structural Tubular Steel/280/120
JF/Structural Tubular Steel/345/150
JF/Structural Tubular Steel/405/180

Pipe/Drain Detail:

JF/Structural Tubular Steel/55/30
JF/Structural Tubular Steel/145/60
JF/Structural Tubular Steel/230/90
JF/Structural Tubular Steel/300/120
JF/Structural Tubular Steel/360/150
JF/Structural Tubular Steel/415/180

Test Results for 70mm Thick System and Section Factor Hp/A = 115m^{-1} [Approval Document Ref. 5]:

Test Description: A jet fire tubular test was performed in accordance with ISO 22899-1:2007.

Description of Test Specimen: Tubular test specimen– 3 metre long circular steel hollow section 5" NB, 141mm O.D., 9.5mm wall thickness and a Section Factor (Hp/A) of 115m^{-1}; fitted with a "FireMaster Tubular Structural Protection System" jet fire resistant insulation system with both circumferential and longitudinal joints of the 0.6mm thick Grade 304 stainless steel outer cladding sheets, all secured by stainless steel securing bands 19mm wide x 0.5mm thick with screw fasteners, all fitted around the insulation at 200mm centres. All longitudinal and circumferential joints secured with stainless steel rivets spaced at 100mm, the cladding sheets were overlapped for 75mm at all joints.

The specimen insulation consisted of: two layers of "BTU Block Flexible" insulation with staggered overlap joints (all 10mm thick, 220 kg/m^3 density) and covered by one layer of "FireMaster Marine Plus Blanket" with staggered overlap joints (50mm thick, 128 kg/m^3 density), with a total nominal insulation thickness of 70mm.

Integrity: 120 minutes (protection remained intact for duration of test)

ATTACHMENT TO CERTIFICATE OF FIRE APPROVAL No. LR2135765SF

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

after 30 minutes of exposure:	49.4°C	after 90 minutes of exposure:	265.1°C
after 60 minutes of exposure:	157.7°C	after 120 minutes of exposure:	366.1°C

Classification: **JF/Structural Tubular Steel/45/30**, **JF/Structural Tubular Steel/155/60**, **JF/Structural Tubular Steel/265/90**, **JF/Structural Tubular Steel/365/120**

Test Results for 108mm Thick System and Section Factor Hp/A = 206m^{-1} [Approval Document Ref. 6]:

Test Description: A jet fire tubular test was performed in accordance with ISO 22899-1:2007.

Description of Test Specimen: Tubular test specimen– 3 metre long circular steel hollow section 3" NB, 88.9mm O.D., 5.16mm wall thickness and a Section Factor (Hp/A) of 206m^{-1}; fitted with a "FireMaster Tubular Structural Protection System" jet fire resistant insulation system with both circumferential and longitudinal joints of the 0.6mm thick Grade 304 stainless steel outer cladding sheets, all secured by stainless steel securing bands 19mm wide x 0.5mm thick with screw fasteners, all fitted around the insulation at 200mm centres. All longitudinal and circumferential joints secured with stainless steel rivets spaced at 100mm, the cladding sheets were overlapped for 75mm at all joints.

The specimen insulation consisted of: seven layers of "BTU Block Flexible" insulation with staggered overlap joints (all 10mm thick, 220 kg/m^3 density) and covered by one layer of "FireMaster Marine Plus Blanket" with staggered overlap joints (38mm thick, 128 kg/m^3 density), with a total nominal insulation thickness of 108mm.

Integrity: 180 minutes (protection remained intact for duration of test)

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

after 30 minutes of exposure:	4.5°C	after 120 minutes of exposure:	93.7°C
after 60 minutes of exposure:	23.1°C	after 150 minutes of exposure:	156.3°C
after 90 minutes of exposure:	53.0°C	after 180 minutes of exposure:	222.9°C

Classification: **JF/Structural Tubular Steel/5/30**, **JF/Structural Tubular Steel/20/60**, **JF/Structural Tubular Steel/50/90**, **JF/Structural Tubular Steel/90/120**, **JF/Structural Tubular Steel/155/150**, **JF/Structural Tubular Steel/220/180**

ATTACHMENT TO CERTIFICATE OF FIRE APPROVAL No. LR2135765SF

SCOPE

The test described in the procedure ISO 22899-1:2007 and ISO 22899-2:2013 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 22899-1: 2007 and ISO 22899-2:2013, 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.

PLACES OF PRODUCTION

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ATTACHMENT TO CERTIFICATE OF FIRE APPROVAL No. LR2135765SF

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).