Certificate No: LR2003513SF
Issue Date: 13/05/2020
Expiry Date: 12/05/2025

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	**KAEFER Energy AS**
Address	Geitaberget 17, 4031 Stavanger, Norway
Type	Cryogenic (Jet Release) and Jet Fire Resisting Enclosure Protection Systems
Description	Steel Protected with "ENERGY Firecover®" Enclosure Protection Systems, for Cryogenic Jet Releases up to 60 minutes followed by Jet Fires for up to 100 minutes
Trade Name	**ENERGY Firecover®**
Specified Standard	ISO 20088-3:2018 "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.

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. LR2003513SF

This Design Appraisal Document forms part of the Certificate.

APPROVAL DOCUMENTATION

1. RISE Fire Research AS, Trondheim, Norway, Test Report No. 120000-50-1, Rev. 1, dated 04 July 2019.
2. RISE Fire Research AS, Trondheim, Norway, Test Report No. 120000-50-2, Rev. 1, dated 04 July 2019.
3. RISE Fire Research AS, Trondheim, Norway, Test Report No. 120000-50-3, Rev. 1, dated 04 July 2019.

CONDITIONS OF CERTIFICATION

1. Application in each case to be approved by Lloyd's Register at the design stage
2. The "ENERGY Firecover®" Enclosure Protection Systems protection systems tested are summarised as follows in the following table. A detailed description of the "ENERGY Firecover®" Enclosure Protection Systems, construction make-up and securing arrangements which must be adhered to are outlined in full in the 'Sequential Cryogenic Jet Release followed by Jet Fire Test Results' Section of this Certificate Section of this Certificate. The associated sequential cryogenic jet release and jet fire test results of the various tested configurations are also outlined in the 'Sequential Cryogenic Jet Release followed by Jet Fire Test Results' Section of this Certificate

Test Report Ref.	Air Gap from Steel Substrate	"ENERGY Firecover®" Enclosure Protection System Description	Total System Thickness (Excl. Air Gap)
120000-50-1, Rev. 1	48mm	2 x 6mm thick layers of "ENERGY Fireboard®" 5mm thick "Superwool® Plus Paper" (190-200kg/m³ Density) 0.7mm thick SS316L Outer Cladding	17.7mm
120000-50-2, Rev. 1	16mm	1 x 4mm thick layer of "ENERGY Fireboard®" 5mm thick "Superwool® Plus Paper" (190-200kg/m³ Density) 0.7mm thick SS316L Outer Cladding	9.7mm
120000-50-3, Rev. 1	15.3mm	1 x 4mm thick layer of "ENERGY Fireboard®" 0.7mm thick SS316L Outer Cladding	4.7mm

3. The "ENERGY Firecover®" Enclosure Protection Systems protection systems arrangements consisted of a 650mm / 600mm long protection box with a circular cross section split into two identical half shells, secured together via SS316L Adjustable Snap Locks attached to the SS316L Outer Cladding via SS316L Pop Rivets. The at SS316L Adjustable Snap Locks shall be at a maximum spacing of 185mm centres and 50mm from edges

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4. The "ENERGY Firecover®" Enclosure Protection Systems may be fitted with inspection hatches which shall be constructed of the same composition as the "ENERGY Firecover®" Enclosure Protection System being provided and shall be secured as follows depending upon the tested configurations:

Test Report Ref.	Total System Thickness (Excl. Air Gap)	Maximum Inspection Hatch Size	Inspection Hatch Overlap Arrangements	Inspection Hatch Securing Arrangements
120000-50-1, Rev. 1	17.7mm	470mm x 270mm	30mm overlap on all sides with "Nitoseal SC N" Sealant in the overlap around the whole hatch	SS316L Adjustable Snap Locks at approx. 137mm centres attached to the SS316L Outer Cladding via SS316L Pop Rivets
120000-50-2, Rev. 1	9.7mm	360mm x 200mm	30mm overlap on all sides with "Nitoseal SC N" Sealant in the overlap around the whole hatch	SS316L Adjustable Snap Locks at approx. 100mm centres attached to the SS316L Outer Cladding via SS316L Pop Rivets
120000-50-3, Rev. 1	4.7mm	360mm x 200mm	30mm overlap on all sides with "Nitoseal SC N" Sealant in the overlap around the whole hatch	SS316L Adjustable Snap Locks at approx. 100mm centres attached to the SS316L Outer Cladding via SS316L Pop Rivets

5. The "ENERGY Firecover®" Enclosure Protection Systems may also be fitted with an "ENERGY Drainplug®" which has a hole diameter of 15mm and during normal operations prevents moisture build up within the "ENERGY Firecover®" Enclosure Protection Systems and during a fire is designed to react and prevent the passage of flame and heat. The "ENERGY Drainplug®" shall be secured to the SS316L Outer Cladding via two SS316L Pop Rivets

6. Suitable for use on assembly sections (valve & flanges) not exceeding an Hp/A section factor of $163m^{-1}$. (Where 'Hp' is the outside circumference and 'A' is the cross-sectional area). Should this wish to be used on larger section factors, the suitability would have to be robustly demonstrated by an appropriate means

7. Generally used in external locations, where personnel are not normally present during an emergency event. Consideration may be given to the use in internal locations for limited applications only (for example, in modules or spaces where personnel are not normally present during an emergency event)

8. An overlap of at least 75mm shall be provided between the "ENERGY Firecover®" Enclosure Protection Systems and any other protection system to ensure suitability and integrity of the overlaps during cryogenic jet and jet fire exposure. The adjoining insulation system shall be constructed of "Foamglas® ONE" cellular glass pipeshells, "FireMaster® Marine Plus" insulation blankets (128 kg/m^3 density) and a 0.5mm SS316L stainless steel outer cladding or equivalent system that allows a tight fit to be maintained with the "ENERGY Firecover®" Enclosure Protection Systems

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9. 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

10. 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

11. 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. No additional suite / range of hydrocarbon fire tests demonstrating were submitted by the manufacturer to demonstrate the relationship between hydrocarbon and jet fire test results, to enable variations in time / temperature criteria, thickness or Hp/A values to be assessed.

2. It should be noted that the cryogenic jet release exposure testing outlined in this Certificate, conducted to ISO 20088-3:2018 were followed by sequential jet fire testing to ISO 22899-1: 2007 to allow the specimen protected with "ENERGY Firecover®" Enclosure Protection Systems to be exposed to liquid nitrogen (-196°C) jet release for cryogenic cooling immediately before jet fire testing, in order to demonstrate the effects of an LNG release (-162°C) followed by a jet fire.

3. The "ENERGY Firecover®" Enclosure Protection Systems, may be assigned a **Cryogenic Jet Release (LiN) Classification** based on **ISO 20088-3: 2018, Annex C** (Exposure Type / Protected Equipment / Critical Temperature Drop (Average Temperature Drop) / Minutes), or **Jet Fire Exposure Classification** based on **ISO 22899-1:2007, Section 15** (Exposure Type / Protected Equipment / Critical Temperature Ruse / Minutes), depending on type of application, particular construction make-up of the insulation system and minimum core temperatures specified in the 'Sequential Cryogenic Jet Release followed by Jet Fire Test Results' Section of this Certificate.

4. The "Classifications" mentioned in Note 3 above and listed in the 'Sequential Cryogenic Jet Release followed by Jet Fire Test Results' Section of this Certificate depend on the particular application, Hp/A Section Factor, insulation thickness and the limiting critical core temperature required, in accordance with ISO 20088-3:2018 and ISO 22899-1:2007.

5. In relation to cryogenic jet release exposure, this Certificate may be 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).

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SEQUENTIAL CRYOGENIC JET RELEASE FOLLOWED BY JET FIRE TEST RESULTS

1. RISE Fire Research AS, Trondheim, Norway, Test Report No. 120000-50-1, Rev. 1, dated 04 July 2019:

Specimen Type Hp/A of 163m^{-1} ("ENERGY Firecover®" Enclosure Protection System) with a 48mm Air Gap and 17.7mm thick Protection System.

Test Description: A 60 minute, 14 second cryogenic jet release test (LiN) in line with ISO 20088-3:2018, followed by a 102 minute, 29 second jet fire release test in line with ISO 22899-1:2007.

Integrity: **60 minutes** for **cryogenic jet release** (protection remained in place for full duration of test).
100 minutes for **jet fire release** (protection remained in place for full duration of test).

Insulation: The following maximum average temperature drops for **cryogenic jet release exposure** were recorded on specimen in line with ISO 20088-3:2018:

after 15 minutes of exposure	-5°C	after 45 minutes of exposure	-30°C
after 30 minutes of exposure	-17°C	after 60 minutes of exposure	-41°C

The following maximum temperature rises for **jet fire exposure** were recorded on the specimen:

after 15 minutes of exposure	107°C	after 75 minutes of exposure	468°C
after 30 minutes of exposure	181°C	after 90 minutes of exposure	560°C
after 45 minutes of exposure	272°C	after 100 minutes of exposure	617°C
after 60 minutes of exposure	370°C		

Notes: The above Cryogenic Jet Release Exposure Protection Durations are based on the time period when the specimen core temperature dropped from the specimen's average temperature from the central band of thermocouples (cryogenic jet impingement location) at the start of test (23°C ± 3°C as per ISO 20088-3:2018) and reached the relevant limiting temperatures [Critical Temperature Drop as defined in ISO 20088-3:2018, Annex C], as determined by average thermocouple measurements.

Classification (Cryogenic Jet Release): The protection system may be assigned a Cryogenic Jet Release Exposure (LiN) Classification (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 maximum core temperatures specified as follows:

CJ/Assemblies/-5/13	**CJ/Assemblies/-25/35**	**CJ/Assemblies/-40/55**
CJ/Assemblies/-10/20	**CJ/Assemblies/-29/40**	**CJ/Assemblies/-46/60*[1]**
CJ/Assemblies/-15/25	**CJ/Assemblies/-30/42**	
CJ/Assemblies/-20/30	**CJ/Assemblies/-35/50**	

[1] *This result is limited by the cryogenic jet release (LiN) test duration. The "ENERGY Firecover®" Enclosure Protection System cryogenic protection product may be able to achieve a better result at this limiting temperature, however the test evidence does not facilitate any assessment of this.*

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Classification (Jet Fire):

The protection system may be assigned a Jet Fire Classification where a Cryogenic Jet Release Exposure has occurred first (Exposure Type / Protected Equipment / Critical Core Temperature / Minutes), depending on type of application, particular construction make-up of the insulation system and maximum core temperatures specified as follows:

JF/Assemblies/150/20	**JF/Assemblies/350/55**	**JF/Assemblies/550/85**
JF/Assemblies/200/30	**JF/Assemblies/400/60**	**JF/Assemblies/600/95**
JF/Assemblies/250/40	**JF/Assemblies/450/70**	**JF/Assemblies/650/100*[1]**
JF/Assemblies/300/45	**JF/Assemblies/500/80**	

***[1]** *This result is limited by the jet fire release test duration. The "ENERGY Firecover®" Enclosure Protection System product may be able to achieve a better result at this limiting temperature, however the test evidence does not facilitate any assessment of this.*

Description of Test Specimen:

A 60 minute, 14 second cryogenic jet release test (LiN) in line with ISO 20088-3:2016, followed by a 102 minute, 29 second jet fire release test in line with ISO 22899-1:2007.

The test specimen consisted of a steel tubular (8" nominal dia.) 219.1mm outside diameter (500mm long, 6.3mm wall thickness) with an Hp/A Section factor of 163m^{-1}; attached at each end to steel tubulars (4" nominal dia.) 114.3mm O.D. (each 1,000mm long, 6.3mm wall thickness); an "ENERGY Firecover®" Enclosure Protection Systems, 650mm long, with a circular cross section fitted over the (8" nominal dia.) tubular at each end of the box. The centre of the jet fire impinged on the mid length of the box facing the joint between the two identical half shells, secured together via SS316L Adjustable Snap Locks attached to the SS316L Outer Cladding via SS316L Pop Rivets. The SS316L Adjustable Snap Locks were installed at a maximum spacing of 185mm centres and 50mm from edges. The "ENERGY Firecover®" Enclosure Protection Systems was also fitted with a 470mm x 270mm inspection hatch constructed of the same composition as the "ENERGY Firecover®" Enclosure Protection System which was secured in place via SS316L Adjustable Snap Locks at approx. 137mm centres attached to the SS316L Outer Cladding via SS316L Pop Rivets. The metal overlap on the inspection hatch was 30mm overlap on all sides with "Nitoseal SC N" Sealant in the overlap around the whole hatch.

Both ends of the "ENERGY Firecover®" Enclosure Protection Systems were overlapped by least 75mm which fitted over the 4 inch nominal dia. tubulars, which were protected by: 40mm thick of "Foamglas® ONE" cellular glass pipeshells; 25mm thick "FireMaster® Marine Plus" insulation blankets (128 kg/m^3 density); and 0.5mm SS316L stainless steel outer cladding***[2]**.

The "ENERGY Firecover®" Enclosure Protection System was comprised of the following: 48mm air gap from the steel substrate; 2 x 6mm thick layers of "ENERGY Fireboard®"; 5mm thick "Superwool® Plus Paper" (190-200kg/m^3 Density); 0.7mm thick SS316L Outer Cladding; resulting in a nominal outside diameter of 341mm.

***[2]** *It was noted that the insulation build-up on the pipe was Standard NORSOK R-004 V.3 Class 5 Fire Protection used on the Norwegian continental shelf: 40mm thick Cellular Glass; 25mm thick AES Fibre; and 0.5mm thick SS316 Stainless Steel Outer Cladding.*

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2. RISE Fire Research AS, Trondheim, Norway, Test Report No. 120000-50-2, Rev. 1, dated 04 July 2019:

Specimen Type Hp/A of 163m^{-1} ("ENERGY Firecover®" Enclosure Protection System) with a 16mm Air Gap and 9.7mm thick Protection System.

Test Description: A 60 minute, 20 second cryogenic jet release test (LiN) in line with ISO 20088-3:2018, followed by a 55 minute, 21 second jet fire release test in line with ISO 22899-1:2007.

Integrity: **60 minutes** for **cryogenic jet release** (protection remained in place for full duration of test).
55 minutes for **jet fire release** (protection remained in place for full duration of test).

Insulation: The following maximum average temperature drops for **cryogenic jet release exposure** were recorded on specimen in line with ISO 20088-3:2018 :

after 15 minutes of exposure	-9°C	after 45 minutes of exposure	-38°C
after 30 minutes of exposure	-25°C	after 60 minutes of exposure	-49°C

The following maximum temperature rises for **jet fire exposure** were recorded on the specimen:

after 15 minutes of exposure	167°C	after 45 minutes of exposure	537°C
after 30 minutes of exposure	346°C	after 55 minutes of exposure	669°C

Notes: The above Cryogenic Jet Release Exposure Protection Durations are based on the time period when the specimen core temperature dropped from the specimen's average temperature from the central band of thermocouples (cryogenic jet impingement location) at the start of test (23°C ± 3°C as per ISO 20088-3:2018) and reached the relevant limiting temperatures [Critical Temperature Drop as defined in ISO 20088-3:2018, Annex C], as determined by average thermocouple measurements.

Classification (Cryogenic Jet Release): The protection system may be assigned a Cryogenic Jet Release Exposure (LiN) Classification (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 maximum core temperatures specified as follows:

CJ/Assemblies/-5/10	**CJ/Assemblies/-25/30**	**CJ/Assemblies/-40/45**
CJ/Assemblies/-10/15	**CJ/Assemblies/-29/34**	**CJ/Assemblies/-46/50**
CJ/Assemblies/-15/20	**CJ/Assemblies/-30/35**	**CJ/Assemblies/-50/60*[1]**
CJ/Assemblies/-20/25	**CJ/Assemblies/-35/40**	

***[1]** *This result is limited by the cryogenic jet release (LiN) test duration. The "ENERGY Firecover®" Enclosure Protection System product 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 TYPE APPROVAL No. LR2003513SF

Classification (Jet Fire):

The protection system may be assigned a Jet Fire Classification where a Cryogenic Jet Release Exposure has occurred first (Exposure Type / Protected Equipment / Critical Core Temperature / Minutes), depending on type of application, particular construction make-up of the insulation system and maximum core temperatures specified as follows:

JF/Assemblies/150/10	**JF/Assemblies/350/30**	**JF/Assemblies/550/45**
JF/Assemblies/200/15	**JF/Assemblies/400/33**	**JF/Assemblies/600/47**
JF/Assemblies/250/20	**JF/Assemblies/450/35**	**JF/Assemblies/650/50**
JF/Assemblies/300/25	**JF/Assemblies/500/40**	**JF/Assemblies/700/55*[1]**

***[1]** *This result is limited by the jet fire release test duration. The "ENERGY Firecover®" Enclosure Protection System product may be able to achieve a better result at this limiting temperature, however the test evidence does not facilitate any assessment of this.*

Description of Test Specimen:

A 60 minute, 20 second cryogenic jet release test (LiN) in line with ISO 20088-3:2016, followed by a 55 minute, 21 second jet fire release test in line with ISO 22899-1:2007.

The test specimen consisted of a steel tubular (8" nominal dia.) 219.1mm outside diameter (500mm long, 6.3mm wall thickness) with an Hp/A Section factor of 163m^{-1}; attached at each end to steel tubulars (4" nominal dia.) 114.3mm O.D. (each 1,000mm long, 6.3mm wall thickness); an "ENERGY Firecover®" Enclosure Protection Systems, 600mm long, with a circular cross section fitted over the (8" nominal dia.) tubular at each end of the box. The centre of the jet fire impinged on the mid length of the box facing the joint between the two identical half shells, secured together via SS316L Adjustable Snap Locks attached to the SS316L Outer Cladding via SS316L Pop Rivets. The SS316L Adjustable Snap Locks were installed at a maximum spacing of 185mm centres and 50mm from edges. The "ENERGY Firecover®" Enclosure Protection Systems was also fitted with a 360mm x 200mm inspection hatch constructed of the same composition as the "ENERGY Firecover®" Enclosure Protection System which was secured in place via SS316L Adjustable Snap Locks at approx. 100mm centres attached to the SS316L Outer Cladding via SS316L Pop Rivets. The metal overlap on the inspection hatch was 30mm overlap on all sides with "Nitoseal SC N" Sealant in the overlap around the whole hatch.

The "ENERGY Firecover®" Enclosure Protection Systems was also fitted with an "ENERGY Drainplug®" which has a hole diameter of 15mm and was secured to the SS316L Outer Cladding via two SS316L Pop Rivets.

Both ends of the "ENERGY Firecover®" Enclosure Protection Systems were overlapped by least 75mm which fitted over the 4 inch nominal dia. tubulars, which were protected by: 40mm thick of "Foamglas® ONE" cellular glass pipeshells; 25mm thick "FireMaster® Marine Plus" insulation blankets (128 kg/m^3 density); and 0.5mm SS316L stainless steel outer cladding***[2]**.

The "ENERGY Firecover®" Enclosure Protection System was comprised of the following: 16mm air gap from the steel substrate; 1 x 4mm thick layer of "ENERGY Fireboard®"; 5mm thick "Superwool® Plus Paper" (190-200kg/m^3 Density); 0.7mm thick SS316L Outer Cladding; resulting in a nominal outside diameter of 276mm.

***[2]** *It was noted that the insulation build-up on the pipe was Standard NORSOK R-004 V.3 Class 5 Fire Protection used on the Norwegian continental shelf: 40mm thick Cellular Glass; 25mm thick AES Fibre; and 0.5mm thick SS316 Stainless Steel Outer Cladding.*

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3. RISE Fire Research AS, Trondheim, Norway, Test Report No. 120000-50-3, Rev. 1, dated 04 July 2019:

Specimen Type Hp/A of 163m^{-1} ("ENERGY Firecover®" Enclosure Protection System) with a 15.3mm Air Gap and 4.7mm thick Protection System.

Test Description: A 41 minute, 29 second cryogenic jet release test (LiN) in line with ISO 20088-3:2018, followed by a 47 minute, 37 second jet fire release test in line with ISO 22899-1:2007.

Integrity: **40 minutes** for **cryogenic jet release** (protection remained in place for full duration of test).
45 minutes for **jet fire release** (protection remained in place for full duration of test).

Insulation: The following maximum average temperature drops for **cryogenic jet release exposure** were recorded on specimen in line with ISO 20088-3:2018 :

after 15 minutes of exposure	-19°C	after 40 minutes of exposure	-58°C
after 30 minutes of exposure	-44°C		

The following maximum temperature rises for **jet fire exposure** were recorded on the specimen:

after 15 minutes of exposure	237°C	after 45 minutes of exposure	623°C
after 30 minutes of exposure	462°C		

Notes: The above Cryogenic Jet Release Exposure Protection Durations are based on the time period when the specimen core temperature dropped from the specimen's average temperature from the central band of thermocouples (cryogenic jet impingement location) at the start of test (23°C ± 3°C as per ISO 20088-3:2018) and reached the relevant limiting temperatures [Critical Temperature Drop as defined in ISO 20088-3:2018, Annex C], as determined by average thermocouple measurements.

Classification (Cryogenic Jet Release): The protection system may be assigned a Cryogenic Jet Release Exposure (LiN) Classification (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 maximum core temperatures specified as follows:

CJ/Assemblies/-5/5	**CJ/Assemblies/-29/20**	**CJ/Assemblies/-50/32**
CJ/Assemblies/-10/10	**CJ/Assemblies/-30/21**	**CJ/Assemblies/-55/35**
CJ/Assemblies/-15/12	**CJ/Assemblies/-35/23**	**CJ/Assemblies/-60/40*[1]**
CJ/Assemblies/-20/15	**CJ/Assemblies/-40/25**	
CJ/Assemblies/-25/18	**CJ/Assemblies/-46/30**	

***[1]** *This result is limited by the cryogenic jet release (LiN) test duration. The "ENERGY Firecover®" Enclosure Protection System cryogenic protection product may be able to achieve a better result at this limiting temperature, however the test evidence does not facilitate any assessment of this.*

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Classification (Jet Fire):

The protection system may be assigned a Jet Fire Classification where a Cryogenic Jet Release Exposure has occurred first (Exposure Type / Protected Equipment / Critical Core Temperature / Minutes), depending on type of application, particular construction make-up of the insulation system and maximum core temperatures specified as follows:

JF/Assemblies/150/5	**JF/Assemblies/350/20**	**JF/Assemblies/550/35**
JF/Assemblies/200/10	**JF/Assemblies/400/25**	**JF/Assemblies/600/40**
JF/Assemblies/250/13	**JF/Assemblies/450/27**	**JF/Assemblies/650/45*[1]**
JF/Assemblies/300/15	**JF/Assemblies/500/30**	

***[1]** *This result is limited by the jet fire release test duration. The "ENERGY Firecover®" Enclosure Protection System product may be able to achieve a better result at this limiting temperature, however the test evidence does not facilitate any assessment of this.*

Description of Test Specimen:

A 41 minute, 29 second cryogenic jet release test (LiN) in line with ISO 20088-3:2016, followed by a 47 minute, 37 second jet fire release test in line with ISO 22899-1:2007.

The test specimen consisted of a steel tubular (8" nominal dia.) 219.1mm outside diameter (500mm long, 6.3mm wall thickness) with an Hp/A Section factor of 163m^{-1}; attached at each end to steel tubulars (4" nominal dia.) 114.3mm O.D. (each 1,000mm long, 6.3mm wall thickness); an "ENERGY Firecover®" Enclosure Protection Systems, 600mm long, with a circular cross section fitted over the (8" nominal dia.) tubular at each end of the box. The centre of the jet fire impinged on the mid length of the box facing the joint between the two identical half shells, secured together via SS316L Adjustable Snap Locks attached to the SS316L Outer Cladding via SS316L Pop Rivets. The SS316L Adjustable Snap Locks were installed at a maximum spacing of 185mm centres and 50mm from edges. The "ENERGY Firecover®" Enclosure Protection Systems was also fitted with a 360mm x 200mm inspection hatch constructed of the same composition as the "ENERGY Firecover®" Enclosure Protection System which was secured in place via SS316L Adjustable Snap Locks at approx. 100mm centres attached to the SS316L Outer Cladding via SS316L Pop Rivets. The metal overlap on the inspection hatch was 30mm overlap on all sides with "Nitoseal SC N" Sealant in the overlap around the whole hatch.

The "ENERGY Firecover®" Enclosure Protection Systems was also fitted with an "ENERGY Drainplug®" which has a hole diameter of 15mm and was secured to the SS316L Outer Cladding via two SS316L Pop Rivets.

Both ends of the "ENERGY Firecover®" Enclosure Protection Systems were overlapped by least 75mm which fitted over the 4 inch nominal dia. tubulars, which were protected by: 40mm thick of "Foamglas® ONE" cellular glass pipeshells; 25mm thick "FireMaster® Marine Plus" insulation blankets (128 kg/m^3 density); and 0.5mm SS316L stainless steel outer cladding***[2]**.

The "ENERGY Firecover®" Enclosure Protection System was comprised of the following: 15.3mm air gap from the steel substrate; 1 x 4mm thick layer of ENERGY Fireboard; 0.7mm thick SS316L Outer Cladding; resulting in a nominal outside diameter of 266mm.

***[2]** *It was noted that the insulation build-up on the pipe was Standard NORSOK R-004 V.3 Class 5 Fire Protection used on the Norwegian continental shelf: 40mm thick Cellular Glass; 25mm thick AES Fibre; and 0.5mm thick SS316 Stainless Steel Outer Cladding.*

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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.

PLACE OF PRODUCTION

KAEFER Energy AS
Geitaberget 17
4031 Stavanger
Norway

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

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).