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CERTIFICATE

No. 30468301E/CS/20.05.21

In accordance with the Specification API 6FB (dated May 2019) the gasket

Deutsche Akkreditierungsstelle D-PL-12008-01-00

SIGRAFLEX® UNIVERSAL PRO 2 mm
V20010C2IP
6" CLASS300

of the gasket manufacturer

SGL CARBON GmbH
Werner-von-Siemens-Str. 18
86405 Meitingen, DE

was tested in respect of fire safety. The test was made under the following conditions:

Total bolt load:	850.83	kN
Burn period:	30	min
Average temperature calorimeters:	> 650	°C
Test pressure (absolute):	40	bar
Test medium:	Water	
Leak rate complete test:	**0.03**	**ml/(inch · min)**
Leak rate pressure test:	**0.12**	**ml/(inch · min)**

After the burn period the connection was air cooled to a flange temperature below 100 °C. During the cool-down the connection was still pressurized with the test pressure. Afterwards a pressure test for 5 min was done.

Therefore the gasket is in compliance with the tightness criteria of **1 ml/(inch · min)** of API 6FB during burn period, cool-down and pressure test. The gasket manufacturer can mark the gasket as **"Fire Safe"** in accordance to the specification API 6FB.

This certificate is only valid in combination with the test report 3046831/-.

Lauffen, May 20th,2021

AMTEC Advanced Measurement Messtechnischer Service GmbH

B. Eng. C. Six
Test Engineer

Dipl.-Ing. F. Herkert
Head of Laboratory

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DAkkS Deutsche Akkreditierungsstelle D-PL-12008-01-00

Test Report

Customer:	SGL CARBON GmbH Werner-von-Siemens-Str. 18 DE – 86405 Meitingen
Project number (amtec):	304 683
Report number:	304 683 1/-
Test procedure:	API Specification 6FB (dated May 2019)
Material:	flat gasket – SIGRAFLEX® UNIVERSAL PRO 2 mm V20010C2IP
Date:	May 20th, 2021
Pages:	5
Appendices:	7

Author:	Approval:
B. Eng. C. Six	Dipl.-Ing. F. Herkert
Test Engineer	**Head of Laboratory**

Test results are only relevant to the test objects submitted.

1. Subject of Investigation

The following documents and samples were submitted to amtec.

The subject of investigation was a flat gasket manufactured by SGL CARBON GmbH which is customer named:

- SIGRAFLEX® UNIVERSAL PRO 2 mm V20010C2IP.

SIGRAFLEX® UNIVERSAL PRO 2 mm V20010C2IP is an adhesive-free gasket sheet made of SIGRAFLEX flexible graphite foils with one 0.1 mm thick tanged ASTM 316L stainless steel reinforcement. The sheet is impregnated to reduce leakage and improve handling (anti-stick).

2. Goal of Investigation

The goal of the investigation was the qualification of the gasket material SIGRAFLEX® UNIVERSAL PRO 2 mm V20010C2IP in accordance to the API Specification 6FB (dated May 2019): API Specification for Fire Test for End Connections.

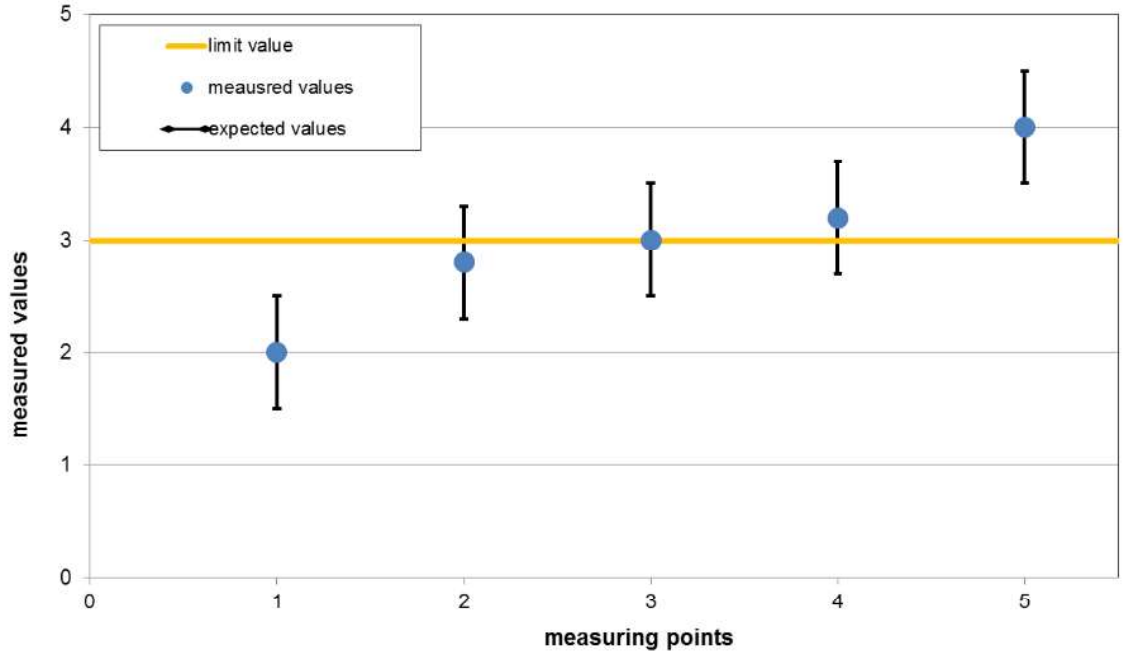
The API Specification 6FB describes the testing procedure and evaluation of the performance of API end connections when exposed to fire.

2.1 Declaration of conformity in the test laboratory of amtec

A declaration of conformity is a written confirmation at the end of a conformity assessment in which the amtec test laboratory for a specific examination bindingly declares and confirms that the product sample has a specified property. The properties are usually specified by limit values in standards, technical specifications or test methods.

For declarations of conformity in the amtec test laboratory the following decision rules have to be considered. The decision rules are explained in an example.

In the following test, a limit value of ≤ 3 should be reached.



conformity assessment	√ = pass	x = fail			
measuring points	1	2	3	4	5
decision rule	√ = pass	√ = pass	x = fail	x = fail	x = fail

In the example above, measurement points 1 and 2 are a positive conformity statement, the measuring points 3, 4 and 5 are a negative conformity statement.

The standard deviations of the different physical parameters pressure, temperature, and leakage can be found in the protocols of the last maintenance of each test rig.

3. Test Specimen

The dimension of the test specimen was: 6" Class 300

Geometry of the gasket: 249.79 mm x 168.99 mm x 2.12 mm

4. Testing Equipment

The gasket test was carried out on the following testing equipment in the laboratory of amtec:

Fire Test: TEMES fire.safe Ident No. 010595

A photo and the schematic view of the testing equipment are shown in **appendices 1 and 2**.

The Fire Safe Testing Device is used to maintain a fire for a period of 30 minutes.

Depending on the type of test, different flanges and valves can be tested.

For this test the following components were used:

- Blind flanges ASME B 16.5, 6" Class 300, RF / Ra 3,2 - 6,3 µm (125-250 µin), ASTM A 105
- Stud bolt, Grade B7, ASME B18.2.1, ¾" - 10 UNC x 5
- Hexagon nuts, Grade 2H ; ASME B18.2.2, ¾" - 10 UNC
- Washers, ¾" hardened 45 HCR

The water pressure is measured by a pressure transducer; the water volume is measured with a scale. The temperature of the fire is measured with 6 different thermocouples and with 5 calorimeters which are shared around the flange or valve. The control of the fire is done by a controller. Software is used for data logging and online evaluation.

5. Test Procedure

The Fire Test according to API Specification 6FB (dated May 2019) requires that any sealing end connection hold for 30 minutes in a flame condition and hold for a cool down period. After the assembly is cooled down to room temperature the line is depressurized and then re-pressurized. During all facets of the test the gasket must not exceed an API proscribed leak rate.

In the Fire Test a 6" Class 300 flange is pressurized with a test pressure of 75% of the API rated working pressure. The test pressure is maintained during the burn and cool-down period. After 5 minutes a fire is established and the flame temperature is monitored. The average of the thermocouples must reach 760 °C within 2 minutes and maintain the average temperature between 760 °C to 982 °C with no reading less than 704 °C until the average of the calorimeter temperature reaches 649 °C.

The average of the calorimeter shall reach 649 °C within 15 minutes. The burn period shall last for 30 minutes. After the burn period the connection is air-cooled down to 100 °C or less. After cooling down the flange is depressurized and the pressure is increased again to the test pressure and held for 5 minutes.

The maximum leak rate is 1 ml/inch/min of mean gasket circumference.

6. Results

Test date: May 12th, 2021.

In the API Specification 6FB the flat gasket SIGRAFLEX® UNIVERSAL PRO 2 mm V20010C2IP was mounted in a 6" Class 300 flange with hydraulic spanners to a bolt load of 70.9 kN which means a total load of 850.83 kN and a gasket surface stress of 60 MPa.

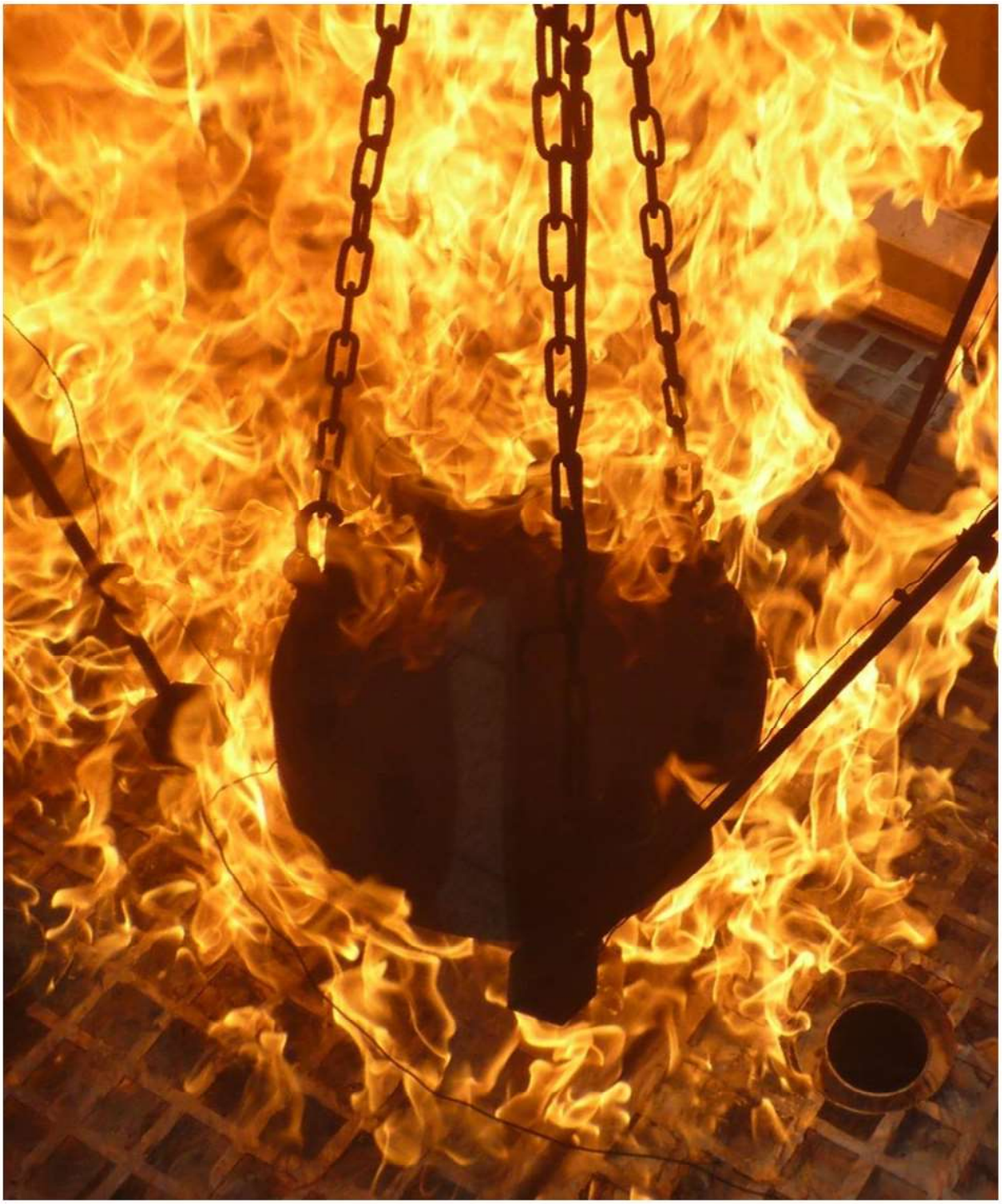
After that the flange was pressurized with an internal pressure of 40 bar. The test medium was water. After 5 minutes flame impingement starts for a period of 30 minutes, see **appendices 3 to 6**. During burning period the flame temperature was nearly constant. After 30 minutes of burning the flange was cooled down to a temperature less than 100 °C and the system was depressurized and the pressure was increased to 40 bar again.

During burning period a leak rate of 0.14 ml/inch/min could be measured and during complete pressurization with water a leak rate of 0.03 ml/inch/min was measured. During the pressure test after cooldown a leak rate of 0.12 ml/inch/min was measured.

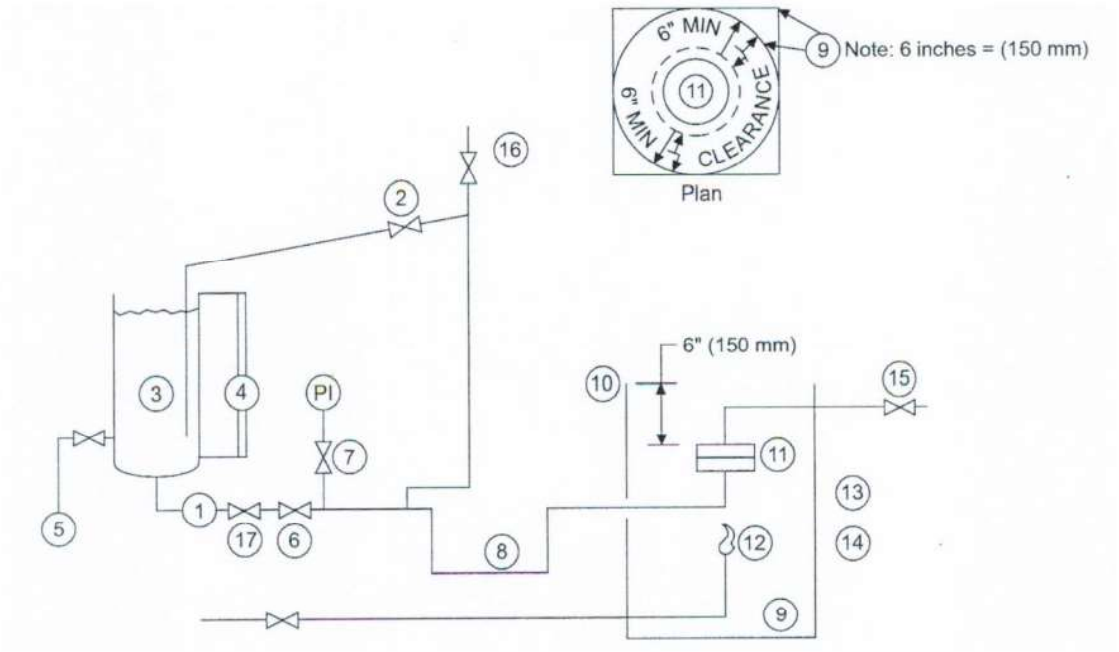
All leak rates are below the allowable leak rate of 1 ml/inch/min and therefore the flat gasket SIGRAFLEX® UNIVERSAL PRO 2 mm V20010C2IP **passed** the Fire Test according to API Specification 6FB dated May 2019.

7. Photo documentation

In **appendix 7** photos of the gasket specimen SIGRAFLEX® UNIVERSAL PRO 2 mm V20010C2IP before and after the Fire Test are presented.



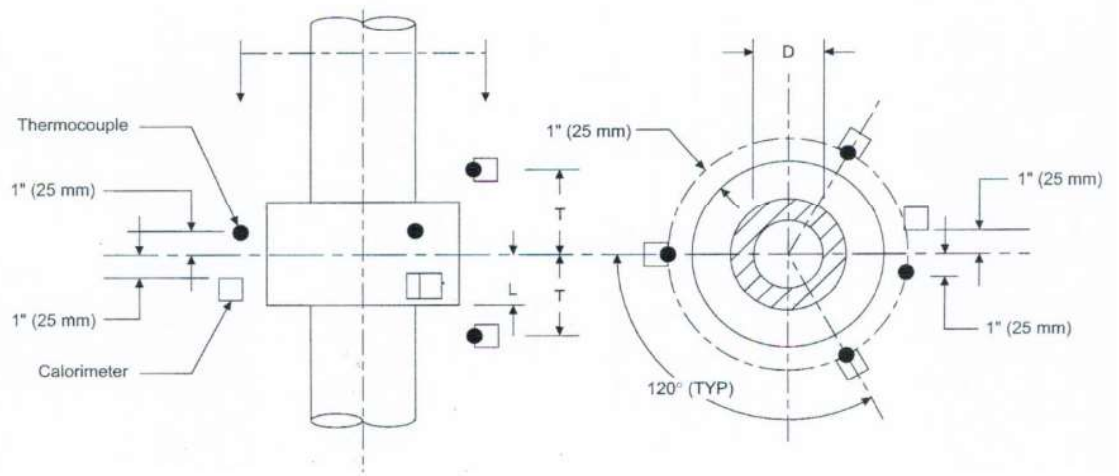
Fire Safe Testing Device



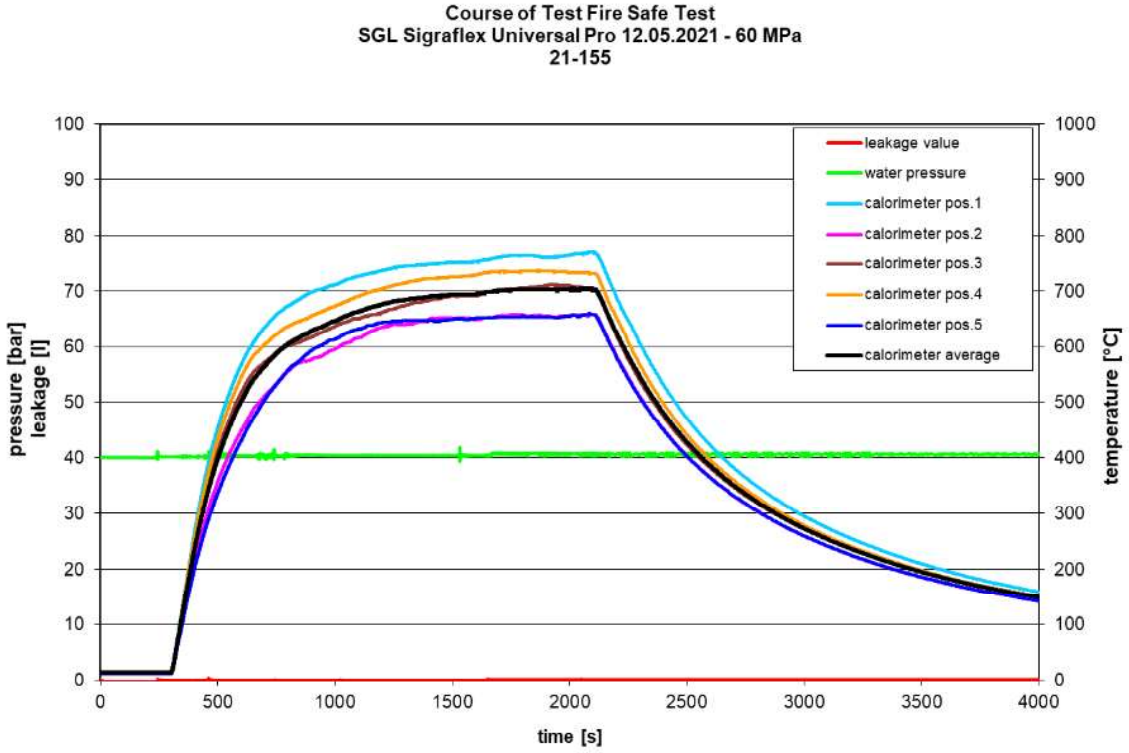
Legend

1. Pressure source
2. Pressure regulator and relief
3. Vessel for water
4. Calibrated sight gauge
5. Water supply
6. Shutoff valve
7. Pressure gauge
8. Piping arranged to provide vapour trap
9. Enclosure for test
10. Minimum height of enclosure shall be 6 inches above the top
11. Test connection mounted horizontally
12. Fuel gas supply
13. Calorimeter cubes
14. Flame temperature thermocouple
15. Shutoff valve
16. Vent valve
17. Check valve

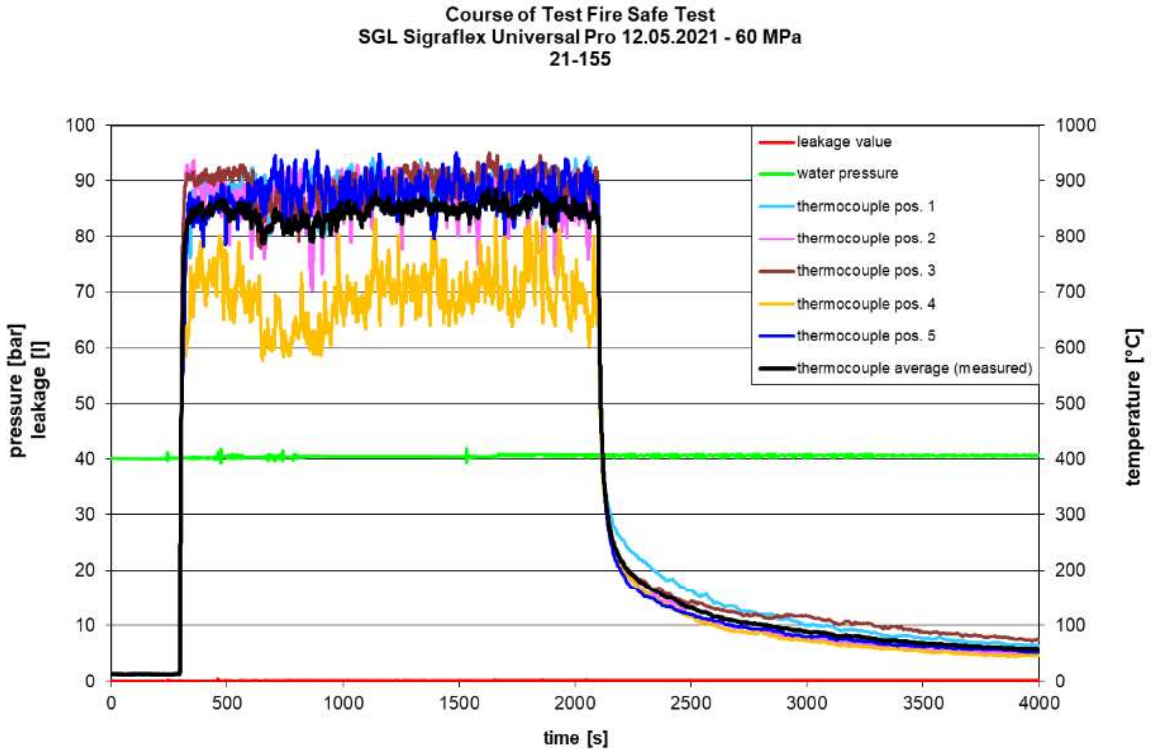
Schematic System for Fire Testing of End Connections



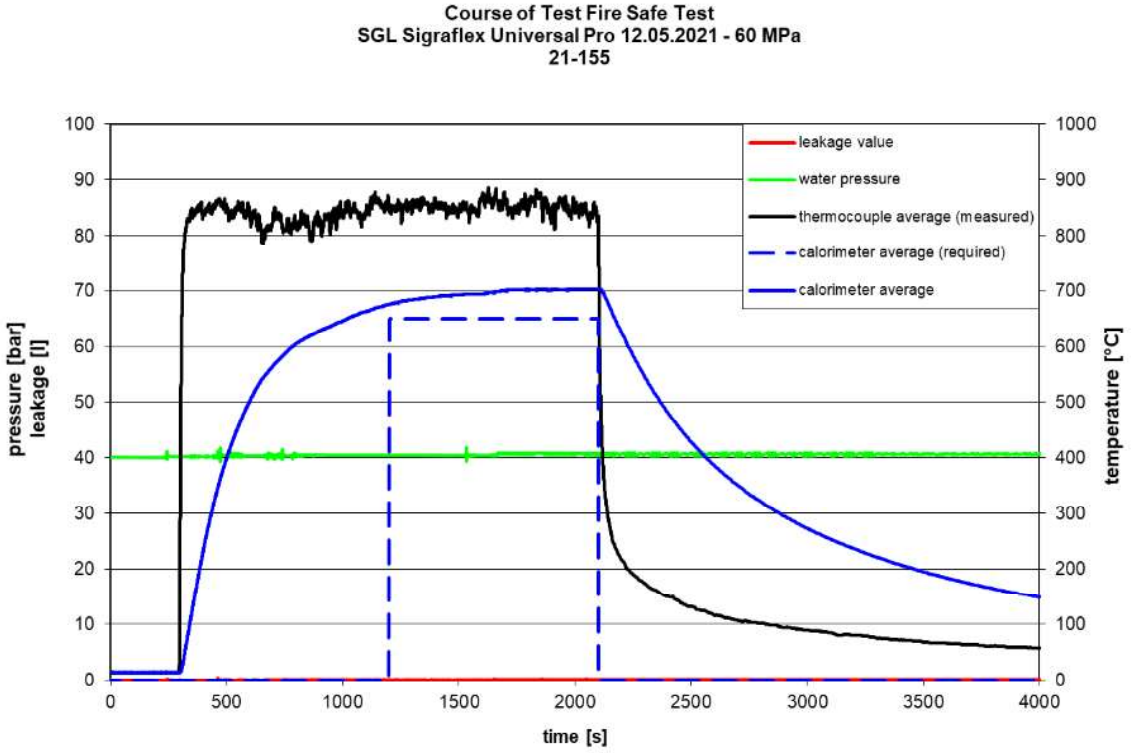
Location of Thermocouples and Calorimeters – Onshore Condition



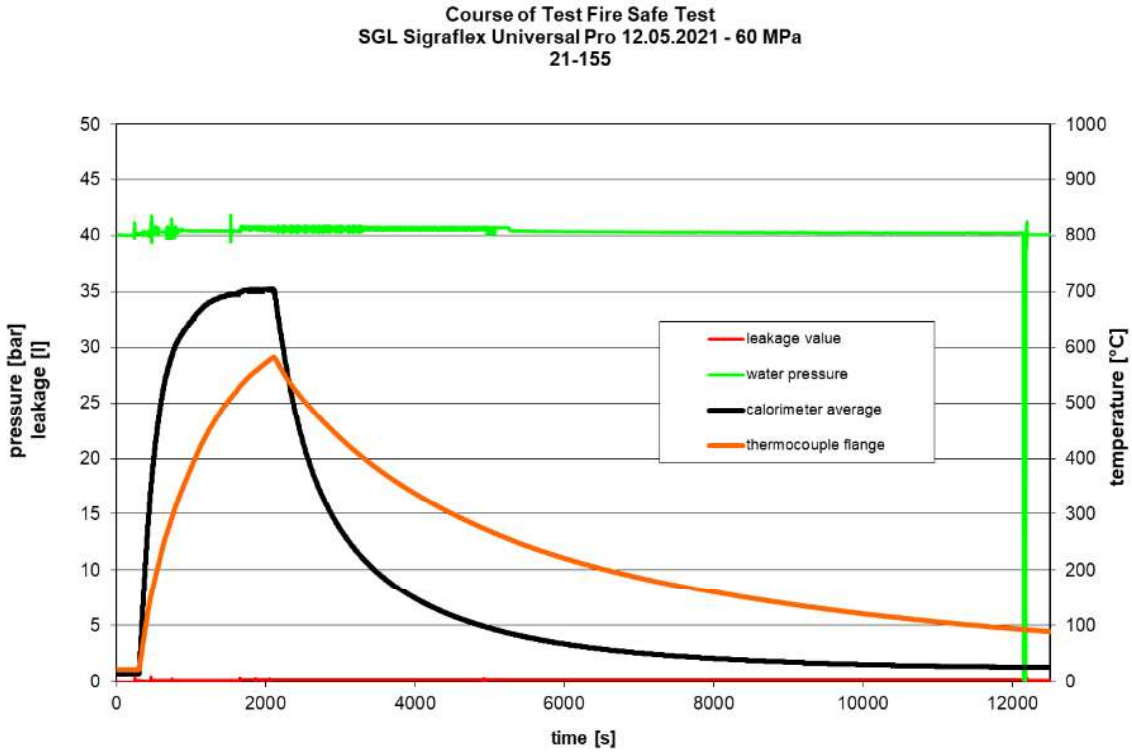
API Specification 6FB - calorimeters



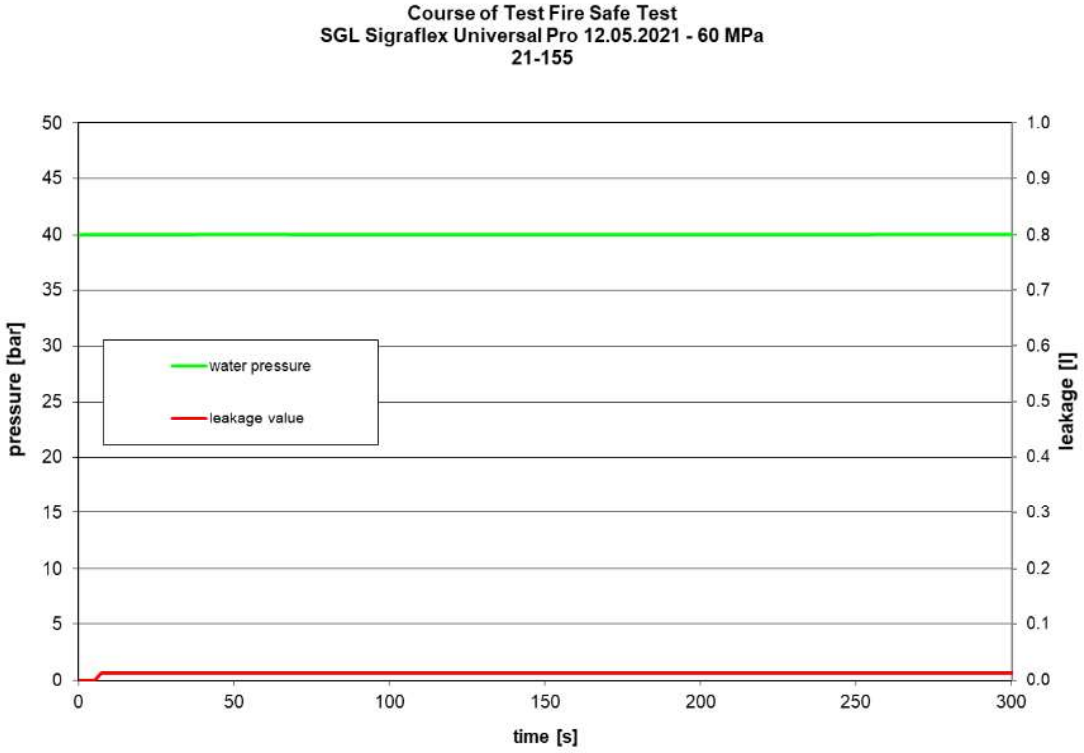
API Specification 6FB – thermocouples



API Specification 6FB – thermocouple and calorimeter average



API Specification 6FB – medium and flange



API Specification 6FB – pressure test

SGL CARBON GmbH – SIGRAFLEX® UNIVERSAL PRO 2 mm V20010C2IP 304 683

geometries of gasket and flanges

bolts	12
OD gasket	249.8 mm
ID gasket	169.0 mm
height gasket	2.1 mm
material gasket	Graphite
mean gasket circumference total	604.6 mm
contact area total	14180.51 mm²
OD flange raised face (NPS 6 Class 300)	215.9 mm
leak rate criteria	**1 ml / inch / min**

test conditions

testrig	TEMES fire.safe
name	I010595
test procedure	API Specification 6FB
dated	05/2019

bolts, nuts, washers

type of bolts	3/4" - 10 UNC
nuts	3/4" - 10 UNC
grade	B7
washers	3/4" hardened 45 HCR

calculation of gasket stress

hydraulic mounting device	
force per bolt	70.90 kN
force total	850.83 kN
gasket stress sealing element	**60.00 MPa**

calculation of leak rate of complete test

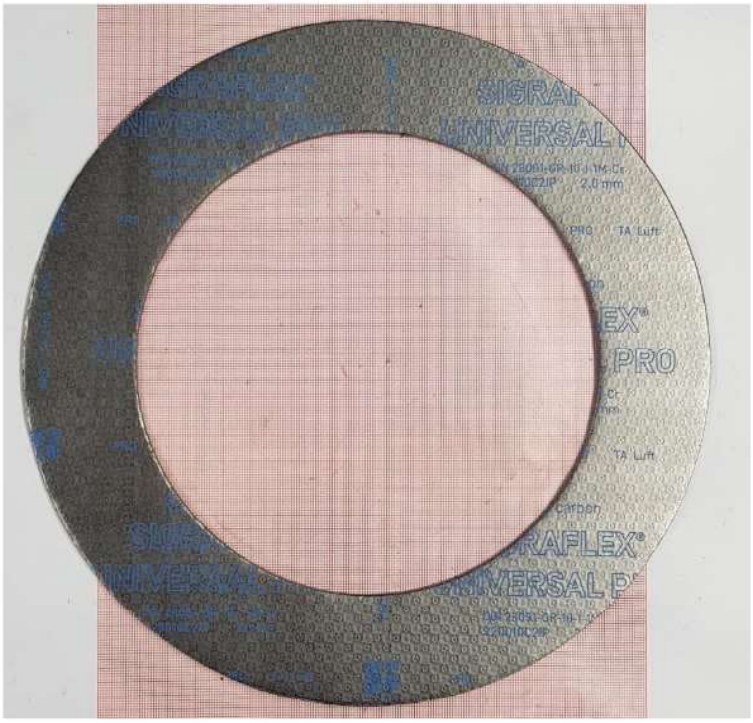
start value scale	29.12 kg
end value scale	29.01 kg
start test	08:49:56
end test	11:56:46
test duration (min)	186.83 min
leakage	112.40 ml
leak rate	**0.03 ml / inch / min**
requirement	**passed**

calculation of leak rate of burning period

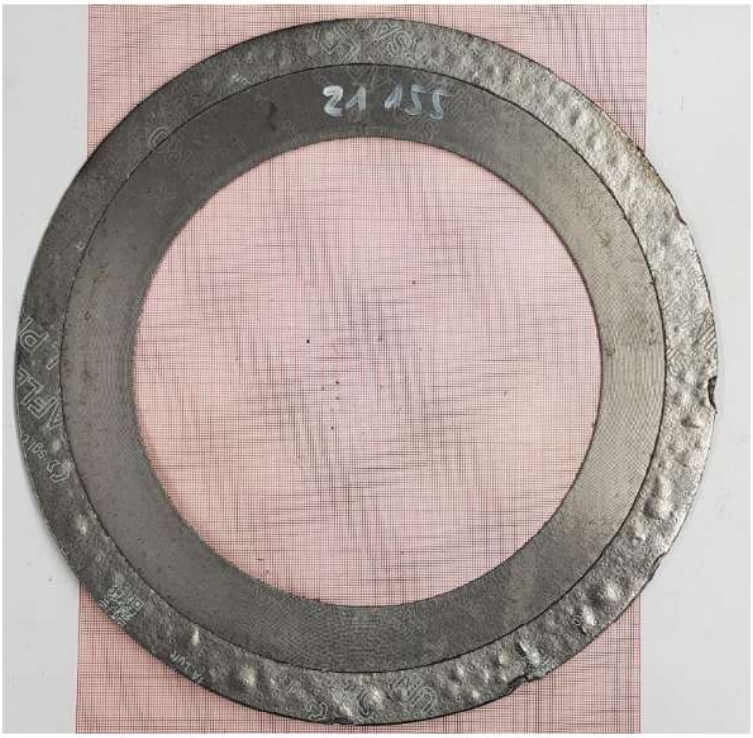
start value scale	29.12 kg
end value scale	29.02 kg
start test	08:49:56
end test	09:19:57
test duration (min)	30 min
leakage	101.10 ml
leak rate burning period	**0.14 ml / inch / min**

calculation of leak rate of pressure test after cooldown

start value scale pressure test	29.08 kg
end value scale pressure test	29.06 kg
start pressure test	12:08:18
end pressure test	12:13:18
test duration (min)	5 min
leakage	14.00 ml
leak rate pressure test	**0.12 ml / inch / min**
requirement	**passed**



SIGRAFLEX® UNIVERSAL PRO 2 mm V20010C2IP before testing



SIGRAFLEX® UNIVERSAL PRO 2 mm V20010C2IP after Fire Test 21-155 according to API Specification 6FB