FORTE
TESTING AND CONSULTANTS CO., LTD.

HOKLAS 191
TEST

FIRE RESISTANCE TEST REPORT

SUSPENED CEILING SYSTEM

in accordance with ***BS 476-22: 1987***

Test Sponsor: **Kingtec Building Materials (HK & Macau) Limited**
Unit 4, 3/F., Block B, Shatin Ind., Centre,
5-7 Yuen Shun Circuit, Shatin,
New Territories, Hong Kong.
Tel: 852-2640 8688 Fax: 852-2142 8128

Test Laboratory: **Forte Testing and Consultants Company Limited**
Contact Information:
Flat 31, 5/F., My Loft, 9 Hoi Wing Road,
Tuen Mun, Hong Kong.
Tel: 852-2152 0638 Fax: 852-3186 2737

Report Number: **IT 16-127**

Date of Issue: **2016-09-12**

HKAS has accredited Forte Testing and Consultants Company Limited (Reg. No. 191 – TEST) under HOKLAS for specific laboratory activities as listed in the HOKLAS directory of accredited laboratories. The results shown in this report were determined by this laboratory in accordance with terms of accreditation. This report may not be reproduced, except in full, without prior written approval from FORTE.

HOKLAS Approved Signatory: **CHENG San Mei, Sammi**

1. Scope of Test

This report is a record of a fire resistance test conducted by Forte Testing and Consultants Co., Ltd, in conformity with requirements in *BS 476-20: 1987 "Method for determination of the fire resistance of elements of construction (general principals)"* and with the particular requirements in *Clause 9; BS 476-22: 1987 "Methods for determination of the fire resistance of non-loadbearing elements of construction"*.

A specimen of Kingtec Hawk Pan suspended ceiling system was overall sized 4020 mm (width) x 3030 mm (long) was constructed with steel channel supporting grid. A layer of 9 mm (thick) Kingtec Hawk Pan board was fastened to the underside of the steel channel grid members with rock wool laid out on the top of the board layer. The specimen was supplied for test by Kingtec Building Materials (HK & Macau) Limited, the Sponsor.

The specimen achieved the following fire resistance:

INTEGRITY 65 Minutes
INSULATION 63 Minutes

2. Test Information

Test Laboratory:	FORTE Testing and Consultants Company Limited		
Test Location:	State Key Laboratory of Subtropical Building Science, North Campus of South China University of Technology, 381 Wushan Road, Tianhe District, Guangzhou Province, China.		
Test Sponsor:	Kingtec Building Materials (HK & Macau) Limited		
Fire Board Manufacturer:	Yichun Kingtec Building Materials Industrial Company Limited		
ID no. of the Specimen:	QT16-185		
Date Received:	2016-07-18		
Test Number:	QT16-185		
Date Tested:	2016-07-21	**Start Time:**	15:15
Approved Test Operator from FORTE:	Mr. Walter Tang		
Witness of the Test:	Mr. Liu Hai Hui and Ms. Lilian Tse – Official Delegates of the Sponsor		
Report Issue Record:	Version 1 – 2016-09-12		

3. Description of Test Specimen

3.1 Specimen Description

3.1.1 Board Configuration

The Kingtec Hawk Pan suspended ceiling system was overall sized 4020 mm (width) x 3030 mm (long) x 118 mm (thick) with a layer of 9 mm (t) Kingtec Hawk Pan board lining fixed to the underside of the steel channel grid members. The boards were fastened to the steel channel framework by ø3.5 mm x 38 mm self-tapping screw spaced at maximum 200 mm centres at along perimeter board edges. Gaps between the boards & test frame and screw heads were applied with fire rated sealant. 2 layers of 50 mm rockwool were laid out on the top of the board layer.

3.1.2 Structural Framework

The perimeter framework was made by 48 mm x 48 mm x 0.8 mm (t) steel angle, and it was fastened to the concrete test frame by ø6 mm x 55 mm (l) anchors spaced at 400-560 mm centres. The skeleton framework was constructed with 6 numbers of C-profile channel, sizes 52 mm (web) x 30 mm (flange) x 0.9 mm (t) with 10 mm width return. The C-profile channels were 3020 mm (l) and were spaced at 610 mm centres. Two ends of the C-profile channel were supported into a perimeter framework. All steel channel connections were joined by 2 numbers of ø3.5 mm x 38 mm self-tapping screw. The channel clips were applied along each C-profile channel at spacing 610 mm centre to centre and connected to U-profile carrying channels with ø9.2 x 600 mm hanger track rod which were suspended from the suspension framework. Three rows of U-profile carrying channel, size 38 mm (web) x 12 mm (flange) x 1 mm (t) x 4010 mm long were joined between the C-profile channels spaced at 750-780 mm centre to centre. A 9 mm (t) Kingtec Hawk Pan board with 100 mm width was a fillet to apply on underside of the steel channel grid members and were fastened to the framework by ø3.5 mm x 38 mm self-tapping screw spaced at maximum 200 mm centres. A line of fire sealant was applied to the web surface of the channel before fixed the fillet to the framework.

4. Test Assembly

4.1 Definition of Test Specimen

The specimen was provided by the Sponsor.

The component of the specimen was transferred to the Test Location on 2016-07-18 by the Manufacturer. FORTE did not involve in selection of the specimen.

All the components of the test specimen were supplied by the Manufacturer.

4.2 Assembly of the Test Specimen

The specimen was installed by workers of the Sponsor from 2016-07-18 to 2016-07-20.

4.3 Supporting Construction

The specimen was fixed into a reinforced concrete supporting frame provided by FORTE.

Concrete Supporting Frame Specification:

Cure Time	≥28 Days
Thickness	350 mm
Structural Opening	3040 mm (w) x 4040 mm (l)

4.4 Test Specimen Configuration

The Sponsor designated and installed that the board configuration on fire side of the suspended ceiling system.

The specimen was asymmetrical along the plane parallel to the furnace opening.

Horizontal and cross joints were present on the specimen.

5. Test Method

5.1 Heating Condition

The temperature inside the furnace was monitored according to the standard temperature/time condition stated in *BS 476-20: 1987* given by the equation:

$$T = 345 \log_{10} (8t+1) + 20$$

Where,

t = time (minutes), up to 360 minutes

T = mean furnace temperature (°C)

5.1.1 Furnace Temperature

The temperature inside the furnace was measured in conformity with *BS 476-20: 1987* by 10 numbers of type K thermocouples. These thermocouples were positioned symmetrically inside the furnace with approximate 100 mm away from the exposed surface of the specimen. The positions of furnace thermocouples are shown in *Figure 1*.

5.1.2 Ambient Temperature

The ambient temperature was measured in conformity with *BS 476-20: 1987* by a type K thermocouple, which was screened by two concentric plastic pipes, at a position approximate 1500 mm outside the test construction.

5.1.3 Unexposed Surface Temperature of the Specimen

The unexposed surface temperatures of the specimen were measured in conformity with *BS 476-20: 1987* by 5 numbers of properly positioned and attached fixed surface type K thermocouples.

The positions of unexposed surface temperature measurement points are explained in the following table and shown in *Figure 2*.

Thermocouple	Position	Description
U1 – U5	Ceiling system	For average and maximum unexposed surface temperature rise
U16 – U27	Inner face of steel framework	For additional information only and NOT assessed against insulation criterion; Data is shown in Appendix E

5.2 Pressure Condition

The pressure inside the furnace was continuously monitored in compliance with *BS 476-20: 1987* during the whole test. The pressure at the underside of the horizontal test construction shall at no time exceed a maximum value of 20 Pa. The pressure was controlled to within 10 ± 2 Pa with respect to atmosphere at 800 meter underside of the horizontal test construction after the first five minutes of the test.

5.3 Deflection Measurements

Measurements of the deflection of the test specimen were taken with displacement transducers fixed onto the unexposed surface of the specimen.

The positions of all measurement points were shown in *Figure 3*.

Figure 1. Position of thermocouples and pressure measuring probe inside the furnace.

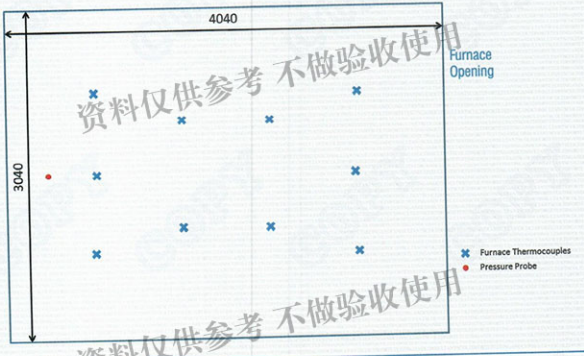
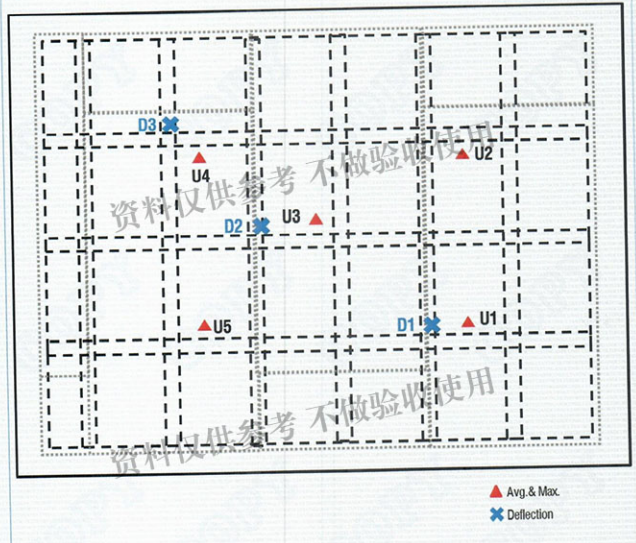


Figure 2. Positions of fixed surface thermocouples (U) and deflection measurement points (D) on specimen.

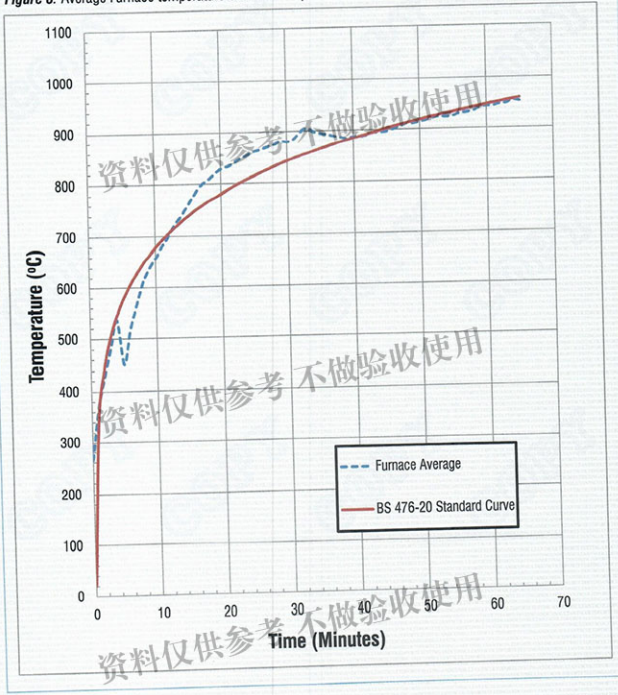


6. Test Data

6.1 Mean Furnace Temperature

The average furnace temperature over the test period was shown in *Figure 3*.

Figure 3. Average Furnace temperature over the test period.

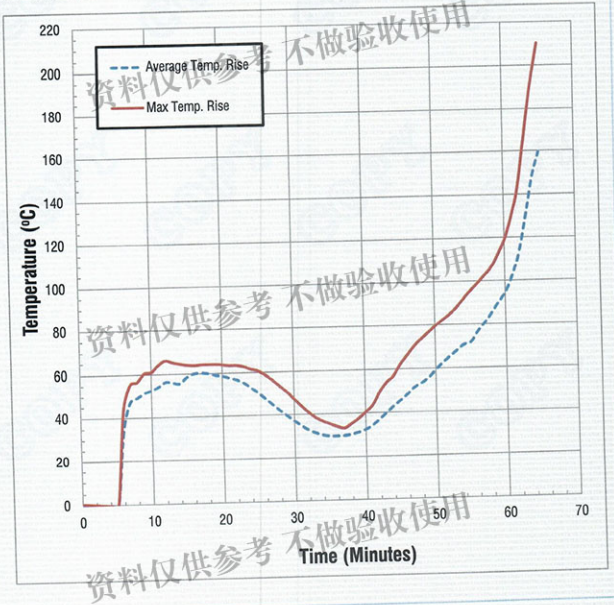


6.2 Unexposed Surface Temperature Rise – Fixed Surface Thermocouples

The temperature rises of unexposed surface of the specimen measured by fixed surface thermocouples over the test period were shown in *Figure 4*.

The average temperature rise measured at 63.4 minute of test was 140.8°C, which was in excess of 140°C limit; whereas the maximum temperature rise measured at 63.4 minute of test was 180.4°C at U2, which was in excess of 180°C limit.

Figure 4. Average and maximum unexposed surface temperature rises of the specimen over the test period.

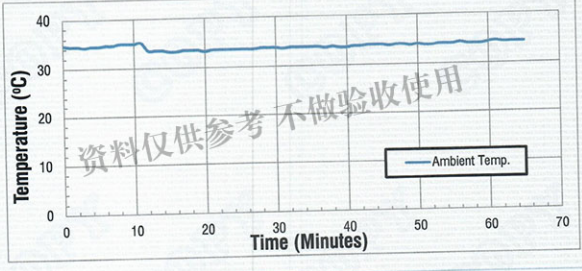


6.3 Ambient Temperature

The ambient temperature over the test period was recorded and shown in *Figure 5.*

The ambient temperature at the commencement of test was 34.7°C.

Figure 5. Ambient temperature over the test period.



6.4 Pressure

The pressure inside furnace at 800 mm underside the horizontal test construction was maintained to be 10 ± 2 Pa over the test period after 5 minutes from commencement of the test.

6.5 Lateral Deflections

Measured lateral deflections over the test period are summarized in the following table. A positive measurement indicates a movement towards into the furnace and vice versa.

Measurements were taken in mm.

Maximum deflection value of the specimen is BOLDED in the following table.

Positions \ Time (min)	0	10	20	30	40	50	60	65
D1	0.0	+3	+5	+6	+7	+7	+7	+8
D2	0.0	+8	+11	+14	+15	+17	**+18**	**+18**
D3	0.0	+4	+6	+6	+7	+7	+7	+7

6.6 Observations

Significant behaviours of the specimen during the test period are summarized in the following table.
Photos taken during the test period are attached in *Appendix C*.

Time (min.sec)	Observation (from unexposed side)
00.00	Test Started.
05.02	Smoke released at the center the specimen.
08.35	Smoke released at the perimeter of the specimen.
16.00	Light smoke released at all the fixed perimeter edges of the specimen.
18.35	Smoke release slightly increased at center of the specimen.
23.47	Smoke released decrease from the specimen.
30.00	**No integrity failure had occurred.**
36.45	Some edges of the rockwool turned in light brown.
38.18	Smoke release slightly increased at the joint between the rockwool boards.
45.09	Cotton fiber pad test was carried out on center of the specimen. No flaming or glowing on the cotton pad was observed.
58.03	Cotton fiber pad test was carried out on center of the specimen. No flaming or glowing on the cotton pad was observed.
60.00	**No integrity failure had occurred.**
63.20	Some edges of the rockwool turned in light dark.
65.37	**Test was terminated at request of the Sponsor.**

7. Conclusion

A fire resistance test was conducted in accordance with the test procedures and requirements specified in *BS 476-22: 1987* and *BS 476-20: 1987* on a suspended ceiling system.

Insulation failure occurred at 63 minute of test because average and maximum unexposed surface temperature rise were in excess of 140°C and 180°C limit respectively.

According to *BS 476-20: 1987* and *Clause 9; BS 476-22: 1987 (Appendix A)* the above test specimen satisfied corresponding fire resistance criteria based on the test data for the following period:

INTEGRITY	65 Minutes
INSULATION	63 Minutes

The test was terminated after a test period of 65 minutes at request of the Sponsor.

8. Limitations

The results only relate to the behavior of the specimen of the element of construction under the particular conditions of test; they are not intended to be the sole criteria for assessing the potential fire performance of the element in use nor do they reflect the actual behavior in fires.

This report details method of construction, the test conditions and the results obtained when the specific element of construction described herein was tested following the procedure outlined in *BS 476-22: 1987*. Any significant variation with respect to size, constructional details, loads, stresses, edges or end conditions, other than those allowed under the field of direct application in the relevant test method is not covered by this report.

This report may only be reproduced in full by the Sponsor, without comment, abridgement, alteration or addition, unless otherwise agreed with written approval by FORTE.

Appendix A

Criteria of Fire Resistance Failure in *BS 476-20: 1987* and *BS 476-22: 1987*

Statements concerning criteria of fire resistance failure in corresponding standards are quoted:

British Standards Institution, London, 1987- BS 476-20: 1987, 10.3 & 10.4

10.3 Integrity

10.3.1 *General.* A failure of the test construction to maintain integrity shall be deemed to have occurred when collapse or sustained flaming on the unexposed face occurs or the criteria given in **10.3.2** for impermeability are exceeded (see clause 2).

10.3.2 *Impermeability.* Failure shall be deemed to have occurred when one or other of the following conditions prevail.

a) For situations where the cotton pad (**6.4.2.3**) is suitable (see **C.10.3.2**), failure shall be deemed to have occurred when flames and/or hot gases cause flaming or glowing of the cotton fibre pad.

b) For situations where the use of the cotton pad is not suitable, failure shall be deemed to have occurred when either:
1) the 6 mm diameter gap gauge can penetrate a through gap such that the end of the gauge projects into the furnace and the gauge can be moved in the gap for a distance of at least 150 mm; or 2) the 25 mm diameter gap gauge can penetrate a through gap such that the end of the gauge projects into the furnace.

10.4 Insulation

Failure shall be deemed to have occurred when one of the following occurs:

a) if the mean unexposed face temperature increases by more than 140 °C above its initial value;

b) if the temperature recorded at any position on the unexposed face, either by a fixed thermocouple (see **6.4.2.1**) or by the roving thermocouple subject to the following provisions (see **6.4.2.2**) is in excess of 180 °C above the initial mean unexposed face temperature; or

c) when integrity failures as defined in **10.3** occur.

British Standards Institution, London, 1987- BS 476-22: 1987, 9.7.1

9.7.1 Criteria of failure

The fire resistance of a ceiling membrane shall be determined with respect to integrity and insulation. The criteria for failure shall be as given in **10.3** and **10.4** of *BS 476-20: 1987*.

----- END of QUOTE -----

Appendix B

Parts Specifications and Drawings provided by the Sponsor

Note: *marked items in *Appendix B* were verified by FORTE.

Fire Board/Fillet

Supplier:	Kingtec Building Materials (HK & Macau) Limited
Manufacturer:	Yichun Kingtec Building Materials Industrial Company Limited
Brand:	Kingtec Hawk Pan
Material Description:	Mainly Used Calcium Silicate + Compounds Mixture (Calcium Silicate, Reinforced-fiber, Mica, Perlite etc.)*
Nominal Density:	1050 kg/m^3
Measured Density:	1056 kg/m^3
Nominal Thickness:	9 mm
Measured Thickness:	9.25 mm

C-profile Channel

Supplier:	Kingtec Building Materials (HK & Macau) Limited
Material:	Galvanized Steel
Sizes:	52 mm x 30 mm x 0.9 mm

U-profile Carrying Channel

Supplier:	Kingtec Building Materials (HK & Macau) Limited
Material:	Galvanized Steel
Sizes:	38 mm x 12 mm x 1 mm

Angle

Supplier:	Kingtec Building Materials (HK & Macau) Limited
Material:	Galvanized Steel
Sizes:	48 mm x 48 mm x 0.8 mm

Channel Clip

Supplier:	Kingtec Building Materials (HK & Macau) Limited
Manufacturer:	Saint Kees-Amarm (Hong Kong) Limited
Material:	Galvanized Steel
Model:	SRA-13
Sizes:	52 mm x 48 mm x 0.5 mm

Hanger

Supplier:	Kingtec Building Materials (HK & Macau) Limited
Manufacturer:	Saint Kees-Amarm (Hong Kong) Limited
Material:	Galvanized Steel
Model:	SRA-12
Sizes:	13 mm x 96 mm x 1 mm

Rockwool

Supplier:	Kingtec Building Materials (HK & Macau) Limited
Brand:	ROCKWOOL
Model:	TR-S80
Nominal Density:	80 kg/m^3
Measured Density:	86.62 kg/m^3
Nominal Thickness:	50 mm

Fixing –Screw

Supplier:	Kingtec Building Materials (HK & Macau) Limited
Type:	Self-tapping Screw
Material:	Steel
Sizes:	Ø3.5 mm X 38 mm

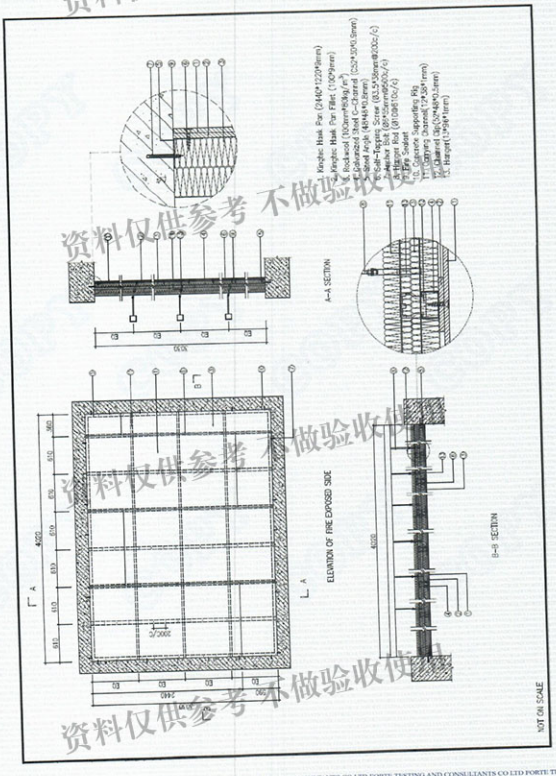
Fixing – Anchor Bolt

Supplier:	Kingtec Building Materials (HK & Macau) Limited
Type:	Expansion Anchor Bolt
Material:	Steel
Sizes:	Ø6 mm x 55 mm
Location Applied:	Perimeter Framework to Concrete Support Frame

Fire Sealant

Brand:	Lorient
Material:	Intumescent Mastics
Location Applied:	Gaps Between Boards & Test Frame, Web Surface of the Channel and Screw Heads

Drawings of Specimen provided by the Sponsor (1)



Appendix C

Photos of the Specimen

Photo 1. Exposed surface of the specimen before test.

Photo 2. Unexposed surface of the specimen before the test.

Photo 3. Unexposed surface of the specimen at 30 minute of test.

Photo 4. Unexposed surface of the specimen at 60 minute of test.

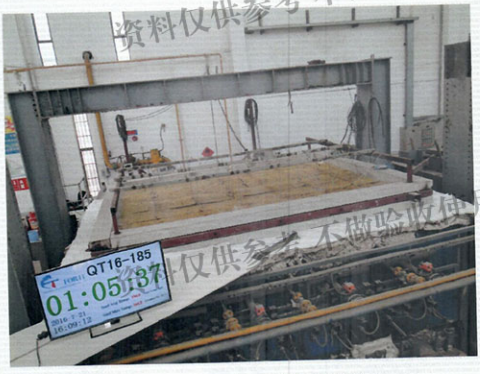


Photo 5. Unexposed surface of the specimen at 65 minute of test.

Photo 6. Unexposed surface of the specimen – taking photo from 16 hours after terminate of the test.

Appendix D – Unexposed Surface Temperature Record of the Specimen

The measured values from the unexposed surface fixed thermocouples (U1 to U5) on the specimen were summarized in the following tables. Measurements were taken in °C.

Measured values from U1 to U5.

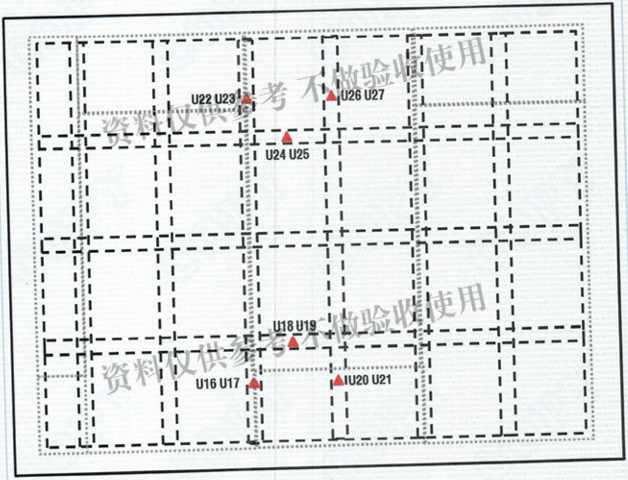
Time (min)	U1	U2	U3	U4	U5
0	33.6	34.3	34.5	33.6	34.3
5	33.4	33.1	33.8	33.7	33.1
10	81.6	75.6	95.1	92.6	88.7
15	84.7	89.0	94.0	98.1	97.2
20	88.8	90.6	90.6	97.9	96.1
25	80.4	78.1	80.0	94.7	89.7
30	67.9	64.6	66.0	81.3	75.3
35	60.0	63.9	58.8	69.3	68.1
40	57.9	74.4	70.2	66.0	64.6
45	64.8	93.1	96.3	71.8	73.2
50	75.1	106.9	113.4	87.0	85.0
55	82.0	124.2	129.4	92.0	100.9
60	84.7	153.0	151.1	125.1	129.6
61	85.6	163.6	161.6	131.0	139.0
62	88.4	177.8	178.0	137.1	153.3
63	97.0	198.0	202.1	144.7	174.4
64	114.1	225.9	219.5	153.5	195.1
65	118.6	243.7	230.9	163.8	210.9

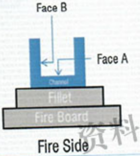
Appendix E

AE.1 - Additional Temperature – Framework

Fixed surface thermocouples were attached to different locations of the framework to obtain additional information. Locations of these thermocouples were shown and summarized in the following figure and table.

Figure 6. Location of Additional Thermocouples





Position	Face A	Face B
Inner face of the Channel	U16, U18, U20, U22, U24, U26	U17, U19, U21, U23, U25, U27

AE.2 - Additional Thermocouples – Detailed Temperature Records

The measured values of the additional thermocouples (U16 to U27) on framework of the specimen were recorded in the following table. For additional information only and NOT assessed against insulation criterion of the specimen. Measurements were taken in °C.

Measured values from U16 to U25.

Time (min)	U16	U17	U18	U19	U20	U21	U22	U23	U24	U25	U26	U27
0	35.0	35.7	33.4	35.0	35.3	35.0	36.8	36.1	35.4	35.3	32.8	33.8
5	98.3	96.3	70.5	73.4	95.1	97.7	97.1	97.0	38.9	37.9	99.5	102.4
10	95.6	98.4	98.1	97.7	96.9	97.1	95.8	96.4	48.9	51.3	98.8	122.3
15	92.6	98.1	100.2	99.2	93.8	94.8	96.0	97.0	66.9	77.5	110.9	127.8
20	104.1	106.7	100.5	99.4	99.6	100.6	104.0	104.3	86.5	95.9	102.6	128.7
25	168.3	141.4	100.5	99.6	152.6	155.9	138.1	139.5	96.0	100.2	154.1	139.3
30	263.3	234.4	100.4	99.2	245.0	250.6	218.0	221.2	99.3	100.6	248.5	216.5
35	360.9	312.7	100.3	99.2	336.1	346.2	307.1	305.6	100.4	100.5	342.5	300.7
40	451.8	399.0	100.0	98.7	426.7	434.4	392.9	389.0	100.8	100.1	437.8	383.9
45	534.5	482.3	99.2	98.4	511.8	518.9	479.6	469.2	100.5	99.7	524.0	468.8
50	604.0	561.1	98.5	98.3	585.4	592.4	560.3	549.2	100.3	99.3	593.2	550.8
55	662.6	627.8	98.2	97.9	643.0	646.2	624.9	614.6	100.2	99.2	657.0	619.0
60	703.4	676.5	97.8	97.4	690.0	690.9	669.4	663.0	100.3	99.4	700.3	668.3
61	709.2	684.1	97.6	97.1	697.4	696.8	679.5	670.3	100.3	99.4	706.3	675.0
62	715.3	691.8	97.3	96.7	705.1	703.2	687.5	677.0	100.3	99.5	712.6	685.1
63	719.9	697.7	97.0	96.4	710.0	708.9	694.7	684.0	100.3	99.5	718.6	692.5
64	725.1	704.3	96.7	95.7	713.3	713.9	701.6	691.7	100.3	99.5	725.1	700.3
65	732.2	710.2	96.2	95.2	718.7	717.8	707.2	698.2	100.3	99.5	730.9	706.4

Measured values from U26 to U27.

Time (min)	U26	U27
0	32.8	33.8
5	99.5	102.4
10	98.8	122.3
15	110.9	127.8
20	102.6	128.7
25	154.1	139.3
30	248.5	216.5
35	342.5	300.7
40	437.8	383.9
45	524.0	468.8
50	593.2	550.8
55	657.0	619.0
60	700.3	668.3
61	706.3	675.0
62	712.6	685.1
63	718.6	692.5
64	725.1	700.3
65	730.9	706.4

END OF REPORT