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REACTION TO FIRE TEST REPORT No EUI - 18 - FF - 000131

Test: EUI-18-FF-000131

Performed on: 27 June 2019

Test Standard: **BS 8414-2:2015+A1:2017** – Fire performance of external cladding systems Part 2: Test method for non-loadbearing external cladding systems fixed to and supported by a structural steel frame

Product referenced: Façade system incorporating 90 mm Kooltherm K15 Rainscreen and 90 mm K15 Black Kingspan Insulation, cavity and Branco Michaela Granite stone cladding panels

Test sponsor : KINGSPAN INSULATION LTD
Bree Industrial Estate, Castleblayney
Co Monaghan
AK75 X966, Ireland

UKAS TESTING
10169

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1. INTRODUCTION

The test was carried out in accordance with BS 8414-2:2015+A1:2017 which provides a method for determining the fire performance characteristics of non-loadbearing external cladding systems fixed to and supported by a structural steel frame when exposed to an external fire under controlled conditions. The fire exposure is representative of an external fire source or a fully-developed (post-flashover) fire in a room, venting through an opening such as a window aperture that exposes the cladding to the effects of external flames, or from an external fire source.

This test report relates only to the actual specimen as tested and described in this report.

1.1. DETAILS OF THE TEST

This report describes the reaction to fire test performed at Efectis UK/Ireland Ltd (EUI) fire laboratory located on Shore Road, Newtownabbey in Northern Ireland, UK

at the request of:

KINGSPAN INSULATION LTD
Bree Industrial Estate, Castleblayney
Co Monaghan
AK75 X966, Ireland

EUI Job number: EUI-18-000131

Test date: 27 June 2019

Test method: in accordance with BS 8414-2:2015+A1:2017

Deviations:

- An extra concrete lintel of 200 mm x 200 mm cross section was fixed by sponsor just in front of the combustion chamber's lintel on the main face to support stone panels.

The test was witnessed by:

Mr Alan Macklin	of Kingspan Ltd
Mr Paul McCabe	of Kingspan Ltd
Mr Andrew Ward	of Kingspan Ltd
Mr Brett O'Sullivan	of Kingspan Ltd
Mr Liam Hughes	of Stone Systems Ltd
Mr Simon Lyness	of Stone Systems Ltd
Mr Aaron Hughes	of Stone Systems Ltd
Mr Keith Lawlor	of Stone Systems Ltd

2. DESCRIPTION OF THE TESTED PRODUCT

Technical data in this chapter and drawings from page 14 to page 16 of Appendix 1 concerning the sample and its composition have been supplied by the sponsor who attests their accuracy.

All test materials were supplied and installed by the sponsor's and STONE SYSTEMS LTD construction crews.

EFECTIS UK/IRELAND was not involved in the specimen selection process and therefore cannot take any responsibility for the relationship between specimen supplied for testing and product placed on the market.

2.1. DESCRIPTION OF SUBSTRATE

The cladding system prior to fire test is shown in Figure 4.8 of Appendix 4. Full details of the system have been provided by the client and are summarised in the following section. All materials used in detail are provided in section 2.6.

The tested cladding system build up is given in order from steel frame (Efectis testing frame) to the external face of the facade:

- Single layer of 12.5 mm WallBoard (KNAUF) plasterboard
- Infill Kingframe Steel Framing System (KINGSPAN) of 100 mm x 50 mm x 1.2 mm thick studs
- Single sheathing board layer of 12 mm thick Multi-Pro (RESISTANT BUILDING PRODUCTS LTD)
- Waterproof membrane Rubberclad EPDM (MOY MATERIALS LTD)
- Single layer of 90 mm thick Kooltherm K15 Rainscreen (KINGSPAN) insulation and a single layer of K15 Black (KINGSPAN) giving a total of 180 mm insulation layer
- Air cavity of 40 mm thickness
- Stainless Steel loadbearing brackets and restraints (METLOC SYSTEMS LTD)
- Siderise RV120/120 (SIDERISE) Vertical cavity barriers
- Siderise RH25G 90/30 (SIDERISE) Horizontal open state cavity barriers
- Outer face cladding panels reference Branco Michaela Granite (STONE SYSTEMS LTD) of 40 mm thickness and flamed finished surface

The side edges of the system were left open; no closing flashings were used. Around the opening a 2 mm aluminium pod-frame was used. Drawings of the system and photographs of system during construction can be seen in Appendix 1.

2.2. INSTALLATION OF SPECIMEN

All test materials were supplied by the sponsor and STONE SYSTEMS LTD. Installation was performed by working crews from sponsor and STONE SYSTEMS LTD. Efectis UK/Ireland was not involved in the sample selection process and therefore cannot take any responsibility for the relationship between samples supplied for testing and product placed on the market.

Drawings in Appendix 1 were supplied by the test sponsor and checked by the EFECTIS UK/Ireland laboratory during the mounting and were found compliant with the tested product.

2.3. INSTALLATION SEQUENCE

2.3.1. SFS Kingframe

The steel frame reference SFS Kingframe (KINGSPAN) was infill, constructed using 'C' section lipped channel stud reference C100050120 (KINGSPAN). Studs of dimensions 100 mm x 50 mm x 1.2 mm were fixed to the head and the base track at 300 mm and 600 mm centres using screws reference CFC26 Tek Screws of Ø 5.5 mm x 25 mm dimensions. The head track and the base track were made using rails references U104067180 and U104055120 (KINGSPAN) respectively, fixed on the concrete slabs using fixings reference Multi-Monti-S-7.5x75, were of Ø 7.5 mm x 75 mm dimensions. The assembly of the frame was performed according to client's specification. There were four lintels, of 200 mm wide, on the main face

having (bottom to top) 200, 480, 280 and 280 mm heights respectively and three lintels of same width and 630, 280 and 280 mm heights respectively on the wing face.

2.3.2. Unexposed face of the facade

2.3.2.1. Plasterboard layer

A single layer of plasterboards reference WallBoard (KNAUF) of dimensions 2400 mm x 1200 mm and thickness 12.5 mm were installed on the unexposed face of the SFS system. The boards were fixed to the SFS studs using fixings reference SCS3/25-PH2-4.8-42 of Ø 4.8 mm x 42 mm dimensions evenly spaced at approx. 300 mm centres.

2.3.3. Exposed face of the facade

2.3.3.1. Sheathing board layer

A single layer of 12 mm thick board reference Multi-Pro (RESISTANT BUILDING PRODUCTS LTD) of dimensions 2400 mm x 1200 mm was installed on the exposed face of the SFS system. The boards were fixed to the SFS studs using fixings reference DF3-W-5.5 x 50 of Ø 5.5 mm x 50 mm dimensions evenly spaced at approx. 300 mm centres.

2.3.3.2. Waterproof membrane

The waterproof membrane layer, reference Rubberclad EPDM (MOY MATERIALS LTD) of 0.7 mm thickness was installed on top of the sheathing board layer. The membrane was adhesively fixed on the sheathing board using the adhesive reference BA-007 (GISCOSA).

2.3.3.3. Insulation layer

On top of the membrane layer, double layer of insulation was used, comprising insulation reference Kooltherm K15 Rainscreen (KINGSPAN) against the waterproof membrane and single layer of insulation reference K15 Black (KINGSPAN) with black side exposed. Insulation was fixed on the sheathing board layer using fixings reference SF-RS-SSA4-4.8 x 120 (SureFast) of Ø 4.8 mm x 120 mm (1st layer) dimensions combined with 70 mm diameter washers according to manufacturer's recommendations. Each layer of insulation was of 90 mm giving in total 180 mm thick layer. The outer layer was fixed using fixings SF-RS-SSA4-4.8 x 200 (SureFast) of Ø 4.8 mm x 200 mm dimensions along with reference SF-T-50 x 25 tube washers (SureFast).

2.3.3.4. Fire stop barriers

Horizontal open state cavity fire stop barriers (no3) were installed on the lintels behind the outer face cladding panels in locations as shown in the drawings of Appendix 1. The fire barriers reference RH25G 90/30 (SIDERISE) were fixed using galvanized brackets reference B195 (SIDERISE) as recommended by the manufacturer, fixed at 400-600 mm centres according to sponsor's locations. The brackets were screwed on the concrete lintels using fixings reference standard self-drilling screw 4 x 40 of Ø 4 mm x 40 mm dimensions combined with washer. Vertical cavity fire stop barriers reference RV 120/120 (SIDERISE) were installed vertically; two of them on the outer side of the combustion chamber on the main face and the last one close to the edge of the wing face. Installation followed manufacturer's recommendations.

2.3.3.5. Bracket support system

Supporting brackets were used to support stone cladding panels. The brackets reference ML A5-100 (METLOC SYSTEMS LTD) were fixed on the concrete lintels horizontally spaced at 467 and 1008 mm centres using fixings reference FBN II 12/20 A4 Mechanical Anchor (FISCHER) of Ø 12 mm x 116 mm dimensions. They were combined with 100 mm cleats.
In addition, stainless steel restraint fixings were fixed on SFS Kingframe using fixings reference E-X T25 BR 2 12 5.5 x 25 (END) of Ø 5.5 mm x 25 mm dimensions.

2.3.3.6. Air cavity

Air cavity of thickness 40 mm was created between the insulation layer and the inner face of the cladding stone panels.

2.3.3.7. Outer face

The outer face cladding stone panels reference Branco Michaela Granite (STONE SYSTEMS LTD) were of 40 mm thickness and flamed finished surface. They were clad on the support brackets following staggered pattern starting from the bottom of the rig up to the top on the main face. On the wing face were clad following straight pattern; vertical joint was running vertically up to the top of the system.

2.3.4. Flashings and closures

The side and top edges of the system were left open; no closing flashings were used. Around the opening a 2 mm aluminium pod-frame was used.

2.3.5. Joints

The outer face cladding panels were installed so that there were both vertical and horizontal open joints having thickness of 8 mm.
On the main face, a vertical joint incorporated to the system was located on the centreline above the combustion chamber, extending up to 592 mm high.
In addition, a horizontal joints incorporated to the system at distance 2400 mm above the combustion chamber's opening.

2.4. DIMENSIONS OF THE TEST SPECIMEN

In accordance with the requirements of the BS 8414-2:2015+A1: 2017, the cladding system measured:

Test requirement	Actual measurement
shall extend horizontally from the finished corner of the test sample, at least 2 400 mm on the main test face	3000 mm
shall extend horizontally from the finished corner of the test sample, at least 1 200 mm on the wing	1620 mm
shall extend from the base of the test apparatus to a height of at least 6 000 mm above the top of the combustion chamber opening on both faces	7000 mm
allow a distance of (260 ±100) mm from the side of the opening of the combustion chamber to the finished face of the test specimen	360 mm
Allow unobstructed the combustion chamber opening (Width x Height) of (2 000 ±100) x (2 000 ±100)	1970 mm x 2030 mm

2.5. SUMMARY OF MATERIALS USED

Based on the information provided by the test sponsor, the materials as used on the as-built façade system are given in the following table.

Material	Reference	Composition	Characteristics	Supplier
Steel Formed Sections - studs	C100050120	gauge steel	100 mm × 50 mm × 1.2 mm thick	KINGSPAN
Steel Formed Sections – Head Track	U104067180	gauge steel	104 mm × 50 mm × 2 mm thick	KINGSPAN
Steel Formed Sections –Base Track	U104055120	gauge steel	104 mm × 50 mm × 1.2 mm thick	KINGSPAN

Plasterboards of non-exposed face	WallBoard	Gypsum board with ivory paper face	2400 mm x 1200 mm x 12.5 mm thick Reaction to fire: A2-s1,d0	KNAUF
Sheathing board layer	Multi-Pro	-	2400 mm x 1200 mm x 12 mm thick Reaction to fire: A1	RESISTANT BUILDING PRODUCTS LTD
Waterproof membrane Rubberclad EPDM	Rubberclad EPDM	EPDM	0.7 mm thick Black colour	MOY MATERIALS LTD
Adhesive used for membrane	BA-007	-	-	GISCOSA
Double insulation layer	Kooltherm K15 Rainscreen and K15 Black	Phenolic foam	90 mm thick; total 180 mm Black colour on the exposed face Reaction to fire Kooltherm K15 Rainscreen: C-s1,d0 Reaction to fire K15 Black: NPD	KINGSPAN
Vertical fire barriers (no3)	RV 120/120	Non-combustible stone-wool lamella core, with reinforced aluminium foil face	Reaction to fire: A1	SIDERISE
Horizontal open state fire barriers (no3)	RH25G 90/30	Non-combustible stonewool lamella core with aluminium foil face c/w intumescent	Reaction to fire: A1	SIDERISE
Brackets for fixing the fire stop barriers	B195	Galvanized	-	SIDERISE
Brackets for stone panel support	ML A5-100	Stainless steel	Combined with 100 mm cleats	METLOC SYSTEMS LTD
Restraint fixings	-	Stainless steel	-	-
Outer face cladding material	Branco Michaela Granite	Stone	40 mm thick Flamed finish surface Grey colour	STONE SYSTEMS LTD
Screws for fixing the studs on the head/base channels of SFS	CFC26 Tek Screws	-	5.5 mm x 25 mm	-
Screws for fixing head/base tracks on the lintels	Multi-Monti-S-7.5x75	-	7.5 mm x 75 mm	-
Screws for fixing the plasterboards on the SFS frame	SCS3/25-PH2-4.8-42 of Ø	-	4.8 mm x 42 mm	-
Screws for fixing the sheathing boards on the SFS frame	DF3-W-5.5 x 50	-	5.5 mm x 50 mm	-

Fixings used for insulation layers	SF-RS-SSA4-4.8 x 120 (layer 1) SF-RS-SSA4-4.8 x 200 (layer 2)	-	4.8 mm x 120 mm c/w 70 mm washers 4.8 mm x 200 mm	SureFast
Tube washers used on 2nd insulation layer	SF-T-50 x 25 tube washers	-	50 mm x 25 mm	SureFast
Screws for fixing brackets on the lintels	standard self-drilling screw 4 x 40		4 mm x 40 mm	-
Anchors for fixing support brackets	FBN II 12/20 A4 Mechanical Anchor	Steel	12 mm x 116 mm	FISCHER
Fixings used for restraint fixings	E-X T25 BR 2 12 5.5 x 25	Steel	5.5 mm x 25 mm	END

3. TEST DETAILS

3.1. CONDITIONING

In accordance with paragraph 7 of BS 8414-2:2015+A1: 2017 the hygrometric stability of the specimen was reached for the test according to material and sponsor specifications; no curing period was needed.

Mounting : from 4 June 2019 to 25 June 2019
Test : 27 June 2019

The specimen was installed, conditioned and tested indoors thus protected from adverse environmental conditions such as water, windload and ambient temperatures outside the range - 5 °C to +40 °C during the application, curing and test period.

3.2. THERMAL PROGRAM

In accordance with annex A of the standard BS 8414-2:2015+A1: 2017, a wood crib acted as a fuel source. The crib compromised:

- 100 long sticks dimensions 50±2 × 50±2 × 1 500±5 mm ;
- 150 short sticks dimensions 50±2 × 50±2 × 1 000±5 mm ;
- 16 strips of low density fibreboard having nominal dimensions of 25 × 12 × 1 000 mm.

Low density fibreboard was soaked inside a container filled with 5 litres of white spirit for at least 5 minutes prior to the test.

Sticks were cut from Scots pine (Pinus sylvestris) with the average density of 470 (dry basis). Wood was stored inside the lab prior to the test reaching average moisture content prior to the test of 11.7 %.

4. APPARATUS

Efectis UK.Ireland Ltd erected a large steel frame based on recommendations given in Annex B of BS 8414-2:2015+A1: 2017. Dimensions and layout of the steel frame are given below. Moreover, a combustion chamber was constructed for wood crib. Details are shown in Figures 1-3.

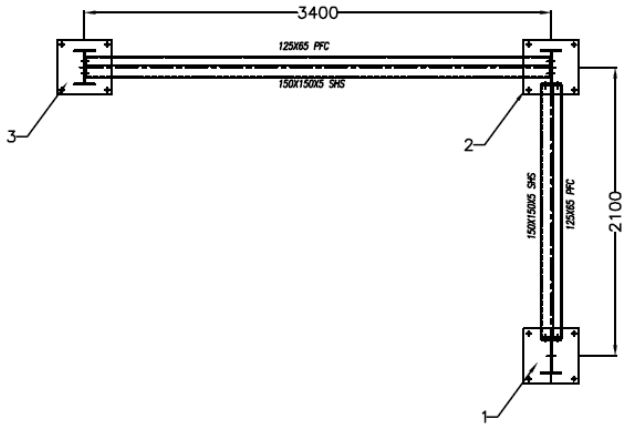

Figure 1. Top view of Efectis UK/Ireland test frame

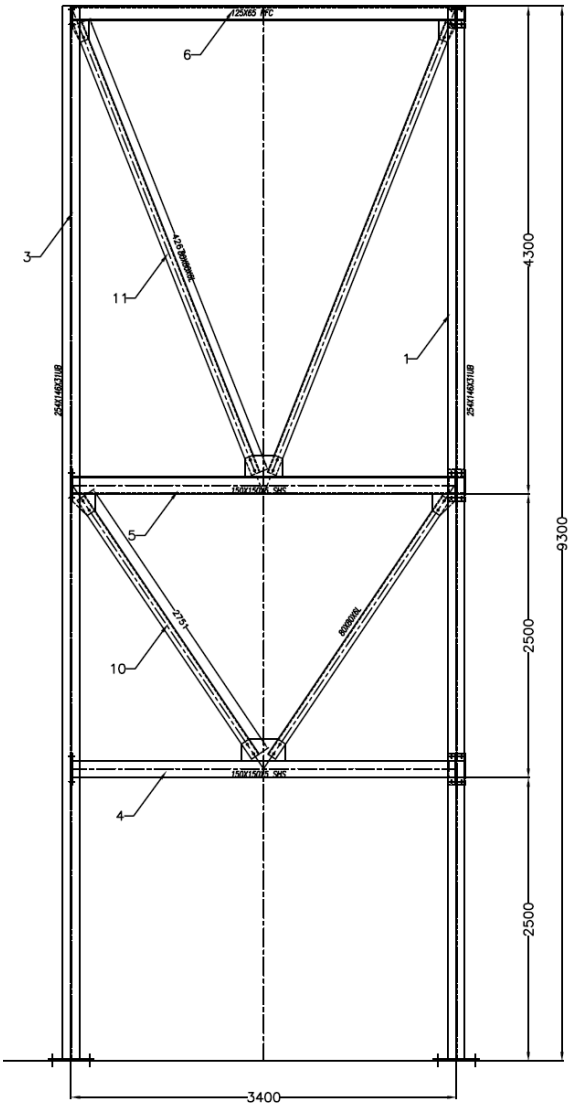

Figure 2. Front view of Efectis UK/Ireland test frame

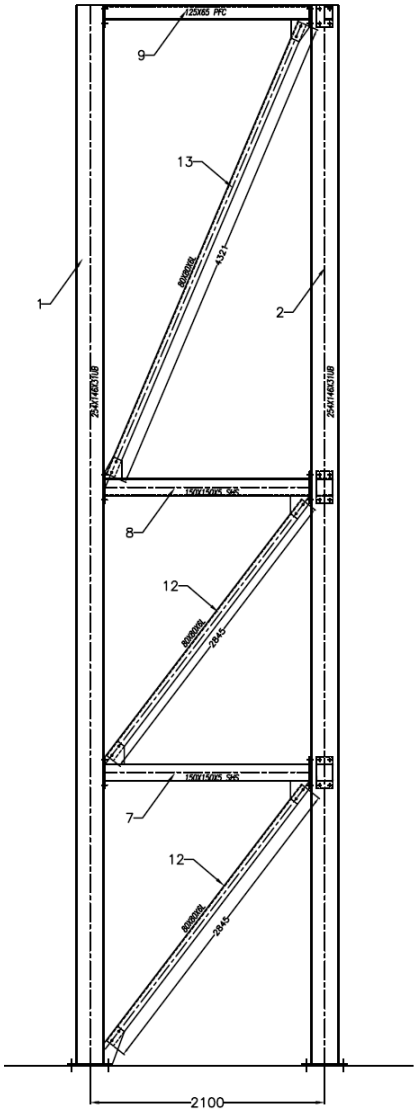

Figure 3. Side view of Efectis UK/Ireland test frame

5. INSTRUMENTATION

After the application of the system on the test frame the specimen was instrumented with Ø 1.5 mm calibrated mineral insulated thermocouples to monitor the specimen temperature. Their positions are shown in Appendix No 2. The thermocouples were attached to the test specimen by the staff of the test Laboratory EFECTIS UK/Ireland.

The thermocouples were Type 'K' (nickel / chrome, nickel / aluminium) and were therefore suitable for continuous use at temperatures up to 1100°C. Each thermocouple was connected to the data logger, and the signal was recorded at intervals of 6 s.

The temperatures recorded are shown in Figures 3.1 to 3.8, in Appendix 3.

Location	Markings
External thermocouples at level 1 (Main face)	101 to 105
External thermocouples at level 1 (Wing face)	106 to 108
External thermocouples at level 2 (Main face)	109 to 113
External thermocouples at level 2 (Wing face)	114 to 116
Internal thermocouples (Main face), midpoints inside the stone outer face panels layer, at level 2	201 to 205
Internal thermocouples (Wing face), midpoints inside the stone outer face panels layer, at level 2	206 to 208
Internal thermocouples (Main face), midpoints inside the air cavity layer, at level 2	301 to 305
Internal thermocouples (Wing face), midpoints inside the air cavity layer, at level 2	306 to 308
Internal thermocouples (Main face), midpoints inside the insulation layer, at level 2	401 to 405
Internal thermocouples (Wing face), midpoints inside the insulation layer, at level 2	406 to 408
Internal thermocouples (Main face), midpoints inside the sheathing board layer, at level 2	501 to 505
Internal thermocouples (Wing face), midpoints inside the sheathing board layer, at level 2	506 to 508
Internal thermocouples (Main face), midpoints inside the SFS metal frame, at level 2	601 to 605
Internal thermocouples (Wing face), midpoints inside the SFS metal frame, at level 2	606 to 608
Internal thermocouples (Main face), midpoints inside the plasterboard layer, at level 2	701 to 705
Internal thermocouples (Wing face), midpoints inside the plasterboard layer, at level 2	706 to 708

6. TEST RESULTS

6.1. TEST CONDITIONS

- Ambient temperature before the test: 18.5°C
- Ambient humidity before the test: 58%
- Wind speed: tested indoors, 0.2 m/s

6.2. TEMPERATURE PROFILES

Figures 3.1 to 3.6 in Appendix No.3 show temperature history during the test. Summary of the temperature data is shown in table below.

Parameter	Result
Start temperature – T_s	18.2 °C
Start time - t_s	84 sec after ignition of the crib (16.4 min after datalogging started)
Peak temperature/time at Level 2, external	388°C at 16.7 min from t_s, at location 111
Peak temperature/time at Level 2, internal	170°C at 22.8 min from t_s, at location 303

6.3. VISUAL OBSERVATIONS DURING THE TEST

Height observation are given relative to the top of combustion chamber. If not mentioned otherwise, the heights reported below refer to centre line of the combustion chamber.

Time from ignition (min:sec)	***t_s (min:sec)***	***Observation***
00:00		Ignition of crib
00:55		Flames from the chamber started to impinge on façade system
01:24	00:00	Start time (t_s) threshold achieved. External temperature at level 1 (2.5 m above the top of combustion chamber) ≥ 230.6°C (T_s+200°C) at thermocouple 103
01:35	00:11	Discoloration of pod-frame; top part bending
02:15	00:51	Flame tip reached Level 1 (=2500mm above chamber's opening)
06:00	04:36	Crackling noise
07:00	05:36	Flames constantly located at Level 1
07:30	06:06	Pod-frame bended on top Crack visible on 2nd row's stone panel at the left side of centreline above chamber
08:40	07:16	Pod-frame melting – Burning droplets
15:00	13:36	Small part of stone panel from 1st row right-hand side above chamber's opening
17:25	16:01	Flames reached at height 3000-3500 mm above chamber's opening
21:00	19:36	Cracks on 1st row of stone panels above chamber's opening
22:00	20:36	Flames reached at height 4000-4500 mm above chamber's opening
24:00	22:36	Flame tip reached Level 2 (=5000mm above chamber's opening)
25:00	23:36	Part of wood crib fell out
27:00	25:36	Part of wood crib fell out
30:00-31:00	28:36-29:36	Extinction of the heating source commenced
33:00	31:36	Glowing observed behind stone panels – burning of insulation
40:00	38:36	Flames observed behind stone cladding just below the 2nd fire stop barrier
60:00	58:36	**Termination of the test.**

6.4. POST-TEST EXAMINATION

The cladding system was examined when cooled (within 24 h of the test). Examination compromised of external surface and internal layers. Post-examination photos and evidence are shown in Appendix 4.

6.4.1. Outer face cladding panels

On the main face:
On the main face of the cladding system, all panels were in-place after testing. Some cracks were observed on three panels located just above the combustion chamber's opening. Discolouration was observed up to a height of 3000 mm.

On the wing face:
On the wing face, all stone cladding panels were intact and in-place. No damage or discolouration was observed.

6.4.2. Brackets support system

Brackets and restraints were intact and in place after the test. Some minor discolouration only observed on the ones just above the chamber's opening on the main face.

6.4.3. Fire stop barriers

On the main face:
The bottom horizontal fire stop barrier installed was activated during the test along the two vertical fire stop barriers. It was partially damaged as about 15% was detached from the system. Only about 10% was intact; on the left hand side edge of the system's main face. The middle one was partially activated but was still in place without suffering any major damage. The top horizontal fire stop barrier was in place without been activated and without any damage or detachment.

The vertical fire stop barriers were in place after the test without major damage. Only the right hand side vertical fire stop barrier was suffered some damage above the combustion chamber up to the bottom horizontal fire stop barrier.

On the wing face:
All horizontal fire stop barriers were not activated and in-place after testing without any damage observed.

Same observation was made for the vertical fire stop barrier located close to the edge of the wing face.

6.4.4. Insulation layer

On the main face:
The reference Kooltherm K15 Rainscreen insulation layer on the main face was intact and in place after testing. There was no charring or damage observed on it. However, the layer of reference K15 Black insulation was charred and partially burnt on the area just above the combustion chamber up to a height of approx. 2500 mm above the chamber. That area was confined in the space between the two vertical barriers of the main face. Higher areas were without any damage or burnt being observed.

On the wing face:
Insulation layer on the wing face was intact and in-place after testing. There was no charring or burnt observed on it.

6.4.5. Waterproof membrane

The waterproof membrane was in place and intact after testing. No damage was noted after removing the insulation layer from the system.

6.4.6. Sheathing board layer

The sheathing board layer sheets were intact and in place after testing. No discoloration was observed.

6.4.7. Plasterboard layer

No damage was observed to plasterboard layer installed on the unexposed side of the system. No discoloration was observed.

6.4.8. SFS Kingframe

No damage was observed to SFS Kingframe; all studwork was in place and intact after testing. No discoloration was observed.

7. REFERENCE

BS 8414-2:2015+A1: 2017 'Fire performance of external cladding systems - Part 2: Test method for non-loadbearing external cladding systems fixed to and supported by a structural steel frame', British Standards Institute, 2017.

The test results relate to the behaviour of the test specimens of a product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

The attention is drawn on the fact that the results obtained with the sample being the subject of the present test report can not be generalized without justification of the representativeness of the samples and tests.

Belfast, on 28th May 2020

WRITTEN BY:

CHOTZOGLOU Konstantinos
Project Leader

AUTHORIZED BY:

FLAMMIER Damien
Lab Manager

APPENDIX 1 – DRAWINGS OF THE SYSTEM (AS SUPPLIED BY SPONSOR)

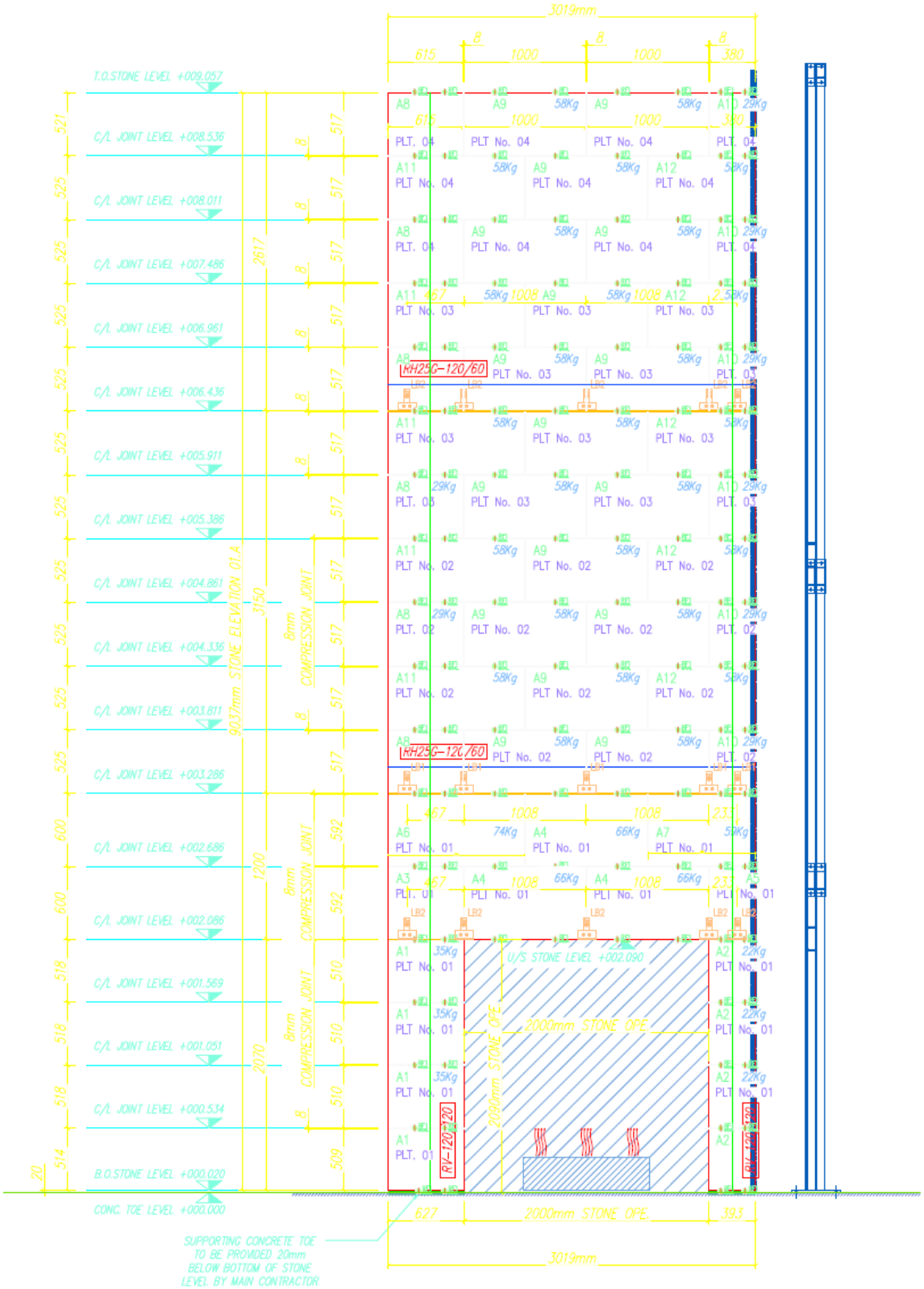

Figure 1.1. Sketch of the tested facade. Front elevation layout.

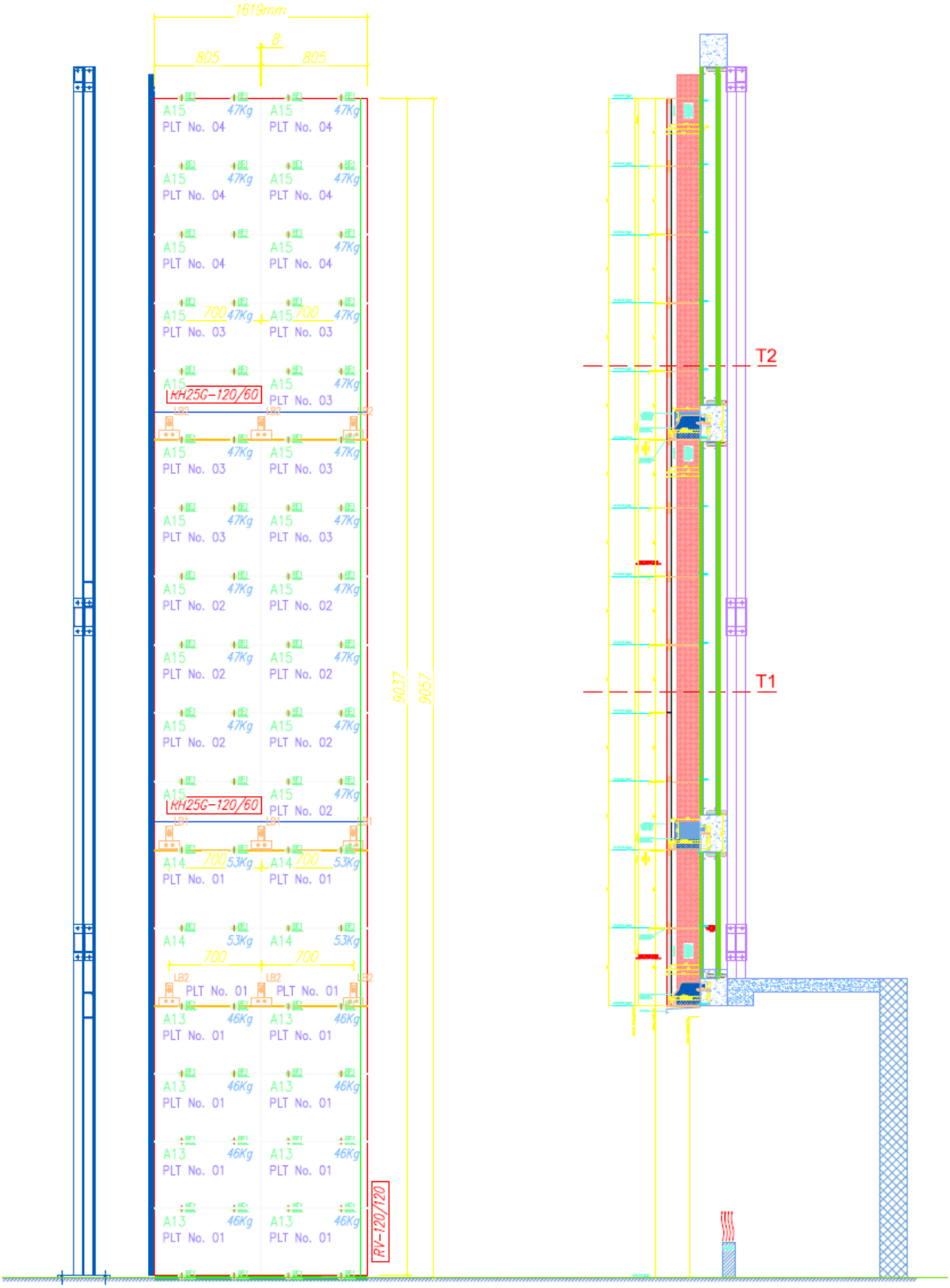

Figure 1.2. Sketch of the tested facade. Side elevation and Section layout.

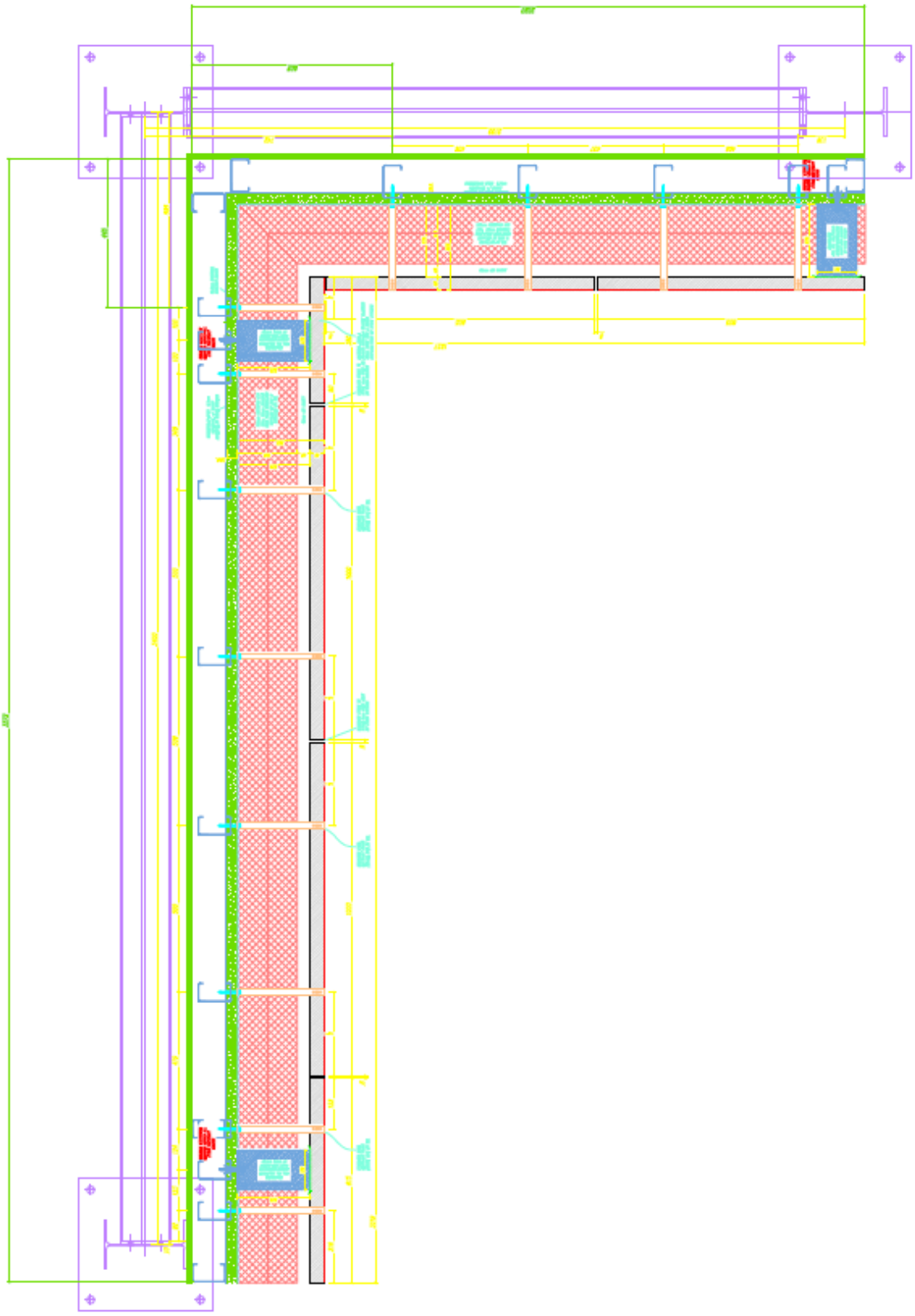

Figure 1.3. Sketch of façade system detail. Plan view of tested facade.

APPENDIX 2 – THERMOCOUPLES LOCATION

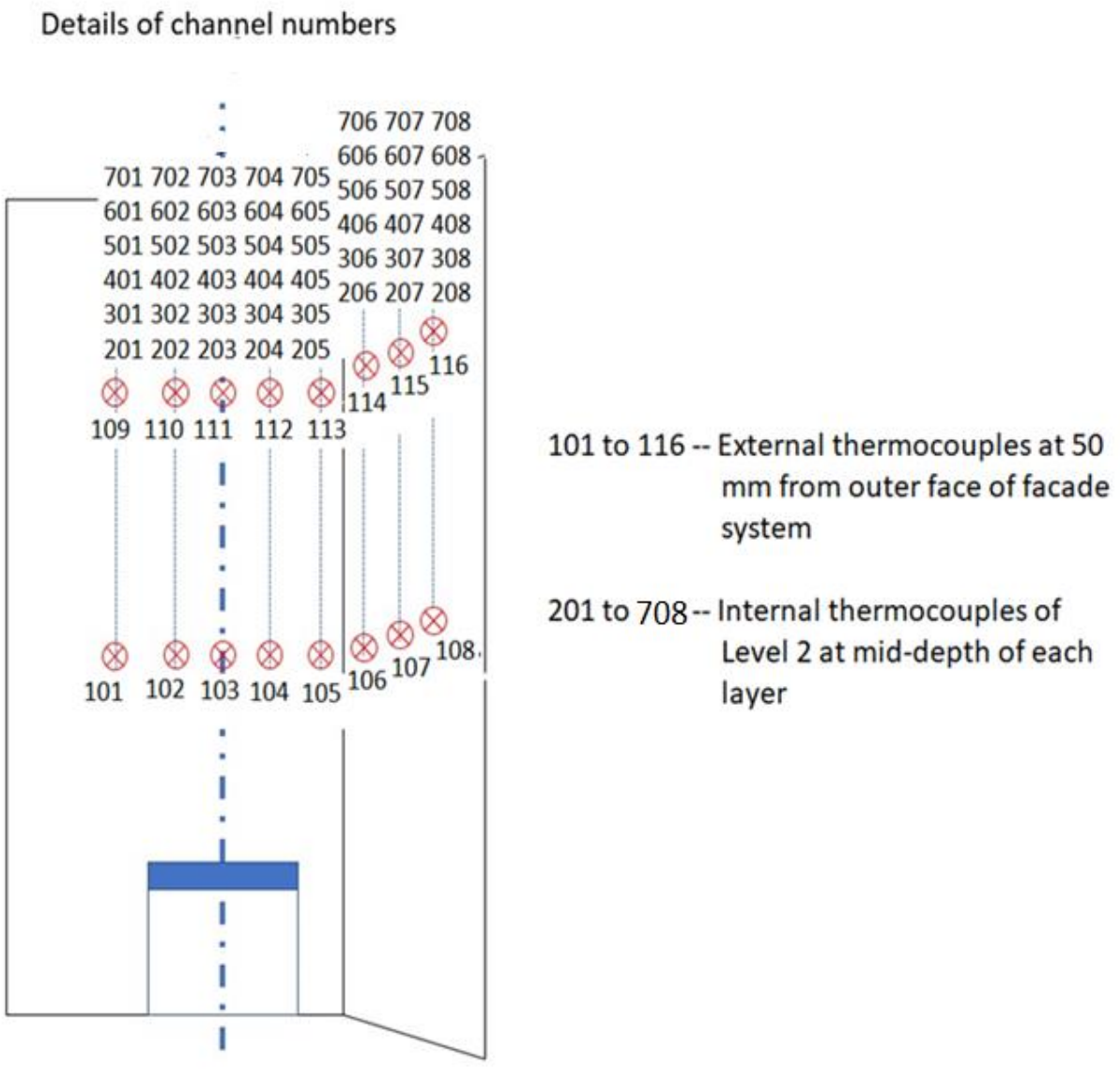

Figure 2.1. Thermocouple locations

APPENDIX 3 – GRAPHS

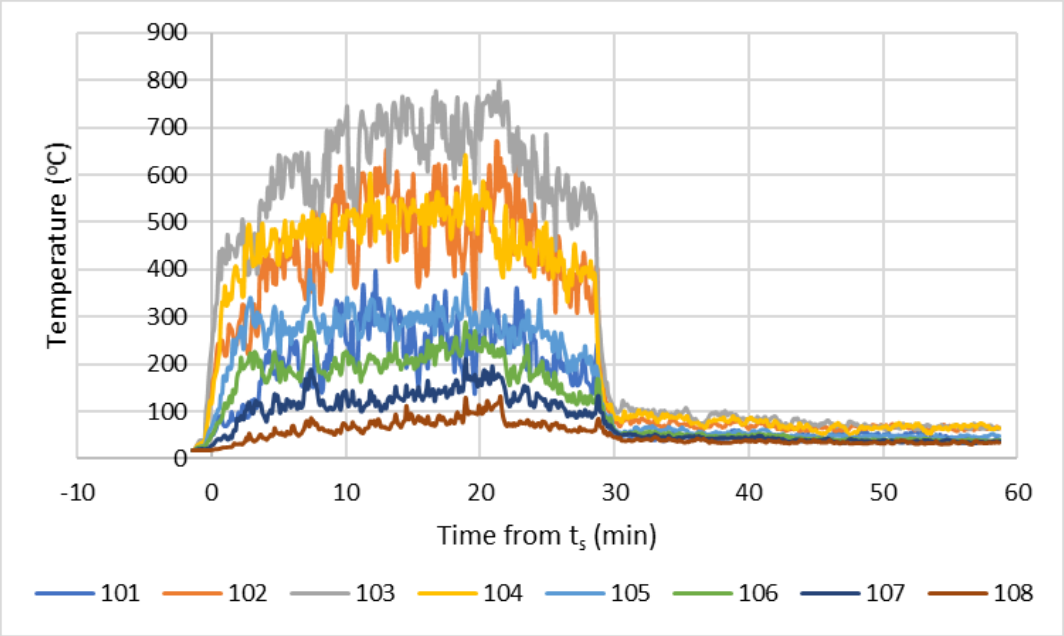

Figure 3.1. Level 1 external temperatures history recorded during the test

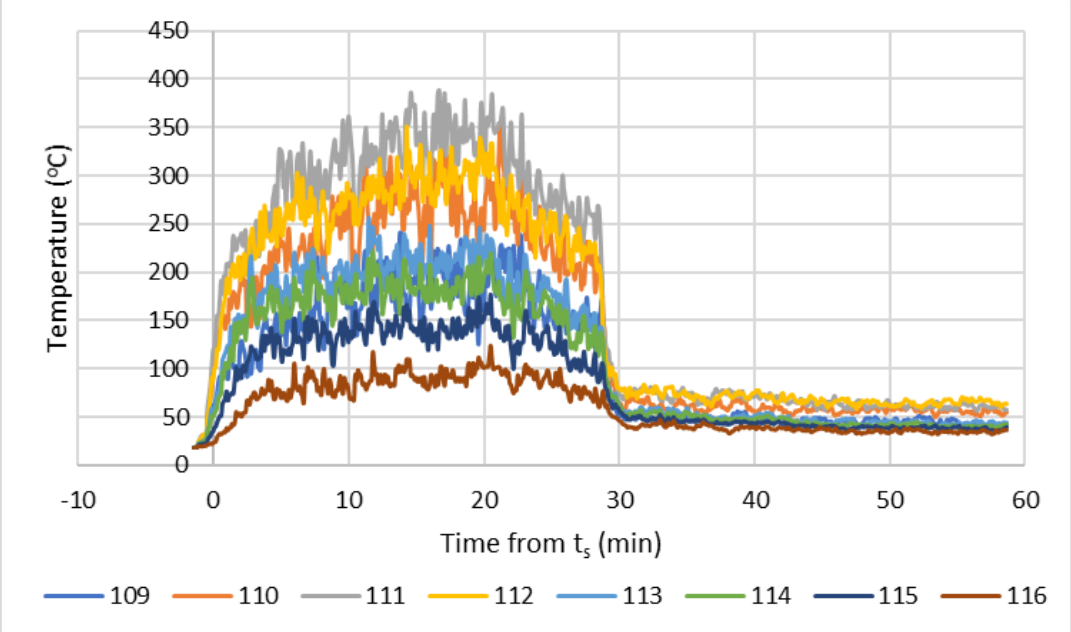

Figure 3.2. Level 2 external temperatures history recorded during the test

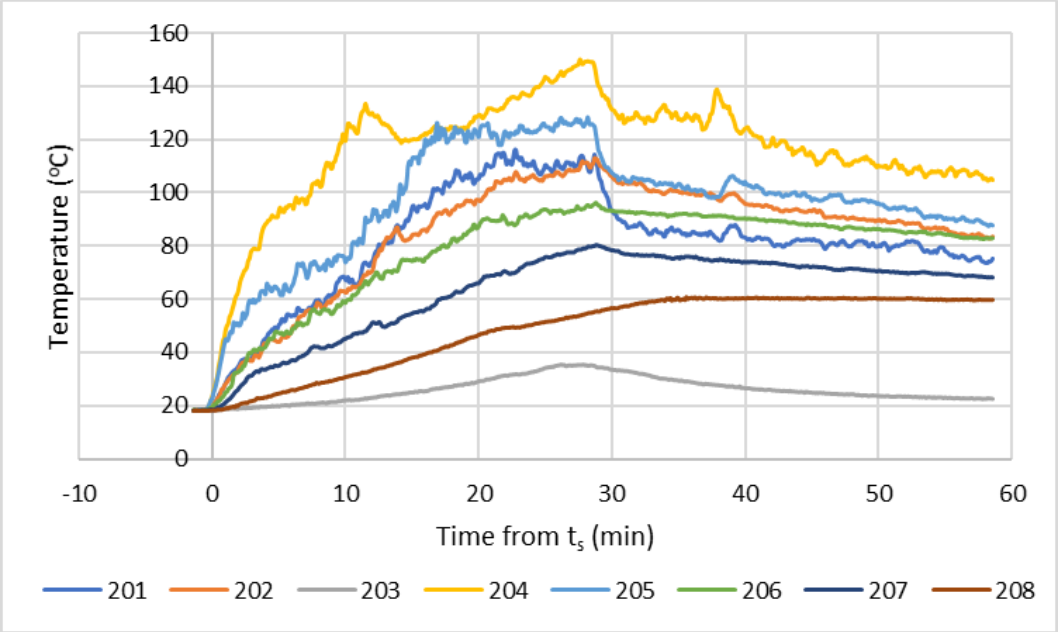

Figure 3.3. Level 2- Stone outer face panels internal temperatures history recorded during the test

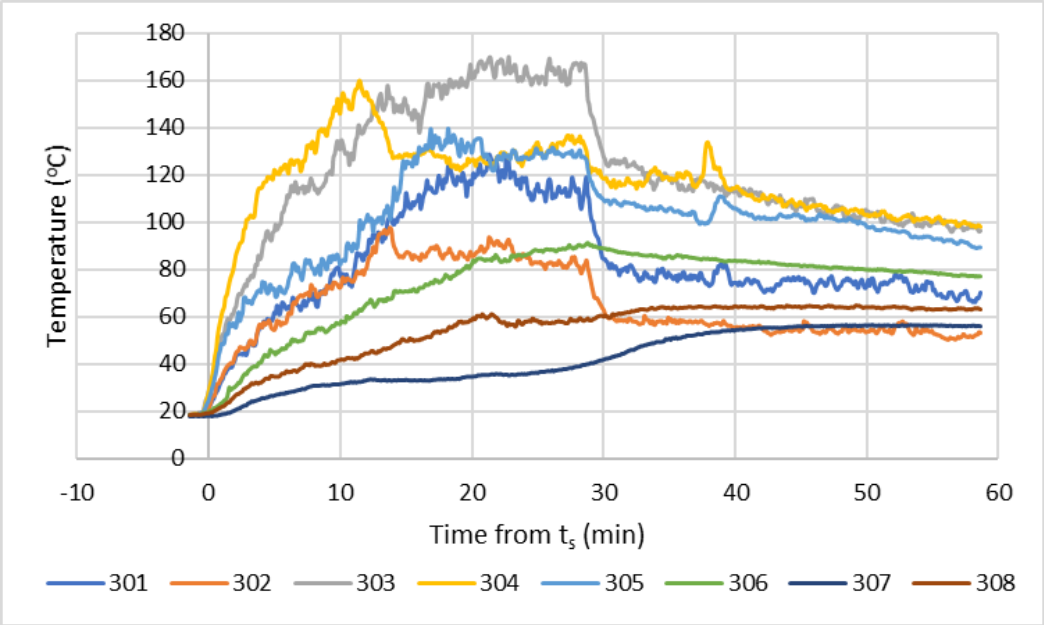

Figure 3.4. Level 2- Air cavity internal temperatures history recorded during the test

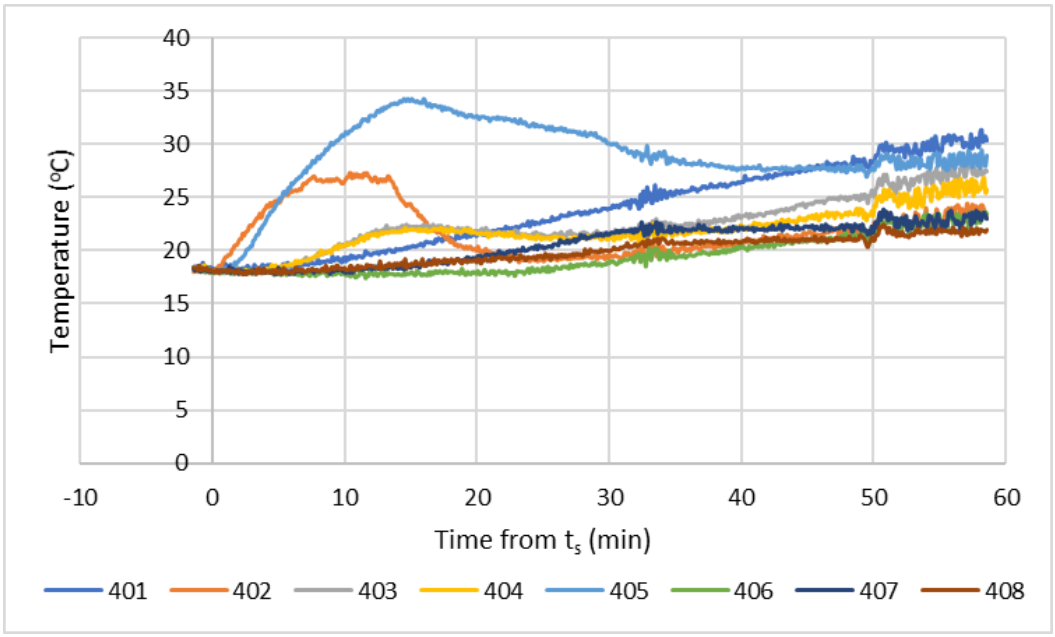

Figure 3.5. Level 2- Insulation layer internal temperatures history recorded during the test

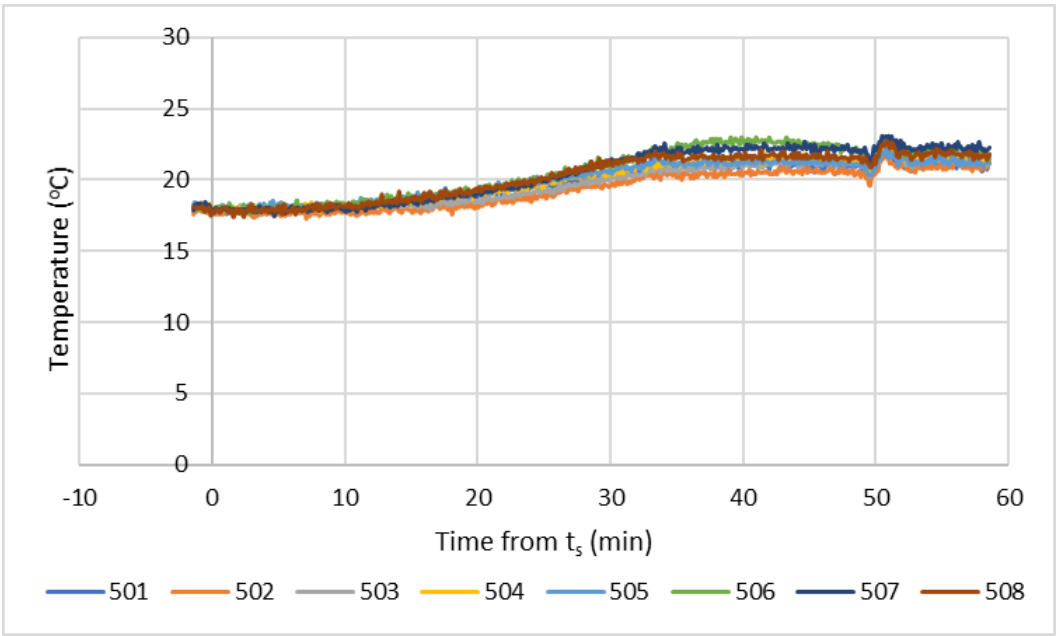

Figure 3.6. Level 2- Sheathing board layer internal temperatures history recorded during the test

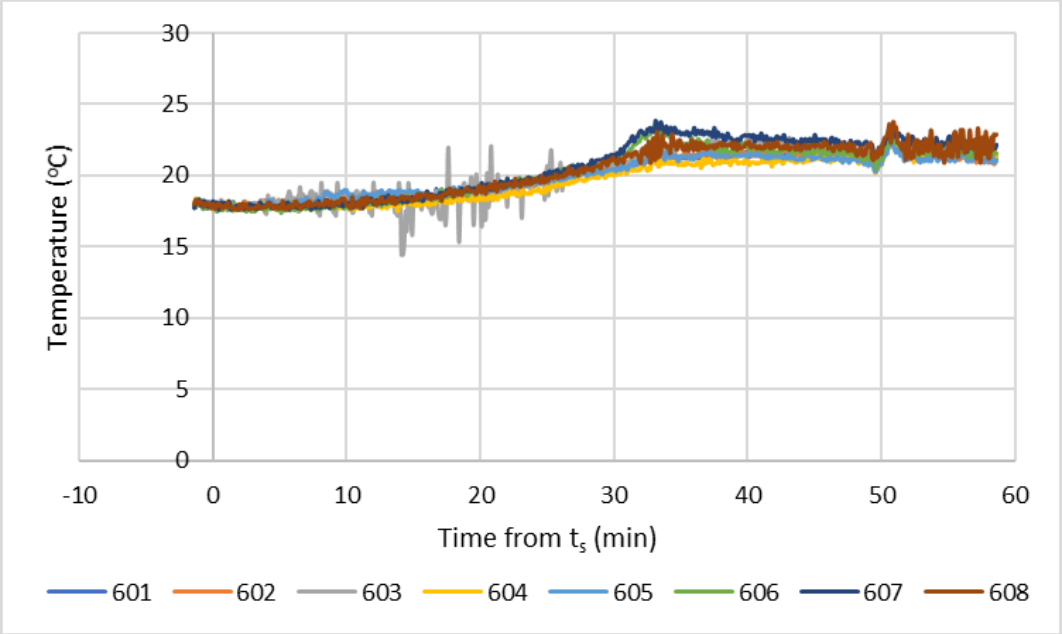

Figure 3.7. Level 2- SFS metal frame internal temperatures history recorded during the test

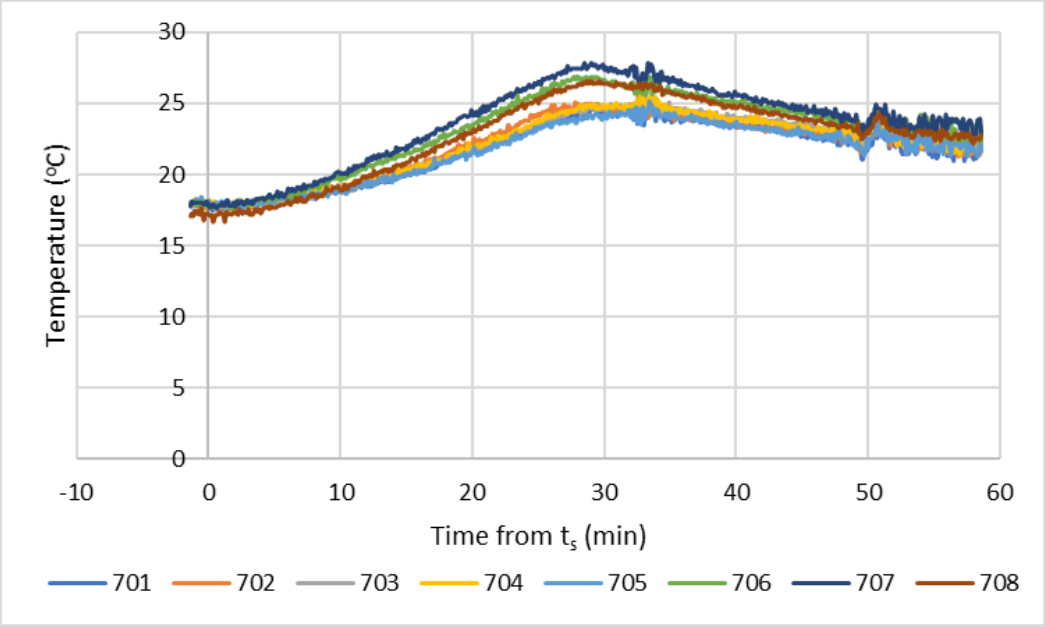

Figure 3.8. Level 2- Plasterboard layer internal temperatures history recorded during the test

APPENDIX 4 – PHOTOGRAPHS

Figure 4.1. Wood crib used on the tested façade – dimensions of the opening are shown.

Figure 4.2. Installation of concrete lintel in front of combustion chamber's lintel on the main face during construction.

Figure 4.3. Insulation of SFS Kingframe and sheathing board layer during construction.

Figure 4.4. View after completing sheathing board layer mounting during construction. Start of waterproof membrane installation.

Figure 4.5. Installation of waterproof membrane completed during construction. Aluminum pod-frame also shown. Start of insulation and vertical fire stop barriers installation.

Figure 4.6. Close view of insulation and vertical fire stop barrier installation.

Figure 4.7. Installation of stone cladding panels during construction.

Figure 4.8. Cladding system before test.

Figure 4.9. Cladding system before test. Wing face.

Figure 4.10. Front view of the finished main face of the system just before the test.

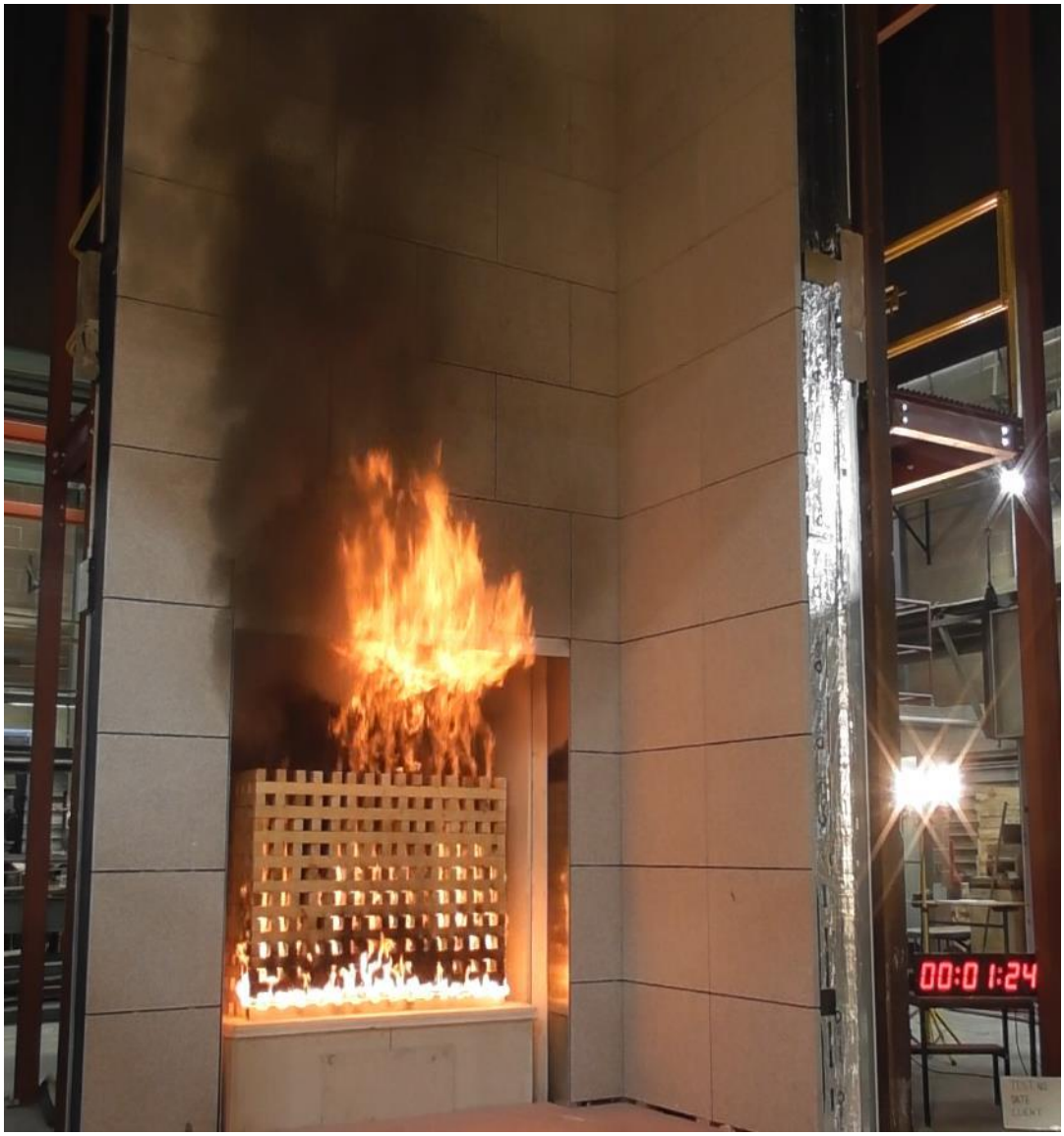

Figure 4.11. Cladding system during the fire test at start time t_s (01 min 24 sec after ignition of crib).

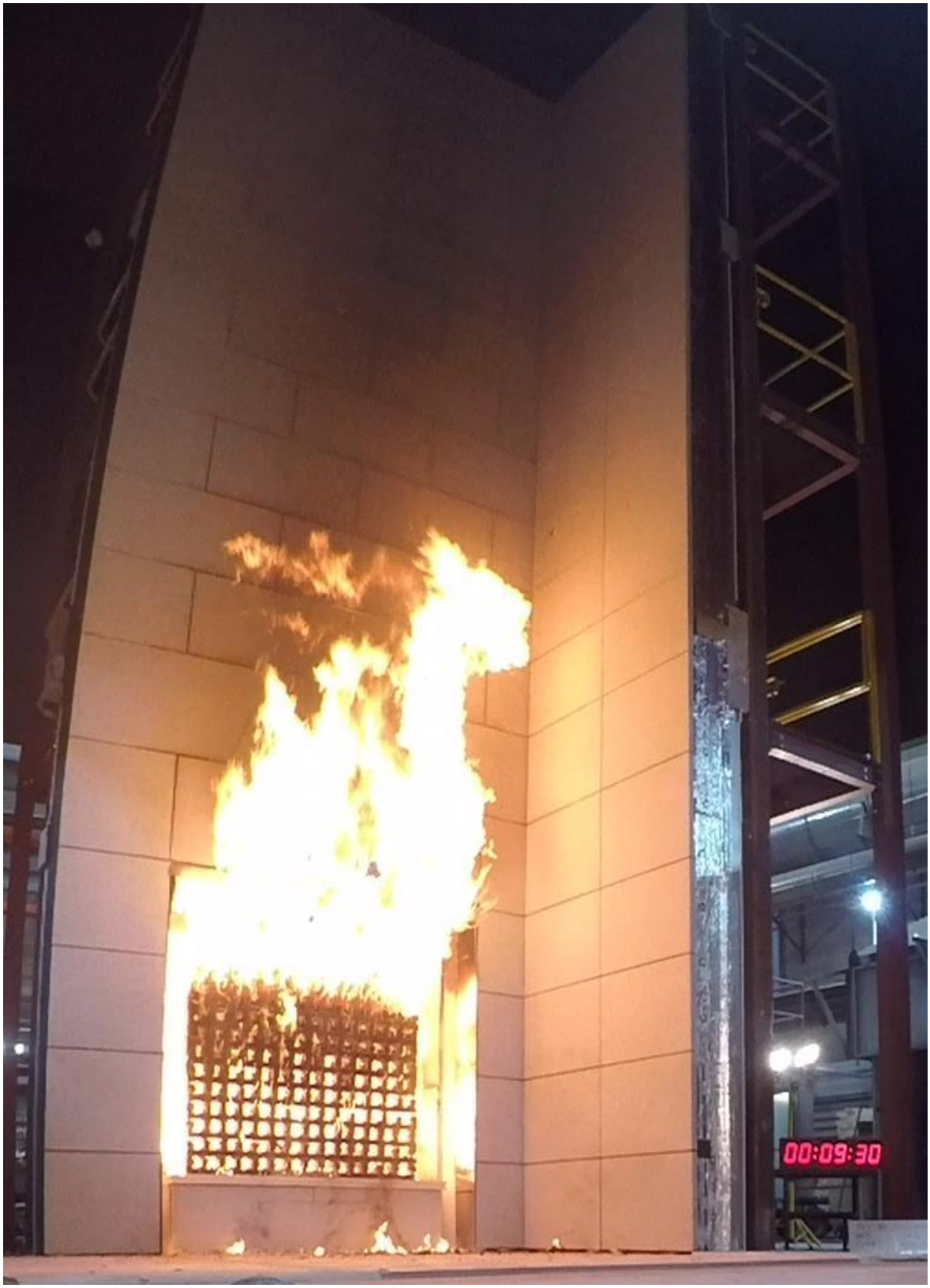

Figure 4.12. Cladding system during fire test (09 min 30 sec after ignition of the crib).

Figure 4.13. Cladding system after fire extinguishment (34 min 50 sec after ignition of the crib).

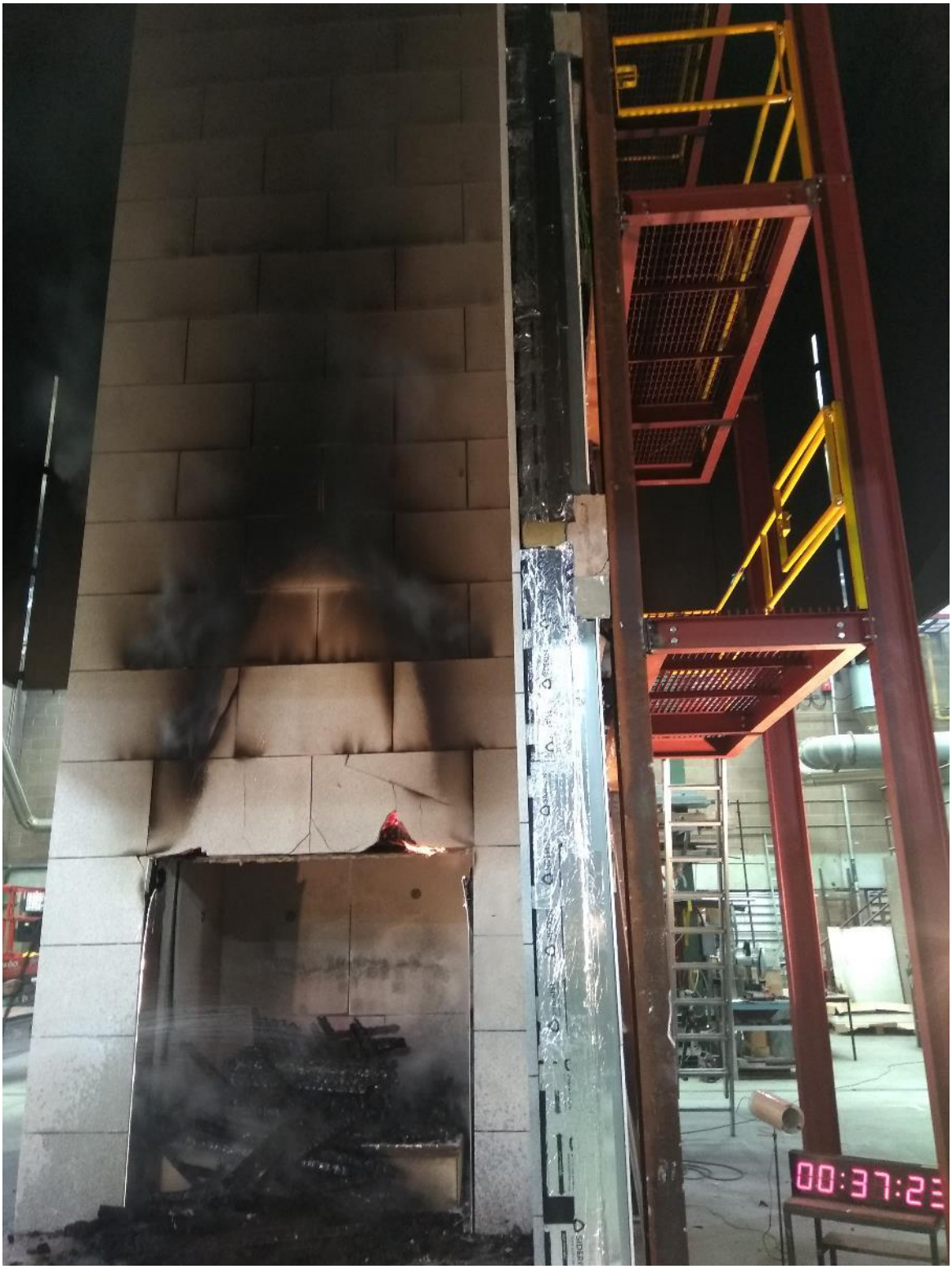

Figure 4.14. Cladding system after fire extinguishment (37 min 23 sec after ignition of the crib).

Figure 4.15. Cladding system just after the fire test (60 min 01 sec after ignition of the crib).

Figure 4.16. Post-examination damage. Insulation mainly charred and burnt above the combustion chamber on the main face; intact on the wing face. Vertical fire stop barriers in-place with some damage on the one located right of the chamber.

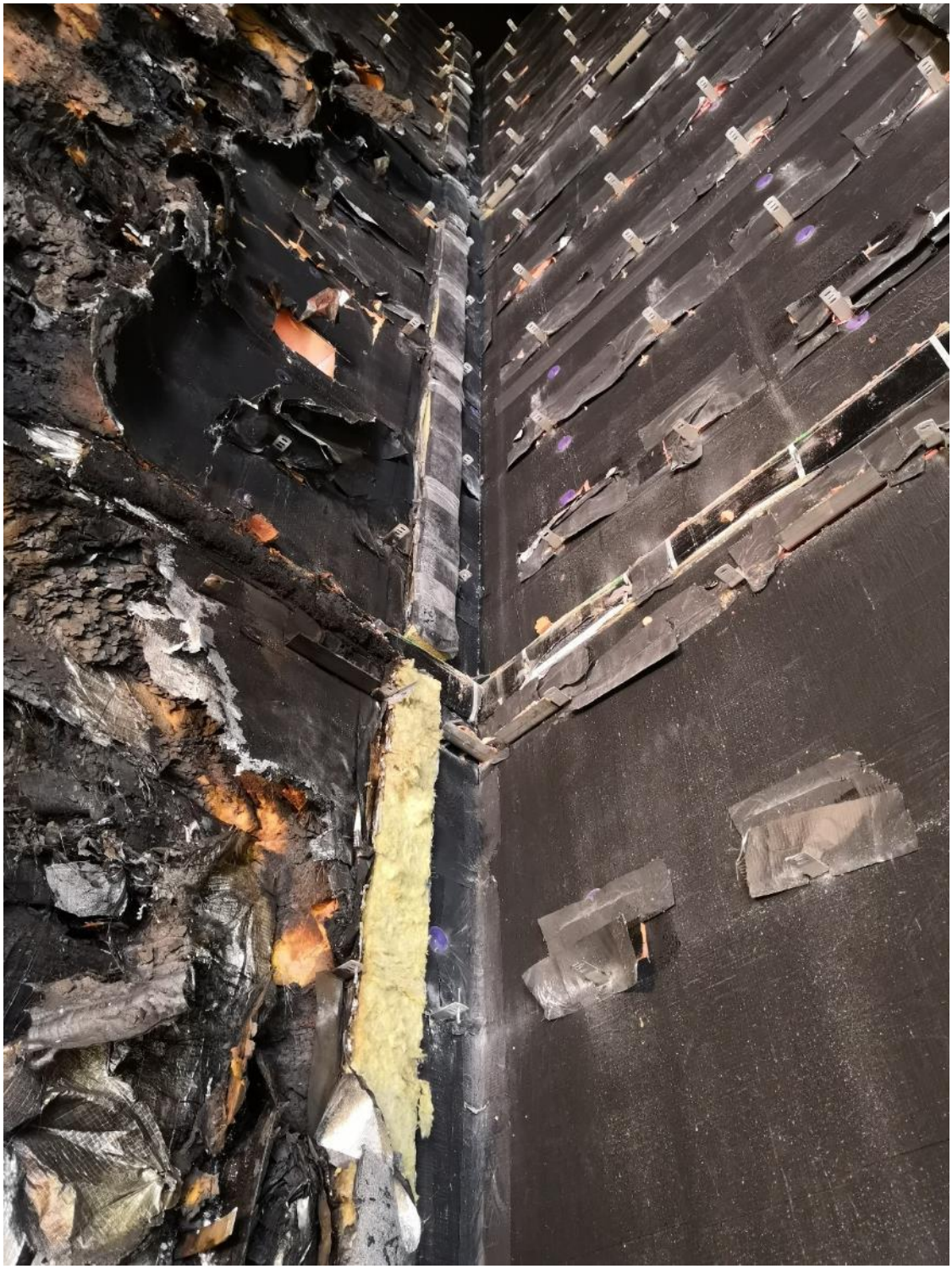

Figure 4.17. Post-examination damage. Vertical fire stop barrier located on the corner of the system. Damage observed up to first horizontal fire stop barrier; rest in place without any damage.

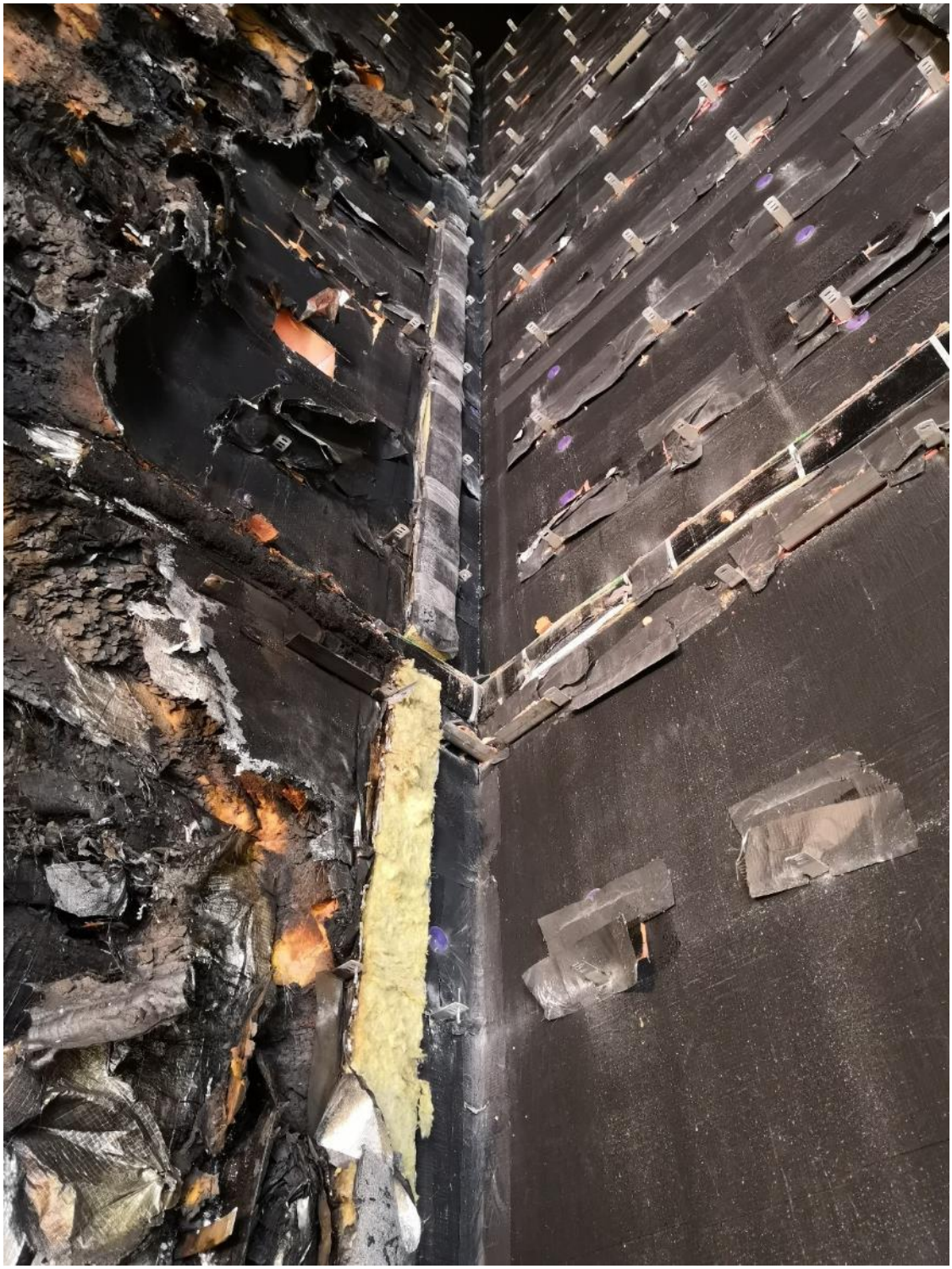

Figure 4.18. Post-examination damage. Vertical fire stop barrier located on the corner of the system. Damage observed up to first horizontal fire stop barrier; rest in place without any damage.

Figure 4.19. Post-examination damage. Vertical fire stop barrier located on the left-hand side edge of the system's main face. No damage observed; in-place and intact.

Figure 4.20. Post-examination damage. Photo of the bottom horizontal fire barrier installed on the main face. Fully activated and partially detached (especially above the chamber).

Figure 4.21. Post-examination damage. Photo of the bottom horizontal fire barrier installed on the wing face. In-place and without been activated.

Figure 4.22. Post-examination damage. Photo of the middle horizontal fire barrier installed on both faces. Partially activated on the main face but in-place; not activated or detached on the wing face.

Figure 4.23. Post-examination damage. Photo of one bracket located just above the combustion chamber. No damage except discoloration observed.

Figure 4.24. Post-examination damage. Waterproof membrane intact and in place after removing insulation layer from system.

Figure 4.25. Post-examination damage. Photo of the system showing the plasterboard layer and SFS Kingframe after the test.

END OF TEST REPORT