SYSTEM BRIEF DETAIL

Report detailing the testing and classification of a precast concrete panel and mineral wool insulation external cladding system tested in accordance with the requirement as described in British Standard 8414

Fire Protection Association

CUSTOMER TEST REPORT

10536

BS 8414-2:2020 Test Report with Classification in Accordance with BR135

Prepared by:
The Fire Protection Association
London Road
Moreton-in-Marsh
Gloucestershire
GL56 0RH

Prepared for:
MPA Precast
The Old Rectory,
Main Street,
Glenfeild,
LE3 8DG

Report Date(s):	14/02/2022	Test Sponsor Reference:	Precast Concrete Façade
Report Reference:	103138.002	Version number:	1.2

This report, and the underlying work on which it is based, has been prepared and is submitted in accordance with the contract with the client and is intended solely for use by the client.

FPA warrants that the report has been prepared with all reasonable skill and care. FPA will accept liability for deficiencies in any report caused by its breach of contract or negligence. Negligence shall be as defined as in Section 1(1) of the Unfair Contract Terms Act 1977. Except in the case of death or personal injury arising from the negligence of FPA, liability of FPA for breach of contract or negligence or otherwise in relation to the preparation of the report shall in no case exceed the fee paid by the Client for the report. FPA shall in no circumstances be liable for any other loss, charges, damages, indirect or consequential loss (including loss of profit) or expenses of any kind. The Client acknowledges that all possible circumstances in which the report may have some relevance cannot be foreseen at the time the report is prepared. The Client also acknowledges that FPA would not be able to provide the Report for the agreed fee if FPA were obliged to accept all far-reaching responsibilities.

The scope of any report produced by FPA shall be limited to matters specifically identified in the Proposal or indicated in the report. Except where FPA has otherwise agreed in writing, FPA shall not be liable for any reliance placed on a report by any person other than the Client or for any reliance placed on a report which is not specified in or envisaged by the Proposal. FPA shall not be liable for any loss caused by a report where such loss arises as a result of the provision to FPA of false, misleading or incomplete information by the Client or as a result of the act or omissions of any other person.

Any report shall only be valid and may only be relied upon for the period stated in the report. FPA accepts no responsibility for the accuracy of information contained in the report after the stated period of validity. Where so indicated by FPA any report is to be regarded as expressing the opinion only of FPA and is not to be relied upon as being factually correct.

Fire Protection Association

UKAS TESTING
10536

Review

Approval	Name	Date
Author	George Edwardes	30/11/2021
Author's signature		
Reviewed and authorised by	Dr Jim Glockling	16/12/2021
Reviewer/authoriser's signature		

Distribution

Name	Company
Matthew Butcher	MPA Precast

Document version history

Version	Date	Superseded documents/description/details
1.0	30/11/2021	Initial Release
1.1	16/12/2021	Update and further clarification
1.2	14/02/2022	Update and inclusion of build up images

Disclaimer

This report has been produced by the Fire Protection Association for the British Precast Concrete Federation Ltd.

- *This report may only be distributed in its entirety, without amendment.*
- *Results presented relate only to the specimens tested.*
- *FPA takes no responsibility for the design, materials, workmanship or performance of the product tested.*
- *The report does not constitute an approval, certification or endorsement of the products tested.*
- *Any references made to this work must be accompanied by provision of the full, unabridged, report.*
- *The report does not imply that FPA believe the BS8414 test regime alone is appropriate for the guarantee of end-use system performance.*

Contents

1 Introduction

The test method, BS 8414-2:2020 describes a method of assessing the behaviour of non-load bearing external cladding systems, rain screen over cladding systems and external wall insulation systems when applied to the face of the building and exposed to an external fire under exposed conditions. The fire exposure is claimed to be 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.

This report applies to the cladding system as detailed. The report only covers the details as tested.

The test method does not cover the performance of glazed window openings or the detailing at such openings. It does not apply to curtain walling systems or systems that include glass panels.

Performance Criteria and Classification methodology of the external fire performance covered by this test can be found in report *BR 135: Fire performance of external thermal insulation for walls of multi -storey buildings*

Unless explicitly stated otherwise, the system drawings, material specification and included material data sheets have been provided by the test sponsor. All other information listed in the report, including test data and photographs of the installation and demolition of the test specimen have been provided by the test house.

2 Details of the test carried out

Name of Test House: Fire Protection Association Ltd

Test House Address: London Road
Moreton-in-Marsh
Gloucestershire
GL56 0RH

Test reference: 103138.001

Date of Test: 19/08/2021

Test Sponsor: MPA Precast
The Old Rectory
Main Street
Glenfield
LE3 8DG

Construction of Test Specimen Carried Out By: Decomo UK Ltd
137 Euston Road
London
NW1 2AA

Method: Tested in accordance with BS 8414-2:2020

Deviations: None

FPA Commentary:

1. Because the concrete cladding panels are not a named commercial product, application of this report is only valid for panels of the same composition and reinforcement method (as outlined in Section 4.1), and securing / supporting system as described in Appendix D, used in association with other named products in the same exact geometrical configuration.

3 Details of test apparatus used (BS 8414-2:2020)

The apparatus is defined in the Test Standard [1] and consists of a steel frame structure that forms a vertical main test wall and a vertical return wall at a 90º angle at one end of the main test wall as shown in Figure 1. The main wall includes the combustion chamber.

Aside from apparatus described above, and the applied fuel, all additional items used to form the built up 'system' are considered part of the cladding system under test.

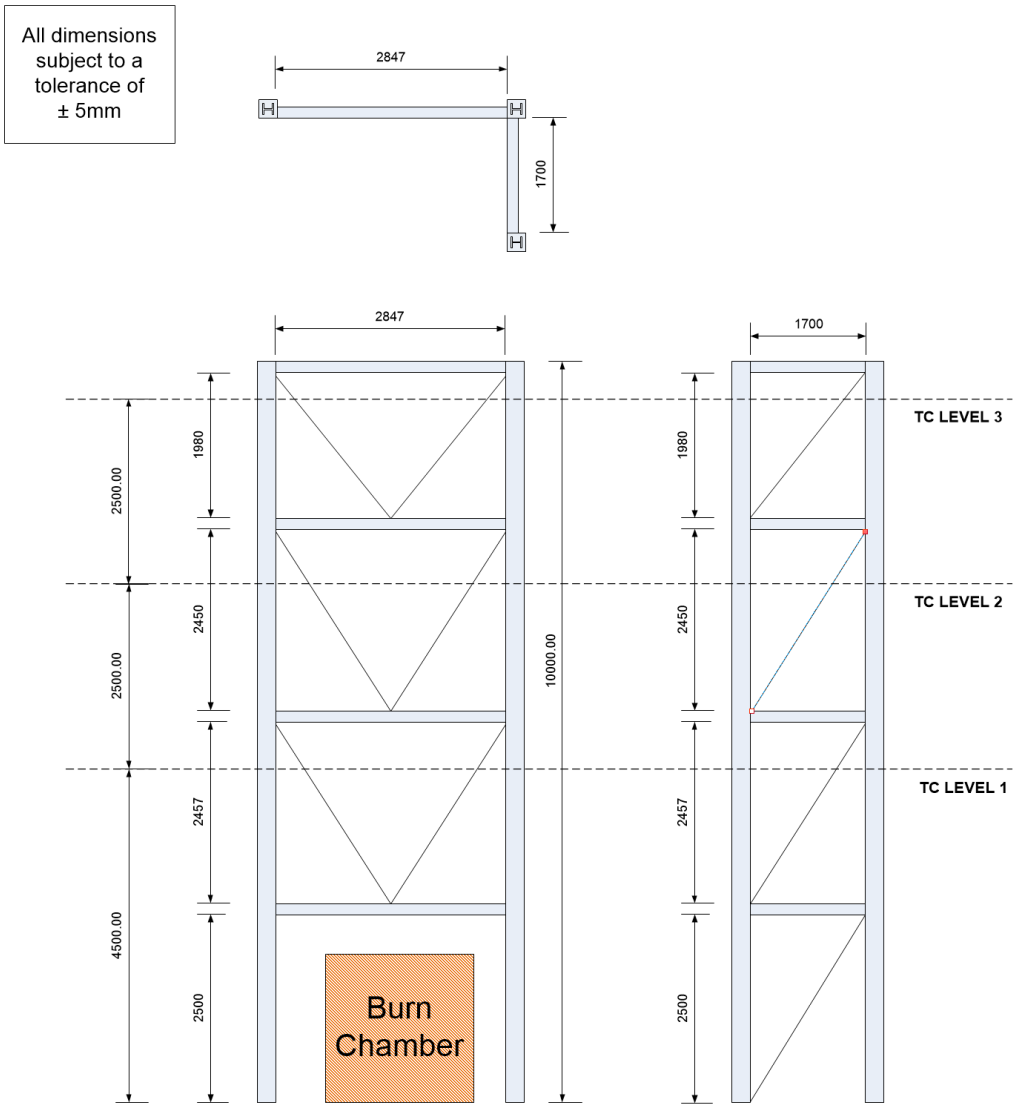


Figure 1 - Test apparatus dimensions [As specified by test Standard Figure B.1]

4 Description of the system under test

Aside from apparatus described in Section 3, and the applied fuel, all additional items used to form the built-up 'system' are considered part of the cladding system under test with the potential to impact upon its overall performance. These include, but might not be limited to:

- Panels
- Insulation
- Cavity barriers and their rating
- Bracketry
- All fixtures and fittings
- Window / aperture material specification
- Vapour and breather membranes

Similarly, many assumed design factors pertinent to the installation might also contribute to overall performance such as:

- The building substrate – masonry, timber frame, steel etc.
- Method of panel attachment – i.e. riveted or hung
- Form of panel – flat or folded
- Insulation thickness / rating
- Void size behind panel
- Panel spacing
- Distance between cavity barriers
- Cavity barrier locations
- Type of cavity barrier used
- Assumed window detailing – recessed or flush

Some elements of a cladding system are not by default tested through this test regime which again have the potential to be important to overall performance such as:

- Provision of breaches within the system, such as vents
- Provision of vapour and breather membranes

Expert consideration of all assumed test design factors will need to be made when using the test data to confirm end-use suitability where deviation in the material specification or design detailing from the as-tested design may exist.

4.1 Description of product

All information supplied by the customer. The system drawings (see Appendix D – System Drawings) imply it was a precast concrete façade covering a mineral wool insulation manufactured by Rockwool.

4.1.1 Cavity Barriers

- Siderise CW-FS 120

4.1.2 Insulation

- 150mm thick RW3 Rockwool – Foil face mineral wool insulation - VCL. A1 classified (to BS EN 13501-1)

4.1.3 Panel

- 150mm thick Min C32/40 wet cast concrete panels, traditionally reinforced to EC2 design and manufactured to BS8297

4.1.4 Fixings

- Vertical load from the panels applied into the structure using a combination of independent support and stacked to ground. Both being restrained back to structure to resist lateral loads.
- All fixings back to primary structure being of carbon steel or stainless steel, to EC3 design

4.1.5 Sealants

- Externally wet applied double mastic seal, for air and water tightness purposes, between panel to panel joints.

4.2 Test Specimen

4.2.1 Installation of specimen

The design, installation, procurement and specification of the materials of the cladding system were undertaken by the test sponsor. It was the responsibility of the test sponsor or any nominated sub-contractor(s) to ensure that all components were installed as per the manufacturer's guidelines.

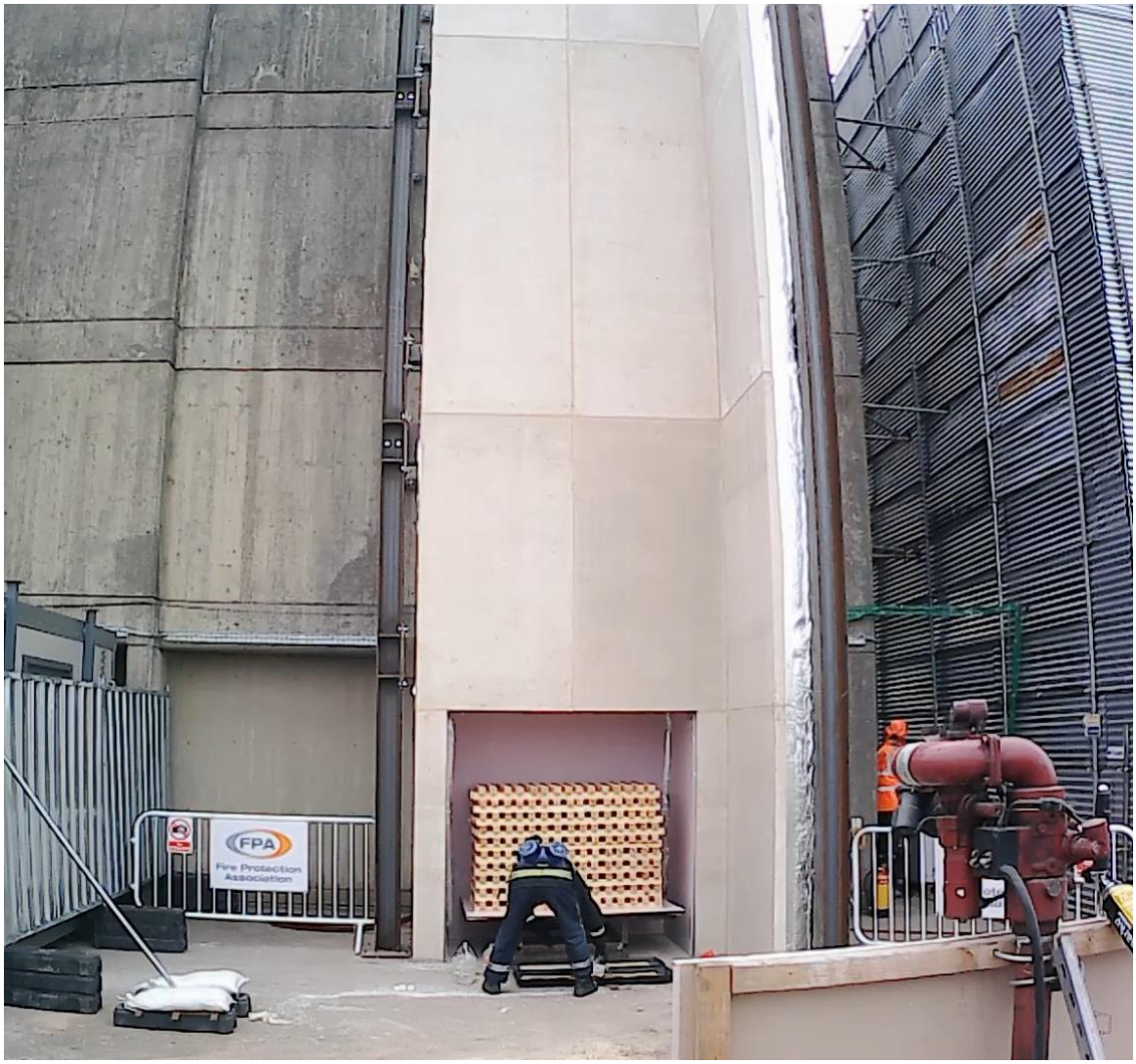


Figure 2 – Completed test specimen prior to test start

4.2.2 System installation

Installation details		
Date of assembly and installation of test specimen	Installation Started:	28th July 2021
	Installation Completed:	17th August 2021
Curing time allowed	Precast concrete panels were cured offsite prior to installation	
Method of assembly and installation of test specimen	Mechanically assembled onsite	
Relationship between test sponsor and installation team	Work was carried out by Decomo UK Ltd, who are members of the British Precast Concrete Federation	
Details of pre-test conditioning of test specimen	Stored undercover in the temperature range -5ºC to +40	

4.2.3 Measurements of system installed

Wall component	Requirement for BS8414-2:2020	Actual measurement
Height of test specimen	≥ 9700mm	10118mm
Width of main wall	≥ 2600mm	2508mm
Width of return wall	≥ 1500mm	1339mm
Combustion chamber opening height	2000mm ±100mm	2018mm
Combustion chamber opening width	2000mm ±100mm	2007mm
Jamb of combustion chamber to the front face of return wall	260mm ±100mm	260mm

4.3 Test conditions

Test date:	19/08/2021
Ambient temperature:	19.1˚C
Wind speed:	0.7 m/s
Frequency of measurement:	All temperature measurements recorded at 0.2 Hz
Fuel load:	300m softwood pinus silvestris 50mm x 50mm sticks arranged in a stacked crib
Ignition package:	16 strips of low density fibreboard, 25mm x 12mm x 1000mm. Uniformly soaked in 5 litres of white sprit.
Fuel load density: *(average of 4 randomly selected crib sticks)*	551 kg/m^3
Fuel load moisture content: *(average of 10 randomly selected crib sticks)*	14.2%

5 Test results

5.1 Fire spread and start time

Test results for the evaluation of fire spread and start time are detailed in the tables below. Temperature profiles recorded during the test are shown in Figure 3 to Figure 4.

Table 1 – Start temperature and start time

Parameter	Result
T_s, Start temperature – the mean temperature of the thermocouples at level 1 during the 5 minutes before ignition	19.1 ˚C
t_s, Start time – the time when the temperature of any external thermocouple at level 1 equals or exceeds a 200 ˚C temperature rise above T_s, and remains above this value for at least 30 seconds	90 seconds after ignition of the crib

Table 2 – Peak temperatures measured by level 2 thermocouples within 15 minutes of start time (t_s)

External fire spread								
Level 2, external thermocouples								
Thermocouple ID	9a	10a	11a	12a	13a	14a	15a	16a
Peak temperature (˚C)	199.5	281.0	319.9	285.7	292.4	324.0	281.9	205.6
Internal fire spread								
Level 2, thermocouples in façade								
Thermocouple ID	9b	10b	11b	12b	13b	14b	15b	16b
Peak temperature (˚C)	22.6	20.1	19.3	22.1	34.7	43.0	27.0	20.7
Level 2, thermocouples in cavity								
Thermocouple ID	9c	10c	11c	12c	13c	14c	15c	16c
Peak temperature (˚C)	17.2	17.4	18.0	18.0	18.5	20.9	20.3	19.9
Level 2, thermocouples in insulation								
Thermocouple ID	9d	10d	11d	12d	13d	14d	15d	16d
Peak temperature (˚C)	29.8	23.3	22.6	24.5	23.0	33.7	39.4	44.2

Table 3 – Peak temperatures measured by level 3 thermocouples within 15 minutes of start time (t_s)

External fire spread								
Level 3, external thermocouples								
Thermocouple ID	17a	18a	19a	20a	21a	22a	23a	24a
Peak temperature (˚C)	141.3	166.1	189.8	197.2	187.7	194.7	183.9	154.6
Internal fire spread								
Level 3, thermocouples in façade								
Thermocouple ID	17b	18b	19b	20b	21b	22b	23b	24b
Peak temperature (˚C)	21.3	20.3	18.3	20.1	19.1	19.8	19.0	20.5
Level 3, thermocouples in cavity								
Thermocouple ID	17c	18c	19c	20c	21c	22c	23c	24c
Peak temperature (˚C)	18.1	18.4	18.4	18.2	-	24.5	19.5	18.9
Level 3, thermocouples in insulation								
Thermocouple ID	17d	18d	19d	20d	21d	22d	23d	24d
Peak temperature (˚C)	24.0	24.4	25.4	21.6	20.0	38.6	40.4	49.7

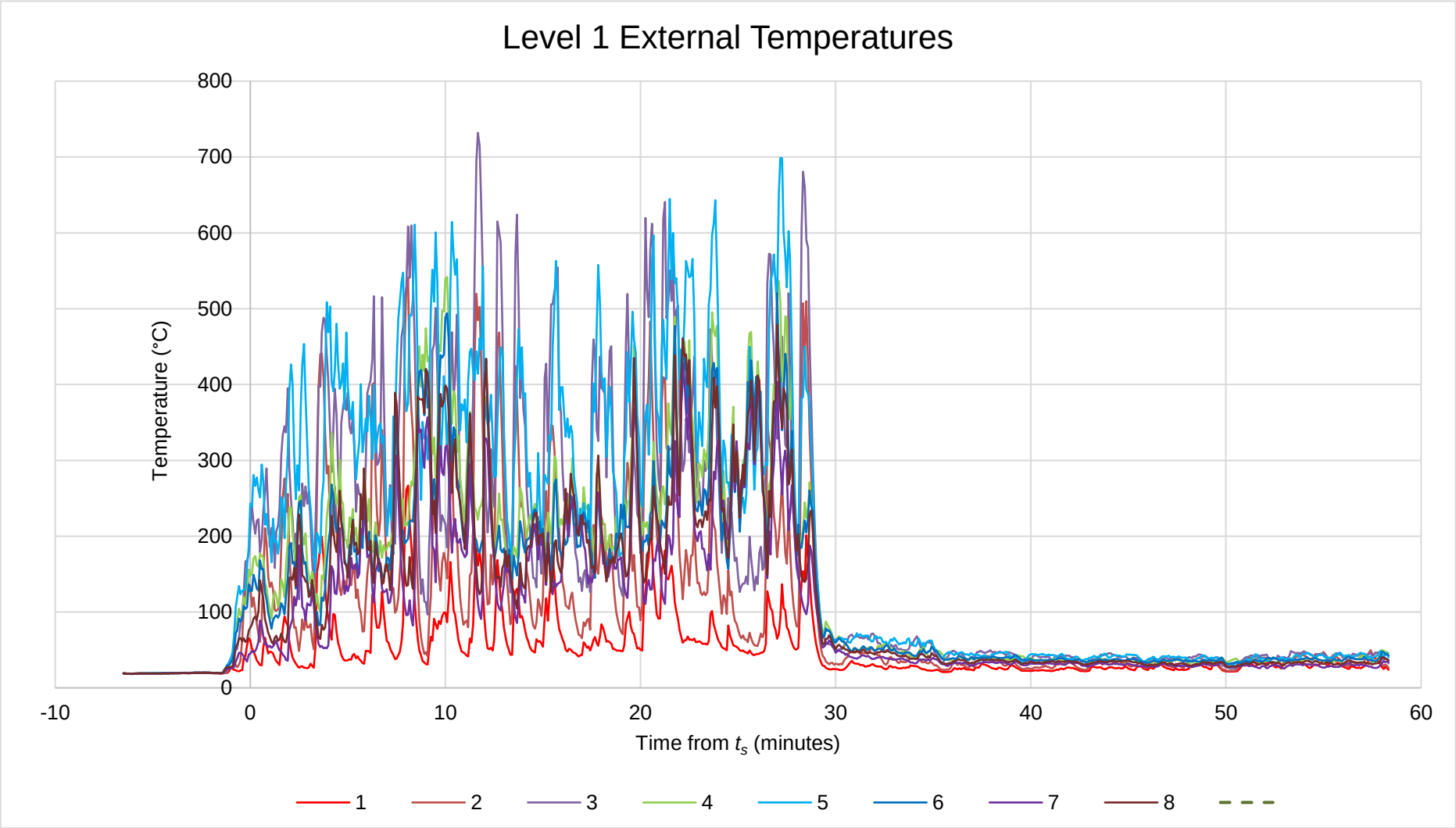


Figure 3 – External temperatures at level 1

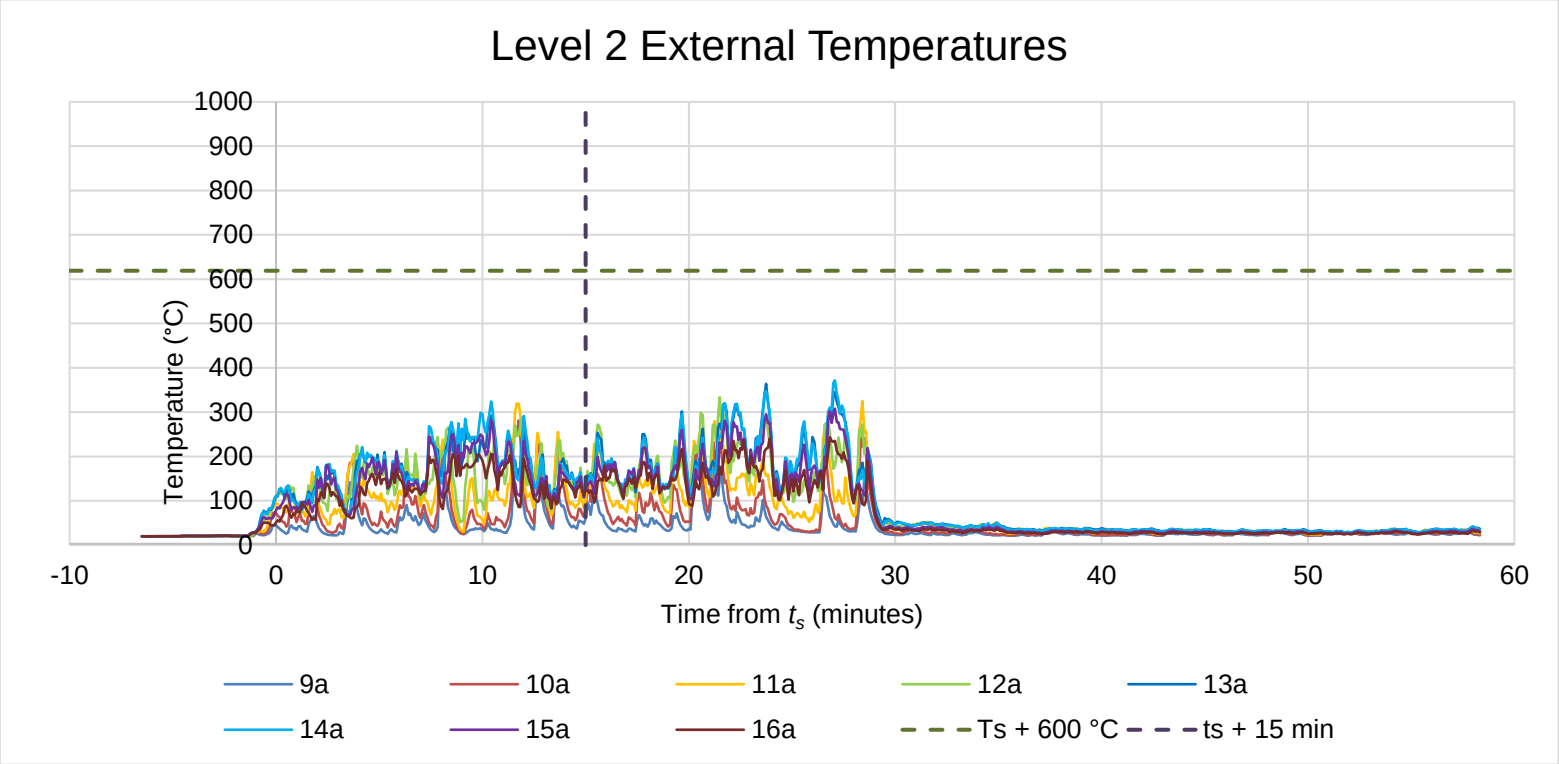


Figure 4 External temperatures at level 2

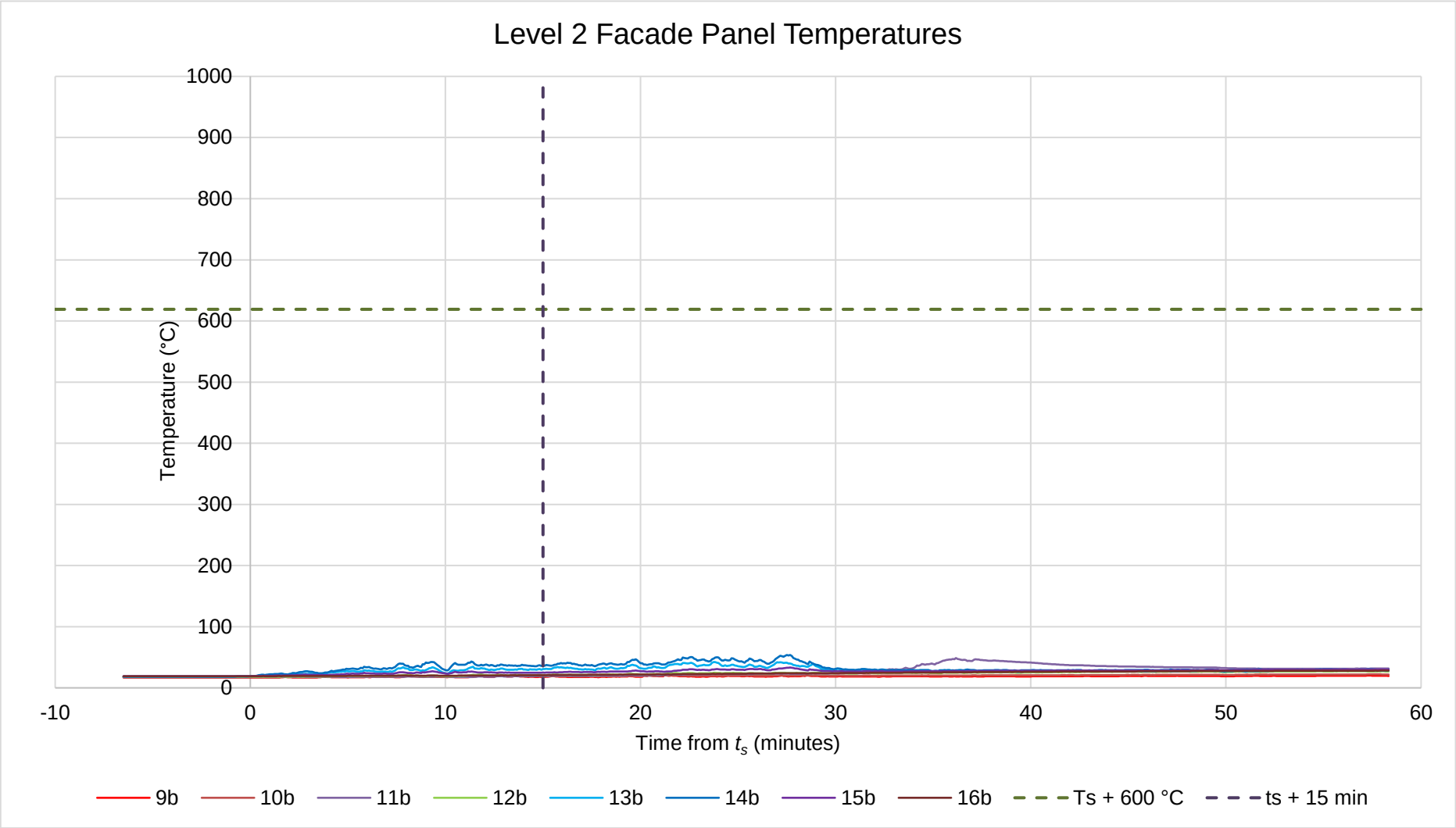


Figure 5 – Façade internal temperatures at level 2

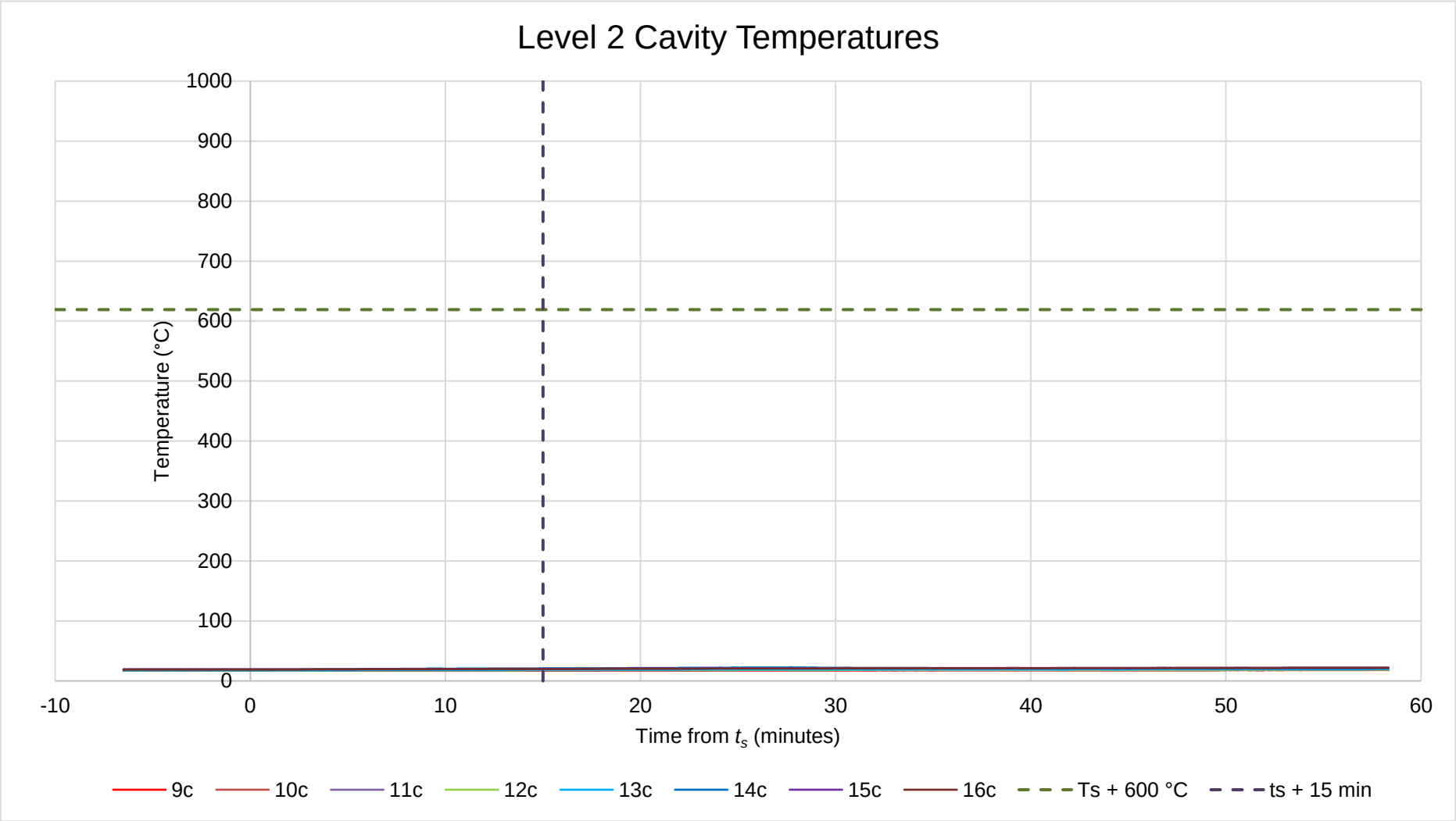


Figure 6 – Cavity internal temperatures at level 2

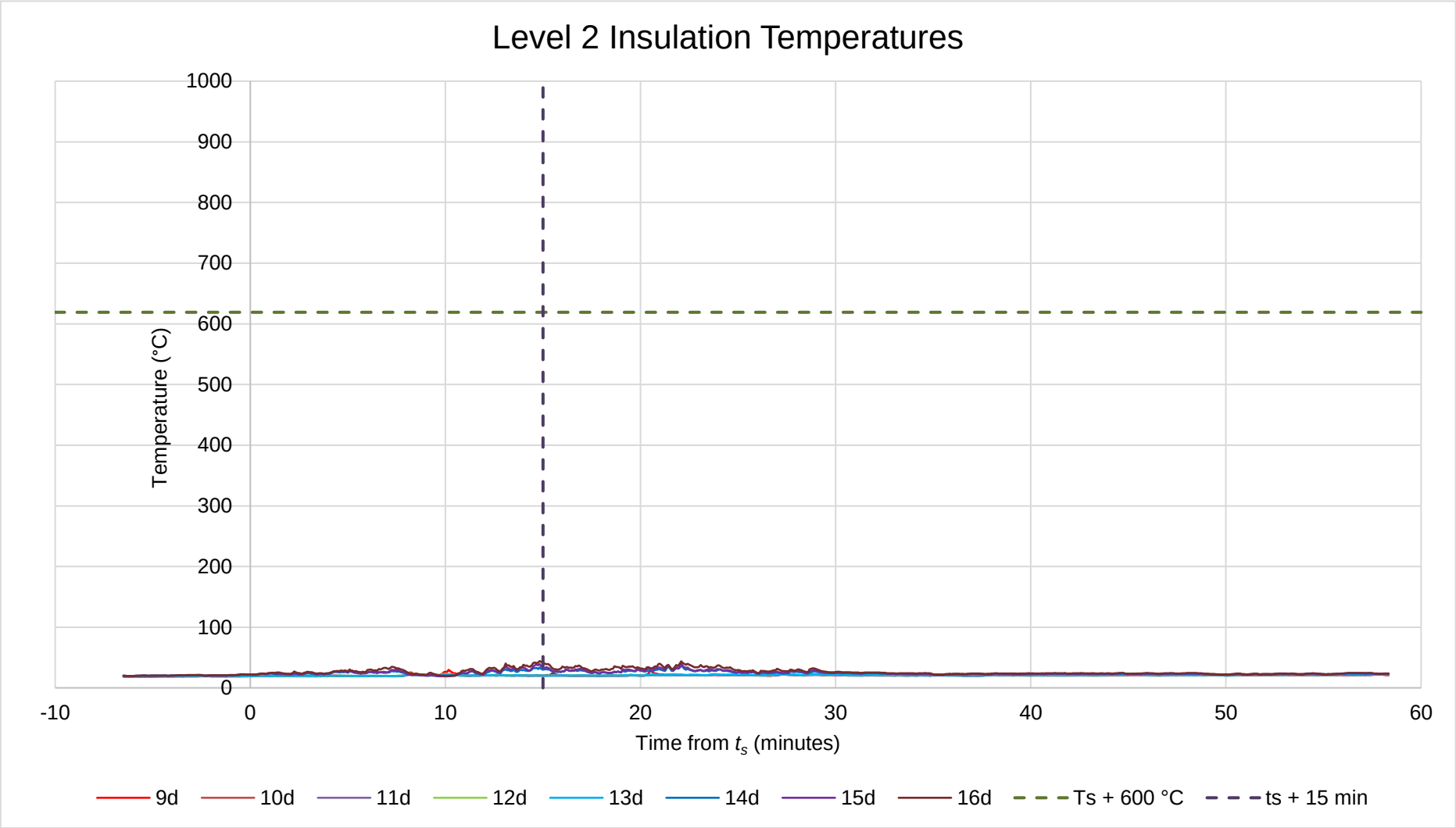


Figure 7 – Insulation internal temperatures at level 2

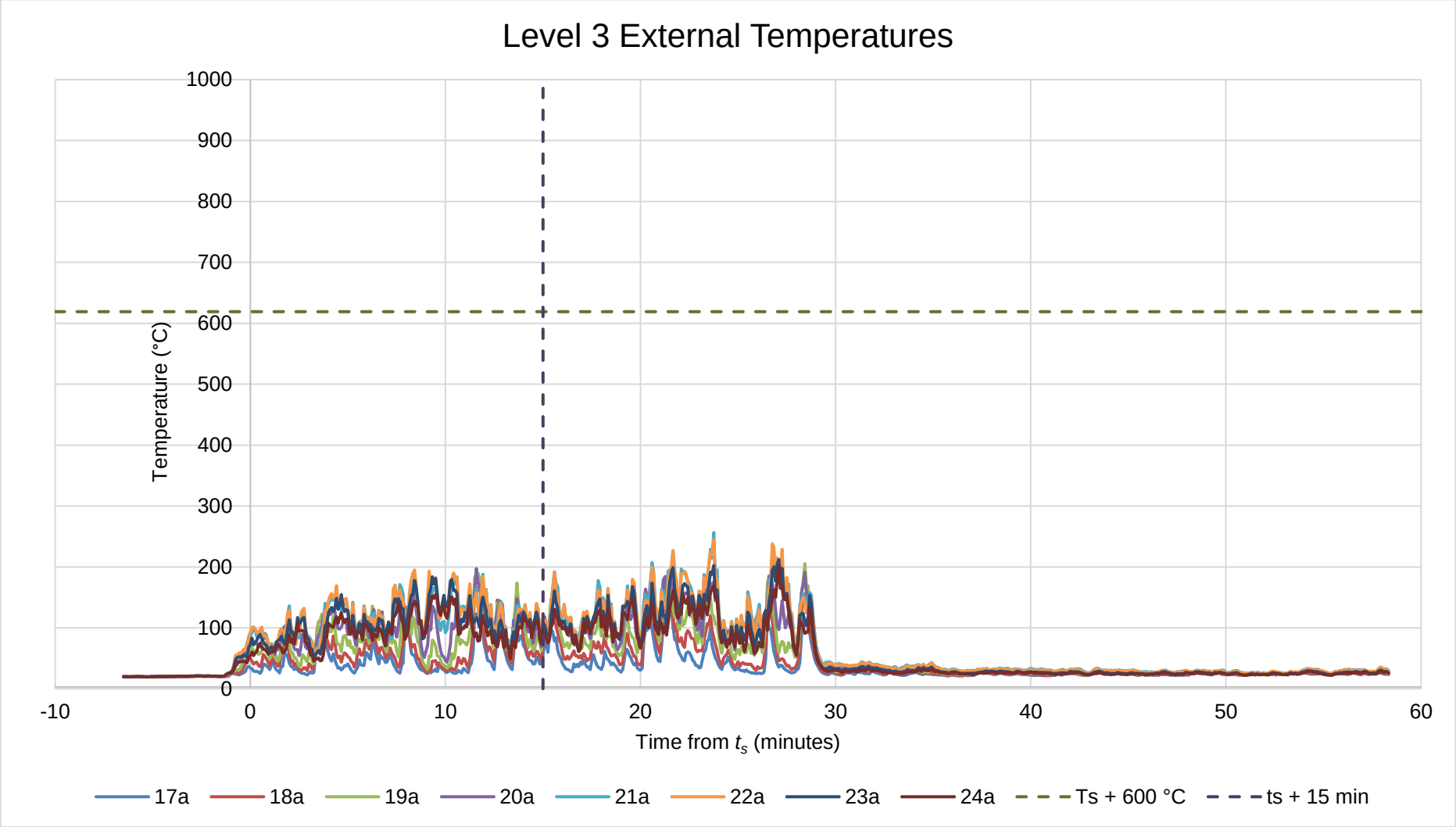


Figure 8 – External temperatures at level 3

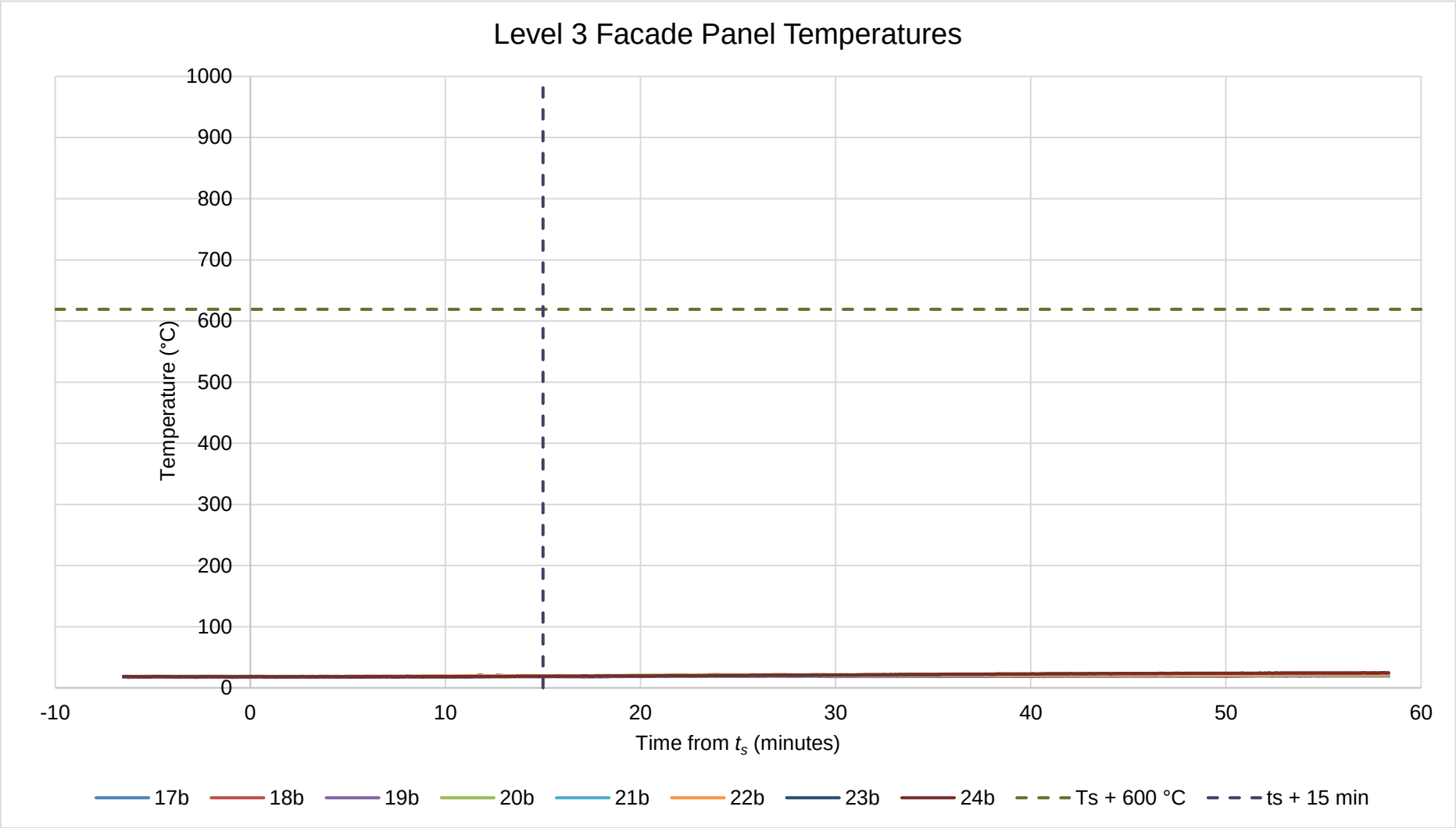


Figure 9 – Façade internal temperatures at level 3

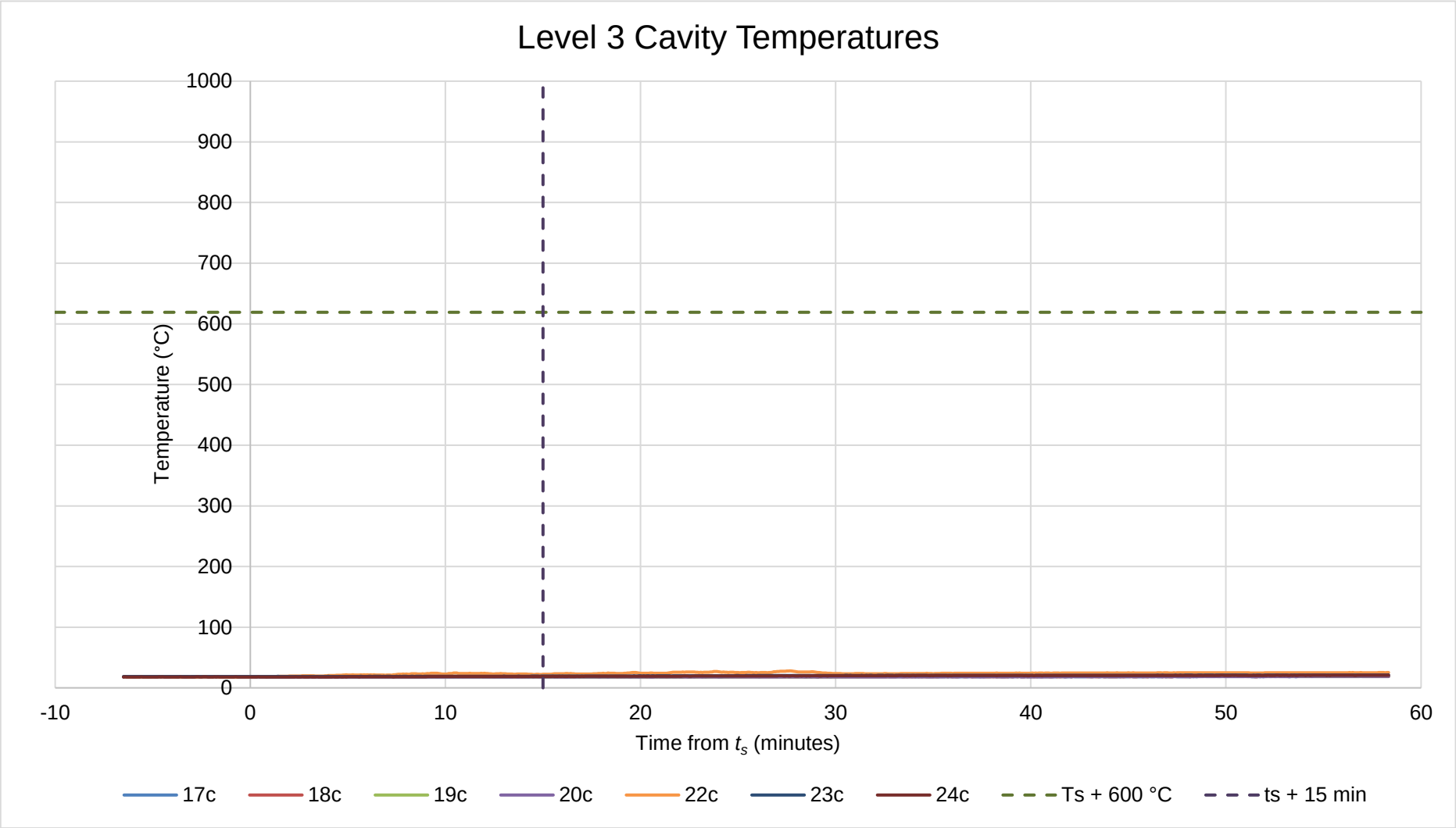


Figure 10 – Cavity internal temperatures at level 3

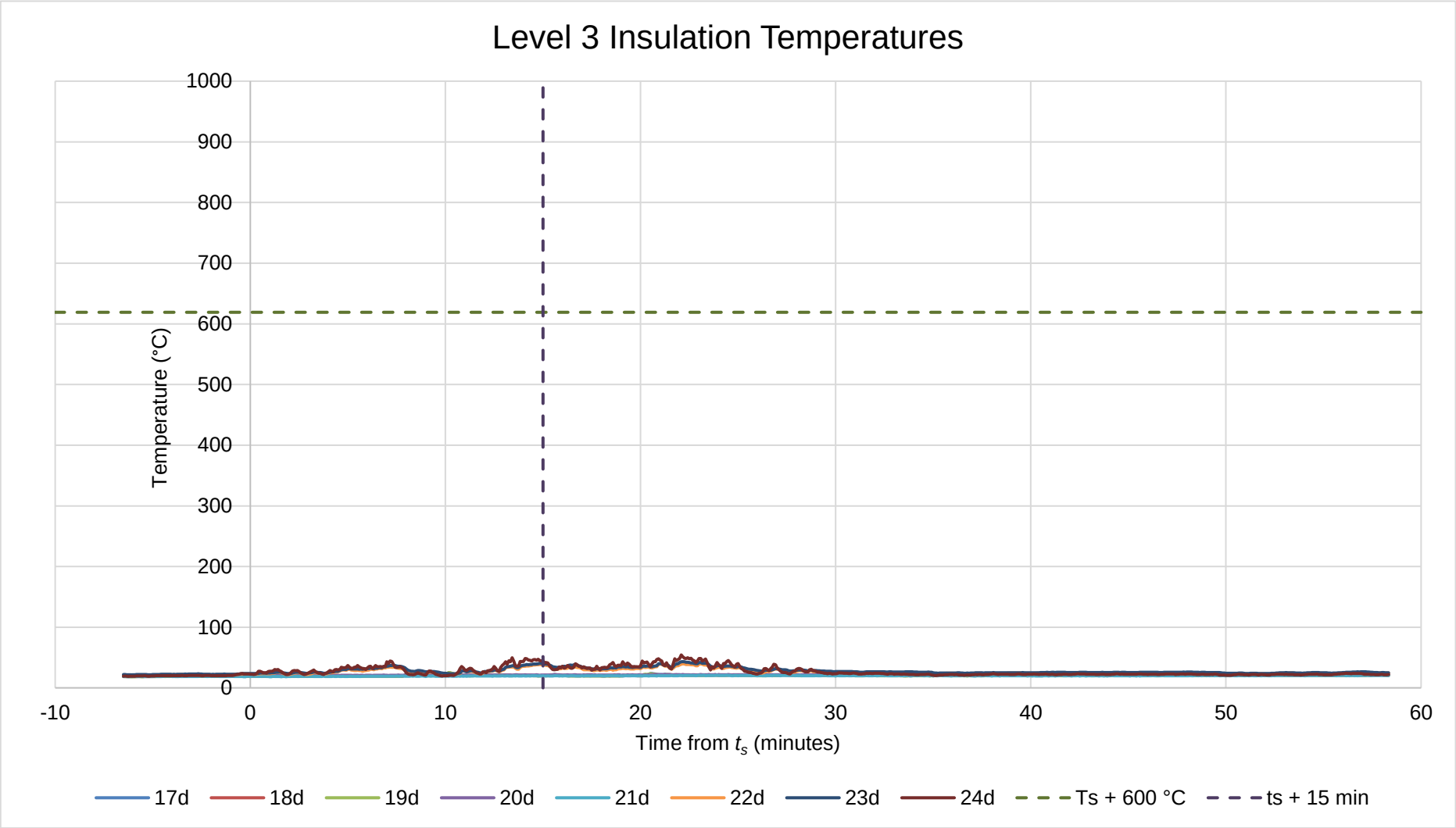


Figure 41 – Insulation internal temperatures at level 3

5.2 Visual observations

Visual observations from direct observation are detailed in the table below.
(Where direct observation was unsafe and to augment direct observations, visual observation of test video was also used).

For identification purposes, the façade panels were numbered as follows:

Figure 52 – Façade Panel Numbering

Table 4 – Key tests times and visual observations.

Time from ignition (mins:secs)	Description
-08:00	Datalogger and video recording started
-07:00	Stopwatch started
-07:00	Fibreboard sticks inserted into crib
00:00	Ignition of crib
02:15	Crib fully involved
02:40	Discolouration bottom of panels 8 & 9
05:15	Small chips appear in 8 (<5 cm2)
06:00	More small chips appear in 8 (<5 cm2)
06:40	Small chips appear in 8 (~5 cm2)
07:30	Constant sustained spalling
08:00	Large chip shower (panel 8)
09:19	>5cm2 spalling
11:05	More >5cm2 spalling
15:15	Flaming in centre joint between 7 & 8
16:40	No spalling for approximately 3 minutes
27:30	Wing wall joint between 9 & 12 flaming
30:00	Crib extinguished. No further flaming observed
60:00	Test Complete

5.3 Test Footage

The test was filmed using the FPA's SANCE CCTV system in the test chamber. The following images (Figure 6 to Figure) are screenshots taken directly from the footage recorded of the test.

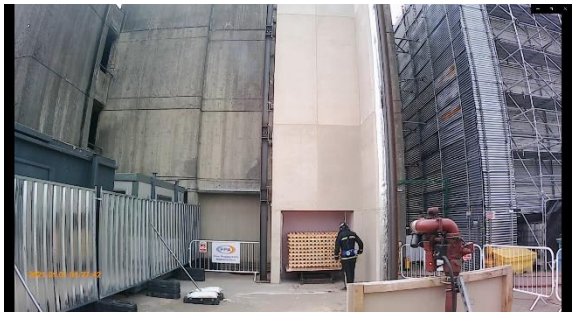


Figure 63 – 00:00

Figure 14 – 05:00

Figure 75 – 10:00

Figure 86 – 15:00

Figure 97 – 20:00

Figure 108 – 25:00

Figure 119 – 30:00

Figure 20– Test End

6 Classification

This section provides a classification of the system detailed in this report.

Classification is carried out in accordance with the procedures given in BR 135 – 'Fire performance of external thermal insulation for walls of multi-storey buildings', Third edition, 2013[a].

6.1 Performance Criteria

The performance criteria and classification method are based on the recommendations of BR135 (Colewell & Baker, 2013), which states that the primary concerns for performance criteria of these systems are the fire spread away from the initial fire source, and the rate of fire spread. The classification only applies to the system as tested.

For classification to be undertaken the system must be tested to the full test-duration requirements of BS 8414-2 (British Standards Insitute, 2017) without any early termination of the full fire-load exposure period. Early termination shall be conducted if:

a) Flame spread extends above the test apparatus at any time during the test duration (60 minutes after ignition of the fuel source); or

b) There is a risk to the safety of personnel or impending damage to equipment.

If fire spreads away from the initial fire source, the rate of fire spread or tendency to collapse should not unduly hinder intervention by the emergency services.

System performance is evaluated against the following criteria:

6.1.1 External fire spread: The temperature recorded at any external thermocouple at level 2 should not exceed Ts by more than 600˚C for a period of at least 30 seconds, within 15 minutes of start time ts.

6.1.2 Internal fire spread: The temperature recorded at any internal thermocouple at level 2 should not exceed T_s by more than 600˚C for a period of at least 30 seconds, within 15 minutes of start time t_s.

6.1.3 Mechanical performance: No failure criteria are set for mechanical performance. However, ongoing system combustion following extinguishing of the ignition source shall be included in the test classification reports, together with details of any system collapse, spalling, delamination, flaming debris or pool fires. The nature of the mechanical performance should be considered as part of the overall risk assessment when specifying the system.

[a] Annex A for BS8414-1 test or Annex B for BS 8414-2 test

6.2 Mechanical Performance

The system appeared to be structurally intact post-test with some spalling from the concrete façade. No further information on the mechanical performance is available.

6.3 System Performance

Table 5 – System performance

Test criteria	Requirement met/not met
System tested to full duration	Requirement Met
External fire spread	Requirement Met
Internal fire spread	Requirement Met

7 Disclaimers.

- The FPA is not responsible for the validity of results that rely on information supplied by the customer.
- The customer is responsible for providing the installed system for test (‘the sample’). Therefore, the results contained within this report apply to the sample as received.
- If any information displayed in the report is to be queried by a third party after the publication of the report, The Fire Protection Association will be available to assist where possible.

8 References

[1] British Standards Institute, “BS 8414-2:2020, Fire performance or 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, London, 2020.

[2] S. Colewell and T. Baker, “BR135 Fire performance of external thermal insulation for walls of multistorey buildings, Third Edition,” IHS BRE Press, Watford, 2013.

9 Appendix A – Location of thermocouples on test wall

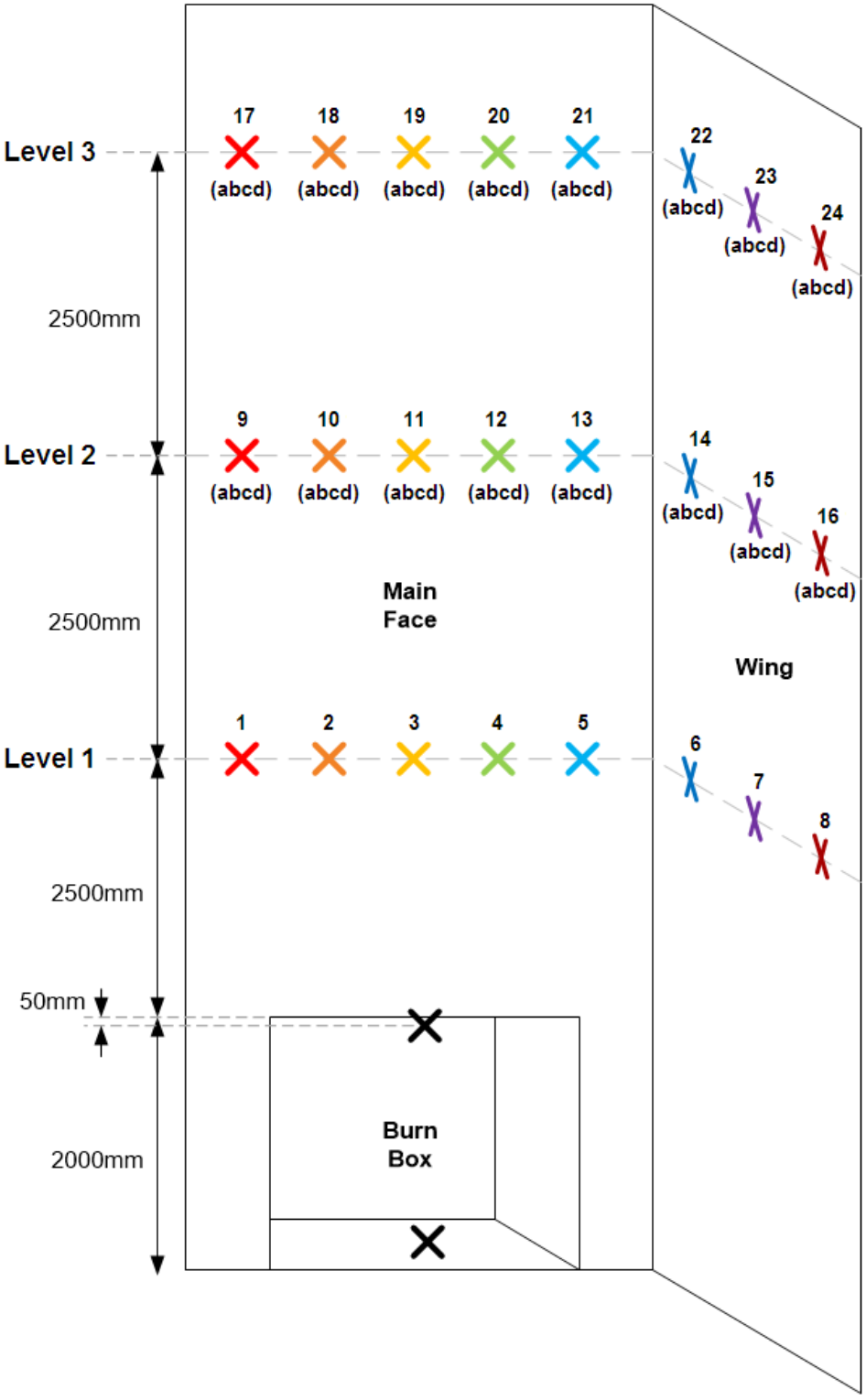


Figure 121 – Thermocouple locations on the test wall

10 Appendix B – Installation process

Figure 22 Detail of precast panel attached to frame

Figure 23 Façade completed

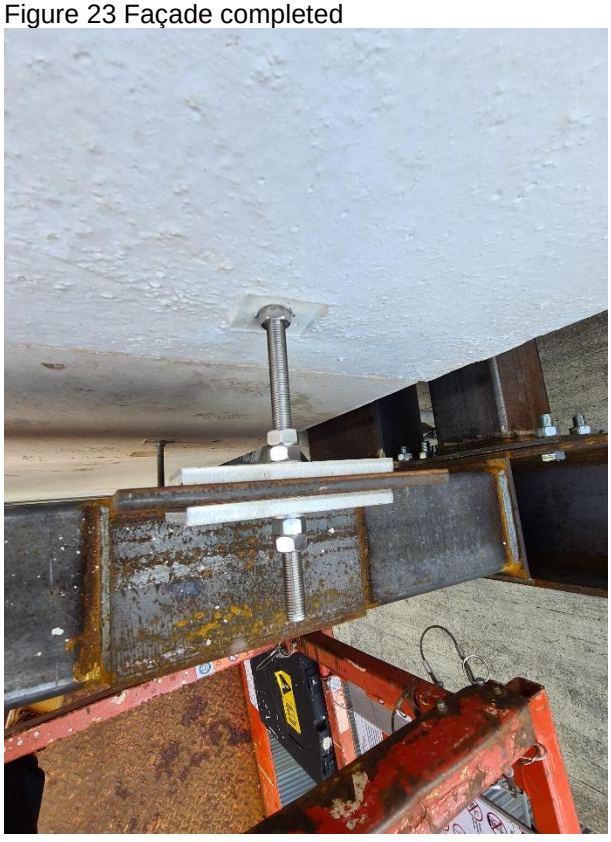


Figure 24 Detail of bracket holding panel to frame

Figure 25 Detail of bracket holding panel to frame

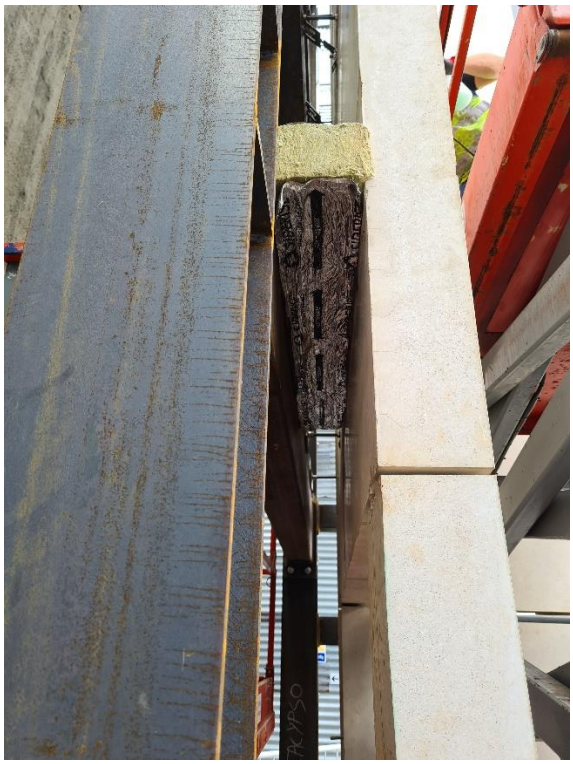


Figure 26 Horizontal cavity barrier installed

Figure 27 More detail of horizontal cavity barrier.


Figure 28 Second horizontal cavity barrier installed.

Figure 29 Rear of panel showing beginning of insulation install

Figure 30 Rear of panel showing insulation completed

Figure 31 Front face of insulation

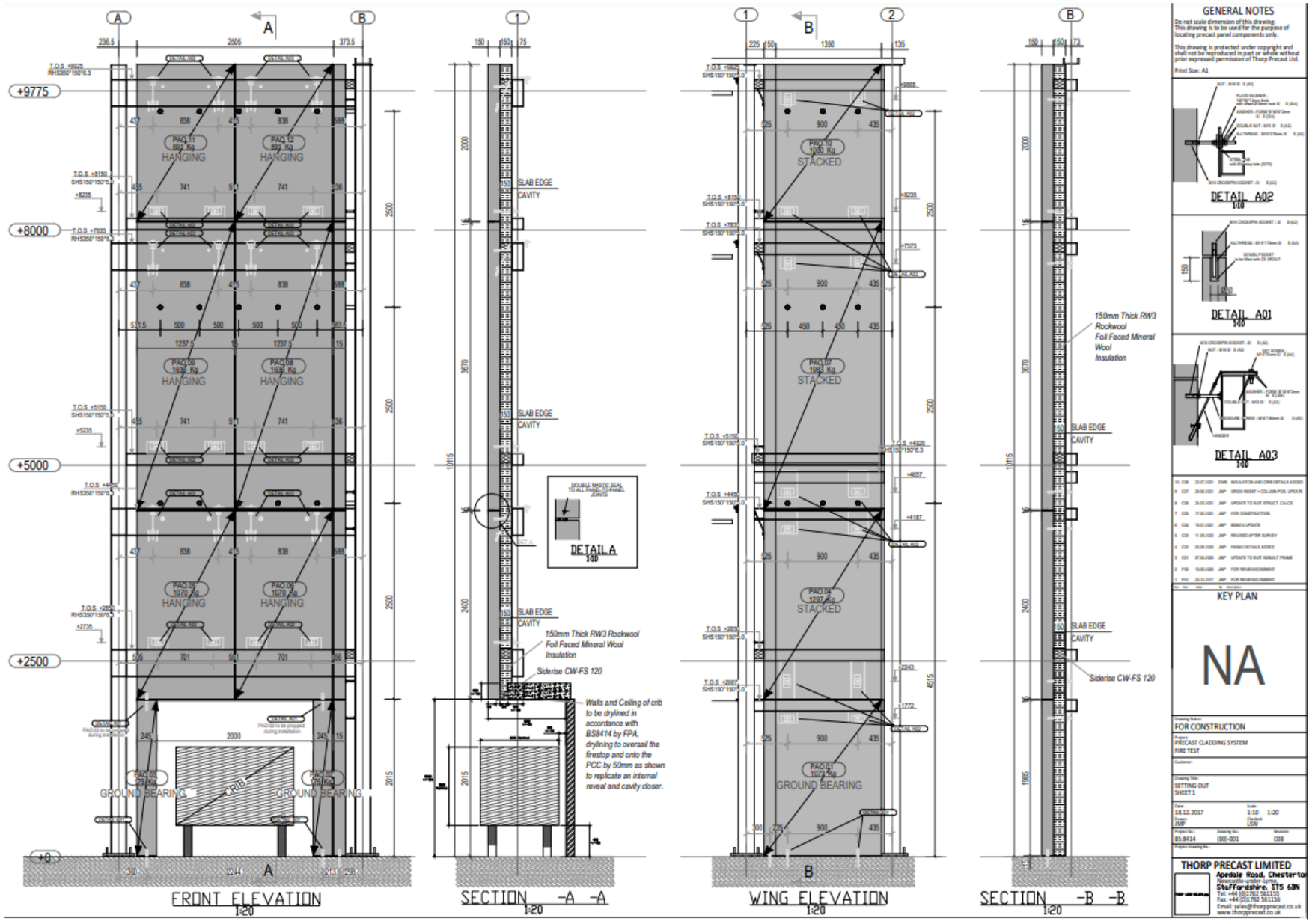
Figure 32 Detail of top of façade

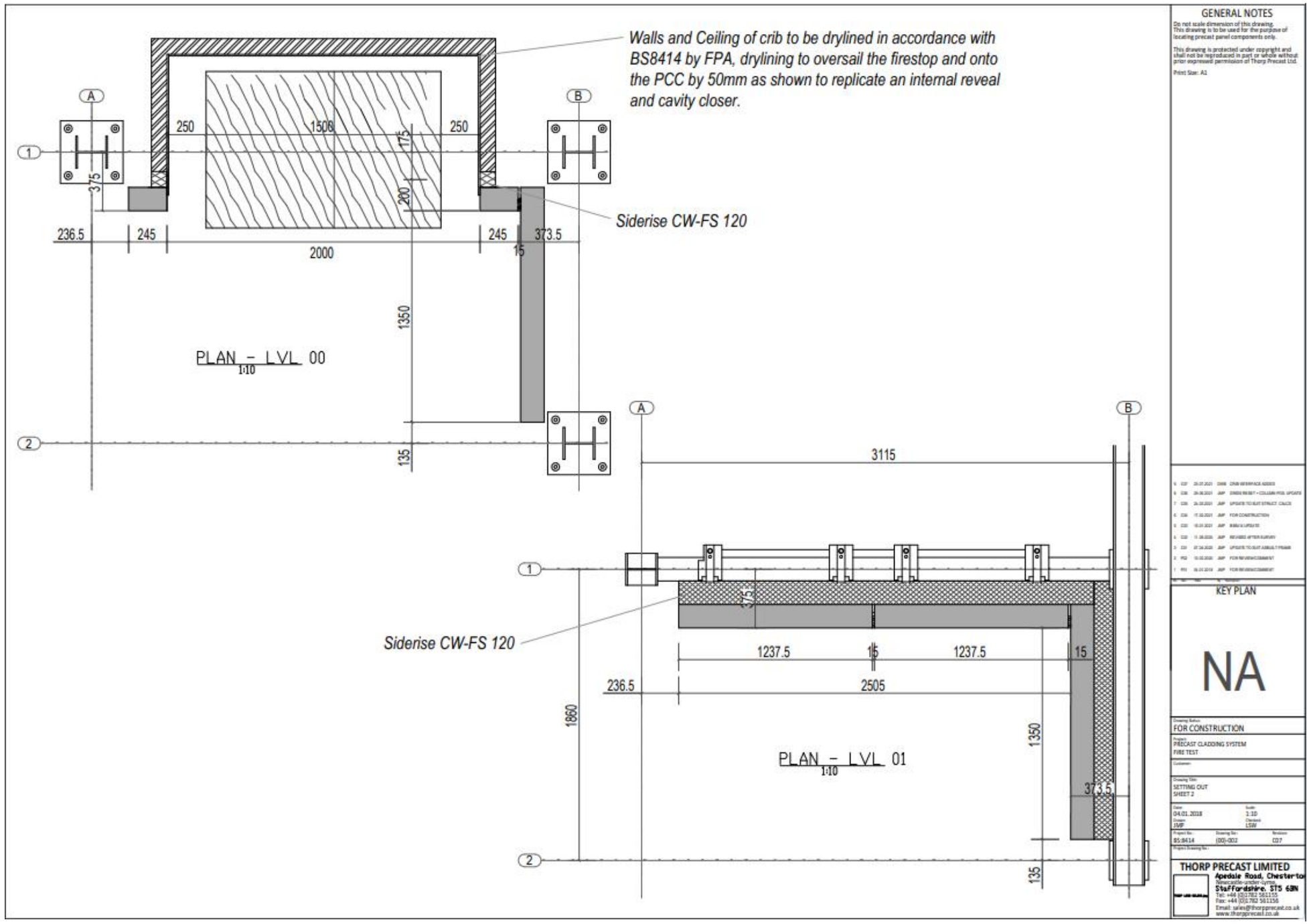
Figure 33 Full façade prior to ignition of crib

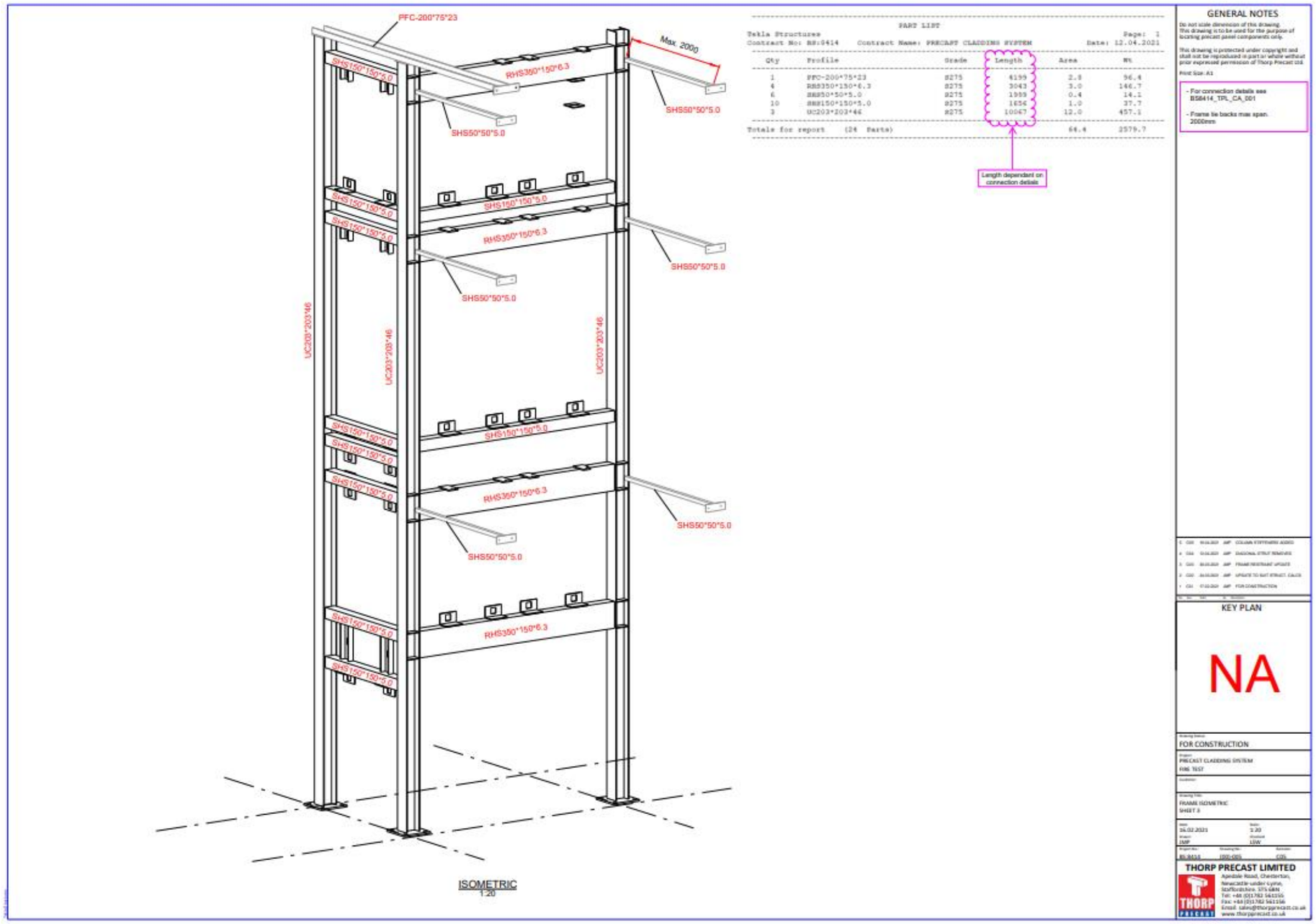
11 Appendix C – Post-test photographs

Figure 34 – Full façade post test

12 Appendix D – System Drawings




Walls and Ceiling of crib to be drylined in accordance with BS8414 by FPA, drylining to oversail the firestop and onto the PCC by 50mm as shown to replicate an internal reveal and cavity closer.
Siderise CW-FS 120
A
B
1
2
250
1506
250
175
200
375
236.5
245
2000
245
373.5
15
1350
135
PLAN - LVL 00
1:10
3115
Siderise CW-FS 120
1237.5
15
1237.5
15
236.5
2505
1860
1350
373.5
PLAN - LVL 01
1:10
GENERAL NOTES
Do not scale dimension of this drawing.
This drawing is to be used for the purpose of locating precast panel components only.
This drawing is protected under copyright and shall not be reproduced in part or whole without prior expressed permission of Thorp Precast Ltd.
Print Size: A1
KEY PLAN
NA
FOR CONSTRUCTION
PRECAST CLADDING SYSTEM
FIRE TEST
SETTING OUT
SHEET 2
04.01.2018
1:10
JMP
LSW
85.8414
(00)-002
C07
THORP PRECAST LIMITED
Apedale Road, Chesterton
Newcastle-under-Lyme
Staffordshire. ST5 6BN
Tel: +44 (0)1782 561155
Fax: +44 (0)1782 561156
Email: sales@thorpprecast.co.uk
www.thorpprecast.co.uk



PART LIST

Tekla Structures — Page: 1
Contract No: BS:8414 Contract Name: PRECAST CLADDING SYSTEM — Date: 12.04.2021

Qty	Profile	Grade	Length	Area	Wt.
1	PFC-200*75*23	S275	4199	2.8	96.4
4	RHS350*150*6.3	S275	3043	3.0	146.7
6	SHS50*50*5.0	S275	1959	0.4	14.1
10	SHS150*150*5.0	S275	1656	1.0	37.7
3	UC203*203*46	S275	10047	12.0	457.1
Totals for report (24 Parts)				64.4	3579.7

Length dependant on connection details

GENERAL NOTES

Do not scale dimension of this drawing.
This drawing is to be used for the purpose of erecting precast panel components only.

Print Size: A1

- For connection details see BS8414_TPL_CA_001
- Frame tie backs max span. 2000mm

KEY PLAN

NA

FOR CONSTRUCTION

PRECAST CLADDING SYSTEM
FIRE TEST

FRAME ISOMETRIC
SHEET 3

16.02.2021 — 1:20
JWP — LW
BS 8414 — 0001-0001 — 03

THORP PRECAST LIMITED
Agecroft Road, Cheriton,
Newcastle-under-Lyme,
Staffordshire. ST5 6BN
Tel: +44 (0)1782 561555
Fax: +44 (0)1782 561556
Email: sales@thorpprecast.co.uk
www.thorpprecast.co.uk

13 Appendix F - Equipment Calibration details

13.1 Time

Two timers were used during the test and data analysis, details of equipment used, and verification tests are as follows:

Procedure and reference equipment	
FPA procedure	MEOP-08: Management and use of chronometers, Version 1.0
Reference equipment	British Telecom 'Speaking Clock'
Test equipment	
Stopwatch A	
Description	Salter digital timer
Asset tag ID	9116
Date of last verification test	13/05/2020
Stopwatch B	
Description	Salter digital timer
Asset tag ID	9120
Date of last verification test	13/05/2020
Stopwatch C	
Description	Salter digital timer
Asset tag ID	9122
Date of last verification test	13/05/2020

13.2 Distance

Measurements of length were taken using an EU Class 1 retractable tape measure, details as follows:

Procedure and test equipment	
FPA procedure	MEOP-07: Management and use of linear distance measuring devices, Version 2.0
Description of equipment	2x Fisco TL8M Tri-Lok 8m tape measure
Asset tag ID	9002 & 9105

13.3 Temperature

72 thermocouples were used in the test. Details of equipment used, and verification test conducted are as follows:

Procedure and reference equipment	
FPA procedure	MEOP-03: Management and use of thermocouples, Version 2.0
Test equipment	
Datalogger	Datataker DT85.005, Asset ID: 9019
Laptop	Asset ID: 9152
Thermocouples	1.5mm type k mineral insulated thermocouples, Asset ID numbers: FPA TC13-01 to FPA TC13-24d *(TC Set FPA 8414-13)*
Date of last verification tests	17/09/2020

Thermocouple locations on test wall, see					
Test location	Asset ID	Test location	Asset ID	Test location	Asset ID
1	FPA TC13-1	13a	FPA TC13-13A	19a	FPA TC13-19A
2	FPA TC13-2	13b	FPA TC13-13B	19b	FPA TC13-19B
3	FPA TC13-3	13c	FPA TC13-13C	19c	FPA TC13-19C
4	FPA TC13-4	13d	FPA TC13-13D	19d	FPA TC13-19D
5	FPA TC13-5	14a	FPA TC13-14A	20a	FPA TC13-20A
6	FPA TC13-6	14b	FPA TC13-14B	20b	FPA TC13-20B
7	FPA TC13-7	14c	FPA TC13-14C	20c	FPA TC13-20C
8	FPA TC13-8	14d	FPA TC13-14D	20d	FPA TC13-20D
9a	FPA TC13-9A	15a	FPA TC13-15A	21a	FPA TC13-21A
9b	FPA TC13-9B	15b	FPA TC13-15B	21b	FPA TC13-21B
9c	FPA TC13-9C	15c	FPA TC13-15C	21c	FPA TC13-21C
9d	FPA TC13-9D	15d	FPA TC13-15D	21d	FPA TC13-21D
10a	FPA TC13-10A	16a	FPA TC13-16A	22a	FPA TC13-22A
10b	FPA TC13-10B	16b	FPA TC13-16B	22b	FPA TC13-22B
10c	FPA TC13-10C	16c	FPA TC13-16C	22c	FPA TC13-22C
10d	FPA TC13-10D	16d	FPA TC13-16D	22d	FPA TC13-22D
11a	FPA TC13-11A	17a	FPA TC13-17A	23a	FPA TC13-23A
11b	FPA TC13-11B	17b	FPA TC13-17B	23b	FPA TC13-23B
11c	FPA TC13-11C	17c	FPA TC13-17C	23c	FPA TC13-23C
11d	FPA TC13-11D	17d	FPA TC13-17D	23d	FPA TC13-23D
12a	FPA TC13-12A	18a	FPA TC13-18A	24a	FPA TC13-24A
12b	FPA TC13-12B	18b	FPA TC13-18B	24b	FPA TC13-24B
12c	FPA TC13-12C	18c	FPA TC13-18C	24c	FPA TC13-24C
12d	FPA TC13-12D	18d	FPA TC13-18D	24d	FPA TC13-24D

13.4 Moisture content

The fuel load moisture content was measured using a conductivity moisture meter for use with wood, details as follows:

Procedure and test equipment	
FPA procedure	MEOP-10: Management and use of wood moisture sensors, Version 1.0
Description of equipment	FPA's Wood Moisture Meter
Asset tag ID	9005

13.5 Wind Speed Measurement

Wind speed was measured using a hot wire anemometer, details as follows:

Procedure and test equipment	
FPA procedure	MEOP-11: Management and use of anemometers, Version 1.0
Description of equipment	FPA's hot-wire air velocity meter
Asset tag ID	9104