TEST REPORT FOR FIRE PROPAGATION CHARACTERISTICS OF EXTERIOR WALL ASSEMBLIES

Test Sponsor:

FAZAH Industrial Company
P.O. Box: 11557
Second Industrial Area,
Riyadh 14333, Saudi Arabia
T: +966 11 2655467 | F: +966 11 2655612
Website: www.fazah.net

Test Assembly:

FAZAH 3D 4mm Thick Metal Composite Panel Cladding.

Test Standard:

NFPA 285: Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components, 2019 Edition.

THOMAS BELL-WRIGHT
INTERNATIONAL CONSULTANTS

Test Date: 5-Sep-19
Issue Date: 13-Oct-19
Test Reference No.: TB041

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DUBAI ABU DHABI DOHA

Accreditation

Testing

ISO/IEC 17025: General requirements for the competence of testing and calibration laboratories with

International Accreditation Service (IAS) - Testing Laboratory: **TL-626**
www.iasonline.org

Memberships

Members of European Group of Organization for Fire Testing, Inspection and Certification

www.egolf.org.uk

Member of International Trade Council

www.thetradecouncil.com

Member of Association for Specialist Fire Protection

www.asfp.org.uk

Member of Centre for Window and Cladding Technology

www.cwct.co.uk

The work which is the subject of this report falls wholly or partly under the accreditation of ISO 17025 IAS.

Table of Contents

1. INTRODUCTION

This report outlines the determination of the fire propagation characteristics of FAZAH 3D 4mm thick Metal Composite Panel cladding (MCP) according to:

NFPA 285: Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components, 2019 Edition.

2. SPONSOR

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3. TESTING LABORATORY

Name: Thomas Bell-Wright International Consultants (TBWIC)
Address: Corner of 46th and 47th streets, Jebel Ali Industrial Area 1
P.O. Box 26385, Dubai, U.A.E.
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4. DATE OF TEST

The test was conducted on 5-Sep-19, and has been witnessed by the following parties:

Name	Company	Contact Number
Mr. Ahmed	FAZAH Industrial Company	+971 50 692 8164
Mr. Shyju. K	Emirates Aluminium Co. LLC	+971 50 840 5510
Mr. Muhammad Rana		+971 50 545 3758
Mr. Chandran Kayipullil		+971 56 737 5489

5. TEST SAMPLES

5.1. General Assembly Description

The 5500 x 4550mm (h x w) intermediate scale multi-story assembly (ISMA) test wall was constructed of a base wall onto which support brackets were fixed, anchored into the studs of the base wall. Vertical runners were fixed to the support brackets. Cavity fire barriers were fixed around the perimeter of the window opening. In addition, one horizontally oriented cavity fire barrier was fixed along the width of the specimen, at a height of 837mm from the head of the window opening. Mineral wool slabs were fixed onto the exterior face of the base wall using insulation fasteners, covering the entire exterior face of the base wall, except for in the location of the cavity fire barriers and the brackets. Aluminium cleats of the ACP's were fixed to the vertical runners. The panel joint gaps were filled with backer rods and were capped off with silicone sealant.

5.2.Standard Specific Requirements

Section 5 of NFPA 285:2019 outlines a series of construction requirements, primarily related to joint location, and this section describes the presence of them, or their absence and resulting limitation to field application. All section references below are related to NFPA 285:2019.

In accordance with section 5.7.2.1.2, a horizontal panel joint was located between 1 foot (305mm) and 3 feet (914mm) above the top of the window head.

In accordance with section 5.7.2.2.2, a vertical joint was included in the construction, extending continuously from the window head to the head of the specimen, and was within 1 foot (305mm) of the window opening center line.

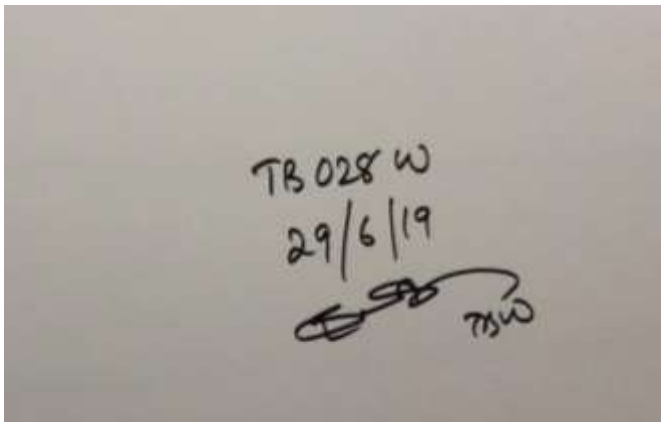
5.3.Supporting Construction

The test assembly was installed on a substrate base wall, which was in turn installed on a moveable test frame constructed of 150 x 150mm steel I-beams with 3 Nos. of 100 x 100mm steel angles welded horizontally at locations specified by the NFPA 285 standard, 2019 Edition.

6. SPECIMEN DEFINITION & INSTALLATION

6.1.Specimen Definition & Verification of the Test Specimen.

TBWIC testing laboratory has not been involved in the design of the specimen. However, the panels were selected, marked, and signed by Mr. Suresh Kumar from TBWIC Certification Division (Certification Body) on 29-Jun-19 as shown below. The material was tested in an as-received condition.



6.2.Specimen Installation

Installation of the specimen: FAZAH Industrial Company

Frame and base wall preparation: TBWIC.

The specimen was delivered on 27-Aug-19 and installed between 28-Aug-19 and 3-Sep-19. The specimen was stored in ambient conditions at temperatures ranging between 29°C and 36°C and 42% to 85% humidity.

7. METHOD OF TEST

The fire test was carried out according to NFPA 285: 2019 Edition. The assembly was tested based on values obtained during the most recent calibration as per the NFPA 285 standard, expressed in Appendix 2 of this report.

7.1. Specimen Instrumentation & Measurements

A 100 channel Agilent 34970A data logger was used to record the output of the thermocouples on 15 second intervals.

A total of 54 Type-K thermocouples were used on the specimen, with all interior thermocouples fixed within the specimen placed at mid-depth of the air cavity, nominally 189.5mm from the interior face of the base wall, as per figure 6.1(b), Detail H in the NFPA 285 standard, shown in Appendix 1, Figure 4 of this report.

The burn room thermocouples were placed at 6 inches below the first story test room ceiling and distributed according to NFPA 285; Fig. 6.1(d).

Thermocouples 55 to 81 were not included in the test as the basewall and exterior cavity insulation were not inherently combustible, and their interior temperatures are not required to be monitored.

The window burner was centered on the vertical centerline of the window, 9 inches below the top of the opening, and with the longitudinal centerline of the burner at 3.5 inches from the plane of the exterior wall, consistent with the standard and the calibration of the test apparatus.

For graphs and tabulated data, refer to Appendix 5 & 6.

8. FIRE TEST

8.1. Ambient Conditions & Test Situation

The ambient temperature at the commencement of the test was recorded as 87.62°F and the relative humidity was recorded as 59%. The airflow, measured with an anemometer placed at a right angle and within 1 meter of the test face, at the beginning at test was recorded at less than 0.1 m/s. Video recording digital photographs, visual observations, and data collection were performed prior, during, and after testing was completed.

8.2. Pre-Test Observations

The specimen was found satisfactory and fit to be tested.

8.3. Fire Test Observations

Time (mm:ss)	Observations from In Front of the Specimen (Exterior Face)
0:00	**The test was started.**
1:57	Flaming was witnessed escaping from the burn room.
5:00	The window burner was ignited.
5:32	The top coat of the panels above the window head began to peel off.
6:25	Flaming was observed at the top left corner of the window opening, emitting towards the panel above the window head.
7:58	Soot stains were present at the corner of the window flashing jamb.
8:25	The panels above the window head had deflected outwards.
10:00	The specimen was stable.
13:52	The top coat of the panel above the window head had peeled off up to 3 feet.

15:00	The specimen was stable.
16:12	Flaming was observed along the vertical panel joints, above the window head up to 5 feet.
19:25	Flaming was observed along the horizontal panel joints, adjacent to the window head up to 2 feet.
20:00	The specimen was stable.
24:25	The coating of the panel above the window head had peeled off up to 3 feet.
25:00	The specimen was stable.
28:29	The coating of the panel above the window head had peeled off up to 6 feet.
29:25	Flaming had spread up to a height between 2 to 6 feet above the window head.
30:00	**The specimen was stable, the test was stopped and gas shut off, as per the NFPA 285 Standard, and the 10-minute observation period began.**
30:01	Residual flaming was observed between the horizontal joint above the window head, extending up to 3 feet.
32:18	The panels right above the window head were drooped, exposing the insulation slab and cavity fire barrier behind it.
35:00	The specimen was stable.
40:00	**The observation period was ended as per the NFPA 285 standard and the NFPA 285 test was completed.**

8.4.Second Floor Test Room Observations

Time (mm:ss)	Observations from the 2nd Floor Room (Interior Face)
0:00	**The test was started**
5:00	The second floor room was stable.
10:00	The second floor room was stable.
15:00	The second floor room was stable.
20:00	The second floor room was stable.
25:00	The second floor room was stable.
30:00	**The 2nd floor room was stable, no flaming was observed, the test was stopped and gas shut off, as per the NFPA 285 Standard, and the 10 minute observation period began.**
35:00	The second floor room was stable. No activity was observed.
40:00	**The observation period was ended as per the NFPA 285 standard and the NFPA 285 test was completed.**

9. EXTENT OF DAMAGE

9.1.Exterior Face Observations

The Metal Composite Panel, cavity barrier & mineral wool insulation slabs right above the window head had melted off. Soot stain was visible vertically, along the specimen. Outer coating of the panels above window head had peeled off up to 3 feet.

9.2.Interior Face Observations

No damage was observed to the interior of the base wall in the second floor test room. The gypsum within the first floor test room was badly burned, but still intact.

9.3. Dismantling Observations

Damage was largely limited to the mineral wool insulation slab up to 7 feet. However, upon removal of it, slight smoke damage and charring was observed on the gypsum beneath the cavity insulation.

10. FIRE PROPAGATION ANALYSIS

Test Performance Evaluation Summary Table		
Test Requirement	**Test Observation**	**Pass/Fail**
Flames emitting from the surface of the exterior face of the test specimen shall not reach a height of 10ft or greater above the top of the window opening.	Flames **did not reach** 10 feet above the window opening.	**Pass**
Flames emitting from the surface of the exterior face of the test specimen shall not reach a horizontal distance of 5ft or greater from the vertical centerline of the window opening.	Flames **did not reach** a lateral distance of 5ft from the vertical centerline.	**Pass**
Flames shall not occur in the second-story test room.	There was **no** visible flaming in the second story test room.	**Pass**
Temperatures shall not exceed 1000°F as measured by thermocouples Tc-11 and Tc-14 through Tc-17.	Tc-11 and Tc-14 through Tc-17 **did not exceed** the 1000°F limit.	**Pass**
Temperatures in the wall cavity air space shall not exceed 1000°F as measured by thermocouples Tc-18 and Tc-19.	Tc-18 and Tc-19 **did not exceed** the 1000°F limit.	**Pass**
Temperatures in the wall cavity air space shall not exceed 1000°F as measured by thermocouples Tc28 and Tc-31 through 40.	Tc-28 and Tc-31 through Tc-40 **did not exceed** the 1000°F limit.	**Pass**
Temperatures measured 1 in. (25mm) from the interior surface of the test specimen within the second story, the test room shall not exceed 500 °F above ambient air temperature of test facility at the start of the fire test as measured by Tc-49 through Tc-54.	Tc-49 through Tc-54 **did not exceed** the maximum temperature of 588.16°F. (500°F + Initial Ambient Temperature = 500°F + 88.16°F = 588.16°F)	**Pass**

11. SUMMARY OF RESULTS

The FAZAH 3D 4mm thk. MCP assembly has been evaluated in accordance with NFPA 285: Standard Test Method for Evaluation of Fire Propagation Characteristic of Exterior Wall Assemblies Containing Combustible Components, 2019 Edition.

The results of the fire performance evaluation conducted on the wall assembly described herein indicate that the assembly **met** the acceptance criteria stated in the standard.

12. LIMITATION

The results of this test report are only applicable to the type and orientation of the installation which relates to what has been tested. Uncertainty factors with respect to a large-scale fire or changes in design are not considered within the scope of this test report.

TBWIC is wholly responsible for data and information provided in this report, except where indicated by the limitations specified in section 6.1 of this report. This report and all records of the test to which it relates may not be retained by TBWIC beyond 5 years from the date of testing.

This test report is respectfully submitted by Thomas Bell-Wright International Consultants

Prepared By:

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Reviewed By:

Fawaz Hashim, AIFireE
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13. APPENDIX 1 – ORIENTATION OF THERMOCOUPLES

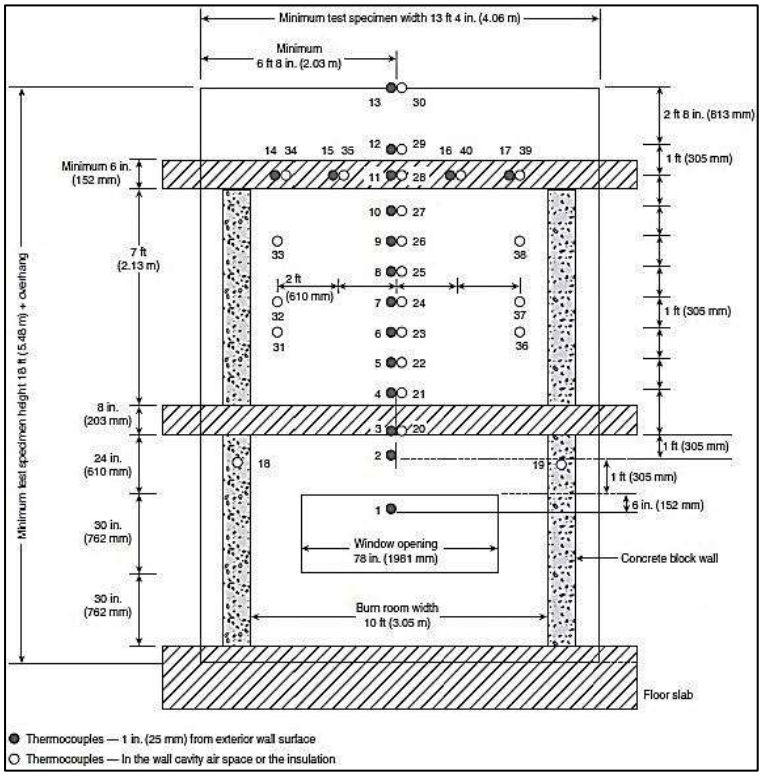


Figure 1: Overall instrumentation on the exterior wall surface and air cavity.

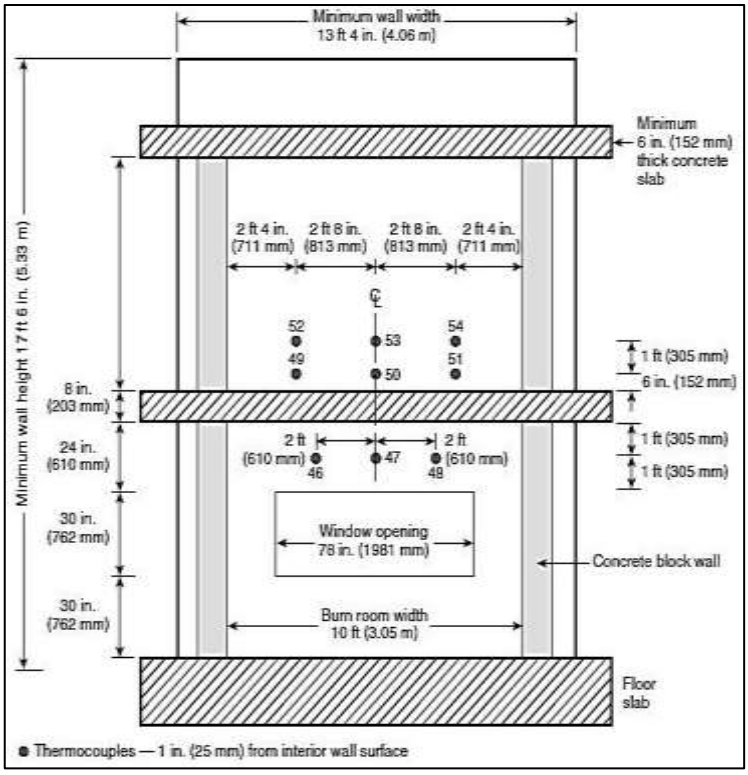


Figure 2: Overall instrumentation on the interior wall

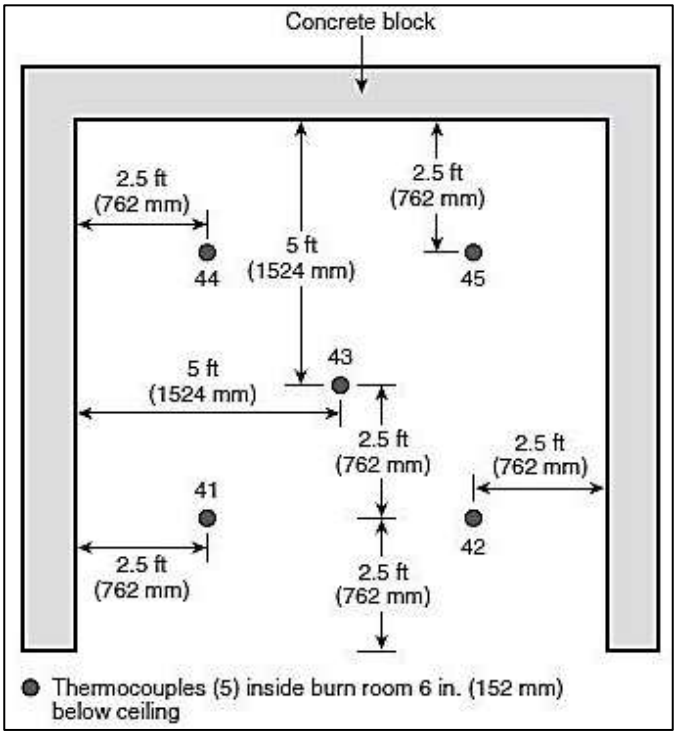


Figure 3: Overall instrumentation inside of the 1st story burn room (Top View)

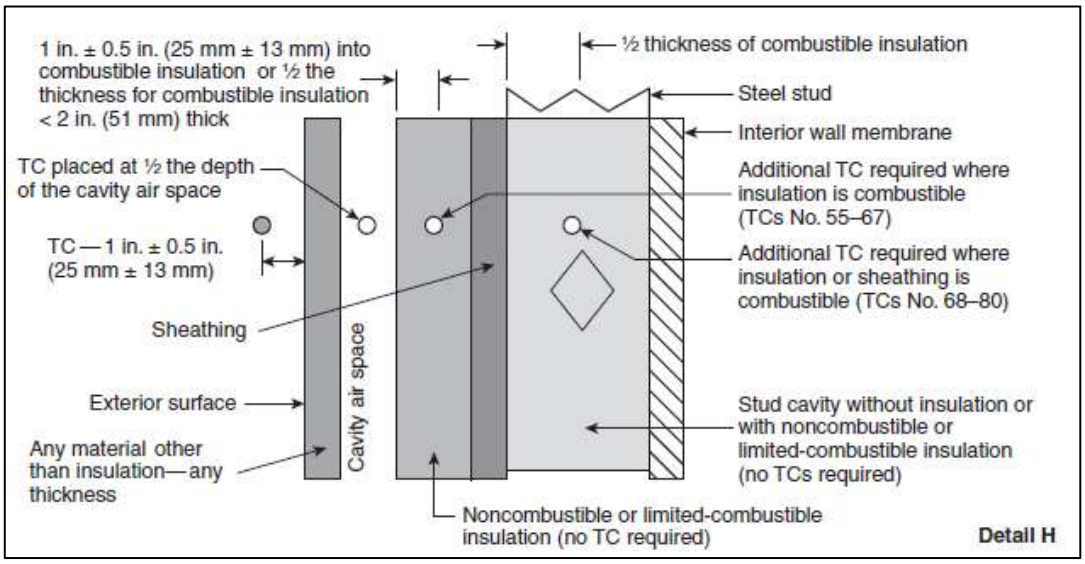


Figure 4: Figure 6.1(b) Detail H of the NFPA 285 standard, showing the thermocouple depth specifications of the specimen.

14. APPENDIX 2 – CALIBRATION & BURNER GAS FLOW DATA

The calibration for the test rig was performed on 10th June, 2019 and followed the procedure and practices outlined for calibration in NFPA 285:2019, Chapter 7.

Table 1 shows gas flow values during the test and during the calibration, table 2 shows the average heat flux, and table 3 shows the average temperature obtained during the calibration test. The values are within the allowable ranges as specified in table 7.1.11 (±10% allowable tolerance).

Table 1: Gas Flow Values During Testing & Calibration

Time	During Fire Test		During Calibration	
	Room Burner	Window Burner	Room Burner	Window Burner
0 – 5 mins	15.2 SCFM	0.0 SCFM	15.2 SCFM	0.0 SCFM
5 – 10 mins	16.2 SCFM	4.7 SCFM	16.2 SCFM	4.7 SCFM
10 – 15 mins	17.2 SCFM	6.1 SCFM	17.2 SCFM	6.1 SCFM
15 – 20 mins	18.2 SCFM	6.9 SCFM	18.2 SCFM	6.9 SCFM
20 – 25 mins	19.2 SCFM	7.6 SCFM	19.2 SCFM	7.6 SCFM
25 – 30 mins	20.2 SCFM	8.1 SCFM	20.2 SCFM	8.1 SCFM

**SCFM: Standard Cubic Feet per Minute*

Table 2: Average Heat Flux Values During Calibration

Time Interval (min)	Average Heat Flux 2FT (W/cm²)	Average Heat Flux 3FT (W/cm²)	Average Heat Flux 4FT (W/cm²)
0:00-5:00	0.78	1.13	0.78
5:00-10:00	2.23	2.33	1.76
10:00-15:00	2.99	2.97	2.18
15:00-20:00	3.46	3.40	2.53
20:00-25:00	3.99	3.96	2.74
25:00-30:00	4.56	4.76	2.97

Table 3: Average Temperature Values During Calibration

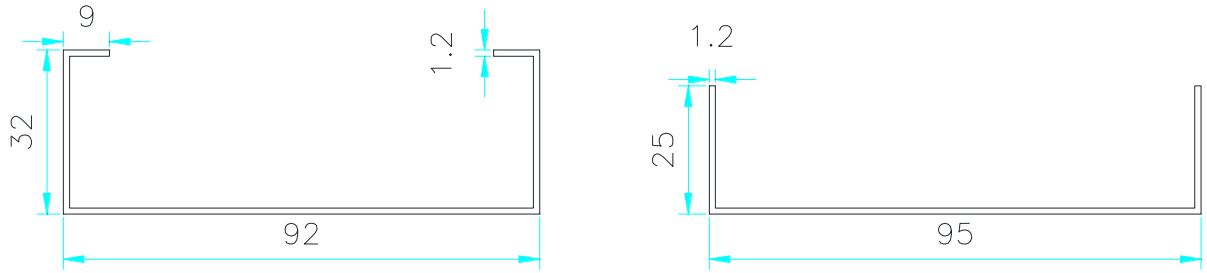
Time Interval (min)	Avg. Burn Room Temp (°F)	Avg. Int. Wall Temp (°F)	Avg. 1 FT Temp (°F)	Avg. 2 FT Temp (°F)	Avg. 3 FT Temp (°F)	Avg. 4 FT Temp (°F)	Avg. 5 FT Temp (°F)	Avg. 6 FT Temp (°F)
0:00-5:00	1177	1097	641	714	630	634	569	498
5:00-10:00	1388	1368	955	997	912	931	842	744
10:00-15:00	1486	1514	1063	1090	986	1023	920	825
15:00-20:00	1574	1643	1146	1163	1060	1104	996	904
20:00-25:00	1636	1732	1205	1235	1122	1168	1053	959
25:00-30:00	1696	1820	1282	1320	1223	1252	1119	1022

15. APPENDIX 3 – COMPONENTS DESCRIPTION

Note: All information provided herein Appendix 3 has been provided either by TBWIC or Test Sponsor. Information marked with a single asterisk indicates the information provided by the Test Sponsor which has been checked against the materials used in the test where appropriate, however, it does not fall under the responsibility of TBWIC. All dimensions are expressed in millimetres (mm), unless otherwise specified.

A. Base Wall:

Basewall Components



Material	Galvanized Steel	15.9mm Type X (GW-TX)	Knauf Joint Tape	Knauf Readygips
Manufacturer	JB Mechanical Services	Knauf LLC	Knauf LLC	Knauf LLC
Dimension	As Shown | Cut to Required Length	1220 x 2400 x 15.9 mm (w x h x thk.)	50mm wide	N/A
Fixing method & Application	Studs were fixed at the edge of the wall span and nominally spaced to match the distribution of the Aluminium wall brackets (see drawings in Appendix 4). The top and bottom edges were welded within tracks at the head and sill of the base wall and also around the window opening. Both were welded directly to the standardized test frame at appropriate locations. The boards were fixed with Knauf TB 3.5 x 35mm self-tapping screws, spaced nominally at 300mm C/C vertically on each stud. Two layers of jointing compound were applied along all exterior meeting edges of the boards, with ample drying time and single strips of jointing tape embedded within the first layer of the jointing compound. The jointing compound was also applied over all exposed screw heads.			

B. Framing System

Wall Bracket	
Material	Aluminium*
Alloy	6063 – T6
Manufacturer	National Aluminium Extrusion Co. LLC
Reference	90111
Dimension	50 x 50 x 4mm (w x h x thk.)
Fixing Method	The brackets were fixed, anchored into the studs of the base wall using steel Ø6.2 x 50mm self-drilling screw.

Runners	
Material	Aluminium*
Alloy	6063 – T6
Manufacturer	National Aluminium Extrusion Co. LLC
Reference	90107
Dimension	40 x 40 x 3mm (w x h x thk.) l Cut into required length
Fixing Method	The runners were fixed onto the wall brackets aligned vertically, using Ø6.2 x 32mm self-drilling screw.

C. Exterior Insulations

Cavity Fire Barrier		
	Cavity Barrier	**Grip Nails**
Material	Pre-compressed Stone Wool Slab*	Galvanized Steel*
Manufacturer	Siderise® Insulation Ltd.	Retail
Reference	CW-FS120	-
Density	80kg/m³ (stated)	N/A
Dimensions	120 x 120mm (h x thk.)	Ø5 x 60mm (Dia. x l)
Fixing Method	One unit of horizontal cavity fire barrier was fixed onto the base wall and around the perimeter of the window opening. The horizontal fire cavity barrier was fixed at a height of 837mm above the window header. They were fixed using galvanized steel grip nails, which were self-adhered onto the base wall.	

Cavity Insulation System			
	Insulation	**Grip Nails**	**Foil Tape**
Material	Mineral wool slab with Aluminium facing on one side*	Galvanized Steel*	Acrylic Adhesive Polypropylene*
Manufacturer	Fujairah Rockwool Factory	Retail	Retail
Reference	S2XX	-	Aluminum Foil
Density	50kg/m^3 (stated)	N/A	N/A
Dimensions	Max: 1000 x 1200 x 50 mm (l x w x thk.)	Ø5 x 60mm (Dia. x l)	45mm wide
Fixing Method	A single layer of 50mm thick insulation was installed on the exterior face of the base wall, in between the Aluminium wall brackets, connectors and runners using grip nails evenly distributed on the exterior face of the slab. Each slab was impaled to the wall with roughly six insulation fasteners on each slab. All meeting edges and termination of the insulation slabs were covered with 50mm wide acrylic adhesive tape.		

D. Exterior Cladding

Aluminium Composite Panels			
Material	Metal Composite Panel*		
Manufacturer	FAZAH Industrial Company		
Reference	FAZAHBOND 3D		
Core	Aluminium core 1100/HO*		
Core Thickness	3mm (measured)		
Panel Thickness	4mm (measured)		
Dimension	**Panel Reference**	**Dimensions (w x h), mm**	**Quantity**
	P1	280 X 974	2
	P2	954 X 974	2
	P3	986 X 974	2
	P4	280 X 1000	4
	P5	954 X 1000	4
	P6	986 X 1000	4
	P7	280 X 729	2
	P8	954 X 729	2
	P9	986 X 729	2
	P10	280 X 777	2
	P11	954 x 777	2
	P12	280 x 819	2
	P13 & P14	954 X 819	4
Air Cavity and Specimen Depth	The total depth from the exterior face of the base wall to the exterior face of the ACP panel was 199mm. The air gap between the exterior face of the mineral wool slab and the inner face of the panel was 25mm. Refer to drawing no. 4 from Appendix 4 for the exact location of each panels.		

Fixing Method	The panels were fixed through the cleats into the runners using 2 nos. of Ø8 x 20mm pan head metal screws. The gap between adjacent panels was 10mm horizontally and vertically.

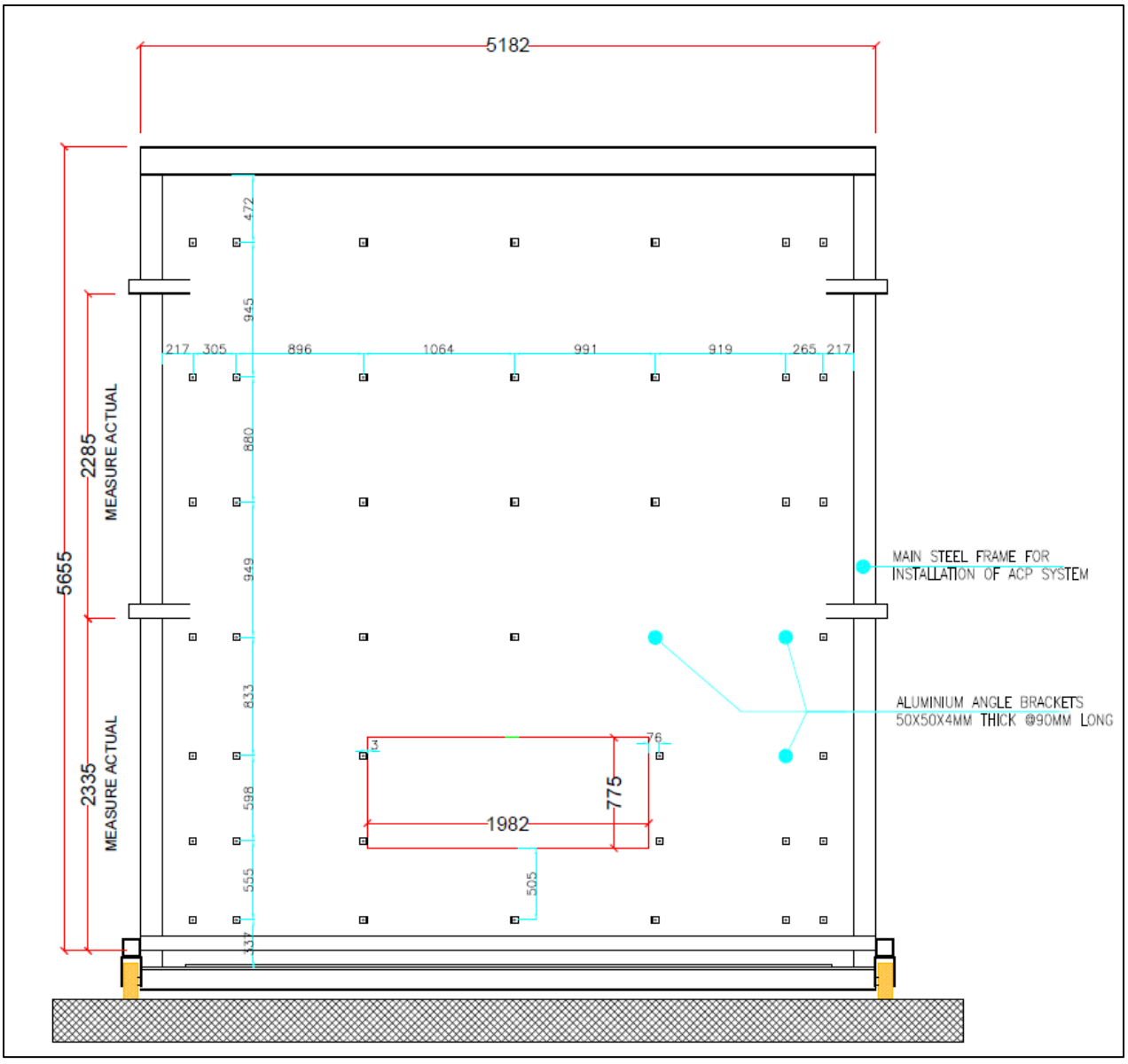
Joint gap infill		
	Backer Rod	**Sealant**
Manufacturer	Arnon	Hilti AG
Reference	Back-Up Rod™	CP 601S
Dimension	Ø10mm (Dia.)	8mm (depth)
Fixing Method	A 10mm panel gap was maintained along the vertical joint and the horizontal joint of the panels. Initially, two strips of backer rod were inserted into these gaps and was later capped off using silicone sealant.	

E. Window Detail

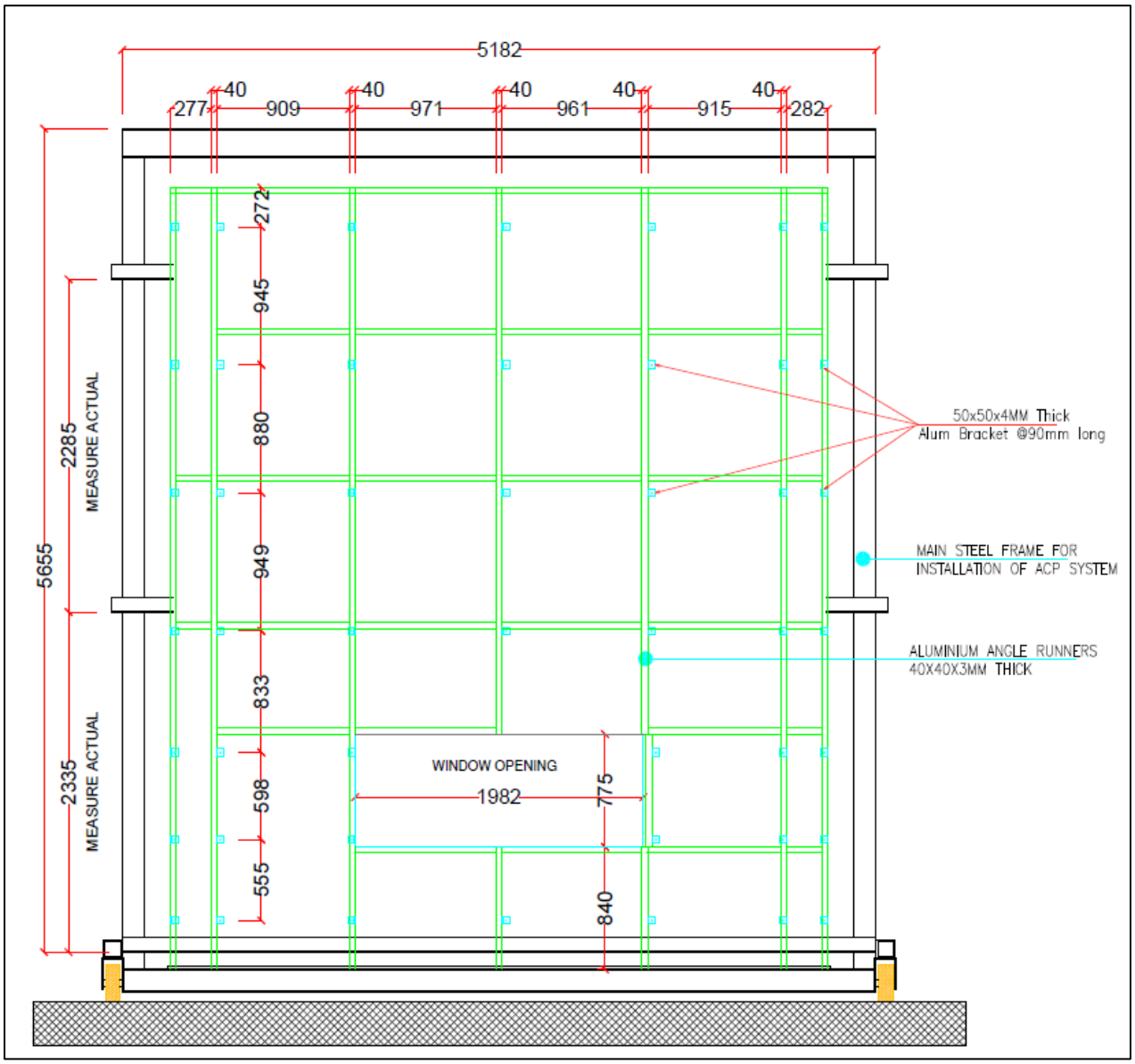
Window Flashing	
Material	Aluminium*
Alloy	5052
Manufacturer	Atlas Steels
Fabricator	Emirates Aluminium Co. LLC
Thickness	1mm
Fixing Method	1mm thk. Aluminium sheet was used around the perimeter of the window opening, fixed using pan head metal screws of Ø8 x 50mm (dia. x l), spacing of 30mm c/c. The bent sections of Aluminum sheet were overlapped into the interior face of the basewall by 50mm. The overlap edge was fixed by pan head metal screws at a spacing of 150mm c/c.

16. APPENDIX 4 – ASSEMBLY DRAWINGS

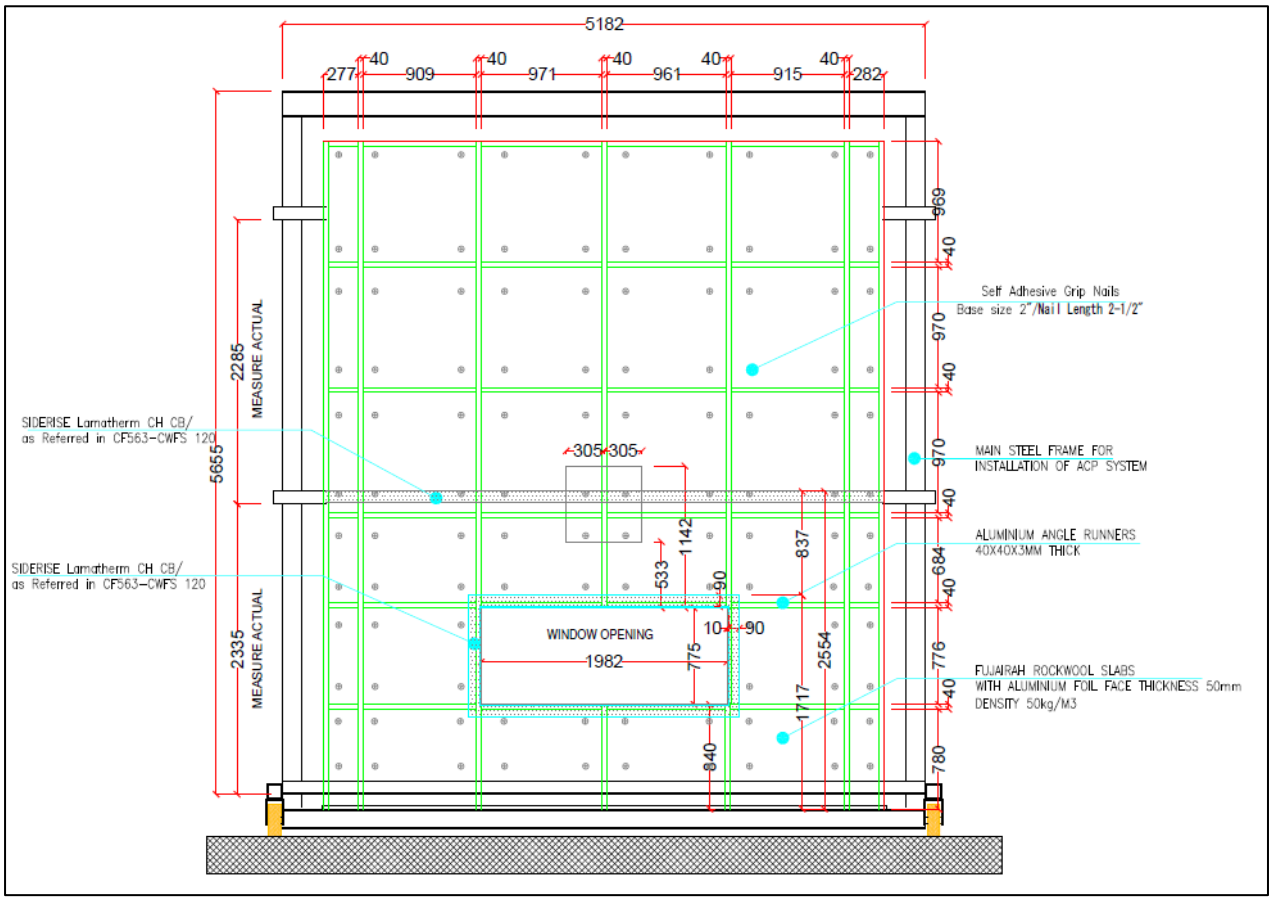
(Note: All dimensions shown in this section are in mm, unless stated otherwise in the drawings.)



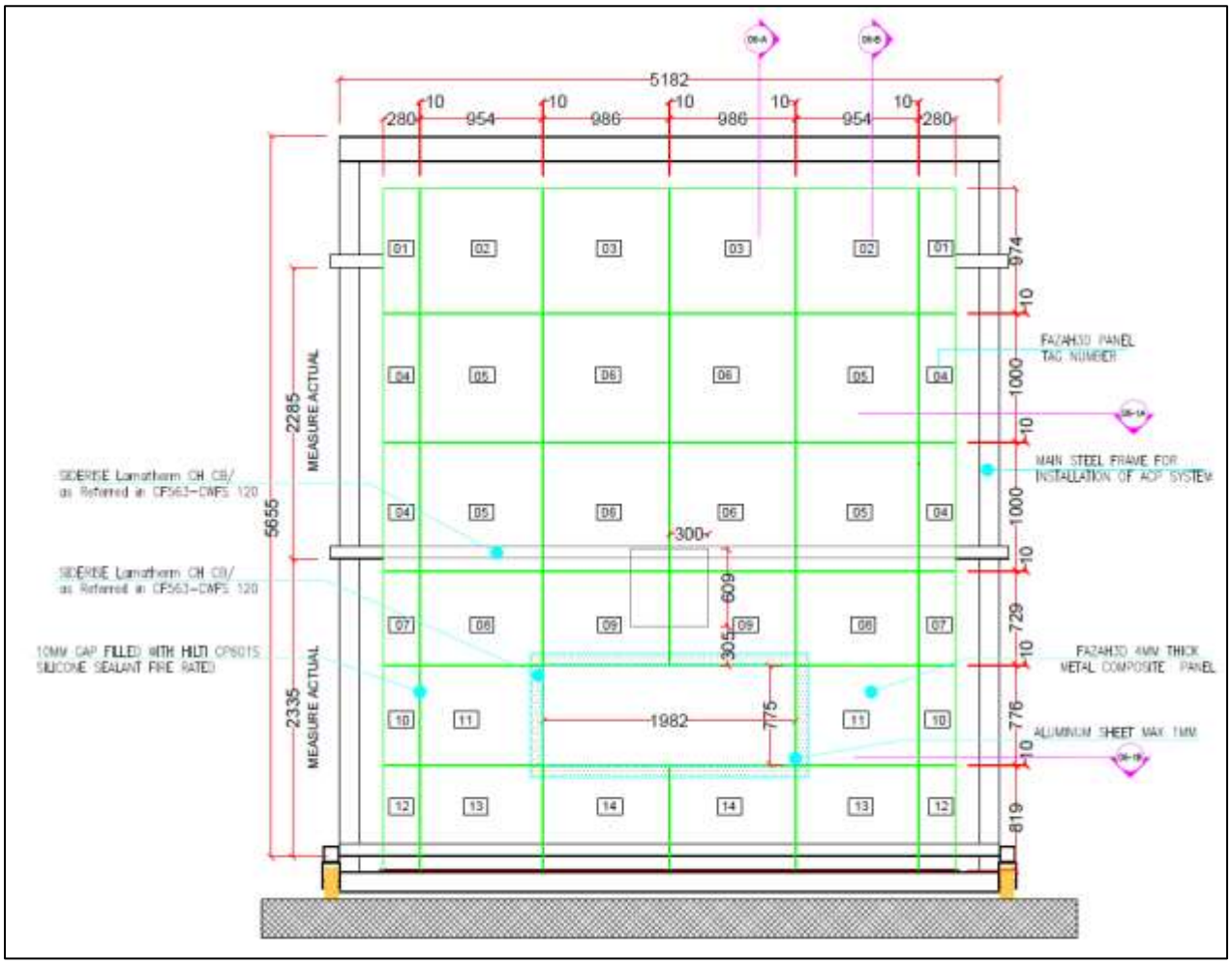
Drawing 1: Elevation of the wall brackets fixed onto the basewall.
(Drawing provided by the test sponsor)



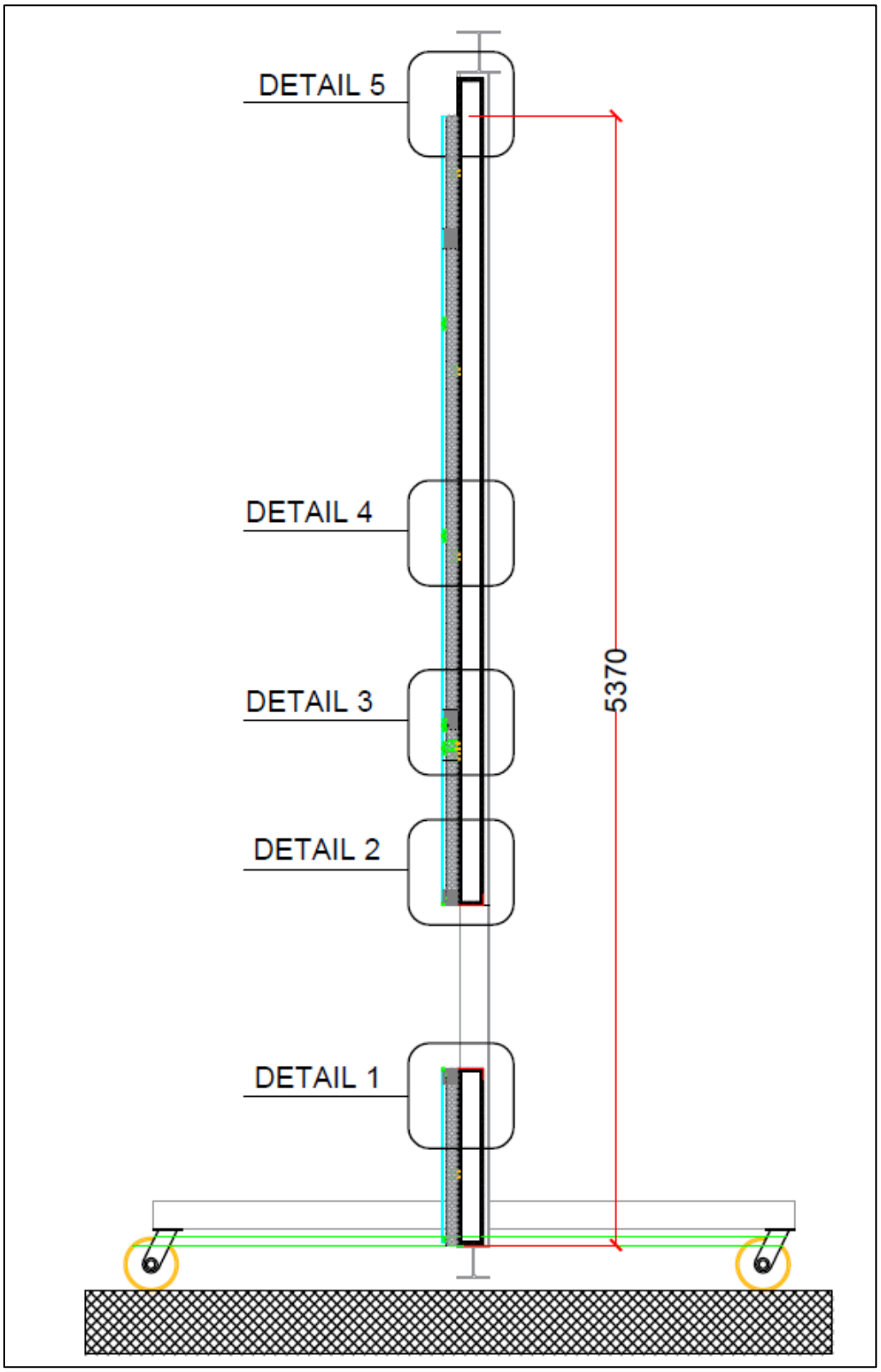
Drawing 2: Elevation of the runners fixed onto the wall brackets.
(Drawing provided by the test sponsor)



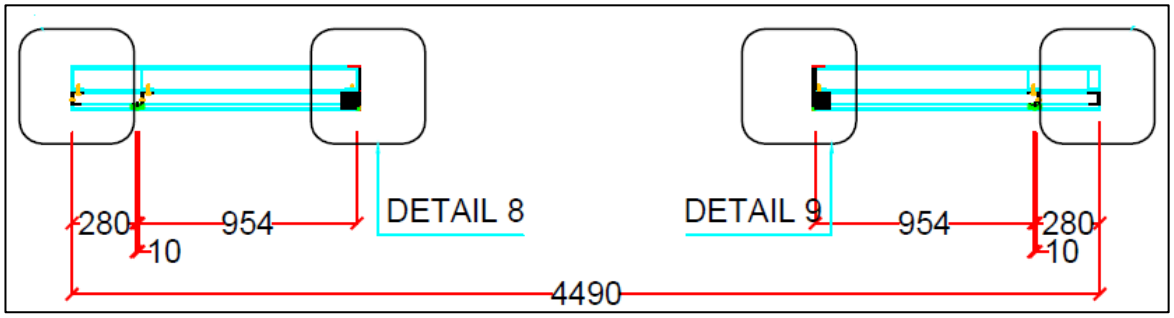
Drawing 3: Elevation of the cavity fire barriers and insulation mineral wool slabs fixed onto the base wall.
(Drawing provided by the test sponsor)



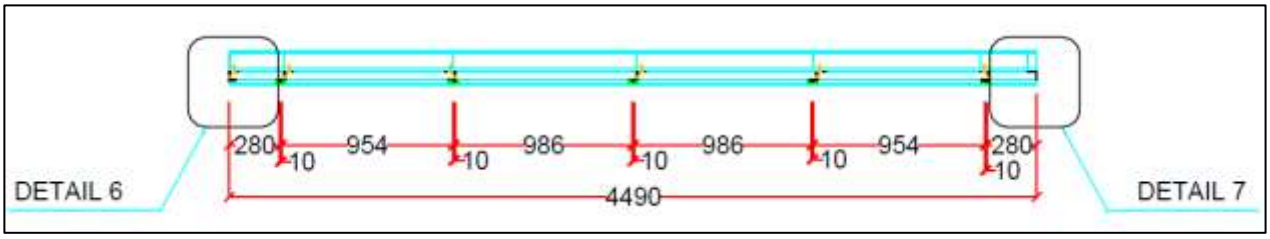
Drawing 4: Elevation view of the ACPs fixed onto the runners.
(Drawing provided by the test sponsor)



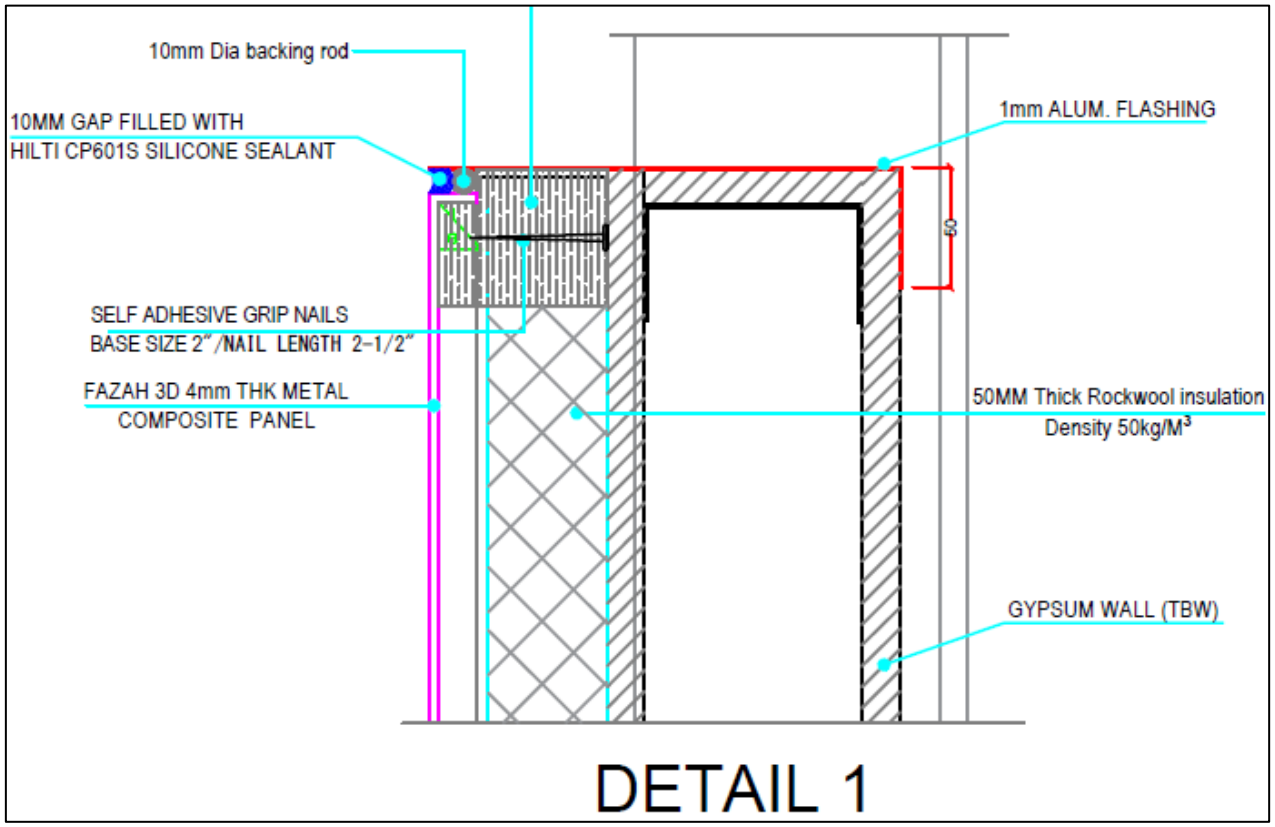
Drawing 5: Vertical section detail of the specimen.
(Drawing provided by the test sponsor)



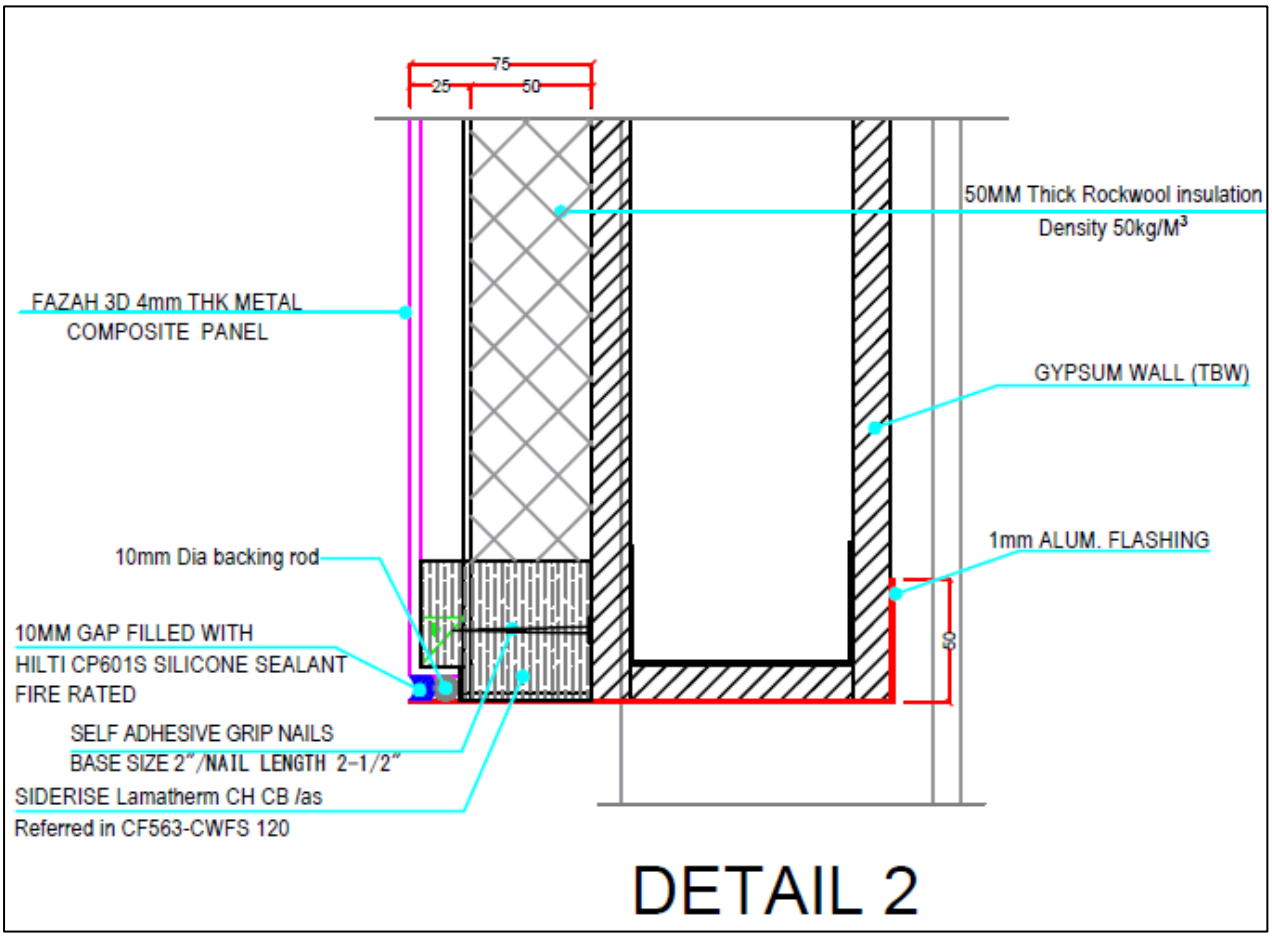
Drawing 6: Horizontal sectional detail at the window opening of the specimen.
(Drawing provided the test sponsor)



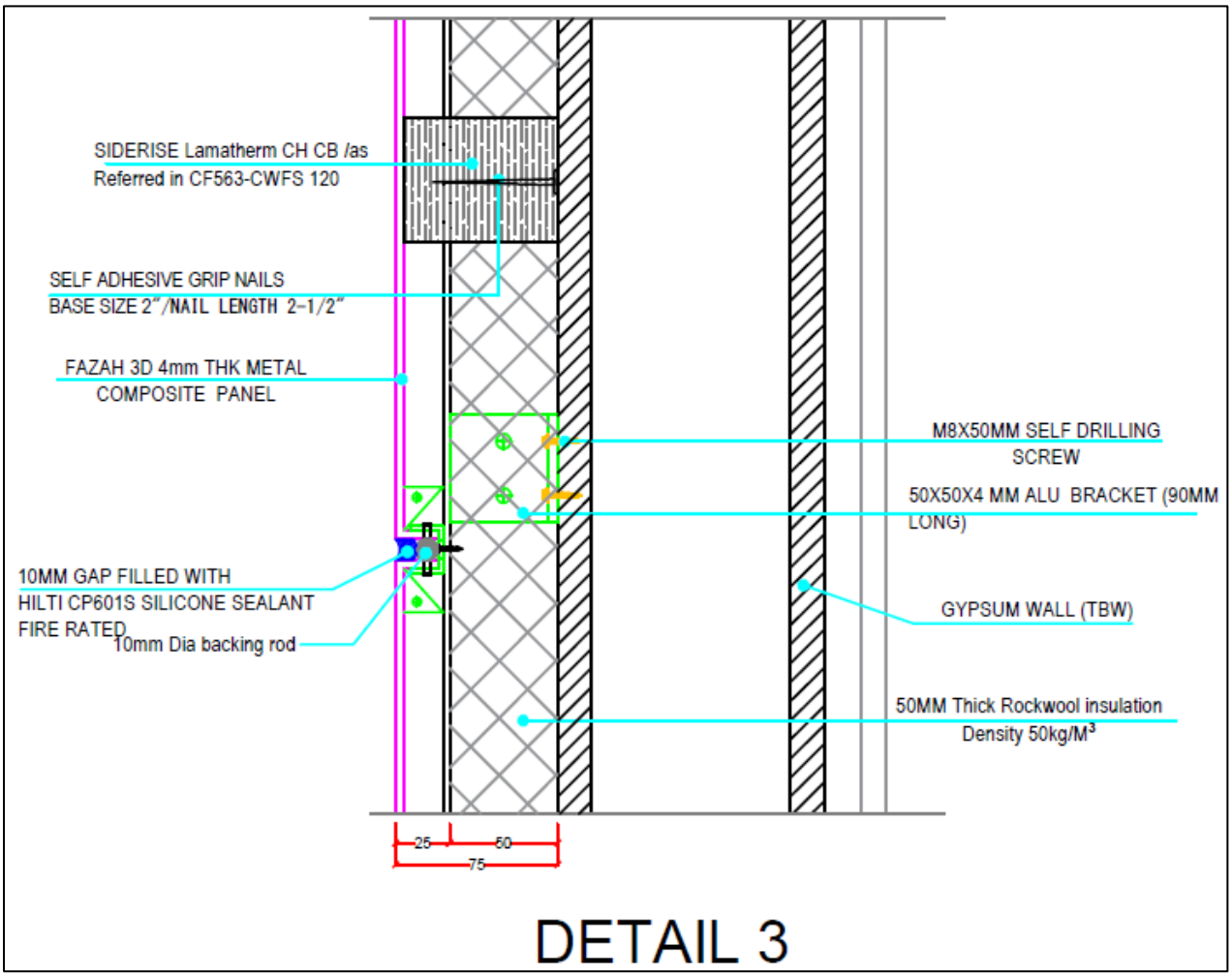
Drawing 7: Horizontal sectional detail of the specimen.
(Drawing provided by the test sponsor)



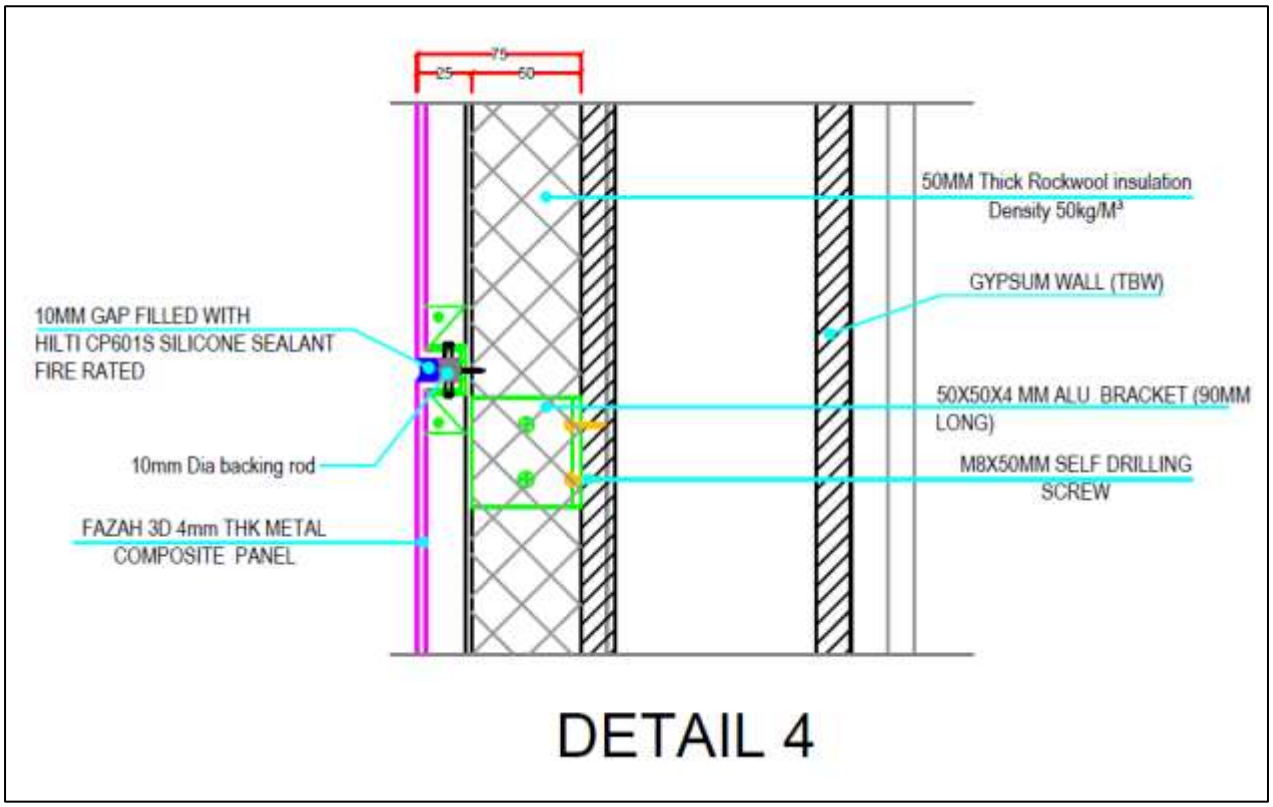
Drawing 8: Detail 1 of drawing 5.
(Drawing provided by the test sponsor)



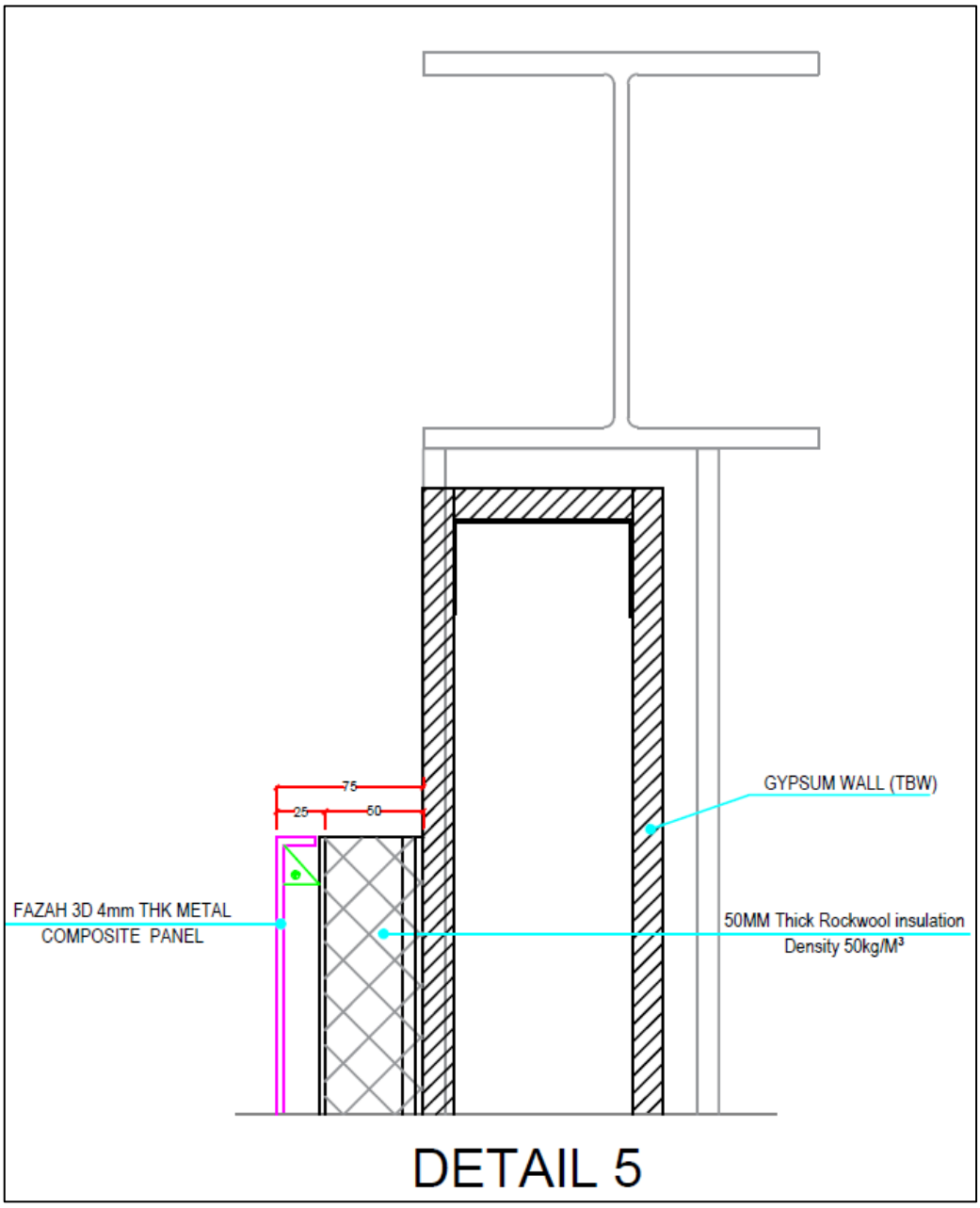
Drawing 9: Detail 2 of drawing 5.
(Drawing provided by the test sponsor)



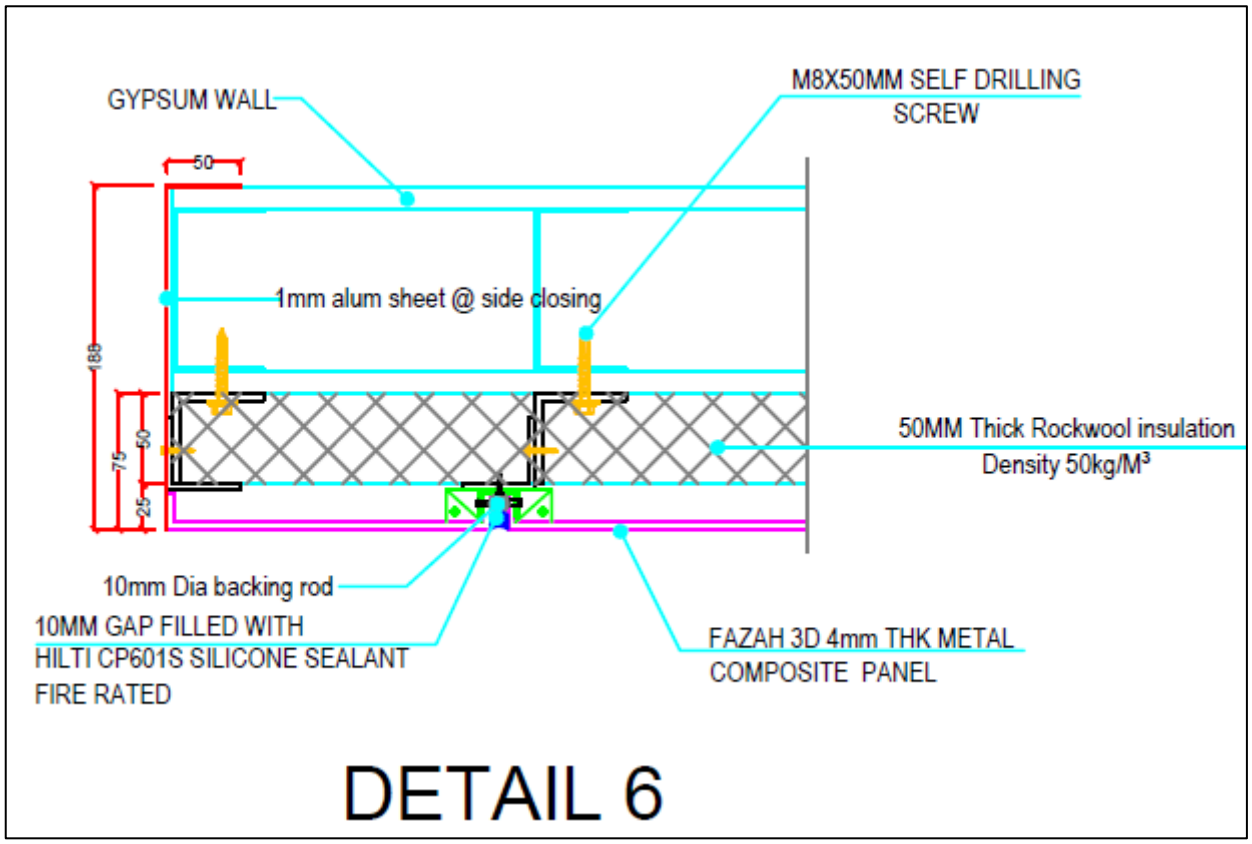
Drawing 10: Detail 3 of drawing 5.
(Drawing provided by the test sponsor)



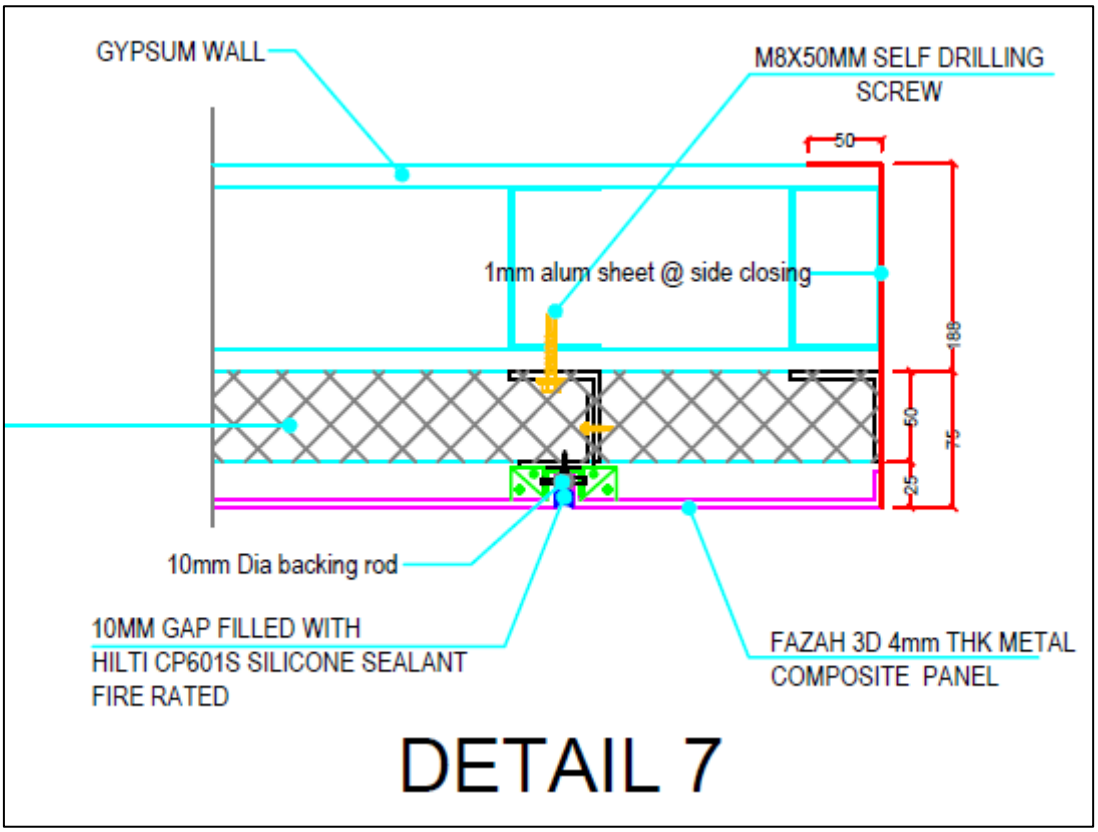
Drawing 11: Detail 4 of drawing 5.
(Drawing provided by the test sponsor)



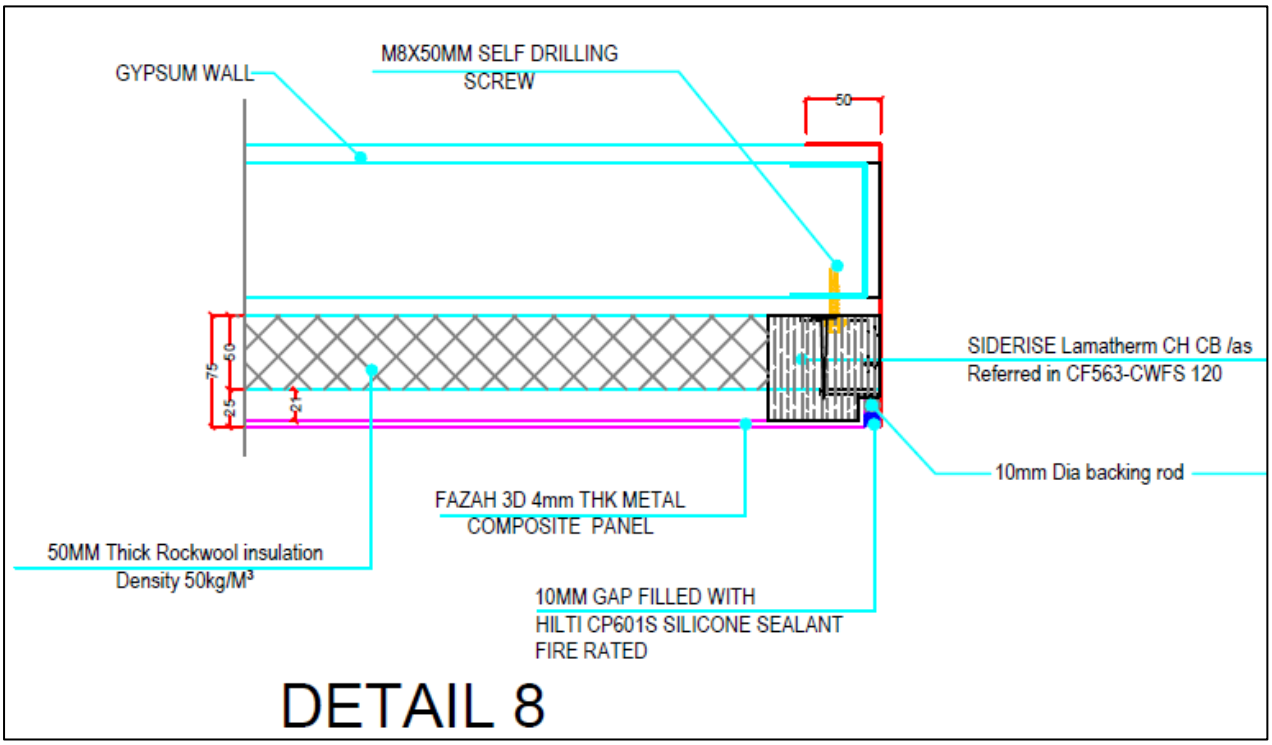
Drawing 12: Detail 5 of drawing 5.
(Drawing provided by the test sponsor)



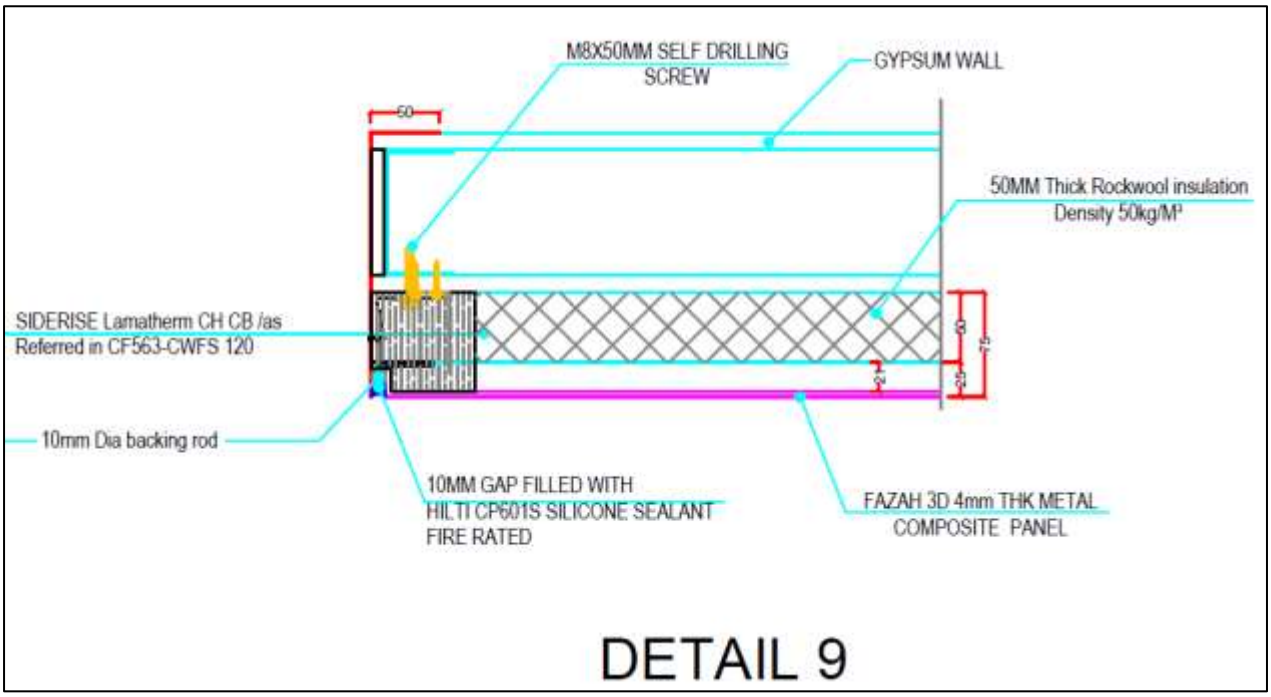
Drawing 13: Detail 6 of drawing 7.
(Drawing provided by the test sponsor)



Drawing 14: Detail 7 of drawing 7.
(Drawing provided by the test sponsor)



Drawing 15: Detail 8 of drawing 6.
(Drawing provided by the test sponsor)



Drawing 16: Detail 9 of drawing 6.
(Drawing provided by the test sponsor)

17. APPENDIX 5 – THERMOCOUPLE DATA

Time (min:sec)	Tc 1 (°F)	Tc 2 (°F)	Tc 3 (°F)	Tc 4 (°F)	Tc 5 (°F)	Tc 6 (°F)	Tc 7 (°F)	Tc 8 (°F)	Tc 9 (°F)
0:00	113	97	97	92	94	91	90	90	90
0:15	479	395	433	453	485	421	288	321	250
0:30	642	595	599	512	580	467	416	379	269
0:45	713	652	640	531	598	483	431	390	294
1:00	819	678	677	566	636	503	445	408	318
1:15	840	695	704	585	651	519	469	432	337
1:30	888	732	742	612	689	545	484	437	355
1:45	939	718	746	632	697	569	501	449	366
2:00	935	731	757	637	702	573	514	475	397
2:15	506	739	759	643	704	583	525	483	397
2:30	920	733	751	625	693	566	507	474	397
2:45	959	748	767	646	715	583	528	485	400
3:00	922	759	770	624	700	568	512	465	388
3:15	915	761	790	681	746	617	557	518	419
3:30	952	770	808	708	770	649	589	545	448
3:45	949	781	803	685	747	619	560	515	426
4:00	962	789	818	704	764	640	564	515	427
4:15	981	804	819	692	754	627	567	525	443
4:30	978	798	820	699	759	647	586	543	458
4:45	1002	806	818	695	757	641	585	538	456
5:00	1019	844	861	720	798	665	591	548	468
5:15	1091	956	1003	922	991	851	752	694	527
5:30	1124	997	1060	958	1037	864	764	698	532
5:45	1134	1012	1064	972	1053	898	807	759	566
6:00	1116	1030	1083	976	1070	885	775	736	574
6:15	1144	1034	1091	964	1070	880	743	719	576
6:30	1132	1046	1084	979	1059	900	748	754	585
6:45	1174	1055	1102	976	1074	898	756	746	603
7:00	1132	1072	1105	972	1070	883	725	718	597
7:15	1131	1090	1115	957	1069	866	703	712	592
7:30	1183	1097	1117	966	1062	856	734	732	608
7:45	1157	1103	1108	956	1053	850	732	739	611
8:00	1142	1117	1106	944	1035	846	738	747	617
8:15	1149	1123	1116	963	1057	863	752	754	627
8:30	1172	1222	1135	945	1049	834	717	723	606
8:45	1177	1228	1158	957	1062	848	727	738	611
9:00	1180	1168	1157	991	1084	879	762	784	630
9:15	1148	1261	1204	1012	1113	896	776	797	636
9:30	1139	1295	1208	994	1101	878	769	799	641
9:45	1188	1317	1257	1029	1151	906	773	803	648

Time (min:sec)	Tc 1 (°F)	Tc 2 (°F)	Tc 3 (°F)	Tc 4 (°F)	Tc 5 (°F)	Tc 6 (°F)	Tc 7 (°F)	Tc 8 (°F)	Tc 9 (°F)
10:00	1174	1308	1261	1061	1161	949	821	859	681
10:15	1163	1413	1318	1065	1178	953	840	869	699
10:30	1196	1410	1348	1119	1220	984	865	889	715
10:45	1214	1431	1383	1148	1261	985	875	893	733
11:00	1228	1450	1370	1110	1227	942	829	842	716
11:15	1250	1530	1398	1134	1253	967	858	862	740
11:30	1216	1529	1418	1137	1265	957	849	877	731
11:45	1215	1512	1374	1096	1209	924	810	819	714
12:00	1262	1500	1369	1090	1212	918	807	811	716
12:15	1219	1527	1422	1141	1281	935	878	836	712
12:30	1331	1488	1412	1142	1282	929	934	857	713
12:45	1275	1515	1425	1149	1294	934	935	859	721
13:00	1196	1441	1359	1142	1255	936	946	889	729
13:15	1189	1383	1313	1120	1217	912	914	856	718
13:30	1245	1356	1288	1081	1187	885	896	826	706
13:45	1253	1389	1314	1091	1209	874	890	808	688
14:00	1181	1360	1286	1083	1193	1001	908	831	662
14:15	1211	1346	1278	1093	1195	1018	943	860	679
14:30	1150	1333	1286	1081	1198	1011	925	850	677
14:45	1183	1327	1284	1089	1201	983	938	863	690
15:00	1202	1317	1292	1097	1210	968	926	852	689
15:15	1187	1317	1297	1103	1212	973	948	877	712
15:30	1208	1317	1327	1110	1232	962	951	884	728
15:45	1251	1328	1349	1117	1248	961	957	887	737
16:00	1295	1327	1358	1131	1263	969	962	889	742
16:15	1207	1305	1326	1122	1235	967	923	886	750
16:30	1228	1289	1301	1127	1229	967	898	906	765
16:45	1222	1286	1282	1117	1208	960	980	926	780
17:00	1205	1307	1292	1098	1199	934	944	878	760
17:15	1205	1288	1276	1079	1184	1014	935	854	718
17:30	1252	1277	1268	1090	1186	1028	954	881	728
17:45	1229	1280	1268	1091	1190	1019	936	854	720
18:00	1194	1273	1257	1109	1186	1039	954	882	726
18:15	1179	1264	1250	1103	1181	1032	947	873	716
18:30	1228	1281	1257	1122	1196	1051	954	877	725
18:45	1193	1265	1240	1104	1175	1047	959	892	733
19:00	1200	1269	1251	1123	1195	1060	971	905	743
19:15	1186	1260	1252	1115	1191	1056	971	911	756
19:30	1164	1256	1249	1114	1189	1067	988	933	762
19:45	1195	1260	1245	1096	1185	1045	962	896	747

Time (min:sec)	Tc 1 (°F)	Tc 2 (°F)	Tc 3 (°F)	Tc 4 (°F)	Tc 5 (°F)	Tc 6 (°F)	Tc 7 (°F)	Tc 8 (°F)	Tc 9 (°F)
20:00	1198	1269	1261	1109	1202	1047	958	899	747
20:15	1186	1267	1258	1121	1201	1072	984	929	761
20:30	1171	1276	1279	1140	1234	1084	991	926	767
20:45	1245	1299	1301	1155	1252	1092	994	921	758
21:00	1218	1294	1299	1153	1256	1085	985	914	756
21:15	1240	1305	1304	1157	1252	1082	977	919	765
21:30	1243	1300	1288	1149	1237	1086	988	924	763
21:45	1234	1300	1293	1148	1243	1083	986	920	767
22:00	1248	1310	1298	1150	1253	1072	970	899	753
22:15	1229	1296	1295	1153	1250	1076	965	895	748
22:30	1225	1298	1295	1175	1257	1097	988	931	765
22:45	1218	1291	1282	1135	1221	1064	959	903	756
23:00	1195	1298	1304	1168	1261	1091	975	933	760
23:15	1202	1290	1292	1161	1249	1090	978	924	766
23:30	1229	1288	1295	1149	1237	1081	973	933	767
23:45	1206	1290	1300	1168	1253	1102	997	959	778
24:00	1175	1292	1306	1164	1248	1094	1000	969	792
24:15	1196	1292	1304	1169	1252	1107	1014	983	796
24:30	1168	1286	1299	1178	1247	1116	1026	999	818
24:45	1220	1284	1291	1157	1228	1081	993	937	788
25:00	1236	1296	1303	1173	1243	1096	1000	953	786
25:15	1230	1283	1289	1155	1226	1087	989	937	781
25:30	1256	1304	1313	1167	1243	1089	986	927	767
25:45	1240	1305	1307	1165	1236	1095	994	939	779
26:00	1232	1318	1330	1189	1270	1101	991	933	775
26:15	1212	1334	1345	1208	1283	1121	1012	959	784
26:30	1264	1363	1373	1209	1294	1114	1001	939	769
26:45	1207	1338	1350	1202	1274	1115	1005	958	787
27:00	1231	1344	1358	1210	1285	1125	1015	962	783
27:15	1207	1333	1347	1209	1275	1127	1018	960	781
27:30	1276	1347	1357	1222	1289	1135	1024	955	778
27:45	1284	1345	1360	1212	1283	1112	1004	923	756
28:00	1250	1346	1352	1197	1268	1112	1007	950	775
28:15	1258	1340	1336	1193	1259	1128	1011	954	773
28:30	1279	1329	1316	1179	1237	1126	1017	972	790
28:45	1230	1328	1320	1186	1248	1129	1020	970	794
29:00	1296	1343	1341	1202	1265	1135	1016	944	783
29:15	1251	1335	1319	1176	1238	1115	1006	946	773
29:30	1242	1329	1324	1193	1257	1122	1007	944	778
29:45	1270	1346	1341	1223	1279	1154	1035	981	800
30:00	1275	1355	1342	1217	1266	1139	1028	972	802

Time (min:sec)	Tc 10 (°F)	Tc 11 (°F)	Tc 12 (°F)	Tc 13 (°F)	Tc 14 (°F)	Tc 15 (°F)	Tc 16 (°F)	Tc 17 (°F)	Tc 18 (°F)
0:00	89	90	89	60	89	90	88	88	92
0:15	271	231	242	-40	119	218	151	101	91
0:30	316	247	275	-77	139	237	176	112	92
0:45	328	256	279	-93	150	244	169	104	92
1:00	344	271	291	-100	162	253	172	103	92
1:15	362	291	304	-111	174	268	177	107	92
1:30	358	291	301	-116	175	269	187	108	92
1:45	347	283	275	-94	180	263	165	103	92
2:00	391	311	311		174	284	165	99	92
2:15	387	316	297	255	182	284	164	98	92
2:30	378	316	295	256	180	283	173	103	92
2:45	395	327	316	273	173	284	182	104	92
3:00	368	313	298	260	179	273	183	109	92
3:15	414	344	333	286	186	288	198	106	92
3:30	446	362	356	302	178	300	205	108	93
3:45	436	364	351	297	176	298	205	113	93
4:00	434	365	353	300	164	302	213	115	93
4:15	434	361	348	306	167	290	217	116	93
4:30	446	375	361	314	177	303	216	121	93
4:45	437	373	358	307	171	301	217	123	94
5:00	453	387	374	319	167	321	224	122	94
5:15	550	462	455	380	180	385	266	139	94
5:30	553	469	457	388	190	395	265	140	95
5:45	601	510	497	405	200	423	244	131	96
6:00	602	516	497	398	209	423	271	141	96
6:15	576	518	498	404	192	431	275	134	97
6:30	616	523	503	413	208	431	277	136	97
6:45	598	541	518	418	210	453	289	153	98
7:00	587	539	515	421	217	442	318	150	99
7:15	580	533	507	413	218	438	298	147	100
7:30	599	550	526	418	216	454	307	149	100
7:45	594	553	529	432	218	457	308	157	101
8:00	599	558	534	429	212	458	288	147	102
8:15	606	567	542	444	210	466	295	158	103
8:30	576	551	523	428	218	450	325	156	105
8:45	575	555	529	420	226	471	308	160	107
9:00	611	569	546	446	213	475	306	162	108
9:15	612	573	549	443	190	478	349	180	110
9:30	619	577	554	446	199	473	350	164	111
9:45	619	584	559	447	193	480	345	164	113

Time (min:sec)	Tc 10 (°F)	Tc 11 (°F)	Tc 12 (°F)	Tc 13 (°F)	Tc 14 (°F)	Tc 15 (°F)	Tc 16 (°F)	Tc 17 (°F)	Tc 18 (°F)
10:00	679	611	588	483	174	484	339	166	115
10:15	689	625	602	491	168	496	374	199	115
10:30	694	641	613	502	174	503	360	188	115
10:45	699	651	623	498	185	524	360	191	115
11:00	654	639	609	484	223	516	372	186	115
11:15	688	660	632	504	225	521	362	175	115
11:30	676	649	617	487	234	532	376	199	115
11:45	645	637	605	470	255	523	362	186	116
12:00	654	640	607	474	256	528	343	185	117
12:15	658	637	606	481	241	518	355	186	118
12:30	678	632	601	474	255	522	315	176	119
12:45	696	642	611	496	258	516	337	169	120
13:00	714	644	611	497	232	518	343	176	121
13:15	685	634	601	493	223	517	359	184	122
13:30	666	625	592	478	242	509	355	178	123
13:45	643	610	574	459	236	496	355	183	125
14:00	652	582	549	462	211	476	359	185	125
14:15	697	596	568	498	206	470	398	205	126
14:30	686	596	566	495	202	459	440	213	126
14:45	693	608	574	488	213	455	409	208	127
15:00	697	609	578	500	192	451	397	194	129
15:15	723	632	602	523	203	462	410	191	129
15:30	731	646	613	521	203	490	404	204	129
15:45	732	657	624	537	193	496	433	209	129
16:00	722	660	625	526	207	514	396	201	130
16:15	727	668	634	523	227	522	382	209	130
16:30	739	679	647	533	212	542	416	222	130
16:45	784	695	665	566	193	518	428	217	131
17:00	734	681	643	532	216	507	418	218	131
17:15	705	639	601	512	202	492	408	217	132
17:30	728	649	613	532	200	471	408	244	133
17:45	698	642	605	514	222	493	377	219	133
18:00	720	644	610	519	191	496	392	234	134
18:15	705	634	596	514	201	484	410	215	134
18:30	712	640	604	510	186	495	410	240	135
18:45	738	647	614	531	177	498	409	245	135
19:00	729	652	617	516	204	492	433	235	136
19:15	763	666	633	543	195	493	454	231	137
19:30	774	670	635	552	186	501	430	239	137
19:45	743	661	623	537	186	490	418	231	138

Time (min:sec)	Tc 10 (°F)	Tc 11 (°F)	Tc 12 (°F)	Tc 13 (°F)	Tc 14 (°F)	Tc 15 (°F)	Tc 16 (°F)	Tc 17 (°F)	Tc 18 (°F)
20:00	741	657	622	527	207	500	432	233	139
20:15	769	668	634	561	190	492	422	212	139
20:30	767	674	639	559	195	500	420	234	140
20:45	747	665	626	532	199	514	429	240	140
21:00	745	661	621	522	203	519	419	241	141
21:15	741	665	626	520	235	528	402	224	141
21:30	749	665	628	534	223	532	416	223	142
21:45	755	670	631	532	229	530	416	225	143
22:00	723	656	616	513	256	517	440	225	143
22:15	718	648	611	514	230	524	413	226	144
22:30	764	663	628	545	212	521	435	240	145
22:45	744	660	624	537	264	524	391	214	145
23:00	750	661	624	543	236	523	430	228	146
23:15	754	667	628	538	232	526	433	230	147
23:30	772	669	634	555	213	531	453	235	147
23:45	778	678	640	557	216	520	451	234	148
24:00	801	692	658	580	211	525	448	248	149
24:15	814	695	659	584	205	538	458	249	150
24:30	846	717	682	610	190	529	439	242	150
24:45	778	691	652	559	227	510	435	230	151
25:00	782	686	649	565	230	512	453	235	152
25:15	769	679	641	548	230	521	461	249	153
25:30	755	664	626	543	201	522	442	239	153
25:45	766	675	637	549	223	530	449	253	154
26:00	755	668	630	534	234	533	439	237	155
26:15	783	675	641	571	198	542	439	257	156
26:30	755	662	625	543	242	544	464	279	157
26:45	801	679	645	556	219	562	472	261	158
27:00	806	673	637	561	199	564	465	277	159
27:15	798	670	633	555	201	559	469	252	159
27:30	804	668	632	554	191	555	482	261	160
27:45	728	645	608	522	235	560	439	250	161
28:00	806	664	632	562	208	570	433	247	162
28:15	804	663	628	555	198	558	435	251	163
28:30	844	681	648	581	189	557	444	254	164
28:45	853	688	655	597	185	543	457	263	165
29:00	784	678	641	569	194	556	459	252	165
29:15	793	667	632	565	183	545	451	262	166
29:30	784	672	636	558	180	555	439	250	167
29:45	835	691	658	594	178	560	457	251	168
30:00	829	693	661	602	185	554	436	241	169

Time (min:sec)	Tc 19(°F)	Tc 20(°F)	Tc 21(°F)	Tc 22(°F)	Tc 23(°F)	Tc 24(°F)	Tc 25(°F)	Tc 26(°F)	Tc 27(°F)
0:00	91	92	93	93	93	92	93	92	91
0:15	91	92	94	94	93	93	93	90	89
0:30	91	94	95	95	95	93	94	92	90
0:45	92	100	97	99	99	94	97	95	91
1:00	92	107	99	104	103	95	100	97	91
1:15	92	116	101	109	109	97	103	100	91
1:30	92	127	104	115	114	98	106	104	92
1:45	92	139	108	121	121	100	110	107	93
2:00	92	152	111	128	129	102	113	110	94
2:15	92	165	115	133	136	104	116	113	94
2:30	92	179	119	142	144	106	120	116	95
2:45	92	192	123	150	151	108	124	119	96
3:00	92	205	127	157	158	111	127	122	97
3:15	92	217	132	164	167	114	131	125	98
3:30	93	229	136	170	174	116	134	128	99
3:45	93	241	141	177	182	119	138	131	100
4:00	93	251	146	185	190	122	141	134	102
4:15	93	262	151	191	197	125	145	137	104
4:30	93	271	157	198	204	129	148	141	106
4:45	93	280	163	202	211	132	152	144	107
5:00	94	289	169	206	218	135	156	146	110
5:15	94	301	176	214	227	139	162	149	110
5:30	94	317	185	229	238	145	174	156	112
5:45	95	336	196	248	252	152	186	163	114
6:00	95	358	206	262	266	160	196	170	116
6:15	96	382	216	273	278	168	205	176	118
6:30	96	404	229	282	293	231	219	183	119
6:45	97	427	236	291	302	186	224	190	123
7:00	97	451	246	306	314	195	231	198	126
7:15	98	474	257	317	325	203	239	203	129
7:30	99	495	264	328	335	211	243	209	132
7:45	99	512	269	342	346	219	249	214	135
8:00	100	528	275	353	356	228	254	221	139
8:15	101	543	281	361	366	236	261	227	142
8:30	101	560	288	368	374	243	265	233	146
8:45	102	577	295	375	379	251	270	240	150
9:00	103	596	303	382	387	257	275	245	153
9:15	103	615	311	391	395	264	279	251	157
9:30	104	633	319	403	402	272	285	257	160
9:45	105	644	328	414	410	279	288	262	164

Time (min:sec)	Tc 19(°F)	Tc 20(°F)	Tc 21(°F)	Tc 22(°F)	Tc 23(°F)	Tc 24(°F)	Tc 25(°F)	Tc 26(°F)	Tc 27(°F)
10:00	106	656	338	424	423	286	293	267	168
10:15	107	668	348	438	435	295	298	272	172
10:30	107	682	361	454	447	303	304	277	175
10:45	108	698	377	470	462	311	311	282	179
11:00	109	716	396	496	480	322	319	288	183
11:15	110	731	420	523	498	331	325	295	188
11:30	111	746	445	557	520	341	334	301	191
11:45	112	764	477	592	536	351	345	309	196
12:00	113	778	500	606	546	359	355	315	201
12:15	114	787	531	612	563	369	361	320	205
12:30	115	797	556	621	564	380	367	325	210
12:45	116	808	583	628	574	392	371	329	214
13:00	117	821	611	644	581	405	374	333	218
13:15	118	832	637	661	589	417	377	340	223
13:30	119	840	656	673	603	426	380	344	228
13:45	121	847	667	680	614	432	383	348	232
14:00	122	855	674	687	622	436	386	354	239
14:15	123	867	679	696	630	440	390	358	244
14:30	124	883	693	709	639	444	394	361	248
14:45	125	900	699	720	648	446	397	365	252
15:00	126	922	708	730	664	447	400	370	256
15:15	127	944	727	741	678	448	403	374	260
15:30	128	954	748	752	687	448	407	377	263
15:45	129	971	766	762	697	450	411	381	268
16:00	130	1018	786	780	707	451	414	385	272
16:15	131	1052	813	793	719	454	418	387	276
16:30	131	1077	841	806	730	457	423	390	278
16:45	132	1109	864	817	739	461	429	396	283
17:00	133	1122	878	829	749	464	433	400	287
17:15	133	1136	889	842	758	467	437	406	294
17:30	134	1154	886	845	764	471	441	408	298
17:45	136	1151	909	863	774	475	444	411	302
18:00	137	1155	909	861	779	478	447	413	306
18:15	138	1158	908	867	784	482	451	416	310
18:30	138	1162	905	867	788	486	453	419	314
18:45	139	1159	898	870	792	490	457	422	317
19:00	140	1160	901	872	796	494	460	424	321
19:15	140	1164	903	877	800	499	463	428	325
19:30	141	1166	900	875	801	503	467	431	328
19:45	141	1164	917	887	805	508	470	435	332

Time (min:sec)	Tc 19(°F)	Tc 20(°F)	Tc 21(°F)	Tc 22(°F)	Tc 23(°F)	Tc 24(°F)	Tc 25(°F)	Tc 26(°F)	Tc 27(°F)
20:00	142	1168	931	887	807	513	473	438	335
20:15	143	1172	916	878	804	517	476	440	338
20:30	143	1173	925	887	809	522	479	443	342
20:45	144	1175	933	893	813	527	482	446	345
21:00	145	1176	937	897	817	532	485	450	348
21:15	146	1176	941	900	821	537	489	453	351
21:30	147	1176	935	897	823	543	492	456	354
21:45	148	1176	933	896	825	548	496	459	357
22:00	148	1177	932	895	827	552	500	462	361
22:15	149	1174	922	890	827	555	503	465	363
22:30	150	1175	914	887	826	558	505	466	366
22:45	151	1177	909	888	828	562	508	468	369
23:00	152	1179	905	887	830	564	511	469	371
23:15	152	1177	907	889	832	568	513	472	373
23:30	153	1177	904	886	831	571	516	473	375
23:45	154	1174	902	885	832	574	519	475	377
24:00	155	1177	895	880	830	577	521	477	380
24:15	156	1172	890	877	830	580	525	480	382
24:30	156	1173	886	874	830	583	528	483	384
24:45	157	1171	881	872	830	586	531	487	387
25:00	158	1175	872	867	828	589	533	489	390
25:15	159	1171	865	863	827	591	535	492	392
25:30	160	1177	859	859	825	593	537	495	395
25:45	161	1182	853	856	824	594	538	497	398
26:00	162	1186	850	854	823	596	539	499	401
26:15	162	1198	850	855	823	599	542	502	404
26:30	163	1218	849	855	824	603	544	505	407
26:45	164	1211	847	854	825	606	546	508	410
27:00	165	1213	847	855	826	609	549	511	413
27:15	166	1205	847	856	827	612	552	515	416
27:30	167	1207	845	855	828	615	555	518	419
27:45	167	1211	845	856	830	619	556	521	423
28:00	168	1208	842	856	830	622	558	523	425
28:15	169	1200	840	856	832	627	560	525	428
28:30	170	1189	836	855	832	630	562	528	431
28:45	171	1188	834	854	832	634	564	531	434
29:00	171	1201	832	854	832	636	566	533	437
29:15	172	1196	829	853	833	638	566	534	439
29:30	173	1193	828	853	833	641	567	536	442
29:45	174	1200	828	853	834	644	568	537	445
30:00	175	1199	828	854	835	647	570	539	447

Time (min:sec)	Tc 28(°F)	Tc 29(°F)	Tc 30(°F)	Tc 31(°F)	Tc 32(°F)	Tc 33(°F)	Tc 34(°F)	Tc 35(°F)	Tc 36(°F)
0:00	91	92	90	93	92	92	92	92	91
0:15	89	90	88	95	95	95	95	95	91
0:30	91	91	91	95	94	95	95	95	91
0:45	93	92	93	94	93	93	93	94	91
1:00	95	92	95	94	93	93	93	94	92
1:15	97	92	97	94	93	93	93	95	92
1:30	99	92	100	94	93	93	93	96	92
1:45	101	93	103	95	93	93	93	97	92
2:00	104	93	106	96	94	94	93	98	92
2:15	106	93	109	96	94	94	94	100	92
2:30	108	93	112	97	94	95	94	101	92
2:45	110	94	114	98	95	95	94	103	92
3:00	112	94	117	99	95	96	95	104	92
3:15	114	94	120	100	96	97	95	106	92
3:30	116	96	123	101	96	97	96	108	93
3:45	118	96	126	102	97	98	96	109	93
4:00	120	96	128	102	97	99	97	111	93
4:15	123	97	132	103	97	99	97	111	93
4:30	125	98	135	103	97	99	97	113	94
4:45	127	99	137	104	98	100	98	114	94
5:00	129	101	140	105	98	101	98	115	94
5:15	130	100	143	106	100	102	100	118	95
5:30	133	98	147	107	100	103	100	121	95
5:45	135	100	151	109	102	105	102	124	96
6:00	139	98	156	110	102	105	102	126	96
6:15	142	100	160	112	104	107	103	130	97
6:30	146	101	165	111	103	107	104	132	98
6:45	150	98	170	113	105	109	105	135	98
7:00	154	100	175	114	105	109	105	138	99
7:15	157	98	179	115	106	111	106	142	100
7:30	161	98	183	116	107	111	107	145	101
7:45	164	100	188	117	108	112	107	148	101
8:00	168	99	193	118	108	113	108	151	102
8:15	172	99	198	119	109	113	108	154	103
8:30	175	101	202	120	110	114	109	157	104
8:45	178	103	207	120	110	115	109	159	104
9:00	181	101	211	121	111	116	110	162	105
9:15	184	102	215	122	112	117	111	165	106
9:30	187	101	219	123	112	118	112	168	107
9:45	190	101	223	124	113	118	112	171	108

Time (min:sec)	Tc 28(°F)	Tc 29(°F)	Tc 30(°F)	Tc 31(°F)	Tc 32(°F)	Tc 33(°F)	Tc 34(°F)	Tc 35(°F)	Tc 36(°F)
10:00	194	103	227	125	114	120	113	174	109
10:15	198	103	231	125	114	120	113	176	110
10:30	201	103	236	126	115	121	114	179	111
10:45	206	103	241	128	117	122	115	182	112
11:00	211	103	246	128	117	123	115	184	114
11:15	215	104	250	128	117	123	115	186	115
11:30	218	103	255	132	119	124	117	189	116
11:45	223	104	259	132	119	124	117	191	117
12:00	227	104	264	133	119	124	117	194	118
12:15	231	105	267	134	121	125	117	197	119
12:30	235	106	272	134	120	125	117	198	120
12:45	238	108	274	136	122	126	118	202	121
13:00	241	106	277	139	124	128	119	205	122
13:15	245	110	280	141	125	129	119	207	123
13:30	250	108	284	142	126	129	119	208	125
13:45	253	111	286	144	128	130	120	210	126
14:00	259	113	290	142	124	127	117	208	127
14:15	262	112	292	144	127	129	118	210	128
14:30	265	112	294	145	130	130	118	211	130
14:45	268	111	294	146	133	131	119	212	131
15:00	270	114	296	147	132	132	120	213	133
15:15	273	115	298	148	131	134	121	214	135
15:30	275	115	300	150	132	135	122	215	136
15:45	278	115	302	151	133	136	122	216	137
16:00	281	114	306	151	135	136	123	216	139
16:15	283	115	309	153	137	138	123	219	141
16:30	285	115	310	155	139	140	125	222	142
16:45	289	115	314	155	139	139	124	222	144
17:00	293	118	319	155	140	139	124	223	146
17:15	298	119	325	153	138	137	121	222	147
17:30	301	118	328	154	139	137	122	223	149
17:45	304	120	331	154	139	138	122	225	151
18:00	306	120	333	155	140	139	123	227	153
18:15	309	119	335	156	141	139	123	229	155
18:30	311	119	338	156	142	140	123	230	157
18:45	314	120	340	157	142	140	124	232	160
19:00	316	120	343	158	143	141	124	234	162
19:15	319	122	345	158	144	141	124	235	165
19:30	322	123	348	159	144	142	125	237	167
19:45	324	124	352	159	144	142	125	238	170

Time (min:sec)	Tc 28(°F)	Tc 29(°F)	Tc 30(°F)	Tc 31(°F)	Tc 32(°F)	Tc 33(°F)	Tc 34(°F)	Tc 35(°F)	Tc 36(°F)
20:00	327	125	355	159	144	143	125	239	172
20:15	329	125	357	160	145	143	126	241	174
20:30	331	128	360	160	146	144	126	241	176
20:45	334	127	364	161	146	144	127	242	178
21:00	336	130	367	161	147	144	127	244	181
21:15	339	135	370	162	147	144	127	246	184
21:30	341	135	372	163	148	145	128	248	186
21:45	344	134	375	163	148	145	128	250	187
22:00	347	135	378	163	148	145	128	252	189
22:15	349	134	379	164	149	146	128	254	191
22:30	351	136	380	165	150	147	129	257	192
22:45	354	138	382	165	150	147	129	258	193
23:00	356	139	384	167	151	148	130	260	194
23:15	359	142	386	167	151	149	130	261	195
23:30	361	142	388	169	152	150	131	263	195
23:45	363	143	389	169	153	150	131	264	196
24:00	366	143	391	171	153	151	132	265	196
24:15	368	145	393	172	154	152	133	266	197
24:30	370	145	396	173	155	153	133	266	198
24:45	372	149	399	173	155	153	133	266	199
25:00	374	151	401	174	156	154	134	267	200
25:15	375	152	402	175	156	154	134	268	200
25:30	377	158	403	176	157	155	135	268	201
25:45	378	159	404	176	157	156	135	269	202
26:00	379	158	405	177	158	156	135	270	203
26:15	381	159	406	178	159	157	136	272	203
26:30	382	159	407	179	159	158	136	273	205
26:45	384	161	408	180	160	158	137	274	206
27:00	385	161	409	181	161	159	138	276	207
27:15	387	162	411	182	161	160	138	278	208
27:30	389	161	412	182	162	160	138	279	209
27:45	391	162	413	183	162	161	138	280	210
28:00	392	162	412	184	163	161	139	282	211
28:15	394	162	413	185	163	162	140	284	212
28:30	396	167	414	185	164	163	140	285	213
28:45	397	168	416	186	164	163	140	285	215
29:00	399	167	418	186	164	163	140	284	216
29:15	400	165	419	187	165	164	141	286	217
29:30	401	165	420	187	166	164	141	286	217
29:45	403	165	421	188	166	165	142	287	218
30:00	404	167	423	188	166	165	142	287	219

Time (min:sec)	Tc 37(°F)	Tc 38(°F)	Tc 39(°F)	Tc 40(°F)	Tc 41(°F)	Tc 42(°F)	Tc 43(°F)	Tc 44(°F)	Tc 45(°F)
0:00	91	92	92	91	168	166	211	220	222
0:15	91	92	92	91	548	557	781	842	823
0:30	91	92	92	91	806	801	1071	1168	1102
0:45	91	92	92	92	915	939	1155	1275	1172
1:00	91	92	92	93	976	1009	1176	1328	1206
1:15	91	92	92	94	1008	1046	1193	1332	1231
1:30	91	92	92	95	1026	1071	1197	1322	1242
1:45	92	92	92	96	1042	1082	1187	1360	1252
2:00	92	92	92	97	1052	1099	1206	1377	1258
2:15	92	92	92	98	1059	1120	1213	1367	1261
2:30	92	92	92	99	1065	1121	1212	1408	1272
2:45	92	93	92	100	1076	1126	1213	1395	1273
3:00	92	93	92	101	1085	1127	1219	1425	1268
3:15	92	93	92	102	1090	1142	1238	1414	1295
3:30	92	93	93	104	1100	1155	1238	1424	1305
3:45	92	93	93	105	1112	1151	1249	1445	1316
4:00	93	94	93	107	1120	1148	1254	1466	1337
4:15	93	94	93	108	1130	1149	1277	1495	1345
4:30	94	95	93	110	1138	1153	1279	1498	1371
4:45	94	95	93	111	1150	1167	1294	1482	1380
5:00	94	95	94	113	1159	1172	1299	1499	1395
5:15	94	96	94	115	1186	1197	1340	1562	1458
5:30	95	96	94	117	1211	1226	1382	1555	1494
5:45	95	97	94	120	1212	1242	1382	1561	1474
6:00	95	97	95	122	1217	1253	1376	1579	1501
6:15	95	98	95	124	1229	1252	1389	1567	1500
6:30	96	98	95	127	1235	1249	1386	1599	1518
6:45	96	99	95	129	1232	1261	1392	1563	1502
7:00	97	99	96	132	1242	1257	1383	1602	1549
7:15	97	100	96	135	1240	1262	1377	1532	1539
7:30	98	101	96	138	1247	1268	1394	1552	1541
7:45	98	101	96	141	1253	1277	1402	1570	1535
8:00	99	102	97	143	1258	1276	1393	1576	1567
8:15	99	102	97	145	1262	1281	1397	1573	1555
8:30	99	103	97	148	1260	1276	1387	1568	1548
8:45	100	104	97	150	1265	1277	1393	1588	1571
9:00	100	104	97	152	1264	1285	1395	1583	1570
9:15	101	105	98	155	1277	1277	1402	1586	1535
9:30	101	105	98	158	1283	1277	1406	1603	1550
9:45	102	106	98	160	1278	1290	1407	1578	1604

Time (min:sec)	Tc 37(°F)	Tc 38(°F)	Tc 39(°F)	Tc 40(°F)	Tc 41(°F)	Tc 42(°F)	Tc 43(°F)	Tc 44(°F)	Tc 45(°F)
10:00	102	107	99	163	1285	1283	1415	1594	1542
10:15	103	108	99	166	1299	1287	1413	1582	1532
10:30	104	108	99	169	1318	1301	1449	1610	1567
10:45	104	109	100	172	1318	1316	1462	1627	1608
11:00	105	110	100	174	1321	1328	1463	1627	1641
11:15	106	111	100	177	1323	1345	1469	1627	1675
11:30	106	112	100	179	1326	1346	1463	1619	1638
11:45	107	112	101	182	1339	1343	1477	1627	1627
12:00	107	113	101	184	1335	1363	1487	1632	1668
12:15	108	114	102	186	1342	1361	1481	1629	1666
12:30	108	114	102	187	1348	1382	1502	1617	1661
12:45	109	115	102	189	1355	1373	1500	1660	1697
13:00	109	116	103	190	1360	1368	1484	1672	1658
13:15	110	116	103	192	1365	1362	1492	1673	1605
13:30	110	117	104	194	1361	1383	1501	1646	1698
13:45	111	118	105	196	1365	1377	1501	1643	1646
14:00	112	118	105	197	1375	1372	1515	1659	1671
14:15	112	119	106	199	1371	1372	1507	1662	1622
14:30	113	120	106	203	1371	1372	1499	1662	1634
14:45	114	120	107	206	1370	1373	1490	1680	1628
15:00	115	121	107	208	1381	1375	1514	1697	1598
15:15	115	122	108	210	1382	1370	1512	1684	1583
15:30	116	123	108	213	1393	1374	1509	1680	1611
15:45	117	123	109	215	1410	1398	1545	1742	1630
16:00	118	124	109	218	1421	1407	1553	1714	1646
16:15	119	125	110	220	1421	1414	1545	1722	1701
16:30	119	125	110	223	1420	1419	1562	1724	1679
16:45	120	126	111	226	1425	1409	1547	1681	1621
17:00	121	127	111	228	1426	1411	1537	1706	1649
17:15	121	127	112	231	1430	1418	1565	1738	1633
17:30	122	128	113	233	1436	1417	1563	1742	1625
17:45	123	129	113	234	1429	1424	1553	1710	1667
18:00	124	129	114	235	1440	1426	1557	1734	1642
18:15	125	130	114	237	1443	1430	1560	1739	1664
18:30	126	131	115	238	1444	1431	1567	1732	1659
18:45	127	132	115	240	1445	1428	1563	1740	1623
19:00	128	133	115	242	1441	1426	1562	1720	1652
19:15	129	133	116	244	1447	1425	1565	1722	1640
19:30	130	134	116	246	1446	1429	1557	1730	1661
19:45	131	135	117	248	1448	1440	1563	1737	1694

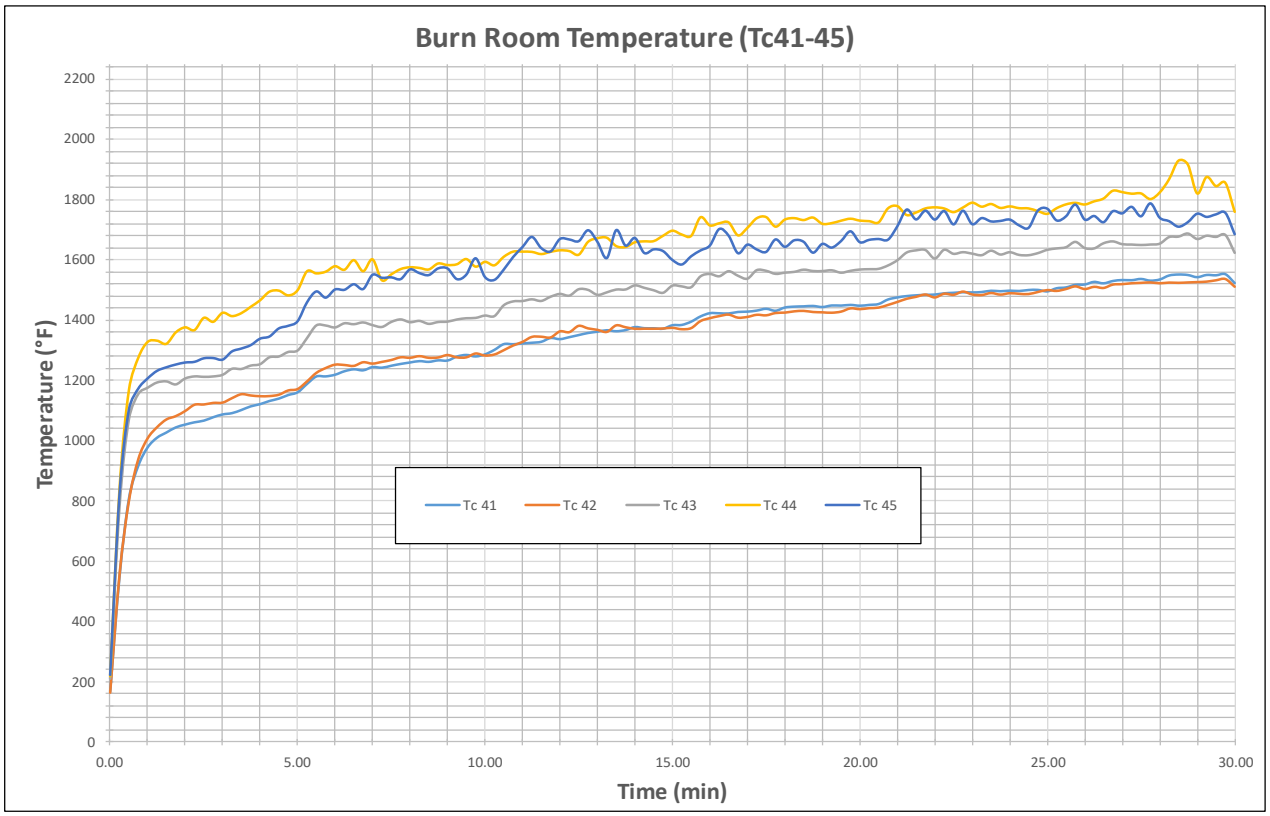
Time (min:sec)	Tc 37(°F)	Tc 38(°F)	Tc 39(°F)	Tc 40(°F)	Tc 41(°F)	Tc 42(°F)	Tc 43(°F)	Tc 44(°F)	Tc 45(°F)
20:00	132	136	117	249	1446	1437	1568	1730	1657
20:15	132	137	118	251	1448	1440	1569	1729	1665
20:30	133	138	118	253	1451	1442	1570	1725	1668
20:45	134	139	119	254	1466	1451	1581	1771	1666
21:00	135	139	119	256	1473	1461	1598	1778	1710
21:15	136	140	120	257	1478	1471	1624	1749	1766
21:30	137	141	120	258	1480	1478	1631	1757	1733
21:45	138	142	121	259	1482	1485	1632	1771	1762
22:00	138	143	121	260	1483	1476	1604	1774	1732
22:15	139	144	122	261	1487	1488	1633	1771	1761
22:30	140	145	122	262	1489	1485	1620	1759	1717
22:45	141	145	122	264	1490	1495	1625	1774	1762
23:00	142	146	123	264	1490	1486	1620	1790	1717
23:15	143	147	123	266	1491	1484	1615	1777	1737
23:30	143	147	123	267	1495	1490	1630	1785	1726
23:45	144	148	123	268	1494	1485	1617	1772	1728
24:00	145	149	124	270	1496	1490	1625	1777	1732
24:15	146	149	124	272	1494	1488	1616	1772	1713
24:30	147	150	124	273	1498	1487	1615	1771	1705
24:45	148	151	125	274	1498	1494	1622	1762	1762
25:00	149	152	125	275	1493	1500	1633	1753	1769
25:15	150	153	125	277	1504	1497	1637	1772	1730
25:30	151	154	126	278	1506	1504	1641	1784	1743
25:45	152	155	126	280	1515	1512	1659	1789	1782
26:00	153	156	127	281	1516	1504	1639	1784	1732
26:15	155	156	127	282	1525	1511	1637	1794	1744
26:30	156	157	127	283	1520	1507	1655	1804	1724
26:45	156	158	128	284	1528	1518	1661	1829	1760
27:00	157	159	128	286	1531	1520	1651	1825	1753
27:15	158	160	129	287	1530	1523	1650	1820	1775
27:30	158	161	129	289	1534	1524	1649	1821	1743
27:45	159	162	129	290	1529	1526	1650	1802	1786
28:00	160	162	130	291	1533	1523	1653	1824	1739
28:15	161	163	130	291	1546	1525	1675	1868	1727
28:30	162	164	131	292	1549	1524	1676	1929	1709
28:45	163	165	131	292	1547	1526	1687	1916	1724
29:00	163	166	131	294	1540	1527	1669	1820	1752
29:15	164	166	132	295	1548	1528	1680	1875	1741
29:30	165	167	132	296	1546	1533	1676	1845	1750
29:45	166	168	132	296	1550	1537	1682	1856	1755
30:00	168	169	133	297	1521	1511	1623	1760	1684

Time (min:sec)	Tc 46(°F)	Tc 47(°F)	Tc 48(°F)	Tc 49(°F)	Tc 50(°F)	Tc 51(°F)	Tc 52(°F)	Tc 53(°F)	Tc 54(°F)
0:00	173	159	189	87	88	87	87	87	87
0:15	575	523	599	87	88	87	87	87	87
0:30	826	781	793	88	88	87	87	87	87
0:45	946	924	899	88	88	87	87	87	87
1:00	1006	1005	966	88	88	87	87	87	87
1:15	1051	1059	1011	87	87	87	87	87	87
1:30	1089	1108	1074	87	88	87	87	87	87
1:45	1131	1143	1094	87	88	87	87	87	87
2:00	1130	1158	1128	88	88	87	87	87	87
2:15	1148	1170	1148	88	88	87	88	88	87
2:30	1165	1188	1173	88	88	87	87	87	87
2:45	1181	1206	1176	88	88	87	87	88	88
3:00	1188	1219	1197	88	88	87	88	88	88
3:15	1215	1235	1204	88	88	88	88	88	88
3:30	1232	1244	1216	88	88	88	88	88	88
3:45	1241	1259	1230	88	88	88	88	88	88
4:00	1248	1274	1251	88	89	88	88	88	88
4:15	1269	1292	1252	89	89	88	89	88	88
4:30	1264	1293	1260	89	89	88	89	88	88
4:45	1284	1300	1261	89	89	88	89	89	88
5:00	1289	1312	1262	89	89	89	89	89	88
5:15	1333	1349	1300	89	89	89	89	89	89
5:30	1361	1372	1314	90	90	89	89	89	89
5:45	1375	1398	1336	90	90	89	90	89	89
6:00	1384	1409	1342	90	90	89	90	89	89
6:15	1389	1414	1338	90	91	89	90	90	89
6:30	1397	1417	1357	90	91	90	91	90	90
6:45	1403	1423	1357	91	92	90	91	90	90
7:00	1400	1408	1356	91	92	90	91	91	90
7:15	1413	1419	1363	91	92	90	91	91	90
7:30	1420	1431	1374	92	92	90	92	91	91
7:45	1436	1435	1369	92	93	91	92	91	91
8:00	1445	1433	1368	92	93	91	92	92	91
8:15	1449	1449	1379	92	94	91	92	91	91
8:30	1433	1428	1383	93	94	91	93	92	91
8:45	1443	1427	1378	93	94	92	93	92	92
9:00	1448	1438	1390	93	94	92	93	92	92
9:15	1430	1431	1391	94	95	92	93	93	92
9:30	1428	1439	1402	94	95	93	93	93	92
9:45	1457	1440	1411	94	96	93	94	93	93

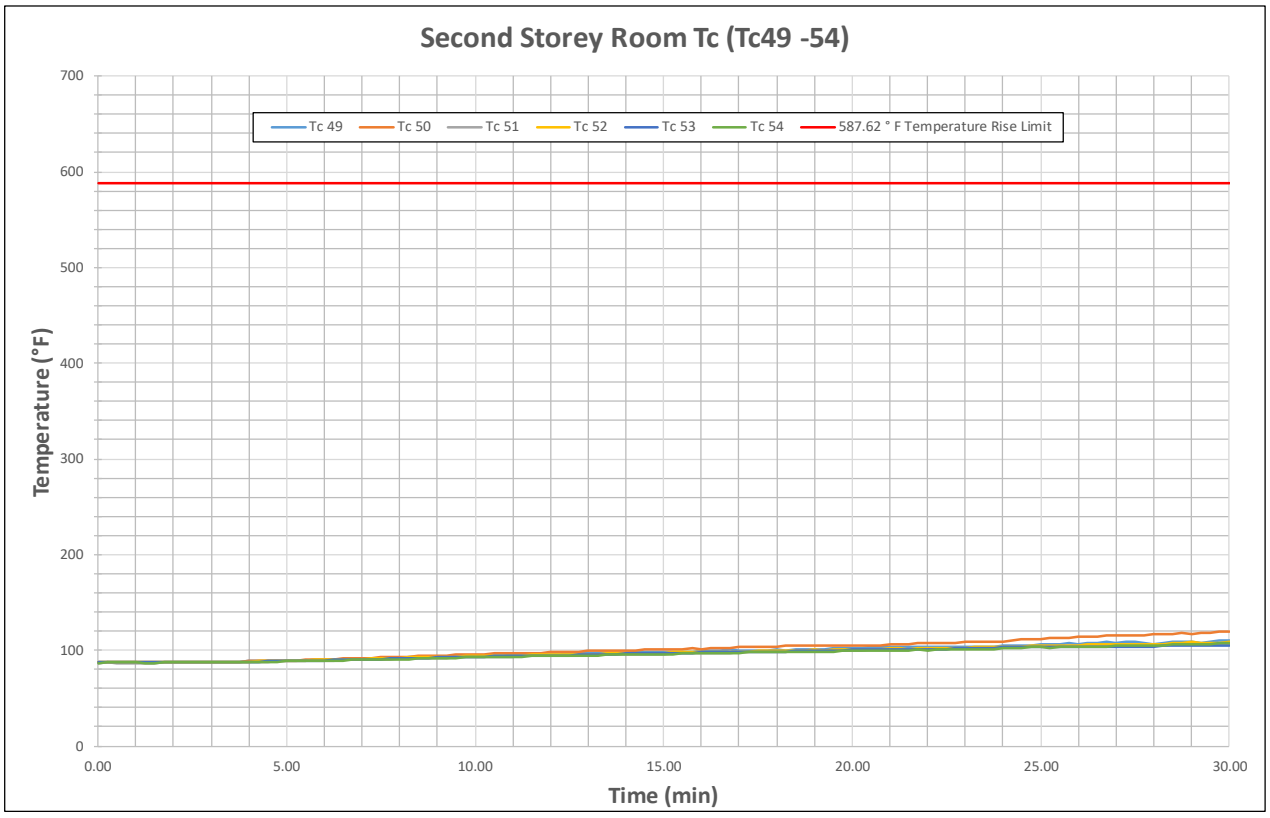
Time (min:sec)	Tc 46(°F)	Tc 47(°F)	Tc 48(°F)	Tc 49(°F)	Tc 50(°F)	Tc 51(°F)	Tc 52(°F)	Tc 53(°F)	Tc 54(°F)
10:00	1461	1452	1411	94	96	93	94	93	93
10:15	1471	1453	1413	95	96	93	94	93	93
10:30	1479	1472	1437	95	96	93	94	94	93
10:45	1511	1499	1457	95	97	94	95	94	93
11:00	1509	1501	1465	95	97	93	95	94	93
11:15	1546	1522	1469	95	97	94	95	94	93
11:30	1540	1524	1466	95	97	94	95	94	94
11:45	1533	1512	1477	96	97	94	95	94	94
12:00	1548	1533	1482	96	98	95	96	94	94
12:15	1535	1526	1475	96	98	95	96	94	94
12:30	1550	1582	1519	96	98	95	96	95	94
12:45	1569	1566	1508	97	99	95	96	95	94
13:00	1573	1559	1508	97	99	95	96	95	95
13:15	1579	1569	1513	97	99	95	96	96	95
13:30	1585	1563	1503	97	100	95	96	96	95
13:45	1584	1557	1514	97	100	96	96	96	95
14:00	1600	1562	1520	98	100	96	97	96	95
14:15	1610	1573	1516	98	100	96	97	97	96
14:30	1624	1568	1516	98	100	96	97	97	96
14:45	1606	1564	1516	98	101	96	97	97	96
15:00	1586	1568	1524	98	101	96	98	97	96
15:15	1604	1575	1525	98	101	97	98	97	96
15:30	1634	1600	1538	98	101	97	98	97	96
15:45	1644	1616	1561	99	102	97	98	97	97
16:00	1671	1641	1585	99	102	97	98	98	97
16:15	1666	1653	1599	100	102	97	98	98	97
16:30	1662	1673	1600	100	103	97	98	98	97
16:45	1692	1661	1595	100	103	98	99	98	97
17:00	1690	1654	1588	100	103	98	99	98	98
17:15	1689	1682	1600	100	103	98	99	98	98
17:30	1667	1682	1603	100	104	99	99	99	98
17:45	1681	1657	1601	100	104	98	100	99	98
18:00	1681	1677	1606	101	104	98	100	99	98
18:15	1714	1697	1617	100	104	99	100	99	98
18:30	1698	1690	1618	101	105	99	100	99	98
18:45	1680	1733	1630	101	105	100	100	99	99
19:00	1683	1674	1627	101	105	99	100	99	99
19:15	1731	1697	1613	101	105	99	100	100	99
19:30	1719	1702	1632	102	105	100	101	100	99
19:45	1715	1687	1621	102	105	100	101	100	99

Time (min:sec)	Tc 46(°F)	Tc 47(°F)	Tc 48(°F)	Tc 49(°F)	Tc 50(°F)	Tc 51(°F)	Tc 52(°F)	Tc 53(°F)	Tc 54(°F)
20:00	1703	1695	1620	103	105	100	101	100	99
20:15	1730	1689	1620	103	104	100	102	100	99
20:30	1724	1698	1627	103	104	100	101	100	99
20:45	1741	1734	1651	103	105	101	101	101	99
21:00	1776	1745	1664	103	106	101	102	101	100
21:15	1782	1756	1661	103	106	101	102	101	100
21:30	1769	1758	1667	103	106	101	101	101	100
21:45	1781	1753	1683	104	107	101	102	101	101
22:00	1780	1758	1677	104	107	101	102	101	100
22:15	1788	1745	1672	104	108	101	103	102	100
22:30	1802	1789	1695	104	108	102	103	102	101
22:45	1775	1756	1664	104	108	102	102	102	101
23:00	1785	1771	1696	104	109	102	102	102	102
23:15	1796	1785	1688	104	109	102	103	102	101
23:30	1771	1772	1701	104	109	102	103	102	101
23:45	1829	1808	1696	104	109	102	104	103	101
24:00	1810	1788	1703	104	110	103	104	103	102
24:15	1800	1762	1707	105	111	103	104	103	103
24:30	1802	1795	1712	105	111	103	104	103	103
24:45	1800	1787	1708	106	112	103	105	103	103
25:00	1792	1785	1688	107	112	103	105	103	103
25:15	1812	1794	1715	106	112	103	105	103	103
25:30	1828	1832	1745	107	113	104	105	103	103
25:45	1842	1822	1748	107	113	104	105	103	104
26:00	1850	1837	1743	106	114	104	105	104	104
26:15	1853	1833	1742	107	114	104	106	103	104
26:30	1835	1863	1755	107	114	104	106	103	104
26:45	1834	1823	1756	108	115	105	107	104	104
27:00	1857	1828	1755	108	116	105	106	104	105
27:15	1855	1828	1754	109	116	105	107	104	105
27:30	1847	1810	1764	108	116	106	107	104	105
27:45	1834	1824	1766	107	116	105	107	104	105
28:00	1845	1872	1772	106	116	105	107	104	105
28:15	1804	1850	1807	107	117	105	107	104	105
28:30	1786	1861	1815	109	117	106	107	104	106
28:45	1798	1871	1840	109	118	106	107	105	106
29:00	1843	1864	1799	108	117	107	108	105	107
29:15	1830	1885	1814	108	119	107	108	105	107
29:30	1861	1886	1827	109	119	106	108	105	107
29:45	1840	1860	1821	110	119	107	108	105	107
30:00	1753	1786	1731	111	120	106	108	106	107

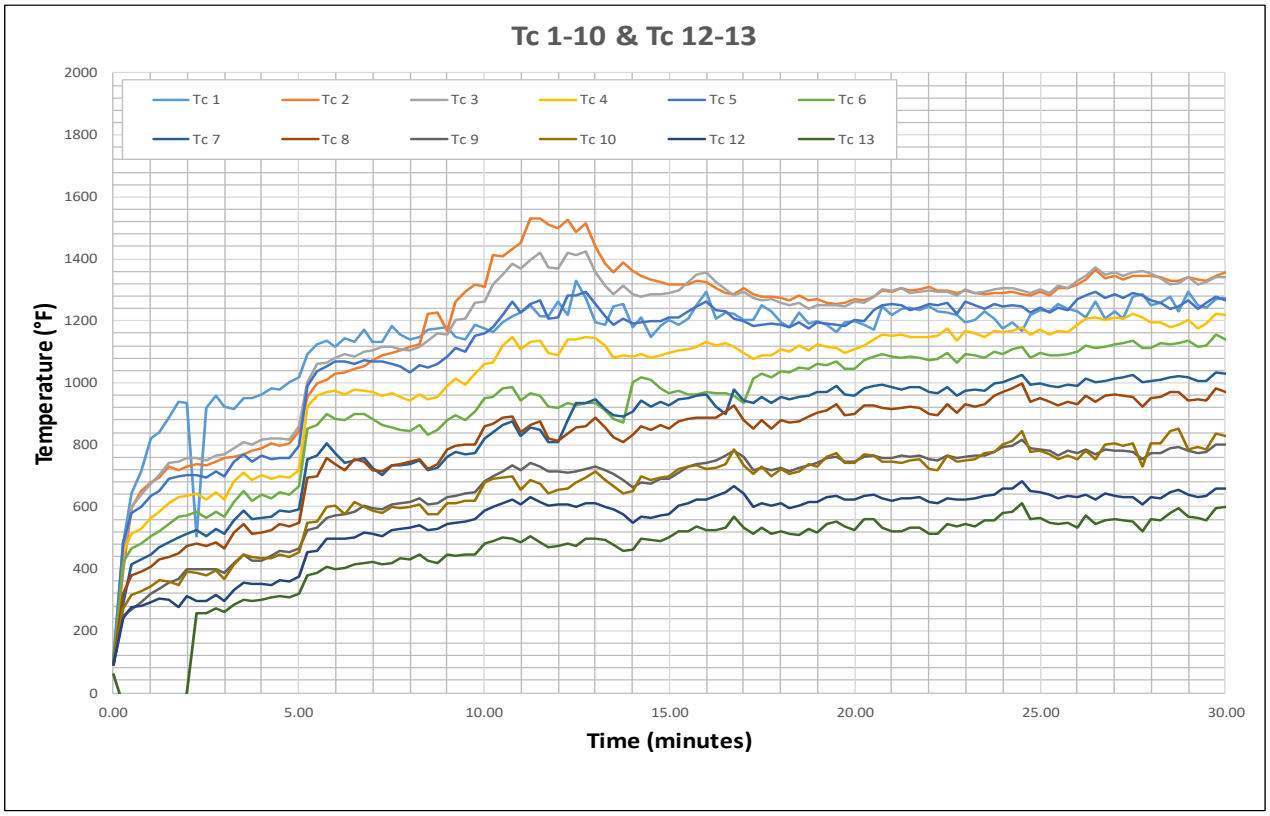
18. APPENDIX 6 – GRAPHS



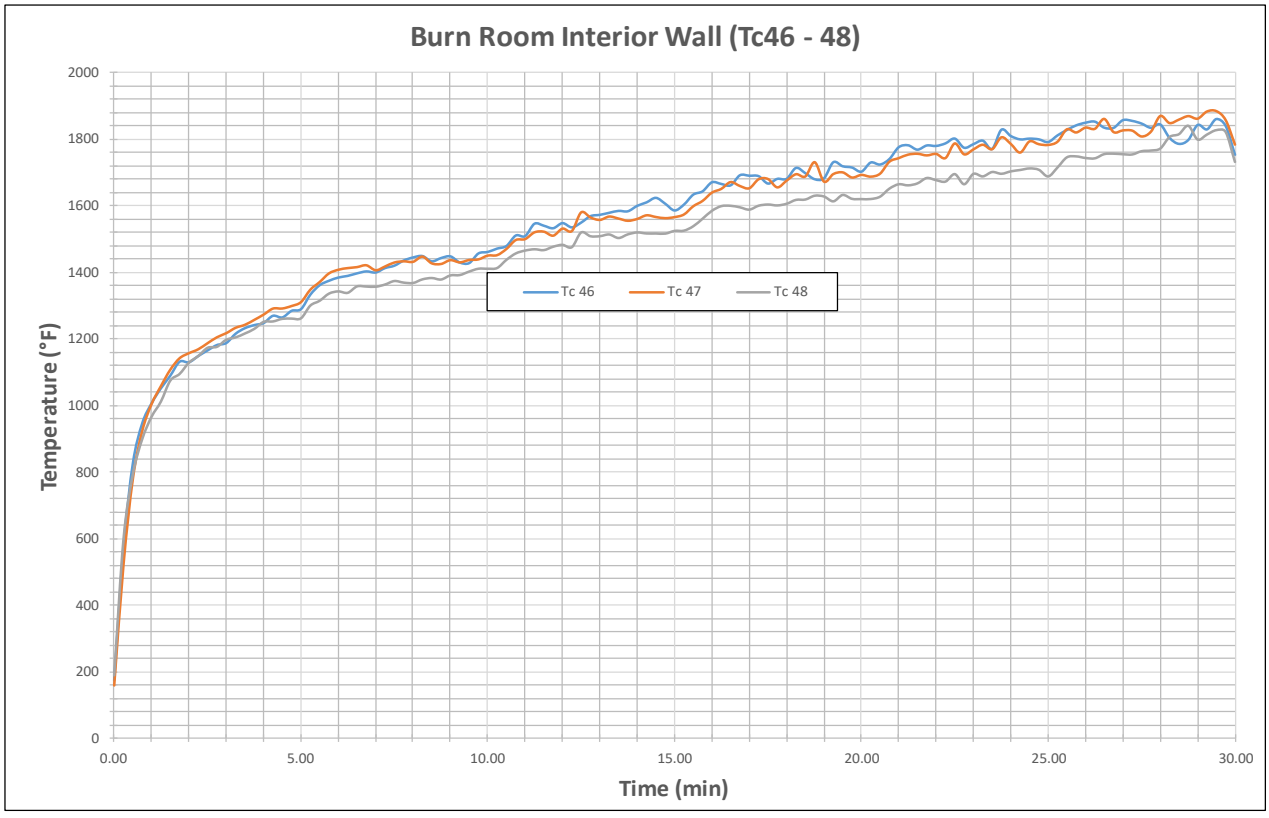
Graph 1: Burn room thermocouple temperature (Tc41 – Tc45)



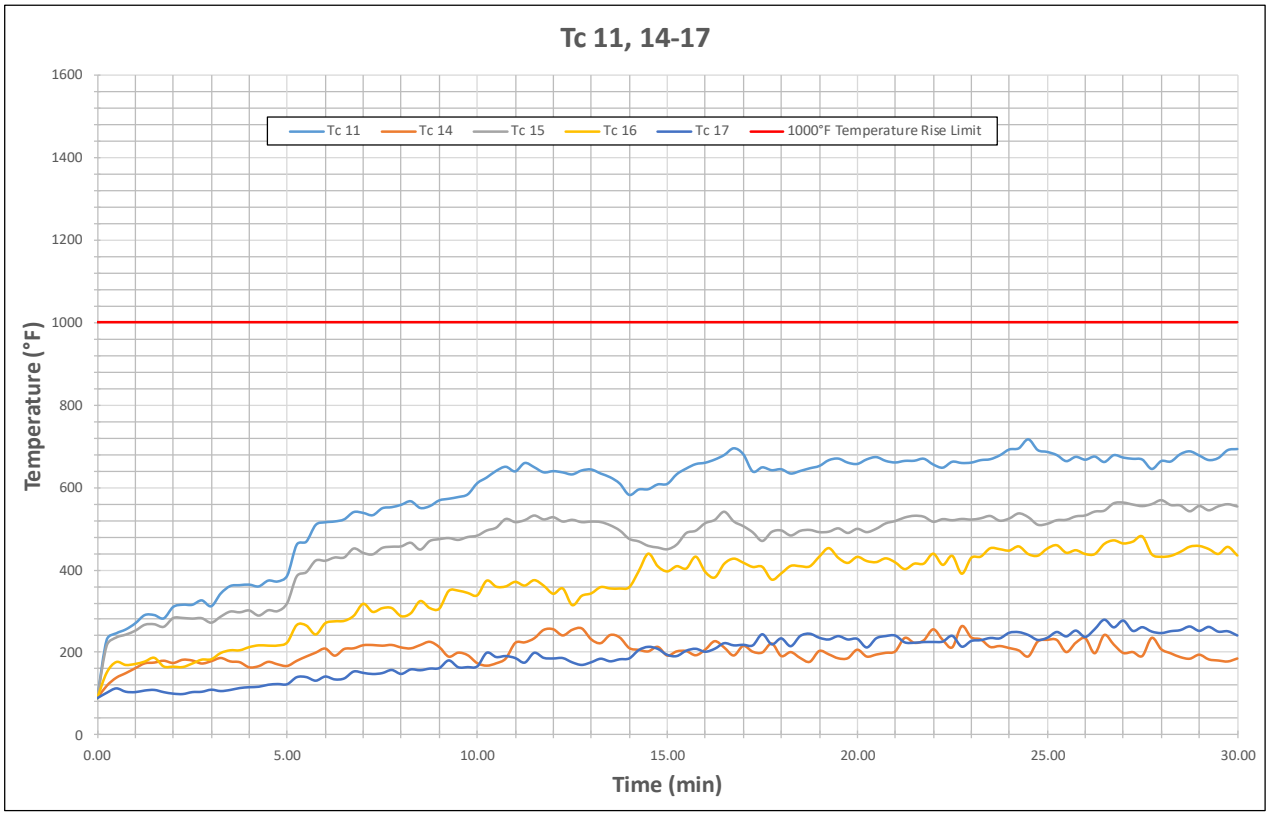
Graph 2: Second story room thermocouple temperatures (Tc49-Tc54)



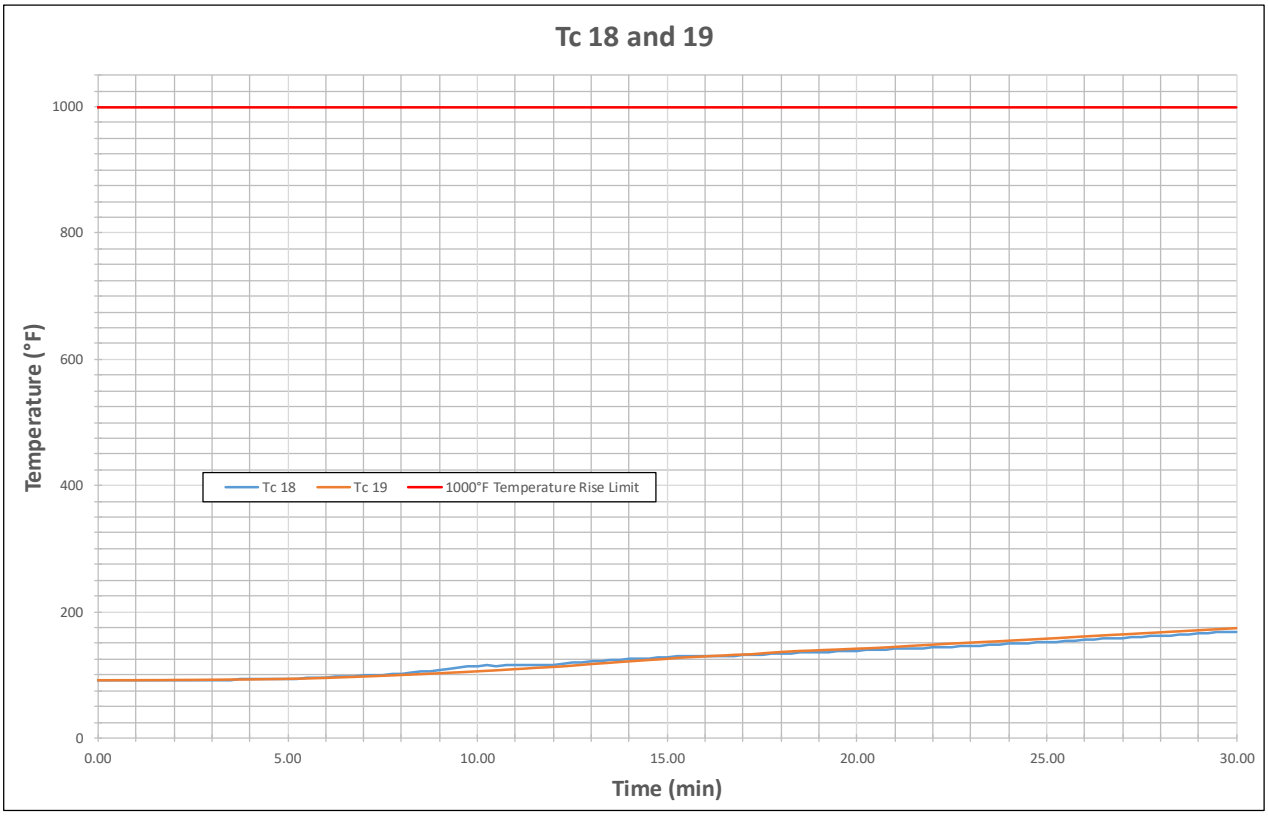
Graph 3: Thermocouple temperatures for Tc1 -Tc10 and Tc12 – Tc23.



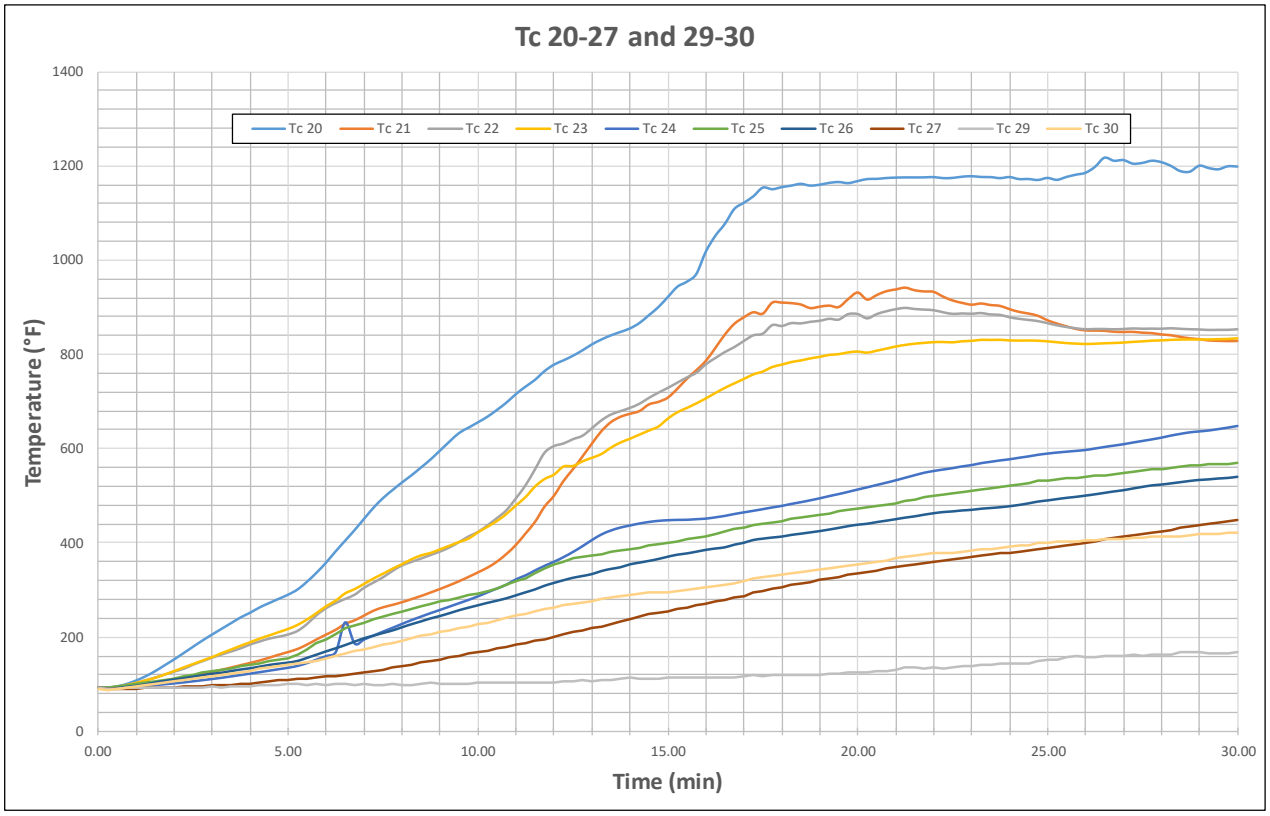
Graph 4: Burn room interior wall temperature (Tc46 – Tc48)



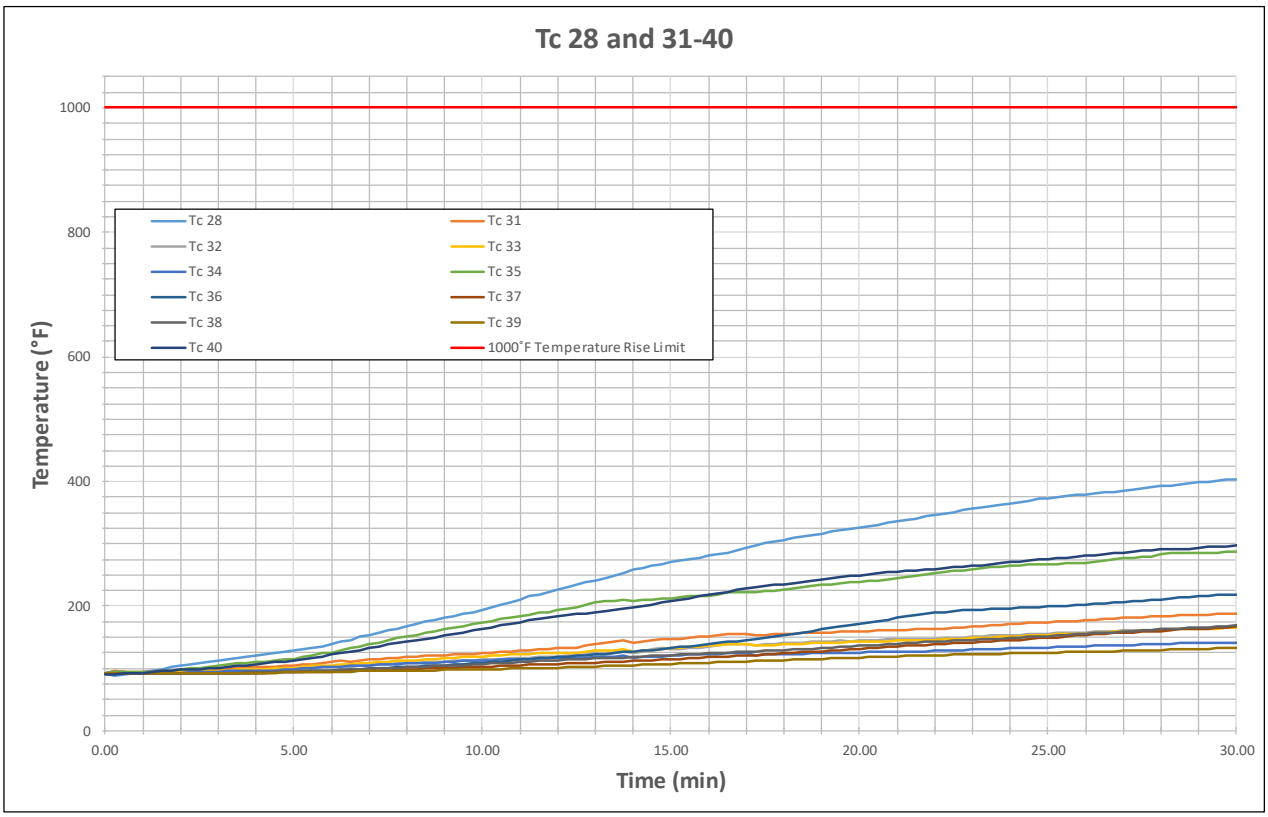
Graph 5: Thermocouple temperatures for Tc11 and Tc14 – Tc17.



Graph 6: Thermocouple temperatures for Tc18 and Tc19.



Graph 7: Thermocouple temperatures for Tc20 – Tc27 and Tc29 – Tc30.



Graph 8: Thermocouple temperatures for Tc28 and Tc31 – Tc40.

19. APPENDIX 7 – CONSTRUCTION PHOTOGRAPHS

Picture 1: Base wall prior to installation.

Picture 2: The wall bracket fixed onto the base wall and runners to the wall bracket.

Picture 3: The runners fixed onto the wall brackets.

Picture 4: The cavity fire barrier and mineral wool slab were fixed using grip nails on the base wall.

20. APPENDIX 8 – TEST PHOTOGRAPHS

Picture 5: The specimen at the beginning of the test.

Picture 6: The specimen at 5:00 minutes and when the window burner was ignited.

Picture 7: The specimen at 10:00 minutes.

Picture 8: The specimen at 15:00 minutes.

Picture 9: The specimen at 20:00 minutes.

Picture 10: The specimen at 25:00 minutes.

Picture 12: The specimen immediately before the end of the test.

Picture 11: The specimen immediately after the gas was shut off, starting the observation period.

Picture 13: The specimen at the end of the observation period and end of the NFPA 285 test.

Picture 14: The specimen during dismantling.

----- End of Test Report -----