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**Title:**

Additional Test Report Of The Fire Resistance Performance Of Eighteen Specimens Of Penetration Sealing System And One Specimen Of Linear Joint Sealing System, When Tested In Accordance With EN 1366-3: 2009 And EN 1366-4: 2006 +A1:2010.

**WF Report No:**

349127



**Prepared for:**

**Everbuild Building Products**

Site 41, Knowsthorpe Way  
Cross Green Ind Est  
Leeds  
LS9 0SW

**Note: This report is additional to that issued as WARRES 346512 and dated 5<sup>th</sup> February 2015. The original remains valid and is not replaced by this additional report**

**Date:**

10<sup>th</sup> February 2015

**Notified Body No:**

0833



0249

# Summary

**Objective** To evaluate the ability of eighteen specimens of penetration sealing system to reinstate the integrity and insulation performance of a drywall construction when tested in accordance with EN 1366-3: 2009, and the ability of one specimen of linear joint sealing system to reinstate the integrity and insulation performance between a drywall and rigid wall construction when tested in accordance with EN 1366-4: 2006 +A1:2010.

**Test Sponsor** Sika Services AG

**Address** Tueffenwies 16, 8048 Zuerich, Switzerland

The specimens were referenced A to S for the purpose of the test.

The drywall construction was of overall dimensions 3000 mm wide by 3000 mm high by 100 mm thick. The framing comprised 50 mm wide galvanised steel studs, at maximum 600 mm centres, friction fitted into galvanised steel head and base channel. Each side of the stud frame was faced with two layers of 12.5 mm thick Gypsum 'Type F' plasterboard. The drywall framework was infilled with a single layer of nominally 50 mm thick mineral wool insulation with a nominal density of 100 kg/m<sup>3</sup>. The wall was provided with twelve 125 mm by 125 mm apertures and two 50 mm by 50 mm apertures. Twelve of the apertures were penetrated by a range of cable bundles and two of the apertures were not penetrated by service items. The wall also incorporated four circular apertures, each penetrated by a range of copper pipes that were plugged on the exposed face with a ceramic fibre plug.

The wall also incorporated a 35 mm wide by 3000 mm long head of wall horizontal running linear joint, which was between the top edge of the drywall and the top horizontal edge of the supporting test frame. The linear joint was sealed on each face of the top steel channel of the partition framework using a 25 mm depth of "Everbuild Fireseal 300". The drywall construction incorporated two free edges.

Details of each specimen are included in the table below:

Specimen	Aperture size and seal type	Services
A	125 mm high by 125 mm wide aperture, sealed with a nominally 25 mm depth of 'Everbuild Fire Mate', applied flush with both faces of the wall and a 50 mm deep infill of friction fitted mineral wool insulation of nominal density 60 kg/m <sup>3</sup>	The aperture was not penetrated by service items
B		A bundle of 1 no "C1", 1 no "C2", 1 no "C3" and 1 no "E" cables
C		A bundle of 1 no "D1", 1 no "D2" and 1 no "D3" cables
D		A bundle of 1 no "B", 3 no "A1", 3 no "A2" and 3 no "A3" cables
E		A bundle of 1 no "G1" and 1 no "G2" cables
F		A 100 mm diameter bundle of "F" telecom cables, two 16 mm diameter by 1.0 mm wall thickness PVC conduits and two 16 mm diameter by 0.5 mm wall thickness copper conduits

Specimen	Aperture size and seal type	Services
G	50 mm high by 50 mm wide aperture, sealed with a nominally 25 mm depth of 'Everbuild Fire Mate', applied flush with both faces of the wall and a 50 mm deep infill of friction fitted mineral wool insulation of nominal density 60 kg/m <sup>3</sup>	1 no "E" cable
H	125 mm high by 125 mm wide aperture, sealed with a nominally 25 mm depth of 'Everbuild Fireseal 300, applied flush with both faces of the wall and a 50 mm deep infill of friction fitted mineral wool insulation of nominal density 60 kg/m <sup>3</sup>	The aperture was not penetrated by service items
I		A bundle of 1 no "C1", 1 no "C2", 1 no "C3" and 1 no "E" cables
J		A bundle of 1 no "D1", 1 no "D2" and 1 no "D3" cables
K		A bundle of 1 no "B", 3 no "A1", 3 no "A2" and 3 no "A3" cables
L		A bundle of 1 no "G1" and 1 no "G2" cables
M		A 100 mm diameter bundle of "F" telecom cables, two 16 mm diameter by 1.0 mm wall thickness PVC conduits and two 16 mm diameter by 0.5 mm wall thickness copper conduits
N	50 mm high by 50 mm wide aperture, sealed with a nominally 25 mm depth of 'Everbuild Fireseal 300, applied flush with both faces of the wall and a 50 mm deep infill of friction fitted mineral wool insulation of nominal density 60 kg/m <sup>3</sup>	1 no "E" cable
O	65 mm diameter aperture, sealed with a nominally 25 mm depth of 'Everbuild Fire Mate', applied flush with both faces of the wall and a 50 mm deep infill of friction fitted mineral wool insulation of nominal density 60 kg/m <sup>3</sup>	15 mm diameter by 0.7 mm wall thickness copper pipe
P	90 mm diameter aperture, sealed with a nominally 25 mm depth of 'Everbuild Fire Mate', applied flush with both faces of the wall and a 50 mm deep infill of friction fitted mineral wool insulation of nominal density 60 kg/m <sup>3</sup>	42 mm diameter by 1.3 mm wall thickness copper pipe

Specimen	Aperture size and seal type	Services
Q	65 mm diameter aperture, sealed with a nominally 25 mm depth of 'Everbuild Fireseal 300', applied flush with both faces of the wall and a 50 mm deep infill of friction fitted mineral wool insulation of nominal density 60 kg/m <sup>3</sup>	15 mm diameter by 0.7 mm wall thickness copper pipe
R	90 mm diameter aperture, sealed with a nominally 25 mm depth of 'Everbuild Fireseal 300', applied flush with both faces of the wall and a 50 mm deep infill of friction fitted mineral wool insulation of nominal density 60 kg/m <sup>3</sup>	42 mm diameter by 1.3 mm wall thickness copper pipe
S	35 mm wide by 3000 mm long horizontal running aperture, sealed with a nominally 25 mm thickness of Everbuild Fireseal 300' fitted flush with the outer faces of the partition	The aperture was not penetrated by service items

## Test results

Specimen	Integrity (minutes)			Insulation (minutes)
	Cotton pad	Sustained flames	Gap Gauge	
A	123*	123*	123*	123*
B	123*	123*	123*	52
C	123*	123*	123*	56
D	123*	123*	123*	37
E	123*	123*	123*	25
F	66	66	66#	37
G	123*	123*	123*	43
H	123*	123*	123*	116
I	123*	123*	123*	45
J	123*	123*	123*	59
K	123*	123*	123*	52
L	123*	123*	123*	17
M	60	60	60#	18
N	123*	123*	123*	50
O	123*	123*	123*	57
P	123*	123*	123*	7
Q	123*	123*	123*	51
R	62	62	62~	5
S	123*	123*	123*	123*

\*The test duration. The test was discontinued after a period of 123 minutes.  
 ~Flaming of specimen extinguished to allow the test to continue. #Specimen blanked off to allow the test to continue.

**Date of Test** 18<sup>th</sup> December 2014.

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## Signatories

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Responsible Officer  
**D. Yates\***  
Testing Officer



Approved  
**C. Abbott\***  
Principal Certification Engineer



Head of Department  
**S. Hankey \***  
Operations Manager

\* For and on behalf of **Exova Warringtonfire**.

Report Issued

Date : 10<sup>th</sup> February 2015

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# Test Procedure

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## Introduction

Penetration sealing systems are required to maintain the fire resistance of a separating element at the position at which it has been penetrated by a service or services. The penetration specimens were therefore tested in accordance with EN 1366-3: 2009 'Fire resistance tests for service installations - Part 3: Penetration seals' This test report should be read in conjunction with that Standard and with EN 1363-1: 2012, Fire resistance tests - Part 1: General requirements'.

The penetration specimens were judged on their ability to comply with the performance criteria for integrity and insulation, as required by EN 1366-3: 2009.

Linear joint sealing systems are required to maintain the fire resistance of gaps in separating elements or joints where two separating elements meet. The linear gap specimens were therefore tested in accordance with EN 1366-4: 2006 +A1:2010 'Fire resistance tests for service installations - Part 4: Linear Joint seals'. This test report should be read in conjunction with that Standard and with EN 1363-1: 2012, Fire resistance tests - Part 1: General requirements'.

The linear joint specimen was judged on its ability to comply with the performance criteria for integrity and insulation, as required by EN 1366-4: 2006 +A1:2010.

## Fire Test Study Group/EGOLF

Certain aspects of some fire test specifications are open to different interpretations. The Fire Test Study Group and EGOLF have identified a number of such areas and have agreed Resolutions, which define common agreement of interpretations between fire test laboratories, which are members of the Groups. Where such Resolutions are applicable to this test they have been followed.

## Instruction to test

The test was conducted on the 18<sup>th</sup> December 2014 at the request of the original sponsor of the test.

Mr. C. Voellm, Mr. G. Southerington and Mr. A. Scanlon, representatives of the test sponsor witnessed the test.

## Test Specimen Construction

A comprehensive description of the test construction is given in the Schedule of Components. The description is based on a detailed survey of the specimens and information supplied by the sponsor of the test.

## Installation

The drywall assembly was constructed by representatives of **Exova Warringtonfire** between the 6<sup>th</sup> and 12<sup>th</sup> November 2014.

The cable and pipe services and supports were supplied and installed by representatives of **Exova Warringtonfire** between the 13<sup>th</sup> and 17<sup>th</sup> November 2014.

The specimen penetration and linear seals were supplied and installed by representatives of the sponsor between the 18<sup>th</sup> and 19<sup>th</sup> November 2014.

**Sampling**

A representative of Warrington Certification Limited selected and sampled the intumescent acrylic sealant referenced 'Everbuild Fire Mate' and "Everbuild Fireseal 300" on the 11<sup>th</sup> November 2014.

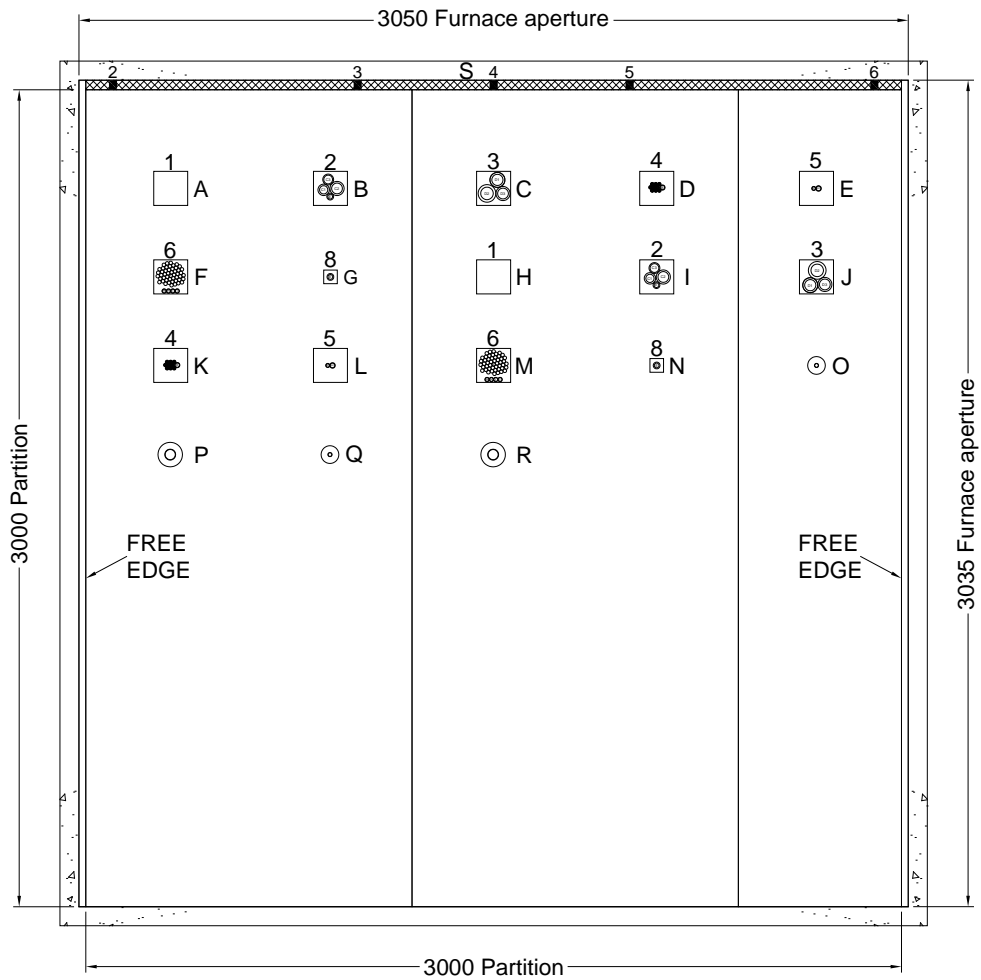
**Conditioning**

The specimens' storage, construction, and test preparation took place in the test laboratory over a total, combined time of 43 days. Throughout this period of time both the temperature and the humidity of the laboratory were measured and recorded as being within a range of 12°C to 22°C and 40% to 78% respectively.



# Test Specimen

Figure 1- General Elevation of Test Construction



■ Positions of thermocouples

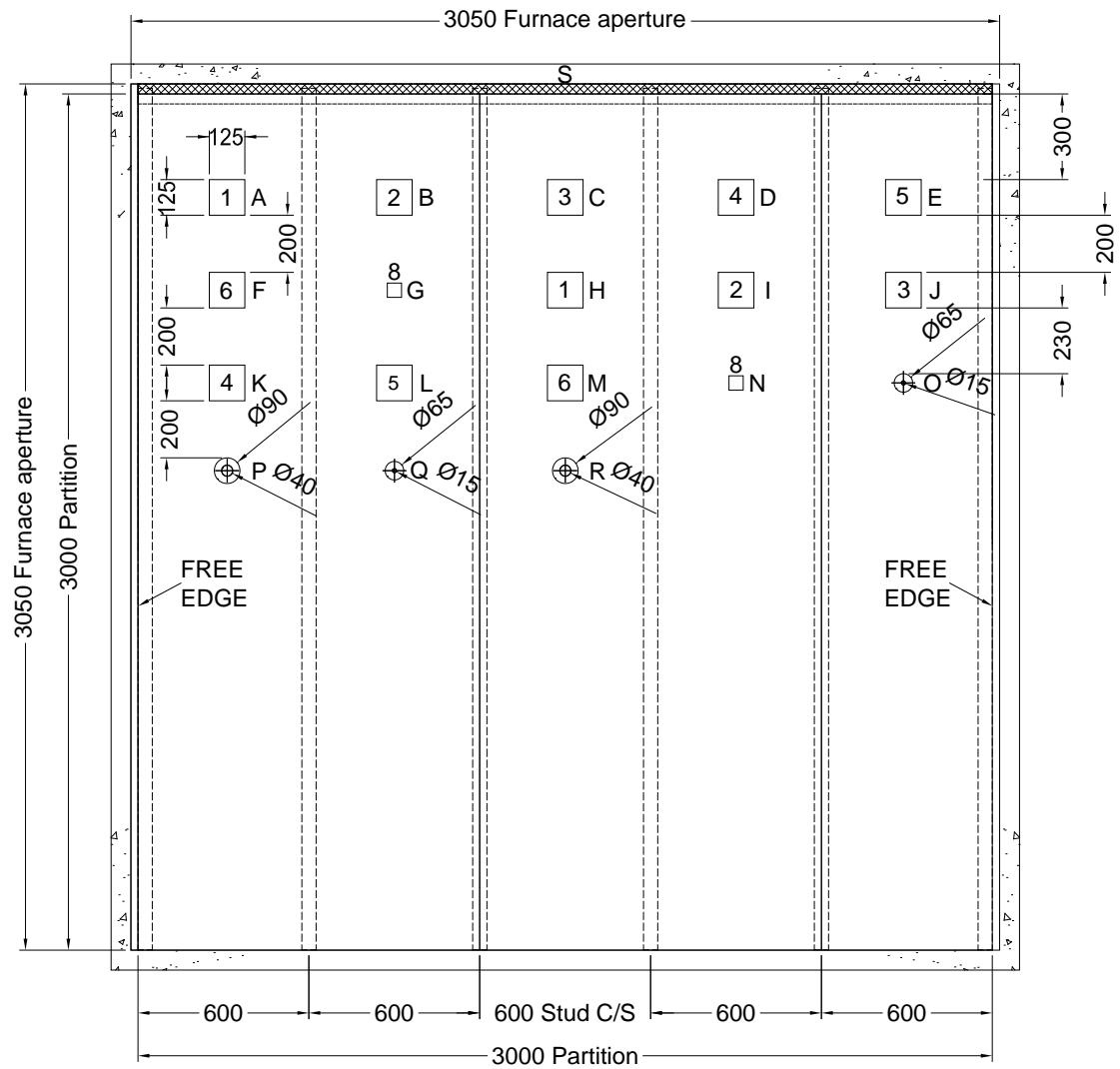
1-8 - SPECIMEN DESIGNATION REFERENCE

A-S - EXOVA SPECIMEN DESIGNATION REFERENCE

SUPPORT FRAMEWORK NOT SHOWN FOR CLARITY

Do not scale. All dimensions are in mm

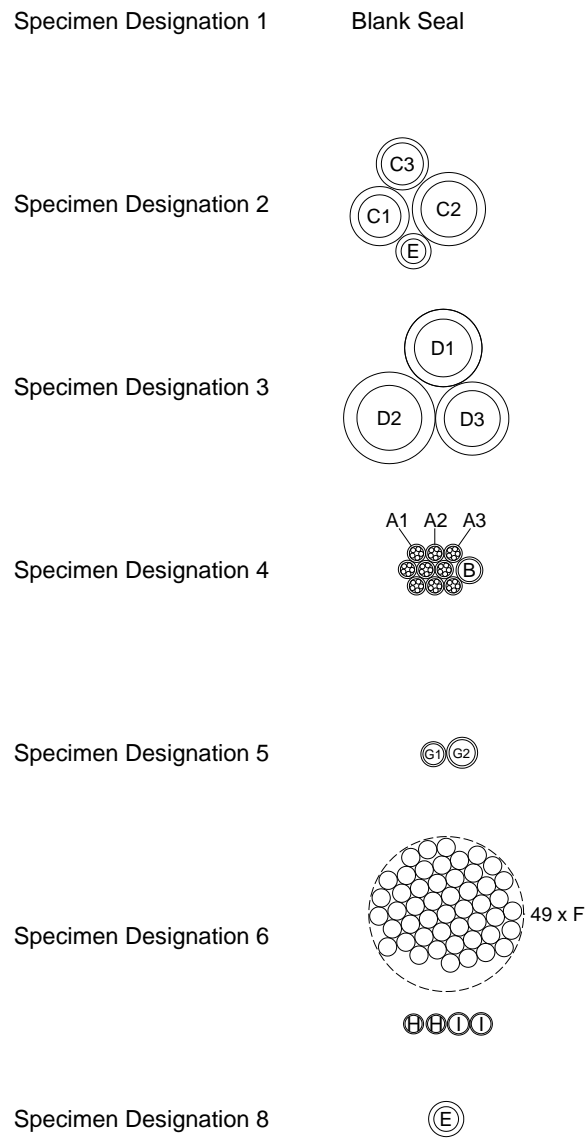
**Figure 2 – General Elevation of Test Construction**



1-8 SPECIMEN DESIGNATION REFERENCE  
 A-S EXOVA SPECIMEN DESIGNATION REFERENCE  
 SUPPORT FRAMEWORK NOT SHOWN FOR CLARITY

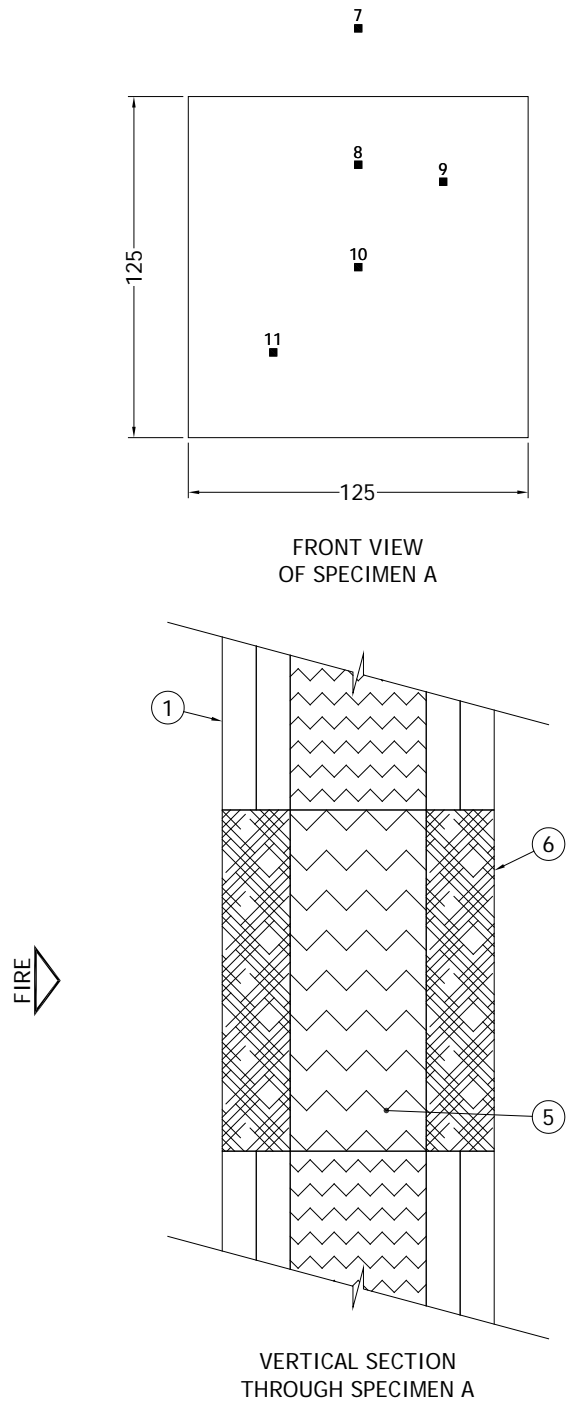
Do not scale. All dimensions are in mm

**Figure 3 – Details of Penetration Services**



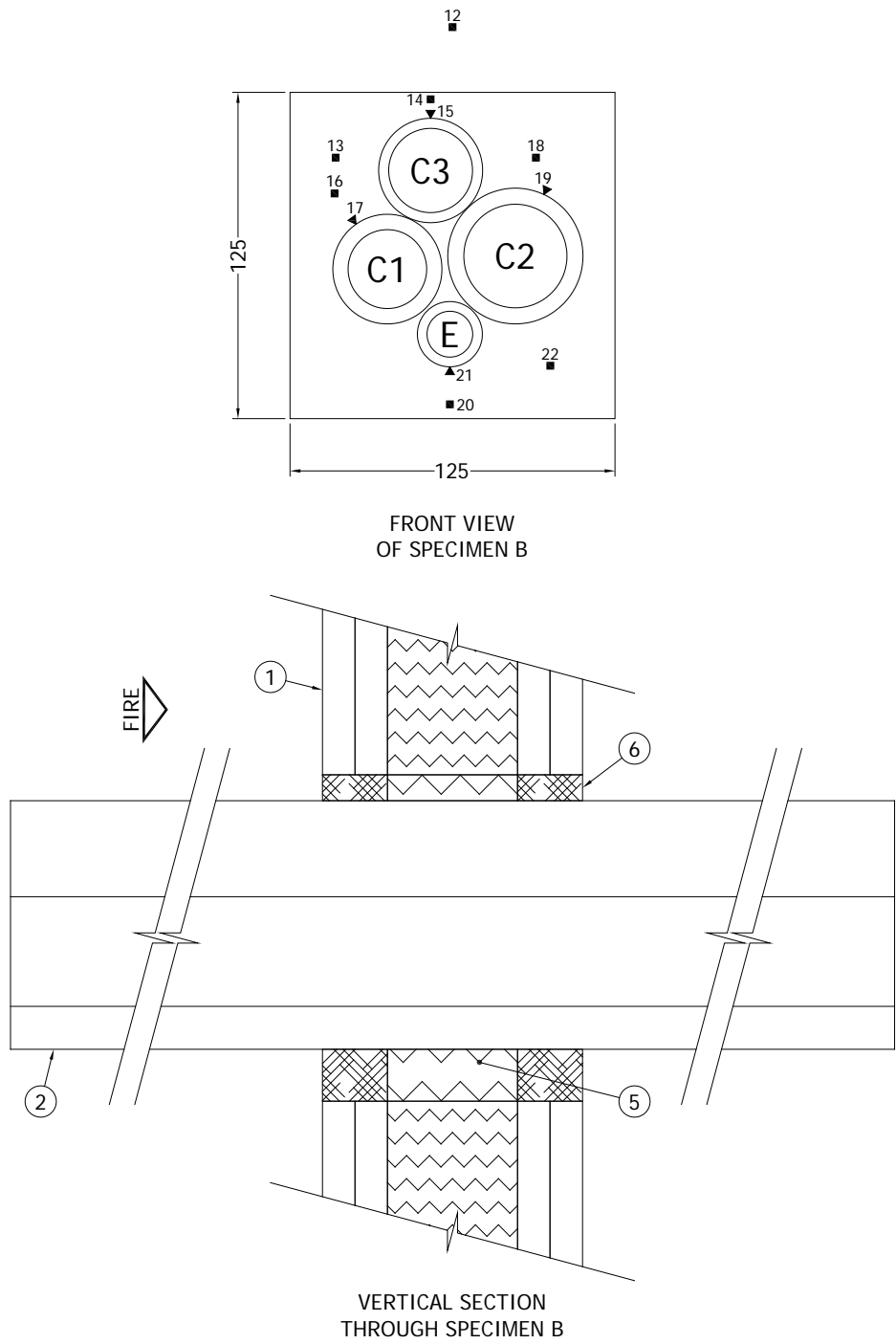
Do not scale. All dimensions are in mm

Figure 4 – Details of Specimen



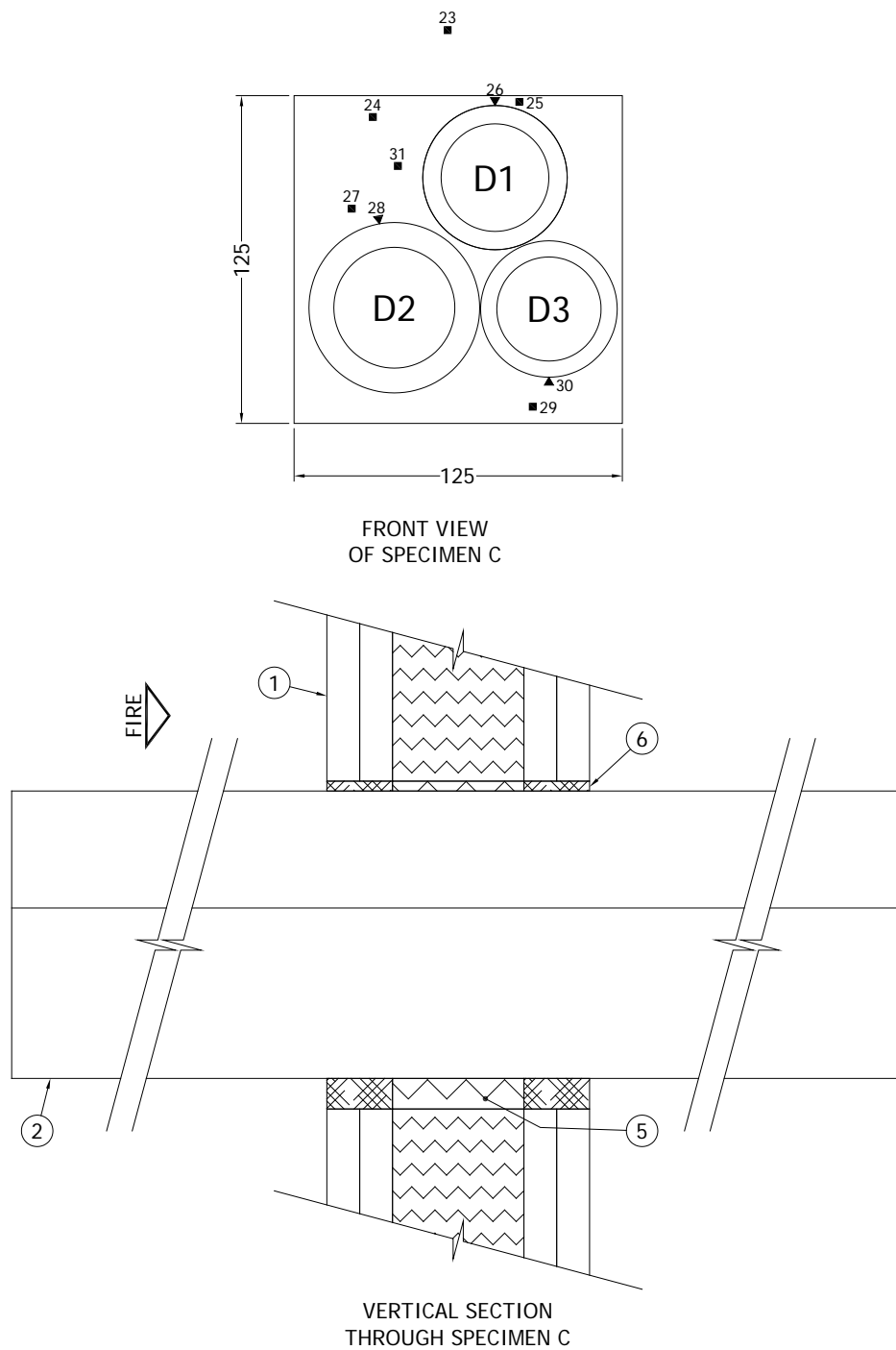
Do not scale. All dimensions are in mm

Figure 5 – Details of Details of Specimen



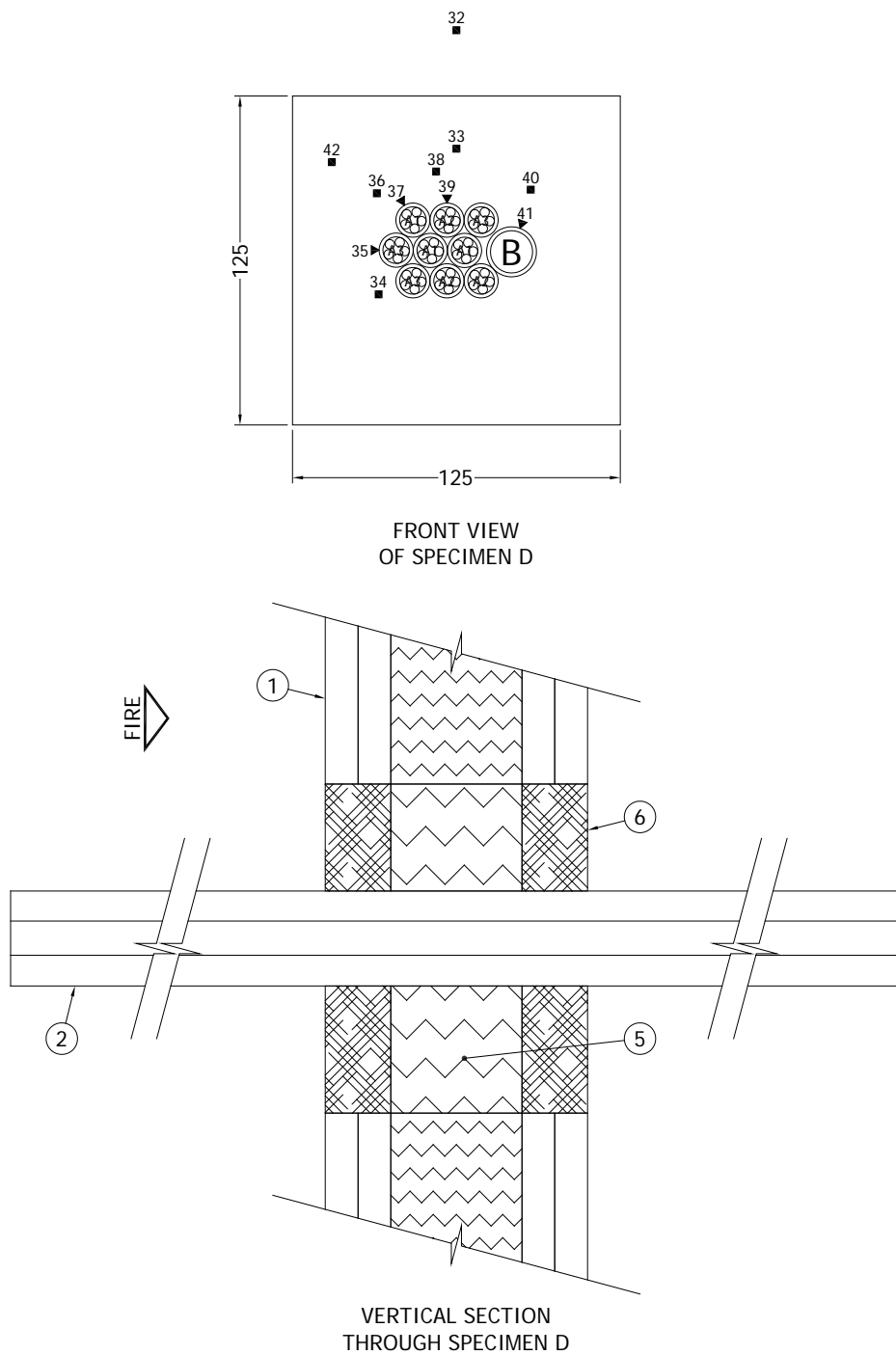
Do not scale. All dimensions are in mm

Figure 6 – Details of Details of Specimen



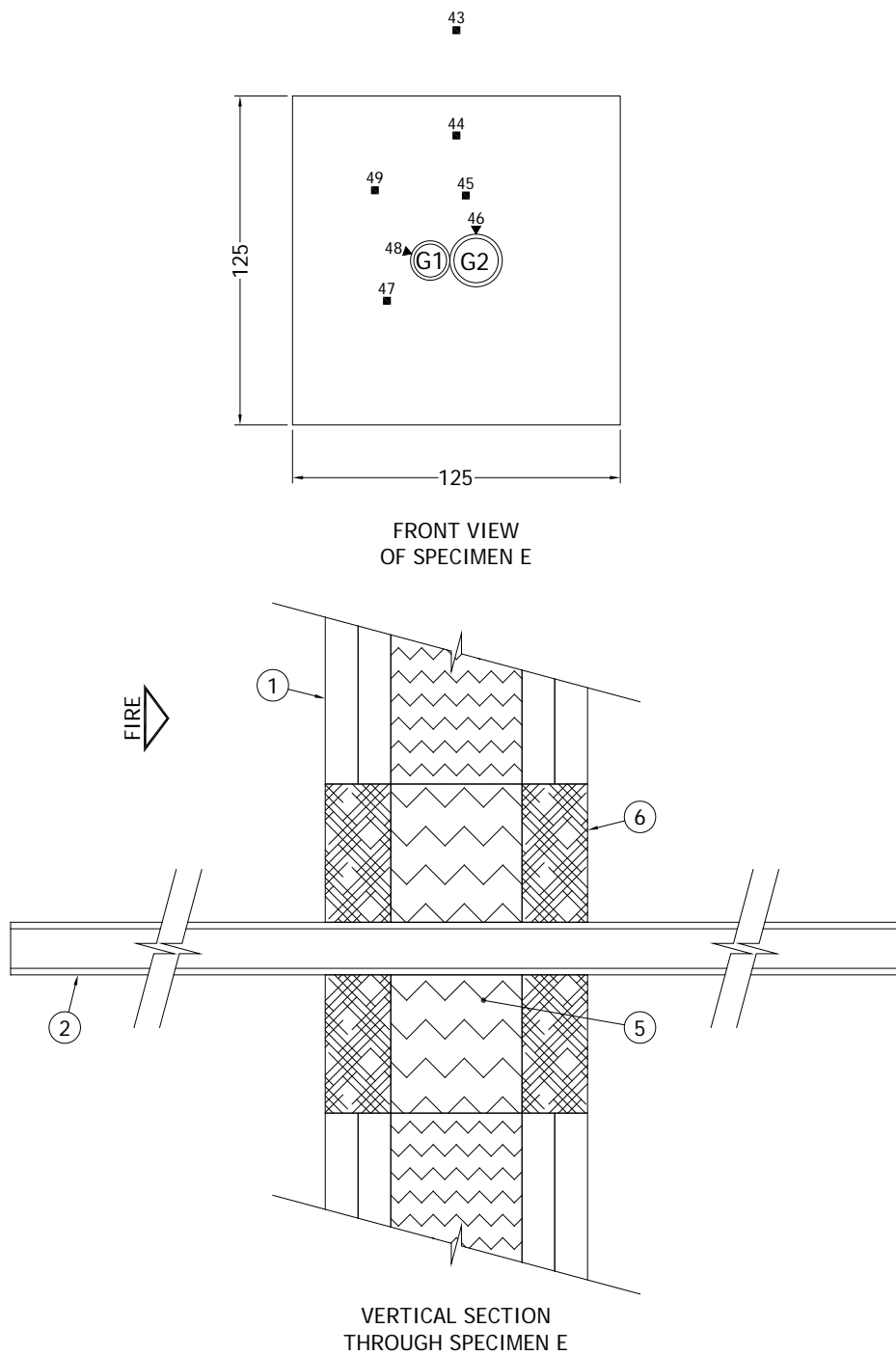
Do not scale. All dimensions are in mm

Figure 7 – Details of Details of Specimen



Do not scale. All dimensions are in mm

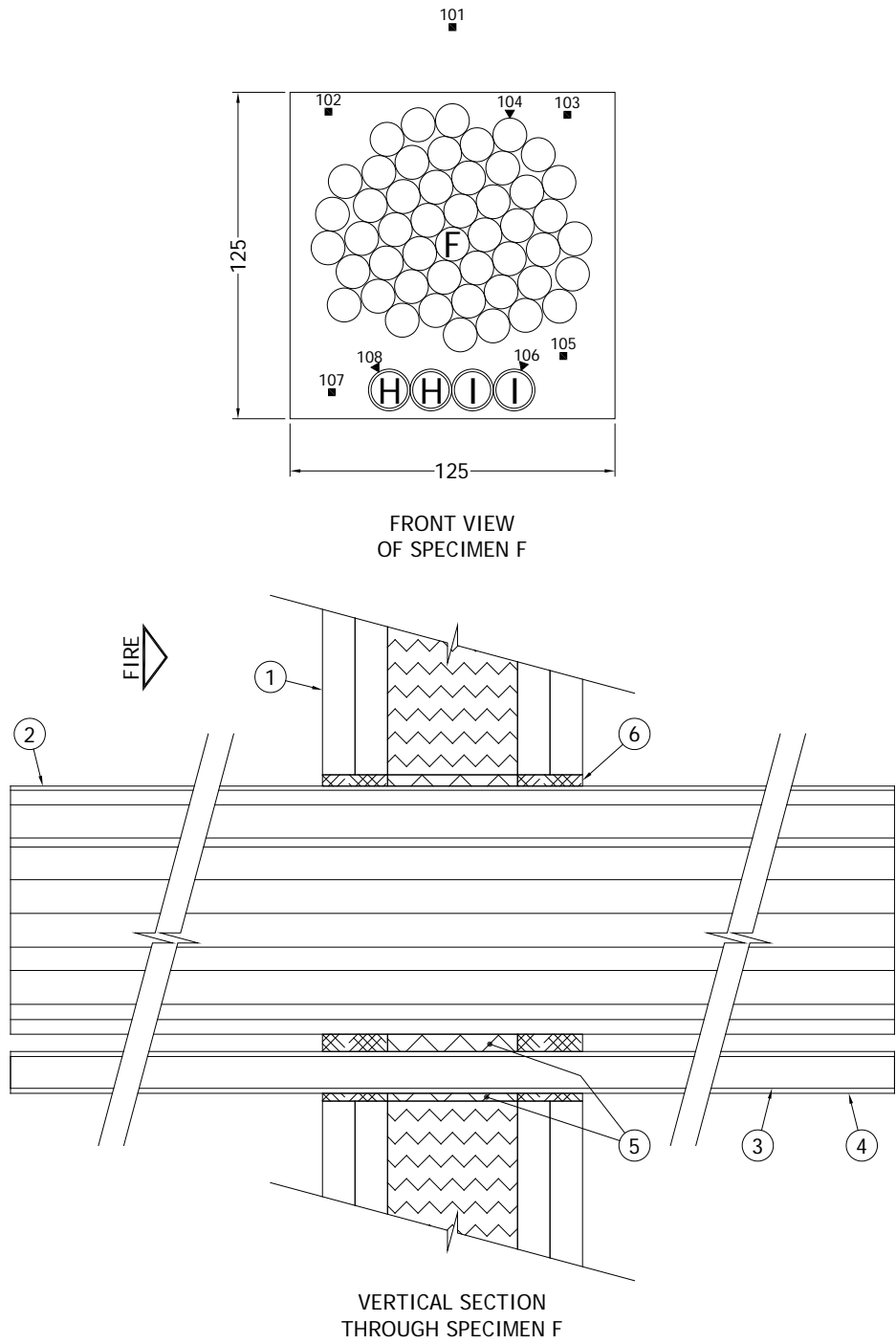
**Figure 8 – Details of Details of Specimen**



Do not scale. All dimensions are in mm

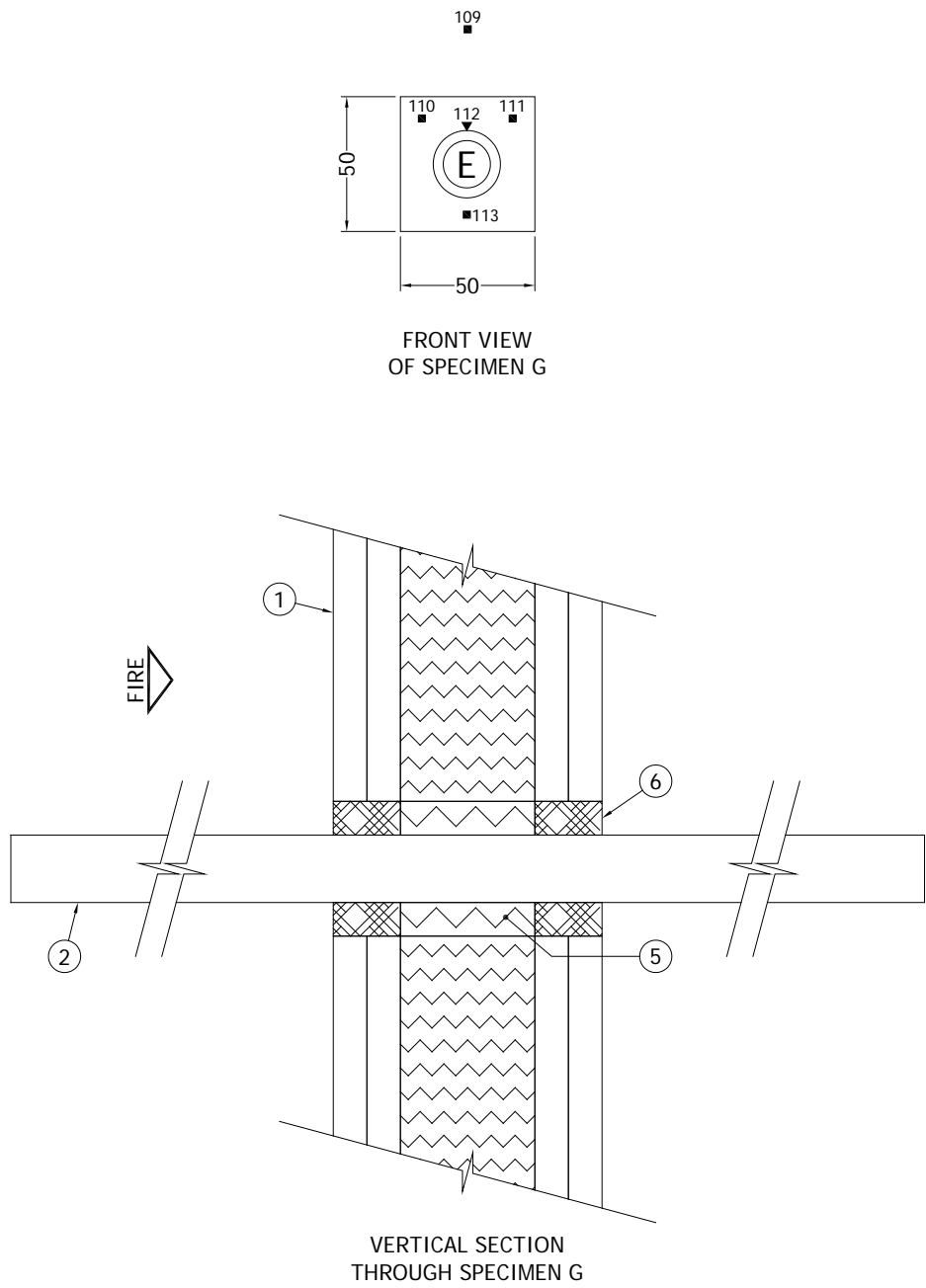


Figure 9 – Details of Details of Specimen



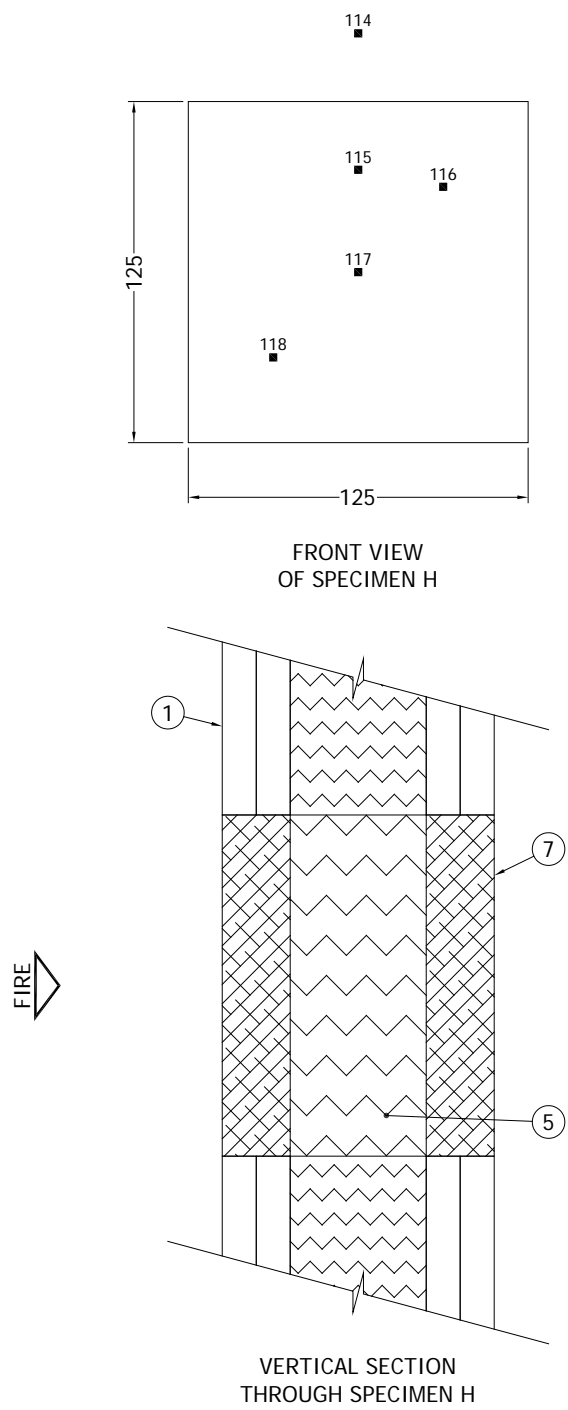
Do not scale. All dimensions are in mm

Figure 10 – Details of Details of Specimen



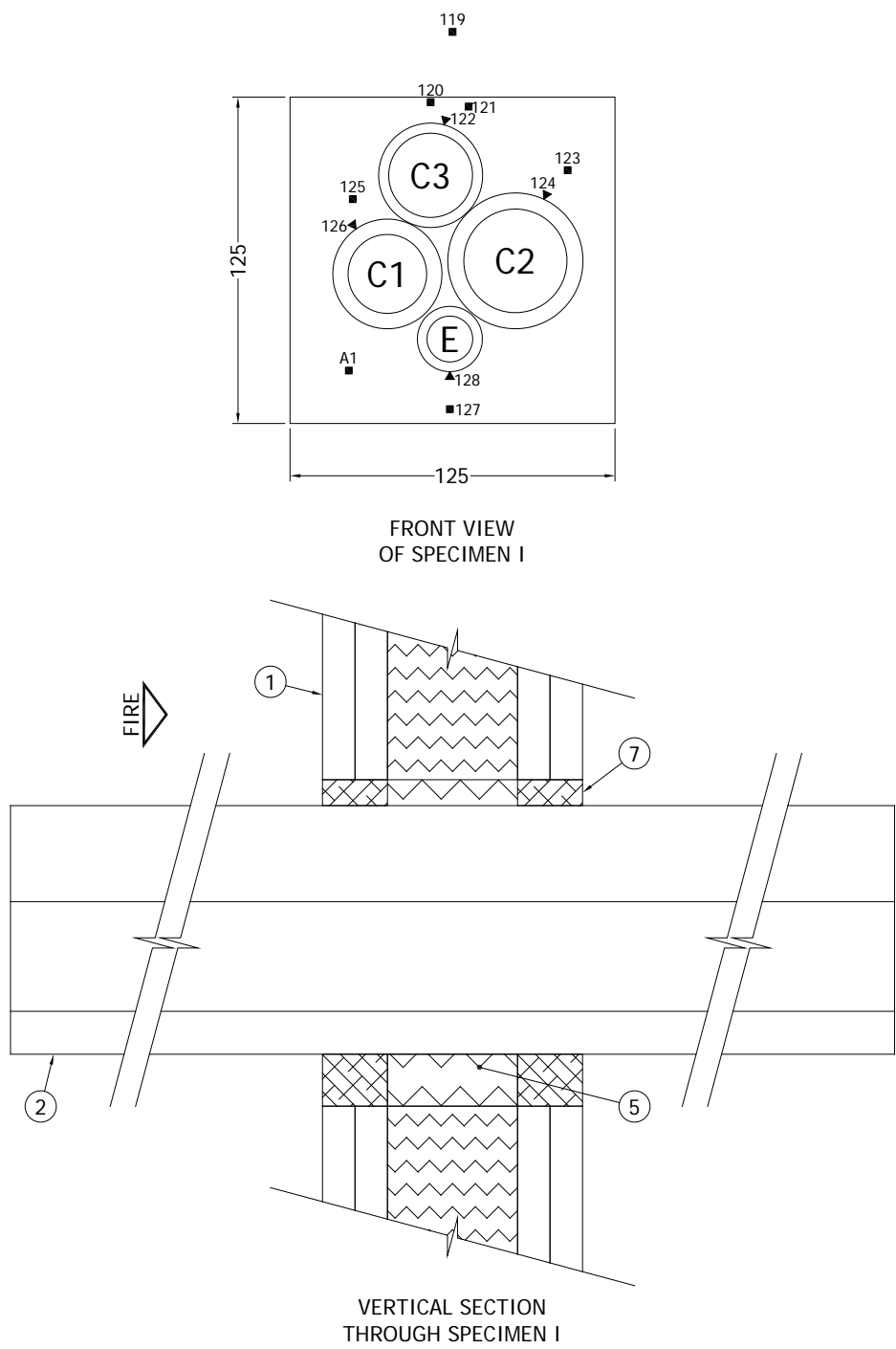
Do not scale. All dimensions are in mm

Figure 11 – Details of Details of Specimen



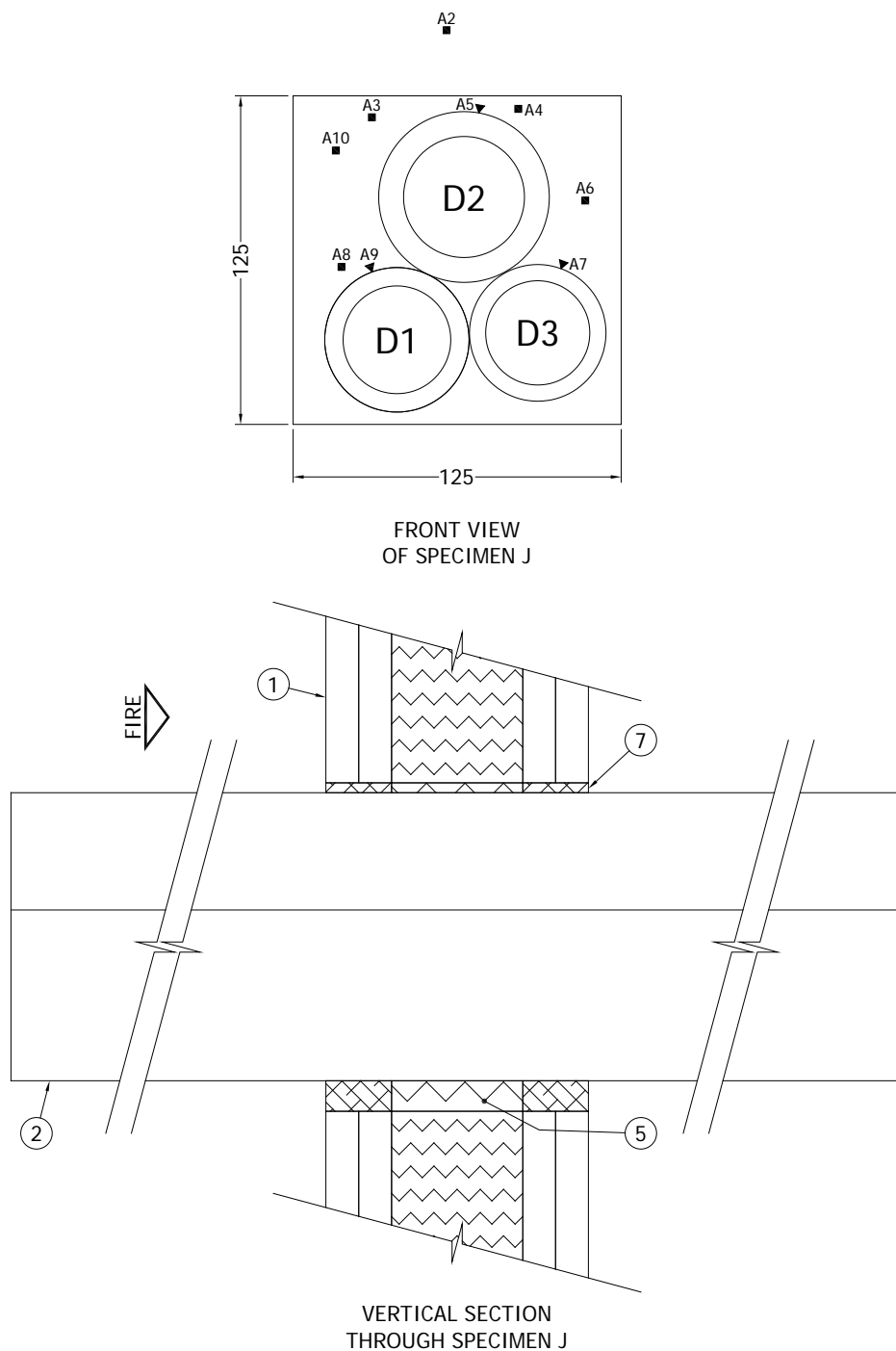
Do not scale. All dimensions are in mm

Figure 12 – Details of Details of Specimen



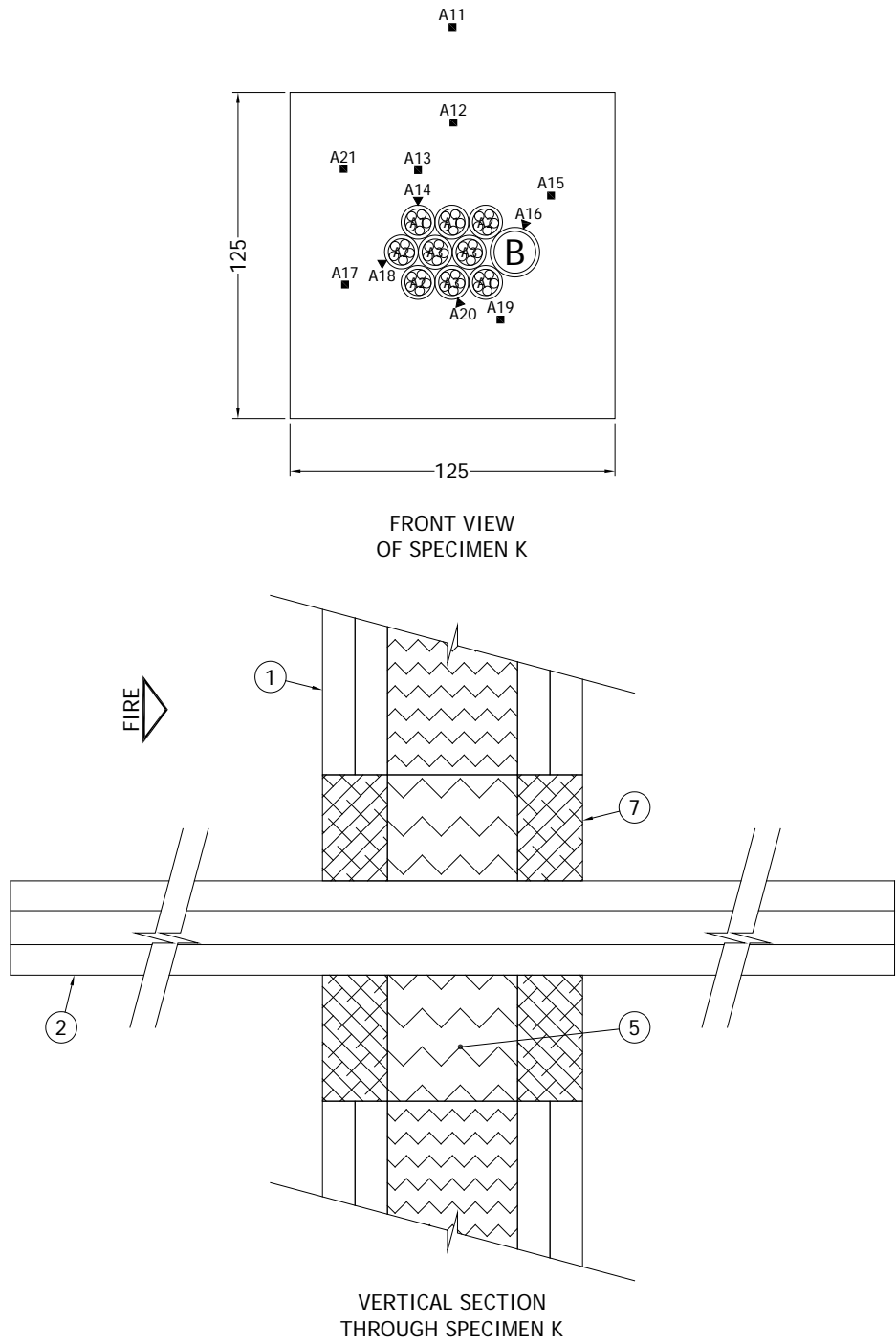
Do not scale. All dimensions are in mm

Figure 13 – Details of Details of Specimen



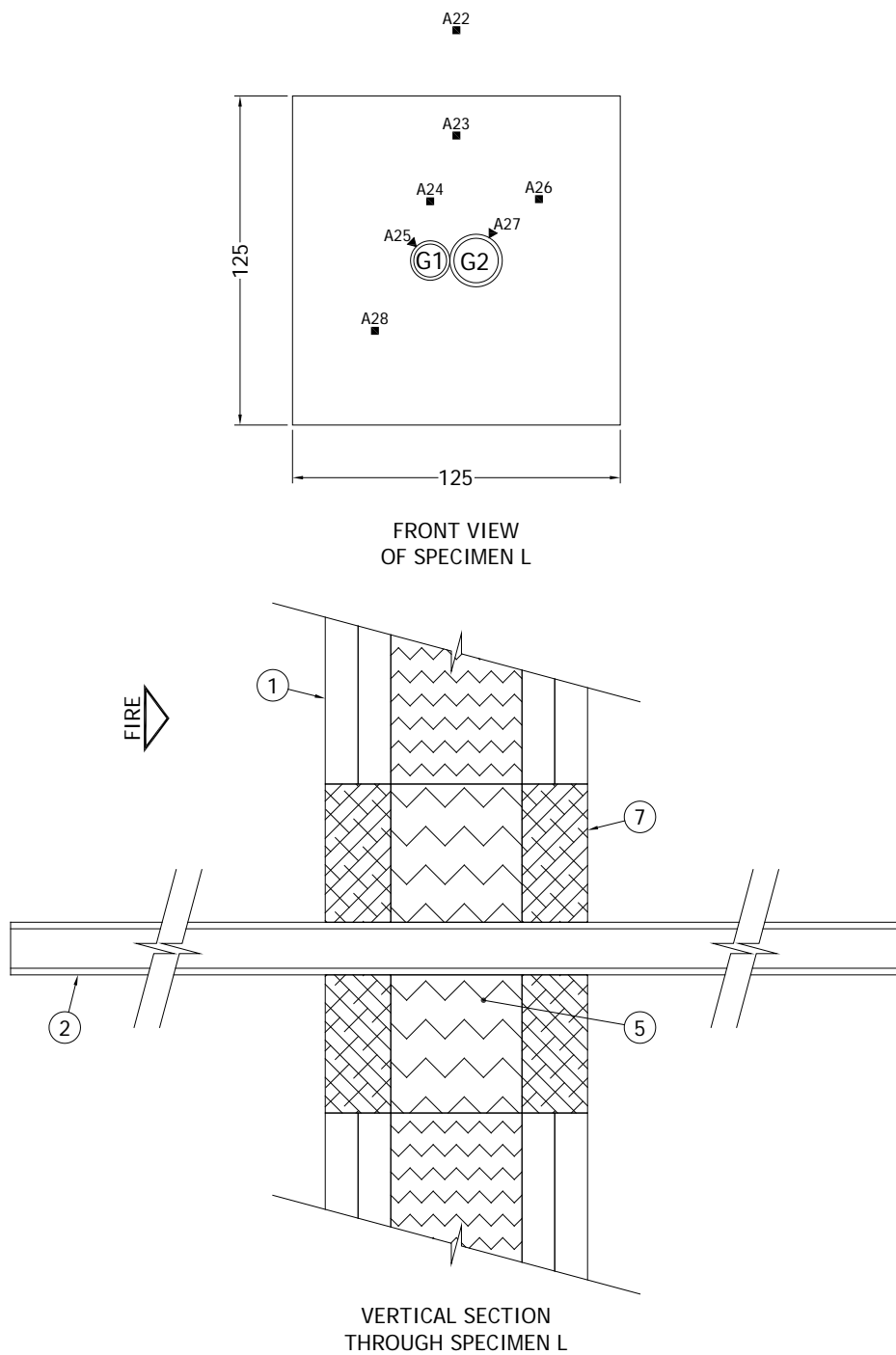
Do not scale. All dimensions are in mm

Figure 14 – Details of Details of Specimen



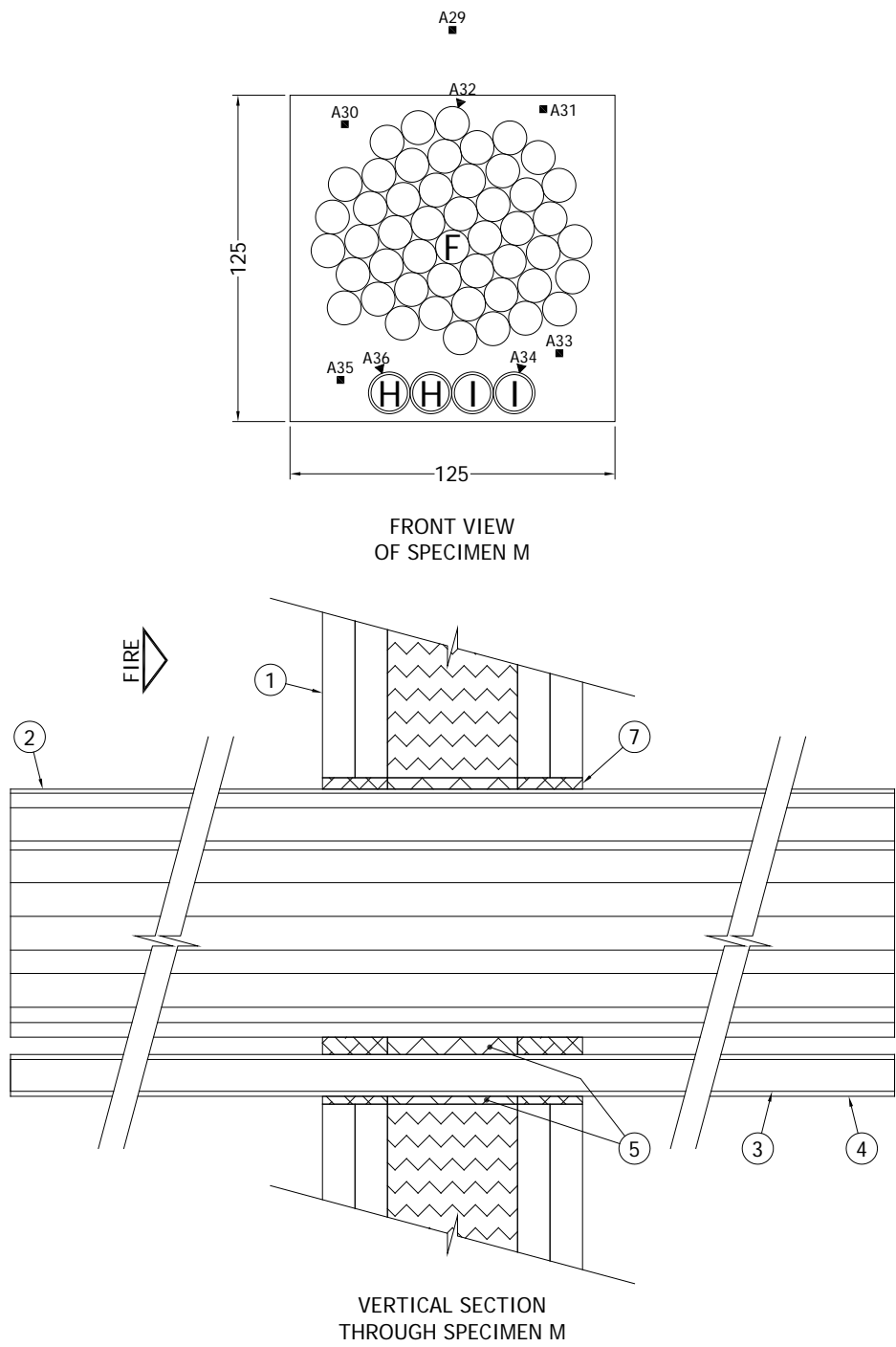
Do not scale. All dimensions are in mm

Figure 15 – Details of Details of Specimen



Do not scale. All dimensions are in mm

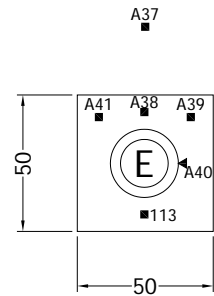
Figure 16 – Details of Details of Specimen



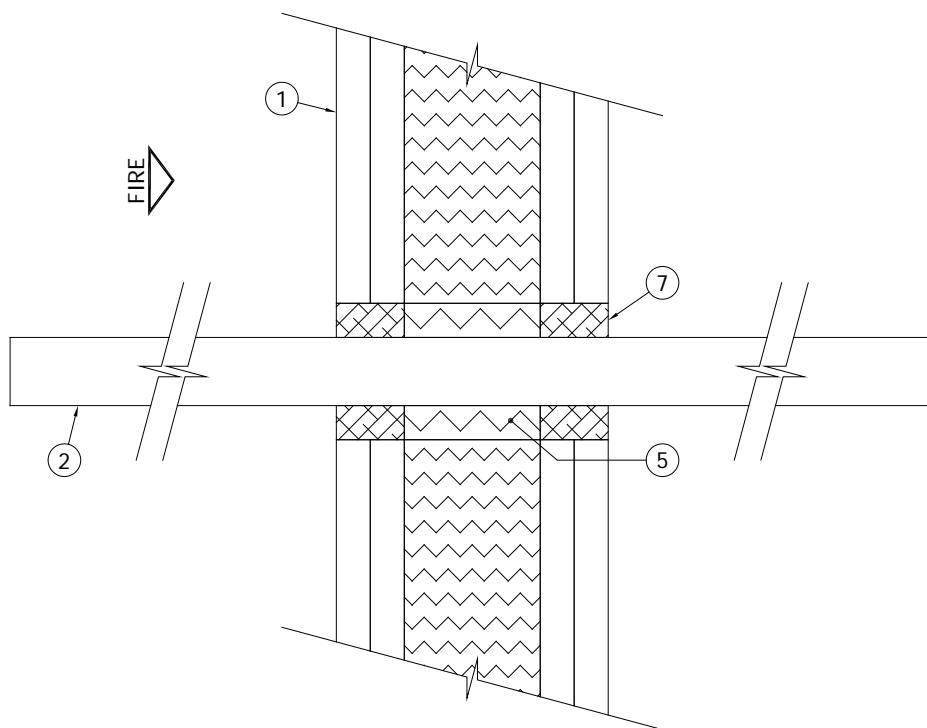
Do not scale. All dimensions are in mm



Figure 17 – Details of Details of Specimen



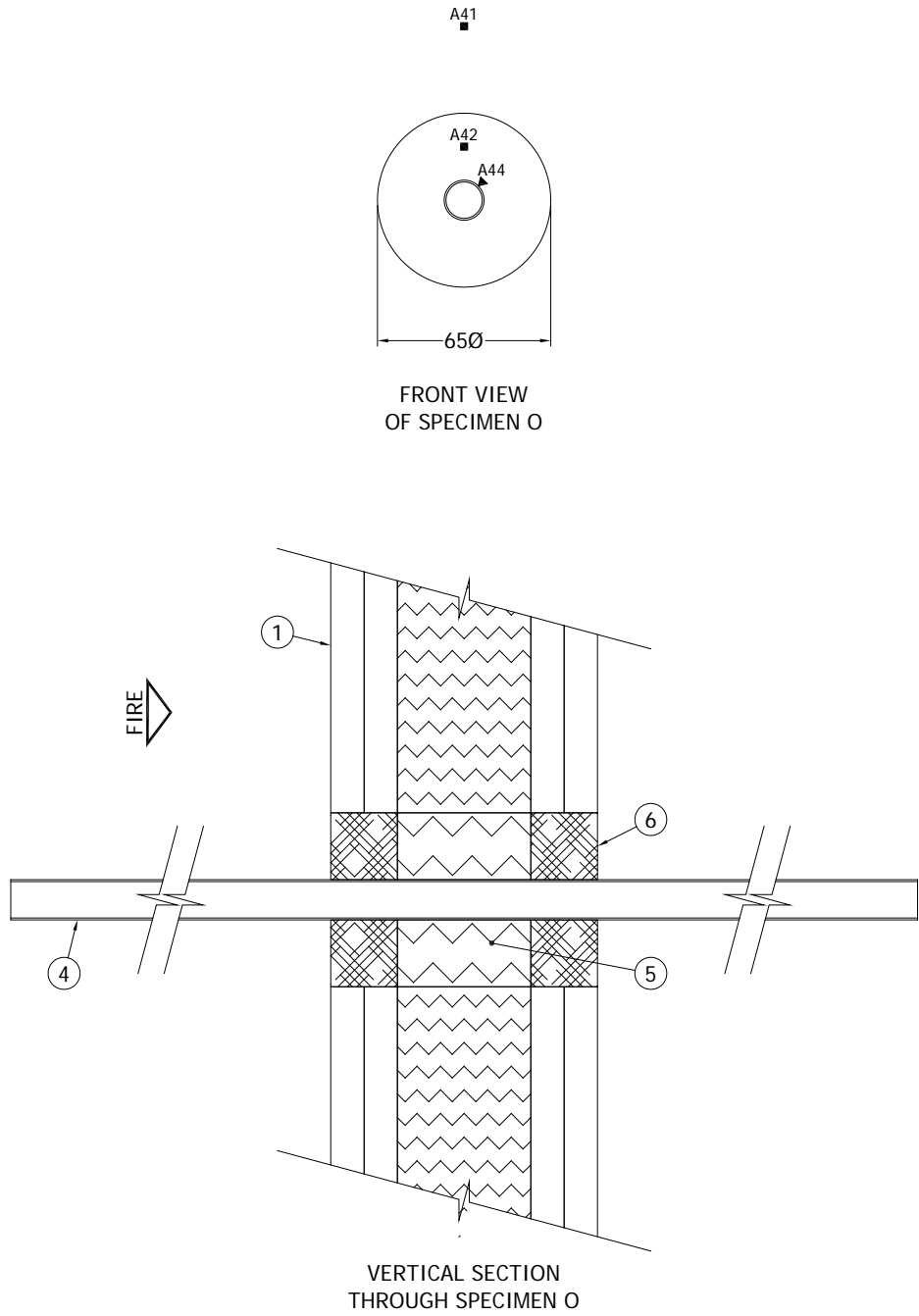
FRONT VIEW  
OF SPECIMEN N



VERTICAL SECTION  
THROUGH SPECIMEN N

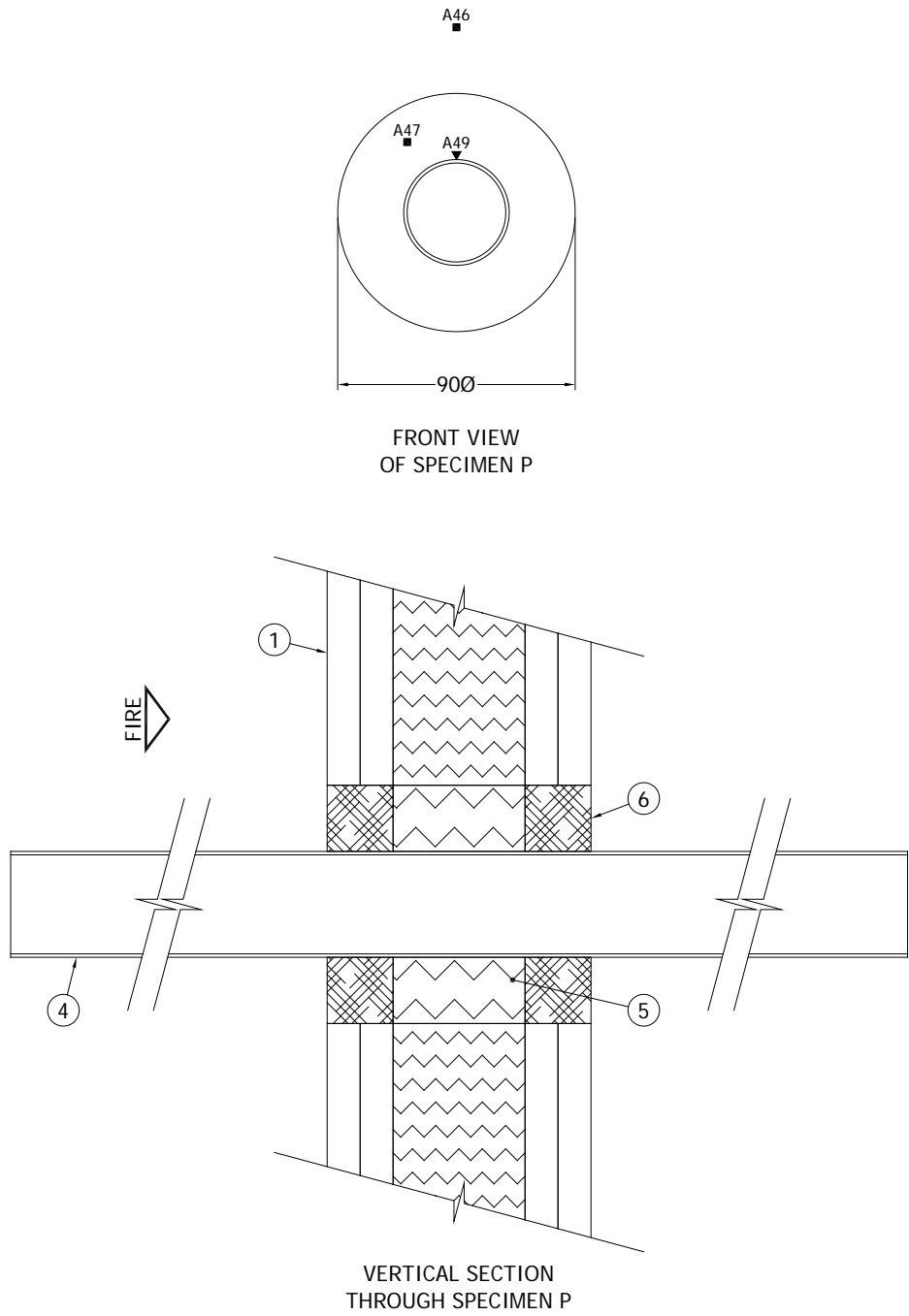
Do not scale. All dimensions are in mm

Figure 18 – Details of Details of Specimen



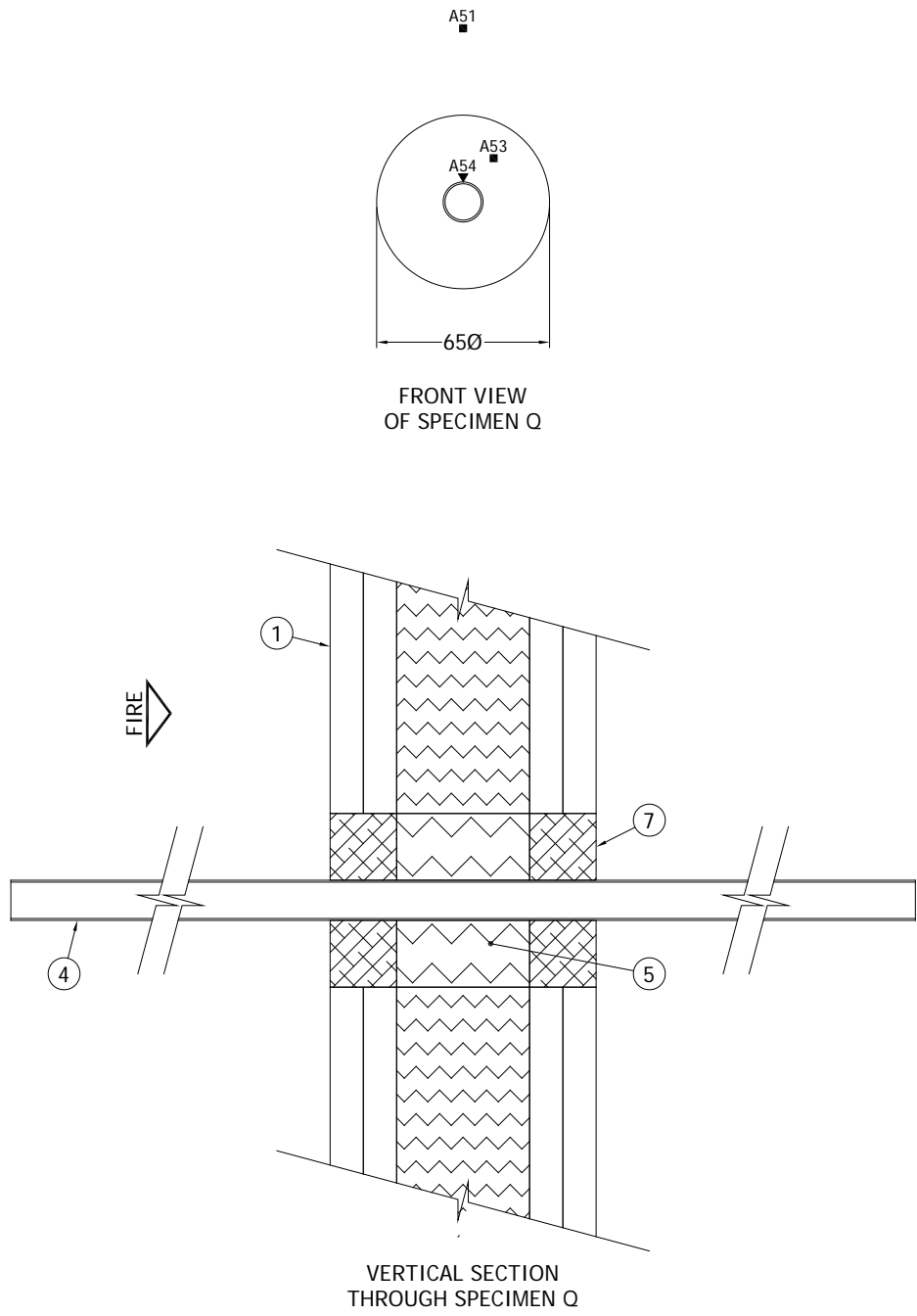
Do not scale. All dimensions are in mm

Figure 19 – Details of Details of Specimen



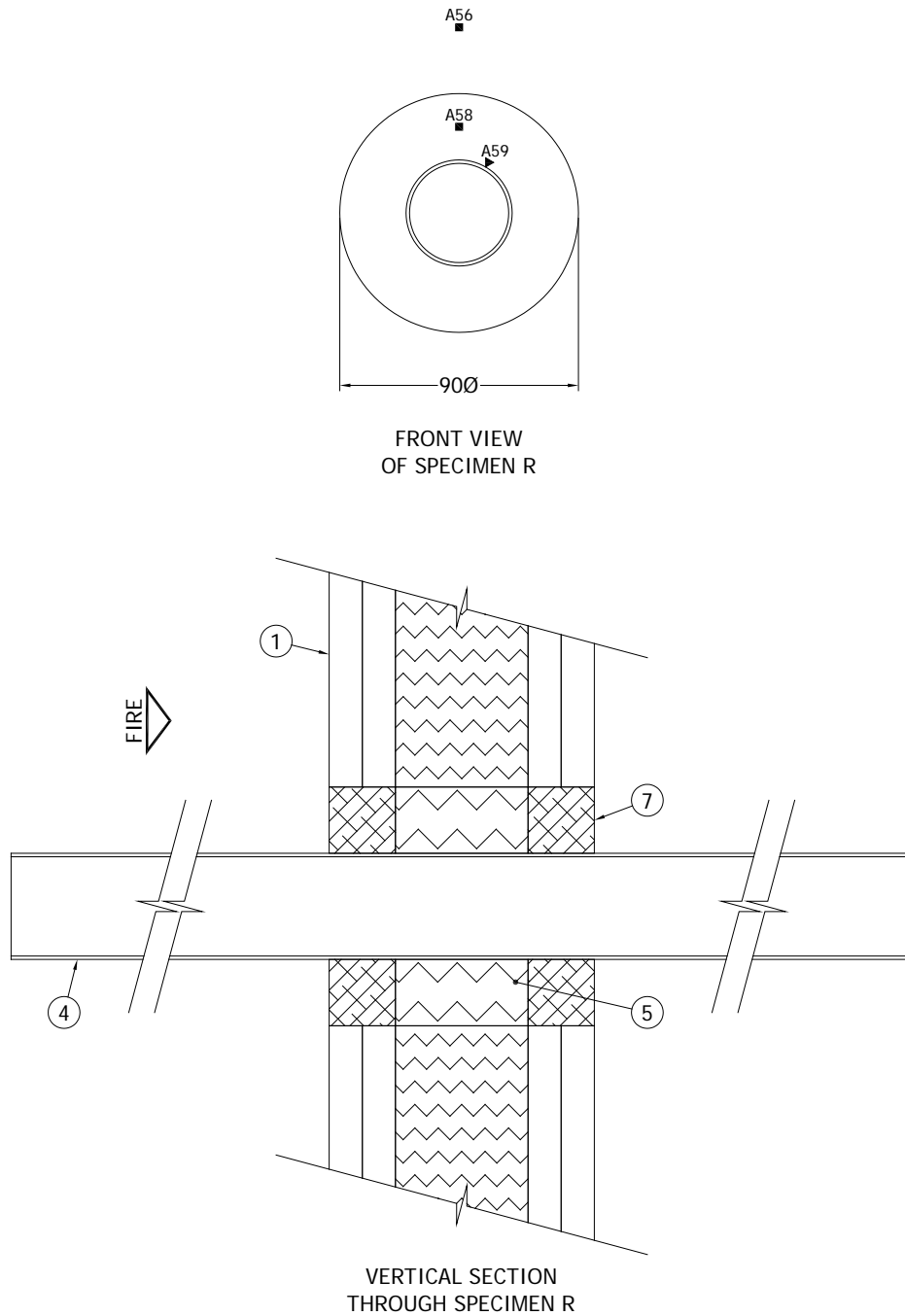
Do not scale. All dimensions are in mm

Figure 20 – Details of Details of Specimen



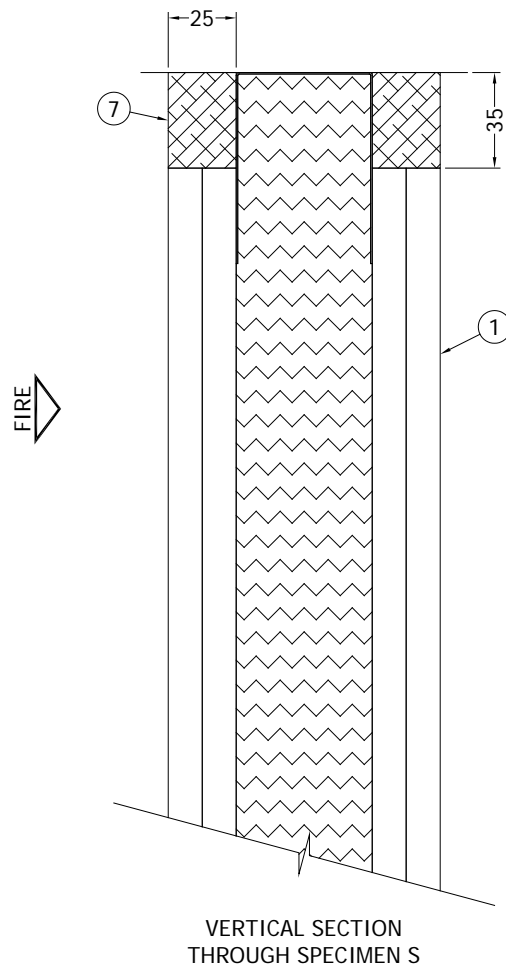
Do not scale. All dimensions are in mm

Figure 21 – Details of Details of Specimen



Do not scale. All dimensions are in mm

Figure 22 – Details of Details of Specimen



Do not scale. All dimensions are in mm

# Schedule of Components

(Refer to Figures 1 to 22)  
 (All values are nominal unless stated otherwise)  
 (All other details are as stated by the sponsor)

<u>Item</u>	<u>Description</u>
<b>1. Partition</b>	
Manufacturers	
i. top track	: British Gypsum
ii. bottom track	: British Gypsum
iii. studs	: British Gypsum
iv. plasterboards	: Siniat Ltd
v. insulation	: Rockwool Ltd
Reference	
i. top track	: 70 S 50
ii. bottom track	: 50 C 50
iii. studs	: 48 S 50
iv. plasterboards	: GTEC Standard board
v. insulation	: ProRox SL 960 UK (RW5 Slab)
Material	
i. top track	: Hot dipped galvanised mild steel
ii. bottom track	: Hot dipped galvanised mild steel
iii. studs	: Hot dipped galvanised mild steel
iv. plasterboards	: Gypsum to BS EN520 categorised as type D & F
v. insulation	:
Density	: 100 kg/m <sup>3</sup> , <b>stated manufacturers density</b>
Thickness'	
i. top track	: 0.55 mm
ii. bottom track	: 0.55 mm
iii. studs	: 0.55 mm
iv. plasterboards	: 25 mm, 2 off layers of 12.5 mm
v. insulation	: 50 mm
Overall sizes	
i. top track	: 50 mm wide x 70 mm deep
ii. bottom track	: 50 mm wide x 50 mm deep
iii. studs	: 50 mm wide x 32 mm deep with 6 mm returned edges
iv. plasterboards	: 3000 mm x 1200 mm
v. insulation	: 1200 mm x 600 mm
Fixing methods	
i. top track	: Anchor screw fixed to concrete lining of restraint frame
ii. bottom track	: Anchor screw fixed to concrete lining of restraint frame
iii. studs	: Friction fitted between top & bottom track sections allowing 35 mm at the head for expansion during the test
v. plasterboards	: Fitted in 2 layers per side, and screwed to framework using 3.5 mm diameter drywall screws, 25 mm long first layer, 38 mm second layer. The joints of the second layer were staggered with respect to those of the first layer. All joints were paper taped and skimmed
v. insulation	: Friction fitted into gaps between studs and further retained by the plasterboard facings

<u>Item</u>	<u>Description</u>
<b>2. Electric Cables</b>	
The electric cable reference, number and size of the copper cores and the cables overall diameter are;	
Type A1	: NYY-J 5x1,5RE - 5 No. wires x 1.5mm <sup>2</sup> x 12mm diameter
Type A2	: H07RN-F 5G1,5 - 5 No. wires x 1.5mm <sup>2</sup> x 12mm diameter
Type A3	: N2XH-J 5x1,5RE - 5 No. wires x 1.5mm <sup>2</sup> x 12mm diameter
Type B	: NYY-J 1x95RM - 1 No. wire x 95mm <sup>2</sup> x 19mm diameter
Type C1	: NYCWY 4x95SM/50 - 4 x 95mm <sup>2</sup> x 41mm diameter
Type C2	: H07RN-F 4G95 - 4 x 95mm <sup>2</sup> x 50mm diameter
Type C3	: N2XH-J 4x95SM - 4 x 95mm <sup>2</sup> x 37mm diameter
Type D1	: NYCWY 4x185SM/95 - 4 x 185mm <sup>2</sup> x 55mm diameter
Type D2	: H07RN-F 4G185 - 4 x 185mm <sup>2</sup> x 65mm diameter
Type D3	: N2XH-J 4x185SM - 4 x 185mm <sup>2</sup> x 52.5mm diameter
Type E	: NYY-J 1x185RM - 1 x 185mm <sup>2</sup> x 25mm diameter
Type F	: A-2Y (L) 2Y BdFernmelde-Auaenk – 20 x 2mm <sup>2</sup> x 0.6mm screened x 13mm diameter
Type G1	: H07V-R - 1 x 95mm <sup>2</sup> x 15mm diameter
Type G2	: H07V-R - 1 x 185mm <sup>2</sup> x 20mm diameter
<b>Specimens A &amp; H (Designation 1 of BS EN 1366-3: 2009, Annex B)</b>	Blank Seal
<b>Specimens B &amp; I (Designation 2 of BS EN 1366-3: 2009, Annex B)</b>	1 off C1, 1 off C2, 1 off C3, & 1 off E
<b>Specimens C &amp; J (Designation 3 of BS EN 1366-3: 2009, Annex B)</b>	1 off D1, 1 off D2 & 1 off D3
<b>Specimens D &amp; K (Designation 4 of BS EN 1366-3: 2009, Annex B)</b>	3 off A1, 3 off A2, 3 off A3, & 1 off B
<b>Specimens E &amp; L (Designation 5 of BS EN 1366-3: 2009, Annex B)</b>	1 off G1 & 1 off G2
<b>Specimens F &amp; M (Designation 6 of BS EN 1366-3: 2009, Annex B)</b>	49 off F
<b>Specimens G &amp; N (Designation 8 of BS EN 1366-3: 2009, Annex B)</b>	1 off E
<b>3. Plastics Pipes</b>	
Material	: Polyvinyl chloride, PVC
Overall size	: 16 mm diameter x 1 mm wall thickness
Standard designation	: I
Fixing method	: 2 off passed through partition for specimens F & M and supported on each face by the support framework
<b>4. Copper Pipes</b>	
Material	: Copper
Overall sizes	
i. standard designation H	: 16 mm diameter x 0.5 mm wall thickness
ii. specimens O & Q	: 15 mm diameter x 0.7 mm wall thickness
iii. specimens P & R	: 42 mm diameter x 1.3 mm wall thickness



**Item**

**Description**

**4. Copper Pipes (Continued)**

Fixing methods

- i. standard designation H : 2 off passed through partition for specimens F & M and supported on each face by the support framework
- ii. specimens O & Q : Single pipe passed through partition and supported on each face by the support framework
- iii. specimens P & R : Single pipe passed through partition and supported on each face by the support framework

**5. Penetration Infill**

- Manufacturer : Rockwool Ltd
- Reference : ProRox SL 930 UK (RW3 Slab)
- Material : Non-woven stone wool based insulation
- Density : 60 kg/m<sup>3</sup>, **stated manufacturers density**
- Fitting method : Packed into apertures around penetrating cables & pipes

**6. Sealant**

- Manufacturer : (Factory No. 1144)
- Reference : 'Everbuild Fire Mate'
- Material : Intumescent acrylic sealant
- Application method : Cartridge gunned within penetration Specimens A to G, O & P

**7. Sealant**

- Manufacturer : (Factory No. 1144)
- Reference : Everbuild Fireseal 300
- Material : Intumescent & acoustic sealant
- Application method : Cartridge gunned within penetration Specimens H to N, Q & R. Also cartridge gunned within linear gap Specimen S, on each face, across the head of the partition

# Instrumentation

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<b>General</b>	The instrumentation was provided in accordance with the requirements of EN 1366-3: 2009 and EN 1366-4: 2006 +A1:2010.
<b>Furnace</b>	The furnace was controlled so that its mean temperature complied with the requirements of EN 1363-1: 2012 Clause 5.1 using six plate thermometers, distributed over a plane 100 mm from the surface of the test construction.
<b>Thermocouples</b>	<p>Thermocouples were provided to monitor the unexposed surface temperatures of the specimens, and the output of all instrumentation was recorded at no less than one minute intervals, as follows:</p> <p>The locations and reference numbers of the various unexposed surface thermocouples are shown in Figure1 and 4 to 21.</p>
<b>Roving Thermocouple</b>	A roving thermocouple was available to measure temperatures on the unexposed surface of the specimens at any position which might appear to be hotter than the temperatures indicated by the fixed thermocouples.
<b>Integrity criteria</b>	Cotton pads and gap gauges were available to evaluate the integrity of the specimens.
<b>Furnace Pressure</b>	<p>The furnace atmospheric pressure was controlled so that it complied with the requirements of EN 1366-3: 2009, Clause 5.2. The pressure differential relative to the laboratory atmosphere at the top of the uppermost penetration seal was calculated to be 20 (+2, -0) Pa and 11 (+2, -0) Pa at the lowest point of the lowest service.</p> <p>The pressure differential relative to the laboratory atmosphere at the position of the linear joint (Specimen S) was 22 (+2, -0) Pa.</p>

# Test Observations

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Time		All observations are from the unexposed face unless noted otherwise.
mins	secs	The ambient air temperature in the vicinity of the test construction was 14°C at the start of the test with a maximum variation of +4°C during the test.
00	00	<b>The test commences.</b>
01	00	Smoke release issues from all specimens.
03	30	Smoke release has increased from all specimens.
05	30	Smoke release mentioned previously has reduced and almost stopped.
10	00	Smoke release mentioned previously has recommenced from Specimens B, C, D, F, I, J and M at the point of penetration of the services and at the end of the services items also.
14	00	Viewed from the exposed face, large amounts of flaming issues from the service items.
29	30	Smoke release issues from Specimens E and L at the point of penetration of the services.
38	15	The sealing system of Specimens P and R has expanded out of the apertures by approximately 10-20 mm for Specimen P, and 20-25 mm for Specimen R.
39	30	Resinous liquid issues from Specimen L at the point of penetration of the services.
41	00	Viewed from the exposed face, the joints within the first layer of plaster board have opened up by approximately 10-12mm. The plastic casing of each cable has degraded significantly and burnt away.
50	00	Viewed from the exposed face, the cable services appear heavily degraded and have slumped over at the support position.
51	50	Smoke release has increased slightly at the point of penetration of the services of Specimens E, I, M and N. The sealing system of Specimens I, L O and R has expanded out of the aperture. The sealing system of Specimens I and R have expanded out of the apertures the greatest by approximately 25-30 mm.
60	08	Sustained flames issues from the upper surface if Specimen M. <b>Integrity failure of Specimen M is deemed to occur.</b> Specimen M is blanked off at the sponsors request to allow test to continue.
62	50	Sustained flames issue from Specimen R as the penetration seal ignites. <b>Integrity failure of Specimen R is deemed to occur.</b> The flaming of Specimen R is extinguished to allow the test to continue.
65	30	Smoke release increases from Specimen F.

**Time**

**mins secs**

- 66 45** Sustained flames issue from Specimen F at its upper surface. **Integrity failure of Specimen F is deemed to occur.** Specimen F is blanked off to allow the test to continue.
- 70 20** Smoke release begins to issue from Specimen K at point of penetration.
- 75 20** Large cracks have formed within the joint filler along the right hand joint as the partition wall bows away from the furnace at mid height.
- 78 00** The penetration seal of Specimens B, C, K, L and P has discoloured at the point of penetration of the services. Smoke release has increased slightly at these locations.
- 84 00** A through gap has formed at the upper perimeter edge of the service at the point of penetration of Specimen R. Specimen R is blanked off to allow the test to continue.
- 90 00** All specimens (excluding F, M and R) continue to satisfy the integrity criteria.
- 93 40** The plastic casing of the services of Specimens C, E, G, I and L appears swollen, charred and melted at the point of penetration.
- 109 40** Smoke release has increased from Specimen J at the point of penetration.
- 118 00** Smoke release begins to issue from the right hand joint within the partition.
- 123 00** Flames continue to issue from blanked off Specimens F and M. **The test is discontinued at the sponsors request.**

## Test Photographs

The exposed face of the specimens prior to testing.



The unexposed face of the specimens prior to testing



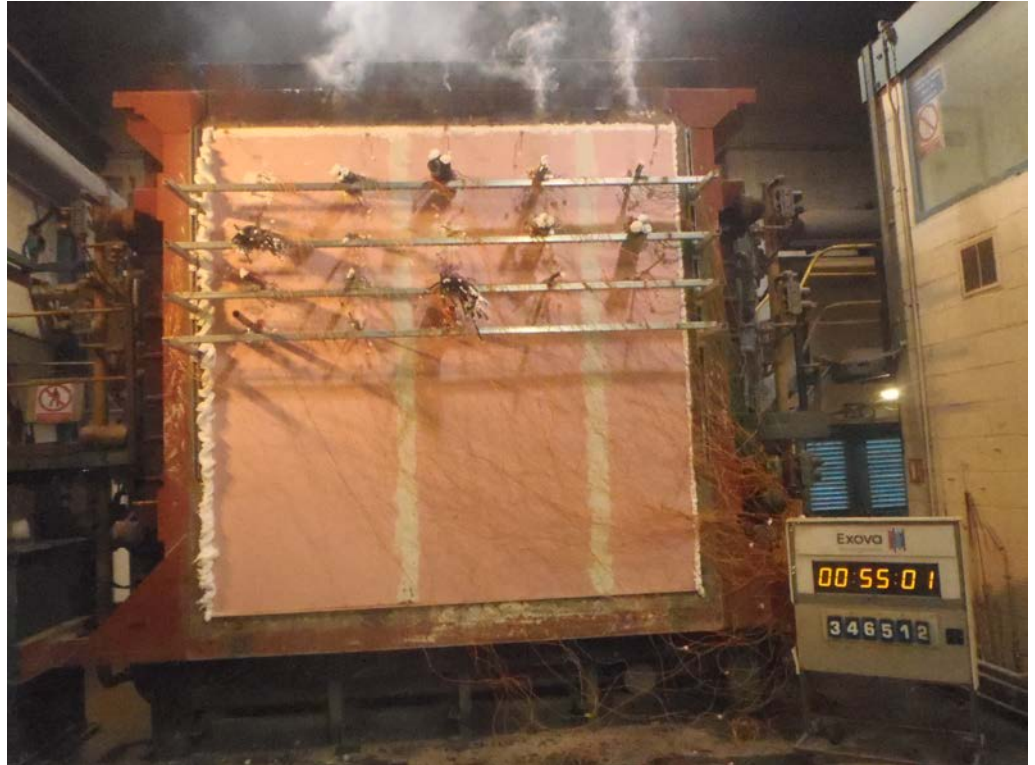
The unexposed face of the specimens after a test duration of 10 minutes



The unexposed face of the specimens after a test duration of 35 minutes



The unexposed face of the specimens after a test duration of 55 minutes



Integrity failure of Specimen M after a test duration of 60 minutes



The unexposed face of the specimens after a test duration of 92 minutes



The unexposed face of the specimens after a test duration of 120 minutes





The unexposed face of the specimens after a test duration of 123 minutes



The exposed face of the specimens immediately after the test



# Temperature Data

Mean Furnace Temperature, Together With The Temperature/Time Relationship Specified In EN 1363-1: 2012

Time Mins	Specified Furnace Temperature Deg. C	Actual Furnace Temperature Deg. C
0	20	23
4	544	581
8	646	634
12	706	685
16	748	738
20	781	766
24	809	825
28	832	848
32	852	865
36	869	879
40	885	891
44	899	895
48	912	913
52	924	923
56	935	932
60	945	947
64	955	954
68	964	959
72	973	978
76	981	975
80	988	991
84	996	1000
88	1003	1002
92	1009	1007
96	1016	1018
100	1022	1024
104	1028	1028
108	1033	1032
112	1039	1036
116	1044	1041
120	1049	1048
123	1053	1053

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen A**

Time Mins	T/C Number 7 Deg. C	T/C Number 8 Deg. C	T/C Number 9 Deg. C	T/C Number 10 Deg. C	T/C Number 11 Deg. C
0	18	19	19	19	19
4	18	19	19	19	19
8	19	20	20	19	19
12	27	30	28	25	22
16	43	45	41	36	30
20	53	54	51	45	39
24	59	59	56	51	45
28	62	62	60	56	50
32	62	64	62	58	54
36	62	64	63	60	57
40	61	64	63	61	60
44	59	64	63	62	61
48	58	63	63	63	62
52	57	62	62	63	62
56	55	61	61	62	62
60	54	60	61	61	62
64	53	60	60	61	63
68	55	61	60	63	*
72	53	60	59	60	
76	54	59	59	59	
80	55	59	60	60	
84	57	60	60	60	
88	59	63	62	61	
92	61	63	62	61	
96	63	65	63	62	
100	66	66	65	63	
104	69	69	67	64	
108	72	72	70	67	
112	74	75	73	69	
116	73	78	76	72	
120	75	81	78	74	
123	76	83	79	75	

\*Thermocouple malfunction

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen B**

Time Mins	T/C Number 12 Deg. C	T/C Number 13 Deg. C	T/C Number 14 Deg. C	T/C Number 15 Deg. C	T/C Number 16 Deg. C	T/C Number 17 Deg. C	T/C Number 18 Deg. C	T/C Number 19 Deg. C
0	19	20	20	16	16	16	17	16
4	20	20	20	17	16	18	17	17
8	20	21	21	23	19	26	17	20
12	26	30	28	34	26	40	23	28
16	37	43	40	45	37	57	33	38
20	46	52	50	59	51	75	43	50
24	53	60	58	76	65	91	50	63
28	59	67	68	93	75	106	58	76
32	62	72	75	108	82	120	66	89
36	63	77	80	123	86	134	73	101
40	63	82	84	137	90	148	79	114
44	64	84	86	151	93	167	82	126
48	68	85	89	165	98	179	85	138
52	69	84	92	176	105	195	86	150
53	70	84	93	179	107	199	86	153
56	71	84	95	185	113	209	86	161
60	72	85	97	193	122	224	87	173
64	71	87	98	201	131	236	28	184
68	72	90	100	208	140	246	26	193
72	74	93	103	216	149	265	27	197
76	75	95	104	222	157	288	25	205
80	75	97	106	226	166	313	27	212
84	76	98	108	230	175	325	69	216
88	77	100	111	230	183	333	*	222
92	79	102	114	230	191	349	92	230
96	79	102	116	227	199	359	114	236
100	81	104	119	226	206	370	*	239
104	82	105	124	241	213	387		244
108	84	108	131	277	222	397		252
112	86	114	140	302	233	412		258
116	87	120	150	347	242	416		262
120	87	128	163	396	247	419		270
123	87	134	174	415	248	427		276

\*Thermocouple malfunction

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen B (Continued)**

Time Mins	T/C Number 20 Deg. C	T/C Number 21 Deg. C	T/C Number 22 Deg. C
0	16	15	19
4	17	23	19
8	20	44	20
12	26	68	24
16	37	96	31
20	52	119	41
24	65	139	53
28	78	149	65
32	88	158	73
36	97	155	78
40	104	144	82
44	113	144	84
48	121	138	86
52	130	136	88
53	133	136	89
56	143	138	90
60	169	150	95
64	189	170	102
68	237	182	123
72	238	204	141
76	239	226	153
80	246	243	164
84	255	258	174
88	266	280	185
92	275	289	199
96	282	296	205
100	295	306	209
104	300	314	214
108	303	316	215
112	295	*	212
116	288		210
120	296		214
123	302		218

\*Thermocouple malfunction

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen C**

Time Mins	T/C Number 23 Deg. C	T/C Number 24 Deg. C	T/C Number 25 Deg. C	T/C Number 26 Deg. C	T/C Number 27 Deg. C	T/C Number 28 Deg. C	T/C Number 29 Deg. C	T/C Number 30 Deg. C	T/C Number 31 Deg. C
0	19	20	20	20	20	20	19	19	19
4	19	20	20	21	21	20	19	20	20
8	19	22	22	26	22	21	19	25	21
12	30	37	30	36	33	23	22	37	34
16	48	50	44	48	46	27	27	52	47
20	57	57	56	61	54	33	35	68	55
24	62	62	65	73	59	38	44	85	61
28	64	65	72	85	63	44	54	100	67
32	65	67	78	96	67	50	65	117	73
36	66	70	83	108	70	56	73	130	78
40	66	71	88	121	74	63	78	143	83
44	67	73	92	134	76	70	82	159	87
48	68	75	96	143	79	77	86	173	91
52	69	76	99	152	82	85	88	185	93
56	70	77	106	165	84	94	92	197	95
57	70	78	108	168	85	96	92	200	96
60	71	78	119	184	87	103	95	209	98
64	74	82	140	211	92	114	106	232	101
68	74	82	155	236	94	123	109	234	104
72	75	83	172	254	96	134	114	239	107
76	76	85	186	270	99	144	120	248	112
80	76	88	200	290	102	155	127	263	114
84	77	88	213	306	106	163	135	274	117
88	79	91	229	328	109	171	142	282	123
92	81	93	244	346	112	176	148	290	130
96	81	95	258	353	115	176	155	298	138
100	86	102	269	364	122	179	170	312	152
104	86	102	283	380	124	176	170	319	163
108	87	105	296	397	129	177	176	328	177
112	92	109	312	417	136	178	183	335	192
116	95	119	327	433	147	189	200	351	215
120	100	129	344	457	160	199	221	372	242
123	105	138	361	483	171	209	230	380	261

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen D**

Time Mins	T/C Number 32 Deg. C	T/C Number 33 Deg. C	T/C Number 34 Deg. C	T/C Number 35 Deg. C	T/C Number 36 Deg. C	T/C Number 37 Deg. C	T/C Number 38 Deg. C	T/C Number 39 Deg. C
0	18	18	14	18	17	16	17	17
4	18	19	18	22	18	40	18	43
8	19	22	*	32	24	44	20	46
12	22	30		41	31	75	26	73
16	34	45		50	41	78	38	77
20	45	57		61	52	81	49	79
24	52	65		71	62	86	57	86
28	57	71	42	79	70	90	62	91
32	61	76	44	84	75	93	66	99
36	64	80	50	88	79	102	69	110
37	64	81	52	89	79	104	70	113
38	64	82	53	90	80	105	71	116
40	65	84	57	93	81	109	73	123
44	66	86	59	100	83	118	77	133
48	66	88	56	107	86	127	79	143
52	66	88	54	114	87	134	80	150
56	65	90	53	120	90	140	81	159
60	65	91	51	125	92	146	81	166
64	65	93	51	131	94	152	82	173
68	67	96	52	135	95	158	83	180
72	68	97	50	139	96	162	85	187
76	70	100	45	142	98	166	87	194
80	72	102	44	147	101	171	90	201
84	75	104	45	151	103	175	92	206
88	77	107	46	155	105	179	93	213
92	78	109	47	159	107	182	90	219
96	80	112	46	161	110	185	92	226
100	81	116	44	165	112	188	93	232
104	82	120	45	170	117	192	95	238
108	83	124	44	173	120	195	96	243
112	83	129	42	177	122	198	96	248
116	84	134	42	182	126	202	98	253
120	86	139	39	185	130	206	99	258
123	87	144	39	188	132	209	100	261

\*Temporary thermocouple malfunction

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen D (Continued)**

Time Mins	T/C Number 40 Deg. C	T/C Number 41 Deg. C	T/C Number 42 Deg. C
0	13	18	18
4	14	25	18
8	*	40	19
12		62	22
16		81	31
20		100	40
24		122	48
28	64	146	55
32	68	169	60
36	71	192	64
37	72	197	65
38	72	201	65
40	72	207	67
44	74	207	69
48	74	212	71
52	75	217	72
56	76	225	73
60	77	233	74
64	78	239	76
68	78	244	76
72	80	252	77
76	80	257	78
80	81	262	80
84	85	267	82
88	89	273	85
92	93	276	84
96	96	279	85
100	100	282	85
104	107	286	87
108	112	288	88
112	116	290	88
116	118	296	89
120	124	294	91
123	127	298	93

\*Temporary thermocouple malfunction



**Individual Temperatures Recorded On The Unexposed Surface Of Specimen E**

Time Mins	T/C Number 43 Deg. C	T/C Number 44 Deg. C	T/C Number 45 Deg. C	T/C Number 46 Deg. C	T/C Number 47 Deg. C	T/C Number 48 Deg. C	T/C Number 49 Deg. C
0	10	10	9	10	11	11	10
4	10	10	*	*	11	*	11
8	11	10			*		11
12	*	*					25
16		38	54	136	34	131	36
20	47	46	66	159	41	149	42
24	50	52	74	180	46	165	45
25	50	53	75	186	47	170	46
26	50	54	76	192	47	174	46
28	50	55	77	195	48	181	46
32	49	57	78	188	48	192	47
36	48	59	80	189	49	202	49
40	48	60	84	196	48	220	52
44	47	61	88	207	49	237	55
48	46	62	93	218	51	251	57
52	46	63	99	229	53	265	59
56	45	64	105	240	54	272	57
60	44	64	111	251	54	280	57
64	45	67	118	263	55	281	55
68	45	68	123	273	55	281	52
72	46	68	127	283	54	278	50
76	47	70	132	291	53	284	50
80	47	70	135	293	53	282	49
84	46	71	140	297	44	295	49
88	46	69	143	304	37	300	49
92	46	71	146	309	33	306	45
96	42	67	143	308	31	301	41
100	41	68	146	313	21	305	38
104	39	69	148	312	21	306	36
108	36	69	148	313	27	304	35
112	41	80	161	319	31	313	33
116	39	82	164	315	31	305	32
120	46	97	179	327	37	316	30
123	48	99	182	322	33	306	25

\*Temporary thermocouple malfunction

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen F**

Time Mins	T/C Number 101 Deg. C	T/C Number 102 Deg. C	T/C Number 103 Deg. C	T/C Number 104 Deg. C	T/C Number 105 Deg. C	T/C Number 106 Deg. C	T/C Number 107 Deg. C	T/C Number 108 Deg. C
0	15	15	15	15	15	15	16	17
2	15	15	15	18	16	16	16	22
4	16	16	17	24	17	18	17	47
6	17	19	19	28	20	20	18	72
8	19	25	22	31	23	21	20	92
10	25	35	28	37	27	26	26	108
12	36	49	36	44	33	32	35	114
14	47	60	45	53	40	37	45	115
16	56	68	52	60	46	39	53	119
18	62	74	59	65	53	42	60	126
20	65	76	64	71	58	45	66	134
22	66	78	68	73	64	47	70	139
24	67	80	72	75	71	50	73	145
26	67	82	74	79	74	53	76	153
28	68	84	77	85	76	54	77	160
30	69	86	79	89	76	56	79	169
32	70	88	80	91	78	59	80	176
34	72	89	82	92	79	61	81	184
36	73	91	83	93	80	63	82	191
37	74	93	84	94	80	64	82	195
38	75	94	84	95	81	65	83	198
40	75	96	86	96	82	68	83	205
42	76	98	87	99	83	69	85	212
44	77	101	88	103	84	71	85	218
46	78	104	90	107	85	75	86	223
48	78	106	90	111	85	76	87	229
50	78	108	92	114	86	79	87	236
52	78	111	93	115	86	81	88	241
54	79	114	95	122	86	83	89	246
56	80	116	96	125	87	84	90	253
58	82	119	99	130	88	86	90	260
60	83	122	101	135	89	91	91	266
62	86	125	104	160	90	94	92	272
64	89	130	107	189	90	96	94	277
65	91	133	108	204	91	97	94	280
66	#	#	#	#	#	#	#	#

#Specimen blanked off to allow the test to continue

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen G**

Time Mins	T/C Number 109 Deg. C	T/C Number 110 Deg. C	T/C Number 111 Deg. C	T/C Number 112 Deg. C	T/C Number 113 Deg. C
0	18	18	19	18	19
4	18	19	20	22	19
8	21	33	33	53	29
12	40	59	64	102	53
16	59	80	93	137	75
20	70	92	109	161	90
24	77	101	122	175	100
28	80	106	133	178	107
32	83	113	143	182	111
36	84	123	155	189	116
40	85	134	168	195	123
43	84	141	174	198	128
44	84	144	177	199	130
48	84	156	183	202	138
52	85	167	187	208	147
56	85	176	192	215	154
60	87	183	203	226	162
64	90	190	213	237	169
68	94	198	221	242	176
72	98	204	228	246	182
76	100	210	235	254	189
80	102	215	241	258	194
84	104	219	246	263	199
88	106	223	250	264	203
92	110	228	256	268	209
96	112	231	262	279	210
100	115	235	269	286	215
104	115	242	280	295	222
108	114	248	287	304	230
112	114	251	295	312	234
116	117	259	307	326	238
120	120	265	315	337	247
123	124	272	322	344	253

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen H**

Time Mins	T/C Number 114 Deg. C	T/C Number 115 Deg. C	T/C Number 116 Deg. C	T/C Number 117 Deg. C	T/C Number 118 Deg. C
0	18	15	16	16	16
4	19	16	16	16	16
8	19	16	16	16	16
12	24	20	19	18	21
16	34	28	26	23	29
20	42	35	34	29	35
24	47	41	38	34	40
28	50	45	42	38	44
32	53	48	46	42	47
36	56	51	49	45	49
40	58	54	52	47	51
44	59	55	54	50	53
48	58	56	55	51	54
52	56	56	56	52	54
56	56	56	56	53	55
60	56	56	56	54	56
64	80	73	77	78	75
68	70	67	70	69	*
72	66	65	66	65	
76	66	65	66	65	
80	67	66	67	66	
84	70	67	68	67	
88	71	67	69	67	
92	74	69	70	68	
96	76	72	73	70	
100	87	81	83	77	
104	79	79	79	76	
108	79	80	80	78	
112	85	85	88	86	
116	98	100	157	152	
117	101	104	187	198	
120	108	112	267	292	
123	122	128	314	345	

\*Thermocouple malfunction

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen I**

Time Mins	T/C Number 119 Deg. C	T/C Number 120 Deg. C	T/C Number 121 Deg. C	T/C Number 122 Deg. C	T/C Number 123 Deg. C	T/C Number 124 Deg. C	T/C Number 125 Deg. C	T/C Number 126 Deg. C
0	16	15	17	12	17	16	17	17
4	16	15	17	12	17	17	18	19
8	17	17	19	*	17	20	23	29
12	26	30	31		22	28	37	46
16	41	47	47		31	37	54	65
20	50	59	55		39	47	69	86
24	55	66	63	69	47	56	81	107
28	58	74	68	76	54	66	88	127
32	60	78	73	86	61	78	93	149
36	63	80	80	97	67	92	97	162
40	65	83	87	108	72	106	101	176
44	67	85	93	120	76	119	106	191
45	68	86	94	123	77	122	108	194
46	68	87	95	126	78	126	110	198
48	69	89	97	132	79	133	115	204
52	71	93	102	144	81	146	128	218
56	74	99	107	154	83	157	141	235
60	76	104	112	160	85	169	153	257
64	79	111	116	166	86	178	167	293
68	79	115	119	170	87	178	178	323
72	81	118	122	174	90	188	184	340
76	82	121	126	177	92	191	191	352
80	82	124	128	180	94	196	197	364
84	84	128	130	183	95	202	206	375
88	89	135	133	185	98	205	216	386
92	93	143	137	190	101	209	228	397
96	95	149	142	200	103	217	241	407
100	101	161	148	217	107	219	260	412
104	107	177	158	237	111	228	293	426
108	114	194	168	250	116	234	330	440
112	116	210	180	272	123	238	369	454
116	119	226	195	299	128	248	400	468
120	134	250	215	331	135	252	425	486
123	141	273	230	358	142	259	450	498

\*Temporary thermocouple malfunction

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen I (Continued)**

Time Mins	T/C Number 127 Deg. C	T/C Number 128 Deg. C	T/C Number A1 Deg. C
0	17	16	16
4	17	22	*
8	19	38	
12	24	55	
16	33	58	
20	43	63	52
24	52	72	59
28	60	86	66
32	66	106	71
36	71	132	76
40	72	158	79
44	75	172	81
45	76	172	81
46	76	173	82
48	76	175	82
52	76	183	84
56	78	200	85
60	78	222	88
64	79	249	93
68	81	281	95
72	82	314	92
76	83	347	92
80	84	367	95
84	85	383	100
88	87	408	106
92	89	431	115
96	91	442	121
100	94	452	131
104	95	461	132
108	96	468	138
112	99	479	148
116	101	482	151
120	102	491	162
123	105	499	167

\*Temporary thermocouple malfunction

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen J**

Time Mins	T/C Number A2 Deg. C	T/C Number A3 Deg. C	T/C Number A4 Deg. C	T/C Number A5 Deg. C	T/C Number A6 Deg. C	T/C Number A7 Deg. C	T/C Number A8 Deg. C	T/C Number A9 Deg. C	T/C Number A10 Deg. C
0	15	14	14	14	14	13	14	15	14
4	16	15	14	*	14	*	16	15	15
8	16	*	*		*		18	16	*
12	*						22	*	
16							*		
20	48	38	67	53	79	59			45
24	49	42	69	64	77	73			45
28	46	45	68	74	73	94			*
32	44	47	67	83	67	115			
36	41	49	67	91	66	127			
40	38	50	68	100	66	140			
44	36	50	72	110	68	153			
48	37	50	77	122	71	162			
52	41	51	81	131	74	168			
56	41	50	85	142	77	181			
58	39	50	85	148	78	187			
59	38	49	86	153	79	191			
60	37	49	87	157	80	194			
64	*	49	92	177	88	211			
68		49	102	215	101	226			
72		48	121	236	115	238			
76		49	143	256	125	248			
80		49	159	277	133	257			
84		*	167	302	141	268			
88			181	328	150	299			
92			197	346	162	341	69	74	
96			209	362	177	382	91	154	
100			223	378	190	407	93	169	
104			234	397	205	428	83	160	
108			243	413	220	446	81	144	
112			251	426	233	449	83	186	
116			259	441	250	455	94	217	
120			269	450	261	447	100	280	
123			269	450	261	447	100	280	

\*Thermocouple malfunction

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen K**

Time Mins	T/C Number A11 Deg. C	T/C Number A12 Deg. C	T/C Number A13 Deg. C	T/C Number A14 Deg. C	T/C Number A15 Deg. C	T/C Number A16 Deg. C	T/C Number A17 Deg. C	T/C Number A18 Deg. C
0	18	18	18	18	19	18	18	18
4	19	19	20	22	21	28	20	21
8	20	23	24	28	27	53	22	27
12	28	36	35	39	43	86	29	36
16	40	51	49	48	62	116	44	47
20	50	64	61	59	77	139	57	58
24	59	75	72	71	87	160	68	72
28	64	80	81	80	92	176	75	80
32	68	85	86	88	95	180	80	87
36	68	87	89	96	96	183	82	92
40	68	89	90	104	98	186	85	100
44	68	89	92	111	99	190	87	107
48	68	91	94	116	101	194	87	113
52	69	92	96	121	103	197	88	118
53	69	93	96	123	103	199	88	119
56	69	94	96	126	105	205	89	122
60	70	96	98	132	106	220	91	129
64	73	98	99	139	107	242	92	134
68	76	101	100	145	113	257	92	141
72	81	102	105	158	122	266	93	144
76	78	102	104	161	135	273	93	148
80	83	104	107	168	149	275	94	153
84	100	115	121	190	164	286	96	159
88	149	*	183	229	160	299	99	173
92	128		182	238	168	325	100	186
96	116		174	226	182	342	100	192
100	117		175	228	202	356	101	200
104	130		183	236	215	362	104	207
108	142		191	245	225	366	107	213
112	151		206	256	232	371	109	218
116	153		204	256	238	373	113	223
120	159		211	257	244	378	116	226
123	159		211	257	244	378	116	226

\*Thermocouple malfunction



**Individual Temperatures Recorded On The Unexposed Surface Of Specimen K (Continued)**

Time Mins	T/C Number A19 Deg. C	T/C Number A20 Deg. C	T/C Number A21 Deg. C
0	19	18	18
4	20	22	20
8	21	30	22
12	28	40	30
16	40	52	44
20	52	65	55
24	66	80	65
28	72	86	72
32	77	94	78
36	80	102	81
40	82	109	84
44	86	119	85
48	88	127	86
52	88	136	87
53	88	138	87
56	89	144	88
60	92	155	87
64	93	164	86
68	95	173	85
72	95	181	89
76	95	188	89
80	95	195	88
84	96	202	93
88	97	211	101
92	97	218	101
96	99	228	98
100	100	235	96
104	102	242	99
108	103	248	100
112	105	255	101
116	106	263	101
120	108	268	102
123	108	268	102

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen L**

Time Mins	T/C Number A22 Deg. C	T/C Number A23 Deg. C	T/C Number A24 Deg. C	T/C Number A25 Deg. C	T/C Number A26 Deg. C	T/C Number A27 Deg. C	T/C Number A28 Deg. C
0	19	19	18	19	19	19	19
4	19	20	28	52	21	39	19
8	22	29	51	118	34	98	24
12	36	49	72	158	57	136	35
16	50	66	87	187	72	163	45
17	53	69	90	197	74	171	47
18	56	71	92	208	77	180	49
20	61	76	96	219	80	193	53
24	68	82	103	227	86	195	59
28	73	86	108	232	89	202	64
32	74	88	111	240	90	213	68
36	75	92	116	253	92	224	72
40	76	95	123	259	93	237	75
44	76	97	131	266	96	249	76
48	76	100	139	273	99	258	77
52	76	103	146	282	102	267	78
56	76	105	153	291	105	275	77
60	78	108	161	296	111	286	77
64	79	112	167	302	116	292	78
68	80	116	172	305	121	292	80
72	81	121	179	307	125	296	82
76	83	125	182	311	131	303	85
80	84	129	185	310	137	309	85
84	83	131	186	313	143	315	87
88	85	136	190	317	145	311	89
92	88	139	193	320	150	318	91
96	89	140	192	322	154	323	92
100	90	141	201	334	154	327	93
104	93	146	219	337	161	344	94
108	91	155	278	394	169	357	95
112	89	176	340	435	178	365	97
116	92	200	393	442	201	401	100
120	95	223	429	456	229	416	103
123	95	223	429	156	229	416	103

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen M**

Time Mins	T/C Number A29 Deg. C	T/C Number A30 Deg. C	T/C Number A31 Deg. C	T/C Number A32 Deg. C	T/C Number A33 Deg. C	T/C Number A34 Deg. C	T/C Number A35 Deg. C	T/C Number A36 Deg. C
0	30	17	18	17	17	30	18	36
2	55	20	18	20	18	55	20	115
4	52	28	19	28	19	52	28	177
6	43	39	22	40	20	43	35	142
8	44	51	32	51	22	44	40	141
10	55	65	45	65	27	55	48	157
12	64	73	57	73	35	64	56	178
14	71	78	65	78	42	70	64	196
16	78	81	71	81	49	77	72	201
18	80	84	75	84	54	80	78	212
19	80	86	77	87	57	80	80	218
20	82	88	79	89	59	82	82	222
22	85	93	81	93	63	85	86	232
24	87	97	84	97	66	87	89	236
26	87	100	85	100	69	87	92	244
28	88	100	87	100	72	88	94	247
30	91	101	88	102	74	91	96	254
32	90	103	89	103	75	90	97	262
34	94	106	90	106	76	94	98	267
36	99	110	91	110	78	99	99	274
38	102	113	92	113	79	102	101	281
40	105	116	93	116	80	105	103	292
42	108	122	94	122	80	108	104	303
44	112	130	95	130	81	111	105	313
46	117	141	96	141	81	117	108	320
48	122	153	97	153	82	122	109	327
50	129	163	98	163	82	129	111	335
52	134	174	99	174	82	134	114	341
54	139	183	101	183	83	139	116	350
56	143	189	102	189	84	143	119	359
58	147	195	105	195	85	147	122	370
60	151	242	112	242	85	151	126	376
61	#	#	#	#	#	#	#	#

#Specimen blanked off to allow the test to continue

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen N**

Time Mins	T/C Number A37 Deg. C	T/C Number A38 Deg. C	T/C Number A39 Deg. C	T/C Number A40 Deg. C	T/C Number A41 Deg. C
0	19	19	19	19	15
4	19	*	22	26	15
8	29		48	60	*
12	46		77	101	
16	58		100	133	
20	66		116	155	
24	72		129	172	
28	76		140	177	
32	79		149	177	
36	81		160	179	
40	82		171	183	
44	82		181	188	
48	81		192	194	
50	81		197	197	
51	80		200	198	
52	80		202	200	
56	79		213	203	
60	80		225	208	
64	81		234	209	
68	83		238	213	
72	85		246	219	
76	88		254	225	
80	91		258	233	
84	93		261	243	
88	95		265	253	
92	98		270	262	
96	99		275	270	
100	101		280	281	
104	103		287	287	
108	105		292	291	
112	108		318	300	
116	101		335	243	
120	108		351	299	
123	108		351	299	

\*Thermocouple malfunction

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen O**

Time Mins	T/C Number A42 Deg. C	T/C Number A43 Deg. C	T/C Number A44 Deg. C
0	15	15	14
4	38	*	58
8	61		92
12	76		107
16	89		120
20	100		139
24	110		153
28	118		162
32	121		169
36	123		171
40	125		175
44	128		176
48	132		183
52	136		185
56	142		192
57	143		194
58	144		195
60	146		195
64	151		202
68	155		207
72	160		211
76	164		216
80	170		232
84	184		272
88	198		301
92	209		321
96	216		326
100	221		332
104	224		326
108	227		330
112	229		335
116	237		334
120	249		356
123	251		355

\*Thermocouple malfunction

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen P**

Time Mins	T/C Number A46 Deg. C	T/C Number A47 Deg. C	T/C Number A49 Deg. C
0	18	19	20
4	21	50	167
7	25	65	173
8	26	68	204
12	35	94	357
16	51	114	409
20	66	139	429
24	79	166	445
28	86	184	456
32	93	202	471
36	96	216	480
40	101	228	491
44	105	240	500
48	107	248	506
52	108	256	513
56	109	266	524
60	116	277	533
64	119	283	534
68	118	286	536
72	120	290	536
76	119	297	542
80	117	300	541
84	118	301	547
88	112	295	547
92	111	294	542
96	114	296	543
100	121	301	547
104	124	301	541
108	123	303	539
112	125	310	539
116	132	330	539
120	134	354	550
123	138	367	554

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen Q**

Time Mins	T/C Number A51 Deg. C	T/C Number A53 Deg. C	T/C Number A54 Deg. C
0	18	18	20
4	20	51	124
8	27	71	153
12	39	83	166
16	49	90	177
20	56	95	182
24	63	98	185
28	69	101	187
32	73	102	191
36	74	104	193
40	74	107	194
44	72	110	194
48	71	113	200
51	71	116	200
52	70	117	201
56	70	120	206
60	70	123	213
64	71	126	216
68	72	131	227
72	73	135	236
76	75	140	242
80	76	144	246
84	77	145	263
88	79	146	287
92	82	149	299
96	84	153	312
100	86	160	336
104	90	171	361
108	92	185	377
112	93	195	391
116	97	213	407
120	103	230	416
123	105	237	410

**Individual Temperatures Recorded On The Unexposed Surface Of Specimen R**

Time Mins	T/C Number A56 Deg. C	T/C Number A58 Deg. C	T/C Number A59 Deg. C
0	18	19	22
2	19	22	84
4	24	43	171
5	28	54	201
6	32	64	216
8	40	77	227
10	52	87	242
12	64	95	254
14	71	102	265
16	76	107	273
18	80	113	280
20	83	118	285
22	85	123	291
24	85	128	296
26	86	132	299
28	87	137	305
30	87	142	311
32	87	146	316
34	88	150	320
36	88	153	323
38	88	156	327
40	89	158	329
42	88	160	332
44	87	161	335
46	88	163	339
48	88	164	343
50	88	166	346
52	90	167	349
54	90	167	352
56	91	167	356
58	92	169	362
60	92	166	368
61	125	192	389
62	~	~	~

~Flaming of specimen extinguished to allow the test to continue



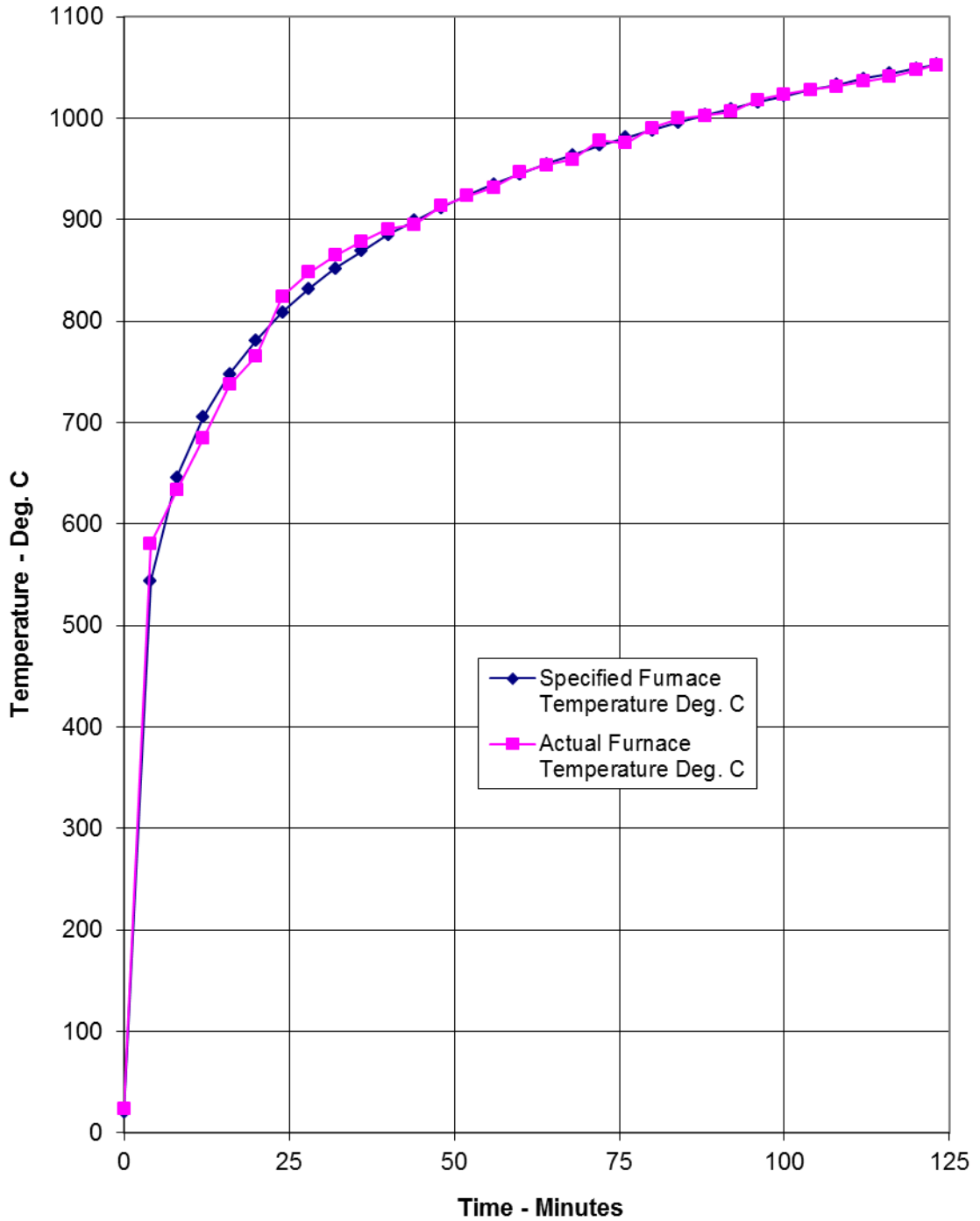
**Individual Temperatures Recorded On The Unexposed Surface And Adjacent To Specimen S**

Time Mins	T/C Number 2 Deg. C	T/C Number 3 Deg. C	T/C Number 4 Deg. C	T/C Number 5 Deg. C	T/C Number 6 Deg. C
0	18	17	18	18	18
4	23	18	18	18	18
8	34	19	19	18	19
12	37	22	21	20	20
16	40	27	30	26	26
20	43	34	45	33	37
24	47	41	56	41	44
28	51	46	61	47	51
32	54	52	63	53	55
36	57	56	63	57	59
40	59	59	64	59	61
44	61	61	65	61	63
48	61	60	65	61	64
52	61	59	65	61	65
56	62	58	64	59	65
60	62	57	65	58	64
64	63	57	68	58	64
68	66	58	70	59	63
72	68	60	73	59	63
76	70	63	75	61	64
80	73	67	78	64	65
84	75	70	80	67	65
88	76	73	81	71	67
92	77	78	82	75	69
96	78	84	83	79	70
100	78	90	90	83	71
104	79	94	86	85	72
108	78	98	87	86	73
112	78	100	89	89	74
116	77	106	97	91	75
120	68	109	101	93	75
123	73	113	104	96	75

**Table Showing Recorded Furnace Pressure At The Top Of The Uppermost Penetration Seals**

Time Mins	Recorded Pressure Pascals
0	0.0
4	19.1
8	20.0
12	18.0
16	17.2
20	19.0
24	19.7
28	18.3
32	19.2
36	20.1
40	23.4
44	22.4
48	19.8
52	20.0
56	19.8
60	21.9
64	21.1
68	21.3
72	21.1
76	22.6
80	21.3
84	21.0
88	22.4
92	22.0
96	22.1
100	22.0
104	20.2
108	19.6
112	18.2
116	18.7
120	19.2
123	19.3

**Graph Showing Mean Furnace Temperature, Together With The Temperature/Time Relationship Specified In EN 1363-1: 2012**



# Performance Criteria and Test Results

## Integrity Performance

It is required that the specimens retain their separating function, without either permitting the penetration of a gap gauge in the prescribed manner, causing ignition of a cotton pad when applied as specified in EN 1363-1:2012, or resulting in sustained flaming on the unexposed surface.

These requirements were satisfied for the periods shown below:

Specimen	Integrity (minutes)		
	Cotton pad	Sustained flames	Gap Gauge
A	123*	123*	123*
B	123*	123*	123*
C	123*	123*	123*
D	123*	123*	123*
E	123*	123*	123*
F	66	66	66#
G	123*	123*	123*
H	123*	123*	123*
I	123*	123*	123*
J	123*	123*	123*
K	123*	123*	123*
L	123*	123*	123*
M	60	60	60#
N	123*	123*	123*
O	123*	123*	123*
P	123*	123*	123*
Q	123*	123*	123*
R	62	62	62~
S	123*	123*	123*

\*The test duration. The test was discontinued after a period of 123 minutes.  
 ~Flaming of specimen extinguished to allow the test to continue. #Specimen blanked off to allow the test to continue.

## Insulation performance

The requirements of the standard are that the maximum temperature rise shall not be greater than 180°C. Insulation failure also occurs simultaneously with integrity failure as specified in EN 1363-1:2012.

These requirements were satisfied for the periods shown below:

Specimen	Insulation (minutes)
A	123*
B	52
C	56
D	37

\*The test duration. The test was discontinued after a period of 123 minutes.

**Insulation  
performance  
(continued)**

<b>Specimen</b>	<b>Insulation (minutes)</b>
E	25
F	37
G	43
H	116
I	45
J	59
K	52
L	17
M	18
N	50
O	57
P	7
Q	51
R	5
S	123*

\*The test duration. The test was discontinued after a period of 123 minutes.

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## **Ongoing Implications**

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### **Limitations**

This report details the method of construction, the test conditions and the results obtained when the specific elements of construction described herein was tested following the procedure outlined in EN 1366-3: 2009 and EN 1366-4: 2006 +A1:2010. Any significant deviation with respect to size, constructional details, loads, stresses, edge or end conditions other than those allowed under the field of direct application in the relevant test method is not covered by this report. Annex A of EN 1363-1: 2012, provides guidance information on the application of fire resistance tests and the interpretation of test data.

Because of the nature of fire resistance testing and the consequent difficulty in quantifying the uncertainty of measurement of fire resistance, it is not possible to provide a stated degree of accuracy of the result.

This report is additional to that issued as WARRES 346512 and dated 5th February 2015. The original report remains valid and is not replaced by this additional test report. The product which was the subject of the test has not been retested and this additional report does not involve and technical change or technical review of the original test report. Details of the original product name and sponsor of the test are documented by WFRC and are maintained in confidential company records

# Conclusions

## Evaluation against objective

Eighteen specimens of penetration sealing system and one specimen of linear joint sealing system have been tested to evaluate their ability to reinstate the integrity and insulation performance (as defined in EN 1366-3: 2009 and EN 1366-4: 2006 +A1:2010) of the supporting construction, where it has been provided with apertures and penetration services.

The evaluation of the specimens against the requirements of EN 1366-3: 2009 and EN 1366-4: 2006 +A1:2010 showed that they satisfied the requirements for the periods shown below.

Specimen	Integrity (minutes)			Insulation (minutes)
	Cotton pad	Sustained flames	Gap Gauge	
A	123*	123*	123*	123*
B	123*	123*	123*	52
C	123*	123*	123*	56
D	123*	123*	123*	37
E	123*	123*	123*	25
F	66	66	66#	37
G	123*	123*	123*	43
H	123*	123*	123*	116
I	123*	123*	123*	45
J	123*	123*	123*	59
K	123*	123*	123*	52
L	123*	123*	123*	17
M	60	60	60#	18
N	123*	123*	123*	50
O	123*	123*	123*	57
P	123*	123*	123*	7
Q	123*	123*	123*	51
R	62	62	62~	5
S	123*	123*	123*	123*

\*The test duration. The test was discontinued after a period of 123 minutes.  
 ~Flaming of specimen extinguished to allow the test to continue. #Specimen blanked off to allow the test to continue.

## Field of Direct Application (Penetration Seals)

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**General** The field of direct application of results is restricted to governing the allowable changes to the test specimen following a successful fire resistance test. These variations can be introduced automatically without the need for the sponsor to seek additional evaluation, calculation or approval.

**Orientation** Test results are only applicable to the orientation in which the penetration sealing systems were tested.

**Supporting construction** Test results obtained with the standard flexible wall constructions according to 7.2.2.1.2 cover all flexible wall constructions of the same fire resistance classification provided,

- The construction is classified in accordance with EN 13501-2;
- The construction has an overall thickness not less than the minimum thickness of the range given in Table 3 for the standard flexible wall used in the test. This rule does not apply to pipe closure devices positioned within the supporting construction unless the length of the seal is increased by an equal amount and the distance from the surface of the supporting construction remains the same on both sides;
- In the case of penetration seals installed within the wall and where a flexible wall with insulation was used in the test an aperture framing shall be used in practice. The aperture frame and aperture lining shall be made from studs and boards of the same specification as those used in the wall in practice. The thickness of the aperture lining shall be minimum 12.5 mm. This rule does not apply in the case where the insulation was removed around the penetration seal(s) (see 7.2.2.1.2);
- The number of board layers and the overall board layer thickness is equal or greater than that tested when no aperture framing is used;
- Flexible wall constructions with timber studs are constructed with at least the same number of layers as given in Table 3, no part of the penetration seal is closer than 100 mm to a stud, the cavity is closed between the penetration seal and the stud, and 100 mm of insulation of class A1 or A2 according to EN 13501-1 is provided within the cavity between the penetration seal and the stud.

An aperture framing is considered as being part of the penetration seal. Tests without an aperture framing cover applications with aperture framing but not vice versa.

The standard flexible wall construction does not cover sandwich panel constructions and flexible walls where the lining does not cover the studs on both sides. Penetrations in such constructions shall be tested on a case by case basis.

Test results obtained with flexible supporting walls may be applied to concrete or masonry elements of an overall thickness equal to or greater than that of the element used in the tests. This rule does not apply to pipe closure devices positioned within the supporting construction unless the length of the seal is increased by an equal amount and the distance from the surface of the supporting construction remains the same on both sides.

### **Service support construction**

The distance from the surface of the separating element to the nearest support position for services shall be as tested or less.

Tests of rectangular seals cover circular seals of the same area but not vice versa.

### **Seal size and distances**

The test results obtained using standard wall and floor configurations for penetration systems are valid for any penetration size (in terms of linear dimensions) equal to or smaller than that tested, provided the total amount of cross sections of the services (including insulation) does not exceed 60 % of the penetration area, the working clearances are not smaller than the minimum working clearances (as defined in Annex A, B, E and F) used in the test and a blank penetration seal of the maximum seal size desired was tested in addition.

A blank penetration seal test may be omitted for mortar seals, seals made from rigid boards and mineral wool boards of a density of minimum 150 kg/m<sup>3</sup> and for single service penetration seals.

For floor constructions, results from tests with a penetration seal length of minimum 1 000 mm apply to any length as long as the perimeter length to seal area ratio is not smaller than that of the test specimen.

The distance between a single service and the seal edge (annular space, e.g. a1 according to Figures B.7 and E.2) shall remain within the tested range.

### **Cable Type (construction characteristics)**

The configuration options 'Small', 'Medium' and 'Large' cover all cable types currently and commonly used in building practice in Europe subject to the rules for cable size below, except tied bundles, waveguides according to 3.23 and non-sheathed cables (wires). Optical fibre cables are covered.

Test results achieved using cable group 5 according to Table A.1 are valid for all non-sheathed cables (wires) subject to the rules for cable size below.

Test results achieved using a tied bundle made from F-cables according to Table A.1 are valid for all tied bundles of cables subject to the rules for cables size below.

### **Cable size**

The test results for the configuration option 'Large' cover cables to a maximum diameter of 80 mm

The test results for the configuration option 'Medium' cover cables to a maximum diameter of 50 mm

The test results for the configuration option 'Small' cover cables to a maximum diameter of 21 mm.

Results of a tied bundle made from F-cables are valid for tied bundles with a diameter of less than or equal to the bundle tested made from cables of a diameter not greater than 21 mm.

Test results for cable G1 are valid for all non-sheathed cables with a diameter equal to or less than 17 mm, test results for cable G2 are valid for all non-sheathed cables with a diameter equal to or less than 24 mm.



<b>Cable support</b>	<p>Results obtained from tests where the supports pass through the seal are applicable to those situations where the support does not. The reverse of this situation does not apply.</p> <p>The test results obtained using standard configurations for cable penetration systems are not valid for lidded cable trays/trunkings where the lid passes through the penetration seal (see also E.3).</p>
<b>Service group 6 according to Table A.2</b>	<p>Test results achieved using service type H (conduit or tube) according to Table A.2 are valid for all steel conduits and steel tubes up to a diameter of 16 mm.</p> <p>Test results for tubes made from copper cover tubes made from steel but not vice versa.</p> <p>Test results achieved using service type I according to Table A.2 are valid for all plastic conduits and plastic tubes up to a diameter of 16 mm.</p>
<b>Pipe diameter and pipe wall thickness</b>	<p>Results of tests conducted as specified in the standard configurations may be interpolated for pipes with diameters and wall thicknesses between those tested, based upon the lowest result achieved (see Figure E.3), provided the minimum pipe diameter is greater than or equal to 40 mm. If pipe A according to figure E.3 was not included in the test the maximum wall thickness is restricted to 14.2 mm.</p>
<b>Type of pipe material</b>	<p>Results of tests conducted as specified in the standard configurations, on a particular pipe material covers pipe materials with a thermal conductivity lower than that tested, subject to the material having a melting point at least equal to the material tested or greater than the furnace temperature achieved at the required classification period.</p>
<b>Pipe arrangement</b>	<p>The results of a test conducted as specified in Option 1 of the standard configurations does not cover 'clusters' of pipes, unless the distances <math>a_3</math> (Figure E.1) or <math>a_2</math> (figure E.2) are &gt;100 mm in practice.</p> <p>The results of a test conducted as specified in Option 2 of the standard configurations covers pipes with linear separation.</p>
<b>Number of pipes</b>	<p>Results from a multiple penetration seal may be extended to a single penetration seal of the same type but not vice versa.</p>
<b>Pipe end configuration</b>	<p>A test with pipe end configuration U/C covers all pipe end situations of Table 2.</p>

## Field of Direct Application (Linear Joint Seal)

**Orientation** The field of application regarding the orientation of the linear joint is given in Table 1 of EN 1366-4: 2006 +A1:2010.

**Table 1 – Field of application regarding orientation**

Tested orientation	Application
A	A, D, E <sup>a</sup>
B	B
C	C, D <sup>b</sup>

<sup>a</sup> Orientation E will only be covered by test orientation A if shear movement was chosen and one face of the joint was fixed and the other face was moved.

<sup>b</sup> Orientation D will only be covered by test orientation C if shear movement was chosen and one face of the joint was fixed and the other face was moved.

### Key

- A. Linear joint in a horizontal test construction.
- B. Vertical linear joint in a vertical test construction.
- C. Horizontal linear joint in a vertical test construction.
- D. Horizontal wall joint abutting a floor, ceiling or roof.
- E. Horizontal floor joint abutting a wall.

Table 1 only applies when both the supporting construction and the location of the seal within the linear joint remain unchanged.

**Supporting construction** A fire resistance time obtained on a specific non-standard supporting construction applies only to that particular construction.

**Seal position** Test results are valid only for the position in which the seal was tested, except that where the linear joint seal was fitted flush with the surface of the supporting construction and is exposed to the fire.

**Mechanically induced movement** The linear joint sealing system was not tested for mechanically induced movement, therefore the movement capability of the linear joint seal must be less than  $\pm 7.5 \%$