



TEST REPORT

Fire-resistance test in accordance with AS 1530.4 – 2014 of TPS cables, metal pipes and Group A and B cable configurations protected by various protection systems penetrating a 128mm thick Boral Firestop plasterboard wall

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1 CONSTRUCTION DETAILS

TEST ASSEMBLY

The test assembly comprised 64mm thick metal frame clad with 2 layers of 13mm Boral Firestop plasterboard on both exposed and the unexposed sides. The overall dimension of the wall was 1600mm wide × 1600mm high × 128mm thick.

The wall system was restrained on all four edges.

TEST SPECIMEN

The wall system was divided into the 6 compartments. Each compartment was separated by the metal frame, 13mm plasterboard and stonewool which filled up the cavity of the stud and noggings.

In the top section of the wall system, a 25mm NB Galvanised steel pipe and a bundle of TPS cables protruded through the wall system on both the exposed and unexposed sides. The pipe and cables were protected by HB Fuller Firesound sealant and a patress of 2 layers of 13mm Firestop plasterboard on both the exposed and unexposed sides.

In the mid-section of the wall system, a 32mm NB Galvanised steel pipe and 2-off bundles of TPS cables protruded through the wall system on both the exposed and unexposed sides. The services were protected by HB Fuller Firesound sealant.

In the bottom section of the wall system, a Group A and a Group B cable configuration protruded through the wall system on both the exposed and unexposed sides. The services were protected by HB Fuller Firesound sealant.

The full descriptions of the specimens are provided in Figures A1.1 to A1.11 and the 'Schedule of Components' Section 2.

ID	Service	Protection system
A	2 × TPS cables	2 layers of 13mm Firestop plasterboard HB Fuller Firesound sealant
B	25mm NB Galvanised steel pipe	2 layers of 13mm Firestop plasterboard HB Fuller Firesound sealant
C	32mm NB Galvanised steel pipe	HB Fuller Firesound sealant 50mm × 50mm fillet cone
D	5 × TPS cables 5 × TPS cables	HB Fuller Firesound sealant 50mm × 50mm fillet cone
E	Group A configuration cable tray	HB Fuller Firesound sealant 70mm × 50mm fillet cone
F	Group B configuration cable tray	HB Fuller Firesound sealant 70mm × 50mm fillet cone

ASSEMBLY AND INSTALLATION METHODS

The plasterboard wall and service were constructed by EWFA representatives on 17 May 2017. The HB Fuller Firesound sealant fire protection system was installed by HB Fuller Australia Co P/L representatives on 21 May 2017.

ORIENTATION

The assembly was asymmetric as the specimen supports were installed on the unexposed side only.

2 SCHEDULE OF COMPONENTS

Item	Description		
Separating element			
1	Name	Boral Firestop 13mm Plasterboard wall system	
	Installation	<p>The wall incorporated wall incorporated two layers of 13mm thick plasterboard on both exposed and unexposed sides with 64mm Rondo steel frame.</p> <p>The perimeter tracks and studs were secured to the concrete blockwork with 6mm masonry anchors at 600mm centres.</p> <p>The wall was divided into six 800mm wide × 463mm height compartments.</p> <p>The compartments were separated from each other by 13mm thick plasterboard with stone wool inserted into the cavity of the metal stud and nogging.</p>	
	Density of plasterboard	894kg/m ³ (measured)	
	Compartmentation	A	<p>Extra two layers of 13mm Firestop plasterboard were applied on the wall system as an extra protection system of the pipe on both exposed and unexposed side.</p> <p>A rectangle hole which extended from the top edge of the wall system to the core hole was formed on the wall system to allow the bundle of cable inserted through the wall system.</p> <p>Part of the bottom of the protection plasterboard was cut out to allow the protection board to be installed.</p> <p>The protection board was 150mm height × 550mm wide and secured to the wall with 8-off S type screws.</p>
		B	<p>Extra two layers of 13mm Firestop plasterboards were applied on the wall system as an extra protection of the pipe on both exposed and unexposed side.</p> <p>A rectangle hole which extended from the top edge of the wall system to the core hole was formed on the wall system to allow the bundle of cable inserted through the wall system.</p> <p>Part of the bottom of the protection plasterboard was cut out to allow the protection board to be installed.</p> <p>The protection board was 150mm height × 550mm wide and secured to the wall with 8-off S type screws.</p>
		C	No extra feature installed in the wall system
		D	No extra feature installed in the wall system
E		No extra feature installed in the wall system	
F		No extra feature installed in the wall system	
2	Name	Sealant	
	Product name	H. B. Fuller Firesound sealant	

Item	Description	
	Installation	<ul style="list-style-type: none"> • To fill up the annular gap between the metal pipe and the plasterboard to full depth • To fill up the annular gap between the metal pipes and the extra protection plasterboard to full depth • To fill up the annular gap between the bundle of cables and the plasterboard to full depth. • To fill up the annular gap between the bundle of cables and the extra protection plasterboard to full depth • Form a 50mm × 50mm sealant cone at the interface between the bundle of cables and the wall system. • Form a 50mm × 50mm sealant cone at the interface between the metal pipe and the wall system. • Form a 70mm × 50mm sealant half-cone at the interface between the top section of Group A and Group B Configuration cable tray and the wall system. • Form a 70mm × 50mm sealant half-cone at the interface between the bottom section of Group A and Group B Configuration cable tray and the wall system.
3	Item name	25 NB Galvanised steel pipe
	Size	OD: Ø33.7mm Thickness: 3.1mm thick
	Hole size	40mm × 90mm rectangular hole on the wall system and 40mm × 100mm rectangular hole on the protection board.
4	Item name	32 NB Galvanised steel pipe
	Size	OD: Ø42.4mm Thickness: 3.2mm
	Hole size	Ø50mm circular hole
5	Item name	Prysmian, 2.5mm ² 2C+E TPS cable
	Size	Overall : 12.2mm wide × 5.5mm high Cross section area: 2.5mm ² each core
	Bundle amount	2 × cable and 2-off 5 × cable
6	Name	Group A – Standard Configuration Electrical Cable Tray
	Reference	AS1530.4-2014 Appendix D
	Cables	1 × single core 630mm ² cable 1 × three cores + earth 185mm ² cable 3 × three cores + earth 6mm ² cables 8 × three cores + earth 16mm ² cables
7	Name	Group B – Standard Configuration Electrical Cable Tray
	Reference	AS 1530.4-2014 Appendix D
	Cables	60 × 50 pairs telecommunication cables
Specimen A		
A	Wall Compartment	Configuration A
	Service	Bundle of cable (2-off cable)
	Location	The bundle of cable was installed 60mm away from the top edge of the compartment.

Item	Description	
	Gap size	4mm
	Protection	The bundle of cable was protected by two layer of 550mm × 150mm × 13mm Firestop plasterboard on the exposed and unexposed side. The protection plasterboards were located 20mm below the top edge of the wall system. The sealant (Item 2) was applied <ul style="list-style-type: none"> On the interface between the bundle of cable and the plasterboard on the exposed and unexposed side. On the 20mm gap between the protection plasterboard and the concrete lintel In the cut out of the wall system and the protection plasterboard board.
	Configuration	Protruded 500mm from the exposed and unexposed side
	Support	On 200mm and 450mm away from the wall system
Specimen B		
B	Wall Compartment	Configuration B
	Service	Ø25mm NB galvanize pipe (Item 3)
	Location	The galvanize pipe was installed 70mm away from the top edge of the compartment.
	Gap size	5mm
	Protection	The galvanize pipe was protected by two layer of 550mm × 150mm × 13mm Firestop plasterboard on the exposed and unexposed side. The protection plasterboards were located 20mm below the top edge of the wall system. The sealant (Item 2) was applied <ul style="list-style-type: none"> On the interface between the galvanize pipe and the plasterboard on the exposed and unexposed side. On the 20mm gap between the protection plasterboard and the concrete lintel In the cut out of the wall system and the protection plasterboard board.
	Configuration	Protruded 500mm from the exposed and unexposed side
	Support	On 200mm and 450mm away from the wall system
Specimen C		
C	Wall Compartment	Configuration C
	Service	32 NB Galvanised steel pipe
	Location	The steel pipe was installed 480mm away from the west edge of the wall system and 735mm from the sill.
	Core hole size	Ø50mm
	Gap size	4mm
	Protection	The sealant was applied on the annular gap between the wall system and the pipe. The sealant extended from the wall system and ended with 50mm × 50mm fillet cone on both exposed and unexposed side.
	Configuration	Protruded 500mm from the exposed and unexposed side
	Support	On 200mm and 450mm away from the wall system

Item	Description	
Specimen D		
D	Wall Compartment	Configuration D
	Service	2 × bundle of cable (5 × TPS cables)
	Hole size	West: Ø50mm East: Ø25mm
	Location	The Ø 50mm core hole was located 1020mm away from the west edge of the wall system and Ø 25mm core hole was located 1265 away from the west edge. Both holes were 735mm above the sill
	Protection	A bundle of cable was inserted into each core holes. Sealant was applied in the annual gap and extended from the wall system and ended with a 50mm × 50mm fillet cone.
	Configuration	Protruded 500mm from the exposed and unexposed side
	Support	On 200mm and 450mm away from the wall system
	Specimen E	
E	Wall compartment	Configuration E
	Service	Group A – Standard Configuration Electrical Cable Tray
	Hole size	335mm wide × 70mm height
	Location	300mm away from the west edge of the wall system and 190mm away from the sill.
	Protection	Sealant was applied into the spacing between the wall system and the cable tray. The sealant extended from the wall system and ended with a fillet cone on both exposed and unexposed side. The fillet cone was 70mm × 50mm on the top section of the cone and 50mm × 50mm on the bottom section.
	Configuration	Protrude 500mm from the exposed and unexposed side
	Support	On 200mm and 450mm away from the wall system
	Specimen F	
F	Wall compartment	Configuration F
	Service	Group B – Standard Configuration Electrical Cable Tray
	Hole size	181mm wide × 130mm high
	Location	1035mm away from the west edge of the wall system and 190mm away from the sill.
	Protection	Sealant was applied into the spacing between the wall system and the cable tray. The sealant extended from the wall system and ended with a fillet cone. The fillet cone was 70mm × 50mm on the top section of the cone and 50mm × 50mm on the bottom section.
	Configuration	Protrude 500mm from the exposed and unexposed side
	Support	On 200mm and 450mm away from the wall system

3 TEST PROCEDURE

STATEMENT OF COMPLIANCE

The test was performed in accordance with the requirements of AS 1530.4-2014 Sections 2 & 10.

VARIATIONS TO TEST METHOD

The pressure for the 5-15 minute period was above the limits prescribed in AS1530.4-2005 by 8-39 Pa. This exceeded the pressure requirement of the standard and was therefore more severe than required by the standard. Based on the above the results of this test remain valid

PRE-TEST CONDITIONING

The installation of the services was finished on the 18 May 2017 and was tested on 31 May 2017. During the period prior to testing, the test specimen was subject to normal laboratory temperatures and conditions.

SAMPLING / SPECIMEN SELECTION

The laboratory was not involved in the sampling or selection of the test specimens for the test.

AMBIENT TEMPERATURE

The ambient temperature at the start of the test was 13°C and did not vary significantly throughout the duration of the test.

TEST DURATION

The test duration was 180 minutes.

INSTRUMENTATION AND EQUIPMENT

The instrumentation was provided in accordance with AS 1530.4-2014 and as detailed below:

The furnace temperature was measured by 4-off mineral insulated metal sheathed Type K thermocouples with wire diameters not greater than 1mm and overall diameter of 3mm with the measuring junction insulated from the sheath. The thermocouples protruded a minimum of 25mm from steel supporting tubes.

The non-fire side specimen temperatures were measured by Type K thermocouples with wire diameters less than 0.5mm diameter soldered to 12mm diameter × 0.2mm thick copper discs covered by 30mm × 30mm × 2.0 mm inorganic insulating pads. The thermocouples positions are described in Table A4.1, and are shown on Figure A4.1 in Appendix 4.

A roving thermocouple was available to measure temperatures at positions that appeared hotter than the positions monitored by the fixed thermocouples.

Cotton pads were available during the test to assess the performance under the criteria for integrity.

The furnace pressure was measured the centre of lowest penetration.

4 TEST MEASUREMENTS

FURNACE TEMPERATURE AND PRESSURE MEASUREMENTS

Furnace temperature and pressure data are provided in Appendix 5.

SPECIMEN TEMPERATURES

Specimen temperature data is provided in Appendix 5.

OBSERVATIONS

A table that includes observations of the significant behaviour of the specimen and details of the occurrence of the various performance criteria specified in AS 1530.4-2014 is provided in Appendix 2. Photographs of the specimen are included in Appendix 6.

5 TEST RESULTS

The specimens listed below achieved the following performance with respect to the performance criteria of AS 1530.4-2014, Section 2 & 10 subject to the test method variations noted in section 3 of this report

Service	Criteria	Result
A	Structural Adequacy	Not applicable
	Integrity	No failure at 180 minutes
	Insulation	No failure at 180 minutes
	FRL	-/180/180
B	Structural Adequacy	Not applicable
	Integrity	No failure at 180 minutes
	Insulation	No failure at 180 minutes
	FRL	-/180/180
C	Structural Adequacy	Not applicable
	Integrity	No failure at 180 minutes
	Insulation	Failure at 153 minutes
	FRL	-/180/120
D	Structural Adequacy	Not applicable
	Integrity	No failure at 180 minutes
	Insulation	Failure at 125 minutes
	FRL	-/180/120
E	Structural Adequacy	Not applicable
	Integrity	No failure at 180 minutes
	Insulation	Failure at 58 minutes
	FRL	-/180/30
F	Structural Adequacy	Not applicable
	Integrity	No failure at 180 minutes
	Insulation	Failure at 122 minutes
	FRL	-/180/120

6 APPLICATION OF TEST RESULTS

TEST LIMITATIONS

The results of this fire test may be used to directly assess fire hazard, but it should be recognized that a single test method will not provide a full assessment of fire hazard under all fire conditions. The results only relate to the behaviour of the specimen of the element of the construction under the particular conditions of the test; they are not intended to be the sole criteria for assessing the potential fire performance of the element in use nor do they necessarily reflect the actual behaviour in fires.

VARIATIONS FROM THE TESTED SPECIMENS

This report details methods of construction, the test conditions and the results obtained when the specific element of construction described herein was tested in accordance with the test method with AS1530.4. Any significant variation 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 addressed by this report. It is recommended that any proposed variation to the tested configuration other than as permitted under the field of direct application specified in Appendix 3 should be referred to the test sponsor in the first instance to obtain appropriate documentary evidence of compliance from Exova Warringtonfire Aus Pty Ltd or another Registered Testing Authority.

UNCERTAINTY OF MEASUREMENT

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.

APPENDIX 1 DRAWINGS OF TEST ASSEMBLY

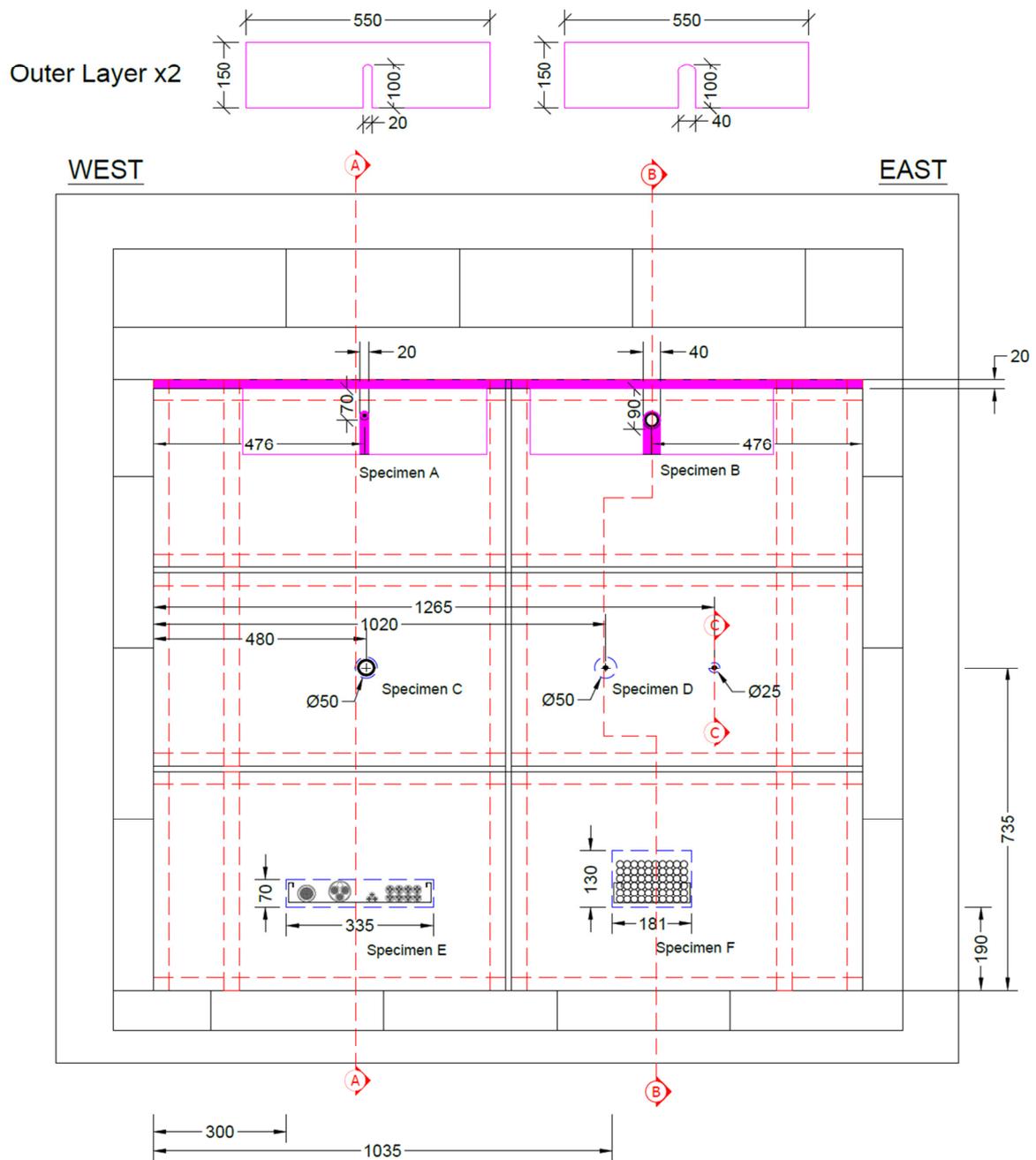


Figure A1.1: Unexposed side of test specimen

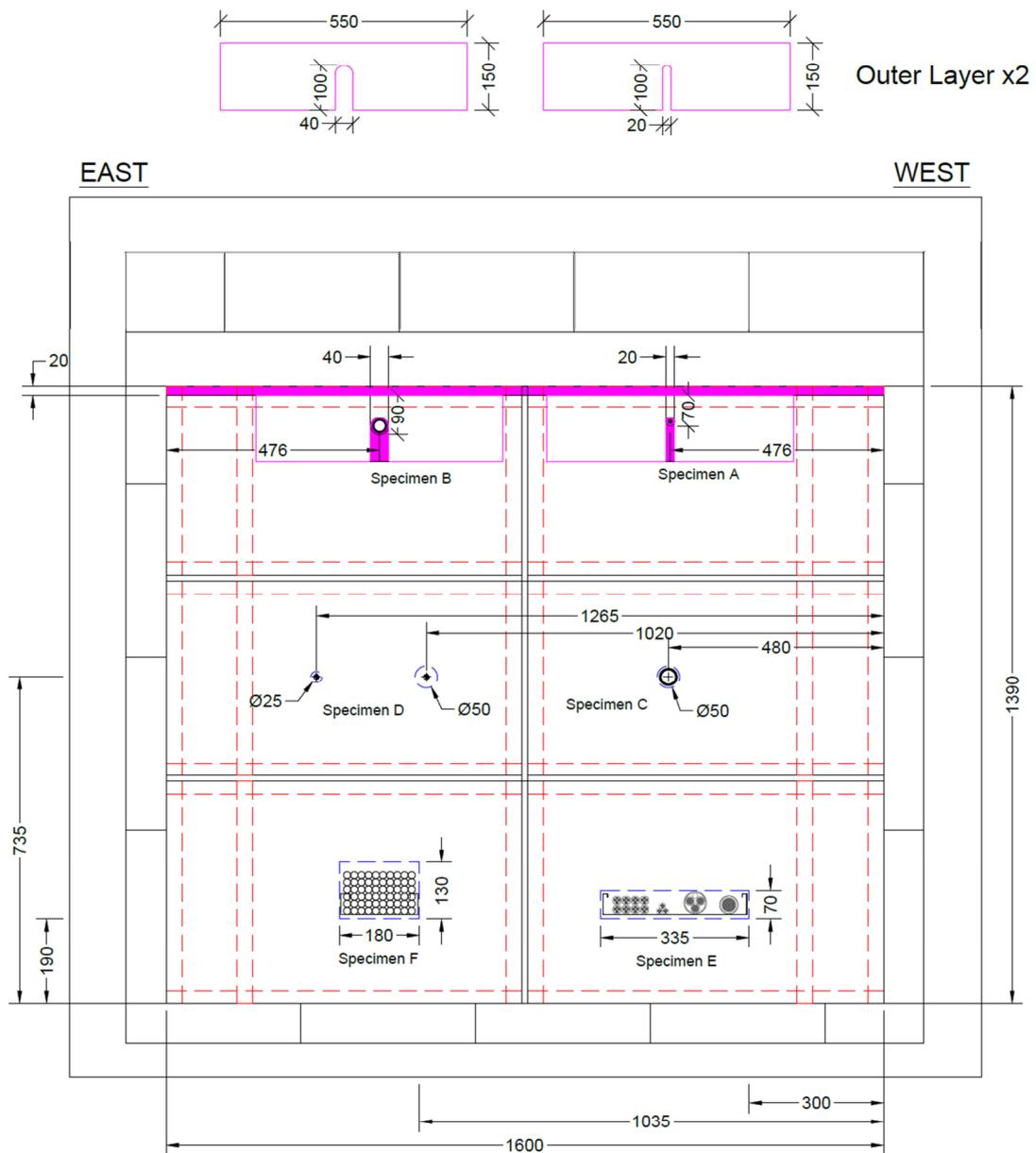


Figure A1.2: Exposed side of test specimen

Exposed
side

Unexposed
side

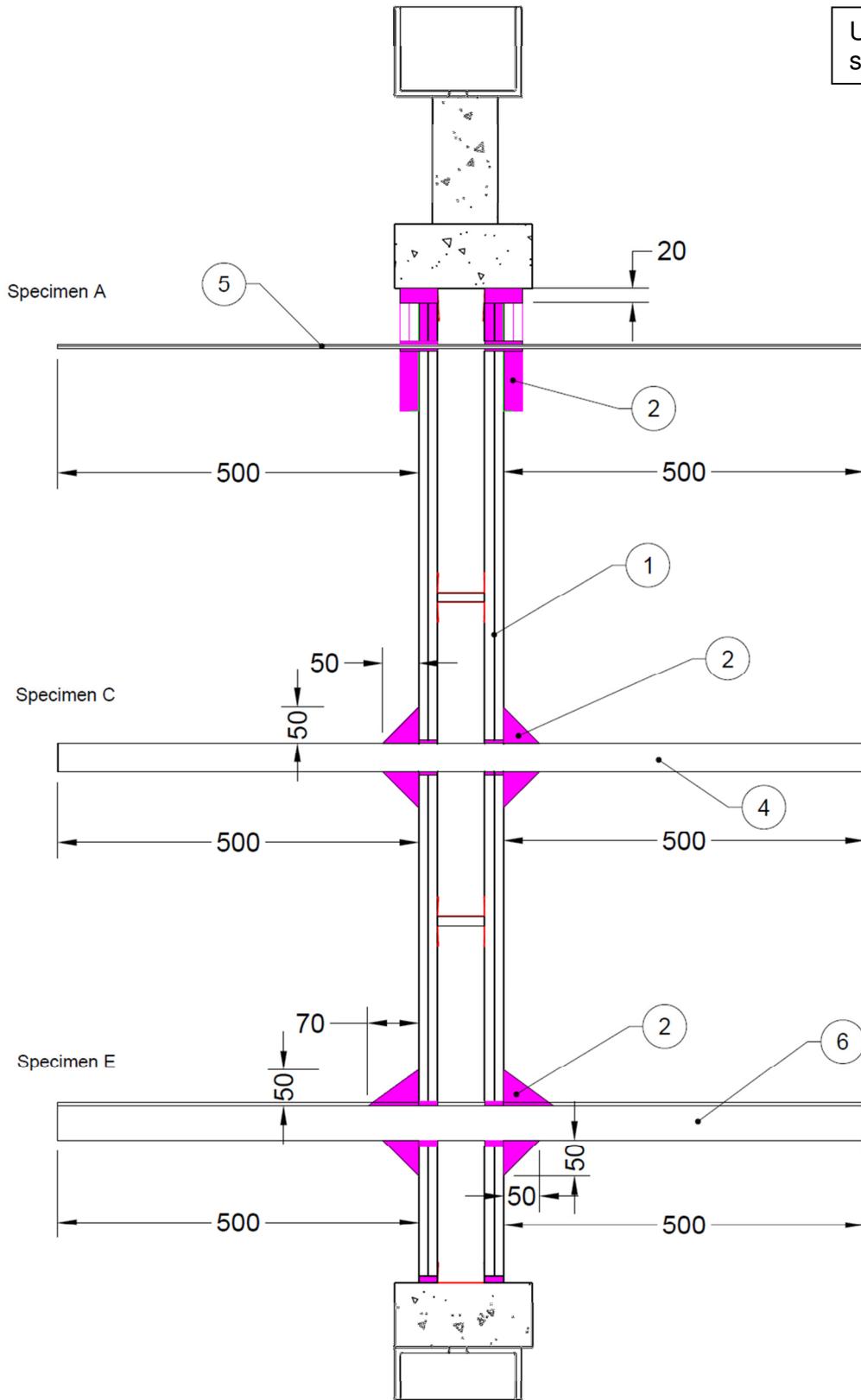


Figure A1.3: Cross-section A-A

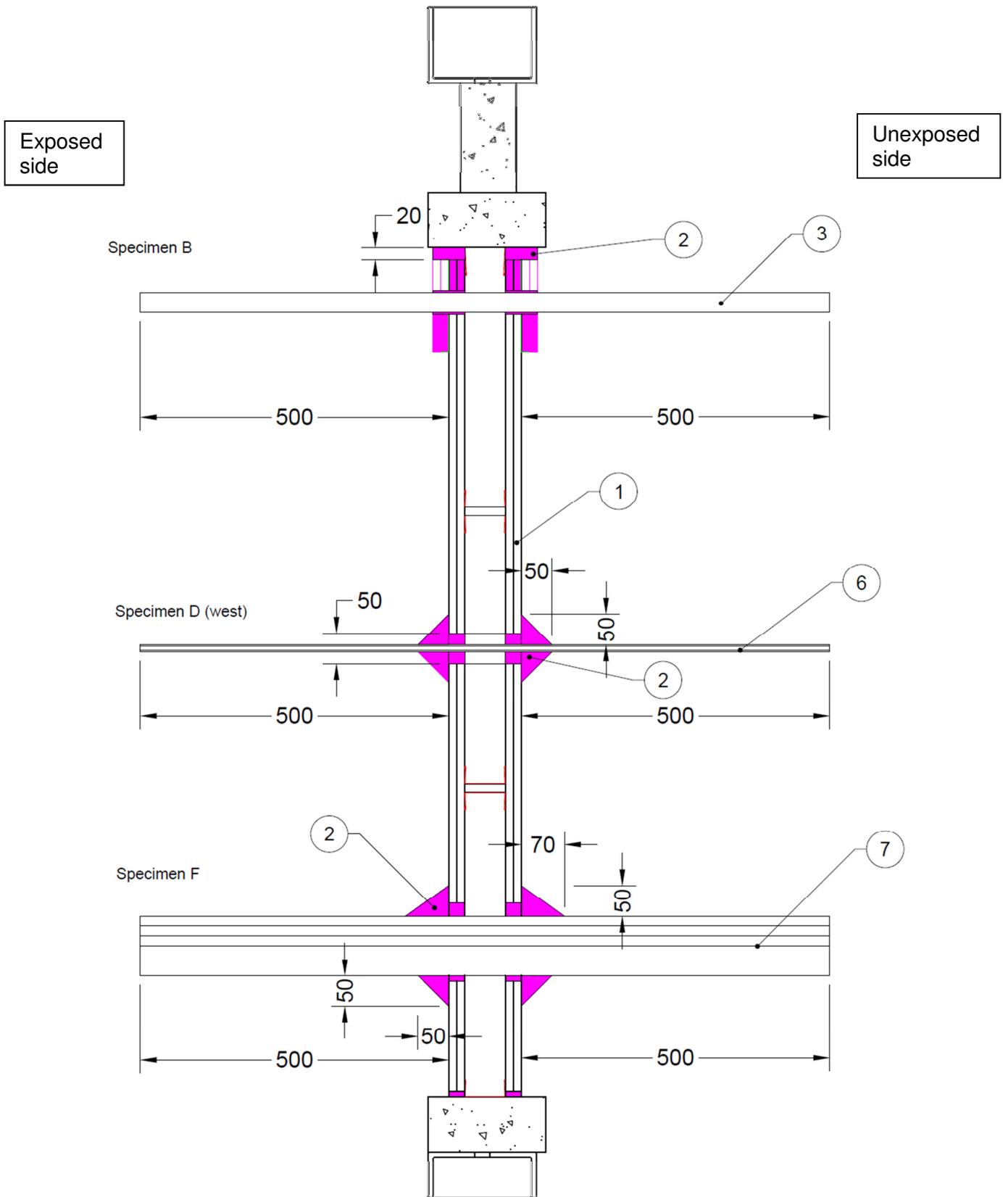


Figure A1.4: Cross-section B-B

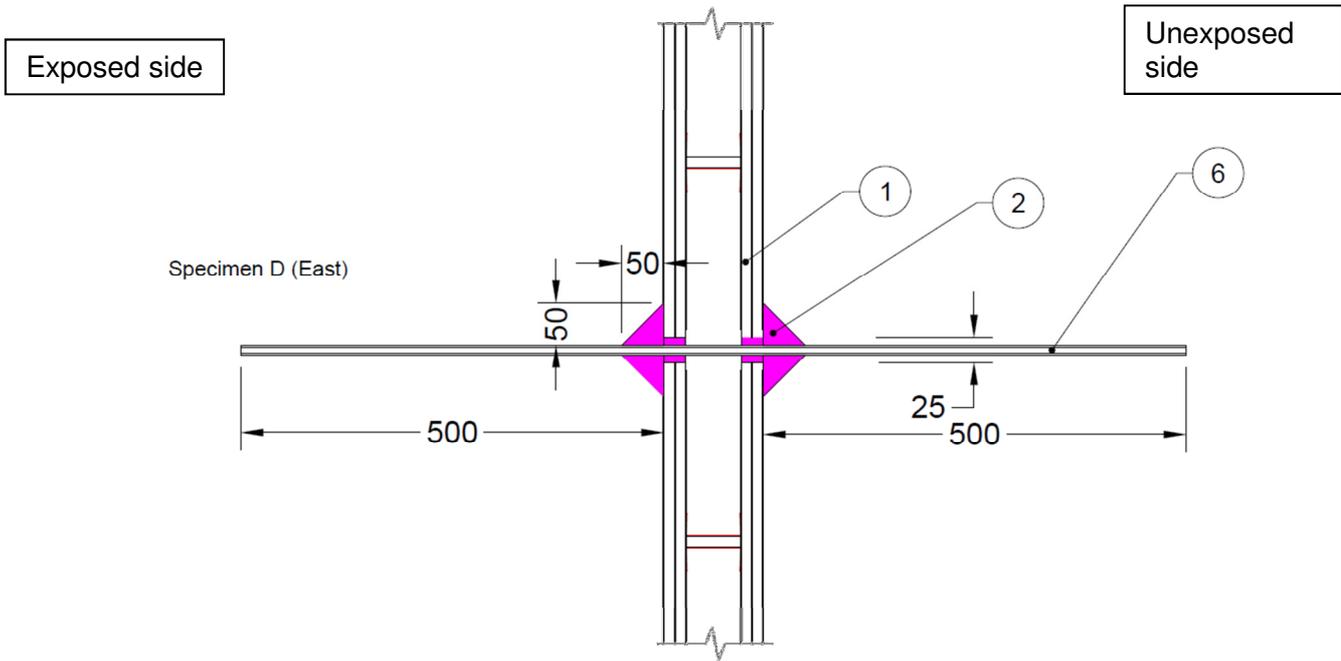


Figure A1.5: Cross-section C-C

APPENDIX 2 TEST OBSERVATIONS

The following include observations of the significant behaviour of the specimen.

Time Min Sec		Observation
Specimen A		
00	00	Fire resistance test commenced and the ambient temperature was approximately 13°C.
30	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
60	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
90	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
111	00	The sealant cone had expanded.
120	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
180	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
181	00	Test stopped at the request of the sponsor
Specimen B		
00	00	Fire resistance test commenced and the ambient temperature was approximately 13°C.
30	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
60	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
80	44	The sealant cone had expanded
90	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
120	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
180	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
181	00	Test stopped at the request of the sponsor
Specimen C		
00	00	Fire resistance test commenced and the ambient temperature was approximately 13°C.
30	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
42	18	Part of the sealant cone had liquefy and dripping to the specimen F
60	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
72	30	The sealant cone had expanded
90	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
120	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
153	50	TC 031 on the metal pipe, 25mm away from sealant recorded a temperature of 193°C. Failure of insulation in accordance with AS 1530.4-2014 clause 2.13.3(b), where the maximum temperature of Thermocouple TC 031 exceeded the initial temperature by more than 180°C.
180	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014

Time Min Sec		Observation
181	00	Test stopped at the request of the sponsor.
Specimen D		
00	00	Fire resistance test commenced and the ambient temperature was approximately 13°C.
30	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
60	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
72	30	The sealant cone had expanded
90	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
120	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
125	15	TC 051 on the bundle of TPS cable on the east side hole, 25mm away from sealant recorded a temperature of 193°C. Failure of insulation in accordance with AS 1530.4-2014 clause 2.13.3(b), where the maximum temperature of Thermocouple TC 051 exceeded the initial temperature by more than 180°C.
137	40	TC 041 on the bundle of TPS cable on the west side hole, 25mm away from sealant recorded a temperature of 193°C. Failure of insulation in accordance with AS 1530.4-2014 clause 2.13.3(b), where the maximum temperature of Thermocouple TC 041 exceeded the initial temperature by more than 180°C.
180	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
181	00	Test stopped at the request of the sponsor.
Specimen E		
00	00	Fire resistance test commenced and the ambient temperature was approximately 13°C.
01	00	Smoke emission appeared from the cable tray gap
24	30	Amount of smoke emission had increased.
30	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
48	18	Part of the sealant cone had liquefied and bubbling appeared.
58	55	TC 104 on the 630mm² single core cable, 25mm away from sealant recorded a temperature of 193°C. Failure of insulation in accordance with AS 1530.4-2014 clause 2.13.3(b), where the maximum temperature of Thermocouple TC 104 exceeded the initial temperature by more than 180°C.
60	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
72	30	The sealant cone had expanded
80	44	Smoke emission on the 185mm ² cable had increased. Discolouration appeared on the 16mm ² cables
82	45	The sheath of the 185mm ² and 630mm ² cable had melted
90	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
120	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
170	00	The molten sheath of the cables was dripping off from the cable tray.
180	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014

Time Min Sec		Observation
181	00	Test stopped at the request of the sponsor.
Specimen F		
00	00	Fire resistance test commenced and the ambient temperature was approximately 13°C.
01	00	Smoke emission appeared from the cable tray gap
24	30	Amount of smoke emission had increased.
24	30	Discoloration appeared on the cables
30	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
48	18	Part of the sealant cone had liquefied and bubbling appeared.
60	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
72	30	The sealant cone had expanded
90	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
120	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
122	75	TC 127 on the bottom of the cable tray, 25mm away from sealant recorded a temperature of 193°C. Failure of insulation in accordance with AS 1530.4-2014 clause 2.13.3(b), where the maximum temperature of Thermocouple TC 127 exceeded the initial temperature by more than 180°C.
170	00	The molten sheath of the cables was dripping off from the cable tray.
180	00	The specimen had continued to maintain integrity and insulation in accordance with AS 1530.4-2014
181	00	Test stopped at the request of the sponsor.

APPENDIX 3 DIRECT FIELD OF APPLICATION

A 3.1 GENERAL

AS 1530.4-2014 indicates that the results of a fire resistance test contained in this report are directly applicable without reference to the testing authority to similar constructions where one or more of the following changes are made:

A 3.2 SEPARATING ELEMENTS

- a) Results obtained from framed wall systems may be applied to the performance of a system in concrete, masonry or solid gypsum blocks of greater or equal thickness to that of the tested prototype. The reverse does not apply.
- b) Results obtained from framed wall systems may be applied to similar walls having studs of the same material with sizes greater than the tested prototype.
- c) Results obtained from a prototype test may be applied to framed wall systems of similar construction but having thicker facings of the same material applied to the stud.

A 3.3 METAL PIPES

A3.3.1 SEALING SYSTEMS TESTED USING STANDARD CONFIGURATIONS

The results may be applied to brass pipes of the same composition up to maximum outside diameter of 101.6 mm (normally 70/30 arsenical brass) and to copper and ferrous metal pipes having wall thicknesses greater than or equal to those listed in Table 10.12.3.1, provided the same penetration sealing system was used for the above penetrations in the same type of separating element and all the specimens achieved the required FRL.

NOTE: For information on standard configurations, see Appendix F.

TABLE 10.12.3.1

METAL PIPE DEEMED TO HAVE EQUIVALENT
FIRE RESISTANCE LEVELS

Nominal size mm	Actual OD (outside diameter) mm	Actual wall thickness mm
32	31.75	0.91
40	38.10	0.91
50	50.80	0.91
65	63.50	0.91
80	76.20	1.22
90	88.90	1.22
100	101.60	1.22
125	127.00	1.42
150	152.40	1.63

A3.3.2 SEALING SYSTEMS TESTED NOT USING STANDARD CONFIGURATIONS

Results obtained with a penetration sealing system protecting the opening around copper or brass pipes may be applied to pipes of the same material and to ferrous metal pipes having outside diameters not greater than the tested diameter, and wall thicknesses not less than the tested thickness.

NOTE: For information on standard configurations for metal pipes, see Appendix F.

A3.3.3 SHAPE AND SIZE OF OPENINGS FOR PENETRATION SEALS

For mineral-fibre, cast and gun-applied sealant seals, results obtained in openings with a smooth surface texture may be applied to openings having a rough surface texture.

A3.3.4 INSULATED (LAGGED) METAL PIPES

Where fire test data on the insulation system are not available, penetration sealing systems that have been subjected to the standard test with uninsulated metal pipes may be used, provided the appropriate requirements of Clause A3.3.2 are satisfied and the following procedures are followed:

- a) If the insulation is non-combustible or is manufactured solely from mineral fibre, it shall be cut away where the service penetrates the separating element, and the opening shall be fire-stopped in accordance with the tested method.
- b) If the insulation is combustible, it shall be cut away for 1000 mm either side of the separating element (provided the pipe did not vent hot gases during the fire resistance test), and the pipe shall be fire-stopped in accordance with the tested method. A non-combustible wrap may be placed over the bare pipe. If venting occurs during the fire-resistance test at a time less than the required FRL, a fire test shall be carried out to evaluate the insulated pipe system.

A3.3.5 ALTERNATIVE PIPE MATERIALS

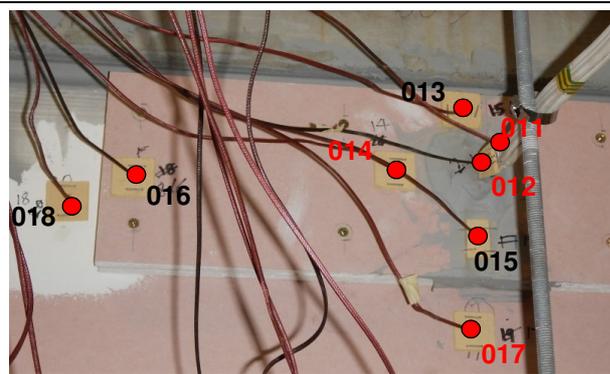
If an element is penetrated by—

- a) a pipe other than brass, copper or ferrous alloys;
- b) a pipe of cross-section other than circular; or
- c) a pipe outside the field of application specified in this Standard for the standard test configuration,

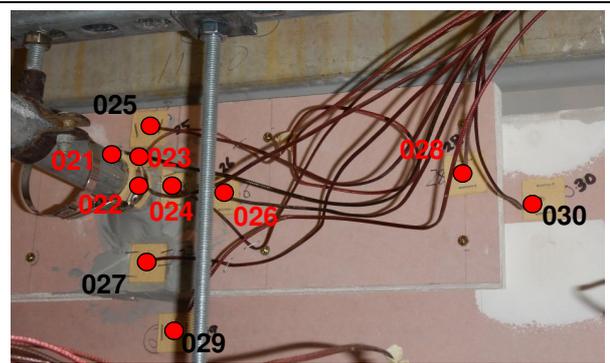
then the results obtained from a single tested system may be applied to these pipes provided the—

- i. melting point of the material is equal to or greater than the tested specimen;
- ii. surface area to mass ratio of a cross-section of the pipe is equal to or less than the tested specimen; and
- iii. thermal conductivity is equal to or less than the tested specimen diffusivity of the material.

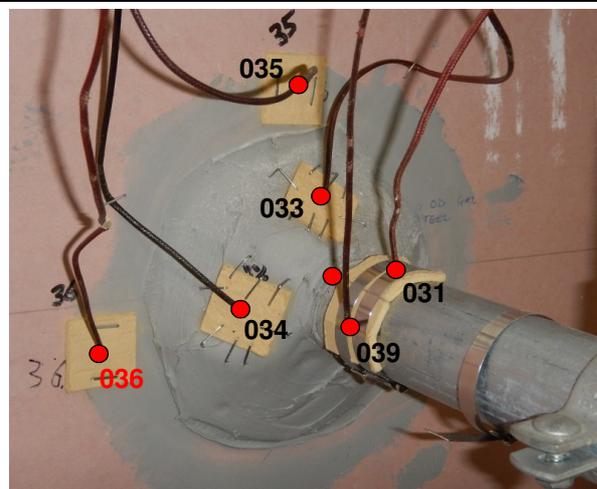
APPENDIX 4 INSTRUMENTATION POSITIONS



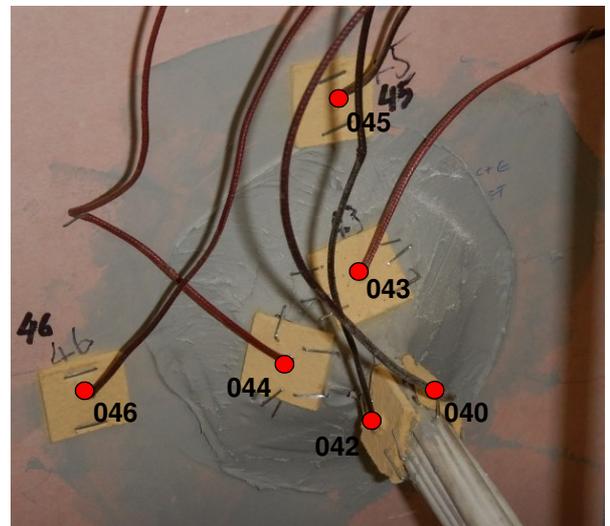
Specimen A



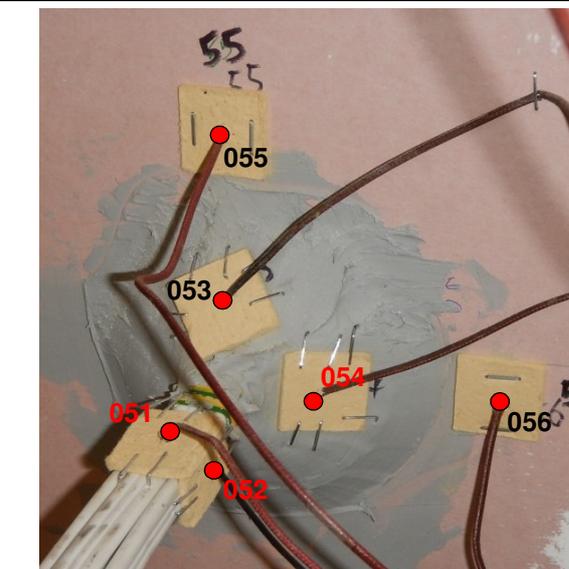
Specimen B



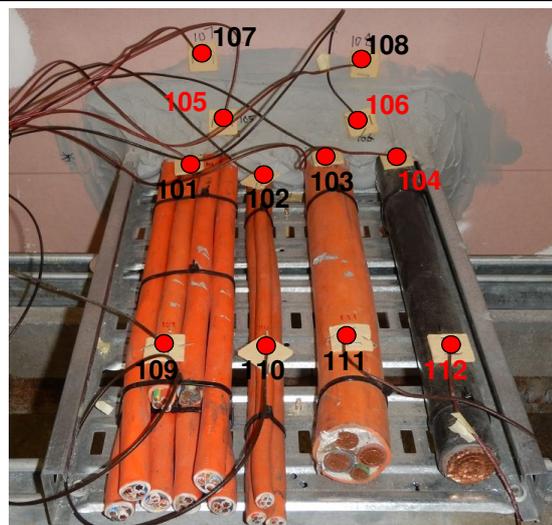
Specimen C



Specimen D West



Specimen D East



Specimen E Top

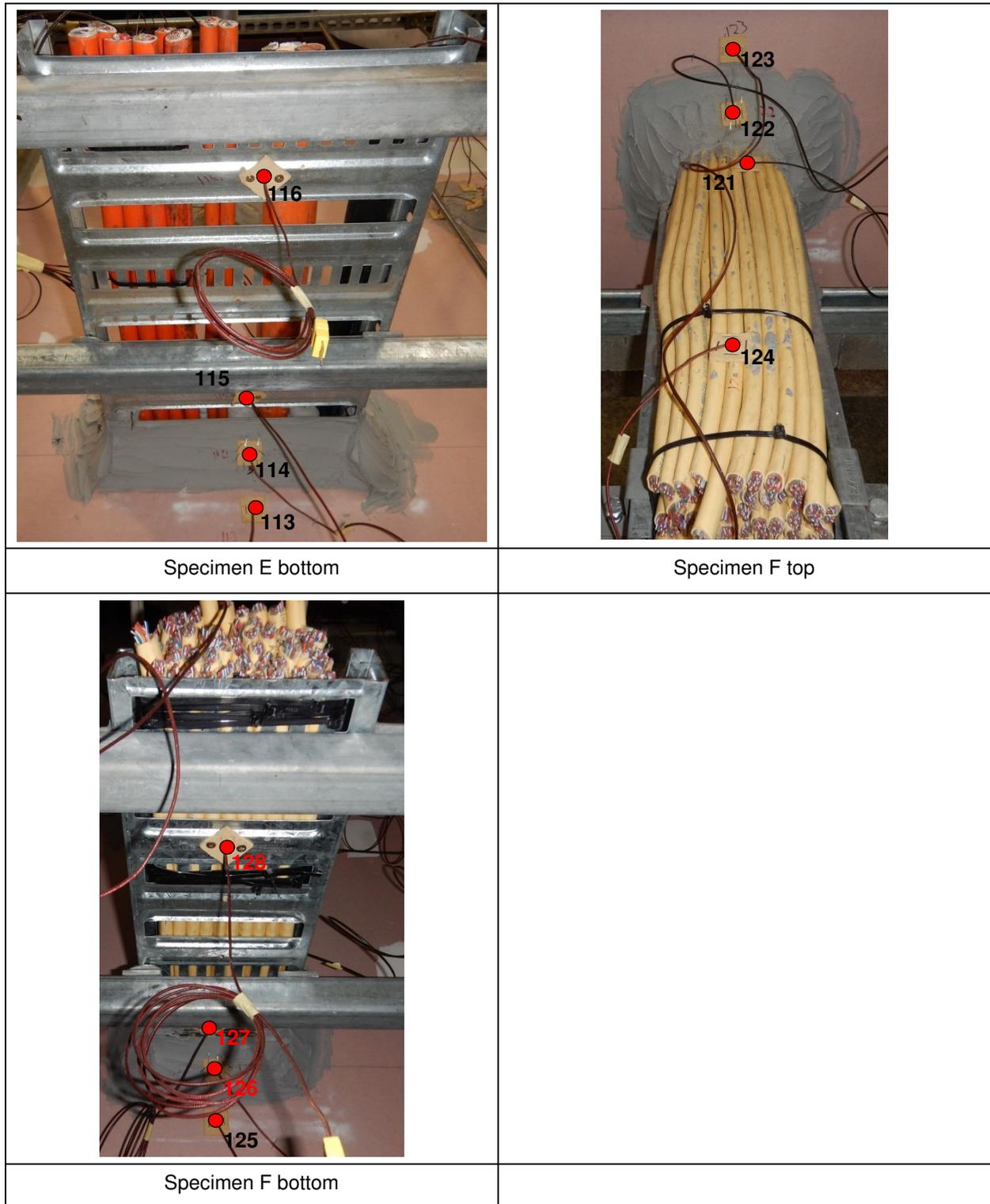


Figure A4.1: Thermocouple locations

Table A4.1 Thermocouple locations

Service	T/C No	Description
A	011	On the top of the bundle of TPS cables, 25mm away from the sealant
	012	On the side of the bundle of TPS cables, 25mm away from the sealant
	013	On the extra protection plasterboard, 25mm away from the sealant
	014	On the extra protection plasterboard, 25mm away from the sealant
	015	On the sealant in the extra protection plasterboard channel , 25mm away from the sealant fillet cone
	016	On the extra protection plasterboard, 25mm away from the wall system below the extra protection plasterboard channel.
	017	On the wall system, 25mm away from the extra protection plasterboard
	018	On the wall system, 25mm away from the extra protection plasterboard
B	021	On the top of the 25mm galvanised steel pipe, 25mm away from the sealant
	022	On the side of the 25mm galvanised steel pipe, 25mm away from the sealant
	023	On the top of the sealant cone, 25mm away from the pipe.
	024	On the side of the sealant cone, 25mm away from the pipe.
	025	On the extra protection plasterboard, 25mm away from the sealant
	026	On the extra protection plasterboard, 25mm away from the sealant
	027	On the sealant in the extra protection plasterboard channel , 25mm away from the sealant fillet cone
	028	On the extra protection plasterboard, 25mm away from the wall system below the extra protection plasterboard channel.
	029	On the wall system, 25mm away from the extra protection plasterboard
	030	On the wall system, 25mm away from the extra protection plasterboard
C	031	On the top of 32mm galvanised steel pipe, 25mm away from the sealant
	032	On the side of 32mm galvanised steel pipe, 25mm away from the sealant
	033	On the top of the sealant cone, 25mm away from the galvanised steel pipe
	034	On the side of the sealant cone, 25mm away from the galvanised steel pipe
	035	On the wall system, 25mm away from the top of the sealant cone
	036	On the wall system, 25mm away from the side of the sealant cone
D (west)	041	On the top of the bundle of TPS cables, 25mm away from the sealant
	042	On the side of the bundle of TPS cables, 25mm away from the sealant
	043	On the top of the sealant cone, 25mm away from the bundle of TPS cable
	044	On the side of the sealant cone, 25mm away from the bundle of TPS cable
	045	On the wall system, 25mm away from the top of the sealant cone
	046	On the wall system, 25mm away from the side of the sealant cone
D (East)	051	On the top of the bundle of TPS cables, 25mm away from the sealant
	052	On the side of the bundle of TPS cables, 25mm away from the sealant
	053	On the top of the sealant cone, 25mm away from the bundle of TPS cable
	054	On the side of the sealant cone, 25mm away from the bundle of TPS cable
	055	On the wall system, 25mm away from the top of the sealant cone
	056	On the wall system, 25mm away from the side of the sealant cone
E	101	On the 16mm ² cables, 25mm away from the sealant cone
	102	On the 6mm ² cable, 25mm away from the sealant cone
	103	On the 185mm ² cable, 25mm away from the sealant cone
	104	On the 630mm ² cable, 25mm away from the sealant cone
	105	On the sealant cone, 25mm away from the 16mm ² cables
	106	On the sealant cone, 25mm away from the 630mm ² cable
	107	On the wall system, 25mm away from the top of sealant cone.
	108	On the wall system, 25mm away from the top of sealant cone.

Service	T/C No	Description
	109	On the 16mm ² cable, 400mm away from the wall system
	110	On the 6mm ² cable, 400mm away from the sealant cone
	111	On the 185mm ² cable, 400mm away from the sealant cone
	112	On the 630mm ² cable, 400mm away from the sealant cone
	113	On the wall system, 25mm away from the bottom of sealant cone.
	114	On the sealant cone, 25mm away from the bottom of cable tray
	115	On the bottom of cable tray, 25mm away from the sealant
	116	On the bottom of cable tray, 400mm away from the wall system
	121	On the communication cables, 25mm away from the sealant cone
	122	On the sealant cone, 25mm away from the communication cables
	123	On the wall system, 25mm away from the top of sealant cone
	124	On the communication cables, 400mm away from the wall
	125	On the wall system, 25mm away from the bottom of sealant cone
	126	On the sealant cone, 25mm away from the bottom of communication cables.
	127	On the bottom of cable tray, 25mm away from the bottom of sealant cone
	128	On the bottom of cable tray, 400mm away from the wall system

APPENDIX 5 TEST DATA

A 5.1 FURNACE TEMPERATURE

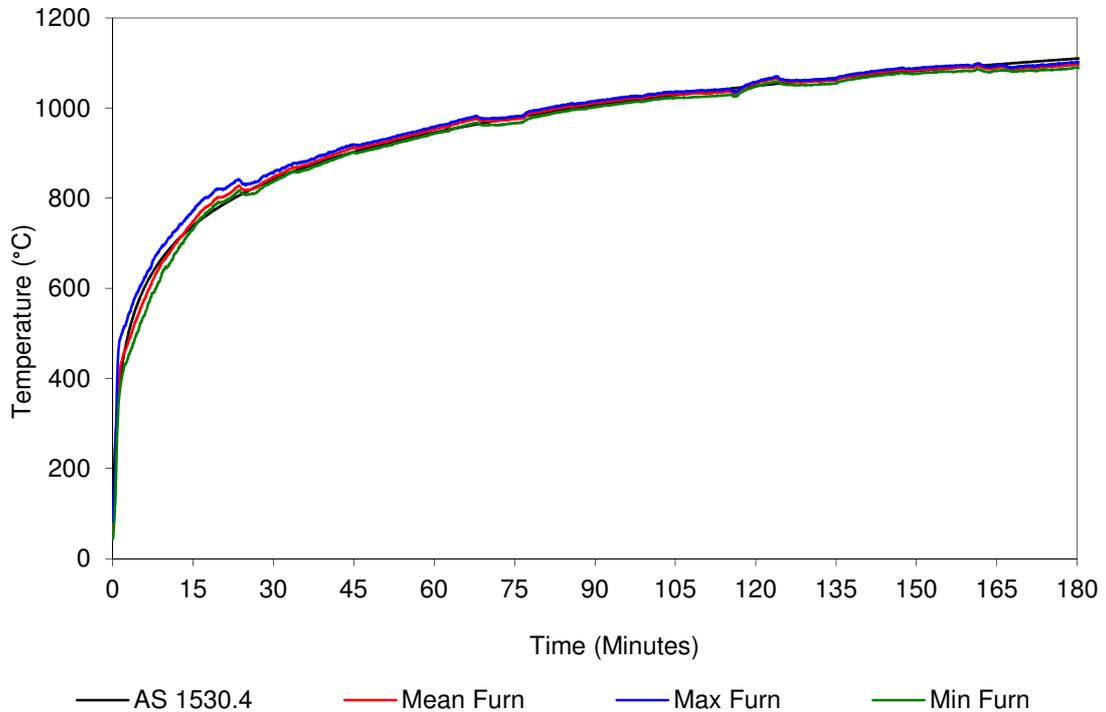


Figure A5.1: Furnace Temperatures vs. Time

A 5.2 FURNACE PRESSURE

The furnace pressure was set to 15Pa at the centre of the lowest penetration

Time (minutes)	Pressure (Pa) Avg	Time (minutes)	Pressure (Pa) Avg	Time (minutes)	Pressure (Pa) Avg
5-10	54	65-70	17	125-130	15
10-15	23	70-75	15	130-135	16
15-20	16	75-80	16	135-140	16
20-25	16	80-85	17	140-145	17
25-30	16	85-90	17	145-150	15
30-35	18	90-95	17	150-155	18
35-40	17	95-100	16	155-160	15
40-45	16	100-105	16	160-165	18
45-50	17	105-110	15	165-170	16
50-55	17	110-115	15	170-175	15
55-60	18	115-120	17	175-180	16
60-65	19	120-125	17		

Note: The furnace pressure was set to 15Pa at the centre of the lowest penetration.

A 5.3 SPECIMEN TEMPERATURES

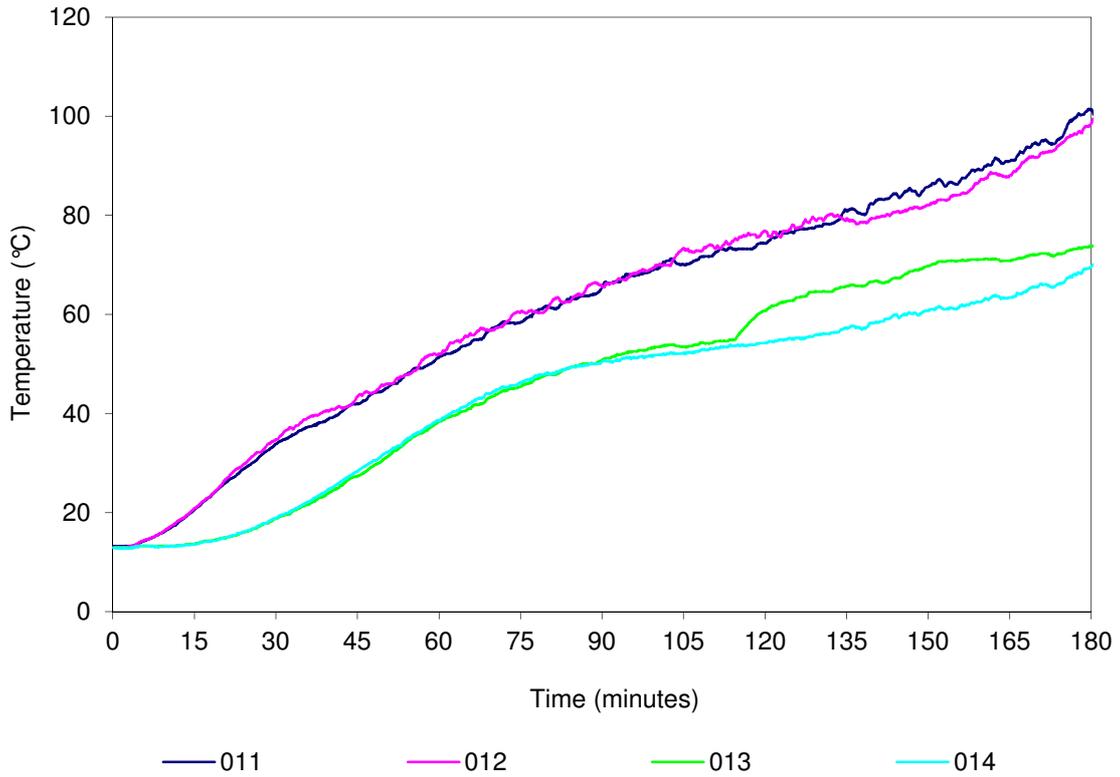


Figure A5.2: Service A (around the bundle of cable). Temperatures vs. Time

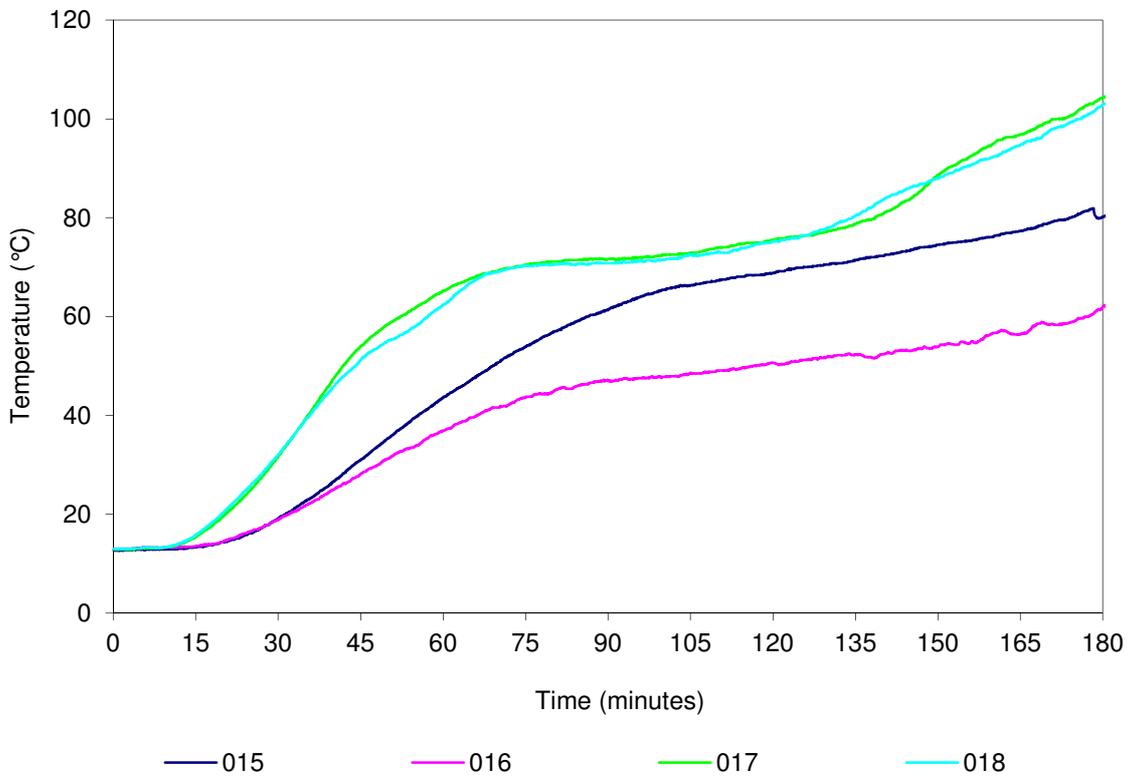


Figure A5.3: Service A (on the extra protection board and wall system). Temperatures vs. Time

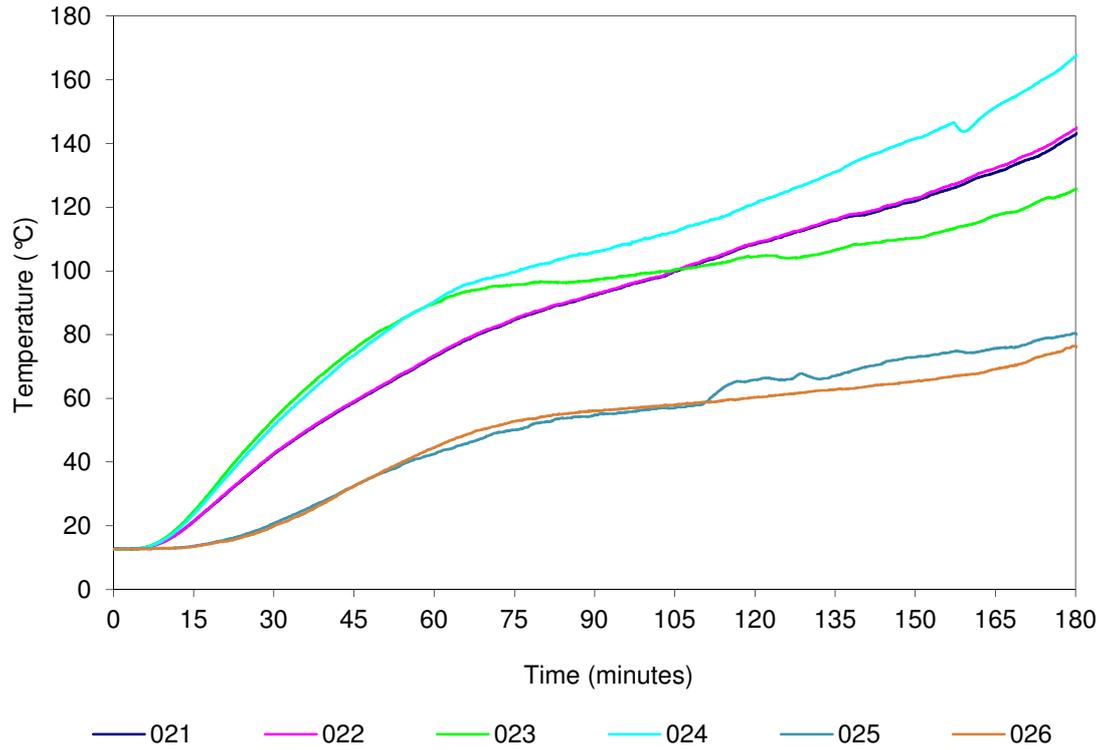


Figure A5.4: Service B (near the galvanised steel pipe). Temperatures vs. Time

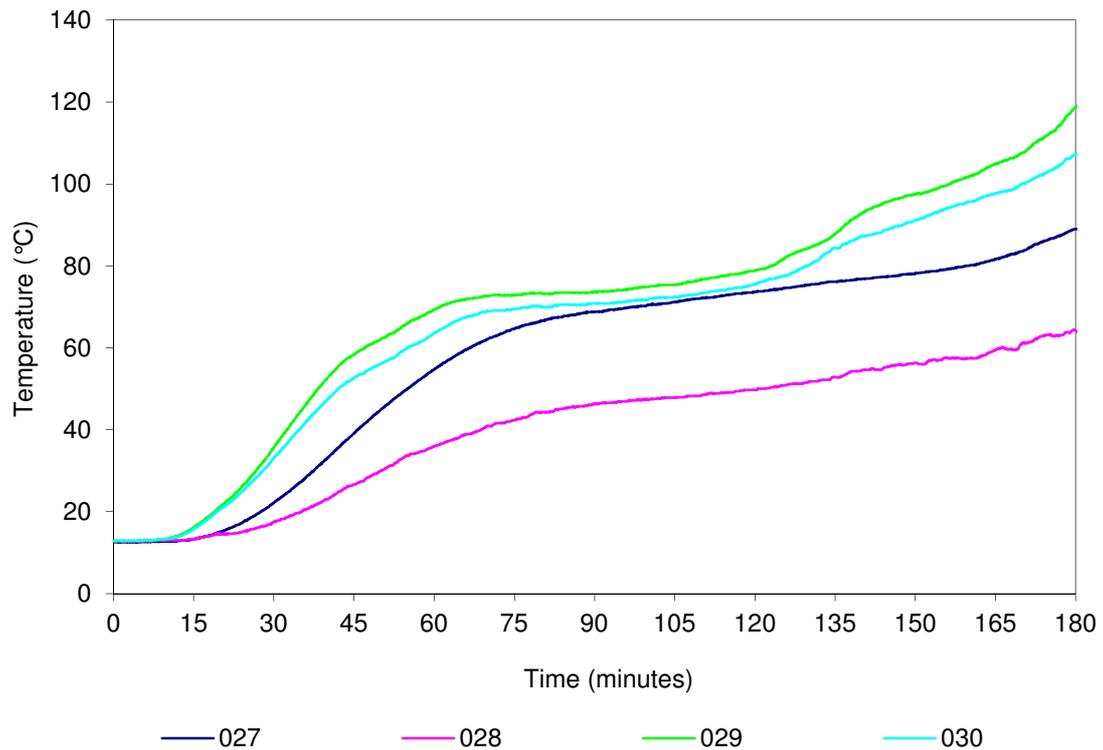


Figure A5.5: Service B (on the extra protection board and wall system). Temperatures vs. Time

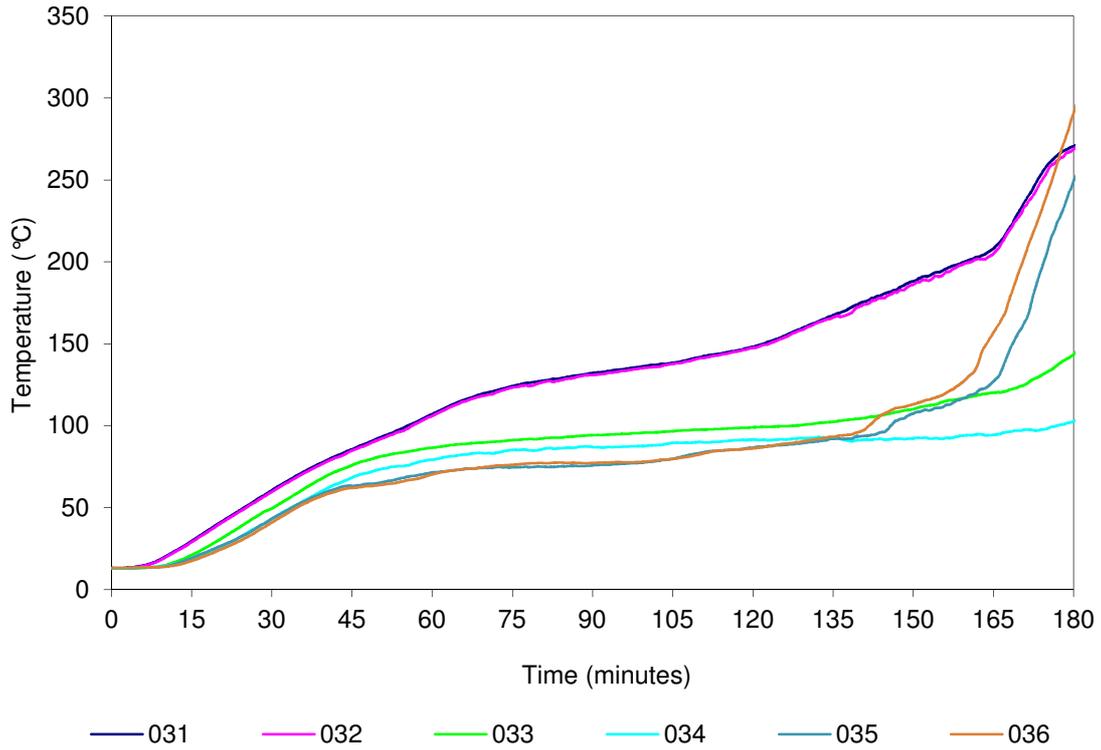


Figure A5.6: Service C. Temperatures vs. Time

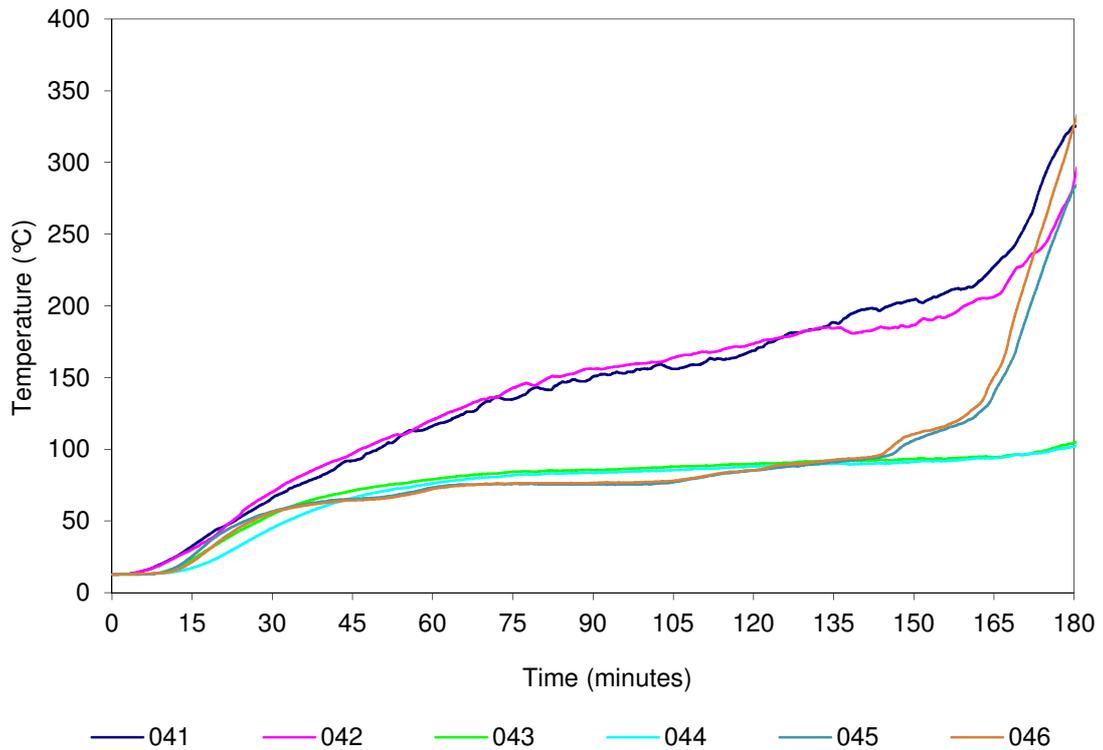


Figure A5.7: Service D (on the west penetration). Temperatures vs. Time

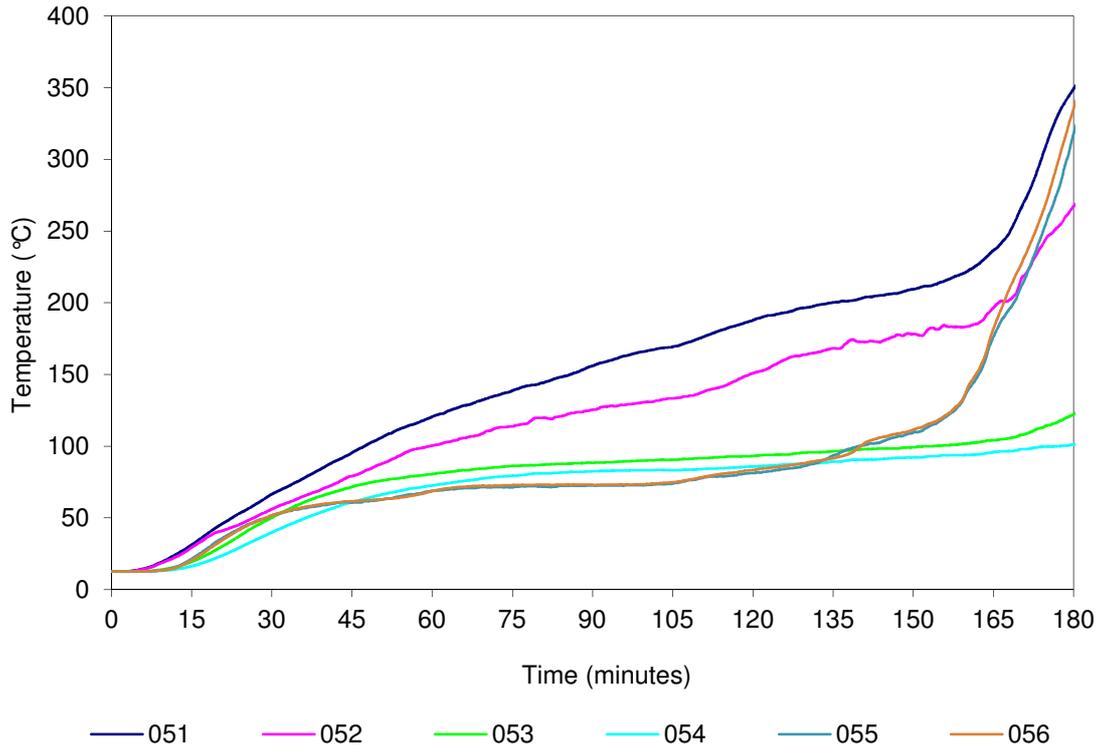


Figure A5.8: Service D (on the east penetration). Temperatures vs. Time

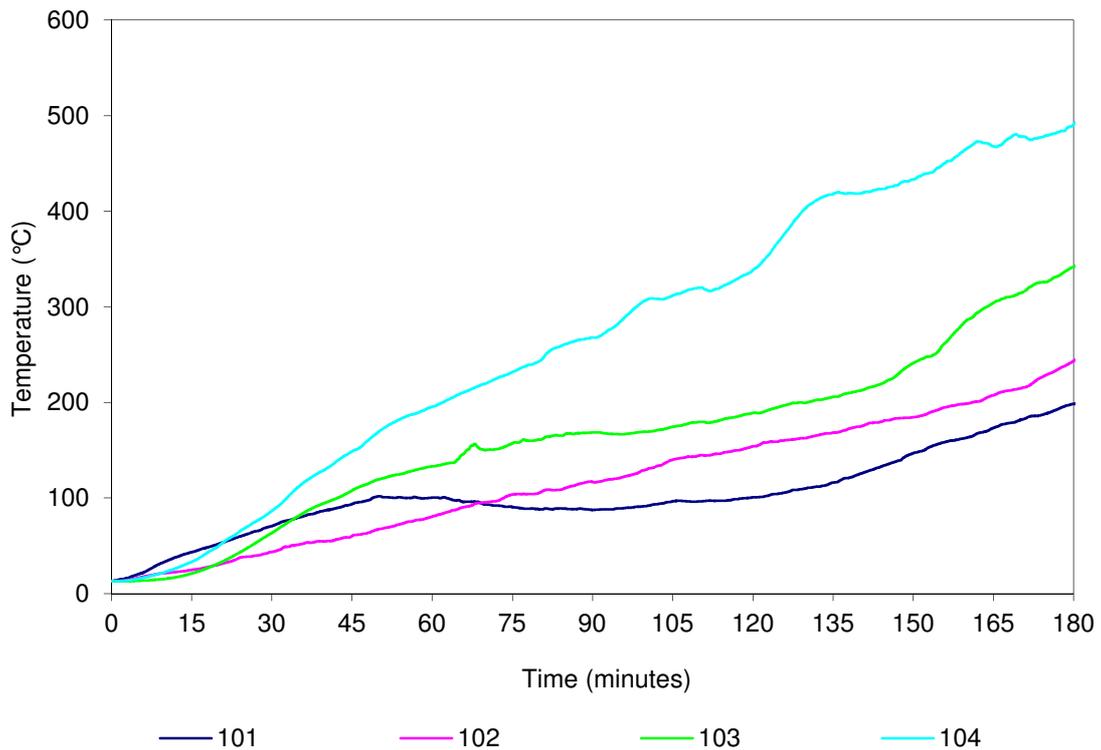


Figure A5.9: Service E (on the cables, 25mm away from sealant). Temperatures vs. Time

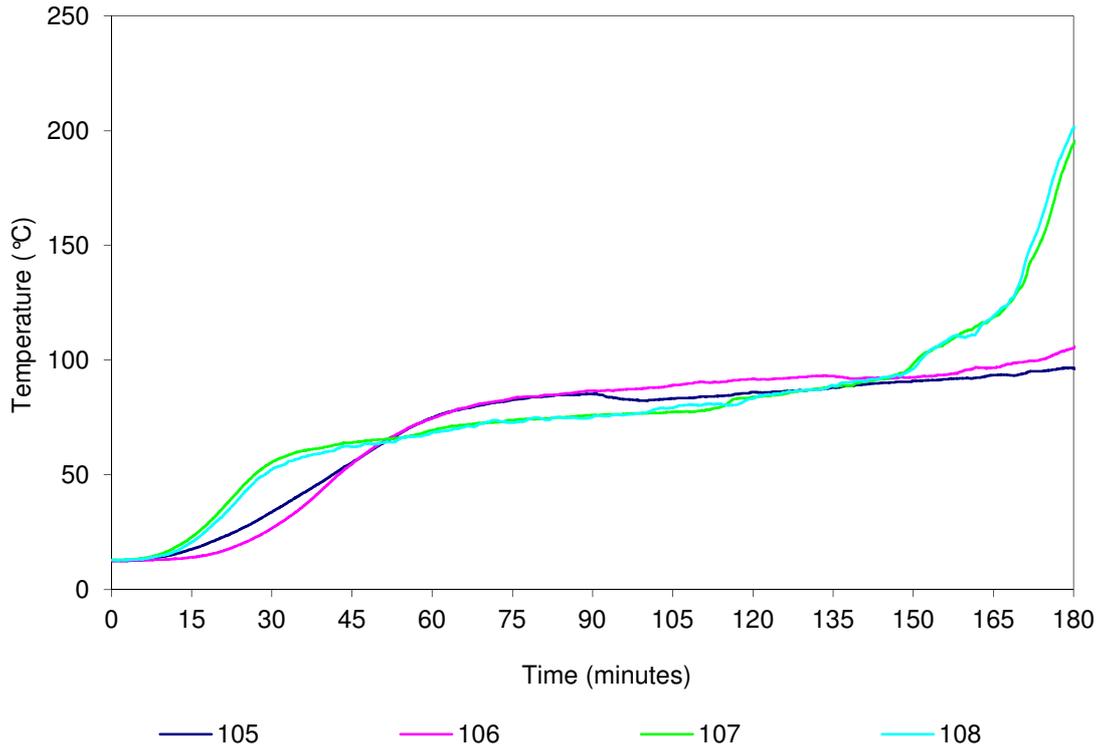


Figure A5.10: Service E (On the sealant and 25mm away from sealant). Temperatures vs. Time

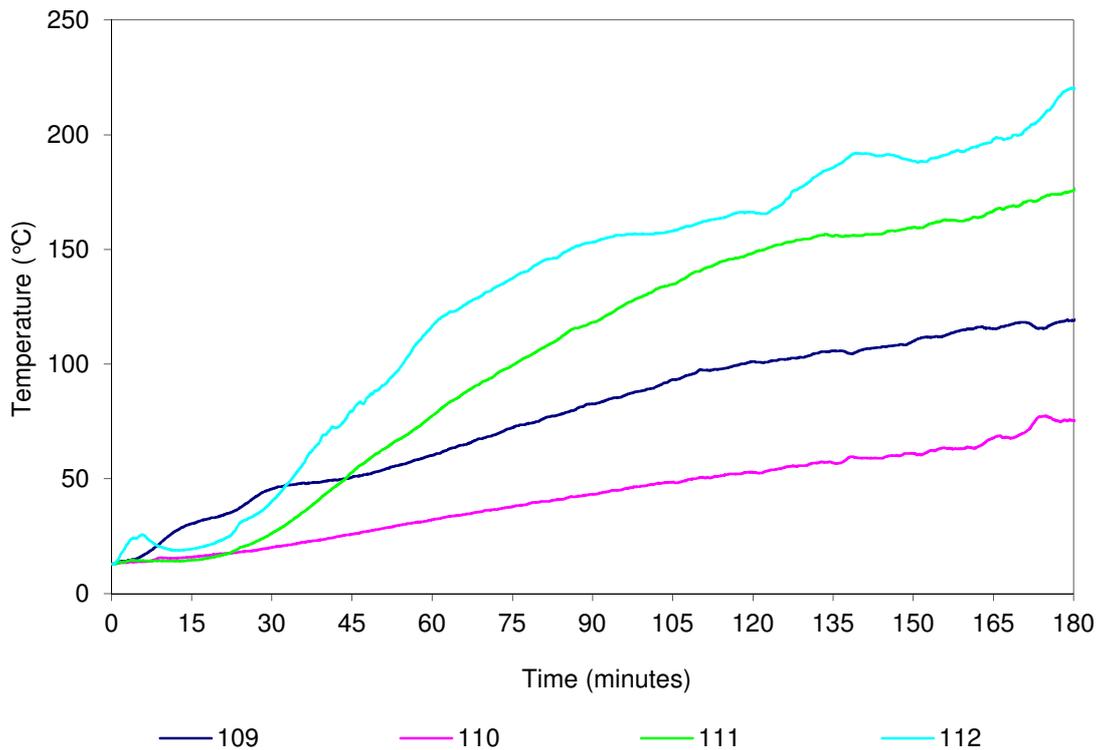


Figure A5.11: Service E (on the cables, 400mm away from wall system). Temperatures vs. Time

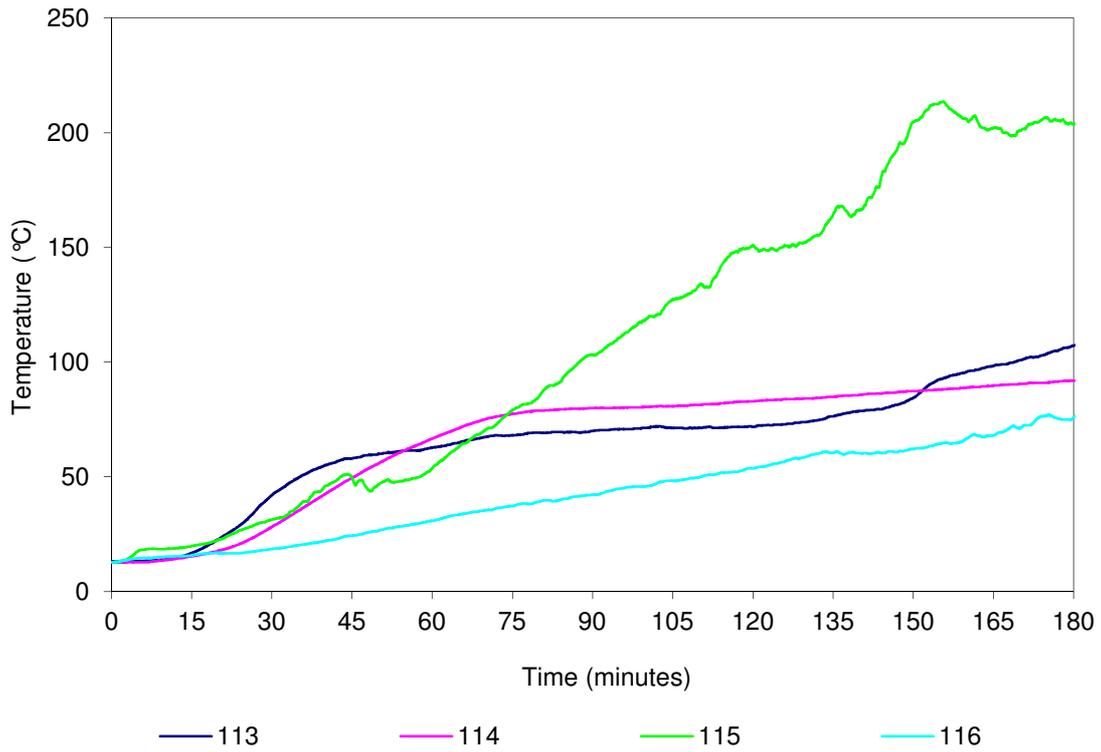


Figure A5.12: Service E (TC on the bottom side of the specimen). Temperatures vs. Time

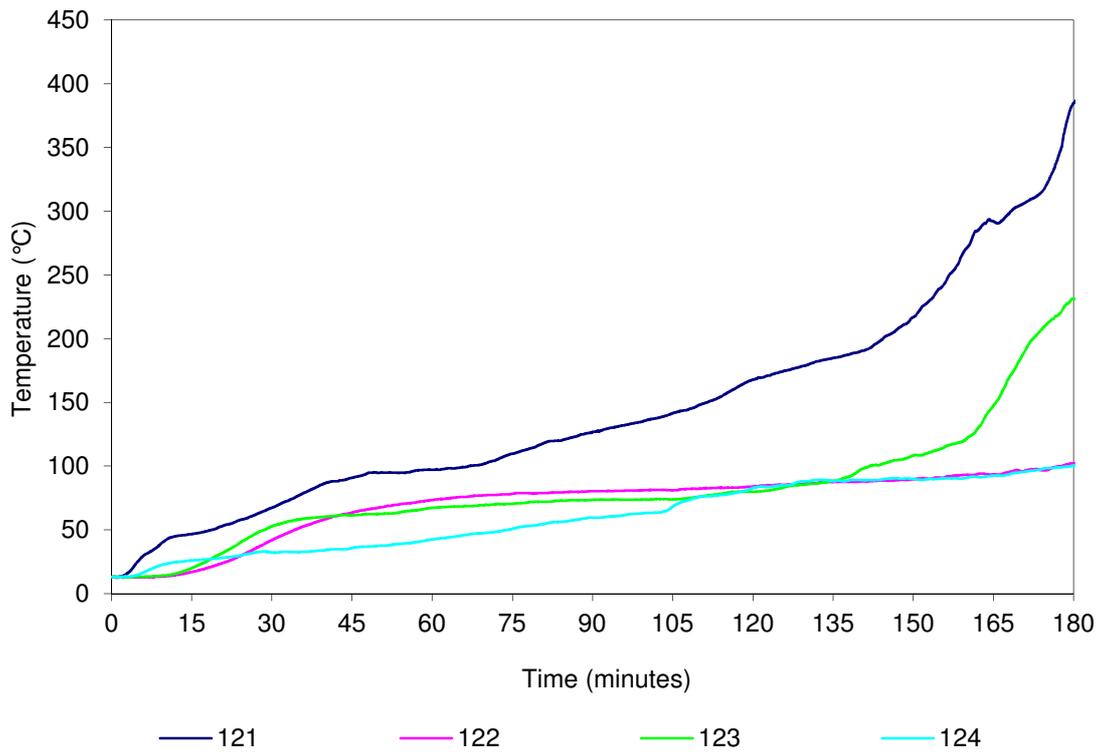


Figure A5.13: Service F on the top side. Temperatures vs. Time

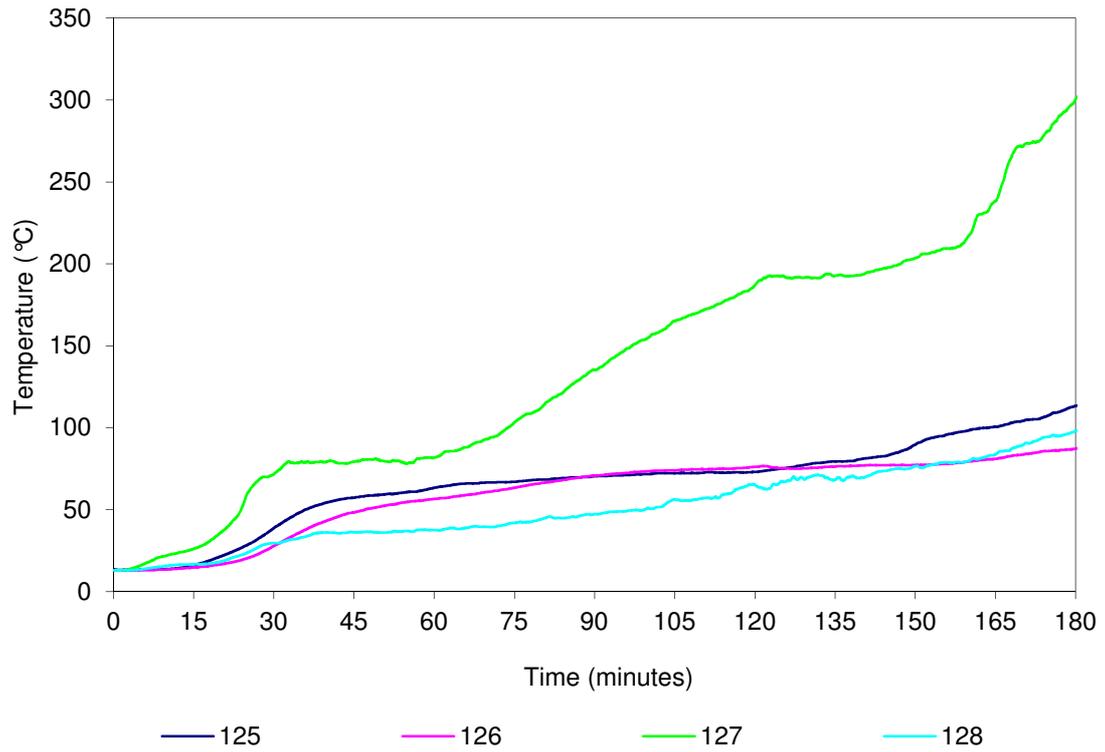


Figure A5.14: Service F on the bottom side. Temperatures vs. Time

Table A5.1: Test Specimen Temperatures

Service	T/C No	Description ²	Temp. (°C) at t (minutes)						Limit ¹ (Mins.)
			t=0	t=30	t=60	t=90	t=120	t=180	
A	011	On the bundle of TPS cables, 25mm away from the sealant	13	34	52	65	75	101	-
	012	On the bundle of TPS cables, 25mm away from the sealant	13	35	52	66	76	98	-
	013	On the protection board, 25mm away from the sealant	13	19	39	51	61	74	-
	014	On the protection board, 25mm away from the sealant	13	19	39	50	54	69	-
	015	On the protection board, 25mm away from the wall system	13	19	44	61	69	80	-
	016	On the protection board, 25mm away from the wall system	13	19	37	47	50	62	-
	017	On the wall system, 25mm away from the protection board	13	32	65	72	76	104	-
	018	On the wall system, 25mm away from the protection board	13	32	63	71	75	103	-
B	021	On the pipe, 25mm away from the sealant	13	43	74	92	109	143	-
	022	On the pipe, 25mm away from the sealant	13	43	74	93	109	144	--
	023	On the sealant cone, 25mm away from the pipe.	13	54	90	97	105	125	-
	024	On the sealant cone, 25mm away from the pipe,	13	52	91	106	122	167	-
	025	On the protection board, 25mm away from the sealant.	13	21	43	55	66	80	-
	026	On the protection board, 25mm away from the sealant.	13	20	45	56	60	76	-
	027	On the sealant in the channel, 25mm away from the sealant cone	13	22	55	69	74	89	-
	028	On the protection board, 25mm away from the wall system.	13	18	36	46	50	64	-
	029	On the wall system, 25mm away from the protection board	13	36	70	74	79	119	-
	030	On the wall system, 25mm away from the protection board	13	33	64	71	76	107	-
C	031	On the pipe, 25mm away from the sealant	13	61	108	132	148	270	153
	032	On the pipe, 25mm away from the sealant	13	60	107	131	148	268	155
	033	On the sealant, 25mm away from the pipe.	13	50	87	94	99	143	-
	034	On the sealant, 25mm away from the pipe.	13	43	79	87	92	102	-
	035	On the wall system, 25mm away from the sealant.	13	43	72	76	87	247	173
	036	On the wall system, 25mm away from the sealant.	13	41	71	77	86	288	169
D (west)	041	On the bundle of TPS cables, 25mm away from the sealant	13	66	117	150	169	325	137
	042	On the bundle of TPS cables, 25mm away from the sealant	13	70	121	156	174	282	156
	043	On the sealant, 25mm from the bundle of cables	13	55	79	85	90	104	-
	044	On the sealant, 25mm from the bundle of cables	13	45	76	84	88	102	-

Service	T/C No	Description ²	Temp. (°C) at t (minutes)						Limit ¹ (Mins.)
			t=0	t=30	t=60	t=90	t=120	t=180	
	045	On the wall system, 25mm away from the sealant	13	57	74	75	85	280	171
	046	On the wall system, 25mm away from the sealant	13	56	73	76	85	323	168
D (East)	051	On the bundle of TPS cables, 25mm away from the sealant	13	67	121	156	188	348	125
	052	On the bundle of TPS cables, 25mm away from the sealant	13	56	101	125	151	266	164
	053	On the sealant, 25mm from the bundle of cables	13	50	81	88	93	122	-
	054	On the sealant, 25mm from the bundle of cable.	12	40	73	83	86	101	-
	055	On the wall system, 25mm away from the sealant	13	52	69	73	81	314	167
	056	On the wall system, 25mm away from the sealant	13	52	69	73	84	332	166
E	101	On the 16mm ² cables, 25mm away from the sealant cone.	13	71	100	88	101	198	177
	102	On the 6mm ² cable, 25mm away from the sealant cone.	13	44	81	117	154	242	155
	103	On the 185mm ² cable, 25mm away from the sealant cone.	13	64	133	168	189	341	123
	104	On the 630mm ² cable, 25mm away from the sealant cone.	13	87	196	268	340	489	58
	105	On the sealant cone, 25mm away from the 16mm ² cables	13	34	75	85	86	97	-
	106	On the sealant cone, 25mm away from the 630mm ² cable	13	27	75	87	92	105	-
	107	On the wall system, 25mm away from the top of sealant cone.	13	56	70	76	84	193	179
	108	On the wall system, 25mm away from the top of sealant cone.	13	53	69	75	84	200	178
	109	On the 16mm ² cable, 400mm away from the wall system	13	46	60	83	101	119	-
	110	On the 6mm ² cable, 400mm away from the sealant cone	13	20	32	43	53	76	-
	111	On the 185mm ² cable, 400mm away from the sealant cone	13	26	78	118	149	176	-
	112	On the 630mm ² cable, 400mm away from the sealant cone	13	40	118	153	166	220	157
	113	On the wall system, 25mm away from the bottom of sealant cone.	13	42	63	70	72	107	-
	114	On the sealant cone, 25mm away from the bottom of cable tray	13	28	67	80	83	92	-
115	On the bottom of cable tray, 25mm away from the sealant	13	31	55	103	150	204	146	
116	On the bottom of cable tray, 400mm away from the wall system	13	19	31	42	54	75	-	
F	121	On the communication cables, 25mm away from the sealant cone	13	67	97	127	168	383	142
	122	On the sealant cone, 25mm away from the communication cables	13	42	74	80	84	102	-
	123	On the wall system, 25mm away from the top of sealant cone	13	53	67	74	80	231	171
	124	On the communication cables, 400mm away from the wall	13	32	43	60	83	100	-
	125	On the wall system, 25mm away from the bottom of sealant cone	13	39	64	70	73	113	-

Service	T/C No	Description ²	Temp. (°C) at t (minutes)						Limit ¹ (Mins.)
			t=0	t=30	t=60	t=90	t=120	t=180	
	126	On the sealant cone, 25mm away from the bottom of communication cables.	13	28	57	71	76	87	-
	127	On the bottom of cable tray, 25mm away from the bottom of sealant cone	13	72	82	135	189	299	122
	128	On the bottom of cable tray, 400mm away from the wall system	13	30	38	47	64	98	-

- Notes**
- ¹ Limit time is the time to the nearest whole minute, rounded down to the nearest minute, at which the temperature recorded by the thermocouple does not rise by more than 180K above the initial temperature.
 - ² Refer to Appendix 4 for locations of thermocouples as only a generic description is included in the table.
 - ³ No insulation failure prior to thermocouple failure.
 - # Thermocouple failure
 - '-' Under limit column indicates the temperature limit was not exceeded during the test period or up until the time of integrity failure if a failure occurred.
 - NA Limit not applicable due to thermocouples located internally to the wall system.

APPENDIX 6 PHOTOGRAPHS

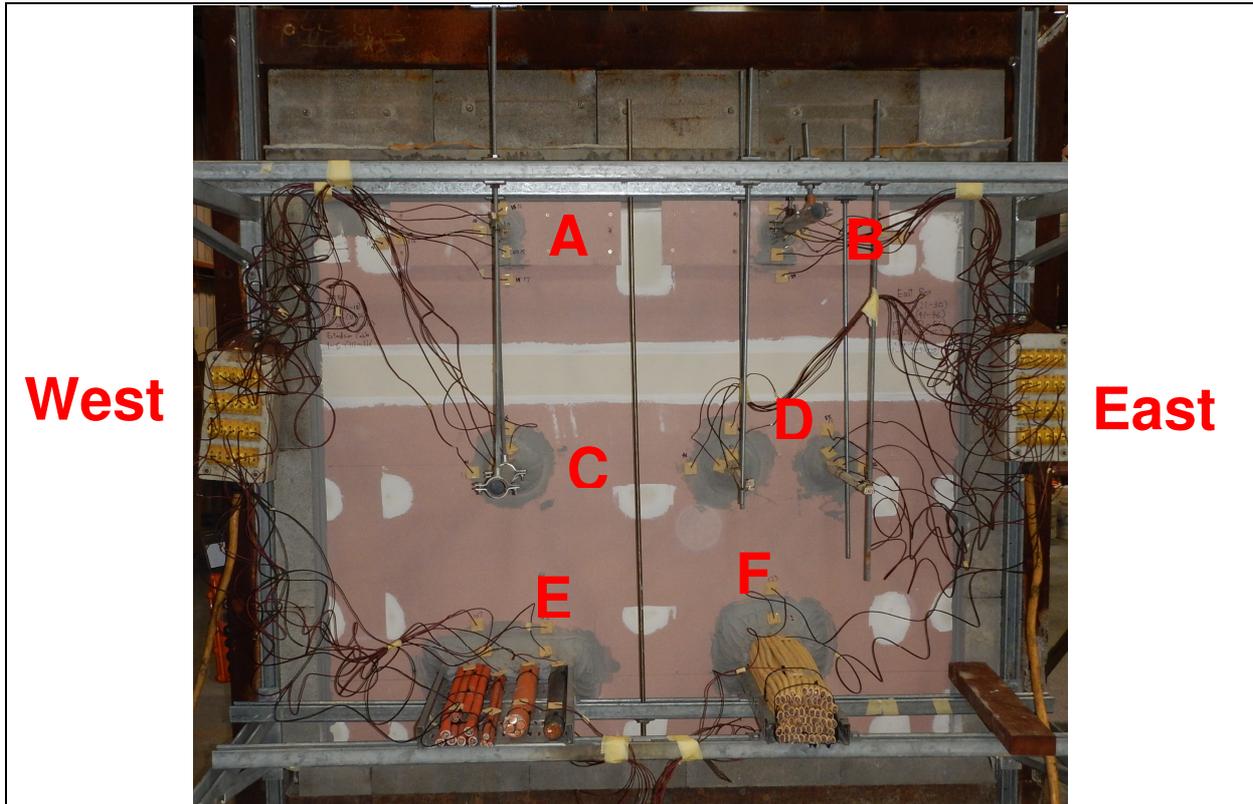


Figure A6.1. Unexposed face of specimen before commencement of the fire-resistance test.

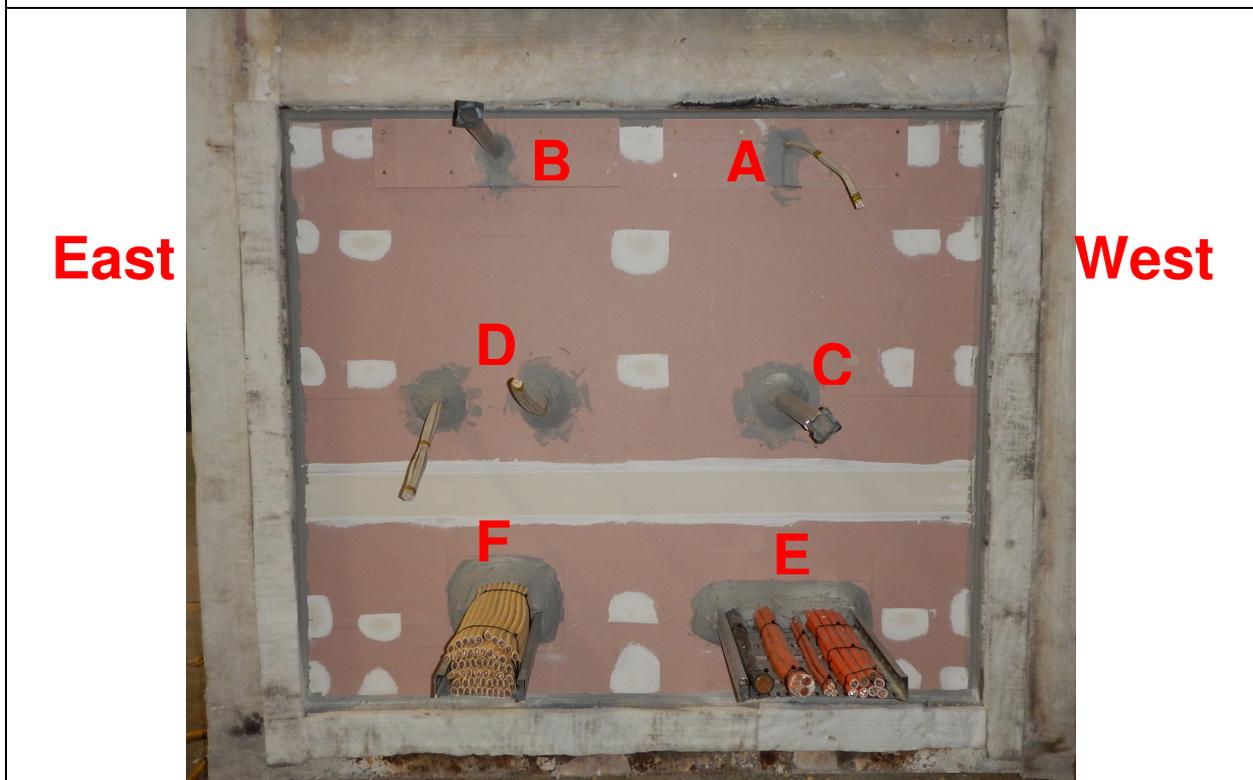


Figure A6.2. Exposed face of specimen before commencement of the fire-resistance test.



Figure A6.3. Unexposed face of specimen at the end of the fire-resistance test.



Figure A6.4. Exposed face of specimen after the end of the fire-resistance test.