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Testing, calibrating, advising.

Title:

The fire resistance performance of a one and a half leaf single acting glazed doorset and a single leaf single acting glazed doorset when tested in accordance with BS EN 1634-1: 2014

WF Report No:

BMT/FEP/F15167
Revision A



Prepared for:

**Jiangsu Sainty Bancom
Wood Co. Ltd**

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Test date:

27th November 2015

Notified Body No:

1314



Exova Warringtonfire – the new name for BM TRADA

On December 1st 2015, Chiltern International Fire Limited (trading as BM TRADA) commenced trading under the name Exova Warringtonfire.

To coincide with this change, our Technical Reports, Test Reports, Product Assessments, company stationery and marketing collateral have been updated to reflect the Exova Warringtonfire branding.

The validity of all documents previously issued by Chiltern International Fire Limited including certificates, test reports and product assessments is unaffected by this change. A letter to this effect is available upon request by e-mailing globalfire@exova.com

About Exova Warringtonfire

Exova Warringtonfire is part of the Exova Group one of the world's leading laboratory-based testing groups, trusted by organisations to test and advise on the safety, quality and performance of their products and operations. Headquartered in Edinburgh, UK, Exova operates 143 laboratories and offices in 32 countries and employs around 4,500 people throughout Europe, the Americas, the Middle East and Asia/Asia Pacific. With over 90 years' experience, Exova specialises in testing across a number of key sectors from health sciences to aerospace, transportation, oil and gas, fire and construction.

Be assured that whilst the name will change, your service provision and primary contacts have not. What will be available to you is a wider team of testing experts and an extended range of testing capabilities including structural steelwork testing, ventilation duct and damper testing, ASTM testing, water mist system testing and smoke toxicity testing and covering additionally both the rail and marine sectors.

If you have any questions, please do not hesitate to contact a member of the team and we will do our best to answer them. We appreciate your business to date and we look forward to working with you in the future.

Kind regards

Exova Warringtonfire

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1 Summary of Performance

The following performance was achieved from the specimens tested. Full details of the testing and specimen construction are described in the report.

Results:

Fire resistance test in accordance with BS EN 1634-1: 2014 and BS EN 1363-1: 2012

Doorset A

Integrity	
Cotton pad	67 (sixty seven) minutes*
Continuous flaming	67 (sixty seven) minutes
Gap gauges	67 (sixty seven) minutes*
Insulation - 2 discrete areas	
Discrete area 1 – timber	
Average set	67 (sixty seven) minutes**
Maximum $\geq 100\text{mm}$ in from leaf edge	64 (sixty four) minutes
Door frame $\geq 180^\circ\text{C}$ temp rise	67 (sixty seven) minutes**
Door frame $\geq 360^\circ\text{C}$ temp rise	67 (sixty seven) minutes**
Discrete area 2 - glass	
	67 (sixty seven) minutes**
Radiation – time to 15kW/m^2	67 (sixty seven) minutes*

* No failure of the test criteria at termination of the test at 67 minutes

** Failure by virtue of integrity failure at 67 minutes

Doorset B

Integrity	
Cotton pad	67 (sixty seven) minutes*
Continuous flaming	63 (sixty three) minutes
Gap gauges	67 (sixty seven) minutes*
Insulation - 2 discrete areas	
Discrete area 1 – timber	
Average set	63 (sixty three) minutes**
Maximum $\geq 100\text{mm}$ in from leaf edge	63 (sixty three) minutes**
Door frame $\geq 180^\circ\text{C}$ temp rise	63 (sixty three) minutes**
Door frame $\geq 360^\circ\text{C}$ temp rise	63 (sixty three) minutes**
Discrete area 2 - glass	
	3 (three) minutes
Radiation – time to 15kW/m^2	67 (sixty seven) minutes*

* No failure of the test criteria at termination of the test at 67 minutes

** Failure by virtue of integrity failure at 63 minutes



Summary of specimens:

A one and a half leaf single acting doorset with glazing and a single leaf single acting doorset with glazing

Doorset A, left leaf size: 2135mm high x 915mm wide x 54mm thick, right leaf size: 2135mm high x 300mm wide x 54mm thick

Doorset B, leaf size: 2440mm high x 915mm wide x 54mm thick

2 Introduction

The doorsets were installed into a flexible supporting construction. In accordance with BS EN 14600: 2005 the leaves were pre-cycled before the fire test. The doorsets were instrumented with the standard set of thermocouples. The doorsets were installed opening in towards the furnace.

3 Specimen verification

The door blanks were supplied for testing to Exova Warringtonfire on 19th June 2015. The component parts of the doorsets were identified based on nominal information provided by the client. The conformity of the specimens against these nominal values has been verified and agreed by the laboratory insofar as the structure of the specimen allowed verification to take place. If possible, additional moisture content readings, species verification and density checks were performed on either the original specimen, or, samples provided by the sponsor. These details are outlined in the construction section of this report (section 6).

3.1 Conditioning

Exova Warringtonfire stored the specimen in climatic conditions approximate to those in normal service.

3.2 Sampling

Exova Warringtonfire was not involved in factory sampling of the components used for the specimen subject to this report.

4 Description of supporting construction

The supporting construction comprised a British Gypsum steel stud partition with 50mm thick 30kg/m³ density insulation fitted between the studs, built in accordance with Clause 7.2.2.4 of BSEN 1363: Part 1, for a flexible supporting construction (table 1 group A). The vertical studs surrounding the apertures created for the doorsets incorporated a 47mm x 29mm softwood timber infill to facilitate the fixings for the specimens. The specimens tested are 60 minute products with an anticipated Category B performance, therefore intended fire resistance is 68 minutes and two layers of 12.5mm thick Gypsum plasterboard type F is required on each face. The supporting construction was only fixed on the horizontal edges, the vertical edges remained free.

5 Description of specimens

Details of the specimen are shown in Figures 1 to 6 of Appendix 1.

5.1 Door leaves

The left leaf of doorset A measured 2135mm high x 915mm wide x 54mm thick and the right leaf measured 2135mm high x 300mm wide x 54mm thick. The leaf of doorset B measured 2480mm high x 915mm wide x 54mm thick.

6 Description of Construction (Refers to Figures 1 to 6 of the Appendix)

Leaf – both doorsets - Identified as being produced from Sainty-Fire Protech blanks

		Species/type	Dimensions (mm)	Density (kg/m ³)	Moisture (% w/w)	Key to figures
Stiles		None fitted	-	-	-	-
Top rails		Pine	36 thick x 25 wide	450*	-	1
Core	Outer	Spruce/Pine mix of vertically orientated lamels	12 thick x 38 wide	450*	-	2
	Inner	Spruce/Pine mix of horizontally orientated lamels	12 thick x 38 wide	450*	-	3
Facings		Poplar core plywood	9 thick	450*	10.4	4
Adhesive	Lipping	PU	-	-	-	-
	Core	WBP Melamine glue	-	-	-	-
	Facings	WBP Melamine glue	-	-	-	-
Lippings – all edges		Sapele	6 thick	640**	10.2	5

* Stated density by client, not verified by laboratory

** Nominal density

Door frame – both doorsets

		Species/type	Dimensions (mm)	Density (kg/m ³)	Moisture (% w/w)	Key to figures
Head & jambs		Sapele	70 wide x 32 thick	640**	10.3-10.6	6
Head to jamb jointing detail		Mortice and tenon – screwed	-	-	-	-
Stops – planted (pinned)		Sapele	15 wide x 12 thick	640**	10.5-10.6	7
Frame to supporting construction fire stopping detail		Tightly packed mineral fibre capped with intumescent acrylic mastic	Nominally 15mm wide x full depth of frame	-	-	-
Frame to supporting construction fixing detail		4No steel woodscrews per jamb	80 long x 6 diameter	-	-	-
Architrave		MDF	45 wide x 18 thick	700**	12.8	-
Threshold		Non combustible	-	-	-	-

** Nominal density

Intumescent materials – doorset A

		Make/type	Size (mm)	Location	Key to figures
Door edges	Left leaf closing edge	Pyroplex 8700 rigid box seal	15 x 4	Fitted 7mm from the exposed face in the left leaf edge	8
	Right leaf closing edge	Pyroplex 8700 rigid box seal	15 x 4	Fitted 7mm from the unexposed face in the right leaf edge	9
Frame reveal	Head and jambs	2No Pyroplex 8700 rigid box seals	15 x 4	Fitted 10mm apart, with the first seal 8mm from the exposed face in the frame reveal	10
Glazing perimeter		Intumescent Seal Ltd Therm-A-Glaze 60 glazing liner	54 x 2	Fitted lining the glazing aperture	11
		Intumescent Seals Ltd Therm-A - bead	25 x 4	Fitted between the glass and bead on both faces	12

Intumescent materials – doorset B

		Make/type	Size (mm)	Location	Key to figures
Door edges		None fitted	-	-	-
Frame reveal	Head and jambs	Pyroplex 8700 rigid box seal	15 x 4	Fitted 10mm apart 8mm from the exposed face in the frame reveal	13
Glazing perimeter		Intumescent Seal Ltd Therm-A-Glaze 60 glazing liner	54 x 2	Fitted lining the glazing aperture	14
		Intumescent Seals Ltd Therm-A - bead	25 x 4	Fitted between the glass and bead on both faces	15

Intumescent interruptions and additional protection – both doorsets

	Make/type	Size (mm)	Location
Around hinge blade	Partially interrupted	-	Hinge blade fully interrupts 1 st seal and partially interrupts 2 nd seal leaving 13mm continuous in frame reveal
Under hinge blades	Interdens	2 thick	Fitted under hinge blade on frame and leaf
Encasing latch body	Interdens	2 thick	Fitted around the body of the latch
Around latch forend – doorset A	Partially interrupted	-	Latch forend partially interrupts seal in left leaf edge with 10mm remaining continuous
Under latch forend – both doorsets	Interdens	2 thick	Fitted under the forend of the latch
Around latch keep – doorset A	Partially interrupted	-	Latch keep partially seal in leaf edge with 7mm remaining continuous
Around latch keep – doorset B	Partially interrupted	-	Latch keep fully interrupts 1 st seal with 9mm of the 2 nd seal remaining intact
Under latch keep	Interdens	2 thick	Fitted under the latch keep

Hardware – both doorsets

		Make/type	Size (mm)	Location	Key to figures
Hinges	Doorset A	3No. Royde and Tucker H101 lift off type hinge fixed with Ø5 x 30mm long screws	100 x 35 (blade size)	Fitted 180mm, 1030mm and 1890mm from the threshold of the leaf	16
	Doorset B	4No. Royde and Tucker H101 lift off type hinge	100 x 35 (blade size)	Fitted 180mm, 855mm, 1520mm and 2190mm from the threshold of the leaf	17
Closer		Rutland TS3204 overhead type closer	220 x 59 (footprint size)	Fitted on the exposed face as per the manufacturers' instructions	18
Latch – engaged		Easi-T mortice latch fixed with 40mm long screws	155 x 22 (forend size)	Fitted 1000mm from the threshold of the leaf	19
			120 x 25 (keep size)		
Furniture		Zoo Hardware lever type handle	100 x 38 (footprint size)	Fitted appropriate to the latch	20

Glazing – doorset A

	Make/type	Size (mm)	Location	Key to figures
Glass type	Pyroguard EI60	23 thick	Fitted 100mm from the head of the left leaf, 100mm from the closing edge	21
Sight size	-	700 high x 510 wide	-	-
Overall aperture size	-	810 high x 560 wide	-	-
Glass size	-	800 high x 550 wide	-	-
Expansion allowance	-	2-3 all round	-	-
Beading	Sapele (640kg/m ³ nominal density)	30 high x 16.5 deep including a 5 x 5 bolection return and a 24° chamfer	Fitted around the glazing aperture on both faces	22
Beading fixings	Steel screws	60 long	Fitted 45mm from corners at 135 mm centres at 35° to the face of the glass	23

Glazing – doorset B

	Make/type	Size (mm)	Location	Key to figures
Glass type	Pilkington Pyrodur	7 thick	Fitted 300mm from the head of the leaf, 195mm from the closing edge	24
Sight size	-	600 high x 460 wide	-	-
Overall aperture size	-	645 high x 505 wide	-	-
Glass size	-	640 high x 500 wide	-	-
Expansion allowance	-	2-3 all round	-	-
Beading	Sapele (640kg/m ³ nominal density, 10.4% m.c.)	29 high x 24.5 deep including a 5 x 5 bolection return and a 20° chamfer	Fitted around the glazing aperture on both faces	25
Beading fixings	Steel screws	60 long	Fitted 45mm from corners at 135 mm centres at 35° to the face of the glass	26

7 Pre-test measurements and mechanical conditioning

Pre test measurements and mechanical conditioning were conducted on the samples in the order detailed below.

7.1 Method of installation

The doorsets were fixed into pre-prepared openings. The details of the fixings and fire stopping between frame and supporting construction are outlined in the construction section and Figure 4 of Appendix 1. The exposed faces of the doorsets were flush with the exposed face of the supporting construction.

7.2 Pre-cycling operability

Operability test of 25 manual cycles was completed on each leaf in accordance with BS EN 14600, section 5.1.1.1.

Minimum angle of opening	90°
Number of operation cycles completed	25

7.3 Specimen self closing

Specimen self closing was completed on each leaf in accordance with BS EN 14600, section 5.1.1.2 / 5.1.1.3.

	Angle of measurement	10° ± 2°
All leaves	Closing speed	1.6 seconds

7.4 Door perimeter gaps

The manufacturer did not declare a working range so the doors were installed to open and close freely, maintaining gaps, where possible, to a range of 2-4mm along all edges except the threshold, and 3-8mm along the threshold. The gaps between the edge of the leaf and frame were measured prior to test in accordance with BS EN 1634-1 2014, section 10.1.2. A total of 31 readings were recorded. The measurements (in mm) are detailed in Figure 5 of Appendix 1.

7.5 Closer forces

Measured in accordance with BS EN 1634-1: 2014 Section 10.1.3.

	Opening Force (Nm)
Doorset A – left leaf	62.3 @ handle position
Doorset A – right leaf	110 @ handle position
Doorset B	64 @ handle position

7.6 Final setting

Final setting of the specimen was conducted in accordance with BS EN 1634-1 2014, section 10.1.4.

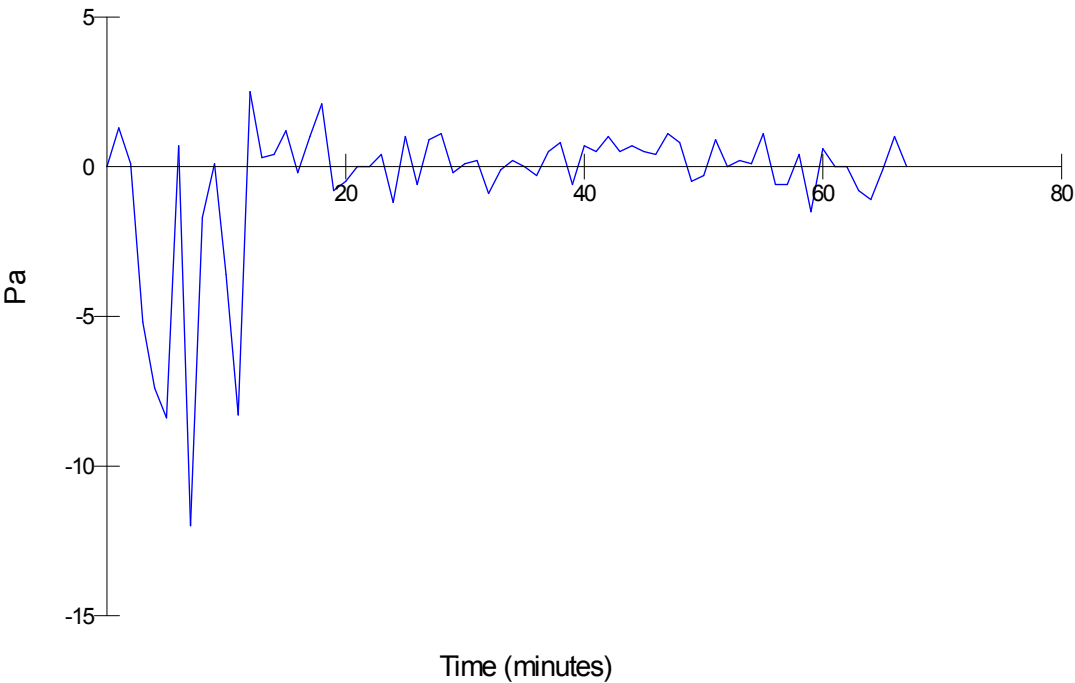
8 **Test Conditions**

8.1 **Ambient temperature**

The ambient temperature of the test area at commencement of test was 13°C. The temperatures recorded during the test are tabulated in Appendix 2.

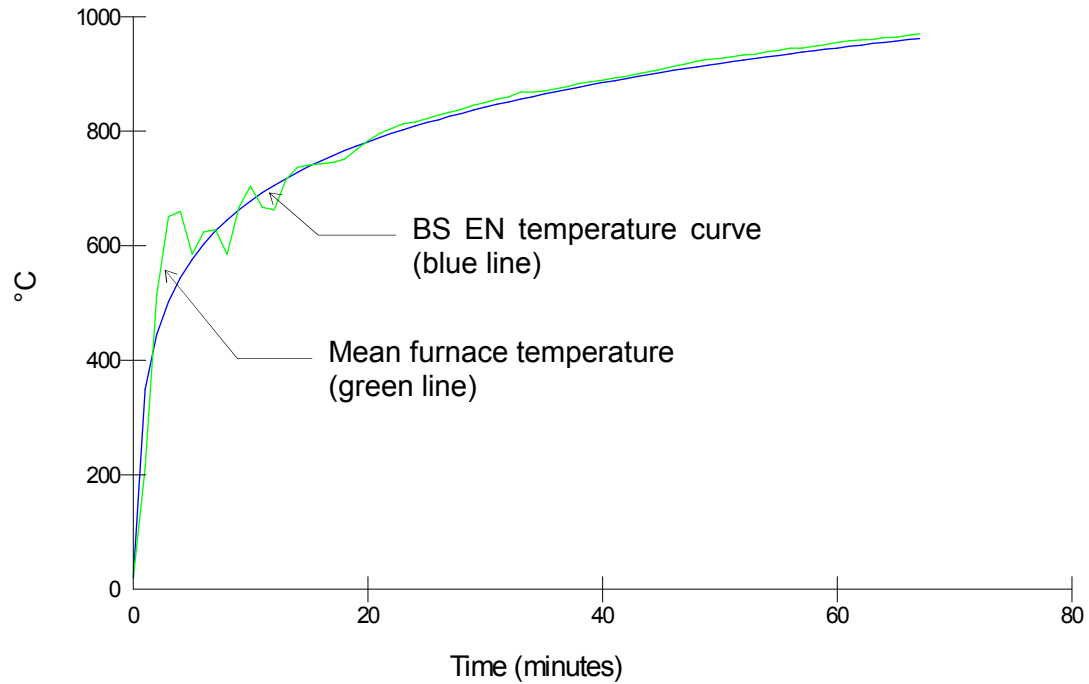
8.2 **Pressure readings**

After the first 5 minutes of the test, the furnace pressure was maintained at 0 ± 5 Pa and after 10 minutes was maintained at 0 ± 3 Pa with respect to atmosphere, at a point 0.5m from the notional floor level. The pressure readings were recorded and are tabulated in Appendix 2 and shown graphically below:



8.3 Furnace temperature

The furnace was controlled to follow the temperature/time relationship specified in BS EN 1363: Part 1: 2012 Section 5.1.1 as closely as possible, using the average of nine plate thermometers suitably distributed within the furnace. The temperatures were recorded and are tabulated in Appendix 2 and shown graphically below:



8.4 Unexposed face temperatures

The temperature of the unexposed face was monitored by means of the following thermocouples:

Doorset A

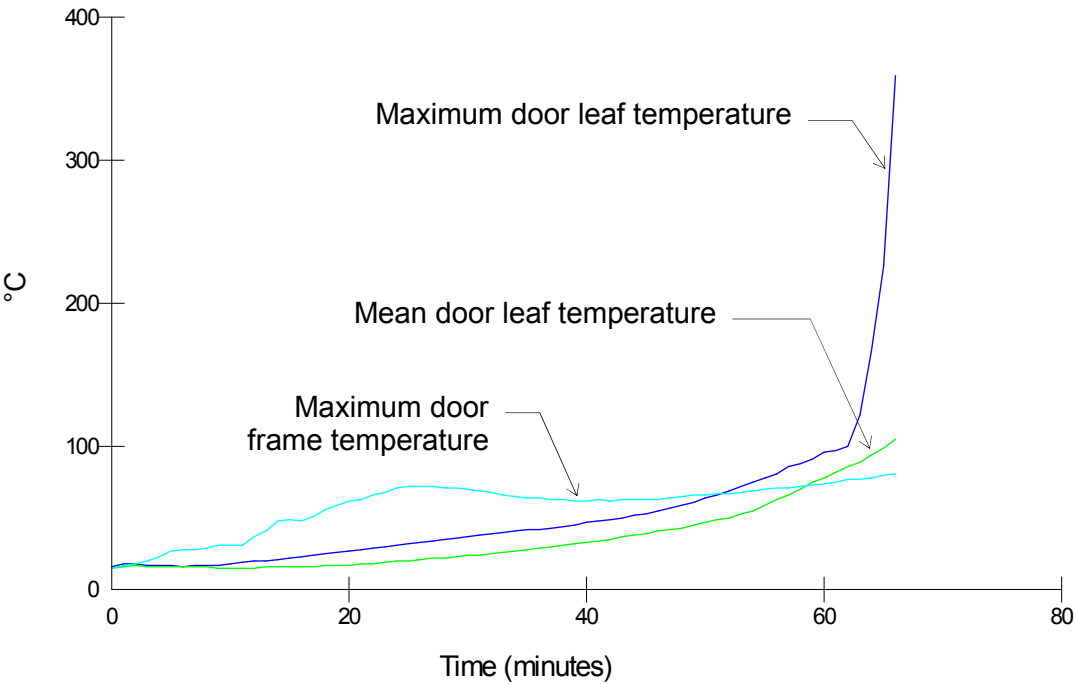
	2 discrete areas	
Leaf	Discrete area 1 (timber)	5 measuring mean temperature rise.
		8 measuring maximum temperature rise, standard set 100mm in from the door leaf edges.
Frame		5 measuring maximum temperature rise
	Discrete area 2 (glass)	2 measuring maximum temperature rise

Doorset B

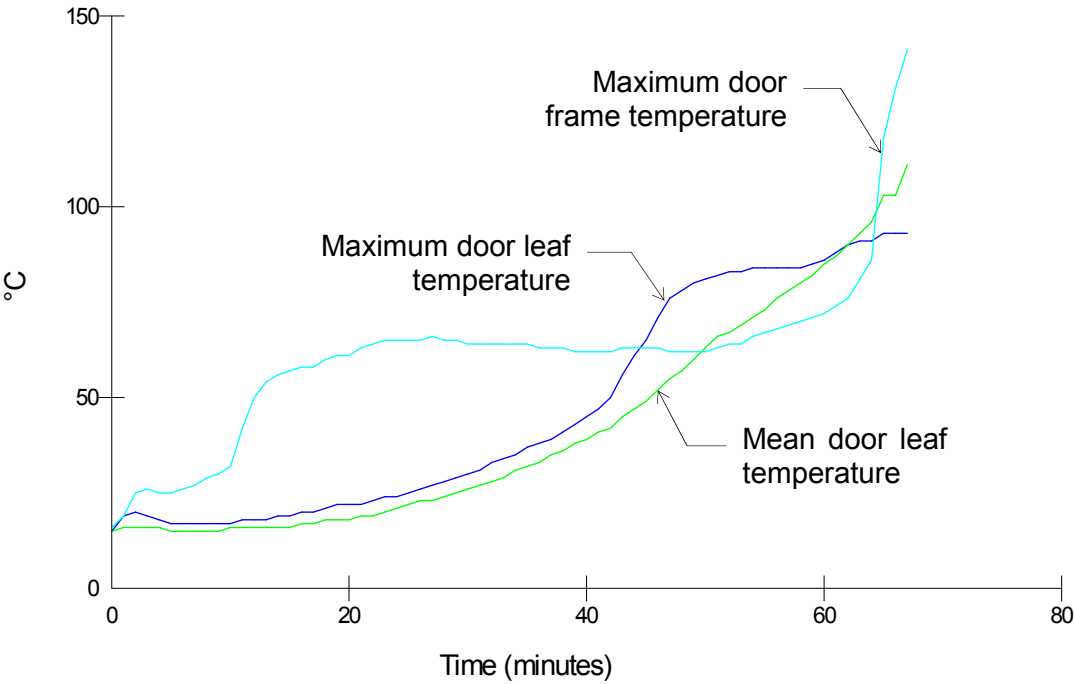
	2 discrete areas	
Leaf	Discrete area 1 (timber)	5 measuring mean temperature rise.
		4 measuring maximum temperature rise, standard set 100mm in from the door leaf edges.
Frame		5 measuring maximum temperature rise
	Discrete area 2 (glass)	2 measuring maximum temperature rise

The locations of the thermocouples are shown in Figure 6 of Appendix 1. The temperatures were recorded and tabulated in Appendix 2 and are shown graphically below:

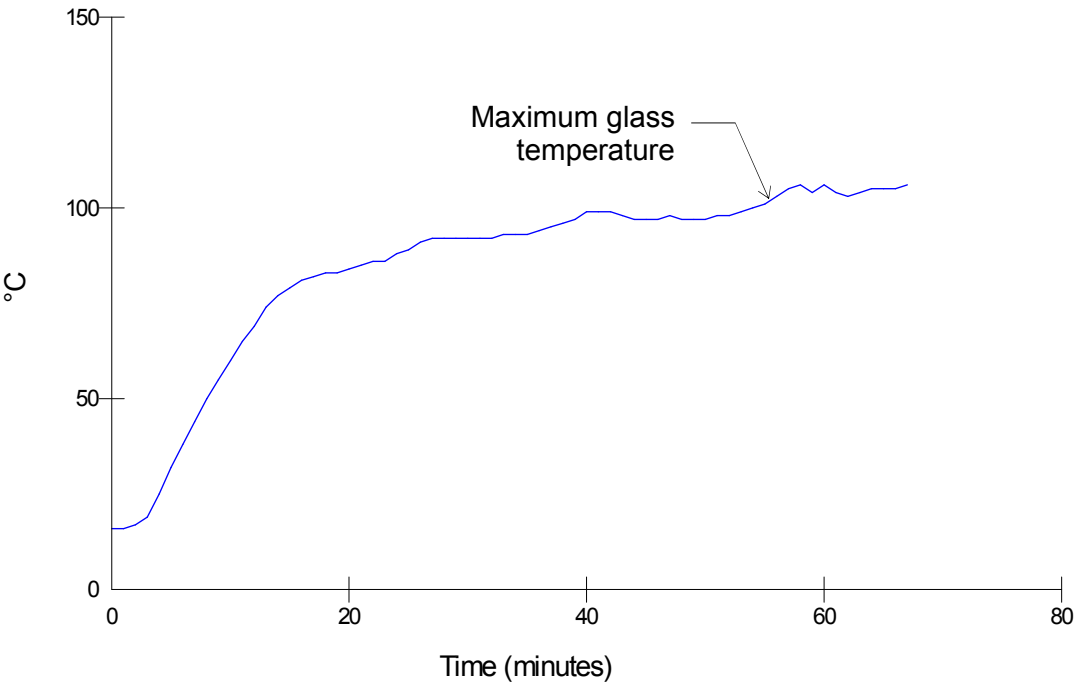
Doorset A



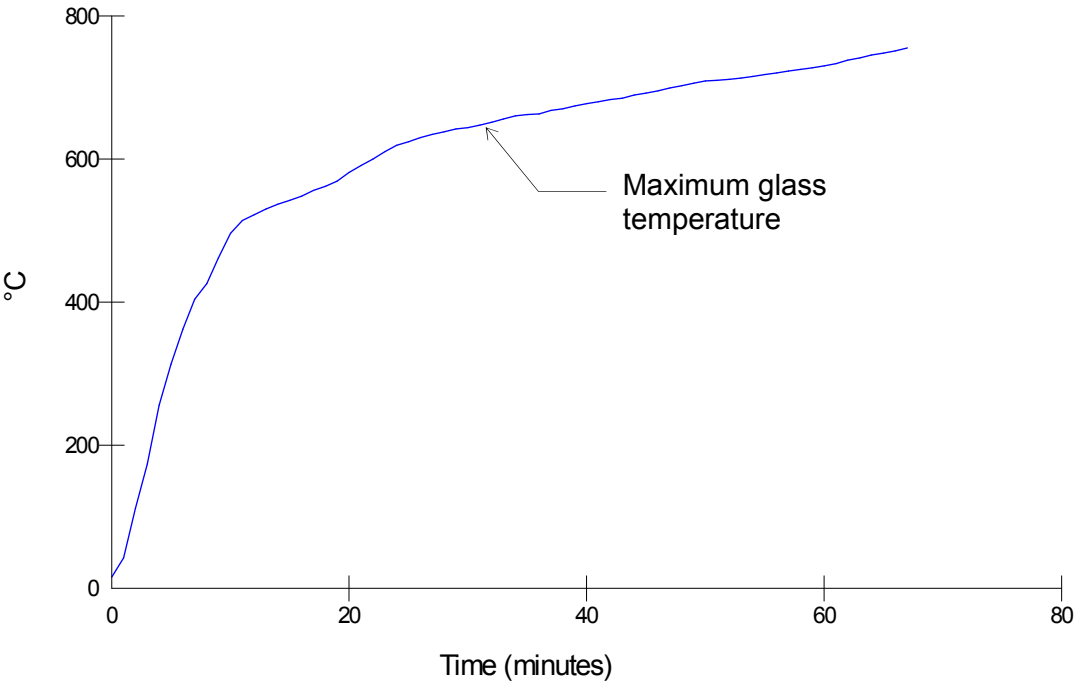
Doorset B



Glazing – doorset A

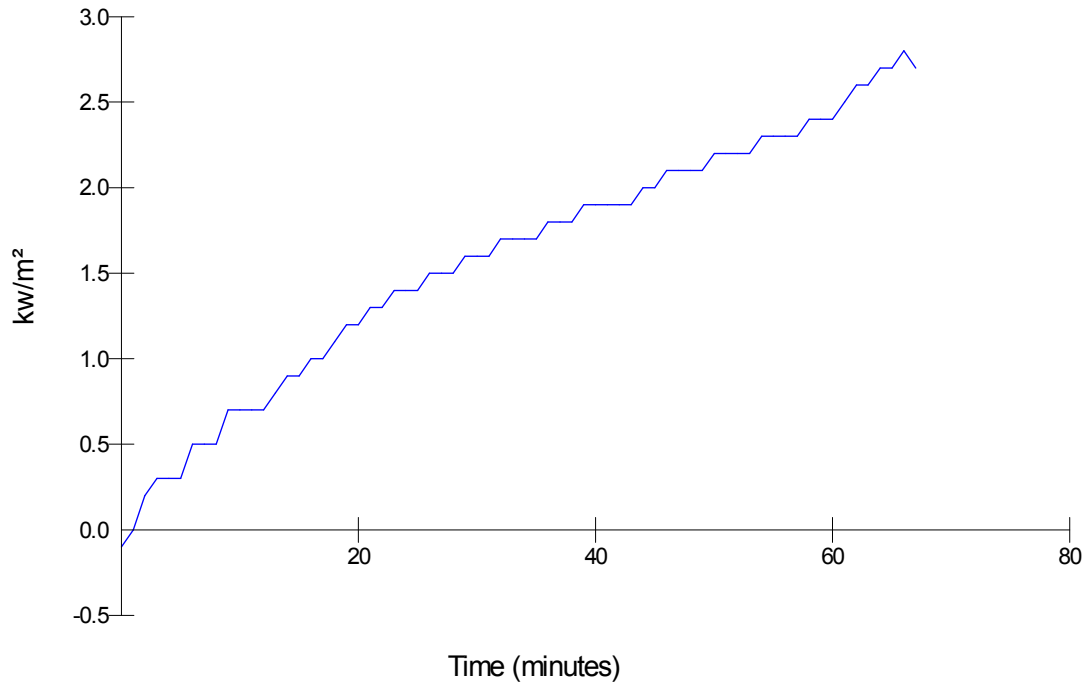


Glazing – doorset B



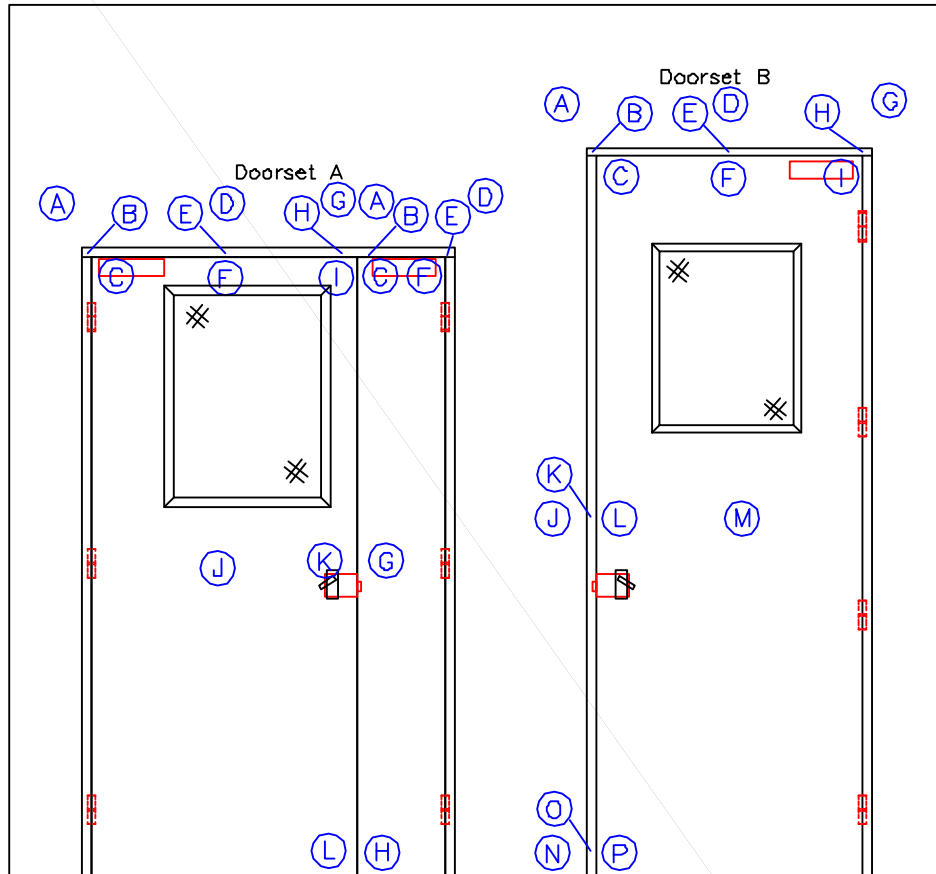
8.5 Radiation

A radiometer was used to measure the radiation 1m away from the specimens. The results of the radiometer were recorded and tabulated in Appendix 2 and are shown graphically below:



8.6 Leaf and frame distortion data

The following tables show the distortion in mm with an accuracy of ± 1 mm.
A positive measurement indicates distortion towards the furnace.
A negative measurement indicates distortion away from the furnace.



Doorset A – (left leaf hung on the left and opening in towards the furnace)

Time	A	B	C	D	E	F	G	H	I	J	K	L
15	2	5	4	7	5	8	6	6	-19	1	11	7
30	1	2	4	3	12	6	4	4	-19	4	5	7
45	2	5	6	5	3	7	5	5	-16	3	7	8
60	11	19	22	25	25	29	31	33	11	-2	-5	5

Doorset A – (right leaf hung on the right and opening in towards the furnace)

Time	A	B	C	D	E	F	G	H
15	7	6	16	8	8	10	8	7
30	3	4	16	4	5	9	9	11
45	6	7	20	9	10	14	9	11
60	33	36	48	33	44	49	4	6

Doorset B – (leaf hung on the right and opening in towards the furnace)

Time	A	B	C	D	E	F	G	H	I	J	K	L
15	5	6	7	4	2	5	0	2	4	2	3	3
30	4	6	8	2	2	7	-1	2	5	0	1	1
45	7	14	17	7	5	7	0	5	9	8	10	8

Time	M	N	O	P
15	3	-1	1	9
30	-1	-1	2	11
45	-2	-1	4	14

9 Observations

All comments relate to the unexposed face unless otherwise specified.

Time (minutes)

00.59	Both doorsets, the glazing is cracking and there is smoke issuing from the top half perimeter leaf/frame gaps
01.57	A, the glazing panels are reacting and whitening
05.20	Both doorsets, the smoke issuing has reduced to the top hanging and closing corners
10.57	Both doorsets, the smoke issuing has ceased
15.15	B, there is smoke issuing from the perimeter of the glazing panel
19.44	Both doorsets, there is smoke issuing from the latch positions
20.43	B, the leaf above the glazing is discolouring
26.05	B, the intumescent at the perimeter of the glazing is expanding
29.40	Both doorsets, there is discolouration at the top hanging and closing corners
34.03	Both doorsets, there is smoke issuing and discolouration at the top hinge position
49.01	B, there is intermittent flaming at the bottom closing corner
49.57	A, the intumescent along the meeting edge is expanding
50.35	B, the bead at the perimeter of the glazing panel is discolouring
54.56	A right leaf and B, the threshold is eroding
56.13	Both doorsets, there is smoke issuing and discolouration at the second hinge position
56.37	A, there is glow at the top meeting edge
60.10	B, a section of intumescent from the left quarter of the head has fallen away
60.54	B, the centre of the leaf is burning through
62.00	A left leaf, there is glow at the right quarter of the head
62.47	B, there is glow at the top closing corner
63.14	B, there is continuous flaming at the top closing corner, thereby constituting integrity failure .

- 64.20 A, a cotton pad integrity test was performed at the top meeting edge which failed to ignite the cotton pad. No failure.
- 64.45 B, there is continuous flaming at the perimeter of the glazing panel, thereby constituting **further integrity failure**.
- 65.50 A, a cotton pad integrity test was performed at the top meeting edge which failed to ignite the cotton pad. No failure.
- 67.14 A, there is continuous flaming across the head, thereby constituting **integrity failure**.
- 67.51 Test terminated

10 Expression of results

Doorset A

Integrity	
Cotton pad	67 (sixty seven) minutes*
Continuous flaming	67 (sixty seven) minutes
Gap gauges	67 (sixty seven) minutes*
Insulation - 2 discrete areas	
Discrete area 1 – timber	
Average set	67 (sixty seven) minutes**
Maximum $\geq 100\text{mm}$ in from leaf edge	64 (sixty four) minutes
Door frame $\geq 180^\circ\text{C}$ temp rise	67 (sixty seven) minutes**
Door frame $\geq 360^\circ\text{C}$ temp rise	67 (sixty seven) minutes**
Discrete area 2 - glass	67 (sixty seven) minutes**
Radiation – time to 15kW/m^2	67 (sixty seven) minutes**

* No failure of the test criteria at termination of the test at 67 minutes

** Failure by virtue of integrity failure at 67 minutes

Doorset B

Integrity	
Cotton pad	67 (sixty seven) minutes*
Continuous flaming	63 (sixty three) minutes
Gap gauges	67 (sixty seven) minutes*
Insulation - 2 discrete areas	
Discrete area 1 – timber	
Average set	63 (sixty three) minutes**
Maximum $\geq 100\text{mm}$ in from leaf edge	63 (sixty three) minutes**
Door frame $\geq 180^\circ\text{C}$ temp rise	63 (sixty three) minutes**
Door frame $\geq 360^\circ\text{C}$ temp rise	63 (sixty three) minutes**
Discrete area 2 - glass	3 (three) minutes
Radiation – time to 15kW/m^2	67 (sixty seven) minutes*

* No failure of the test criteria at termination of the test at 67 minutes

** Failure by virtue of integrity failure at 63 minutes


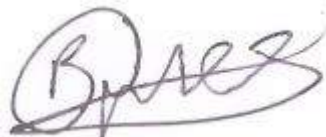
11 Limitations

This report details the method of construction, the test conditions and the results obtained when the specific element of construction described herein was tested following the procedure outline in EN 1363-1, and where appropriate EN 1363-2. Any significant deviation with respect to size, construction 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.

The results only relate to the behaviour of the element of construction under the particular conditions of test; they are not intended to be the sole criteria for assessing the potential fire performance of the element in use nor do they reflect the actual behaviour in fires. The results of this test were obtained using the leaf to frame gaps recorded in Figure 5 of Appendix 1. The fire resistance performance of doors of this design may change if substantially different gaps are employed.

The specification and interpretation of fire test methods are the subject of ongoing development and refinement. Changes in associated legislation may also occur. For these reasons it is recommended that the relevance of test reports over 5 years old should be considered by the user. BM TRADA will be able to offer, on behalf of the legal owner, a review of the procedures adopted for a particular test to ensure that they are consistent with current practices, and if required may endorse the test report.

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.

	Written and checked by:	Authorised by:
Signature:		
Name:	Adam Scott	Robert Axe
Title:	Technical Officer	Lead Technical Officer
Date of issue:	21 January 2016	21 January 2016

Revision A – January 2016 – change to company name in report cover and drawings

12 Field of direct application of test results

The results of the test are directly applicable to similar constructions where one or more of the changes listed in BS EN 1634-1: 2014, Clause 13, are made and the construction continues to comply with that appropriate design code for its stiffness and stability. Other changes are not permitted by the document. A copy of the field of direct application is available from BM TRADA upon request.

Photographs

Intumescent interruptions by hardware

Hinge - both doorsets



Latch forend – doorset A



Latch keep – doorset A



Latch keep – doorset B



At start of test



At 15 minutes



At 30 minutes



At 45 minutes



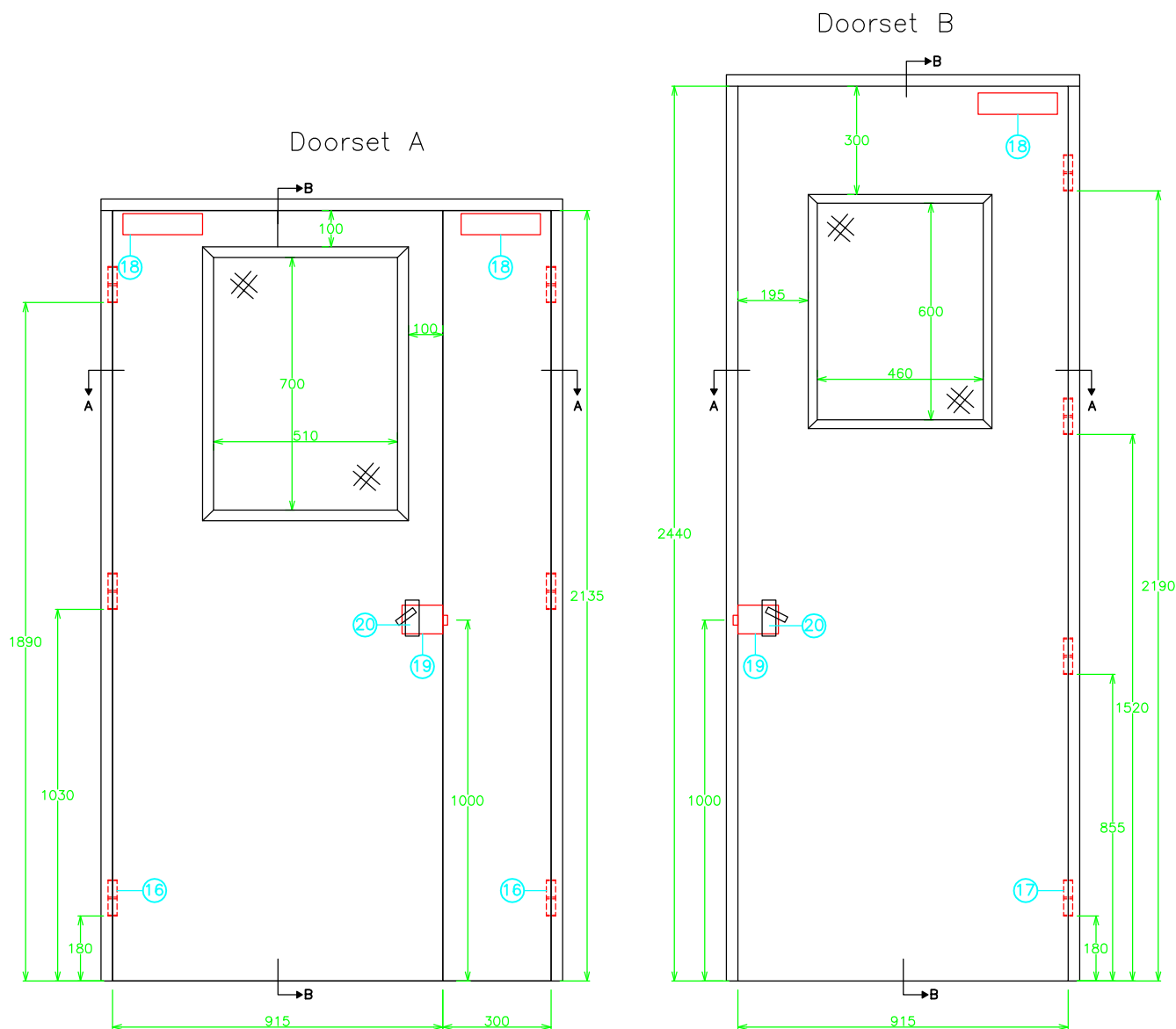
At 60 minutes



Exposed face post test



Appendix 1 – figures 1 to 6



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Tel: +44 (0)1494 569800
Fax: +44 (0)1494 564895

Title Unexposed face elevation
showing hardware positions
(All dimensions in mm)

Date Drawn
9/12/15

Drawn By
ARD

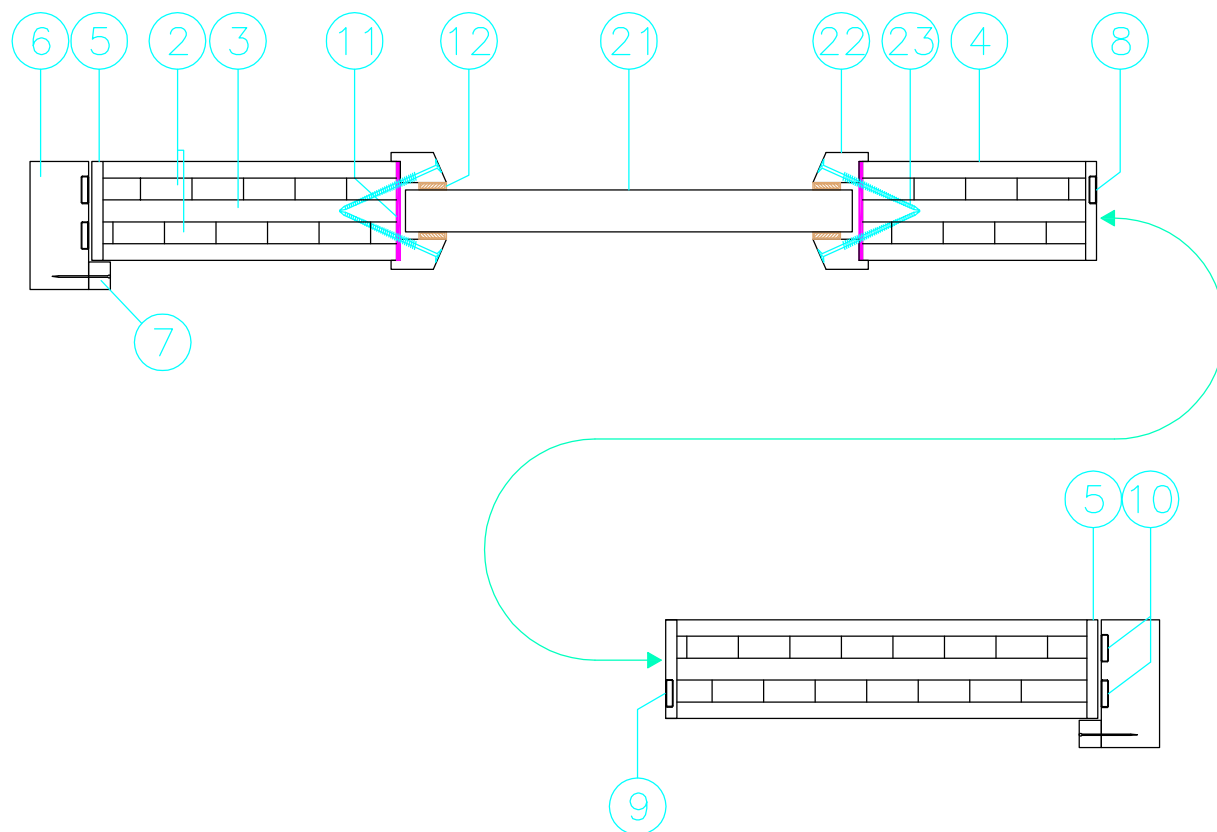
Scale
NTS

Project No.

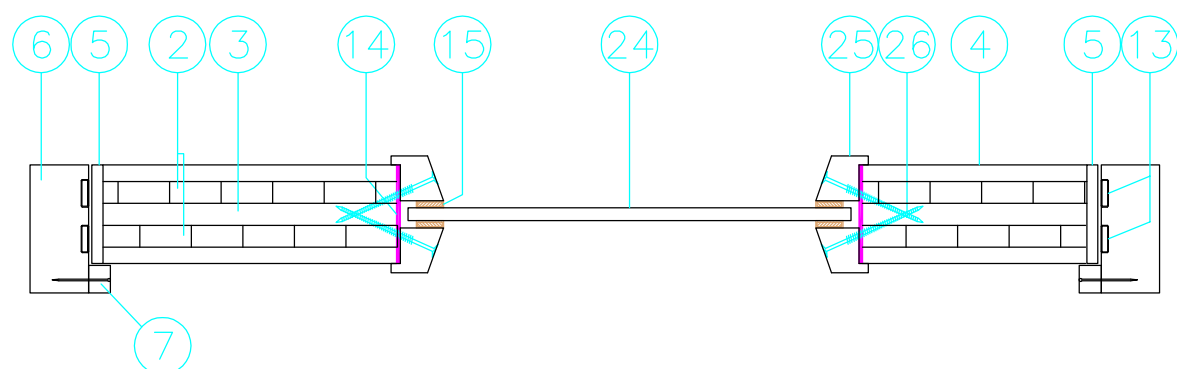
BMT/FEP/F15167 Rev A

Appendix 1

Section A-A



Section B-B



Exova Warringtonfire, Stocking Lane,
Hughenden Valley, High Wycombe,
Buckinghamshire, HP14 4ND, UK.

Tel: +44 (0)1494 569800
Fax: +44 (0)1494 564895

Title

Horizontal cross sections
(All dimensions in mm)

Date Drawn

9/12/15

Drawn By

ARD

Scale

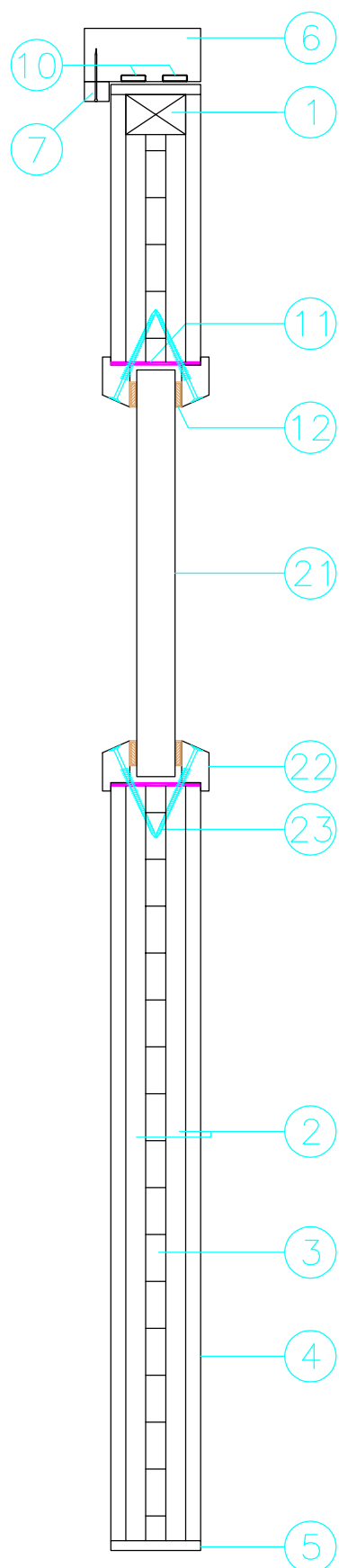
NTS

Project No.

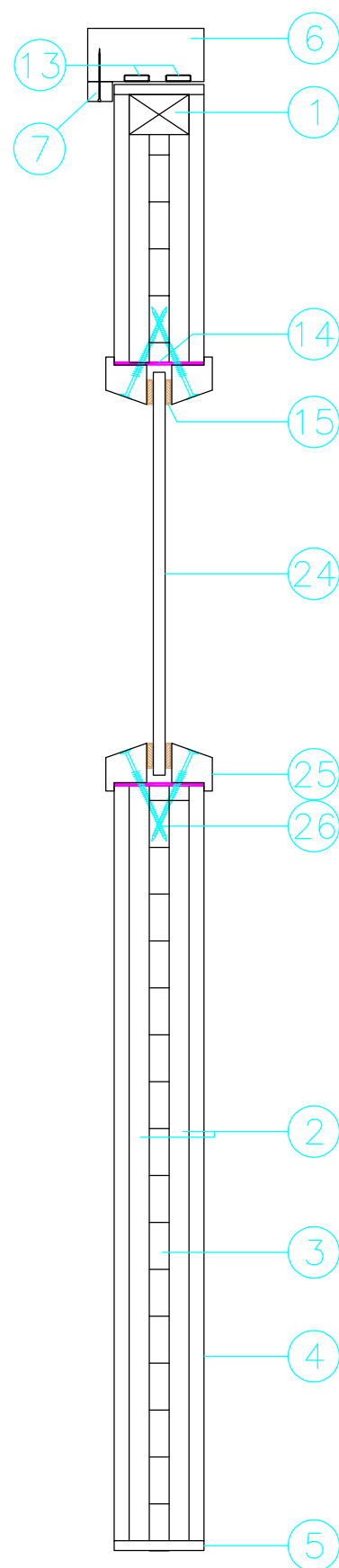
BMT/FEP/F15167 Rev A

Appendix 1

Section C-C



Section D-D



Exova Warringtonfire, Stocking Lane,
Hughenden Valley, High Wycombe,
Buckinghamshire, HP14 4ND, UK.

Tel: +44 (0)1494 569800
Fax: +44 (0)1494 564895

Title

Vertical cross section

(All dimensions in mm)

Date Drawn

9/12/15

Drawn By

ARD

Scale

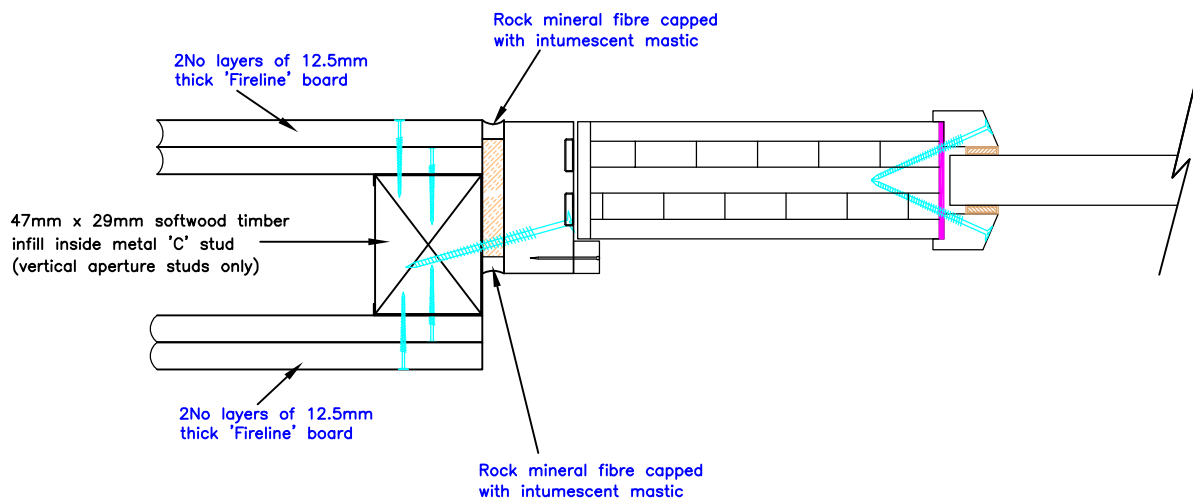
NTS

Project No.

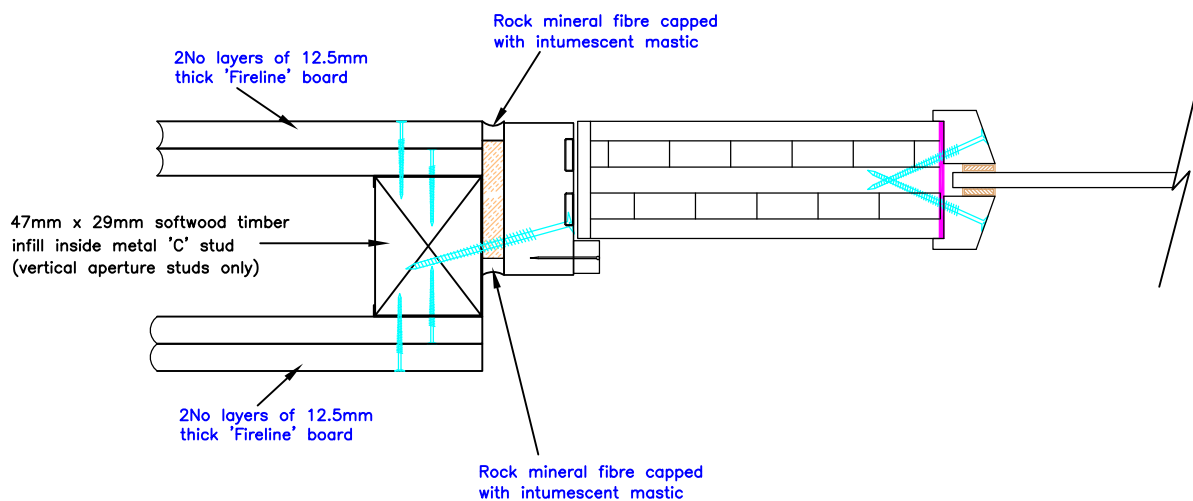
BMT/FEP/F15167 Rev A

Appendix 1

Doorset A



Doorset A



Exova Warringtonfire, Stocking Lane,
Hughenden Valley, High Wycombe,
Buckinghamshire, HP14 4ND, UK.

Tel: +44 (0)1494 569800
Fax: +44 (0)1494 564895

Title
Frame to supporting construction
fixing detail
(All dimensions in mm)

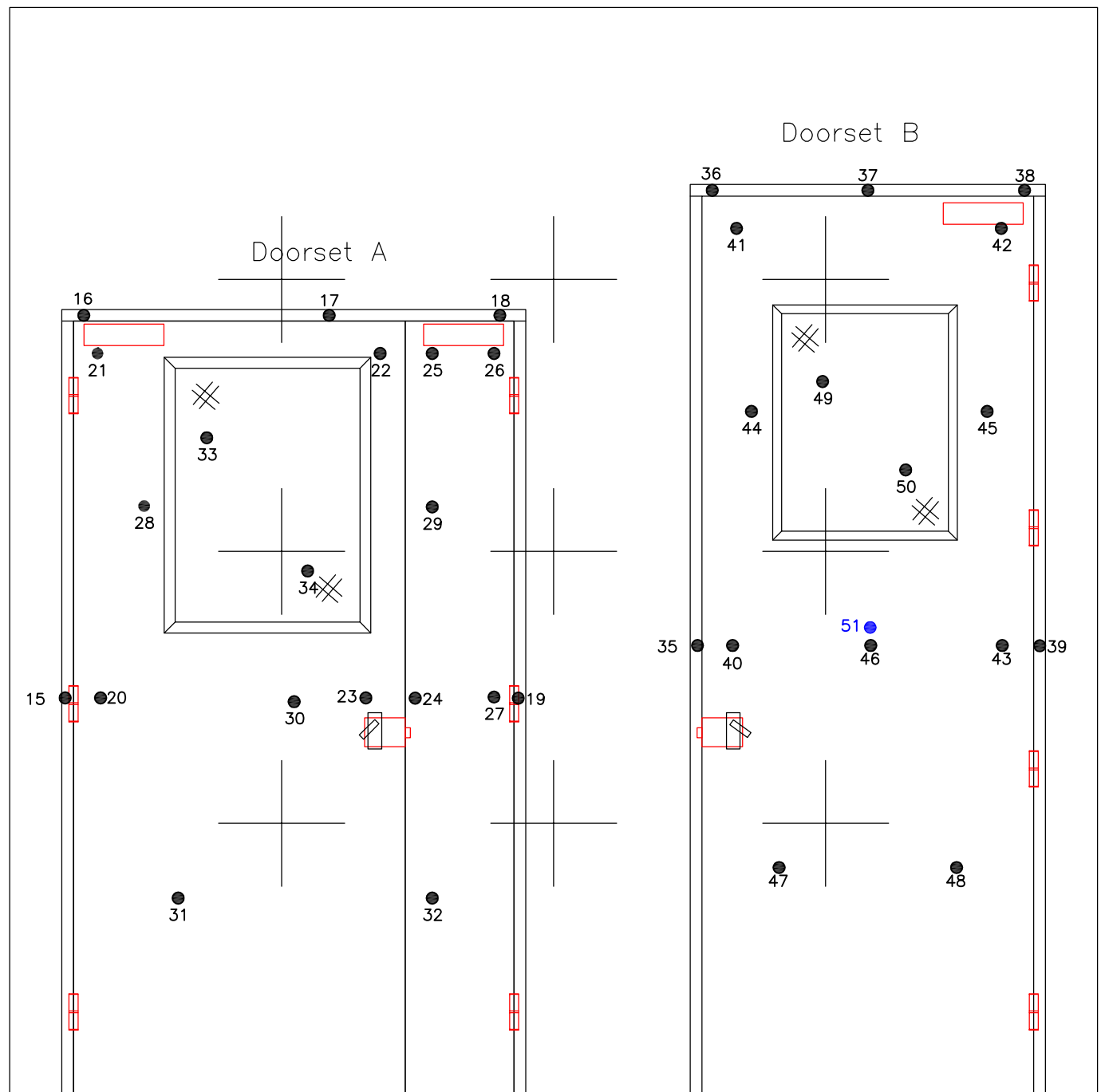
Date Drawn
9/12/15

Drawn By
ARD

Scale
NTS

Project No.
BMT/FEP/F15167 Rev A

Appendix 1



- +
-
-

Furnace Thermocouples

Unexposed Face Thermocouples

Radiometer

Viewed From Unexposed Face



Exova Warringtonfire, Stocking Lane,
Hughenden Valley, High Wycombe,
Buckinghamshire, HP14 4ND, UK.

Tel: +44 (0)1494 569800
Fax: +44 (0)1494 564895

Title

Thermocouple positions
(All dimensions in mm)

Date Drawn

9/12/15

Drawn By

ARD

Scale

NTS

Project No.

BMT/FEP/F15167 Rev A

Appendix 1

Appendix 2 - raw test data (7 pages)

(see figure 6 of Appendix 1 for channel locations)

Furnace thermocouples

Time	Chan 0	Chan 1	Chan 2	Chan 3	Chan 4	Chan 5	Chan 6	Chan 7	Chan 8	Chan 9	Chan 11	Chan 15	Chan 16	Chan 17	Chan 18	Chan 19	Chan 20	Chan 21	Chan 22	Chan 23	Chan 24	Chan 25
min	Pa	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
0	0	18	18	17	18	18	19	19	19	19	13	15	15	15	15	15	14	15	16	15	15	15
1	1.3	203	217	177	152	126	228	271	225	310	13	15	15	16	17	15	15	15	16	15	17	18
2	0.1	483	530	459	405	436	514	614	573	607	13	15	16	17	18	16	15	16	17	16	18	18
3	-5.2	602	664	623	565	639	619	737	703	709	13	15	18	18	20	16	15	16	16	15	17	17
4	-7.4	622	654	647	605	663	639	719	691	700	13	15	19	17	23	15	15	15	16	15	16	17
5	-8.4	532	534	561	562	602	575	643	608	648	13	15	21	17	27	15	15	16	16	15	15	17
6	0.7	591	596	595	587	608	636	678	645	688	13	15	24	17	28	16	15	16	16	15	16	16
7	-12	589	590	602	604	639	631	672	657	674	13	15	23	17	28	16	15	16	17	15	15	16
8	-1.7	532	524	555	575	593	587	642	610	652	13	15	24	17	29	17	15	16	17	15	15	16
9	0.1	633	646	634	634	656	669	720	697	722	13	16	27	17	31	18	15	16	17	15	15	16
10	-3.6	673	698	689	667	701	685	757	726	740	13	16	31	17	30	22	15	16	18	16	15	16
11	-8.3	632	642	631	653	680	662	706	696	705	13	18	29	18	29	31	15	16	19	16	15	16
12	2.5	630	625	619	652	665	671	707	685	717	13	22	33	22	29	37	15	16	20	16	15	16
13	0.3	690	703	683	688	714	708	759	742	758	13	29	38	31	30	41	15	16	20	16	15	16
14	0.4	712	742	724	708	736	720	772	760	764	13	35	41	39	33	48	15	16	21	16	15	16
15	1.2	718	743	730	713	740	727	772	760	766	13	40	45	43	35	49	15	16	22	17	15	17
16	-0.2	722	746	728	718	743	736	772	759	770	13	46	47	44	38	48	15	17	23	17	16	17
17	1	724	745	723	723	747	745	770	758	776	13	51	50	45	42	47	16	17	24	17	16	17
18	2.1	729	746	727	727	751	753	778	765	783	13	56	49	45	44	49	16	17	25	18	16	17
19	-0.8	743	766	743	741	769	767	795	784	802	13	59	58	45	46	49	16	19	26	18	17	18
20	-0.5	760	780	759	755	784	781	811	802	815	13	62	59	45	48	51	16	18	27	18	17	18
21	0	772	797	780	767	798	790	824	815	824	13	63	60	46	49	53	17	18	28	18	17	19
22	0	786	804	789	780	805	796	836	828	829	13	66	59	46	49	53	17	19	29	19	18	19
23	0.4	792	816	799	786	815	804	840	832	839	13	68	58	46	51	55	18	19	30	19	19	20

Time	Chan 0	Chan 1	Chan 2	Chan 3	Chan 4	Chan 5	Chan 6	Chan 7	Chan 8	Chan 9	Chan 11	Chan 15	Chan 16	Chan 17	Chan 18	Chan 19	Chan 20	Chan 21	Chan 22	Chan 23	Chan 24	Chan 25
min	Pa	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
24	-1.2	796	817	804	791	814	808	844	836	839	13	71	59	46	52	57	18	20	31	20	19	20
25	1	803	824	814	797	820	812	846	838	845	13	72	59	46	53	57	19	20	32	20	20	21
26	-0.6	808	830	820	802	824	817	853	848	850	13	72	59	47	54	58	19	21	33	21	21	22
27	0.9	814	835	830	808	829	819	859	852	854	13	72	61	48	55	57	20	21	34	21	22	23
28	1.1	821	840	837	813	833	820	864	858	858	13	71	61	49	55	55	21	22	35	22	22	23
29	-0.2	828	851	843	821	840	828	868	863	863	13	71	62	49	55	56	22	23	36	22	23	24
30	0.1	834	852	847	826	843	836	877	871	870	13	70	64	49	55	56	22	23	37	22	24	25
31	0.2	841	857	856	832	849	839	884	877	875	13	69	64	49	55	56	23	24	38	23	25	26
32	-0.9	846	858	859	838	852	845	891	881	875	13	68	63	48	56	57	24	26	39	23	25	27
33	-0.1	856	868	870	844	861	849	895	886	883	13	66	61	48	56	58	25	27	40	24	27	28
34	0.2	855	867	868	846	860	853	893	888	882	13	65	60	48	56	59	26	28	41	25	28	29
35	0	859	871	871	849	862	855	894	888	885	13	64	60	48	56	60	26	28	42	25	29	30
36	-0.3	862	875	874	853	867	859	899	893	891	13	64	58	48	55	60	27	29	42	26	30	31
37	0.5	867	879	878	857	871	864	900	896	892	13	63	57	48	55	61	28	30	43	27	31	32
38	0.8	871	886	883	861	874	869	906	901	897	12	63	57	48	54	61	29	31	44	27	32	34
39	-0.6	873	886	883	865	877	874	916	903	903	12	62	56	48	54	62	30	32	45	28	34	35
40	0.7	879	891	887	868	878	875	915	904	904	13	62	55	48	55	62	31	34	47	29	35	37
41	0.5	884	897	895	870	882	878	921	910	907	12	61	55	47	54	63	33	35	48	29	36	38
42	1	886	899	893	874	885	884	924	913	912	12	61	55	47	53	62	34	36	49	30	37	40
43	0.5	890	903	900	879	890	888	926	916	913	12	60	55	47	52	63	35	38	50	31	39	41
44	0.7	894	906	904	884	892	893	929	920	918	12	60	56	47	52	63	36	40	52	32	40	42
45	0.5	900	911	909	888	897	897	932	924	919	12	59	56	47	51	63	37	41	53	32	42	44
46	0.4	903	915	915	893	902	902	939	930	923	12	59	56	47	51	63	38	43	55	33	43	45
47	1.1	908	921	919	898	907	906	942	932	927	12	58	56	46	51	64	40	45	57	34	46	46
48	0.8	913	925	925	902	910	909	946	937	933	12	57	56	46	51	65	41	47	59	35	48	48
49	-0.5	916	928	926	905	913	913	951	940	936	12	57	57	46	51	66	42	49	61	36	50	49
50	-0.3	919	931	929	908	916	916	951	941	935	12	57	57	46	52	66	44	52	64	37	52	51
51	0.9	922	932	931	911	918	918	954	946	943	12	56	57	46	52	67	45	54	66	37	54	53
52	0	925	933	934	914	922	919	958	949	945	12	56	58	47	53	67	47	56	69	38	56	55
53	0.2	925	934	935	917	925	921	958	950	947	12	55	58	48	53	68	48	58	72	39	57	57

Time	Chan 0	Chan 1	Chan 2	Chan 3	Chan 4	Chan 5	Chan 6	Chan 7	Chan 8	Chan 9	Chan 11	Chan 15	Chan 16	Chan 17	Chan 18	Chan 19	Chan 20	Chan 21	Chan 22	Chan 23	Chan 24	Chan 25
min	Pa	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
54	0.1	929	940	939	920	930	928	962	953	952	12	55	59	49	53	69	50	60	75	40	59	61
55	1.1	934	943	941	924	932	928	961	955	952	12	55	60	50	54	70	52	61	78	43	61	65
56	-0.6	938	948	945	926	934	930	970	961	956	12	55	61	50	54	71	54	64	81	45	64	69
57	-0.6	938	947	948	926	930	936	967	960	959	12	54	63	50	55	71	56	65	82	47	65	72
58	0.4	942	948	948	930	934	938	972	962	965	12	54	65	52	56	72	57	67	84	48	67	75
59	-1.5	944	953	953	932	938	944	972	966	964	12	55	65	53	57	73	60	69	85	50	69	77
60	0.6	947	956	956	935	941	946	978	968	969	12	55	66	54	58	74	62	70	86	52	71	80
61	0	951	959	960	938	943	951	980	972	973	12	55	66	55	59	75	64	72	86	54	72	81
62	0	951	958	957	939	944	957	984	971	973	12	56	66	55	61	77	67	73	87	56	73	83
63	-0.8	953	958	959	940	946	959	983	971	976	12	56	66	58	62	77	70	74	88	58	74	84
64	-1.1	956	959	958	944	950	960	990	974	979	12	56	66	60	64	78	73	75	89	60	76	85
65	-0.1	958	963	960	944	950	964	987	977	980	12	57	66	61	67	80	77	77	90	64	78	87
66	1	960	963	960	946	954	969	988	979	988	12	58	69	65	67	81	80	79	93	68	79	90
67	0	962	962	960	951	959	973	993	981	989	12	58	71	66	76	82	81	81	93	70	81	93

Time	Chan 26	Chan 27	Chan 28	Chan 29	Chan 30	Chan 31	Chan 32	Chan 33	Chan 34	Chan 35	Chan 36	Chan 37	Chan 38	Chan 39	Chan 40	Chan 41	Chan 42	Chan 43	Chan 44	Chan 45
min	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
0	16	15	16	16	15	14	14	16	16	15	16	16	15	16	14	15	15	15	16	15
1	17	16	16	20	15	14	16	16	16	15	17	19	15	16	15	19	15	15	17	16
2	17	17	16	20	15	15	20	17	17	17	22	25	16	17	16	20	16	16	18	16
3	17	16	16	18	15	15	16	19	19	17	24	26	15	17	15	19	16	15	17	16
4	16	16	16	18	15	15	16	25	24	17	24	25	15	17	15	18	16	15	17	16
5	16	16	16	17	15	15	15	32	31	16	23	25	15	17	15	17	16	15	16	16
6	16	16	16	17	15	15	15	38	38	17	23	26	15	18	15	17	16	15	16	16
7	16	15	16	17	15	15	15	44	44	17	23	27	15	18	15	17	17	15	16	16
8	16	15	16	17	15	15	15	50	50	17	23	29	15	18	15	17	17	15	16	16
9	16	15	16	17	15	15	14	55	55	17	26	30	15	19	15	17	17	15	16	16
10	16	15	16	17	15	15	14	60	60	18	32	32	15	19	15	17	17	15	16	17
11	16	15	16	17	15	15	14	65	65	18	42	33	15	20	15	17	18	15	16	17
12	16	15	16	17	15	15	14	69	69	19	50	34	15	21	15	17	18	15	16	17

Time	Chan 26	Chan 27	Chan 28	Chan 29	Chan 30	Chan 31	Chan 32	Chan 33	Chan 34	Chan 35	Chan 36	Chan 37	Chan 38	Chan 39	Chan 40	Chan 41	Chan 42	Chan 43	Chan 44	Chan 45
min	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
13	16	16	16	17	16	15	15	73	74	20	54	36	16	22	15	17	18	15	16	17
14	16	16	17	17	16	15	15	77	76	21	56	38	16	23	15	17	19	16	17	17
15	17	16	17	17	16	15	15	79	78	24	57	39	17	24	16	17	19	16	17	18
16	17	16	17	18	16	15	15	81	79	30	58	41	17	25	16	18	20	16	17	19
17	17	16	17	18	16	15	15	82	81	34	58	43	19	27	17	18	20	16	18	19
18	18	17	17	19	16	16	16	83	81	37	60	45	21	28	17	19	21	17	18	20
19	18	17	18	19	17	16	16	83	82	40	61	46	23	30	18	19	22	17	19	20
20	18	17	18	19	17	16	16	84	83	46	61	48	26	31	18	20	22	17	19	21
21	19	18	19	19	18	17	17	85	83	49	63	50	28	33	18	20	22	18	20	21
22	19	19	19	20	18	17	18	86	84	51	64	52	30	35	19	21	23	18	20	22
23	20	19	20	21	19	17	18	86	85	53	65	54	33	37	20	22	24	19	21	23
24	21	20	20	22	19	18	19	88	86	56	65	56	37	39	20	22	24	20	22	23
25	21	21	21	22	20	19	20	89	87	55	65	58	39	41	21	23	25	21	23	24
26	22	22	22	23	21	19	21	91	89	56	65	60	41	43	22	24	26	21	24	25
27	23	22	22	23	21	20	22	92	90	56	66	60	42	44	22	24	27	22	24	26
28	23	23	23	23	22	20	22	92	90	55	65	60	42	45	23	25	28	23	25	27
29	24	24	24	24	23	20	23	92	90	55	65	61	43	46	24	26	29	23	26	28
30	25	25	25	25	24	21	24	92	90	56	64	62	43	47	24	27	30	24	27	29
31	26	25	25	25	25	21	25	92	90	56	64	63	44	49	25	28	31	25	27	30
32	27	26	26	26	26	21	26	92	90	56	64	57	45	50	26	28	33	26	28	31
33	28	27	27	27	27	22	27	93	91	57	64	52	46	51	27	30	34	27	29	32
34	29	29	28	28	28	23	28	93	91	57	64	49	46	52	28	31	35	28	30	33
35	31	30	29	29	29	24	29	93	91	57	64	48	47	51	29	32	37	29	31	34
36	32	31	30	29	30	24	30	94	91	57	63	48	47	50	30	33	38	31	32	36
37	34	32	31	30	31	25	31	95	92	57	63	48	48	51	32	35	39	32	33	37
38	35	34	32	31	32	26	32	96	92	57	63	48	48	50	33	36	41	33	34	38
39	37	35	33	32	33	27	33	97	93	57	62	47	49	49	35	38	43	35	36	40
40	39	37	34	33	34	28	35	99	94	57	62	48	49	49	37	41	45	36	37	42
41	40	39	35	35	36	29	36	99	96	56	62	48	50	49	39	44	47	38	39	44
42	42	41	36	36	37	30	37	99	96	56	62	48	49	49	42	49	50	40	40	47

Time	Chan 26	Chan 27	Chan 28	Chan 29	Chan 30	Chan 31	Chan 32	Chan 33	Chan 34	Chan 35	Chan 36	Chan 37	Chan 38	Chan 39	Chan 40	Chan 41	Chan 42	Chan 43	Chan 44	Chan 45
min	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
43	43	43	38	37	38	32	39	98	96	55	63	48	49	49	45	56	53	42	42	51
44	45	45	39	39	39	33	40	97	96	55	63	48	50	49	48	61	57	44	44	56
45	46	47	41	40	40	34	41	97	95	54	63	48	50	49	50	65	64	46	47	60
46	48	49	42	41	42	35	43	97	95	54	63	49	50	49	52	69	71	50	49	64
47	50	51	44	43	43	36	45	98	95	54	62	49	51	49	54	73	76	53	53	66
48	52	53	45	44	44	37	46	97	95	55	62	49	51	50	55	75	78	57	57	68
49	55	56	46	46	46	39	48	97	95	55	62	50	52	50	58	77	80	61	61	70
50	57	58	48	47	48	41	50	97	95	55	62	50	52	51	59	79	81	64	64	72
51	60	60	49	49	50	44	52	98	95	55	63	50	52	51	61	79	82	67	67	73
52	64	62	51	50	52	46	53	98	95	56	64	51	52	51	62	80	83	69	69	73
53	68	64	52	52	54	50	55	99	96	56	64	51	53	51	64	80	83	72	70	75
54	72	65	54	54	56	55	58	100	96	57	66	52	53	51	66	80	84	75	71	77
55	75	68	56	58	59	61	61	101	97	58	67	53	55	52	68	81	84	78	73	80
56	81	70	58	63	61	67	65	103	98	58	68	54	56	53	70	81	84	80	74	84
57	86	72	61	68	64	70	69	105	100	59	69	55	56	53	72	82	84	81	76	87
58	88	74	66	71	68	75	72	106	101	60	70	56	57	54	76	82	84	82	78	89
59	91	75	73	74	71	80	75	104	104	60	71	57	58	55	78	83	85	83	80	90
60	96	77	79	76	75	84	78	103	106	61	72	58	59	56	81	84	86	84	82	93
61	97	78	83	78	80	90	80	103	104	61	74	59	60	59	84	85	88	85	84	96
62	100	80	86	80	84	97	82	103	102	62	76	61	61	62	90	87	89	86	86	100
63	122	81	88	81	87	108	82	104	101	63	81	62	61	64	91	89	90	86	87	107
64	167	82	89	82	89	127	83	105	101	64	86	64	63	68	91	91	90	86	90	119
65	226	85	91	83	91	149	83	105	102	66	92	118	65	71	93	91	92	87	90	135
66	359	87	92	84	93	170	84	105	102	66	89	131	67	76	93	78	87	87	69	147
67	696	88	94	84	94	188	83	106	103	68	85	141	68	74	93	72	85	88	66	169

Time	Chan 46	Chan 47	Chan 48	Chan 49	Chan 50	Chan 51
min	°C	°C	°C	°C	°C	kw/m ²
0	15	15	15	13	16	-0.1
1	15	15	15	20	43	0
2	16	16	16	46	112	0.2
3	16	16	15	59	174	0.3
4	16	15	15	81	256	0.3
5	15	15	15	87	313	0.3
6	15	15	15	107	362	0.5
7	15	15	15	111	404	0.5
8	15	15	15	104	426	0.5
9	15	15	15	110	462	0.7
10	15	15	15	112	496	0.7
11	15	15	15	142	514	0.7
12	16	15	15	123	522	0.7
13	16	16	15	146	530	0.8
14	16	16	15	158	537	0.9
15	16	16	15	145	542	0.9
16	16	16	15	147	548	1
17	17	16	16	171	556	1
18	17	17	16	142	562	1.1
19	18	17	16	143	569	1.2
20	18	17	17	168	581	1.2
21	19	18	17	159	591	1.3
22	19	18	18	164	600	1.3
23	20	19	19	150	610	1.4
24	21	20	20	168	619	1.4
25	22	21	20	167	624	1.4
26	22	21	21	167	630	1.5
27	23	22	22	143	634	1.5
28	24	23	23	161	638	1.5
29	25	24	24	155	642	1.6
30	25	25	25	168	644	1.6

Time	Chan 46	Chan 47	Chan 48	Chan 49	Chan 50	Chan 51
min	°C	°C	°C	°C	°C	kw/m ²
31	26	26	26	157	647	1.6
32	27	28	27	178	651	1.7
33	28	29	28	174	656	1.7
34	30	31	30	173	660	1.7
35	31	32	31	187	662	1.7
36	32	33	32	177	663	1.8
37	34	35	34	200	668	1.8
38	35	36	35	201	670	1.8
39	37	38	37	187	674	1.9
40	39	39	39	200	677	1.9
41	41	40	40	203	680	1.9
42	43	41	41	190	683	1.9
43	45	42	43	199	685	1.9
44	48	43	45	212	689	2
45	50	44	46	208	692	2
46	53	45	49	201	695	2.1
47	57	47	51	221	699	2.1
48	60	48	53	213	702	2.1
49	64	51	56	208	706	2.1
50	69	53	58	210	709	2.2
51	73	55	61	228	710	2.2
52	76	57	62	224	711	2.2
53	78	59	64	196	713	2.2
54	80	60	67	208	715	2.3
55	82	63	69	209	718	2.3
56	84	65	72	209	720	2.3
57	85	66	75	199	723	2.3
58	86	68	78	213	725	2.4
59	87	71	82	209	727	2.4
60	88	74	86	213	730	2.4
61	89	78	90	253	733	2.5

Time	Chan 46	Chan 47	Chan 48	Chan 49	Chan 50	Chan 51
min	°C	°C	°C	°C	°C	kw/m ²
62	91	81	93	324	738	2.6
63	91	82	96	360	741	2.6
64	92	82	98	450	745	2.7
65	94	84	110	438	748	2.7
66	94	82	123	467	751	2.8
67	97	85	140	485	755	2.7