

FIRE ASSESSMENT REPORT

FC21185-01-1

FIRE RESISTANCE OF H.B. FULLER FIRESOUND® AND FULAFLEX™ FR SEALANT AS CONTROL JOINTS IN FIRE RATED CONCRETE AND MASONRY WALLS AND FLOORS IN ACCORDANCE WITH AS 1530.4:2014 AND WITH REFERENCE TO AS 4072.1-2005

CLIENT

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ASSESSMENT OBJECTIVE

To assess the fire resistance of H.B. Fuller Firesound® and FulaFlex™ FR sealants in fire rated control joints in accordance with AS 1530.4:2014 and with reference to AS 4072.1-2005 (including Amendment No. 1) with reference to Section 4, when installed in fire rated concrete or masonry walls and floors.

CONCLUSION

It is considered that the H.B. Fuller Firesound® and FulaFlex™ FR sealants in fire rated control joints would be expected to achieve the stated FRL if tested in accordance with AS 1530.4:2014 with reference to AS 4072.1-2005 (including Amendment No. 1) with reference to Section 4, as stated in the following tables.

Summary of Firesound® & FulaFlex™ FR Sealant - Double Sided Control Joints

Double Sided/Symmetric Sealant Application From Both Sides Concrete and Masonry Walls and Floors Including Horizontally Orientated Head Joints				
Joint Dimensions		Minimum Element Thickness - FRL		
Joint Width (mm)	Sealant Depth (mm)	120 mm	150 mm	175 mm
50	25	-/120/120	-/180/180	-/240/240
40	20	-/120/120	-/180/180	-/240/240
30	15	-/120/120	-/180/180	-/240/240
20	10	-/120/120	-/180/180	-/240/240
10	10	-/120/120	-/180/180	-/240/240

It is considered the control joints may be installed with the following conditions or variations:

- A double sided joint may comprise either one or both Firesound® and FulaFlex™ FR sealants as part of the overall configuration (one per side).
- A control joint installed in a vertical element may be orientated vertically or horizontally.
- The minimum element thickness is applicable to solid block concrete or masonry construction. The separating element may be varied to lightweight concrete or hollow core masonry. In such cases, the separating element must be tested or assessed to achieve the required FRL and be subject to the minimum element thickness.
- Control joints installed in hollow core masonry must always be installed with the backing rod and sealant sandwiched between rigid surfaces for the full depth of the hollow block. Any hollow core voids adjacent to the control joint which could permit the passage of heat between the sealant layers must be cement grout filled or solid block used.

Examples of the double sided joint configurations are shown in Figure 1.

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Summary of Firesound® & FulaFlex™ FR Sealant - Double Caulked Control Joints

Double Caulked/Asymmetric Sealant Application From Either Side Concrete and Masonry Walls and Floors Including Horizontally Orientated Head Joints				
Joint Dimensions		Minimum Element Thickness - FRL		
Joint Width (mm)	Sealant Depth (mm)	120 mm	150 mm	175 mm
26-35	30 & 20	-/120/120	-/180/180	-/240/240
11-25	30 & 20*	-/120/120	-/180/180	-/240/240
10	10 & 10	-/120/120	-/180/180	-/240/240

* Firesound® depth for 120 minute FRL / 120 mm thick elements may be reduced to 30 mm & 15 mm.

It is considered the control joints may be installed with the following conditions or variations:

- For double caulked joints exceeding 10 mm width, the following minimum air gap depths are required (dimensions include minimum 20 mm backing rod):
  - -/120/120 FRL = 40 mm
  - -/180/180 FRL = 45 mm
  - -/240/240 FRL = 70 mm
- A control joint installed in a vertical element may be orientated vertically or horizontally.
- The minimum element thickness is applicable to solid block concrete or masonry construction. The separating element may be varied to lightweight concrete or hollow core masonry. In such cases, the separating element must be tested or assessed to achieve the required FRL and be subject to the minimum element thickness.
- Control joints installed in hollow core masonry must always be installed with the backing rod and sealant sandwiched between rigid surfaces for the full depth of the hollow block. Any hollow core voids adjacent to the control joint which could permit the passage of heat between the sealant layers must be cement grout filled or solid block used.

Examples of the double caulked joint configurations are shown in Figure 2.

LIMITATION

This report is subject to the accuracy and completeness of the information supplied.

BRANZ reserves the right to amend or withdraw this assessment if information becomes available which indicates the stated fire performance may not be achieved.

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DOCUMENT REVISION STATUS

ISSUE NO.	DATE ISSUED	REVIEW DATE	DESCRIPTION
1	16 June 2026	16 June 2036	Initial Issue

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1. INTRODUCTION

This report gives BRANZ's assessment on the fire resistance of H.B. Fuller Firesound® and FulaFlex™ FR sealants in fire rated control joints in fire rated concrete or masonry walls and floors if tested in accordance with AS 1530.4:2014 with reference to AS 4072.1-2005 (including Amendment No. 1) with reference to Section 4.

2. BACKGROUND

2.1 Firesound® Test Data

In Warringtonfire Australia Pty Ltd fire resistance test FRT190135 a number of control joints were tested in a nominally 175 mm thick concrete wall in accordance with AS 1530.4:2014. The wall was provided with four openings nominally 1,000 mm high with various widths, two of which were installed with a double sided configuration of H.B. Fuller Firesound® sealant. The sealant was backed by an open cell backing rod, inserted prior to the sealant application. See Table 1 for a summary of the results of the tested control joints relevant to this assessment.

Table 1: Summary of Fire Resistance Test FRT190135

Specimen	Separating Element Thickness (mm)	Control Joint Dimensions Height x Width x Depth (mm)	Integrity (minutes)	Insulation (minutes)	FRL
C	175 Wall	1,000 x 20 x 10	241 NF	241 NF	-/240/240
D		1,000 x 40 x 20	241 NF	241 NF	-/240/240

NF = No Failure

In Warringtonfire Australia Pty Ltd fire resistance test FRT200213 a number of control joints were tested in a nominally 150 mm thick concrete floor in accordance with AS 1530.4:2014. The floor was provided with five openings nominally 1,900 mm long with various widths, two of which were installed with a double sided configuration of H.B. Fuller Firesound® sealant. The sealant was backed by an open cell backing rod, inserted prior to the sealant application. See Table 2 for a summary of the results of the tested control joints relevant to this assessment.

Table 2: Summary of Fire Resistance Test FRT200213

Specimen	Separating Element Thickness (mm)	Control Joint Dimensions Length x Width x Depth (mm)	Integrity (minutes)	Insulation (minutes)	FRL*
A	150 Floor	1,900 x 30 x 15	241 NF	215	-/180/180
B		1,900 x 50 x 25	241 NF	213	-/180/180

NF = No Failure

*The specimens were tested in a separating element with an established FRL of 180 minutes. The specimen FRL cannot exceed the FRL of the supporting construction.

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In Warringtonfire Australia Pty Ltd fire resistance test FRT200323 a number of control joints were tested in a nominally 150 mm thick concrete floor in accordance with AS 1530.4:2014. The floor was provided with six openings nominally 1,700 mm long with various widths, three of which were installed from the exposed face with a double caulked configuration of H.B. Fuller Firesound® sealant.

The first layer of sealant (furthest from the application face) was backed by an open cell backing rod, inserted prior to the sealant application. A second open cell backing rod was then inserted to the desired depth followed by the second layer of sealant which was finished flush the face of the floor slab. An air gap of nominally 45 mm (measured between sealant layers, includes 20 mm of backing rod) was provided in Specimen A, no air gaps were provided for Specimen B or Specimen C. See Table 3 for a summary of the results of the tested control joints relevant to this assessment.

Table 3: Summary of Fire Resistance Test FRT200323

Specimen	Separating Element Thickness (mm)	Control Joint Dimensions Length x Width x Depth (mm)	Integrity (minutes)	Insulation (minutes)	FRL*
A	150 Floor	1,720 x 35 x 30 & 20	241 NF	241 NF	-/180/180
B		1,720 x 25 x 25 & 15	241 NF	115	-/180/90
C		1,720 x 10 x 10 & 10	241 NF	241 NF	-/180/180

NF = No Failure

*The specimens were tested in a separating element with an established FRL of 180 minutes. The specimen FRL cannot exceed the FRL of the supporting construction.

2.2 FulaFlex™ FR Test Data

In Warringtonfire Australia Pty Ltd fire resistance test FRT190354 a number of control joints were tested in a nominally 120 mm thick concrete wall in accordance with AS 1530.4:2014. The wall was provided with four openings nominally 1,000 mm long with various widths which were installed with a double sided configuration of H.B. Fuller FulaFlex™ FR sealant. The sealant was backed by an open cell backing rod, inserted prior to the sealant application. See Table 4 for a summary of the results of the tested control joints relevant to this assessment.

Table 4: Summary of Fire Resistance Test FRT190354

Specimen	Separating Element Thickness (mm)	Control Joint Dimensions Length x Width x Depth (mm)	Integrity (minutes)	Insulation (minutes)	FRL*
A	120 Wall	1,000 x 10 x 10	241 No Fail	171	-/120/120
B		1,000 x 20 x 10	241 No Fail	165	-/120/120
C		1,000 x 40 x 20	241 No Fail	166	-/120/120
D		1,000 x 50 x 25	241 No Fail	173	-/120/120

NF = No Failure

*The specimens were tested in a separating element with an established FRL of 180 minutes. The specimen FRL cannot exceed the FRL of the supporting construction.

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In Warringtonfire Australia Pty Ltd fire resistance test FRT200213 a number of control joints were tested in a nominally 150 mm thick concrete floor in accordance with AS 1530.4:2014. The floor was provided with five openings nominally 1,900 mm long with various widths, three which were installed with a double sided configuration of H.B. Fuller FulaFlex™ FR sealant. The sealant was backed by an open cell backing rod, inserted prior to the sealant application. See Table 5 for a summary of the results of the tested control joints relevant to this assessment.

Table 5: Summary of Fire Resistance Test FRT200213

Specimen	Separating Element Thickness (mm)	Control Joint Dimensions Length x Width x Depth (mm)	Integrity (minutes)	Insulation (minutes)	FRL*
C	150 Floor	1,900 x 10 x 10	241 NF	225	-/180/180
D		1,900 x 20 x 10	241 NF	218	-/180/180
E		1,900 x 30 x 15	241 NF	217	-/180/180

NF = No Failure

*The specimens were tested in a separating element with an established FRL of 180 minutes. The specimen FRL cannot exceed the FRL of the supporting construction.

In BRANZ fire resistance test FP19882-01 a number of control joints were tested in a nominally 120 mm thick concrete floor in accordance with AS 1530.4:2014. The floor was provided with six openings nominally 1,100 mm long with various widths, two of which were installed with a double caulked configuration of H.B. Fuller FulaFlex™ FR sealant (Specimen C-D), a further opening was sealed with a double sided configuration of H.B. Fuller FulaFlex™ FR Sealant (Specimen E). The sealant was backed by an open cell backing rod, inserted prior to the sealant application.

The application face for Specimen C was from the exposed face. The application face for Specimen D was from the unexposed face. An air gap of nominally 40 mm (measured between sealant layers, includes 20 mm of backing rod) was provided. See Table 6 for a summary of the results of the tested control joints relevant to this assessment.

Table 6: Summary of Fire Resistance Test FP19882-01

Specimen	Separating Element Thickness (mm)	Control Joint Dimensions Length x Width x Depth (mm)	Integrity (minutes)	Insulation (minutes)	FRL*
C	120 Floor	1,100 x 35 x 30 & 20	245 NF	173	-/120/120
D		1,100 x 35 x 30 & 20	245 NF	182	-/120/120
E		1,100 x 50 x 25	245 NF	202	-/120/120

NF = No Failure

*The specimen was tested in a separating element with an established FRL of 120 minutes. The specimen FRL cannot exceed the FRL of the supporting construction.

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2.3 Firesound®/FulaFlex™ FR Head Joint Test Data

In BRANZ fire resistance test FR21125-01 a number of perimeter edge seals were tested in a nominally 96 mm thick steel stud, plasterboard lined wall in accordance with AS 1530.4:2014. The wall was provided with two horizontal perimeter edge seals, nominally 1,100 mm long x 40 mm high x 16 mm deep (on both faces of the wall). Specimen A was sealed with FulaFlex™ FR and Specimen D was sealed with Firesound®. See Table 7 for a summary of the tested perimeter seals relevant to this assessment.

Table 7: Summary of Fire Resistance Test FR21125-01

Specimen	Separating Element Thickness (mm)	Perimeter Seal Dimensions Length x Height x Depth (mm)	Integrity (minutes)	Insulation (minutes)	FRL*
A	Steel Stud 1 x 16 mm Plasterboard per face	1,100 x 40 x 16	120 NF	113	-/90/90
D		1,100 x 40 x 16	120 NF	120 NF	-/90/90

NF = No Failure

*The specimen was tested in a separating element with an established FRL of 90 minutes. The specimen FRL cannot exceed the FRL of the supporting construction.

3. DISCUSSION

3.1 Compliance with NCC 2025

This report has been prepared to meet the NCC 2025 deemed-to-satisfy (DTS) provision Specification 1 which states:

"S1C2 Rating"

A building element meets the requirements of this Specification if—

(b) it is identical with a prototype that has been submitted to the Standard Fire Test, or an equivalent or more severe test, and the FRL achieved by the prototype without the assistance of an active fire suppression system is confirmed in a report from an Accredited Testing Laboratory which—

(i) describes the method and conditions of the test and the form of construction of the tested prototype in full; and

(ii) certifies that the application of restraint to the prototype complied with the Standard Fire Test; or

(c) it differs in only a minor degree from a prototype tested under (b) and the FRL attributed to the building element is confirmed in a report from an Accredited Testing Laboratory which—

(i) certifies that the building element is capable of achieving the FRL despite the minor departures from the tested prototype; and

(ii) describes the materials, construction and conditions of restraint which are necessary to achieve the FRL;

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In accordance the NCC 2025 S1C2 (b), the fire resistance tests referenced in Section 2 were equivalent or more severe, without the assistance of an active fire suppression system, than the standard fire test AS 1530.4:2014. It is considered that in accordance with NCC 2025 S1C2 (c) the differences between the tested prototype and the proposed variations in this report are minor.

This assessment report may be used to demonstrate compliance with the requirements for evidence of suitability under NCC A5G3 (1) d.

3.2 Element Thickness and FRL

The minimum effective thickness of a concrete element required for a given FRL period is shown in AS 3600-2009, *Concrete structures*, Table 5.5.1.

The minimum effective thickness of a masonry element required for a given FRL period is shown in AS 3700-2001, *Masonry structures*, Table 6.3.

3.3 Firesound® & FulaFlex™ FR - Double Sided Control Joints

3.3.1 Examination of the Test Data

H.B. Fuller Australia Pty. Ltd has provided test data from a number of fire resistance tests on double sided control joints installed in fire rated concrete/masonry walls and floors for both sealant types. Following examination of this test data, the following observations of the fire resistance of the sealants have been made:

- All specimen control joints except the 10 mm x 10 mm had a width to depth ratio of 2:1.
- In all of the test data examined, no instance of Integrity failure was ever recorded for either sealant type for test durations up to and including 245 minutes.
- In all test data examined, where Insulation failure occurred, the first failure was always recorded by thermocouples positioned on the separating element.
- Where Insulation failure has been recorded by thermocouples positioned on the sealant, the time of the failure was always a minimum of 30 minutes in excess of the FRL of the separating element.

3.3.2 Firesound® -/120/120, -/180/180 & -/240/240 FRLs

The test data referenced in Section 2 details a series of control joint configurations tested in various separating element types and thicknesses. Not every possible configuration or separating element combination was tested.

In FRT190135, a 20 mm wide x 10 mm deep control joint (Specimen C) and a 40 mm wide x 20 mm deep control joint (Specimen D) were tested, installed in a 240 minute rated, 175 mm thick concrete wall element. Both control joints maintained the Integrity and Insulation criteria for the entire 241 minute test duration.

In FRT200213, a 30 mm wide x 15 mm deep control joint (Specimen A) and a 50 mm wide x 25 mm deep control joint (Specimen B) were tested, installed in a 180 minute rated, 150 mm thick concrete floor element. Both control joints maintained Integrity for the entire 241 minute test duration. Insulation failures were recorded at 215 minutes on Specimen A and at 213 minutes on Specimen B. Both of these Insulation failures were recorded by thermocouple positioned on the separating element.

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The temperature profiles recorded by the seal thermocouples of the control joint specimens tested in FRT190135 and FRT200213 are shown below in Table 8.

Table 8: Summary of Temperature Rise FRT190135 & FRT200213

Specimen	Separating Element Thickness (mm)	Control Joint Dimensions Width x Depth (mm)	Temp Rise @ 120 mins (Deg °C)	Temp Rise @ 180 mins (Deg °C)	Temp Rise @ 240 mins (Deg °C)
C	175 Wall	20 x 10	81	87	145
D		40 x 20	77	83	126
A	150 Floor	30 x 15	84	113	169
B		50 x 25	79	89	161

With both of the control joints tested in FRT200213, installed in the 180 minute rated floor element comfortably achieving a 241 minute Insulation result (excluding element thermocouples), consideration as to what would be the expected Insulation performance when tested in thicker or thinner elements is necessary.

Had the same joint configurations been tested, installed in a 240 minute rated floor element, with the additional 25 mm of floor thickness and air gap between the seals, it is reasonable to expect this would improve the Insulation performance further, i.e. lower temperature rise at 240 minutes, thus a 240 minute Insulation FRL would be expected.

Furthermore, the temperature rise of these control joints (measured on the seal) at 120 minutes was recorded to be 84 Deg °C (Specimen A) and 79 Deg °C (Specimen B). Comparing Specimen B (50 mm x 25 mm / 180 min rated floor) tested in FRT200213 with Specimen D (40 mm x 20 mm / 240 min rated wall) tested in FRT190135, at 120 minutes, the maximum temperature rise difference recorded by thermocouples positioned on the seal was 2 Deg °C (Specimen B was hotter).

It is therefore considered that if the same joint configurations had been tested, installed in a 120 minute rated floor element, although the temperature rise would be expected to be higher, the effect of reducing the floor element thickness from 150 mm to 120 mm would not be so significant as to cause an Insulation failure before 120 minutes, thus a 120 minute Insulation FRL would be expected.

With both of the control joints tested in FRT190135, installed in a 240 minute rated wall element maintaining Insulation for the 241 minute test duration, the same rationale can be applied for the assessment of these control joints installed in thinner wall elements for 120 minute and 180 minute Insulation FRLs.

With a margin of at least 90 Deg °C below 180 Deg °C at 120 minutes and 180 minutes, it is considered that with the reduction of the wall element thickness from 175 mm to 150 mm and 125 mm, the maximum temperature rise would still be expected to be less than 180 Deg °C at 180 minutes and 120 minutes for wall elements.

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As there is no requirement for instrumentation to be positioned directly on the seal of a control joint with a width less than 14 mm; and a wider joint with the same 10 mm depth was tested in a 240 minute rated wall with no Insulation failure recorded during the 241 minute test duration, the proposed 10 mm wide x 10 mm deep control joint would be expected to achieve the same FRL as the element it is installed in.

The data set used in this section of the assessment comes from testing of control joints installed in both vertically and horizontally orientated elements. With the absence of any Integrity failures and the significant margins seen for Insulation in both orientations, it is considered that the control joint configurations tested or assessed would be applicable for wall and floor elements.

The tested and assessed control joint configurations for -/120/120, -/180/180 and -/240/240 FRLs are shown in Table 11.

3.3.3 FulaFlex™ FR -/120/120, -/180/180 & -/240/240 FRLs

The test data referenced in Section 2 details a series of control joint configurations tested in various separating element types and thicknesses. However, not every possible configuration/separating element combination was tested.

In FRT190354, a 120 minute rated, 120 mm thick concrete wall element was installed with four control joints. All of the control joints maintained Integrity for the 241 minute test duration. The temperature profiles recorded by the seal thermocouples of the control joint specimens are shown in Table 9.

Table 9: Summary of Temperature Rise FRT190354

Specimen	Separating Element Thickness (mm)	Control Joint Dimensions Width x Depth (mm)	Temp Rise @ 120 mins (Deg °C)	Temp Rise @ 180 mins (Deg °C)	Temp Rise @ 240 mins (Deg °C)
A*	120 Wall	10 x 10	109	191	240
B		20 x 10	88	160	199
C		40 x 20	81	124	169
D		50 x 25	80	106	141

*Joint less than 14 mm wide therefore temperature rise recorded on the element only.

The test data demonstrated that the three control joints wide enough to be instrumented on the seal, all maintained Insulation for 180 minutes, with the two widest control joints maintaining Insulation for the 241 minute test duration.

Had Specimen B been installed and tested in a 240 minute rated wall element, it is reasonable to expect that it would achieve a 240 minute Insulation FRL.

As there was no 30 mm wide x 15 mm deep control joint in this test, it can be assessed on the basis of the observable trend of Insulation performance improving as the gap width and depth increase. It would therefore be reasonable to expect the Insulation performance of a 30 mm x 15 mm control joint to fall between the Insulation performance demonstrated by the 20 mm x 10 mm and the 40 mm x 20 mm, they are all 2:1 ratio width x depth. Based on this, it is considered that a 30 mm wide x 15 mm deep control joint would achieve at least the same Insulation FRL as the separating element in which it is installed.

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In FRT200213, a 150 minute rated, 180 mm thick concrete floor element was installed with three control joints and in FP19882-01, a 120 minute rated, 120 mm thick concrete floor element was installed with one control joint. The temperature profiles recorded by the seal thermocouples of the control joint specimens are shown in Table 10.

Table 10: Summary of Temperature Rise FRT200213 & FP19882-01

Specimen	Separating Element Thickness (mm)	Control Joint Dimensions Width x Depth (mm)	Temp Rise @ 120 mins (Deg °C)	Temp Rise @ 180 mins (Deg °C)	Temp Rise @ 240 mins (Deg °C)
C*	150 Floor	10 x 10	94	135	213
D		20 x 10	85	119	198
E		30 x 15	75	105	196
E	120 Floor	50 x 25	75	138	210

*Joint less than 14 mm wide therefore temperature rise recorded on the element only.

Again, the test data demonstrated that the three control joints wide enough to be instrumented on the seal, all maintained Insulation for at least 180 minutes, with two of the control joints installed in a 180 minute rated floor element and the third control joint installed in a 120 minute rated floor element. It is therefore reasonable to expect, had the control joints been tested, installed in a 240 minute floor element, they would achieve a 240 minute Insulation FRL.

With a margin of at least 95 Deg °C below 180 Deg °C at 120 minutes for the two control joints wide enough for seal instrumentation, tested in the 150 minute rated floor element (D & E), it is considered that with the reduction of the element thickness from 150 mm to 120 mm, the maximum temperature rise would be expected to be less than 180 Deg °C at 120 minutes

A similar trend with insulation performance increasing with joint width is exhibited by these control joints, therefore a 40 mm wide x 20 mm deep control joint would be expected to perform at least, no worse than Specimen E (30 mm x 15 mm). Based on this, it is considered that a 40 mm wide x 20 mm deep control joint would achieve at least the same Insulation FRL as the separating element in which it is installed.

The 10 mm wide x 10 mm deep control joint was tested in both fire resistance tests, in both cases, Insulation failure occurred by thermocouples positioned on the element and in both cases, Insulation failure occurred at least 45 minutes after the actual FRL of the element. Therefore it is considered that a 10 mm wide x 10 mm deep control joint would be expected to achieve the same FRL as the element it is installed in.

The data set used in this section of the assessment comes from testing of control joints installed in horizontally orientated elements only (floors). It is generally accepted that testing control joints in a horizontally orientated element is more onerous than testing in vertically orientated elements due to; effects of gravity on the joint, molten material behaviour, increased furnace pressure and movement of the element, all of which would been seen to be more significant in a horizontal orientation. Based on this, it is considered that the control joint configurations tested or assessed would be applicable for wall and floor elements.

The tested and assessed control joint configurations for -/120/120, -/180/180 and -/240/240 FRLs are shown in Table 11.

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Table 11: Firesound® and FulaFlex™ FR Double Sided Control Joint Configurations

Joint Dimensions		Concrete Thickness - FRL		
Joint Width (mm)	Sealant Depth (mm)	120 mm	150 mm	175 mm
50	25	-/120/120	-/180/180	-/240/240
40	20	-/120/120	-/180/180	-/240/240
30	15	-/120/120	-/180/180	-/240/240
20	10	-/120/120	-/180/180	-/240/240
10	10	-/120/120	-/180/180	-/240/240

3.3.4 Firesound® & FulaFlex™ FR Interchangeability

It is proposed to allow the interchangeability of Firesound® and FulaFlex™ FR for double side joints, i.e. a control joint can have one sealant type on one face with the other sealant type on the opposing face.

As there is a substantial data set for each sealant type, including its testing with other types of construction elements it is possible to draw conclusions regarding the similarities of the fire resistance performance.

Comparing similar configurations previously referenced in this assessment, we have two, 30 mm x 15 mm control joints, one with Firesound® and one with FulaFlex™ FR tested together, installed in a 180 minute rated, 150 mm thick floor. There is also 50 mm x 25 mm control joints both tested in floors, the Firesound® joint was tested in a 180 minute, 150 mm thick floor while the FulaFlex™ FR was tested in a 120 minute rated, 120 mm thick floor. A summary of the temperature rise for each control joint recorded at 120, 180 and 240 minutes is shown in Table 12.

Table 12: Firesound® Vs FulaFlex™ FR Comparrison

Specimen	Separating Element Thickness (mm)	Control Joint Dimensions Width x Depth (mm)	Temp Rise @ 120 mins (Deg °C)	Temp Rise @ 180 mins (Deg °C)	Temp Rise @ 240 mins (Deg °C)
A - FS	150 Floor	30 x 15	84	113	169
E - FR			75	105	196
B - FS	150 Floor	50 x 25	79	89	161
E - FR	120 Floor		75	138	210

Comparing these two sets of control joints, in both cases, the temperature rise difference is marginal until the sealant temperatures exceed 100 Deg. C. After this, the temperature rise recorded on the FulaFlex™ FR control joints does accelerate faster than the Firesound® control joints (the difference in element thickness for the 50 mm x 25 mm joints will account for some of this difference).

However, due to the margins for Insulation seen in all of the testing for both sealant types, Insulation failure (measured on the sealant) is always at least 30 minutes after the FRL of the element. And with no Integrity failures recorded in any of the test referenced in Section 2, it is considered that use of both sealant types in one configuration (opposing faces only) would not be detrimental to the tested and assessed configurations shown in Table 11.

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3.4 Firesound® & FulaFlex™ FR - Double Caulked Control Joints

3.4.1 Description of Double Caulked Control Joints

For the purposes of this assessment, when describing the configuration of a double caulked joint, the following terminology is defined as:

- A double caulked control joint is asymmetric; both layers of backing rod and sealant are applied from the same face of the element.
- The first layer of backing rod and sealant are positioned furthest from the application face, the backing rod would be inserted first, followed by application of the sealant at the desired depth.
- The second layer of backing rod would then be inserted at a depth, typically to allow for a flush finish of the seconds layer of sealant to the application face.

3.4.2 Examination of the Test Data

H.B. Fuller Australia Pty. Ltd has provided test data from a number of fire resistance tests on double Caulked control joints installed in fire rated concrete floors for both sealant types. Following examination of this test data, the following observations of the fire resistance of the sealants have been made:

- In all of the test data examined, no instance of Integrity failure was ever recorded for either sealant type for test durations up to and including 245 minutes.
- Application from the exposed face is the more onerous configuration orientation in terms of Insulation performance.

3.4.3 Sealant Application from Either Face

Due to the specification of a double caulked control joint, both of the backing rod/sealant layers must be applied from the same face, in onsite situations, this could be from either face. Through the testing referenced in Section 2, it has been determined that installation from the exposed face is the more onerous installation orientation, as detailed below.

When control joints are tested, as in the tests referenced in this assessment, when they were installed from the exposed face, the first layer of backing rod would typically be inserted to a depth to leave the 20 mm clear air gap between the first sealant layer and second backing rod layer, allowing for a flush finish of the second sealant layer to the exposed face of the element. In doing so, the location of the unexposed face thermocouples could be inside the aperture and not flush to the unexposed face. As the element thickness increases, the significance of this increases as we are effectively reducing the thickness of the element with regards to thermal transfer. Whereas for application from the unexposed face, the control joint would be installed in the opposite orientation, the second sealant layer which would be instrumented being flush to the unexposed face, benefiting from the full thickness of the element, the first layer of sealant would also be shielded to some degree as it would be recessed within the aperture. Therefore on the basis that test data is all from exposed face installed control joints, the following assessment of double caulked control joints is applicable to installation from both faces.

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3.4.4 Air Gap Dimensions for -/240/240

In the two tests of double caulked control joints which form the basis of the assessment below, an air gap of 40/45 mm - 20 mm (backing rod) and 20/25 mm (clear air) was shown to be sufficient for the exposed face installed control joints, wider than 10 mm to achieve an Insulation result at least 50 minutes greater than the element FRL (120 minute and 180 minute rated elements). However, for a 240 minute FRL, to be conservative, the air gap dimension shall be increased, at least commensurate to the increase in element thickness. Therefore, the following minimum air gap dimensions are required for control joints wider than 10 mm to achieve the FRL of the element:

- -/120/120 = 40 mm - includes minimum 20 mm backing rod
- -/180/180 = 45 mm - includes minimum 20 mm backing rod
- -/240/240 = 70 mm - includes minimum 20 mm backing rod

3.4.5 Firesound® -/120/120, -/180/180 & -/240/240 FRLs

In FRT200323, a 180 minute rated, 150 mm thick concrete floor element was installed with three control joint specimens which were installed from the exposed face of the element. A summary of the control joint configurations is shown in Table 13.

Table 13: FRT200323 Control Joint Configuration Details

Specimen	Control Joint Dimensions Length x Width x Depth (mm)	Application Face	Air Gap (mm)
A	1,720 x 35 x 30 & 20	Exposed	45
B	1,720 x 25 x 25 & 15	Exposed	0
C	1,720 x 10 x 10 & 10	Exposed	0

All of the control joints maintained Integrity for the 241 minute test duration, Specimen A and Specimen C maintained Insulation for the 241 minute test duration, Specimen B maintained Insulation for a test duration of 115 minutes. It should be noted that the first layer of backing rod and sealant for all three of the control joints was recessed within the apertures and not flush to the unexposed face. The thermocouples attached to Specimen A and Specimen B were nominally 115 mm and 80 mm from the exposed face.

Had Specimen A been tested, installed in a 240 minute rated floor element, with the additional 25 mm of floor thickness and air gap between the seals, it is reasonable to expect this would achieve a 240 minute Insulation FRL.

The maximum temperature rise recorded on the seal of Specimen A after a test duration of 120 minutes was 90 Deg. C. It is therefore considered that if the same joint configuration had been tested, installed in a 120 minute rated floor element, although the temperature rise would be expected to be higher, the effect of reducing the floor element thickness from 150 mm to 120 mm would not be so significant as to cause an Insulation failure before 120 minutes, thus a 120 minute Insulation FRL would be expected.

As detailed in Table 13, Specimen B was installed with no airgap between the two layers of backing rod and sealant. It is reasonable to expect that had Specimen B been provided with a 45 mm airgap (20 mm backing rod included), like Specimen A, it would have maintained Insulation for at least 120 minutes, albeit when installed in a 180 minute rated floor element.

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As it failed Insulation 5 minutes before 120 minutes, it is considered that even with a reduction in the element thickness from 150 mm to 120 mm, the addition of the extra 25 mm of clear air gap would be sufficient to maintain Insulation for at least 120 minutes in a 120 minute rated floor element.

It is proposed for 180 minute and 240 minute FRLs, the depth of the sealant layers would be increased from 25 mm and 15 mm to 30 mm and 20 mm, as tested in the 35 mm wide Specimen A.

The maximum temperature rise recorded on the seal of Specimen A at 180 minutes was 90 Deg. C. The maximum temperature rise recorded on the seal of Specimen A after a test duration of 240 minutes was 162 Deg. C.

It can be reasonably expected that a 25 mm wide, 30 mm and 20 mm double caulked joint, provided with a 45 mm or 70 mm air gap (20 mm backing rod included), would achieve a 180 minute or 240 minute FRL if tested in a 180 minute or 240 minute rated floor element.

The 10 mm wide x 10 mm and 10 mm deep configuration maintained Integrity and Insulation for the 241 minute test duration when tested, installed in a 180 minute rated floor element. With no requirements for instrumentation of the seal, it is considered that this configuration would achieve at least the same FRL as that of the element.

The data set used in this section of the assessment comes from testing of control joints, in horizontally orientated elements only (floors). As previously discussed, it is considered that control joint configurations tested horizontally may be assessed for vertically orientated elements, therefore the control joint configurations tested or assessed would be applicable for wall and floor elements.

The tested and assessed control joint configurations for -/120/120, -/180/180 and -/240/240 FRLs are shown in Table 15.

3.4.6 FulaFlex™ FR -/120/120, -/180/180 & -/240/240 FRLs

In FP19882-01, a 120 minute rated, 120 mm thick concrete floor element was installed with two control joint specimens. A summary of the control joint configurations is shown in Table 14.

Table 14: FP19882-01 Control Joint Configuration Details

Specimen	Control Joint Dimensions Length x Width x Depth (mm)	Application Face	Air Gap (mm)
C	1,100 x 35 x 30 & 20	Exposed	40
D	1,100 x 35 x 30 & 20	Unexposed	40

Both of the control joints maintained Integrity for the 245 minute test duration, Insulation failure, recorded by seal thermocouples occurred at 173 minutes for Specimen C and 210 minutes for Specimen D. These results demonstrate that application from exposed face is more onerous compared to application from the unexposed face.

Therefore using the data for Specimen C, had it been tested, installed in either a 180 minute or 240 minute rated floor element, by virtue of the increased element thickness and air gap dimensions, it would be expected to achieve an Insulation FRL equal to that of the element.

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For control joint widths ranging from 11 mm to 25 mm, the same sealant depths would be applied as those tested for the 35 mm wide control joint. With the only difference being a narrower joint width, it would be expected to achieve an Insulation FRL equal to that of the element.

As there is no requirement for instrumentation to be positioned directly on the seal of a control joint with a width less than 14 mm. The proposed 10 mm wide x 10 mm & 10 mm deep control joint it would be expected to achieve an Insulation FRL equal to that of the element.

As previously discussed, vertically orientated control joint configurations may be assessed from horizontally oriented control joint test data therefore it is considered that the control joint configurations tested or assessed would be applicable for wall and floor elements.

The tested and assessed control joint configurations for -/120/120, -/180/180 and -/240/240 FRLs are shown in Table 15.

Table 15: Firesound® and FulaFlex™ FR Double Caulked Control Joint Configurations

Joint Dimensions		Concrete Thickness - FRL		
Joint Width (mm)	**Sealant Depth (mm)**	**120 mm**	**150 mm**	**175 mm**
26-35	30 & 20	-/120/120	-/180/180	-/240/240
11-25	30 & 20*	-/120/120	-/180/180	-/240/240
10	10 & 10	-/120/120	-/180/180	-/240/240

* Firesound® depth for 120 minute FRL / 120 mm thick elements may be reduced to 30 mm & 15 mm.

3.5 Firesound® & FulaFlex™ FR Horizontal Head Joints

When considering the applicability of test data derived from testing of double sided and double caulked control joints as standard control joints for use as horizontally orientated head joints installed above a vertical wall, one factor requires particular attention, furnace pressure.

As per AS 1530.4:2014, a control joint tested in a vertical separating element would be subjected to a furnace pressure of 15 Pa at mid height of the joint, on the basis that pressure increases by 8 Pa per metre, the highest point of the control joint would be subjected to a pressure of approximately 19 Pa assuming that the joint is minimum 1,000 mm tall.

For control joints tested on horizontal separating elements, the furnace pressure should be set to be 20 Pa, 100 mm below the soffit of the element.

In FR2115-01, the pressure was set to be 15 Pa at mid height of specimens which were not part of this assessment. The horizontal perimeter edge seals referenced in this assessment were located nominally 1,035 mm above the 15 Pa plain resulting in a pressure of approximately 23 Pa.

During this test, both perimeter seals, tested in a 90/90/90 wall element, maintained Integrity for the 120 minute test duration, Specimen A maintained Insulation for a test duration of 113 minutes, Specimen D maintained Insulation of the 120 minute test duration.

Based on the similarities of the furnace pressure conditions of the various tests referenced in Section 2 and Integrity performance demonstrated by horizontal perimeter seals tested in FR21125-01, it is considered that the control joint configurations shown in Table 11 and Table 15 are applicable for horizontal head joints.

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3.6 Horizontally Orientated Joints - Vertical Separating Elements

Generally, a control joint installed in a vertical separating element would be installed in a vertical orientation. For instances where a control joint is required to be installed in a horizontal orientation in a vertical separating element, it would be reasonable to expect that the effects of gravity, molten material behaviour and movement of the element on the joint would be reduced compared to a vertically orientated control joint.

It is therefore considered that the control joint configurations shown in Table 11 and Table 15 are applicable for vertically and horizontally orientated control joints installed in vertically orientated separating elements.

3.7 Alternative Separating Elements

It is proposed to extend the applicability of the control joint configurations shown in Table 11 and Table 15 to include solid block masonry, light weight concrete and hollow core masonry.

Solid block masonry would be expected to achieve the same fire resistance as standard poured concrete slabs used for the testing referenced in Section 2.

Light weight concrete and hollow core masonry constructions must be tested or assessed for the required FRL and comply with the minimum element thicknesses shown in the tables. Furthermore, control joints installed in hollow core masonry must always be installed with the backing rod and sealant sandwiched between rigid surfaces for the full depth of the hollow block. Any hollow core voids adjacent to the control joint which could permit the passage of heat between the sealant layers must be cement grout filled or solid block used.

It is therefore considered that the control joint configurations shown in Table 11 and Table 15 are applicable for solid masonry block, light weight concrete and hollow core masonry subject to the conditions stated above.

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4. CONCLUSION

It is considered that the H.B. Fuller Firesound® and FulaFlex™ FR sealants in fire rated control joints would be expected to achieve the stated FRL if tested in accordance with AS 1530.4:2014 with reference to AS 4072.1-2005 (including Amendment No. 1) with reference to Section 4, as stated in the following tables.

Summary of Firesound® & FulaFlex™ FR Sealant - Double Sided Control Joints

Double Sided/Symmetric Sealant Application From Both Sides Concrete and Masonry Walls and Floors Including Horizontally Orientated Head Joints				
Joint Dimensions		Minimum Element Thickness - FRL		
Joint Width (mm)	Sealant Depth (mm)	120 mm	150 mm	175 mm
50	25	-/120/120	-/180/180	-/240/240
40	20	-/120/120	-/180/180	-/240/240
30	15	-/120/120	-/180/180	-/240/240
20	10	-/120/120	-/180/180	-/240/240
10	10	-/120/120	-/180/180	-/240/240

It is considered the control joints may be installed with the following conditions or variations:

- A double sided joint may comprise either one or both Firesound® and FulaFlex™ FR sealants as part of the overall configuration (one per side).
- A control joint installed in a vertical element may be orientated vertically or horizontally.
- The minimum element thickness is applicable to solid block concrete or masonry construction. The separating element may be varied to lightweight concrete or hollow core masonry. In such cases, the separating element must be tested or assessed to achieve the required FRL and be subject to the minimum element thickness.
- Control joints installed in hollow core masonry must always be installed with the backing rod and sealant sandwiched between rigid surfaces for the full depth of the hollow block. Any hollow core voids adjacent to the control joint which could permit the passage of heat between the sealant layers must be cement grout filled or solid block used.

Examples of the double sided joint configurations are shown in Figure 1.

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Summary of Firesound® & FulaFlex™ FR Sealant - Double Caulked Control Joints

Double Caulked/Asymmetric Sealant Application From Either Side Concrete and Masonry Walls and Floors Including Horizontally Orientated Head Joints				
Joint Dimensions		**Minimum Element Thickness - FRL**		
Joint Width (mm)	**Sealant Depth (mm)**	**120 mm**	**150 mm**	**175 mm**
26-35	30 & 20	-/120/120	-/180/180	-/240/240
11-25	30 & 20*	-/120/120	-/180/180	-/240/240
10	10 & 10	-/120/120	-/180/180	-/240/240

* Firesound® depth for 120 minute FRL / 120 mm thick elements may be reduced to 30 mm & 15 mm.

It is considered the control joints may be installed with the following conditions or variations:

- For double caulked joints exceeding 10 mm width, the following minimum air gap depths are required (dimensions include minimum 20 mm backing rod):
  - -/120/120 FRL = 40 mm
  - -/180/180 FRL = 45 mm
  - -/240/240 FRL = 70 mm
- A control joint installed in a vertical element may be orientated vertically or horizontally.
- The minimum element thickness is applicable to solid block concrete or masonry construction. The separating element may be varied to lightweight concrete or hollow core masonry. In such cases, the separating element must be tested or assessed to achieve the required FRL and be subject to the minimum element thickness.
- Control joints installed in hollow core masonry must always be installed with the backing rod and sealant sandwiched between rigid surfaces for the full depth of the hollow block. Any hollow core voids adjacent to the control joint which could permit the passage of heat between the sealant layers must be cement grout filled or solid block used.

Examples of the double caulked joint configurations are shown in Figure 2.

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Figure 1: Client Supplied Drawing - Double Sided Control Joints

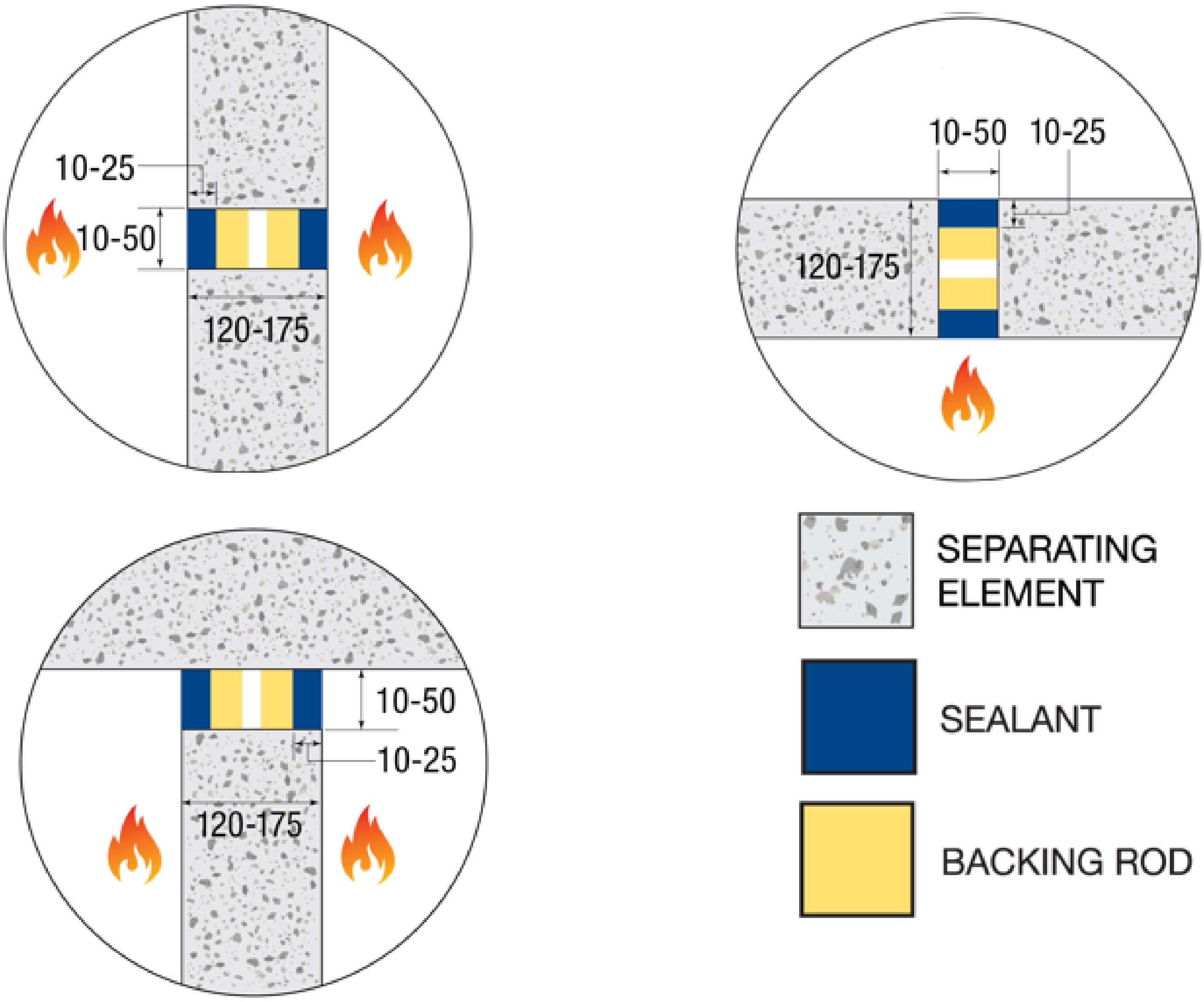

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Figure 2: Client Supplied Drawing - Double Caulked Control Joints