

FIRE ASSESSMENT REPORT

FC15909-01-2

FIRE RESISTANCE OF A MONOKOTE DUCT SYSTEM

CLIENT

GCP Australia Pty Ltd 14 Colebard Street West Archerfield 4108 Queensland Australia

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ASSESSMENT OBJECTIVE

To assess the fire resistance of a Monokote[®] duct projection system for square/rectangular internal and external fire exposure ducts with an increase in size up to a maximum of 2,400 mm x 2,400 mm, if tested in accordance with AS 1530.4:2014.

CONCLUSION

It is considered that the Monokote[®] duct protection system discussed in this report would not be prejudiced before up to 240 minutes, as stated in Table 2 to Table 4 for square and rectangular ducts if tested in accordance with AS 1530.4:2014.

This report is to be read in conjunction with AS 4254.2-2012, details in this assessment report and AS 4254.2-2012 are required to achieve the stated FRL. Where there are any discrepancies between requirements between this report and AS 4254.2, this report shall take precedence.

The maximum allowable stress on the duct and support structures must not exceed 10 N/mm² for an FRL up to 120 minutes or 6 N/mm² for an FRL up to 240 minutes.

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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SIGNATORIES

low Author

P. Chapman Senior Fire Testing Engineer Authorised to Author this report

Reviewed by

E. Soja Senior Fire Safety Engineer Authorised to review this report

. Gum

Authorised by

P. Chapman Senior Fire Testing Engineer Authorised to release this report to client



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2	16 February 2024	To include additional construction details and reference to the NCC. [BRANZ Ref:18193]



1. INTRODUCTION

This report gives BRANZ's assessment of the fire resistance to AS 1530.4: of a Monokote[®] duct protection system for square/rectangular internal and external fire exposure ducts with an increase in size to a maximum of 2,400 mm x 2,400 mm.

The ducts must be installed in accordance with AS 4254.2-2012 except where detailed in this assessment report. Construction details in this assessment are considered to be a minimum requirement to achieve the required fire resistance level (FRL). Where any construction detail specified in this assessment is less than required by AS 4254 then AS 4254 shall take precedence.

2. BACKGROUND

In BRANZ fire resistance test FR 4337 Issue 2 an internal and external steel duct were tested in accordance with AS 1530.4-2005 protected with a Monokote[®] duct protection system. The ducts achieved the following fire resistance level (FRL).

	Internal exposure	External exposure
Stability	126 minutes No failure	126 minutes No failure
Integrity	93 minutes	126 minutes No failure
Insulation	48 minutes	126 minutes No failure

The ducts were nominally 1,000 mm wide x 250 mm high with an average thickness of Monokote[®] of 31 mm and 29 mm for the Internal and External ducts respectively.

In BRANZ fire resistance test FR 4338 Issue 2 an internal and external steel duct were tested in accordance with AS 1530.4-2005 protected with a Monokote[®] duct protection system. The ducts achieved the following fire resistance level (FRL).

	Internal exposure	External exposure
Stability	245 minutes No failure	245 minutes No failure
Integrity	245 minutes No failure	245 minutes No failure
Insulation	157 minutes	245 minutes No failure

The ducts were nominally 1,000 mm wide x 250 mm high with an average thickness of Monokote[®] of 60 mm and 72 mm for the Internal and External ducts respectively.

In BRANZ fire assessment report FC17299-01-1 the Trafalgar Fyrewrap[®] Elite[®] 1.5 system was determined would achieve a given fire resistance in accordance with AS 1530.4:2014 for an external exposure steel ducts with different configurations of the Fyrewrap[®] Elite[®] 1.5 blanket.

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3. **DISCUSSION**

3.1 AS 1530.4 2005 vs 2014

With respect to duct testing there are some differences between the 2005 and 2014 versions of AS 1530.4 in how the Insulation failure is determined for external exposure ducts. The 2005 version determines Insulation failure to occur on the unexposed face of the duct outside the furnace whereas the 2014 version deem Insulation failure to be determined on the inside of the duct, inside the furnace and unexposed face of the duct outside the furnace.

The BRANZ fire resistance tests were conducted in accordance with the 2005 version of the test standard however they included thermocouples on the inside of the ducts, inside the furnace which are included in the reports and comply with the requirements of the 2014 version. Based on reviewing the test data and criteria of AS 1530.4:2014 against the temperature data collected in the fire resistance tests it is considered had the ducts been tested in accordance with this version they would have achieved the following fire resistance:

Test report	Fire exposure	Monokote [®] thickness	Stability	Integrity	Insulation	FRL
FR 4337	Internal	31 mm	126 NF	93	48	120/90/30
	External	29 mm	126 NF	126 NF	34	120/120/30
FR 4338	Internal	60 mm	245 NF	245 NF	157	240/240/120
	External	72 mm	245 NF	245 NF	190	240/240/180

Table 1: Tested Duct Performance in accordance with AS 1530.4:2014

For the purposes of this assessment it is considered the tests referenced in Section 2 undertaken to AS 1530.4-2005 and as discussed above are equivalent to the *Standard Fire Test* (AS 1530.4:2014) as referenced in the NCC.

3.2 General

In fire resistance test FR 4337 the average thickness applied to the ducts was nominally 31 mm for the Internal exposure duct and 29 mm for the External exposure duct. During the test a large part of the Monokote[®] fell away from the underside of the Internal duct revealing the mesh and steel ducting underneath. This was the cause of the Integrity failure of the Internal exposure duct after 93 minutes due to ignition of a cotton pad. No other Integrity failures occurred for the remainder of the test.

A post test examination of the test specimen revealed that the mesh was not positioned mid depth of the Monokote[®] but close to the duct surface such that when the duct was sprayed the Monokote[®] did not fully encapsulate the mesh sufficiently. In fire resistance test FR 4338 the Monokote[®] was applied directly to the duct, to approximately half the thickness, then the duct was covered with mesh and the remainder of the Monokote[®] applied. There were no Integrity failures of the ducts tested in FR 4338 for the 245 minute duration of the test. It is considered had the mesh been positioned mid depth of the Monokote[®] in FR4337 the Integrity failure of the Internal exposure duct would not have occurred before at least 120 minutes.

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An analysis of the Insulation performance of the duct tests has been conducted with intermediate thickness determined by interpolation of test results. Based on the analysis of the performance of the ducts in fire resistance tests FR 4337 and FR 4338 it is considered the Monokote[®] duct protection system would achieve the FRL's as stated in Table 2 to Table 4 if tested in accordance with AS 1530.4:2014.

See Figure 1 and Figure 2 for general horizontal duct installation details.

3.3 Duct Support Trapeze

The stress on the support angle and M12 threaded rods must not exceed 10 N/mm² for an FRL up to 120 minutes or 6 N/mm² for an FRL up to 240 minutes.

3.4 Monokote[®] Duct Protection System

The Monokote[®] is to be applied with the same depth of cover over joints, support angles and threaded rods as the bulk of the duct and the mesh positioned nominally mid depth of the finished Monokote[®] thickness.

The wall transition starts nominally 150 mm from the duct flush with the wall to 100 mm from the wall to the duct collar. The duct collar starts where the wall transition ends and extends 300 mm long the length of the duct.

The threaded rods are to be sprayed with Monokote[®] up to the height of the top of the Monokote[®] on the duct where the unprotected rods are up to a maximum of 2,000 mm. Where the length of the rods above the duct are longer than 2,000 mm they shall be protected with Monokote[®] to the same degree as the duct.

3.5 Duct Sizes up to 1,000 mm Wide x 250 mm High

Max size	Fire exposure	Monokote [®] thickness	FRL
1,000 x 250	Internal	37 mm	60/60/60
1,000 x 250	Internal	47mm	90/90/90
1,000 x 250	Internal	54 mm	120/120/120
1,000 x 250	Internal	64 mm	180/180/180
1,000 x 250	Internal	64 mm	240/240/180
1,000 x 250	External	44 mm	60/60/60
1,000 x 250	External	54 mm	90/90/90
1,000 x 250	External	61 mm	120/120/120
1,000 x 250	External	71 mm	180/180/180
1,000 x 250	External	71 mm	240/240/180

Table 2: Ducts up to 1,000 mm x 250 mm

The ducts were fabricated from nominal 0.7 mm thick mild steel with TDC flanges and lockform seams. It is considered ducting with a base metal thickness (BMT) of not less than 0.6 mm thick as specified in AS 4254.2-2012 would be expected to perform at least as well as the tested ducts.

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The duct sections were bolted at the corners and three clamps to the top and bottom edges and one to each side. The ducts were supported off 50 mm x 50 mm x 5 mm thick angles and M12 threaded rod spaced at 1,200 mm centres along the length of the duct.

3.6 Duct Sizes up to 1,500 mm Wide x 1,500 mm High

Table 3: Ducts from 1,001 mm wide x 251 mm high to 1,500 mm wide x 1,500 mm high

Max size	Fire exposure	Monokote [®] thickness	FRL
1,500 x 1,500	Internal	37 mm	60/60/60
1,500 x 1,500	Internal	47mm	90/90/90
1,500 x 1,500	Internal	54 mm	120/120/120
1,500 x 1,500	Internal	64 mm	180/180/180
1,500 x 1,500	Internal	64 mm	240/240/180
1,500 x 1,500	External	44 mm	60/60/60
1,500 x 1,500	External	54 mm	90/90/90
1,500 x 1,500	External	61 mm	120/120/120
1,500 x 1,500	External	71 mm	180/180/180
1,500 x 1,500	External	71 mm	240/240/180

For ducts up to 1,500 mm x 1,500 mm the ducts must be made from a minimum of 1 mm thick galvanized mild steel. In the referenced fire resistance tests at the wall penetration mesh was rolled up and inserted between the steel duct and wall opening. As the width of the duct increases it is likely that the steel duct could sag at this penetration potentially causing an Integrity failure before that tested. Therefore stiffeners are required to be secured to the ducts at the wall penetration.

The stiffeners are to be a minimum of 25 mm x 25 mm x 3 thick angles positioned each side of the wall and secured to the top of the opening with at least one masonry anchor mid span of the duct. The angles are to be secured to the sides of the duct in accordance with AS 4254. At the location of the trapeze hanger supports an angle section is required to be secured to the top of the duct and supported by the hanger rods along with the bottom angle support angle.

The trapeze hangers are to be positioned at not more than 1,200 mm centres and there must be an intermediate support secured to the duct of at least 25 mm x 25 mm x 3 mm thick angles in accordance with AS 4254.2-2012.

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3.7 Ducts Sizes up to 2,400 mm Wide x 2,400 mm High

Max size	Fire exposure	Monokote [®] thickness	FRL
2,400 x 2,400	Internal	37 mm	60/60/60
2,400 x 2,400	Internal	47mm	90/90/90
2,400 x 2,400	Internal	54 mm	120/120/120
2,400 x 2,400	Internal	64 mm	180/180/180
2,400 x 2,400	Internal	64 mm	240/240/180
2,400 x 2,400	External	44 mm	60/60/60
2,400 x 2,400	External	54 mm	90/90/90
2,400 x 2,400	External	61 mm	120/120/120
2,400 x 2,400	External	71 mm	180/180/180
2,400 x 2,400	External	71 mm	240/240/180

Table 4: Ducts from 1,501 mm wide x 1,501 mm high to 2,400 mm wide x 2,400 mm high

For ducts up to 2,400 mm x 2,400 mm the ducts must be made from a minimum of 1 mm thick galvanised mild steel and include at least one tie rod through mid-width of the duct at the location of the trapeze support and stiffeners/joints. The tie rod at the trapeze support must be installed as required for the support rods and be included as part of the duct support. The tie rod at the location of the stiffeners/joint must be secured to the angles above and below the duct in accordance with AS 4254.2-2012.

3.8 Vertical Ducts

It is proposed the Monokote[®] fire protection system may be used to protect vertical ducts penetrating concrete floor slabs. The differences between vertical and horizontal duct testing in accordance with AS 1530.4:2014 have been reviewed. It is considered that the vertical orientation of the duct is no more onerous in terms of fire resistance testing than that of horizontal duct testing.

Horizontal ducts are more likely to sag between hanger supports (transvers to the duct length) and between hangers along the duct to a greater extent than would be expected with vertical ducts. This is attributed to loads of self-weight and gravity are applied to the ducts differently. For horizontal ducts the loads are directed transverse to the direction of the duct downwards causing the ducting to deflect and sag between the support rods. This is especially significant at the wall penetration where the collar detail must prevent the duct sagging to maintain Integrity. With vertical ducts the loads are transferred along the direction of the duct and the ducts are supported at each floor slab penetration.

It is expected that the vertical ducts will be installed with the same penetration/collar details as the horizontal ducting.

If the vertical ducts span between floor levels is greater than 5,000 mm an intermediate duct support structure must be included which consists of a canter-levered bracket from an adjacent fire rated wall or suspended from above. The intermediate duct support structure

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stress must not exceed 10 N/mm² for an FRL up to 120 minutes or 6 N/mm² for an FRL up to 240 minutes. The intermediate support shall be installed to all four sides of the duct and suspended by rods. The rods shall be protected for a minimum of 300 mm where the total length is 2,000 mm or less. Where the rods are longer than 2,000 mm they shall be fully protected with Monokote[®] to the same extent as the duct protection.

See Figure 3 for a section view of a vertical duct penetrating a concrete floor slab.

3.9 1, 2 and 3 Sided Duct Construction

The steel duct liner can be positioned adjacent to fire rated concrete or masonry constructions such as fire rated walls, floor slab or combinations to one to three sides of the duct liner. This may prevent the steel duct liner being protected with the Monokote[®] duct protection system to all four sides as tested. However the adjacent fire rated construction can form part of the duct protection and be used to support the duct assembly.

The building element must have a fire resistance equal to or greater than the fire resistance required for the duct. The steel duct and hanger supports are the same as for the four sided duct described above.

Where there is a gap between the steel duct liner and fire rated construction it is proposed to secure a nominal 1.0 mm thick steel plate to close the gap. See Figure 4 and Figure 5 for details. The plate may be used to close the gap between the side of the duct and concrete slab above or between the bottom of the duct and adjacent wall.

A nominal 50 mm x 50 mm x 1.0 mm thick mild steel angle is to be secured to the concrete/masonry element with masonry anchors at 400 mm centres. The steel plate is secured to the angle and side of the duct with 6 mm tek screws or steel rivets at maximum 200 mm centres. The mesh is to be secured to the concrete/masonry element at the appropriate distance from the steel plate/duct with masonry anchors at 200 mm centres.

The Monokote[®] shall be applied to the appropriate thickness to the duct and steel plate. At the concrete/masonry and duct/plate junction the Monokote[®] shall be applied starting nominally 150 mm from the duct flush with the wall/ceiling to 100 mm from the wall/ceiling to the duct.

All other parts of the duct construction shall remain the same including the stress on the support structure must not exceed 10 N/mm² for an FRL up to 120 minutes or 6 N/mm² for an FRL up to 240 minutes.

3.10 Fire Protection Junction Details

There might be situations where the Monokote[®] duct protection system is to be used along side another duct protection system i.e. Fyrewrap which is a flexible blanket fire protection system as assessed in BRANZ fire assessment report FC17299-01-1.

To ensure the fire resistance of the steel duct liner is not comprised due to the junction of different fire protection system only the specific Trafalgar Fyrewrap[®] Elite[®] 1.5 system is considered in this assessment and limited to the Insulation performance of the protection system as follows:

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- 1 x 38 mm thick Trafalgar Fyrewrap[®] Elite[®] 1.5 FRL 30/30/30
- 2 x 38 mm thick Trafalgar Fyrewrap[®] Elite[®] 1.5 FRL 60/60/60
- 3 x 38 mm thick Trafalgar Fyrewrap[®] Elite[®] 1.5 FRL 120/120/120

Refer to Table 2 to Table 4 for the appropriate Monokote[®] duct protection system thickness. The minimum Monokote[®] thickness is not less than 37 mm.

It is proposed that the Fyrewrap[®] Elite[®] 1.5 shall overlap the Monokote[®] duct protection system by a minimum of 100 mm where the blanket is secured through the Monokote[®] coating to the steel duct liner. Where there is more than one layer of blanket the jointing methods discussed in fire assessment report FC17299-01-1 shall apply where the Monokote[®] coating would be considered as an inner layer of blanket. The Fyrewrap[®] Elite[®] 1.5 shall overlapping the Monokote[®] shall be secured with pairs of screws/pins at 200 mm centres (as per FC17299-01-1). A 30 mm fillet of Fyreflex sealant is to be applied to the interface between the Monokote[®] duct protection system and Fyrewrap[®] Elite[®] 1.5 system.

The Monokote[®] duct protection system can be considered to be a relatively ridged protection system compared to the Fyrewrap[®] Elite[®] 1.5 blanket which will confirm to the steel duct liner that it is secured to. Therefore it is expected that with the Fyrewrap[®] Elite[®] 1.5 blanket overlapping the Monokote[®] duct protection system it is unlikely any gaps between protection systems could occur which could influence the insulation performance of the systems.

It is expected that the Monokote[®] duct protection system would perform as tested and the Fyrewrap[®] Elite[®] 1.5 blanket which has been tested with the joint system proposed would also be expected to perform at least as well as tested. It is therefore considered that the proposed junction between fire protection systems would maintain the FRL for up to at least 120 minutes if tested in accordance with AS 1530.4:2014.

Note this assessment only applies to the Fyrewrap[®] Elite[®] 1.5 blanket overlapping the Monokote[®] duct protection system as discussed. The reverse does not apply.

4. CONCLUSION

It is considered that the Monokote[®] duct protection system discussed in this report would not be prejudiced before up to 240 minutes, as stated in Table 2 to Table 4 for square and rectangular ducts if tested in accordance with AS 1530.4:2014.

This report is to be read in conjunction with AS 4254.2-2012, details in this assessment report and AS 4254.2-2012 are required to achieve the stated FRL. Where there are any discrepancies between requirements between this report and AS 4254.2, this report shall take precedence.

The maximum allowable stress on the duct and support structures must not exceed 10 N/mm² for an FRL up to 120 minutes or 6 N/mm² for an FRL up to 240 minutes.

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Figure 1: Horizontal Duct – Typical Installation Details

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Figure 2: Horizontal Duct – Penetration Details

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Figure 3: Vertical Duct – Penetration Details

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Figure 4: Two Sided Duct Installation Detail





Figure 5: Two Sided Duct Installation Connection Detail

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Figure 6: Duct Wrap Over Monokote® Interface

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