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Our ref: FCO-2233/CO3746

Mr Lorenzo Fazzini
L & A Fazzini Manufacturing Pty Ltd
23-25 Wentworth Street
GREENACRE NSW 2190

Dear Mr Fazzini,

VERMIDUCT PASSIVE FIRE PROTECTION SYSTEM
Assessment No. FCO-2233
Your telephone call of 28 February.

INTRODUCTION

We have re-examined the information referenced by you on the likely performance of your sprayed insulation system when applied to air handling ducting and subjected to test in accordance with BS 476 Part 24. The information included:-

- British Standard 476, Fire tests on building materials and structures, Part 20:1987, Method for the determination of the fire resistance of elements of construction (general principles):
- British Standard 476, Fire tests on building materials and structures, Part 24:1987, Method for the determination of the fire resistance of ventilation ducts;
- CSIRO assessment reports numbered FCO-1500, FCO-1468 and FCO-1096;
- CSIRO Sponsored Investigation reports numbered: FSH 0236 (test date 18 December 1992); FSH 0230 (test date 20 August 1992); FSH 0092 (test date 23 August 1990); FSH 0540 (test date 28 January 1998) on air-handling ducts ; and
- CSIRO Sponsored Investigation reports numbered FSH 1036 (test date 28 February 2004) and FSH 0970 (test dated 10 May 2003) on air-handling ducts tested in accordance with BS 476: 24-1987.

We have retained this information.

You have requested an assessment as to the performance of your tested duct systems based on national Standards and those conducted in accordance with BS 476 Part 24.

ANALYSIS

CSIRO Sponsored Investigation report numbered FSH 0540

On 28 January 1998 this Division conducted a full-scale fire-resistance test on duct systems. The specimen comprised six ducts fabricated from galvanised sheet steel 0.8 mm thick and protected with Vermiduct sprayed insulation reinforced with square steel mesh and two steel ducts protected with Vermiduct sprayed insulation without the aid of mechanical reinforcement.

Duct V1 was 2300 mm long and was fixed vertically into a 1650 mm x 650 mm opening in the 200 mm thick Hebel slab. The duct projected 100 mm into the furnace chamber and 2000 mm above the Hebel panel. The duct was fixed to the slab with 8 mm masonry anchors through 1.6 mm steel angles which were in turn fixed to the ducts with self tapping screws at 300 mm centres as shown in drawings numbered 0197-003 and 0197-004. The duct incorporated slip on propriety flange (SPF) joints and specifically TDF joints, had 10 mm polystyrene sheeting adhered to its perimeter by means of self adhesive double-sided tape, as well as 25 mm x 25 mm x 1 mm square mesh wrapped to its perimeter.

The duct was protected on the outside with Vermiduct sprayed insulation and was exposed to the fire from the inside. The average sprayed thickness of Vermiduct on the duct (including polystyrene sheeting) ranged from 50 mm to 65 mm with an average of 58.6 mm.

Duct V2 was of similar construction to Duct V1 except for the following differences. Duct V2 incorporated Integrated Machine Rolled Flange (IMRF) joints and specifically 25 mm MEZ joints.

The duct was protected on the outside with Vermiduct sprayed insulation and was exposed to the fire from the inside. The average sprayed thickness of Vermiduct on 50 mm. The duct was clad with 0.55 mm thick galvanised steel sheeting, which was fixed to the duct with self tapping hex screws at 200 mm centres.

Duct H1 was 2350 mm long and was fixed horizontally into a 1650 mm x 650 mm opening in a 230 mm thick brick wall with 100 mm of ductwork projecting into the furnace chamber and 2250 mm outside the furnace. The duct was fixed to the wall with 8 mm masonry anchors through 1.6 mm steel angles which were in turn fixed to the ducts with self tapping screws at 300 mm centres as shown in drawings numbered 0197-001, 0197-002 and 0197-003. The duct had appended, at the end of the horizontal run, a vertical riser duct, this portion of the duct was not sprayed as shown on drawing numbered 0197-003. The duct incorporated slip on propriety flange (SPF) joints and specifically 25 mm MEZ joints, had 25 mm x 25 mm x 1 mm square mesh wrapped to its perimeter tensioned by means of plastic inserts. The duct was supported by trapeze hangers with 8 mm diameter threaded rods and 40 mm x 40 mm x 5 mm steel angle, and incorporated one access panel measuring 600 mm x 600 mm.

The duct was protected on the outside with Vermiduct sprayed insulation and was exposed to the fire from the inside. The average sprayed thickness of Vermiduct on the duct ranged from 45 mm to 62 mm with an average of 53.9 mm.

Duct H2 was of similar construction to Duct H1 except the following differences. The duct had 10 mm thick polystyrene sheeting adhered to its perimeter by means of self adhesive double-sided tape, as well as 25 mm x 25 mm x 1 mm square mesh wrapped to its perimeter and fixed with self tapping screws.

The duct was protected on the outside with Vermiduct sprayed insulation and was exposed to the fire from the inside. The average sprayed thickness of Vermiduct on the duct (including polystyrene sheeting) ranged from 52 mm to 67 mm with an average of 61.2 mm.

Duct H3 was 5220 mm long and was fixed horizontally at both ends into 1650 mm x 650 mm openings in a 230 mm thick brick wall with 100 mm of ductwork projecting outside the furnace on each end. The duct was fixed to the wall with 6 mm masonry anchors through 1.6 mm steel angles which were in turn fixed to the ducts with self tapping screws at 300 mm centres as shown in drawings numbered 0197-001and 0197-004. The duct incorporated Drive Slip (DS) joints, one access panel measuring 600 mm x 600 mm, and was supported by trapeze hangers with 10 mm diameter threaded rods and 40 mm x 40 mm x 5 mm steel angle.

The duct was protected on the outside with Vermiduct sprayed insulation sprayed directly to contour without any mechanical reinforcement and was exposed to the fire from the outside. The average sprayed thickness of Vermiduct on the duct ranged from 35 mm to 49 mm with an average of 42.5 mm.

Duct H4 was of similar construction to Duct H3 except the following differences. Duct H4 had 25 mm x 25 mm x 1 mm square mesh wrapped to its perimeter and tensioned by means of plastic inserts.

The duct was protected on the outside with Vermiduct sprayed insulation and was exposed to the fire from the outside. The average sprayed thickness of Vermiduct on the duct ranged from 35 mm to 59 mm with an average of 48.5 mm.

A full description of the test specimen and the test results are detailed in CSIRO Sponsored Investigation report numbered **FSH 0540**.

CSIRO Sponsored Investigation report numbered FSH 0970

Subsequent to this, on 10 May 2003 this Division conducted a full-scale fire-resistance test in accordance with BS 476 Part 24 on three duct systems.

The three ducts consisted of two horizontal ducts, Duct H1-B was subjected to internal fire exposure and H2-A and V1-C were subjected to external fire exposure.

The ducts were constructed from nominal 0.8-mm thick galvanized steel sheeting with all longitudinal seams of the Pittsburgh lock type. The transverse joint consisted of Integrated Machine Rolled Flange (IMRF), or 38-mm TDF. The IMRF joints were sealed with closed cell fire retarded foam tape. Each duct section was of variable length and nominally 1000-mm wide x 250-mm deep.

Duct V1 consisted of a nominal 4500-mm high duct with nominally 2000-mm above the furnace roof. The hole in the roof was nominally 1050-mm wide x 300-mm deep and did not have any packing except for the Vermiduct® spray.

The duct was secured to the furnace roof, above and below, with nominal angles 75 mm x 75 mm x 1.6-mm thick along all sides. The angle was secured to the roof with 12 masonry anchors and to the duct with self tapping screws.

Duct H1-B was nominally 6340-mm long and installed horizontally into a 1050-mm wide x 800-mm high opening in a brickwork wall. The length of duct inside the furnace was nominally 3610 mm and outside the furnace was nominally 2500 mm. The end of the duct was then connected into a transition piece which then fed into an exhaust fan. The flow rate through the duct was set to 3 m/s before the start of the test. Inside the furnace the duct had an opening in accordance with BS476:24 for internal exposure for type B ducts.

The duct was supported by trapeze hangers with 8-mm diameter threaded rods and 40 mm x 40 mm x 5 mm angles. The duct also had two access panels measuring nominally 198-mm x 332-mm, one inside the furnace the other outside the furnace.

Duct H2-A was of similar construction to Duct H1-B except it had a T-Junction and a 90° bend as shown in drawing HA-1073-1 and was closed to the furnace. Before the start of the test the pressure was set inside the duct to minus 300 Pa below laboratory pressure.

The Vermiduct® Fire Spray material was then applied as per the manufactures instructions in layers up to 20-mm thick until the required thickness was achieved. The applied density of the Vermiduct® was nominally 293kg/m^3. The ducts were sprayed at the following thickness:

- Duct V1-C spayed to 30-mm thickness
- Duct H1-B sprayed to 50-mm thickness
- Duct H2-A sprayed to 60-mm thickness.

The spray was applied so that the joints were not visible i.e. the thickness over the joints was of reduced thickness.

A full description of the test specimen and the test results are detailed in CSIRO Sponsored Investigation report numbered **FSH 0970**.

CSIRO Sponsored Investigation report numbered FSH 1036

Subsequent to this, on 28 February 2004 this Division conducted a full-scale fire-resistance test in accordance with BS 476 Part 24 on two duct systems.

Duct A subjected to external fire exposure and Duct B was subjected to internal fire exposure.

The ducts were constructed from nominal 0.8-mm thick galvanized steel sheeting with all longitudinal seams of the Pittsburgh lock type. The transverse joint consisted of Integrated Machine Rolled Flange (IMRF), or 38-mm TDF. The IMRF joints were sealed with closed cell fire retarded foam tape. Each duct section was of variable length and nominally 1000-mm wide x 250-mm deep.

Duct B was nominally 6340-mm long and installed horizontally into a 1050-mm wide x 300-mm high opening in a brickwork wall. The length of duct inside the furnace was nominally 3610 mm and outside the furnace was nominally 2500 mm. The end of the duct was then connected into a transition piece which then fed into an exhaust fan. The flow rate through the duct was set to 3 m/s before the start of the test. Inside the furnace the duct had an opening in accordance with BS476:24 for internal exposure for type B ducts.

The duct was supported by trapeze hangers with 12-mm diameter threaded rods and 40 mm x 40 mm x 5 mm angles. The duct also had two access panels measuring nominally 198-mm x 332-mm, one inside the furnace the other outside the furnace

Duct A was of similar construction to Duct B except it had a T-Junction and a 90° bend and was closed to the furnace. Before the start of the test the pressure was set inside the duct to minus 300 Pa below laboratory pressure.

The Vermiduct® Fire Spray material was then applied as per the manufactures instructions in a single layer at least 20-mm thick. The applied density of the Vermiduct® was nominally 293kg/m^3. Duct B failed insulation over one of the support hangers due to a reduced thickness in spray in this area. If the spray had the specified minimum 20 mm thickness over the support bracket then it is considered insulation failure would not have occurred until the next temperature recorded, in excess of the test failure criteria, at 115 minutes.

A full description of the test specimen and the test results are detailed in CSIRO Sponsored Investigation report numbered **FSH 1036**.

Below is a summary of these tests in table form.

TABLE 1

REPORT No.	TEST DATE	DUCT	SIZE (mm)	MODE	FIRE SIDE	THICKNESS (mm)	Fire Resistance	
							With Access Panel	Without Access Panel
FSH 0540	28/01/98	H-1	1600 x 600	HORIZ	INT	54	120/120/90	120/120/90
FSH 0540	28/01/98	H-2	1600 x 600	HORIZ	INT	62*	120/120/60	120/120/60
FSH 0540	28/01/98	H-3	1600 x 600	HORIZ	EXT	43	120/120/60	120/120/60
FSH 0540	28/01/98	H-4	1600 x 600	HORIZ	EXT	49	120/120/90	120/120/60
FSH 0540	28/01/98	V-1	1600 x 600	VERTI	INT	59	120/120/120	120/120/120
FSH 0540	28/01/98	V-2	1600 x 600	VERTI	INT	50	120/120/120	120/120/120
FSH 0649	23/12/98	H	1000 x 1000	HORIZ	EXT	40	120/120/120	120/120/120
FSH 0970	10/05/03	H1-B	1000 x 250	HORIZ	INT	50	240/240/185	N/A
FSH 0970	10/05/03	H2-A	1000 x 250	HORIZ	EXT	60	145/145/16	N/A
FSH 0970	10/05/03	V1-C	1000 x 250	VERTI	INT	30	240/240/240	N/A

* Note: (FSH 0540) Spray Thickness incorporated a 10 mm layer of sacrificial/ material/ designed to vaporize during fire conditions.

TABLE 2 Test in accordance with BS 476: 24-1987

REPORT No.	TEST DATE	DUCT	SIZE (mm)	MODE	FIRE SIDE	THICKNESS (mm)	Fire resistance	
							With Access Panel	Without Access Panel
FSH-0970	10/05/03	H1-B	1000 x 250	HORIZ	INT	50	240/185	N/A
FSH-0970	10/05/03	H2-A	1000 x 250	HORIZ	EXT	60	229/229	N/A
FSH-0970	10/05/03	V1-C	1000 x 250	VERTI	INT	30	240/240	N/A
FSH-1036	28/02/04	A	1000 x 250	HORIZ	EXT	20	200/155	N/A
FSH-1036	28/02/04	B	1000 x 250	HORIZ	INT	20	240/27	N/A

As can be seen from the results the structural adequacy and integrity of the systems were of little concern in the test reported in FSH 0540 and observation documented that no failure under these criteria were imminent at the time the testing was terminated. For the test reported in FSH 0970 observation made during and after the completion of the test show that the failures occurred because

(i) H1-B
   a. Insulation failure at 185 minute occurred at a thermocouple located over the joint. As the Vermiduct material had not been profiled over the joint the thickness of the Vermiduct at this point was approximately 12 mm (38_mm TDF joints).

   b. Subsequent insulation failure occurred at 227 minutes when a roving thermocouple was positioned at a point where the insulation had cracked due to the sagging of the duct at the mid-point between supports.

(ii) H2-A.
   a. At 229 minutes the portion of the duct A inside the furnace collapsed due failure of the 8-mm thick support rods. Increasing these rods to 10 mm would increase the loadbearing capacity by 56% as well as reducing the surface areas-to-mass ratio (a measure of the heat intake of the rod) 20%

The critical performance requirements for your spray insulation and that of any protection method attached to ducting is the ability to restrict the temperature rise within the duct. This performance is a factor of the thermal conductivity of the protection material, the thickness of the protection material, the ability of the protection material to remain in place (called stickability) and the severity of the fire exposure.

For the test reported in FSH 1036 observations made after the completion of the test showed that the thickness of the spray at the point of insulation failure of Duct B was due to a reduced thickness of spray over one of the support angles in the underside of the duct. If the spray had been the specified thickness then it is considered that the duct would have in fact failed insulation, at the next temperature recorded in excess of the test failure criteria which was, at 115 minutes. Based on previous test evidence if the thickness of the spray is increased to at least 30 mm where the duct exits both sides of the wall it is considered that the insulation failure would have occurred at the thermocouples positioned further away from the wall. The next insulation failures occurred at 151 minutes.

CONCLUSION/ASSESSMENT

Based on the test data and the factors related to the construction detailed above, it is the assessment of this Division that the Vermiduct systems as detailed in your specification listed above and to be reported in our report numbered FSH 0540, FSH 0970 and FSH 1036 would achieve the following fire-resistance levels in accordance with BS 476 Part 24.

TABLE 3

Maximum SIZE (mm)	ORIENTATION	FIRE SIDE	MINIMUM THICKNESS (mm)	FRL with A/P Structural Stability and Integrity only	MINIMUM THICKNESS (mm)	FRL with A/P Structural Stability, Integrity & Insulation
1600 x 1600	Horizontal / Vertical	Internal / External	5	*60/60/-*	12	*60/60/60*
1600 x 1600	Horizontal / Vertical	Internal / External	8	*90/90/-*	16	*90/90/90*
1600 x 1600	Horizontal / Vertical	Internal / External	10	*120/120/-*	20	*120/120/120*
1600 x 1600	Horizontal / Vertical	Internal / External	15	*180/180/-*	45	*180/180/180*
1600 x 1600	Horizontal / Vertical	Internal / External	25	*240/240/-*	55	*240/240/240*

a) Ducts not to exceed the dimensions of 1600 x 1600 mm;
b) Ductwork to be manufactured in accordance with AS 4254 or BS EN 1505:1998 using minimum 0.8 mm stainless steel or galvanised sheet metal;
c) Trapeze support centres at 1200 mm maximum comprising 50 x 50 x 5 mm angles and suspension rods not less than 10 mm diameter and the stress level not to exceed that of the tested prototype;
d) Tested Joints as follows: Drive Slip@2.4m max.; Mez Joint @ 1.52 m max. centres; TDF @ 1.45 m max centres;
e) Igniseal access panels as distributed by LAF with rebated edges and non-combustible Fire seal all as per tested prototype;
f) Quikmesh reinforcement by LAF all as tested in the above assemblies and secured with adhesive pins;
g) Intermediate support to be used in accordance with Tie Rod attachments SMACNA Fig 2 & 1·3 or AS 4254 Fig 2.3(C) Tie Rod;
h) Spray thickness in all FRL levels to be increased to a minimum 30 mm for a minimum distance of 150 mm from each side of the fire wall.

TABLE 4

Maximum SIZE (mm)	ORIENTATION	FIRE SIDE	MINIMUM THICKNESS (mm)	FRL with A/P Structural Stability and Integrity only	MINIMUM THICKNESS (mm)	FRL with A/P Structural Stability, Integrity & Insulation
2400 x 2400	Horizontal / Vertical	Internal / External	8	*60/60/-*	16	*60/60/60*
2400 x 2400	Horizontal / Vertical	Internal / External	10	*90/90/-*	20	*90/90/90*
2400 x 2400	Horizontal / Vertical	Internal / External	13	*120/120/-*	25	*120/120/120*
2400 x 2400	Horizontal / Vertical	Internal / External	20	*180/180/-*	50	*180/180/180*
2400 x 2400	Horizontal / Vertical	Internal / External	30	*240/240/-*	55	*240/240/240*

a) Ducts not to exceed the dimensions of 2400 x 2400 mm;
b) Ductwork to be manufactured in accordance with AS 4254 or BS EN 1505:1998 using minimum 1.0 mm stainless steel or galvanised sheet metal;
c) Trapeze support centres at 1200 mm maximum comprising 50 x 50 x 5 mm angles and suspension rods not less than 10 mm diameter and the stress level not to exceed that of the tested prototype;
d) Tested Joints as follows: Mez Joint @ 1.52 m max. centres; TDF @ 1.45 m max centres; Angle Flange @ 1.5 max. centres;
e) Igniseal access panels as distributed by LAF with rebated edges and non-combustible Fire seal all as per tested prototype;
f) Quikmesh reinforcement by LAF all as tested in the above assemblies and secured with adhesive pins;
g) Intermediate support to be used in accordance with Tie Rod attachments SMACNA Fig 2 & 1·3 or AS4254 Fig 2.3(C) Tie Rod;
h) Spray thickness in all FRL levels to be increased to a minimum 30 mm for a minimum distance of 150 mm from each side of the fire wall.

TABLE 5

Maximum SIZE (mm)	ORIENTATION	FIRE SIDE	MINIMUM THICKNESS (mm)	FRL with A/P Structural Stability and Integrity only	MINIMUM THICKNESS (mm)	FRL with A/P Structural Stability, Integrity & Insulation
4800 x 3600	Horizontal / Vertical	Internal / External	10	*60/60/-*	16	*60/60/60*
4800 x 3600	Horizontal / Vertical	Internal / External	13	*90/90/-*	20	*90/90/90*
4800 x 3600	Horizontal / Vertical	Internal / External	15	*120/120/-*	25	*120/120/120*
4800 x 3600	Horizontal / Vertical	Internal / External	25	*180/180/-*	55	*180/180/180*
4800 x 3600	Horizontal / Vertical	Internal / External	35	*240/240/-*	65	*240/240/240*

a) Ducts not to exceed the dimensions of 4800 x 3600 mm;
b) Ductwork to be manufactured in accordance with AS 4254 or BS EN 1505:1998 using minimum 1.0 mm stainless steel or galvanised sheet metal;
c) Trapeze support centres at 1200 mm maximum comprising 50 x 50 x 5 mm angles and suspension rods not less than 12 mm diameter and the stress level not to exceed that of the tested prototype;
d) Tested Joints as follows: TDF @ 1.45 m max centres; Angle Flange @ 1.5 max. centres;
e) Igniseal access panels as distributed by LAF with rebated edges and non-combustible Fire seal all as per tested prototype;
f) Quikmesh reinforcement by LAF all as tested in the above assemblies and secured CD welded pins @ 1600 mm c's and adhesive pins thereafter;
g) Intermediate support to be used in accordance with Tie Rod attachments SMACNA Fig 2 & 1·3 or AS 4254 Fig 2.3(C) Tie Rod;
h) Spray thickness in all FRL levels to be increased to a minimum 30 mm for a minimum distance of 150 mm from each side of the fire wall.

TERM OF VALIDITY

This assessment report will lapse on 28 February 2016. Should you wish us to re-examine this assessment with a view to the possible extension of its term of validity, would you please apply to us three to four months before the date of expiry. This Division reserves the right at any time to amend or withdraw this report in the light of new knowledge.

Yours faithfully

Brett Roddy
Team Leader, Fire Testing and Assessment

28 February 2014