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# **FIRE ASSESSMENT REPORT**

## **FAR 4572**

### **FIRE RESISTANCE OF BOSS FLEXICOAT-MAK AND BOSS BATT LINEAR GAP SEALS AND PENETRATION SEALS**

#### **CLIENT**

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## ASSESSMENT OBJECTIVE

To assess the Fire Resistance Level (FRL) of BOSS FlexiCoat-MAK and BOSS Batt linear gap seals and penetration seals in accordance with AS 4072.1-2005 when tested in accordance with AS 1530.4:2014.

## CONCLUSION

It is considered that the BOSS linear gap seals and penetration seals in a BOSS fire barrier as described in paragraph 1.2 and 1.3 would achieve an FRL of up to at least -/240/180 and -/120/120 respectively in accordance with AS 1530.4:2014 and AS 4072.1-2005 as given in Table 3.

## LIMITATION

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# 1. INTRODUCTION

## 1.1 General

This report gives BRANZ's assessment of the Fire Resistance Level (FRL) of linear gap seals comprising BOSS Batt linear gap seals with BOSS FlexiCoat-MAK coating and penetration seals in accordance with AS 4072.1-2005 when tested in accordance with AS 1530.4:2014.

## 1.2 Linear gap seal

The linear gap seals comprise 2 x 50 mm thick x 160 kg/m<sup>3</sup> BOSS Batts, or 1 x 100 mm thick BOSS Flexi-Batt of 80 kg/m<sup>3</sup> density, with a 1 mm dry film thickness, (approx. 2.5 mm wet film thickness), of FlexiCoat-MAK. The BOSS batts are compressed by 20% in width and friction fit into a maximum 200 mm wide gap. The floor or wall may be masonry or concrete (normal and lightweight), Speedpanel or similar product, a framed wall construction or a permanent polymer formwork construction. The wall must be at least 100 mm thick and the floor at least 120 mm thick, or commensurate with the FRL. The FRL of the system is at least -/120/120.

## 1.3 Penetrations

The penetration seal system consists of a BOSS Batt barrier comprising 2 x 50 mm thick x 160 kg/m<sup>3</sup> BOSS Batts, or 1 x 100 mm thick BOSS Flexi-Batt of 80 kg/m<sup>3</sup> density, up to 1,100 mm high x 1,100 mm wide, finished with a 1 mm dry film thickness, (approx.. 2.5 mm wet film thickness), of FlexiCoat-MAK. The penetrations may be:

- Cable trays up to 500 mm wide with AS 1530.4:2014 Appendix D cables.
- Steel pipes up to 220 mm diameter
- Copper pipes up to 159 mm diameter

The BOSS Batt perimeter edges and gaps between penetrations and the BOSS barrier are filled with FireMastic-300. The penetrations are wrapped with 300 mm wide or 750 mm wide, 40 mm thick BOSS P40 MAK-Wrap as required for the service and discussed below.

The wall may be masonry or concrete (normal and lightweight), Speedpanel or similar product, a permanent polymer formwork construction or a framed wall construction with at least an FRL of -/120/120. The wall must be able to support the 100 mm thick BOSS Batt system.

# 2. BACKGROUND

## 2.1 WF Report No. 338688/A

In Exova Warringtonfire fire resistance test report No. 338688/A (WF No. 338688/A) specimens of a Flexi-coat linear gap seal system in a 150 mm thick aerated concrete



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floor and wall were tested in accordance with BS EN 1366-4 using the method and criteria of BS EN 1363-1:1999.

### 2.1.1 Wall Specimen

The aperture in the wall was 150 mm wide x 1,500 mm long and was filled with 100 mm thick Flexi-Batt stone fibre flexible board (for the purposes of this assessment called BOSS Flexi-Batt) of nominal density 80 kg/m<sup>3</sup> inserted into the aperture. The boards were nominally 1,200 mm long and compressed by 20% to enable them to be friction fit into the aperture. The cut ends were butt joined together. The unexposed face was coated with nominal 1 mm dry film thickness, (approx. 2.5 mm wet film thickness), of Flexi-Coat (for the purposes of this assessment called FlexiCoat-MAK).

The linear gap seal was found to satisfy the criteria of BS EN 1363-1:1999 as follows:

Integrity: Cotton Pad	265 minutes (no failure)
Sustained Flaming	265 minutes (no failure)
Insulation:	203 minutes

### 2.1.2 Floor Specimen

The aperture in the floor was 200 mm wide x 2,300 mm long and was filled with 100 mm thick Flexi-Batt stone fibre flexible board (for the purposes of this assessment called BOSS Flexi-Batt) of nominal density 80 kg/m<sup>3</sup> inserted into the aperture. The boards were nominally 1,200 mm long and compressed by 20% to enable them to be friction fit into the aperture. The cut ends were butt joined together. The unexposed face was coated with nominal 1 mm dry film thickness, (approx. 2.5 mm wet film thickness), of Flexi-Coat (for the purposes of this assessment called FlexiCoat-MAK).

The linear gap seal was found to satisfy the criteria of BS EN 1363-1:1999 as follows:

Integrity: Cotton Pad	265 minutes (no failure)
Sustained Flaming	265 minutes (no failure)
Insulation:	208 minutes

## 2.2 CSIRO FSV 1731

In CSIRO fire resistance test FSV 1731 a 78 mm thick Speedpanel wall, with sixteen specimens of penetrations, was tested in accordance with AS 1530.4:2014. Specimens 15 and 16 were supplied by BOSS Products (Australia) Pty Ltd. The penetrations were AS 1530.4 Appendix D2 cables and Appendix D1 cables respectively on cable trays installed in a BOSS Batt system with 300 mm wide BOSS P40 MAK-Wrap with BOSS Ablative coated blanket wrapped around the cable tray each side of the wall. H.B. Fuller Firesound sealant filled all gaps between the batts and opening and between the cables and BOSS Batts. Specimens 15 and 16 were found to achieve an FRL of -/120/120 in accordance with AS 1530.4:2014.



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## 2.3 WF Report No. 343363

In Exova Warringtonfire fire resistance test report No. 343363 (WF No. 343363) various penetrations were tested in accordance with BS EN 1363-3:2009, in a wall with an aperture of 1,100 mm high x 1,100 mm wide. The aperture consisted of a perimeter lining of 100 mm wide hard batt made up of two layers of 50 mm thick stone wool of density 150.2 kg/m<sup>3</sup> coated on both faces with an 0.7 mm thick ablative material. The remainder of the aperture, after installation of the penetrations, is filled with 100 mm thick x 100 mm deep stone wool blocks of density 56.8 kg/m<sup>3</sup> which are compressed by 20%. The blocks are coated on each face with Flexi-Coat of 0.7 mm dry film thickness.

Table 4 gives a list of the penetrations and the results of the test.

The penetrations were wrapped with 40 mm thick stone wool of density 45 kg/m<sup>3</sup> on both the exposed and unexposed face. A 300 mm width of stone wool was wrapped around the cable ladders. A 200 mm width of stone wool was wrapped around the pipes.

The perimeter of the stone wool barrier and all gaps between penetrations and the barrier were filled with fire rated acrylic sealant (for the purposes of the is assessment called FireMastic-300).

## 2.4 Other tests

Various other fire resistance tests have been carried out on BOSS Products (Australia) Pty Ltd penetration seals and include test reports FRT190428, FSP 1833, WF Report No. 359904, FRT180472, FRT180473 and WF Report No. 359904. The specimens tested and results are given in the relevant discussion paragraphs.

The original sponsors of the tests have given Boss Products (Australia) Pty Limited permission to use the data for the purposes of this assessment.

# 3. DISCUSSION

## 3.1 Test Standard

The above referenced tests were carried out in accordance with the heating conditions and criteria specified in BS EN 1366-3 and BS EN 1366-4.

BS EN 1366-3 and BS EN 1366-4 give specific requirements for testing linear gap seals which are similar to those specified in AS 1530.4:2014. The results of the tests can therefore be used in providing an assessment in accordance with AS 4072.1-2005 when tested in accordance with AS 1530.4:2014.

## 3.2 Linear gap seals.

The linear gap seals achieved Integrity of at least 265 minutes and Insulation of 203 minutes when tested in lightweight autoclaved aerated concrete (AAC). This could give a better insulation value than normal concrete or masonry, but is



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considered unlikely to affect the Integrity of the seals. The proposed FRL is -/240/180. This is considered to be a suitable reduction to compensate for the use of ACC, therefore the seals can be used in any type of masonry or concrete construction.

The tests were carried out in walls and floors of thicknesses of 150 mm. The stone wool was 100 mm thick. It is considered that if installed in a floor or wall of at least 100 mm thickness, the BOSS Batt linear gap seals would provide an FRL of at least the rating of the floor or wall up to an FRL of -/240/180 in accordance with AS 1530.4:2014. The Integrity and Insulation will be the lesser of that provided by the floor or wall, but not exceeding -/240/180.

The BOSS Batt linear gap seal or Flexi-Batt may also be used as an end of slab seal between a floor and wall provided the compression requirement of 20% is met.

### 3.3 BOSS Batt Fire Barrier

In CSIRO fire resistance test FSV 1731 a specimen of BOSS Batt system with BOSS P40 MAK-Wrap with cable trays and various cables was tested in accordance with AS 1530.4:2014. The cable trays were wrapped with 300 mm wide P40 MAK-Wrap. That test demonstrated the ability of the BOSS Batt barrier with cable trays and cables to achieve an FRL of at least -/120/120. In that test the sealant used was H.B. Fuller Firesound sealant. It is proposed that the sealant should be FireMastic-300. This is the same sealant used for sealing the perimeter of the fire barrier and gaps between the penetrations and barrier in Exova Warringtonfire fire resistance test report No. 343363. In that test the sealant was used in systems capable of achieving up to 120 minutes Integrity and Insulation. It is therefore considered that the use of FireMastic-300 in the systems tested in FSV 1731 would not be detrimental to their achieving an FRL of at least -/120/120.

In Exova Warringtonfire fire resistance test report No. 343363 the fire barrier was inserted within the thickness of a concrete wall. The barrier and penetrations were found to achieve up to at least an FRL of -/120/120 with lesser values achieved depending on the type of penetration (see Table 4). The barrier in that test and FSV 1731 varied in the type of stone wool used. WF No. 343363 used a 100 mm thickness of 56.8 kg/m<sup>3</sup> stone wool whereas in FSV 1731 the BOSS Batt stone wool was 160 kg/m<sup>3</sup> density in two 50 mm layers separated by a 28 mm airgap. In FSV 1731 the unexposed face barrier temperature did not exceed 100°C. In WF No. 343363 the barrier exceeded the Insulation criteria after 120 minutes.

With the higher density of the BOSS Batt and results from FSV 1731, it is considered that if installed in a masonry wall as in WF No. 343363, the BOSS barrier system would achieve an FRL of at least -/120/120.

The wall may be masonry or concrete (normal and lightweight), Speedpanel, a permanent polymer formwork construction or a framed wall construction with up to at least an FRL of -/120/120. Where the wall thickness is less than 100 mm the system shown in FSV 1731 may be used.



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### 3.4 Cable Penetrations

In FSV 1731 the penetrations were wrapped in 300 mm width of P40 MAK-Wrap. The barrier system included a 28 mm airgap which effectively increases the depth of the barrier and increases the distance between the uninsulated part of the cables from the furnace heating conditions. Temperature data recoded on the unexposed side show that the failure temperature rise of 180°C had not been reached by a significant margin, therefore the 300 mm P40 MAK-Wrap is considered that installing the BOSS batt without the 28 mm airgap would not be detrimental to the penetrations achieving an FRL of at least -/120/120.

In FSV 1731 the cables complied with AS 1530.4:2014 Appendix D and achieved an FRL of -/120/120. In WF No. 343363, those cables, similar to those specified in AS 1530.4:2014 Appendix D, also achieved an FRL of at least -/120/120. It is therefore considered that the BOSS barrier system would achieve an FRL of -/120/120 when penetrated by cable trays and cables complying with AS 1530.4:2014 Appendix D.

### 3.5 Pipe penetrations

All pipe penetrations are insulated with BOSS P40-MAK wrap extending at least 300 mm on the exposed and unexposed faces with BOSS FireMastic-300 applied around the pipes at the batts. Variations to the extent of the wrap are given below, where applicable.

### 3.6 Copper Pipe Penetrations

#### 3.6.1 159 mm diameter

The pipe penetration from WF No. 359904 considered in this report achieved the FRL given in Table 2.

**Table 1: Copper Pipe penetration in WF No. 359904**

	Service	Integrity (minutes)	Insulation (minutes)	FRL
<b>Pipe N</b>	159 x 2 mm copper	132	30	-/120/30

The pipe was insulated with 40 mm thick stone wool P40/40 extending 300 mm on the exposed face only.

These results are considered to apply to a test to AS 1530.4:2014 and therefore the pipe penetration are expected to achieve the FRL as given in Table 3. In this case the 300 mm wide BOSS P40-MAK wrap is installed to both faces.

#### 3.6.2 150 mm diameter

In Warringtonfire fire resistance test report FRT 190428 a 150 mm diameter x 2 mm wall thickness copper pipe in a 100 mm thick BOSS Batt wall with one layer of BOSS P40-MAK wrap extending 600 mm on each side of the BOSS Batts achieved an



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Integrity of 120 minutes and Insulation of 58 minutes in accordance with AS 1530.4:2014.

In CSIRO fire resistance test FSP 1833 a 150 mm diameter copper pipe in a 96 mm thick steel framed plasterboard lined plasterboard wall with two layers of BOSS P40-MAK wrap extending 300 mm on the exposed side and 600 mm on the unexposed side of the BOSS Batts achieved an Integrity of 90 minutes and Insulation of 90 minutes in accordance with AS 1530.4:2014.

Warringtonfire fire resistance test report FRT 190428 demonstrated the ability of a 150 mm diameter copper pipe to achieve integrity of 120 minutes with one layer of BOSS P40-MAK wrap and CSIRO fire resistance test FSP 1833 demonstrated the ability of a 150 mm diameter copper pipe to achieve Insulation of 90 minutes with two layers of BOSS P40-MAK wrap. It is considered that if the pipe tested in FRT 190428 was insulated with two layers of BOSS P40-MAK wrap extending 600 mm on each side of the BOSS Batt wall, it would achieve at least 120 minutes Integrity and 90 minutes Insulation in accordance with AS 1530.4:2014.

### 3.6.3 80 mm diameter

In Warringtonfire fire resistance test report FRT180473 an 80 mm diameter x 1.7 mm wall thickness, copper pipe, specimen J, in a 75 mm thick Hebel wall with a BOSS 150 mm MaxiCollar™, a 50 mm thick Boss Batt, continuous thermal insulation of 50 mm Thermobreak and one layer of BOSS P40-MAK wrap extending 300 mm on each side of the BOSS Batts over the collars achieved an Integrity of 121 minutes and Insulation of 121 minutes in accordance with AS 1530.4:2014. There was no failure recorded at the end of the test.

Temperatures measured on the unexposed face on the insulation did not exceed 45°C rise. This is significantly lower than the failure temperature of 180°C rise therefore it is considered that if the system were installed in a 100 mm thick BOSS Batt system it would achieve at least 120 minutes Integrity and 120 minutes Insulation. In this case the 300 mm wide BOSS P40-MAK wrap is installed to both faces and the 50 mm Thermobreak is continuous along the pipe.

### 3.6.4 50 mm diameter

In Warringtonfire fire resistance test report FRT180472 an 50 mm diameter x 1.5 mm wall thickness copper pipe, specimen A, in a 116 mm thick steel framed, plasterboard lined wall with a BOSS 100 mm MaxiCollar™, a 50 mm thick Boss Batt, continuous thermal insulation of 30 mm Thermobreak and one layer of BOSS P40-MAK wrap extending 300 mm on each side of the BOSS Batts against the collars achieved an Integrity of 121 minutes and Insulation of 104 minutes in accordance with AS 1530.4:2014. Failure of Insulation occurred on the collar body. The BOSS P40-MAK wrap was not installed directly against the wall. If it had been, as demonstrated in FRT180473, it is considered that the Insulation failure would not have occurred.



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Temperatures measured on the unexposed face on the insulation did not exceed 70°C rise. This is significantly lower than the failure temperature of 180°C rise therefore it is considered that if the system were installed in a 100 mm thick BOSS Batt system it would achieve at least 120 minutes Integrity and 120 minutes Insulation. In this case the 300 mm wide BOSS P40-MAK wrap is installed to both faces and the 30 mm Thermobreak is continuous along the pipe.

### 3.6.5 42 mm diameter

In Warringtonfire fire resistance test report WF Report No. 359904 a 42 mm diameter x 1.2 mm wall thickness copper pipe, specimen L, in a 100 mm fire batt (identified by the client as BOSS BATT) wall with one layer of mineral insulation (identified by the client BOSS P40-MAK wrap) extending 300 mm on the unexposed face achieved an Integrity of 132 minutes and Insulation of 132 minutes in accordance with BS EN 1366-3:2009. A comparison with AS 1530.4:2014 has been discussed in Section 3.1 above, therefore the result of the test applies to AS 1530.4:2014.

Temperatures measured on the unexposed face on the insulation did not exceed 70°C rise. This is significantly lower than the failure temperature of 180°C rise therefore it is considered that if the system were installed in a 100 mm thick BOSS Batt system it would achieve at least 120 minutes Integrity and 120 minutes Insulation. In this case the 300 mm wide BOSS P40-MAK wrap is installed to both faces.

## 3.7 Steel Pipe Penetrations

### 3.7.1 220 mm diameter

The pipe penetration from WF No. 343363 considered in this report achieved the FRL given in Table 2.

**Table 2: Steel Pipe penetration in WF No. 343363**

Service		Integrity (minutes)	Insulation (minutes)	FRL
<b>Pipe A</b>	220 x 5 mm steel	110	31	-/90/30

The pipe was insulated with 40 mm thick stone wool extending 200 mm each side of the wall.

These results are considered to apply to a test to AS 1530.4:2014 and therefore the pipe penetration is expected to achieve the FRL as given in Table 3. In this case the 300 mm wide BOSS P40-MAK wrap is installed to both faces.

### 3.7.2 159 mm, 150 mm, 80 mm, 50 mm and 42 mm diameter

In accordance with AS 1530.4:2014 “Permissible Variations to the Tested Specimen”, data from copper pipes may be applied to steel pipes in that the melting point of steel is greater than copper, thermal conductivity of the steel is less than that of the steel. A further condition is that the surface area to mass ratio is equal to or less than the copper. The effect of this is that for a given diameter of copper pipe, the data applies



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to a steel pipe of greater wall thickness. Therefore, steel pipes can be used in place of copper pipes as tested in WF No. 343363, FRT 190428, FRT180473, FRT180472, and WF Report No. 359904 for 159 mm, 150 mm, 80 mm, 50 mm and 42 mm diameter steel pipes.

### 3.7.3 60 mm diameter

In Warringtonfire fire resistance test report FRT180473 an 60 mm diameter x 3.6 mm wall thickness steel pipe, specimen I, in a 75 mm thick Hebel wall with a 50 mm x 50 mm fillet of BOSS FireMastic-300 achieved an Integrity of 121 minutes and Insulation of 106 minutes in accordance with AS 1530.4:2014. There was no BOSS P40-MAK wrap on the pipe.

In comparison with the results of the 80 mm copper pipe tested in FRT180473, which has greater thermal conductivity than the steel pipe, it is considered that applying a 300 mm wide BOSS P40-MAK wrap to the steel pipe would enable the pipe to achieve at least 120 minutes Integrity and at least 120 minutes Insulation.

## 4. CONCLUSION

It is considered that the BOSS linear gap seals and penetration seals in a BOSS fire barrier as described in paragraph 1.2 and 1.3 would achieve an FRL of up to at least -/240/180 and -/120/120 respectively in accordance with AS 1530.4:2014 and AS 4072.1-2005 as given in Table 3.



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**Table 3: FRL of BOSS Batt penetration systems**

Penetration	FRL With wrap/Insulation	FRL Without wrap
Blank Boss Batt, 2 x 50 mm, or Flexi-Batt 1 x 100 mm up to 1,100 mm x 1,100 mm	N/A	-/120/120
Linear gap seals, Boss Batts 2 x 50 mm, or Flexi-Batt 1 x 100 mm up to 200 mm wide.	N/A	-/240/180
Cable trays and Appendix D cables	-/120/120	-/120/-
<sup>1</sup> Steel pipes up to 220 mm diameter	-/90/30	-/90/-
<sup>1</sup> Steel pipes up to 60 mm diameter	-/120/120	-/120/-
<sup>1</sup> Steel and copper pipes up to 159 mm diameter	-/120/30	-/120/-
<sup>2</sup> Steel and copper pipes up to 150 mm diameter	-/120/90	-/120/-
<sup>3</sup> Steel and copper pipes up to 80 mm diameter	-/120/120	-/120/-
<sup>4</sup> Steel and copper pipes up to 50 mm diameter	-/120/120	-/120/-
<sup>5</sup> Steel and copper pipes up to 42 mm diameter	-/120/120	-/120/-

1. One layer BOSS P40-MAK, 300 mm
2. Two layers BOSS P40-MAK, 600 mm
3. One layer BOSS P40-MAK, 300 mm. 50 mm Thermobreak continuous, plus 150 mm BOSS MaxiCollar
4. One layer BOSS P40-MAK, 300 mm. 35 mm Thermobreak continuous, plus 100 mm BOSS MaxiCollar
5. One layer BOSS P40-MAK, 300 mm



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**Table 4: List of penetrations and results. WF Report No. 343363**

	<b>Service</b>	<b>Integrity (minutes)</b>	<b>Insulation (minutes)</b>
<b>Pipe A</b>	220 mm steel	110	31
<b>Pipe B</b>	40 mm copper	152	60
<b>Pipe C</b>	159 mm copper	152	20
<b>Position 1</b>	350 mm cable ladder/tray	115	90
	D1 Cable 4 x 185 mm <sup>2</sup> . 52 mm diameter	115	77
	D2 Cable 4 x 185 mm <sup>2</sup> . 64- 80 mm diameter	115	102
	2 x E Cable 1 x 185 mm <sup>2</sup> . 23-27 mm diameter	115	87
<b>Position 2</b>	250 mm cable ladder/tray	75	75
	D3 Cable 4 x 185 mm <sup>2</sup> . 58 mm diameter	80	73
<b>Position 3</b>	500 mm cable ladder/tray	152	152
	10 x A1 cables, 5 x 1.5 mm <sup>2</sup> . 14 mm diameter.	152	142
	10 x A2 cables, 5 x 1.5 mm <sup>2</sup> . 11.2-14.4 mm diameter.	152	130
	10 x A3 cables, 5 x 1.5 mm <sup>2</sup> . 13 mm diameter.	152	140
	2 x B cables. 1 x 95 mm <sup>2</sup> . 18-21 mm diameter.	152	146
	1 x C1 cable. 4 x 95 mm <sup>2</sup> . 40-47 mm diameter.	152	140
	1 x C2 cable. 4 x 95 mm <sup>2</sup> . 48.4-61 mm diameter.	152	152
	1 x C3 cable. 4 x 95 mm <sup>2</sup> . 42 mm diameter.	152	124
<b>Position 4</b>	500 mm cable ladder/tray	152	152
	Bundle F cables. 20 x 2 x 0.6 mm <sup>2</sup> . 15 to 17 mm diameter.	152	152
	1 x G1 cable. 1 x 95 mm <sup>2</sup> . 14.1-17.1 mm diameter.	152	152
	1 x G2 cable. 1 x 185 mm <sup>2</sup> . 19.3-23.3 mm diameter.	152	141
	3 x H copper conduits. 16 mm x 0.5 mm wall.	152	152
	3 x I PVC conduits. 16 mm x 1 mm wall.	152	152
<b>Barrier</b>		152	120

Notes:

1. Cable designations as given in BS EN 1366.3.
2. Insulation rating is lowest value from EN 1366.3 test results.



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