

Report

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Air Entrapment in Radiators

Report Number 50528/1
September 2008

Carried out for: Spirotech B.V.

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Helmond
The Netherlands

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Total No. of pages: 20



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SUMMARY

A single panel radiator, 600 x1000mm was tested for thermal output with varying amounts of air trapped inside to determine the effects of air entrapment on domestic radiator performance.

The following thermal outputs were determined:

PRODUCT REFERENCE	MEASURED OUTPUT AT 50ΔT (W)
50528A1AR - all air removed	1193
50528A2AR – airspace in top header	1178
50528A3AR – airspace 1cm below header	1160
50528A4AR – airspace 2.5cm below header	1162
50528A5AR – airspace 5cm below header	1098

Infra red images were also taken of the radiator at the various test conditions.

Full details of the test and products can be found in Section 5 of this report.

Conclusions are shown in Section 7.

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1 INTRODUCTION

Thermal performance tests were carried out on a single panel radiators in accordance with the procedures contained in BS EN 442-2 : 1997, using low pressure hot water in the BSRIA radiator test room, described within section 3 of this report.

Additional tests were conducted with various levels of entrapped air inside the radiator.

The work was requested by Spirotech BV of the Netherlands and was carried out during the period 18 to 27 August 2008.

The sample radiator was received from a local supplier, in good condition on 15 August 2008

This report refers only to the items tested and no others.

2 DESCRIPTION OF SAMPLE

The test sample consisted of a single panel, pressed steel radiator, 600 x2000mm manufactured by Stelrad, from the Elite range of product.

The samples were designated as follows :

- 50528A1AR - all air removed
- 50528A2AR – airspace in top header
- 50528A3AR – airspace 1cm below header
- 50528A4AR – airspace 2.5cm below header
- 50528A5AR – airspace 5cm below header

The sample was a four tapping radiator plumbed with top and bottom same end connections (TBSE). The construction was a single, pressed steel panel without fins.

The water level in the radiator was set by means of a valve and sight tube connected to the bottom right corner tapping of the radiator, with the level being successively lowered for each test run.

Further details of the test samples can be found in Appendix A.

3 TEST FACILITY

The test facility consists of a test room 4.0m (l) x 4.0m (w) x 3.0m (h), which is constructed to the requirements contained in BS EN 442-2 : 1997, i.e. five water cooled surfaces and one insulated surface against which the test radiator is installed.

When steady state conditions are achieved the appliance output is determined from measurements of the water flow rate and inlet / outlet water temperature difference.

A standard test consists of three test points. For all appliances a first test is carried out with water supply temperature that produces a mean water temperature of 70°C with the water flow rate such that for radiators the inlet/outlet water temperature difference is 10°C. Two further tests are carried out at the water flow rate established in the first test but with different supply water temperatures.

For all tests the enclosure air temperature is controlled to maintain 20°C at the inner room reference point, which is 0.75m from the floor in the centre of the room.

4 INSTRUMENTATION

TEST RECORD SHEET TP21/7 : TEST EQUIPMENT / INSTRUMENTS

Contract Number	FS50528A
Test Engineer(s)	A Russell

	Instrument No.	Calibration expiry date
Weigh scales	332, 333	15/02/09
Resistance thermometer (air) reference & radiant shield	329	22/01/09
Resistance thermometers (water) reference	435 - 438	28/01/09
Digital voltmeter 7½ digit (resistance thermometer measurement)	331	25/11/08
Barometer	334	28/11/08
Electronic timer within PC	588	02/12/08
2.0m Steel rule	400	29/11/10
1.5m vernier caliper	359	29/11/08
150mm vernier caliper	385	03/03/10
Spring balance	393	21/11/08
Weigh scales (water content)	332	15/02/09

Comments: None

Test Engineer (signature)

Alf Russell

5 TEST RESULTS

TEST REPORT

Date of Test: 18-08-08
 Manufacturer: Spirotech BV
 Model Reference: 600x2000 Full
 Test Reference Number: 50528A1AR
 Type of Heater: 10
 Pipework Connections: T.B.S.E.

HEATER DIMENSIONS

Overall Height: (mm) 600
 Overall Length: (mm) 2000
 Overall Depth: (mm) 14.3
 Convector Height: (mm) 0
 Convector Depth: (mm) 0
 Height above floor: (mm) 110
 Distance from wall: (mm) 80
 Radiated heat factor (Sk) 0.50
 Barometer exponent (np) 0.50

MEAN TEST VALUES

	TEST 1	TEST 2	TEST 3
Room air temperature 0.75m: (C)	20.3	20.1	20.2
Flow rate: (g/s)	27.9	27.7	27.8
Flow Enthalpy: (J/g)	314.7	216.6	360.6
Return Enthalpy: (J/g)	272.2	195.7	306.9
Flow temperature: (C)	75.2	51.8	86.1
Return temperature: (C)	65.0	46.8	73.3
Output: (W)	1184.2	579.5	1495.4
Mean water temperature: (C)	70.1	49.3	79.7
Temperature difference: (C)	49.8	29.2	59.5
Barometric pressure: (mbar)	995.0	994.0	994.0
Corrected output: (W)	1189.6	582.2	1502.5
Estimated output: (W)	1187.1	582.8	1504.4

PERFORMANCE EQUATION

Output (W) = B(mean water temperature minus room air temperature)ⁿ

From test results B = 6.5096
 n = 1.3320

VARIATION OF OUTPUT WITH TEMPERATURE DIFFERENCE

TEMPERATURE DIFFERENCE C	HEAT OUTPUT W
20	352
30	604
40	886
50	1193
60	1521
70	1868

TEST REPORT

Date of Test: 19-08-08
 Manufacturer: Spirotech BV
 Model Reference: 600x2000 Half header
 Test Reference Number: 50528A2AR
 Type of Heater: 10
 Pipework Connections: T.B.S.E.

HEATER DIMENSIONS

Overall Height: (mm) 600
 Overall Length: (mm) 2000
 Overall Depth: (mm) 14.3
 Convector Height: (mm) 0
 Convector Depth: (mm) 0
 Height above floor: (mm) 110
 Distance from wall: (mm) 80
 Radiated heat factor (Sk) 0.50
 Barometer exponent (np) 0.50

MEAN TEST VALUES

	TEST 1	TEST 2	TEST 3
Room air temperature 0.75m: (C)	20.2	20.1	20.2
Flow rate: (g/s)	27.8	27.7	28.0
Flow Enthalpy: (J/g)	314.7	217.1	364.4
Return Enthalpy: (J/g)	272.5	196.4	310.5
Flow temperature: (C)	75.2	51.9	87.0
Return temperature: (C)	65.1	46.9	74.2
Output: (W)	1174.9	572.5	1509.4
Mean water temperature: (C)	70.2	49.4	80.6
Temperature difference: (C)	49.9	29.3	60.4
Barometric pressure: (mbar)	996.0	997.0	999.0
Corrected output: (W)	1179.8	574.8	1514.7
Estimated output: (W)	1176.2	575.7	1517.4

PERFORMANCE EQUATION

Output (W) = B(mean water temperature minus room air temperature)ⁿ

From test results B = 6.2200
 n = 1.3405

VARIATION OF OUTPUT WITH TEMPERATURE DIFFERENCE

TEMPERATURE DIFFERENCE	HEAT OUTPUT
C	W
20	345
30	594
40	874
50	1178
60	1505
70	1850

TEST REPORT

Date of Test: 20-08-08
 Manufacturer: Spirotech BV
 Model Reference: 600x2000 1cm under header
 Test Reference Number: 50528A3AR
 Type of Heater: 10
 Pipework Connections: T.B.S.E.

HEATER DIMENSIONS

Overall Height: (mm) 600
 Overall Length: (mm) 2000
 Overall Depth: (mm) 14.3
 Convector Height: (mm) 0
 Convector Depth: (mm) 0
 Height above floor: (mm) 110
 Distance from wall: (mm) 80
 Radiated heat factor (Sk) 0.50
 Barometer exponent (np) 0.50

MEAN TEST VALUES

	TEST 1	TEST 2	TEST 3
Room air temperature 0.75m: (C)	20.2	20.0	20.3
Flow rate: (g/s)	27.5	27.4	27.3
Flow Enthalpy: (J/g)	314.3	219.3	363.9
Return Enthalpy: (J/g)	272.1	198.3	309.6
Flow temperature: (C)	75.1	52.4	86.9
Return temperature: (C)	65.0	47.4	74.0
Output: (W)	1158.1	573.9	1482.0
Mean water temperature: (C)	70.1	49.9	80.5
Temperature difference: (C)	49.8	29.9	60.1
Barometric pressure: (mbar)	1005.0	1005.0	1005.0
Corrected output: (W)	1160.4	575.1	1485.0
Estimated output: (W)	1154.6	576.6	1489.2

PERFORMANCE EQUATION

Output (W) = B(mean water temperature minus room air temperature)ⁿ

From test results B = 5.7872
 n = 1.3549

VARIATION OF OUTPUT WITH TEMPERATURE DIFFERENCE

TEMPERATURE DIFFERENCE	HEAT OUTPUT
C	W
20	335
30	581
40	857
50	1160
60	1485
70	1830

TEST REPORT

Date of Test: 21-08-08
 Manufacturer: Spirotech BV
 Model Reference: 600x2000 2.5cm under header
 Test Reference Number: 50528A4AR
 Type of Heater: 10
 Pipework Connections: T.B.S.E.

HEATER DIMENSIONS

Overall Height: (mm) 600
 Overall Length: (mm) 2000
 Overall Depth: (mm) 14.3
 Convector Height: (mm) 0
 Convector Depth: (mm) 0
 Height above floor: (mm) 110
 Distance from wall: (mm) 80
 Radiated heat factor (Sk) 0.50
 Barometer exponent (np) 0.50

MEAN TEST VALUES

	TEST 1	TEST 2	TEST 3
Room air temperature 0.75m: (C)	20.2	20.1	20.4
Flow rate: (g/s)	28.2	28.2	28.0
Flow Enthalpy: (J/g)	313.8	218.0	364.0
Return Enthalpy: (J/g)	272.5	197.6	311.0
Flow temperature: (C)	75.0	52.1	86.9
Return temperature: (C)	65.1	47.2	74.3
Output: (W)	1160.7	573.7	1485.7
Mean water temperature: (C)	70.0	49.6	80.6
Temperature difference: (C)	49.8	29.6	60.3
Barometric pressure: (mbar)	1007.0	1007.0	1007.0
Corrected output: (W)	1162.5	574.5	1487.9
Estimated output: (W)	1157.5	575.8	1491.5

PERFORMANCE EQUATION

Output (W) = B(mean water temperature minus room air temperature)ⁿ

From test results B = 6.2519
 n = 1.3357

VARIATION OF OUTPUT WITH TEMPERATURE DIFFERENCE

TEMPERATURE DIFFERENCE	HEAT OUTPUT
C	W
20	342
30	588
40	863
50	1162
60	1483
70	1822

TEST REPORT

Date of Test: 22-08-08
 Manufacturer: Spirotech BV
 Model Reference: 600x2000 5.0cm under header
 Test Reference Number: 50528A5AR
 Type of Heater: 10
 Pipework Connections: T.B.S.E.

HEATER DIMENSIONS

Overall Height: (mm) 600
 Overall Length: (mm) 2000
 Overall Depth: (mm) 14.3
 Convector Height: (mm) 0
 Convector Depth: (mm) 0
 Height above floor: (mm) 110
 Distance from wall: (mm) 80
 Radiated heat factor (Sk) 0.50
 Barometer exponent (np) 0.50

MEAN TEST VALUES

	TEST 1	TEST 2	TEST 3
Room air temperature 0.75m: (C)	20.3	20.1	20.0
Flow rate: (g/s)	27.6	27.3	27.4
Flow Enthalpy: (J/g)	314.2	217.3	345.3
Return Enthalpy: (J/g)	274.4	197.7	329.6
Flow temperature: (C)	75.1	51.9	82.5
Return temperature: (C)	65.6	47.2	78.7
Output: (W)	1097.8	536.5	430.1
Mean water temperature: (C)	70.3	49.6	80.6
Temperature difference: (C)	50.0	29.5	60.6
Barometric pressure: (mbar)	1007.0	1007.0	1011.0
Corrected output: (W)	1099.4	537.3	430.3
Estimated output: (W)	775.5	648.0	826.9

PERFORMANCE EQUATION

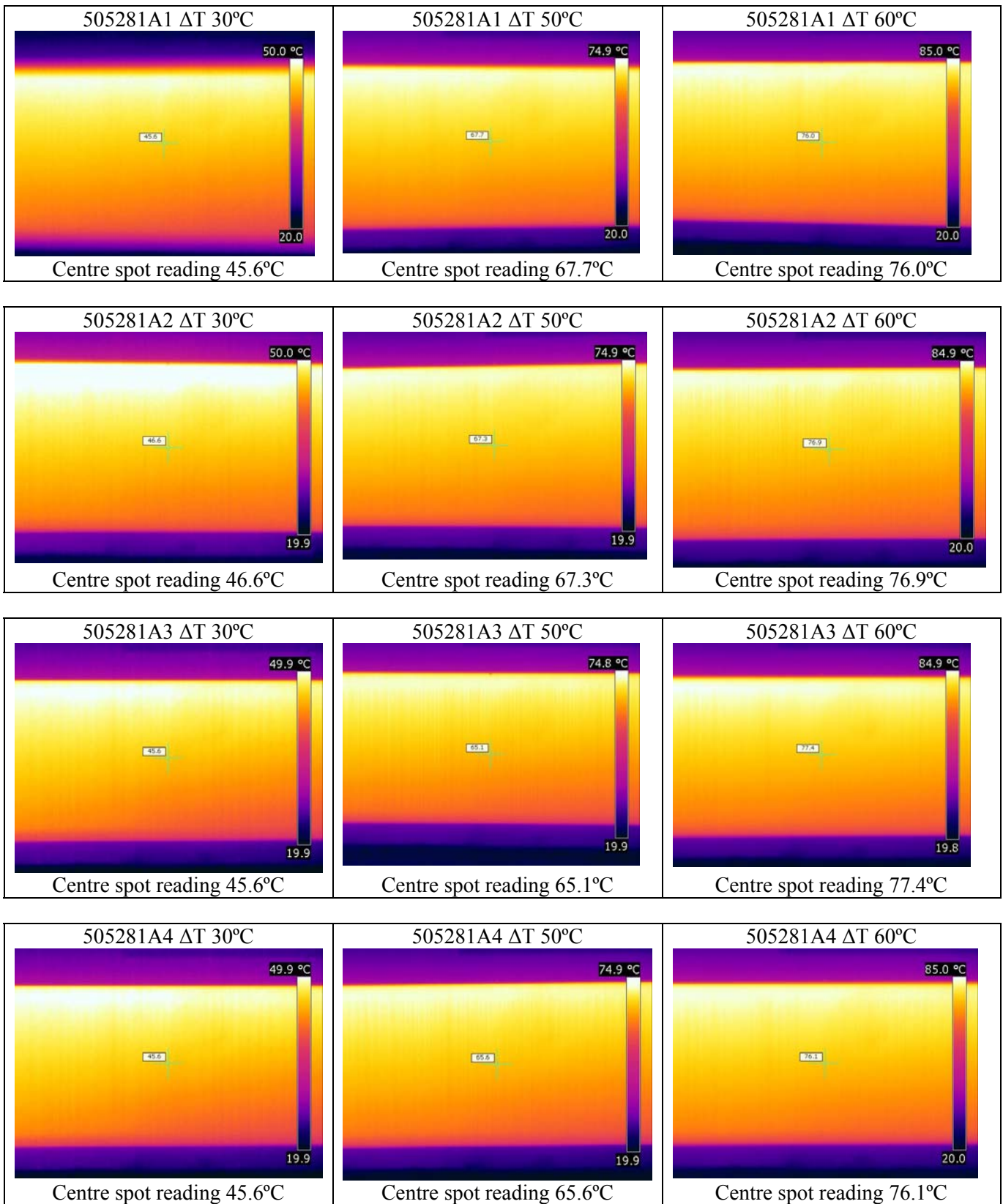
Output (W) = B(mean water temperature minus room air temperature)ⁿ

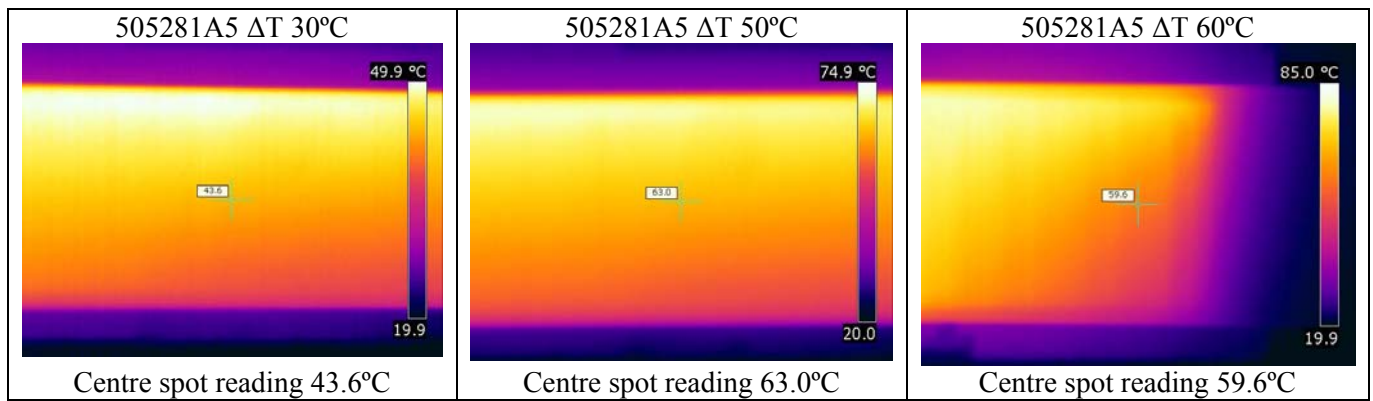
From test results B = 206.5546
 n = 0.3380

VARIATION OF OUTPUT WITH TEMPERATURE DIFFERENCE

TEMPERATURE DIFFERENCE	HEAT OUTPUT
C	W
20	569
30	652
40	719
50	775
60	824
70	868

6 THERMAL IMAGES





7 CONCLUSIONS

The addition of a significant amount of air (50mm below the header) gave a reduction in thermal performance of approximately the 8% at the standard rating condition of 50°C ΔT.

This effect on performance was not seen on most of the infra red images, most likely due to the steel front panel of the radiator conducting and diffusing the heat across the surface, giving similar 'target' temperatures when viewed by the IR camera, at the various test conditions.

With the largest amount of air in the radiator, at the high temperature test condition, there was some visual evidence with the IR image of a flow 'short circuit' within the radiator, giving a colder area towards the right hand side, flow and return being on the left hand side.

Appendix: A Test items.TEST RECORD SHEET TP21/1: TEST ITEMS

Contract number

FS50528A

Sheet number

1 of 1

Please use additional sheets where necessary

Date of receipt	Test Engineer initials	Full description of test item	Test item reference number
15/08/08	AR	White, single panel radiator without fins (600x2000mm) fully filled	50528A1AR
15/08/08	AR	White, single panel radiator without fins (600x2000mm) filled to half header height	50528A2AR
15/08/08	AR	White, single panel radiator without fins (600x2000mm) filled to 1cm below header	50528A3AR
15/08/08	AR	White, single panel radiator without fins (600x2000mm) filled to 2.5cm below header	50528A4AR
15/08/08	AR	White, single panel radiator without fins (600x2000mm) filled to 5.0 cm below header	50528A5AR

Comments:- None

Test Engineer (signature)

Alf Russell

TEST RECORD SHEET TP21/2 : PRODUCT INFORMATION

BSRIA test reference number		50528A1AR
Client		Spirotech BV
Manufacturer		Stelrad
Product reference number		600x2000 Full
Product style		10
Material of construction		Pressed Steel – White Paint
Date of receipt		15/08/08
Product or packaging markings		Weight, manufacturer, size & type
Test start date		18/08/08
Weight (dry)	(kg)	22.6
Water content	(kg)	6.5

DIMENSIONAL MEASUREMENTS

Measurement Parameter	Measured value (mm)	Manufacturer's stated value (mm)	EN 442-2 dimensional tolerance	Pass / Fail
Overall height	600			
Overall depth	14.3			
Overall length	2000		See comment	
Convactor height	0			
Convactor depth	0			

Number of columns per panel		60
Distance installed from the wall	(mm)	80
Distance between centres	(mm)	550
Panel thickness	(mm)	14.3
Convactor overall length	(mm)	0
Convactor thickness	(mm)	0
Spot weld horizontal pitch	(mm)	35
Additional information		T.B.S.E. Height from floor 110

Comments : Not required for audit tests.

TEST ENGINEER (Signature)

Alf Russell

TEST RECORD SHEET TP21/2 : PRODUCT INFORMATION

BSRIA test reference number		50528A2AR
Client		Spirotech BV
Manufacturer		Stelrad
Product reference number		600x2000 Half header
Product style		10
Material of construction		Pressed Steel – White Paint
Date of receipt		15/08/08
Product or packaging markings		Weight, manufacturer, size & type
Test start date		19/08/08
Weight (dry)	(kg)	22.6
Water content	(kg)	N/A

DIMENSIONAL MEASUREMENTS

Measurement Parameter	Measured value (mm)	Manufacturer's stated value (mm)	EN 442-2 dimensional tolerance	Pass / Fail
Overall height	600			
Overall depth	14.3			
Overall length	2000		See comment	
Convactor height	0			
Convactor depth	0			

Number of columns per panel		60
Distance installed from the wall	(mm)	80
Distance between centres	(mm)	550
Panel thickness	(mm)	14.3
Convactor overall length	(mm)	0
Convactor thickness	(mm)	0
Spot weld horizontal pitch	(mm)	35
Additional information		T.B.S.E. Height from floor 110

Comments : Not required for audit tests.

TEST ENGINEER (Signature)

Alf Russell

TEST RECORD SHEET TP21/2 : PRODUCT INFORMATION

BSRIA test reference number		50528A3AR
Client		Spirotech BV
Manufacturer		Stelrad
Product reference number		600x2000 1cm under header
Product style		10
Material of construction		Pressed Steel – White Paint
Date of receipt		15/08/08
Product or packaging markings		Weight, manufacturer, size & type
Test start date		20/08/08
Weight (dry)	(kg)	22.6
Water content	(kg)	N/A

DIMENSIONAL MEASUREMENTS

Measurement Parameter	Measured value (mm)	Manufacturer's stated value (mm)	EN 442-2 dimensional tolerance	Pass / Fail
Overall height	600			
Overall depth	14.3			
Overall length	2000		See comment	
Convactor height	0			
Convactor depth	0			

Number of columns per panel		60
Distance installed from the wall	(mm)	80
Distance between centres	(mm)	550
Panel thickness	(mm)	14.3
Convactor overall length	(mm)	0
Convactor thickness	(mm)	0
Spot weld horizontal pitch	(mm)	35
Additional information		T.B.S.E. Height from floor 110

Comments : Not required for audit tests.

TEST ENGINEER (Signature)

Alf Russell

TEST RECORD SHEET TP21/2 : PRODUCT INFORMATION

BSRIA test reference number		50528A4AR
Client		Spirotech BV
Manufacturer		Stelrad
Product reference number		600x2000 2.5 under header
Product style		10
Material of construction		Pressed Steel – White Paint
Date of receipt		15/08/08
Product or packaging markings		Weight, manufacturer, size & type
Test start date		21/08/08
Weight (dry)	(kg)	22.6
Water content	(kg)	N/A

DIMENSIONAL MEASUREMENTS

Measurement Parameter	Measured value (mm)	Manufacturer's stated value (mm)	EN 442-2 dimensional tolerance	Pass / Fail
Overall height	600			
Overall depth	14.3			
Overall length	2000		See comment	
Convactor height	0			
Convactor depth	0			

Number of columns per panel		60
Distance installed from the wall	(mm)	80
Distance between centres	(mm)	550
Panel thickness	(mm)	14.3
Convactor overall length	(mm)	0
Convactor thickness	(mm)	0
Spot weld horizontal pitch	(mm)	35
Additional information		T.B.S.E. Height from floor 110

Comments : Not required for audit tests.

TEST ENGINEER (Signature)

Alf Russell

TEST RECORD SHEET TP21/2 : PRODUCT INFORMATION

BSRIA test reference number		50528A5AR
Client		Spirotech BV
Manufacturer		Stelrad
Product reference number		600x2000 5cm under header
Product style		10
Material of construction		Pressed Steel – White Paint
Date of receipt		15/08/08
Product or packaging markings		Weight, manufacturer, size & type
Test start date		22/08/08
Weight (dry)	(kg)	22.6
Water content	(kg)	N/A

DIMENSIONAL MEASUREMENTS

Measurement Parameter	Measured value (mm)	Manufacturer's stated value (mm)	EN 442-2 dimensional tolerance	Pass / Fail
Overall height	600			
Overall depth	14.3			
Overall length	2000		See comment	
Convactor height	0			
Convactor depth	0			

Number of columns per panel		60
Distance installed from the wall	(mm)	80
Distance between centres	(mm)	550
Panel thickness	(mm)	14.3
Convactor overall length	(mm)	0
Convactor thickness	(mm)	0
Spot weld horizontal pitch	(mm)	35
Additional information		T.B.S.E. Height from floor 110

Comments : Not required for audit tests.

TEST ENGINEER (Signature)

Alf Russell

Schematic of radiator dimensions

