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Test Report No. C632QPEN

Tests according to EN 12975-2: 2001, Section 5

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1 Description of Collector

1.1 Technical Data of Sample

Product information	
Manufacturer	Focus Technology Co., Ltd
Model	AP-20
Type	ETC with heat pipe and dry coupler
Serial Product	Yes
Drawing Number	--
Serial Number	APSR-20-D-110 APSR-20-D-111
Date when manufactured	07/2003

Sizes	
Gross length	1.929 m
Gross width	1.496 m
Gross height	0.133 m
Gross area	2.886 m ²
Aperture area	1.876 m ²
Absorber area	1.606 m ²
Weight empty	63 kg
Weight without glazing	--
Fluid capacity	0.6 l

Construction	
Type	ETC with heat pipe and dry coupler
Number of absorber elements	20
Absorber pitch	0.070 m
Number of hydraulically parallel tubes	1
Number of thermally serial glazings	1
Material of glazings	Borosilicate glass
Thickness of glazings	1.6 mm

Heat transfer fluid	
Recommended type	Water-Glycol
Specifications	--

Absorber	
Absorber materials	Glass
Length of absorber element	1.725 m
Width of absorber element	--
Thickness of absorber	--
Coating	Graded Al-N/Al on glass
Construction of absorber	Evacuated double glass tube, Heat-conducting metal sheet, Heat pipe Cu

Mounting	
On tilted roof	Yes
In tilted roof	No
On flat roof	No
In flat roof	No
On flat roof with stand	Yes

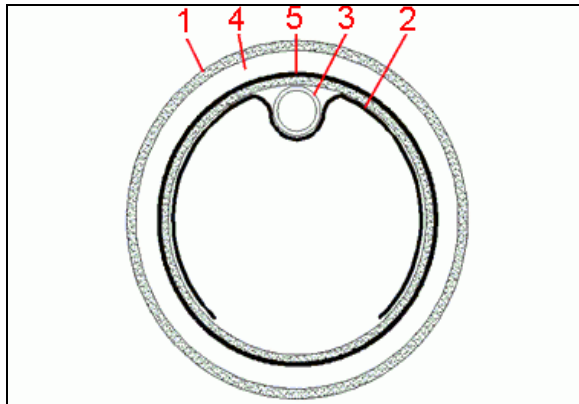
Collector box and Insulation	
Housing material	Stainless steel 0.8 mm
Sealing material	Silicone rubber
Insulation material	Glass Wool
Thickness	--
Aperture dimensions	20 * 1.709 m * 0.0549 m

Limitations	
Maximum temperature	250°C
Maximum pressure	6 bar
Other limitations	--

Test schedule	
Test procedure	EN 12975, Outdoor
Sample received	07.08.2003
Start of test	03.09.2003
End of test	10.03.2004

Remarks on collector design	
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1.2 Sketch of Collector



Key

- 1 Glazing
- 2 Heat conducting metal sheet
- 3 Heat pipe
- 4 Vacuum
- 5 Absorber

1.3 Specifications of Elements

1.3.1 Absorber

Index No.	5
Material(s)	Glass
Construction	Evacuated double glass tube, Heat-conducting metal sheet, Heat pipe Cu
Coating	Graded Al-N/Al on glass

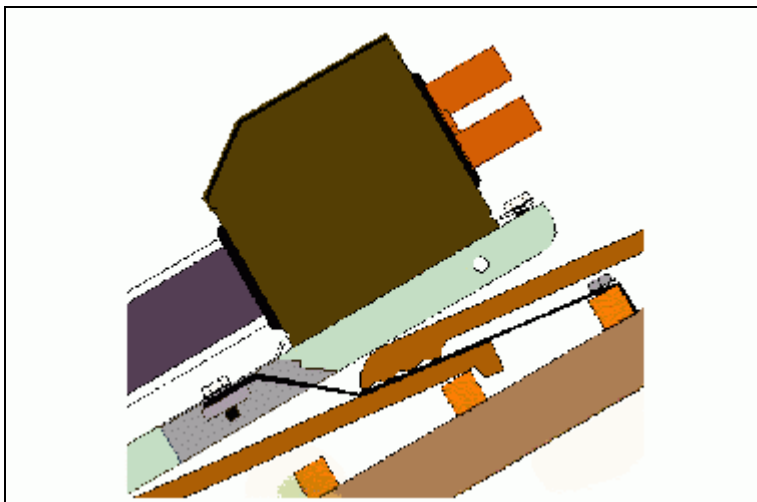
1.3.2 Glazing

Index No.	1
Material	Borosilicate glass
Thickness	1.6 mm

1.4 Photo of Collector



1.5 Schematic of Collector Mounting



Remarks

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2 Test Method and Results

2.1 Tests of Durability

Tests have been performed according to the instructions given in EN 12975-2: 2001, Section 5.

Deviations from these instructions are formatted in the way of this clause and the reason for the deviation is stated.

2.2 Test Sequence and Summary

Test	Start date	End date	Chapter of Standard	Result
Internal pressure	03.09.2003		5.2	passed
High-temperature resistance	04.09.2003		5.3	passed
Exposure	04.09.2003	05.11.2003	5.4	passed
External thermal shock	18.09.2003	25.09.2003	5.5	passed
Internal thermal shock	15.09.2003	17.09.2003	5.6	passed
Rain penetration	04.12.2003		5.7	passed
Freeze resistance	--	--	5.8	not applicable
Internal pressure	05.12.2003		5.2	passed
Thermal performance *	03.12.2003	10.03.2004	6.1 - 6.2 - 6.3	passed
Impact resistance	--	--	5.10	not applicable
Mechanical Load	--	--	5.9	not applicable
Final inspection	05.12.2003	05.12.2003	5.11	passed

Remarks	The order of the tests was adjusted to wishes of the customer and the internal requirements of the testing institute. The marked test (*) has been made on a second collector. The results are transferred according to EN12975 Annex D.
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2.3 Internal Pressure Test

2.3.1 Technical Details of Collector

glazed/unglazed?	glazed
Maximum pressure	600 kPa

2.3.2 Test Conditions

Temperature	20°C
Pressure	900 kPa
Duration	15 min

2.3.3 Test Results

Observation	None.
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2.4 High-Temperature Resistance Test

2.4.1 Method used to heat Collector

Outdoor testing.

2.4.2 Measurement of the Absorber Temperature

Not applicable due to the special collector construction.

2.4.3 Test Conditions

Collector tilt angle (degrees from horizontal)	41.0°
Average irradiance during test	1008.6 W/m ²
Average surrounding air speed	1.6 m/s
Average absorber temperature	n.a.
Duration of test	60 min

The wind speed was higher than the value given as maximum in the standard. While outdoor testing, no other values could be obtained. The effect of this deviation is not significant for vacuum tube collectors.

2.4.4 Test Results

Observations	None.
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Stagnation temperature at 30°C/1000 W/m ²	245°C
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Remarks: Computed according to EN12975-2 Annex C.2, Approach 1

2.5 Exposure Test

2.5.1 Test Method

Outdoor exposure test. Collector mounted on a tracker.

2.5.2 Test Conditions

Part A (2.6.2.1)	Exposition for at least 30 days having minimum daily irradiation $H \geq 14 \text{ MJ/m}^2$.
Part B (2.6.2.2)	Exposition for at least 30 hours at irradiance $G \geq 850 \text{ W/m}^2$ and ambient temperature $T_{\text{amb}} \geq 10^\circ\text{C}$. Minimum duration of every high-irradiance period is $\Delta t \geq 30 \text{ min}$.

2.5.2.1 Climatic Conditions for all Days During the Test (Part A)

Date	H [MJ/m ²]	T _{amb} [°C]	Rain [mm]	Valid days
04.09.2003	14.0	17.4	1.5	1
05.09.2003	14.0	20.6	0	2
06.09.2003	7.5	19.3	0	2
07.09.2003	17.7	20.9	0	3
08.09.2003	13.5	17.7	0	3
09.09.2003	3.1	16.4	18.4	3
10.09.2003	5.7	17.7	1	3
11.09.2003	11.7	15.6	0	3
12.09.2003	14.0	18.1	0	4
13.09.2003	17.6	18.9	0	5
14.09.2003	14.0	16.9	0	6
15.09.2003	5.3	15.7	0	7
16.09.2003	14.0	18.8	0	8
17.09.2003	14.8	20.1	0	9
18.09.2003	14.0	19.2	4	10

Date	H [MJ/m ²]	T _{amb} [°C]	Rain [mm]	Valid days
19.09.2003	14.0	21.2	28	11
20.09.2003	14.0	22.0	13.6	12
21.09.2003	26.6	23.9	17.6	13
22.09.2003	24.5	23.2	29.5	14
23.09.2003	2.3	17.1	27.2	14
24.09.2003	6.1	13.6	24.6	14
25.09.2003	20.0	14.0	3.1	15
26.09.2003	27.1	19.6	5.6	16
27.09.2003	26.2	20.6	4.9	17
28.09.2003	14.1	19.0	0	17
29.09.2003	10.0	14.7	0	17
30.09.2003	23.4	14.6	0	18
01.10.2003	2.5	12.8	0	18
02.10.2003	15.2	19.8	0	19
03.10.2003	6.0	17.5	0.3	19
04.10.2003	1.1	13.7	8.3	19
05.10.2003	1.3	6.7	11.4	19
06.10.2003	17.3	11.7	27.3	20
07.10.2003	1.2	11.9	0	20
08.10.2003	8.3	10.1	0	20
09.10.2003	0.6	11.8	0	20
10.10.2003	4.0	13.8	1.3	20
11.10.2003	27.4	15.3	0.1	21
12.10.2003	20.5	12.8	12.1	22
13.10.2003	24.0	15.6	3.3	23
14.10.2003	1.9	11.0	15.8	23
15.10.2003	19.0	10.5	16.7	24
16.10.2003	9.3	8.4	5.1	24
17.10.2003	--	--	25	24
18.10.2003	--	--	4.7	24
19.10.2003	--	--	2.6	24
20.10.2003	--	--	0	24
21.10.2003	--	--	1.7	24
22.10.2003	--	--	0.4	24
23.10.2003	0.5	5.1	3.5	24
24.10.2003	2.0	2.0	0.4	24
25.10.2003	24.7	4.0	5	25
26.10.2003	19.1	5.5	0	26
27.10.2003	18.1	4.3	2.8	27
28.10.2003	17.9	3.8	0	28
29.10.2003	3.2	8.0	0	28
30.10.2003	9.0	8.7	0	28
31.10.2003	2.6	7.9	0	28
01.11.2003	2.9	8.7	5.4	28
02.11.2003	4.2	9.6	38.4	28
03.11.2003	1.0	7.7	17.8	28
04.11.2003	20.7	11.8	21.3	29
05.11.2003	18.3	8.5	8.8	30

2.5.2.2 Climatic Conditions for all Days During the Test (Part B)

Date / Time	G [W/m²]	T_{amb} [°C]	Δt [min]	Sum [min]
04.09.2003 12:09:00-16:00:00	967.5	23.6	231.0	231.0
05.09.2003 09:10:30-09:45:00	936.8	18.8	34.5	265.5
05.09.2003 11:13:30-13:02:00	962.6	24.5	108.5	374.0
12.09.2003 09:49:00-10:20:30	1002.3	17.5	31.5	405.5
12.09.2003 11:08:30-11:39:30	1013.9	19.0	31.0	436.5
12.09.2003 11:43:00-12:13:00	1035.6	19.8	30.0	466.5
12.09.2003 12:41:30-13:24:00	1049.5	21.1	42.5	509.0
13.09.2003 08:56:30-10:10:00	934.2	18.6	73.5	582.5
14.09.2003 10:50:00-13:48:30	1015.7	21.8	178.5	761.0
16.09.2003 11:45:30-14:01:30	1010.6	19.5	136.0	897.0
16.09.2003 16:02:00-16:34:00	884.2	21.1	32.0	929.0
16.09.2003 09:47:00-10:33:00	969.8	20.1	46.0	975.0
16.09.2003 12:24:00-15:01:30	960.0	24.2	157.5	1132.5
18.09.2003 09:54:00-10:24:00	890.1	17.1	30.0	1162.5
18.09.2003 13:53:00-14:23:00	937.3	23.8	30.0	1192.5
18.09.2003 15:11:30-15:41:30	907.5	25.3	30.0	1222.5
19.09.2003 12:24:30-15:11:30	982.9	28.1	167.0	1389.5
19.09.2003 10:54:30-14:52:30	938.2	28.0	238.0	1627.5
19.09.2003 11:19:30-14:59:30	933.2	27.5	220.0	1847.5

2.5.3 Test Results

2.5.3.1 Observations

Observations	None.
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2.5.3.2 Evaluation

Evaluation according to the following scale:

0 – No problem

1 – Minor problem

2 – Severe problem

* - Inspection to establish the condition was not possible

Collector component	Potential problem	Value
Collector box/fasteners	Cracking, warping, corrosion rain penetration, strength, safety	0
Mountings/structure	Strength, safety	0
Seals/gaskets	Cracking, adhesion, elasticity	0
Cover, reflector	Cracking, crazing, buckling, delamination, warping, outgassing	0
Absorber coating	Cracking, crazing, blistering	0
Absorber tubes and headers	Deformation, corrosion, leakage, loss of bonding	0
Absorber mountings	Deformation, corrosion	0
Insulation	Water retention, outgassing, degradation	0

2.6 External Thermal Shock

2.6.1 Test Method

Outdoor test.

2.6.2 Assessment of Absorber Temperature

No measurement of the absorber temperature during the test.

2.6.3 Test Conditions

Shock-No.		1	2
Conditioning phase			
Collector tilt angle	°	68.7	68.8
Average irradiance	W/m ²	927	901
Minimum irradiance	W/m ²	897	867
Average surrounding temperature	°C	26.8	18.3
Period during which the required conditions were maintained	Min	> 60	> 50
Shock			
Spray rate	l/(s·m ²)	> 0.05	> 0.05
Water temperature	°C	ca. 15	ca. 15
Duration of water spray	Min	15	15
Absorber temperature immediately prior to water spray	°C	n.a.	n.a.
Test combined with 2.6 "Exposure Test"			
		Yes	Yes
Test combined with 2.5 "High-Temperature Resistance Test"			
		No	No

2.6.4 Test Results

Observations	None.
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2.7 Internal Thermal Shock

2.7.1 Test method

Outdoor test

2.7.2 Assessment of Absorber Temperature

No measurement of the absorber temperature during the test.

2.7.3 Test Conditions

Shock-No.		1	2
Conditioning phase			
Collector tilt angle	°	57.0	45.9
Average irradiance	W/m ²	990	990
Minimum irradiance	W/m ²	972	905
Average surrounding temperature	°C	19.9	20.9
Period during which the required conditions were maintained	min	> 60	> 60
Shock			
Flow rate of heat transfer fluid	l/(s·m ²)	> 0.05	> 0.05
Temperature of heat transfer fluid	°C	ca. 15	ca. 15
Duration of heat transfer fluid flow	min	5	5
Absorber temperature immediately prior to water spray	°C	n.a.	n.a.

2.7.4 Test Results

Observations	None.
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2.8 Rain penetration test

2.8.1 Test method

Outdoor test. Collector mounted on an open frame at a tilt angle of 30° to horizontal.

The collector was sprayed from all sides

2.8.2 Assessment of potential leaks

By a) inspection

2.8.3 Test Conditions

Water spray for 4 hours with a spray rate of more than 0.05 l/sm².

2.8.4 Test Results

a) Inspection

Observations	None.
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2.9 Internal Pressure Test (Re-Test)

2.9.1 Test Conditions

Temperature	20°C
Pressure	900 kPa
Duration	15 min

2.9.2 Test Results

Observation	None.
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2.10 Final Inspection

Evaluation according to the following scale:

0 – No problem

1 – Minor problem

2 – Severe problem

* - Inspection to establish the condition was not possible

Collector component	Potential problem	Value
Collector box/fasteners	Cracking, warping, corrosion, rain penetration, strength, safety.	0
Mountings/structure	Strength, safety	0
Seals/gaskets	Cracking, adhesion, elasticity	0
Cover, reflector	Cracking, crazing, buckling, delamination, warping, outgassing	0
Absorber coating	Cracking, crazing, blistering	0
Absorber tubes and headers	Deformation, corrosion, leakage, loss of bonding	0
Absorber mountings	Deformation, corrosion	0
Insulation	Water retention, outgassing, degradation	0

3 Remarks

This report may not be copied except in full.

This test report refers only to the item(s) tested.

This test report is according to the requirements of ISO 17025.

Rapperswil, 22.03.2004



Dr. Andreas Bohren
Head of Collector Department



Dipl.-Ing. Walter Gubler
Test Engineer