

Orderer:

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Test Report No. C814QPEN

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

Content:	page
1 Description of Collector	2
1.1 Technical data of sample	2
1.2 Sketch of collector	3
1.3 Specifications on elements	3
1.4 Photo of collector	5
1.5 Schematic of collector mounting	5
2 Test methods and results	6
2.1 Tests of Durability	6
2.2 Test Sequence and Summary	6
2.3 Internal pressure test	7
2.4 High-Temperature Resistance Test	7
2.5 Exposure test	8
2.6 External Thermal Shock	11
2.7 Internal thermal Shock	12
2.8 Rain penetration test	13
2.9 Mechanical load test	14
2.10 Combined mechanical load- and rain penetration test *	15
2.11 Impact resistance test	16
2.12 Final inspection	17
3 Remarks	18

*) Supplementary tests according to SPF internal guidelines.
Not part of the test procedure according to the European standard.

1 Description of Collector

1.1 Technical data of sample

Product information	
Manufacturer	Viridian Solar Limited
Model	V30
Type	Flat plate collector
Flow	Serpentine
Serial product	Yes
Drawing number	VS-1
Serial number	VS30-004
Date of manufacture	01.08.2006

Physical parameters	
Gross length	2.895 m
Gross width	1.168 m
Gross height	0.088 m
Gross area	3.381 m ²
Aperture area	3.097 m ²
Absorber area	3.007 m ²
Weight (empty, incl. cover)	59.5 kg
Fluid capacity	1.4 l

Construction	
Type	Flat plate collector
Number of absorber elements	1
Absorber pitch	141 mm
Number of hydraulically parallel tubes	1
Number of thermally serial glazings	Single-glazed
Material of glazing(s)	Toughened glass
Thickness of glazing(s)	4.0 mm

Heat transfer fluid (manufacturer recommendation)	
Type	Water-glycol
Specifications	--

Remarks on collector design	
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Absorber	
Absorber element	Aluminium sheet
Length of absorber element	2800 mm
Width of absorber element	1074 mm
Thickness of absorber element	0.5 mm
Coating	Ceramic-metal-structure (Cermet)
Flowed through element	Copper tube
Joining technique	Laser welded
Seam	--

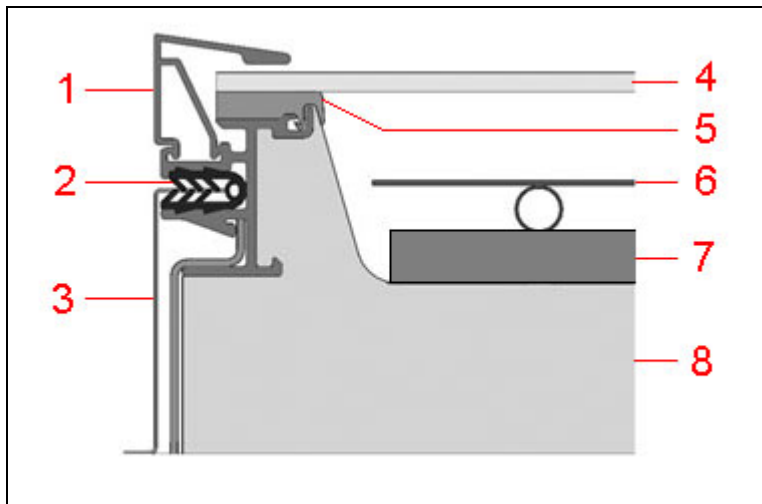
Installation	
On tilted roof	No
In tilted roof	Yes
On flat roof	No
On flat roof with stand	Yes
Facade	No

Casing and insulation	
Casing material	Aluminium
Sealing material	EPDM, Silicone
Insulation material	Mineral wool, Polyurethane foam
Thickness (in mm)	16, 20
Aperture dimensions	2.823 m * 1.097 m

Limitations (manufacturer information)	
Max. temperature	200°C
Max. pressure	3 bar
Other	--

Test schedule	
Test procedure	EN 12975, Outdoor
Sample received	09.08.2006
Start of test	24.08.2006
End of test	24.11.2006

1.2 Sketch of collector



1.3 Specifications on elements

1	Frame Type of construction: Material: Profile: Corners:	Frame Aluminium Extruded profile Riveted corners with corner joints
2	Sealing profile Description:	EPDM
3	Sheet metal surround Description:	Aluminum
4	Glazing Tradename: Material: Thickness [mm]:	Solite Toughened glass 4
5	Sealing Description:	Silicone
6	Absorber Absorber element: Flow-through element: Length of element [mm]: Width of element [mm]: Flow type: Joining technique:	Aluminium sheet Copper tube 2800 1074 serial Laser welded
6	Absorber coating Tradename: Description: Manufacturing process:	Miro Therm Ceramic-metal-structure (Cermet) Physical vapour deposition (PVD)
7	Thermal insulation Material: Thickness [mm]:	Mineral wool 16

8 Thermal insulation

Material:	Polyurethane foam
Lamination:	Aluminum on both sides
Thickness [mm]:	20

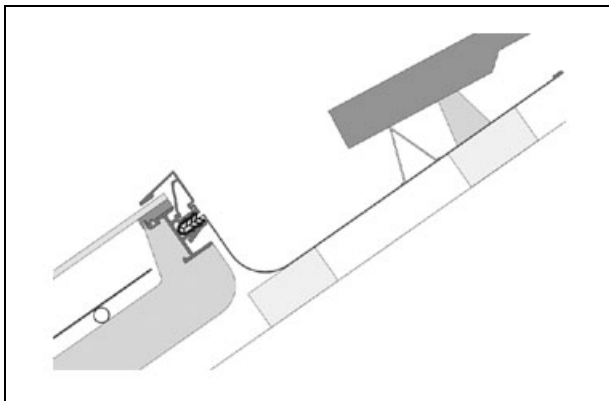
8 Casing

Type of construction:	Casing
Material:	Polyurethane foam
Coating:	Aluminium on both sides

1.4 Photo of collector



1.5 Schematic of collector mounting



2 Test methods and results

2.1 Tests of Durability

Tests carried out according to EN 12975-2: 2001.

*Deviations from these test directions are marked with an *) and highlighted by italic writing.*

2.2 Test Sequence and Summary

Test	Date of test	Chap. of Standard	Result
Internal pressure	24.08.2006	5.2	Passed
High-temperature resistance	13.09.2006	5.3	Passed
Exposure	24.08.2006 – 11.10.2006	5.4	Passed
External thermal shock	Shock No.1 12.09.2006	5.5	Passed
	Shock No.2 13.09.2006		Passed
Internal thermal Shock	Shock Nr.1 12.09.2006	5.6	Passed
	Shock Nr.2 12.09.2006		Passed
Rain penetration	20.11.2006	5.7	Passed
Freeze resistance	--	5.8	N/A
Thermal performance	22.08.2006 - 12.10.2006	6.1 - 6.2 - 6.3	Passed
Impact resistance	24.11.2006	5.10	Passed
Mechanical Load	23.11.2006	5.9	Passed
Final inspection	24.11.2006	5.11	Passed

Remarks	The test sequence may have been adapted to the internal requirements of the test institute. The test "Thermal Performance" may have been made with a conformity-checked second collector.
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2.3 Internal pressure test

2.3.1 Remarks

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2.3.2 Technical details of collector

Glazed/unglazed?	Glazed
Maximum pressure (manufacturer information)	300 kPa

2.3.3 Test conditions

Surrounding temperature	20°C
Test pressure	450 kPa
Duration	15 min

2.3.4 Test results

Observations	None
Major failures	None

2.4 High-Temperature Resistance Test

2.4.1 Remarks on test procedure

Outdoor

Temperature sensor attached to the rear side of the absorber.

2.4.2 Test conditions

Collector tilt angle (degrees from horizontal)	45.1°
Average irradiance during test	1008 W/m ²
Minimum irradiance during test	1000 W/m ²
Average surrounding air speed	1.1 m/s
Average surrounding temperature	25.6°C
Minimum surrounding temperature	24.4°C
Average absorber temperature	198.1°C
Duration of test	>60 min

2.4.3 Test results

Observations	None
Major failures	None

2.4.4 Determination of stagnation temperature

Temperature sensor attached to the rear side of the absorber.

Stagnation temperature for 30°C/1000 W/m ²	201°C
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2.5 Exposure test

2.5.1 Remarks on test procedure

Outdoor exposure test. Collector installed on a tracker.

2.5.2 Test conditions

Part A (2.6.2.1)	Exposition for at least 30 days with a 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 $\Delta t \geq 30 \text{ min}$.

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

Date	H [MJ/m ²]	T _{amb} [°C]	Rain [mm]	Valid days
24.08.2006	7.1	16.0	6.2	0
25.08.2006	14.0	15.7	0.0	1
26.08.2006	14.0	14.9	28.7	2
27.08.2006	2.7	13.9	20.6	2
28.08.2006	5.0	14.0	24.5	2
29.08.2006	6.1	12.2	37.4	2
30.08.2006	7.5	11.7	11.7	2
31.08.2006	14.0	13.7	0.0	3
01.09.2006	14.0	14.0	0.0	4
02.09.2006	13.0	18.2	0.4	4
03.09.2006	10.1	19.2	0.0	4
04.09.2006	14.0	21.2	0.0	5
05.09.2006	14.0	20.8	0.0	6
06.09.2006	14.0	19.7	0.1	7
07.09.2006	14.2	21.1	31.1	8
08.09.2006	16.3	17.2	0.0	9
09.09.2006	27.6	16.1	0.0	10
10.09.2006	20.1	18.5	2.3	11
11.09.2006	22.2	20.5	0.0	12
12.09.2006	31.2	20.2	0.0	13
13.09.2006	30.8	20.2	0.0	14
14.09.2006	13.7	19.9	1.3	14
15.09.2006	11.6	18.5	0.0	14
16.09.2006	14.3	17.8	31.2	15
17.09.2006	2.0	15.5	31.5	15
18.09.2006	1.6	14.8	10.5	15
19.09.2006	12.4	15.7	0.0	15
20.09.2006	29.3	17.1	0.0	16
21.09.2006	31.7	17.8	0.0	17
22.09.2006	30.8	18.8	0.0	18
23.09.2006	23.2	18.1	0.0	19
24.09.2006	21.8	19.0	0.0	20
25.09.2006	1.7	15.4	18.9	20
26.09.2006	4.8	13.9	2.6	20
27.09.2006	12.2	15.8	0.0	20
28.09.2006	17.9	15.4	0.0	21
29.09.2006	27.9	16.6	6.0	22

Date	H [MJ/m ²]	T _{amb} [°C]	Rain [mm]	Valid days
30.09.2006	18.0	17.2	16.1	23
01.10.2006	3.1	15.3	16.8	23
02.10.2006	14.1	12.6	0.0	24
03.10.2006	6.5	16.7	13.5	24
04.10.2006	10.9	12.4	0.6	24
05.10.2006	14.7	11.5	3.3	25
06.10.2006	14.1	12.4	4.0	26
07.10.2006	5.6	12.8	0.0	26
08.10.2006	30.1	11.7	0.0	27
09.10.2006	28.2	13.2	0.0	28
10.10.2006	28.0	13.9	0.0	29
11.10.2006	24.5	13.4	0.0	30

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

Date / Time	G [W/m ²]	T _{amb} [°C]	Δt [min]	Sum [min]
25.08.2006 09:40:00-12:01:30	1038.5	19.4	141.5	141.5
26.08.2006 08:12:00-09:21:30	936.1	16.6	69.5	211.0
26.08.2006 09:33:30-10:09:30	1023.2	18.5	36.0	247.0
26.08.2006 10:33:30-11:03:30	1018.2	20.0	30.0	277.0
26.08.2006 12:18:00-12:48:00	1040.8	22.8	30.0	307.0
26.08.2006 13:28:00-13:58:00	1042.4	23.6	30.0	337.0
31.08.2006 08:00:30-13:36:30	999.0	17.1	336.0	673.0
01.09.2006 11:11:30-16:45:30	982.5	23.0	334.0	1007.0
04.09.2006 09:47:00-10:24:00	965.1	23.7	37.0	1044.0
04.09.2006 12:25:30-14:51:30	981.0	28.5	146.0	1190.0
05.09.2006 11:05:30-16:19:30	969.4	28.2	314.0	1504.0
06.09.2006 08:53:30-09:57:00	958.4	21.0	63.5	1567.5
07.09.2006 08:17:30-10:57:00	936.4	21.9	159.5	1727.0
07.09.2006 11:37:30-12:49:00	1026.7	27.9	71.5	1798.5
08.09.2006 11:43:00-12:49:00	1050.8	19.8	66.0	1864.5

2.5.5 Test results

2.5.5.1 Observations and evaluation

Evaluation according to the following key:

0 – no problem

1 – Minor problem

2 – Severe problem

* – Inspection to establish the condition was not possible

Collector component	Potential problem	Result
Collector box / fastener	Cracking / warping / corrosion / rain penetration	0
Collector mounting / structure	Strength / safety	0
Seals / gaskets	Cracking / adhesion / elasticity	0
Covers / reflectors	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
Major failures	None	

2.6 External Thermal Shock

2.6.1 Remarks on test procedure

Shock-No.1: Outdoor
Temperature sensor attached to the rear side of the absorber.
Shock-No.2: Outdoor
Temperature sensor attached to the rear side of the absorber.

2.6.2 Test conditions

Shock-No.		1	2
Conditioning phase			
Collector tilt angle	°	56.8	45.1
Average irradiance	W/m ²	966	1008
Minimum irradiance	W/m ²	934	1000
Average surrounding temperature	°C	27.2	25.6
Minimum surrounding temperature	°C	26.6	24.4
Period during which the required conditions were maintained before the shock	min	> 60	> 60
Shock			
Spray rate per m ²	l/(s·m ²)	0.03 – 0.05	0.03 – 0.05
Water temperature	°C	ca. 15	ca. 15
Duration of water spray	min	15	15
Absorber temperature prior to water spray	°C	196.4	198.2
Test combined with „Exposure Test”			
		Yes	Yes
Test combined with „High-Temperature Resistance Test”			
		No	Yes

2.6.3 Test results

Observations	Shock Nr.1	None
	Shock Nr.2	None
Major failures	Shock Nr.1	None
	Shock Nr.2	None

2.7 Internal thermal Shock

2.7.1 Remarks on test procedure

Shock-No.1: Outdoor
Temperature sensor attached to the rear side of the absorber.

Shock-No.2: Outdoor
Temperature sensor attached to the rear side of the absorber.

2.7.2 Test conditions

Shock-No.		1	2
Conditioning phase			
Collector tilt angle	°	45.6	45.9
Average irradiance	W/m ²	997	1012
Minimum irradiance	W/m ²	962	1006
Average surrounding temperature	°C	23.2	26.6
Minimum surrounding temperature	°C	22.5	25.7
Period during which the required conditions were maintained before the shock	Min	> 60	> 60
Shock			
Flow rate of water	l/(s·m ²)	≥ 0.02	≥ 0.02
Temperature of water prior to the shock	°C	ca. 15	ca. 15
Duration of water flow	Min	5	5
Absorber temperature prior to the shock	°C	194.3	198.3
Test combined with „Exposure Test“			
		Yes	Yes
Test combined with „High-Temperature Resistance Test“			
		No	Yes

2.7.3 Test results

Observations	Shock No.1	None
	Shock No.2	None
Major failures	Shock No.1	None
	Shock No.2	None

2.8 Rain penetration test

2.8.1 Remarks on test procedure

Outdoor test.

The absorber of the collector is kept warm by circulating hot water at about 50 °C through the absorber.

The collector is protected from solar irradiance.

Collector installed on an open frame. Spraying from all sides.

In-roof collector only: No spraying from the rear side

2.8.2 Test conditions

Collector tilt angle (degrees from horizontal)	30°
Flow rate of water	>0.05 l/(s·m ²)
Temperature of water spray	<30°C
Duration of water spray	4 hours

2.8.3 Determination of water penetration

Detection of ingress of water by the following method(s)

- a) Visual inspection
- b) Humidity measurement

2.8.4 Humidity measurement

Time	Absolute humidity [g/kg]
12.0 h prior to test	6.5
36.0 h after test	6.4

2.8.5 Test results

Observations	None
Major failures	None

2.9 Mechanical load test

2.9.1 Positive pressure test of the collector cover

2.9.1.1 Method used to apply pressure

Positive pressure is applied by means of evenly distributed pneumatically actuated suction cups.

2.9.1.2 Test conditions

Maximum pressure load	1000 Pa
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2.9.2 Negative pressure test of fixings between the cover and the collector box

2.9.2.1 Method used to apply pressure

Negative pressure is applied by means of evenly distributed pneumatically actuated suction cups.

2.9.2.2 Test conditions

Maximum pressure load	1000 Pa
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2.9.3 Negative pressure test of collector mountings

2.9.3.1 Method used to apply pressure

Negative pressure is applied by means of evenly distributed pneumatically actuated suction cups.

2.9.3.2 Test conditions

Maximum pressure load	1000 Pa
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2.9.4 Test results

Observations	None
Major failures	None

2.10 Combined mechanical load- and rain penetration test *

*) Test according to SPF- internal guidelines, not part of the standard test procedure.

2.10.1 Remarks on test procedure

Out door test.

The absorber of the collector is kept warm by circulating hot water at about 50 °C through the absorber.

The collector is protected from solar irradiance.

Collector installed on an open frame. Spraying from all sides.

In-roof collector only: No spraying from the rear side.

Positive and negative pressure is applied by means of evenly distributed pneumatically actuated suction cups.

Repeated cycles of positive and negative loads of 10 sec duration each.

2.10.2 Test conditions

Collector tilt angle (degrees from horizontal)	30°
Flow rate of water	>0.05 l/(s·m ²)
Temperature of water spray	<30°C
Maximum pressure load	600 Pa
Duration of test	180 load cycles

2.10.3 Determination of water penetration

Detection of ingress of water by the following method(s)

a) Visual inspection

2.10.4 Test results

Observations	None
Major failures	None

2.11 Impact resistance test

2.11.1 Remarks on test procedure

Steel balls with diameter 33.34mm and mass of 150g. Horizontal impact.

2.11.2 Test procedure

Drop height [m]	No. of drops
0.4	10
0.6	10
0.8	10
1.0	10
1.2	10
1.4	10
1.6	10
1.8	10
2.0	10

2.11.3 Test results

Observations	None
Major failures	None

2.12 Final inspection

2.12.1.1 Observations and evaluation

Evaluation according to the following key:

0 – no problem

1 – Minor problem

2 – Severe problem

* – Inspection to establish the condition was not possible

Collector component	Potential problem	Result
Collector box / fastener	Cracking / warping / corrosion / rain penetration	0
Collector mounting / structure	Strength / safety	0
Seals / gaskets	Cracking / adhesion / elasticity	0
Covers / reflectors	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 issued according to the requirements of ISO 17025.

Rapperswil, 19.12.2006



Dr. Andreas Bohren
Head of collector department



Dipl.-Ing. Walter Gubler
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