

Orderer:

EKOSOLARIS, a.s.  
Jozky Silneho 2684

CZ-76701 Kromeriz

Tel. +420 573 330 344  
Fax: +420 573 330 343

# Test Report No. C799QPEN

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

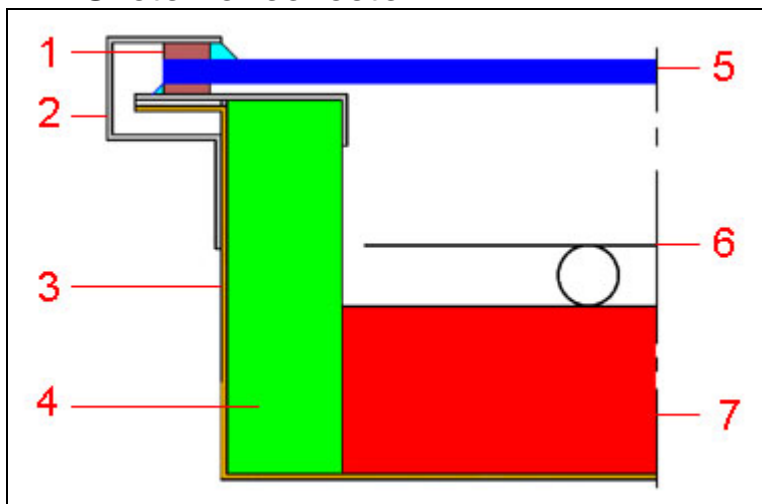
Content:	page
1 Description of Collector .....	2
1.1 Technical data of sample .....	2
1.2 Sketch of collector .....	3
1.3 Specifications on elements .....	3
1.4 Photo of collector .....	4
1.5 Schematic of collector mounting .....	4
2 Test methods and results .....	5
2.1 Tests of Durability .....	5
2.2 Test Sequence and Summary .....	5
2.3 Internal pressure test .....	6
2.4 High-Temperature Resistance Test .....	6
2.5 Exposure test .....	7
2.6 External Thermal Shock .....	10
2.7 Internal thermal Shock .....	11
2.8 Rain penetration test .....	12
2.9 Mechanical load test .....	13
2.10 Final inspection .....	13
3 Remarks .....	14

# 1 Description of Collector

## 1.1 Technical data of sample

Product information		Absorber	
Manufacturer	EKOSOLARIS, a.s.	Absorber element	Copper fins
Model	Therma Blue	Length of absorber element	1940 mm
Type	Flat plate collector	Width of absorber element	105.0 mm
Flow	Parallel grid	Thickness of absorber element	0.2 mm
Serial product	Yes	Coating	Ceramic-metal-structure (Cermet)
Drawing number	--	Flowed through element	Copper tube
Serial number	--	Joining technique	Ultrasonic-welded
Date of manufacture	01.04.2006	Seam	Blank
Physical parameters		Installation	
Gross length	2.070 m	On tilted roof	Yes
Gross width	1.109 m	In tilted roof	No
Gross height	0.101 m	On flat roof	No
Gross area	2.296 m <sup>2</sup>	On flat roof with stand	Yes
Aperture area	2.059 m <sup>2</sup>	Facade	Yes
Absorber area	2.040 m <sup>2</sup>	Casing and insulation	
Weight (empty, incl. cover)	40.5 kg	Casing material	Aluminium
Fluid capacity	1.7 Litre	Sealing material	EPDM
Construction		Insulation material	Rockwool, Rockwool
Type	Flat plate collector	Thickness (in mm)	20, 50
Number of absorber elements	10	Aperture dimensions	2.015 m * 1.022 m
Absorber pitch	101 mm	Limitations (manufacturer information)	
Number of hydraulically parallel tubes	10	Max. temperature	140°C
Number of thermally serial glazings	Single-glazed	Max. pressure	6 bar
Material of glazing(s)	Toughened glass	Other	--
Thickness of glazing(s)	3.2 mm	Test schedule	
Heat transfer fluid (manufacturer recommendation)		Test procedure	EN 12975, Outdoor
Type	Water-Propyleneglycol	Sample received	31.05.2006
Specifications	--	Start of test	01.09.2006
Remarks on collector design		End of test	20.11.2006
--			

## 1.2 Sketch of collector



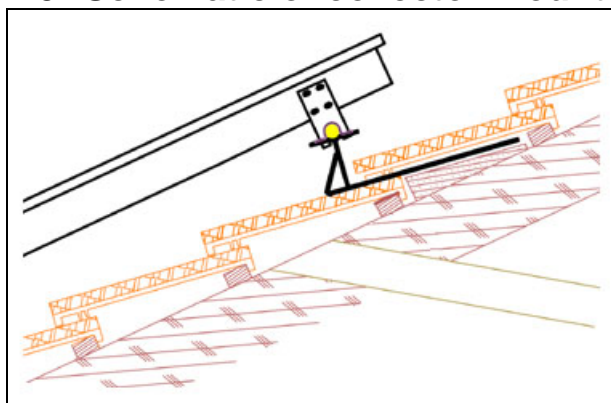
## 1.3 Specifications on elements

<b>1</b>	<b>Sealing</b> Description:	EPDM
<b>2</b>	<b>Glass fixing profile</b> Description:	Aluminum
<b>3</b>	<b>Frame</b> Type of construction: Material:	Casing Aluminium
<b>4</b>	<b>Lateral thermal insulation</b> Material: Lamination: Thickness [mm]: Remarks:	Rockwool None 20 only left and right
<b>5</b>	<b>Glazing</b> Tradename: Material: Thickness [mm]:	Albarino T Toughened glass 3.2
<b>6</b>	<b>Absorber</b> Absorber element: Flow-through element: Length of element [mm]: Width of element [mm]: Flow type: Joining technique: Joining seam:	Copper fins Copper tube 1940 105 Parallel grid Ultrasonic-welded Blank
<b>6</b>	<b>Absorber coating</b> Tradename: Description: Manufacturing process:	EtaPlus Ceramic-metal-structure (Cermet) sputtering
<b>7</b>	<b>Thermal insulation</b> Material: Lamination: Thickness [mm]:	Rockwool Black glass fleece 50

## 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.

### 2.2 Test Sequence and Summary

Test	Date of test	Chap. of Standard	Result
Internal pressure	13.11.2006	5.2	Passed
High-temperature resistance	13.09.2006	5.3	Passed
Exposure	01.09.2006 - 17.10.2006	5.4	Passed
External thermal shock	Shock No.1	12.09.2006	Passed
	Shock No.2	13.09.2006	Passed
Internal thermal Shock	Shock Nr.1	12.09.2006	Passed
	Shock Nr.2	12.09.2006	Passed
Rain penetration	08.11.2006	5.7	Passed
Freeze resistance	--	5.8	N/A
Thermal performance	26.07.2006 - 04.09.2006	6.1 - 6.2 - 6.3	Passed
Impact resistance	--	5.10	N/A
Mechanical Load	11.10.2006	5.9	Passed
Final inspection	20.11.2006	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. The test "Mechanical Load" was made with an other conformity checked collector.
---------	---

## 2.3 Internal pressure test

### 2.3.1 Remarks

--

### 2.3.2 Technical details of collector

Glazed/unglazed?	Glazed
Maximum pressure (manufacturer's information)	6 bar

### 2.3.3 Test conditions

Surrounding temperature	20°C
Test pressure	10 bar
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)	45.0°
Average irradiance during test	1008 W/m <sup>2</sup>
Minimum irradiance during test	1000 W/m <sup>2</sup>
Average surrounding air speed	1.1 m/s
Average surrounding temperature	25.6°C
Minimum surrounding temperature	24.4°C
Average absorber temperature	192.3°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 <sup>2</sup>	195°C
---	-------

## 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 <sup>2</sup> ]	T <sub>amb</sub> [°C]	Rain [mm]	Valid days
01.09.2006	14.0	14.8	0.0	1
02.09.2006	8.5	18.2	0.4	1
03.09.2006	5.2	19.2	0.0	1
04.09.2006	14.2	21.6	0.0	2
05.09.2006	18.9	22.8	0.0	3
06.09.2006	10.7	19.8	0.1	3
07.09.2006	17.8	21.3	31.1	4
08.09.2006	9.9	17.4	0.0	4
09.09.2006	19.5	15.6	0.0	5
10.09.2006	19.6	18.5	2.3	6
11.09.2006	19.0	20.2	0.0	7
12.09.2006	14.0	19.1	0.0	8
13.09.2006	14.0	18.6	0.0	9
14.09.2006	13.7	19.9	1.3	9
15.09.2006	11.6	18.5	0.0	9
16.09.2006	14.3	17.8	31.2	10
17.09.2006	2.0	15.5	31.5	10
18.09.2006	1.6	14.8	10.5	10
19.09.2006	12.4	15.7	0.0	10
20.09.2006	14.0	15.9	0.0	11
21.09.2006	14.0	16.1	0.0	12
22.09.2006	30.8	18.8	0.0	13
23.09.2006	23.2	18.1	0.0	14
24.09.2006	21.8	19.0	0.0	15
25.09.2006	1.7	15.4	18.9	15
26.09.2006	4.8	13.9	2.6	15
27.09.2006	12.2	15.8	0.0	15
28.09.2006	17.9	15.4	0.0	16
29.09.2006	27.9	16.6	6.0	17
30.09.2006	18.0	17.2	16.1	18
01.10.2006	3.1	15.3	16.8	18
02.10.2006	14.1	12.6	0.0	19
03.10.2006	6.5	16.7	13.5	19
04.10.2006	10.9	12.4	0.6	19
05.10.2006	14.7	11.5	3.3	20
06.10.2006	14.1	12.4	4.0	21
07.10.2006	5.6	12.8	0.0	21

Date	H [MJ/m <sup>2</sup> ]	T <sub>amb</sub> [°C]	Rain [mm]	Valid days
08.10.2006	30.1	11.7	0.0	22
09.10.2006	28.2	13.2	0.0	23
10.10.2006	28.0	13.9	0.0	24
11.10.2006	24.5	13.4	0.0	25
12.10.2006	24.8	14.1	0.0	26
13.10.2006	18.0	14.2	0.0	27
14.10.2006	5.0	14.9	0.0	27
15.10.2006	15.1	13.7	0.0	28
16.10.2006	19.7	12.5	0.0	29
17.10.2006	27.8	12.9	0.0	30

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

Date / Time	G [W/m <sup>2</sup> ]	T <sub>amb</sub> [°C]	Δt [min]	Sum [min]
01.09.2006 10:47:30-15:22:30	927.7	22.3	275.0	275.0
04.09.2006 10:22:30-11:51:30	881.4	26.6	89.0	364.0
04.09.2006 13:19:00-13:49:00	860.8	28.8	30.0	394.0
07.09.2006 09:18:30-09:54:30	867.2	21.8	36.0	430.0
07.09.2006 10:08:00-10:41:00	885.4	23.2	33.0	463.0
07.09.2006 12:02:30-12:36:00	934.3	28.1	33.5	496.5
09.09.2006 10:23:00-11:03:30	977.0	17.9	40.5	537.0
09.09.2006 11:57:00-12:29:00	988.4	20.1	32.0	569.0
09.09.2006 13:32:00-14:21:00	930.6	21.7	49.0	618.0
11.09.2006 10:14:00-11:00:00	966.1	23.0	46.0	664.0
11.09.2006 11:52:00-12:29:30	940.1	24.4	37.5	701.5
12.09.2006 08:46:30-13:38:00	983.0	23.5	291.5	993.0
13.09.2006 10:36:30-15:21:30	977.9	25.6	285.0	1278.0
15.09.2006 14:42:30-15:58:00	938.7	22.4	75.5	1353.5
20.09.2006 09:16:00-10:42:30	949.5	18.1	86.5	1440.0
20.09.2006 12:05:30-15:04:30	955.1	22.9	179.0	1619.0
21.09.2006 10:38:30-15:36:30	988.3	22.9	298.0	1917.0

## 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	°	56.9	45.2
Average irradiance	W/m <sup>2</sup>	964	1008
Minimum irradiance	W/m <sup>2</sup>	910	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 <sup>2</sup>	l/(s·m <sup>2</sup> )	0.02 – 0.05	0.02 – 0.05
Water temperature	°C	ca. 15	ca. 15
Duration of water spray	min	15	15
Absorber temperature prior to water spray	°C	192.1	192.3
Test combined with „Exposure Test”			
		Yes	Yes
Test combined with „High-Temperature Resistance Test”			
		No	No

### 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	°	45.1	46.6
Average irradiance	W/m <sup>2</sup>	1001	1010
Minimum irradiance	W/m <sup>2</sup>	962	1002
Average surrounding temperature	°C	23.5	26.8
Minimum surrounding temperature	°C	22.5	25.8
Period during which the required conditions were maintained before the shock	Min	> 60	> 60
Shock			
Flow rate of water	l/(s·m <sup>2</sup> )	> 0.03	> 0.03
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	190.4	193.5
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

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

### 2.8.2 Test conditions

Collector tilt angle (degrees from horizontal)	30°
Flow rate of water	>0.05 l/(s·m <sup>2</sup> )
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 h prior to test	4.2
12 h after test	7.0
60 h after test	4.1

### 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
-----------------------	---------

### 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
-----------------------	---------

### 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
-----------------------	---------

### 2.9.4 Test results

Observations	None
Major failures	None

## 2.10 Final inspection

### 2.10.1.1 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, 02.02.2007



Dr. Andreas Bohren  
Head of collector department



Dipl.-Ing. Walter Gubler  
Test engineer