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STS 301

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Test Report No. C1030LPEN

Performance test according to EN 12975-2:2006, Paragraph 6

Content: **page**

1 Description of Collector

1.1 Technical Data of the Sample

Product information	
Manufacturer	HEWALEX
Model	KSR10
Type	Evacuated tube collector
Flow	Direct flow
Serial product	Yes
Drawing number	A complete set of technical drawings is filed at the test institute.
Serial number	0854
Date of manufacture	04.12.2008

Physical parameters	
Gross length	2.130 m
Gross width	0.856 m
Gross heigth	0.116 m
Gross area	1.823 m²
Aperture area	1.014 m²
Absorber area	0.931 m²
Weight empty	30.0 kg
Fluid capacity	1.8 l

Construction	
Type	Evacuated tube collector
Number of absorber elements	10
Absorber pitch	76.7 mm
Number of hydraulically parallel tubes	10
Number of thermally serial glazings	1
Material of glazing(s)	Glass tube
Thickness of glazing(s)	1.8 mm

Heat transfer fluid (manufacturers' recommendation)	
Type	Water-Propyleneglycol
Specifications	--

Flow range (manufacturers' recommendation)	
Flow range	48 - 90 l/h
Rated flow rate	60 l/h

Absorber	
Absorber element	Copper sheet
Length of absorber element	1940.0 mm
Width of absorber element	48.0 mm
Thickness of absorber element	0.12 mm
Coating	Titanium-Nitrite-Oxide
Flowed through element	Coaxial copper pipe
Joining technique	Ultrasonic welded
Joining seam	Blank

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

Casing and insulation	
Casing material	Aluminium
Sealing material	EPDM
Insulation material	Rockwool, Polyurethane foam
Thickness (in mm)	15, 18
Aperture dimensions	1.954 m * 0.0519 m * 10

Limitations (manufacturer information)	
Max. temperature	120°C
Max. operating pressure	6 bar
Other	--

Remarks on collector design
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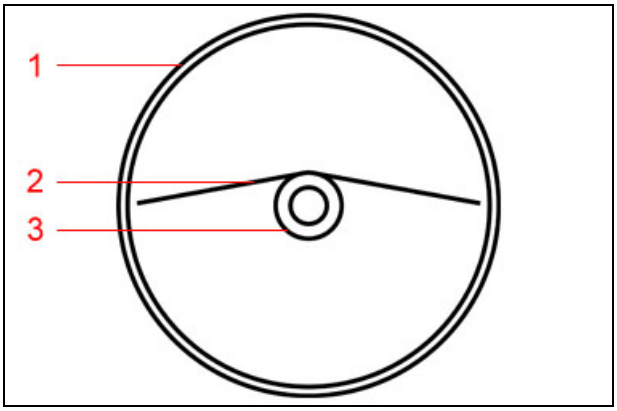
Test schedule	
Test procedure	EN12975:2006, Outdoor test
Sample received	15.12.2009
Start of test	15.01.2009
End of test	21.04.2009

1.2 Sketch of Collector



1.3 Specifications on Elements

1 Glazing

Material:	Glass tube
Thickness [mm]:	1.8
Properties:	Low ferrous content, anti-reflective treatment

2 Absorber

Absorber element:	Copper sheet
Flow-through element:	Coaxial copper pipe
Length of element [mm]:	1940
Width of element [mm]:	48
Flow type:	Parallel
Joining technique:	Ultrasonic welded
Joining seam:	Blank

2 Absorber coating

Tradename:	Tinox
Description:	Titanium-Nitrite-Oxide
Manufacturing process:	Physical vapour deposition (PVD)

3 Coaxial tube

Description:	Copper

1.4 Photo of Collector

1.5 Sketch of Collector Mounting

2 Test Methods and Results

2.1 Test of Thermal Performance

Tests carried out according to EN 12975-2: 2006.

Deviations from this standard are indicated by the same formatting that is used for this clause. The reasons for the deviations are mentioned.

2.2 Schematic of the Test Loop

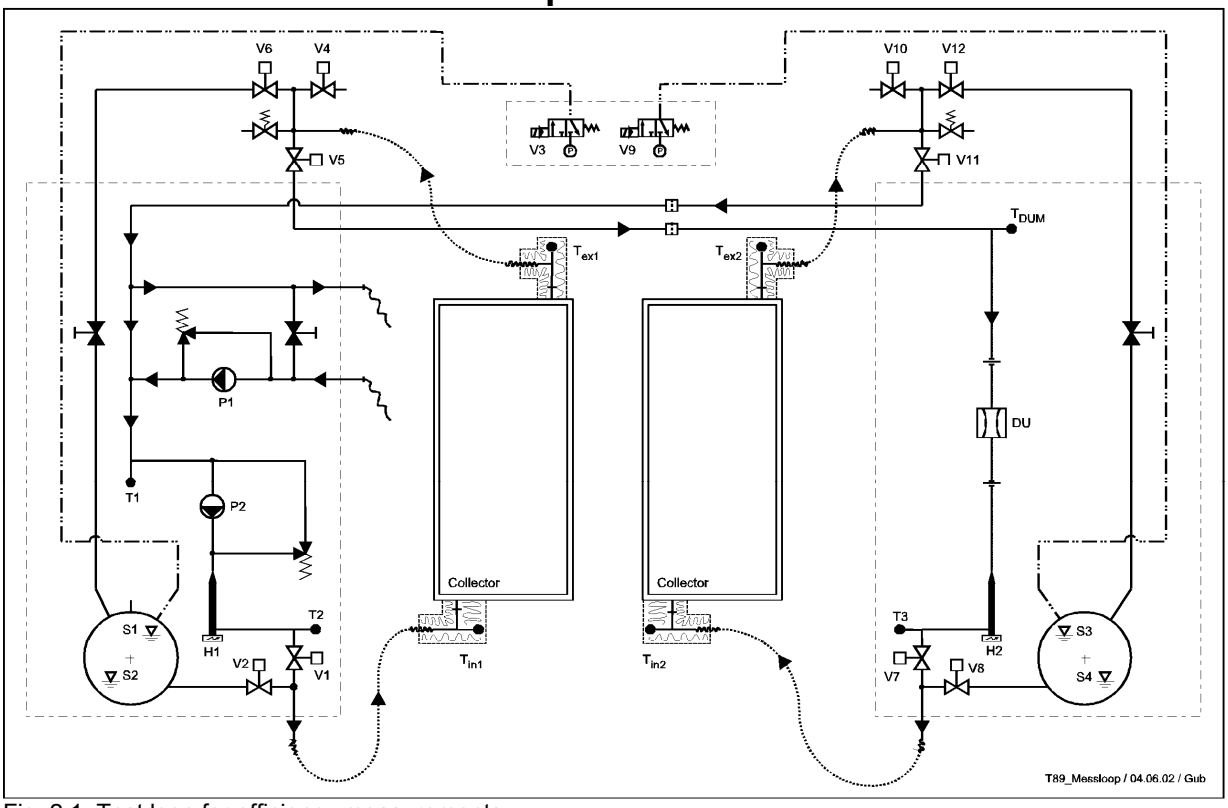


Fig. 2.1: Test loop for efficiency measurements.

2.3 Power Output

2.3.1 General

Flow rate during test	99.0 l/h
Fluid for tests	33.3 Vol-% ethylene glycol
Test method	stationary (steady state)
Geographical position of test site	47.2°N / 8.8°O, 417 m NN
Collector tilt angle	tracked (45±5)°
Collector azimuth angle	tracked (0±48)°
Definition of efficiency	$\eta = \dot{Q}/A \cdot G$
Thermal output power of collector	$\dot{Q}$
Reference area	A
Solar irradiance	G
Solar irradiance on reference area	A·G
Efficiency equation	$\eta = \eta_0 - a_1 \cdot T_m^* - a_2 \cdot G \cdot T_m^{*2}$
Temperature at collector inlet	T_{in}
Temperature at collector outlet	T_{ex}
Ambient temperature	T_a
Mean collector temperature	$T_m = (T_{in} + T_{ex})/2$
Reduced collector temperature	$T_m^* = (T_m - T_a)/G$
Solar irradiance for efficiency diagrams	G = 800 W/m²

2.3.2 Power output per collector unit

2.3.2.1 Peak power

Peak power W_{peak} per collector unit for normal incident irradiation of 1000 Wm^{-2}.

W_{peak} = 791 [W]

2.3.2.2 Diagram

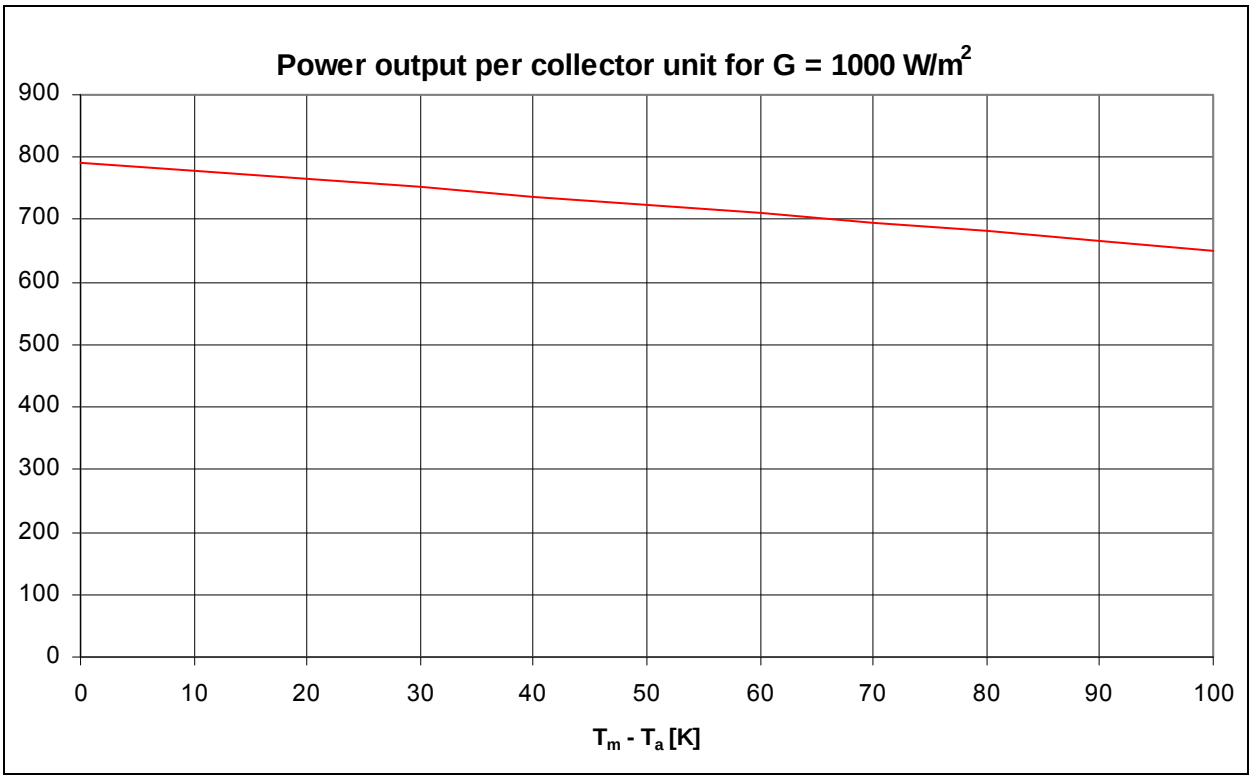


Fig. 2.2: Power output per collector unit at irradiance G = 1000 W/m²

2.3.2.3 Power output per collector unit

$T_m - T_a$	Global irradiance G		
	G=400 W/m²	G=700 W/m²	G=1000 W/m²
10 K	304 W	541 W	778 W
30 K	277 W	514 W	752 W
50 K	249 W	487 W	724 W

2.3.3 Efficiency curve

The efficiency curves with reference to the absorber-, aperture- and gross areas are indicated in addition to the requirements of the norm.

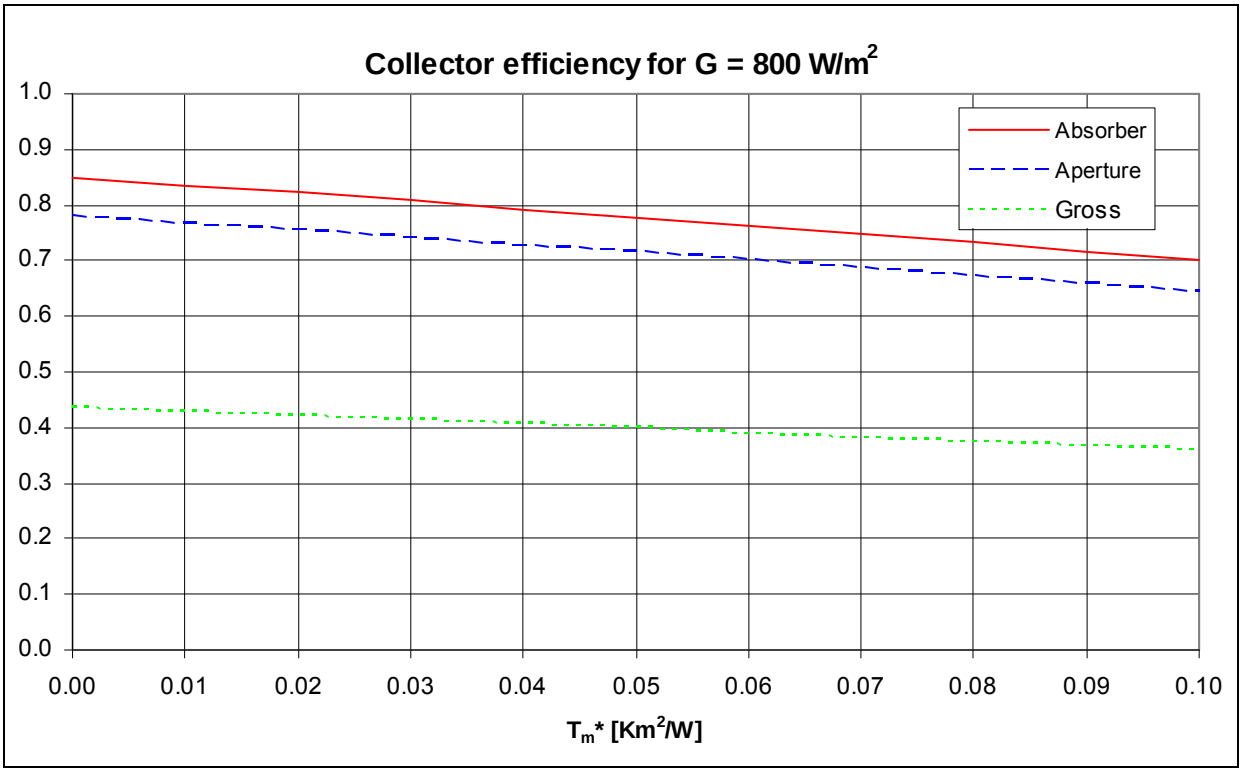


Fig. 2.3: Efficiency diagram for G = 800 W/m²

2.3.3.1 Parameters for efficiency equation

Reference area	Absorber area	Aperture area	Gross area
η_0 (-)	0.850	0.780	0.434
a_1 (W/m²K)	1.38	1.27	0.70
a_2 (W/m²K²)	0.0013	0.0012	0.0007

From repetitive measurements of a reference collector, we estimate the following dispersion for the efficiency measurement (standard deviation of the mean, multiplied with a coverage factor 2):
At T_m*=0.02: 0.27 Efficiency-%,
at T_m*=0.05: 0.44 Efficiency -%,
at T_m*=0.08: 0.62 Efficiency -%.

2.4 Incident Angle Factor

2.4.1 Table of the Incidence Angle Modifier (IAM)

	0°	10°	20°	30°	40°	**50°**	60°	70°	80°	90°
K_{Θ} (longitudinal)	1.00	1.00	1.00	0.99	0.98	**0.94**	0.87	0.74	0.48	0.00
K_{Θ} (transversal)	1.00	1.00	1.00	1.00	1.01	**1.00**	0.99	0.85	0.49	0.00

2.4.2 Diagram of the Incidence Angle Modifier

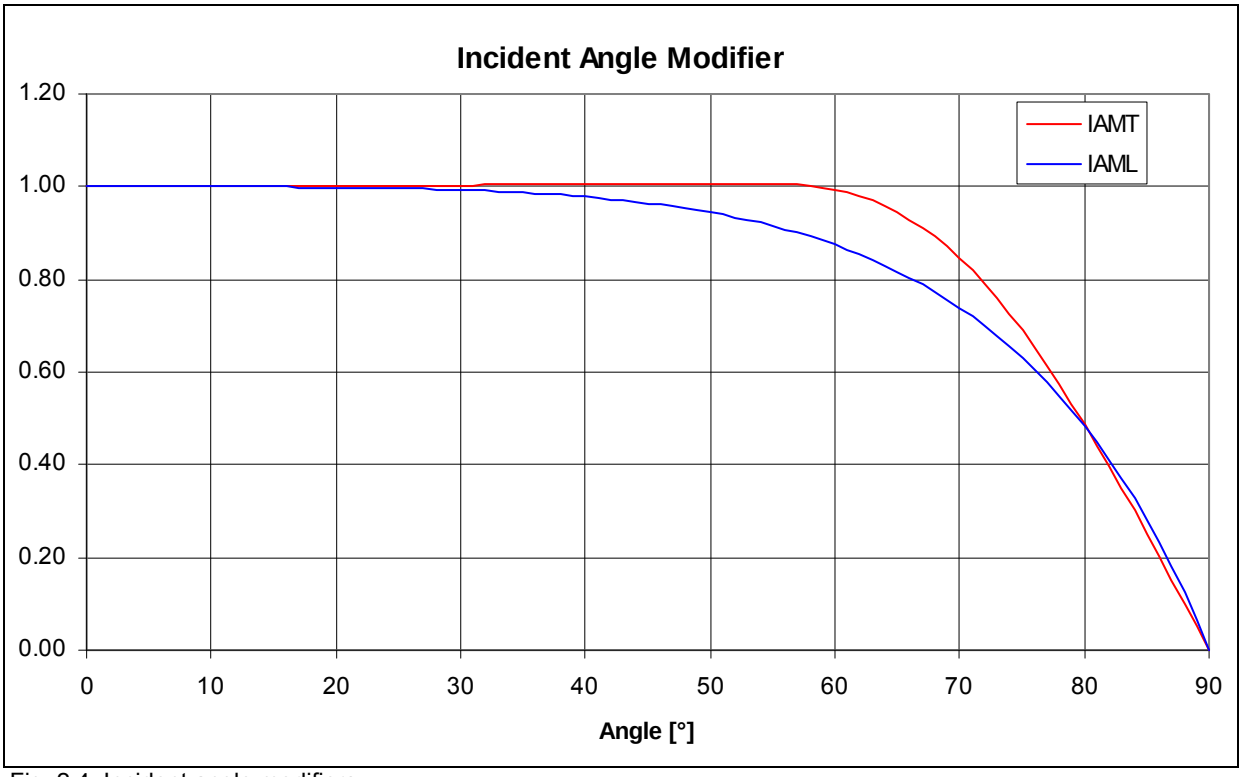


Fig. 2.4: Incident angle modifiers

2.5 Time Constant

τ_C = 113 s

2.6 Effective Thermal Capacity

2.6.1 Determination according to EN12975-2:2006, Annex G.3

Determination based on transient behaviour of the collector.

$C_{eff,G3}$= 23.2 kJ/K (Effective thermal capacity of collector filled with fluid)

Additional information: The thermal capacity was measured with the properties of „Antifrogen N“. For other fluids, the thermal capacity is calculated as follows:

$C_{eff,G3}$ = 1.8 l * density * specific heat capacity of fluid + 16.2 kJ/K

2.6.2 Determination according to EN12975-2:2006, Section 6.1.6.2

Estimation based on material properties.

$C_{eff,6162}$ = 10.4 kJ/K (Effective thermal capacity of collector filled with fluid)

Additional information: The thermal capacity was measured with the properties of „Antifrogen N“. For other fluids, the thermal capacity is calculated as follows:

$C_{eff,6162}$ = 1.8 l * density * specific heat capacity of fluid + 3.4 kJ/K

2.7 Pressure Drop

2.7.1 Diagram

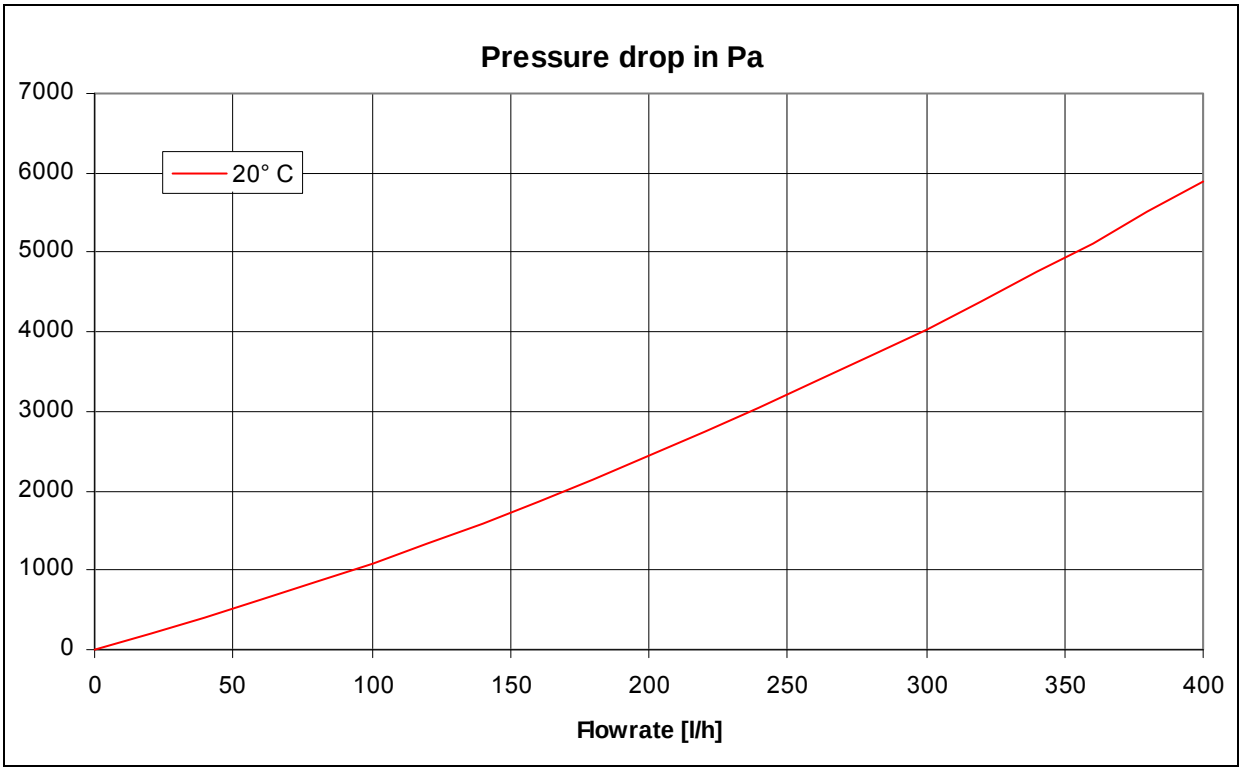


Fig. 2.5: Pressure drop as a function of volume flowrate

2.7.2 Pressure drop at rated flowrate

Conditions:
T_m = 20°C and dV/dt = 60 l/h
Δp = 623 Pa

2.7.3 Table of pressure drop data in Pa

Conditions:
T_m = 20 °C

Flow rate [l/h]	0	80	160	240	320	400
Pressure drop [Pa]	0	851	1867	3046	4390	5898

2.8 Observed Failures

Details about failures that are rated as major failures according to paragraph 5.3.1 of EN12975-1:2006.

Absorber leakage or such deformation that permanent contact between absorber and cover is established.	Passed
Breaking or permanent deformation of cover or cover fixing.	Passed
Breaking or permanent deformation of collector fixing points or collector box.	Passed
Loss of vacuum or low pressure (applicable for vacuum or subatmospheric collectors)	Passed
Accumulation of humidity in form of condensate on the inside of the transparent cover of the collector exceeding 10% of the aperture area	Passed

No major failures according to paragraph 5.3.1 of EN12975-1:2006 were found for this collector.

3 Remarks

This report must not be copied except in full.
The test methods applied fulfil the requirements of EN12975:2006.
The test results only refer to the tested collector sample.
This test report is made according to the requirements of EN12975:2006.
This test report fulfils the requirements of ISO17025.

Rapperswil, 24.02.2010

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