Definition of classes and info material to manufacturers related to EN ISO 9806

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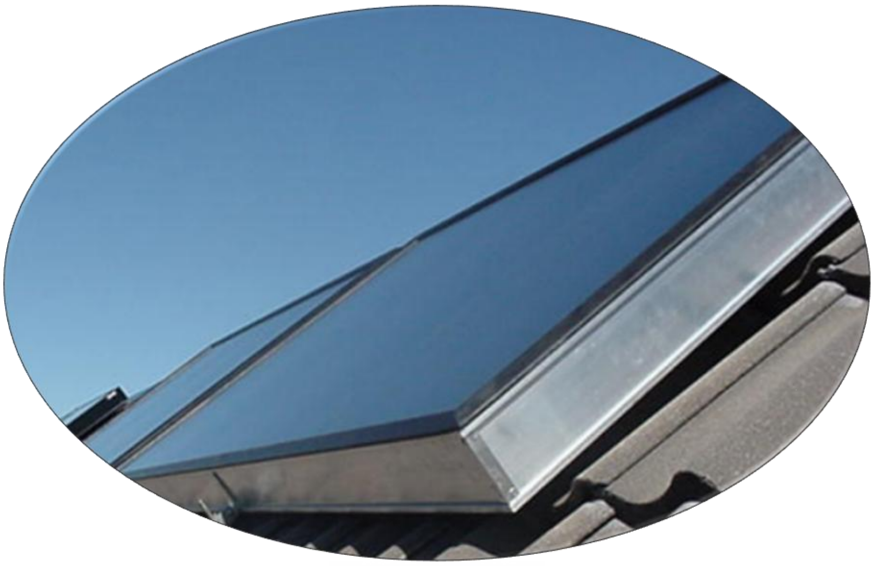

Climate (Irradiation, Temperature): B
Snow (Positive mechanical load): A+
Wind (Negative mechanical load): A
Hail (Impact resistance): B

Energitekniky Technology

Classmate: Definition of classes and drafting info material to manufacturers related to EN ISO 9806

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Executive Summary

Based on the EN 12975:2006 standard and recent developments in collector testing a new version of the ISO 9806 standard has recently been released. In parallel to this the first steps towards a global certification scheme for solar collectors have been taken. This development was encouraged by the great success of the Solar Keymark certification and it aims to facilitate global harmonization and trade of solar collectors. In order to enable a global certification of collectors, increased flexibility in the requirements applied is important. This could be achieved by defining classes for the main properties of the collector that are subject to national or regional differences such as e.g. wind- and snow loads. The report contains an analysis of which properties are relevant to classify, how these classes should be defined and how they correlate to the respective conditions prevailing in different locations.

1 Introduction and background

In the context of globalization and climate crisis it is obvious that united global efforts around solar thermal technologies have a role to play. By facilitating global trade the competition will increase, ideally leading to reduction in costs and increase in quality but it will also help us to share best practices and to cooperate in the further development of this technology.

The ISO 9806 and EN 12975 standards define procedures for solar thermal collector testing and assessment. The content is basically the same and the latter was originally developed on the basis of the former. Additionally, the EN 12975 defines a set of requirements against which a tested collector can be assessed and considered “approved” or “failed“. Currently, a new ISO 9806 standard has been released and is being implemented in practice and this time the EN 12975 standard is the role model. This is due to the fact that for the past fifteen years basically all developments in standardized collector test methods took place in Europe. Nevertheless, the principle of leaving the requirements out of the test standard has been adopted from the 9806 standard and the setting up of requirements is in the future expected to be the issue of certification schemes or by national or regional authorities.

The European Solar Keymark certification of solar thermal collectors was first launched in 2003 and it is now a well-established and widely recognized quality label in Europe. It has enabled a simplified approval process related to subsidies in many countries. It has also given manufacturers access to the whole European market based on only one set of tests according to the EN 12975 standard. Furthermore it has contributed to increased user confidence and overall to a growing market for solar thermal technologies. As the cooperative work between CEN/TC 312 and ISO/TC 180 has now resulted in an updated global standard, the new ISO 9806, the issue of global certification has entered the agenda. Expectations are that a global certification scheme could contribute to a growing global market for solar thermal products and thus to a more sustainable and less politically charged global energy supply.

Defining classes for some of the different tests and properties described in the ISO DIS 9806 standard is important as a basis for a flexible global certification scheme. Not only will it facilitate the setting up of requirements relevant for a specific market, still relying on a common test standard. It will also allow collector manufacturers to differentiate their products for markets with significantly different climatic conditions.

2 Overview of collector tests and properties

The European and International collector test standards define methods for testing performance as well as the durability and reliability of solar thermal collectors. Table 1 lists the different tests that make up the 9806 standard. For some tests or properties classes already exist as e.g. in the case of the exposure tests defined in the ISO FDIS:2013. These are reviewed in this work to assess whether they are relevant in the context of global standardization and certification or if they need to be redefined or extended. For others, tests or properties classes do not exist and the review will assess whether it is relevant, desirable and possible to introduce classes for these.

Table 1. Tests described in the ISO/FDIS 9806:2013 standard and options for introducing classes

Test	Section in the draft standard	Comment on classes
Internal pressure test for fluid channels	6	Not required
Leakage test	7	Not required
Rupture and collapse test	8	Not required

High-temperature resistance	**9**	**Classes according to « Table 2 », same as for the exposure test, possibly with additional class for very severe conditions**
Exposure test	**11**	**Classes according to « Table 4 « , possibly with additional class for very severe conditions**
External thermal shock test	**12**	**Classes according to « Table 4 », same as for the exposure test, possibly with additional class for very severe conditions**
Internal thermal shock test	**13**	**Classes according to « Table 4 », same as for the exposure test, possibly with additional class for very severe conditions**
Rain penetration test	14	Not possible at this stage as it would require a variety of rain penetration tests to choose from
Freeze resistance test	15	Not required
Mechanical load test	**16**	**Classes to be elaborated**
Impact resistance test	**17**	**Classes to be elaborated according to table 5 with the addition of « class 0 »**
Thermal performance test	20	Not possible at the moment but could be considered for a future project
Pressure drop measurement	28	Not required

3 Class definitions for relevant properties

Classes A, B and C, with A-class representing the most durable, were already given by the draft standard. For all classified properties an additional class A+ for even more severe conditions is now introduced. In one case (impact resistance) an additional class D is added, representing “no requirement”.

3.1 Classes for solar radiation/ ambient temperature

The set of test conditions (solar radiation and ambient temperature) for the different classes are given in **Error! Reference source not found.** Alternatively, conditions resulting in the same or higher collector temperature according to section **Error! Reference source not found.** of ISO/FDIS 9806:2013 can be used.

Class A, B and C were taken directly from the ISO/FDIS 9806:2013. Class A+ is corresponding to the Australian/ New Zealand standard AS/NZS 2712:2007.

Table 2. Classes for test defined by irradiance, irradiation and ambient temperature

Property	**C**	**B**	**A**	**A+**
High-temperature resistance [W/m^2]/[°C]	1000/ 20	1000/ 20	1000/ 20	1100/50
Exposure test 30 hours [W/m^2]/[°C]	800/10	900/15	1000/20	1100/50
Exposure test 30 days [MJ/m^2]	420	540	600	700[1]
External thermal shock test [W/m^2]/[°C]	800/10	900/15	1000/20	1100/50

[1] Calculated for 30 days with an irradiation of 6,5 kWh/m^2 and day.

Internal thermal shock test [W/m^2]/[°C]	800/10	900/15	1000/20	1100/50
NOTE: Values given are minimum values for testing. The same class shall be applied for irradiance and for irradiation values respectively.				

If no instruction is given by the manufacturer, testing for class A shall be conducted by the test laboratory.

3.2 Classes for mechanical load

In the current ISO 9806:2013, section 16.3 states that "The test pressure shall be 2400 Pa (positive and negative) or as specified by the manufacturer". Classes according to Table 3 are thus proposed.

- Class C, 1000 Pa, is kept for compatibility with the current standard. It will enable current license holders who only tested for 1000 Pa load to label their products.
- Class B (Positive load) and A (Negative load) correspond to the IEC standards for PV module testing and to the nominal test pressure according to 16.3 in the ISO 9806:2013.
- Class A (Positive load) and A+ (Negative load) were chosen in accordance with requirements for the French market.
- Class A+ (Positive load) correspond to the IEC standards for PV module testing

Table 3. Classes for mechanical i.e. wind- and/or snow loads

Property	C	B	A	A+
Positive Mechanical load [Pa]	1000	2400	3800	5400
Negative Mechanical load [Pa]	1000	1600	2400	3000

3.3 Classes for impact resistance

The classes for impact resistance correspond to values for ice balls in table 5 in section 17.4.2 and to values for steel balls in section 17.5 of ISO 9806:2013. The ice ball diameters are a subset of those used in the IEC standards for PV module testing where the 25 mm ice ball corresponding to class B is the nominal diameter used.

Correlation between ice and steel balls are rough estimations based on first experiments carried out at ITW using an "impact meter".

Table 4. Classes for impact resistance

Property	D	C	B	A	A+
Ice ball diameter [mm]	0	15	25	35	45
Steel ball drop height [m]	0	0,4	0,6	1,0	1,4

4 Correlation of classes to « natural conditions »

4.1 Climate classes

The classes defined for solar radiation and ambient temperature are correlated to the annual global horizontal irradiation values given by Table 5. Threshold values for the different classes were defined based on the irradiation map in Figure 1. Values for an actual location can be taken from Figure 1 or other similar sources.

Table 5. Annual global horizontal irradiation correlated to the climate classes

Property	C	B	A	A+
Annual Irradiation (H) [kWh/m²]	H≤1000	1000<H≤1600	1600<H≤2000	H>2000

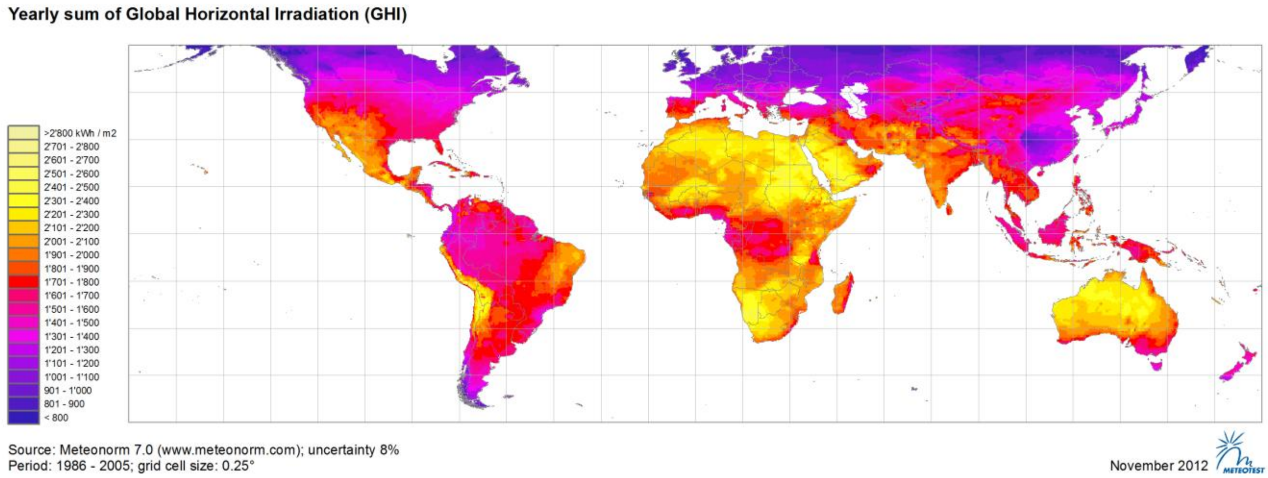

Figure 1. Distribution of global horizontal irradiation, see also Table 5 and [2]

4.2 Snow load classes

It is proposed NOT to try to correlate snow cover heights to loads but rather to refer directly to national codes like the Eurocode where loads are explicitly given in Pascals, kN/m^2 or similar, see example in Figure 2.

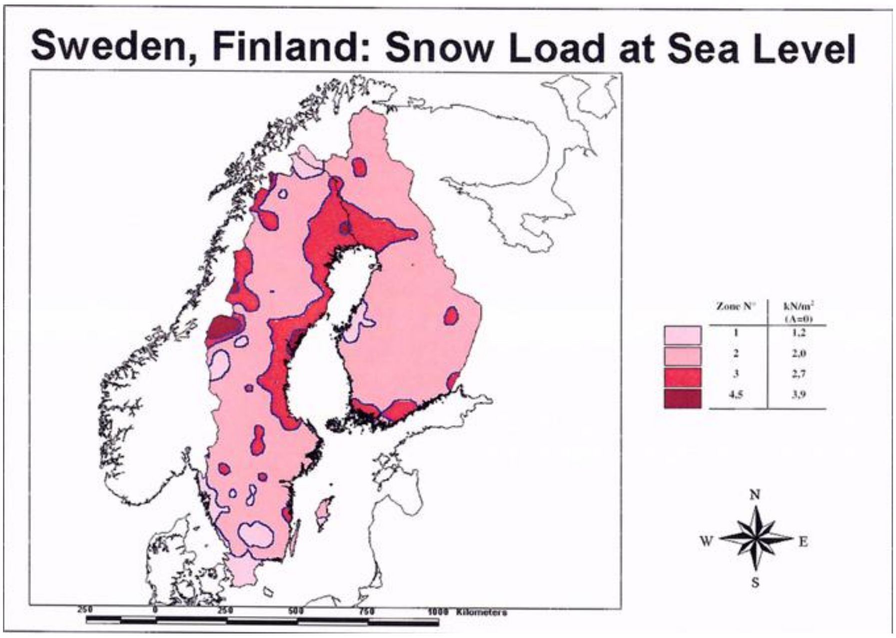

Figure 2. Example of snow load map from the Eurocodes

Table 6. Positive mechanical load classes that can be correlated to snow loads, e.g. according to the Eurocodes, see [3]

Property	C	B	A	A+
Positive Mechanical load [Pa]	1000	2400	3800	5400

4.3 Wind load classes

Wind load classes are correlated to wind speeds by using the equation for dynamic pressure

($\mathbf{p} = ½ * \boldsymbol{\rho} * \mathbf{v^2}$) with ρ= 1,25kg/m^3. The fundamental value of the basic wind velocity v, according to the Eurocodes, is the 10 minute mean wind speed at 10 meters above ground level. For negative mechanical load induced by wind, which is considered to be more severe than the positive load induced by the same wind speed, a form factor of 2 has been chosen. Due to this, the classes are defined by the uplifting forces (negative loads). Design wind speeds can be found in national building regulations, e.g. in national supplements to the Eurocodes [5].

Table 7. Classes for wind load correlated to wind speeds

Property	C	B	A	A+
Wind speeds corresponding to Positive Mechanical load [m/s]	Negative wind loads are considered more severe than positive wind loads			
Wind speeds corresponding to Negative Mechanical load below [m/s]	28	36	44	49
Negative Mechanical load corresponding to Wind speeds above [Pa]	1000	1600	2400	3000

4.4 Impact resistance classes

For choosing the appropriate class, refer to national/local conditions; E.g. if you risk hail with a diameter of 25 mm, class B should be chosen. Collector manufacturers producing a collector to be used only in regions where there is no risk for hail can choose hail class D certification.

It has not been possible to identify any standardized statistics about national or regional occurrence of hail stones. Therefore the classification most probably will have to be defined by metrological expertise in different countries. Contacts with the Swedish National Metrological and Hydrological Institute SMHI led to the conclusion that a “regular” occurrence of hailstones i.e. every five years is likely to encompass hailstones up to a maximum size of 25 mm. Thus, for Sweden, class B should be chosen.

Table 8. Classes correlated to ice ball diameters and steel ball drop heights

Property	D	C	B	A	A+
Ice ball diameter [mm]	0	15	25	35	45
Steel ball drop height [m]	0	0,4	0,6	1,0	1,4

5 Example of classes introduced on the collector label

A manufacturer wants to produce a collector only for the Swedish market. Conditions in Sweden are as follows:

- Irradiation= 800 to 1100 kWh/m^2 and year → Choose class B (1000<H≤1600) according to Table 5
- Snow loads= 1200 to 3900 Pa according to Figure 2 (=figure C8 in [3]). →Choose class A+ according to Table 6 (Or possibly class A which covers >90 of Sweden)
- Wind loads= 43 m/s (Maximum gust speed in coastal area of Sweden according to [4]) → Choose class A according to Table 7.
- Swedish National Metrological and Hydrological Institute SMHI states that a "regular" occurrence of hailstones i.e. every five years is likely to encompass hailstones up to a maximum size of 25 mm. Thus, for Sweden, class B should be chosen.

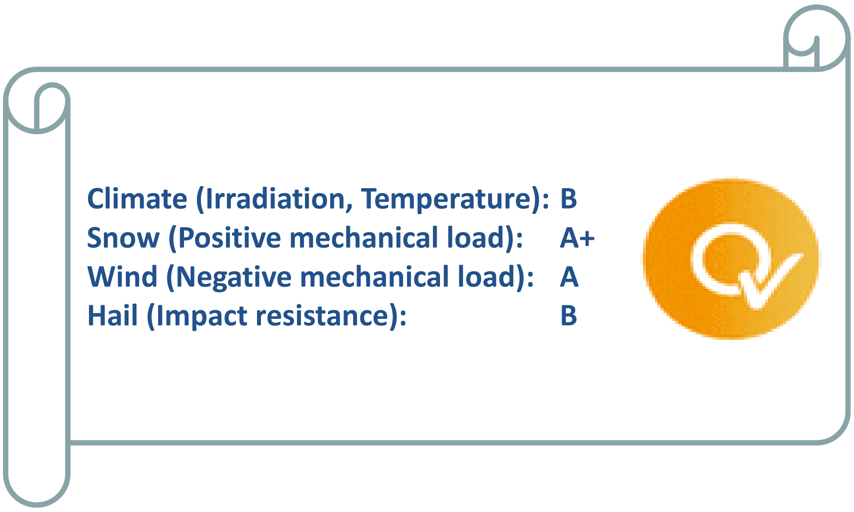

Figure 3. Example of certificate label with classes stated

6 References

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