Working document on possible Commission Regulations implementing Directive 2009/125/EC with regard to professional refrigeration products

Brussels, 09.12.2011

PART 4 – REFRIGERATION PROCESS CHILLERS

Subject matter

This working document pursuant to Directive 2009/125/EC establishes eco-design requirements related to refrigeration process chillers. The preparatory study showed that energy in use phase is the only significant environmental aspect which can be addressed through product design. Other Ecodesign parameters referred to in Annex I, Part 1 of Directive 2009/125/EC, are not considered as significant.

Definitions

Refrigeration process chillers are considered as energy related products within the meaning of Article 2 (1) of Directive 2009/125/EC.

For the purpose of this working document the following definition shall apply.

A 'process chiller' is a factory-built piece of refrigeration equipment which is primarily intended to cool down and maintain the temperature of a liquid[1] through a vapour compression cycle within a refrigeration process, including at least a compressor and an evaporator within a "package".
This includes

- Refrigeration process chillers sold with an integral condenser, and refrigeration process chillers intended for use with a remote condenser, condensing unit or refrigeration system
- Refrigeration process chillers intended for use with air-cooled or water-cooled condensing
- Refrigeration process chillers sold with or without the coolant circuit hardware[2]
- Refrigeration process chillers intended for use at high, medium or low operating temperature
- Refrigeration process chillers of all cooling capacities

This excludes:

- Refrigeration process chillers which are not factory-built units, i.e. are field erected (built in-situ from components purchased separately by the installer)

[1] Water or brine
[2] The coolant circuit hardware is the ancillary equipment designed to drive the refrigerated liquid through the coolant circuit and usually includes a circulation pump and a liquid buffer tank. Refrigeration process chillers sold without the coolant circuit hardware are known as "split chillers" and included into the scope of the present Regulation.

- Refrigeration process chillers exclusively intended for use with evaporative condensing
- Refrigeration process chillers using absorption technology

'Operating temperature' means the temperature of the cooled liquid at the outlet of the evaporator
'Low operating temperature' means that the chillers is intended to function at an operating temperature between -25°c and -8°c, with the reference point at -25°c
'Medium operating temperature' means that the chillers is intended to function at an operating temperature between -12°c and +3°c, with the reference point at -8°c
'High operating temperature' means that the chillers is intended to function at an operating temperature between +2°c and +15°c, with the reference point at +6°c

Eco-design requirements

Products falling under the definitions of paragraph "Definitions" above in this document shall meet the Ecodesign requirements set out in Annex I.

Energy consumption in the use phase accounts for more than 99% of the Gross Energy Requirement (GER) and for ~95% of the Global Warming Potential (GWP) of refrigeration process chillers. It is by far the dominating environmental impact over the product lifetime. Direct greenhouse gas emissions from refrigerant fluids were calculated assuming a base case with a HFC refrigerant charge of 90kg (R134a and R404a). In this case, they account for 3% and 6% of Total Equivalent Warming Impact (TEWI) of refrigeration process chillers operating at medium and low temperature respectively. These estimates are also explained by the very high energy consumption and the long lifetime of the product (15 years). The end of life contribution to the GWP is mainly due to thermal recovery of some components and materials. Therefore, only minimum energy efficiency requirements are proposed for refrigeration process chillers.

According to different sources[3], the average cooling capacity of chillers is in the range of 220-260kW[4]. The energy efficiency increases with the cooling capacity[5]. Besides, chillers with a below average cooling capacity tend to use R404A and hermetic reciprocating compressor, whereas large “best available” chillers tend to use ammonia and screw or reciprocating compressor.

Chillers are sold in low but growing numbers in the EU (6400 units in 2008; 8100 in 2020). They show very high individual energy consumption[6], with energy costs accounting for 90% of life cycle cost.

The proposed requirements under Option 1 are based on the results of the preparatory study, which cover refrigeration process chillers operating at low and medium temperature only.

[3] Including industry and study by Defra. The Base Case of the preparatory study has a cooling capacity of 266kW for both medium and low operating temperatures.
[4] Chillers below 100kW account for 30% of the EU market in units. Chillers above 500kW account for 25%, and reach cooling capacity of 10,000 to 35,000kW.
[5] In all existing schemes (UK ECA scheme, US ASHRAE Standards, Canadian MEPS and Australian MEPS), performance requirements become more stringent as capacity in kW increases.
[6] The Base of the preparatory study consumes 420,946 kWh/year at medium temperature and 587,659 kWh/year at low temperature.

These were refined on the basis of complementary technical analysis provided by manufacturers[7]. Manufacturers propose an alternative scenario, under Option 2, which would allow setting mandatory minimum requirements on the basis of seasonal efficiency instead of COP, thus better rewarding capacity modulation.

The following staged requirements are proposed under Option 1.

1) **Tier-1**: January 1, 2014 onwards, refrigeration process chillers falling into the scope of the present Regulation shall comply with Tier-1 minimum efficiency requirements (formulated in terms of COP) and corresponding product information requirements as indicated in Annex 1. Tier-1 requires a reduction of energy consumption of ~2% to 5 %. It is estimated to be achievable with negligible increase of purchase price (~3%), leading to a slight reduction in life cycle costs for the users by ~2% to 5%. In addition, January 1, 2014 onwards, the Seasonal Energy Performance Ratio (SEPR) of all refrigeration process chillers falling into the scope of the present Regulation shall be declared.
2) **Tier-2**: January 1, 2017 onwards, refrigeration process chillers falling into the scope of the present Regulation shall comply with more stringent Tier-2 minimum efficiency requirements as indicated in Annex 1. Tier-2 requires a reduction of energy consumption of ~12% to 16%. The related price increase may be up to 20% but life cycle costs for the users would be simultaneously reduced by ~15%. Tier-2 requirements correspond to higher efficiency than the real BAT but to lower efficiency than the Least Life Cycle Cost (LLCC) reference point calculated by the preparatory study.
3) **Review**: no later than 4 years after entry into force, and preferably before the entry into application of Tier-2 requirements, the present Regulation shall be reviewed by the European Commission

The estimated saving potential of Option 1 is 2.1 TWh per year in 2020 and 4.6 TWh in 2025 compared to a "freeze" scenario.

The proposed requirements will put the EU market at a comparable efficiency level with other major economies[8].

Form of the Implementing measure

It is intended to propose a directly applicable Implementing Regulation under Directive 2009/125/EC. The proposed Regulation is not expected to have a particular impact on the EU acquis.

Measurement methods

As regards the method for measuring the COP of refrigeration process chillers for the purpose of this Regulation, the Commission intends to publish the references of EN14511 in the Official Journal, C series.

As regards the method for measuring the Seasonal Energy Performance Ratio (SEPR) referred to Annex 1, the Commission intend to mandate the adoption of a new harmonised standard.

[7] Mainly members of EPEE, Eurovent and Asercom

[8] Minimum energy efficiency requirements apply to refrigeration process chillers in Australia, New Zealand and Canada. Proposed requirements are notably in line with Australian MEPS (which base on comparable measurement standards).

Appendix A contains a draft measurement method which is expected to serve as a key input into the standardisation process[9]. This should feed into the draft update of Annex B of the Horizontal Mandate under the Ecodesign Directive. It is proposed to leave the choice to standardisers whether the new standard should be adopted as an update of EN14511, an addendum to prEN14825 or a new separate standard. Once adopted, the Commission intends to publish the references of the relevant standard in the Official Journal, C series.

An Excel calculation sheet (Appendix B) will be available on-line for helping SME manufacturers to comply with the SEPR calculation requirements.

Conformity Assessment

A conformity assessment shall be carried out according to Chapter 8 of Directive 2009/125/EC, Annex IV (Internal design control) or Annex V (Management system for assessing conformity).

Market surveillance

When performing the market surveillance checks referred to in Directive 2009/125/EC, Chapter 3 (2), Member State authorities shall apply the verification procedure set out in Annex IV of this working document.

Benchmarks

No Ecodesign benchmarks are proposed for refrigeration process chillers.

Review

A review of the proposed requirements shall be presented to the Consultation Forum depending on technological progress and not later than 4 years after its entry into force.

[9] This measurement method was proposed by EPEE, Eurovent and Asercom, and is presented to the members of the Consultation Forum with the agreement of the Commission.

Annex I: Ecodesign requirements

Refrigeration process chillers intended for use at several operating temperatures shall comply with all relevant requirements of Annex 1.

a) Specific requirements - Minimum energy efficiency requirements

January 1, 2014 onwards, refrigeration process chillers falling into the scope of the present Regulation shall meet the following minimum requirements

Table 1 – Minimum requirements to be met by air-cooled process chillers

Operating temperature	**Cooling capacity**	**Option 1 Minimum COP**	**Option 2 Minimum SEPR**
Medium	<300kW	1.8	2.24
	>300kW	2.1	2.8
Low	>200kW	1.2	1.48
	<200 kW	1.5	1.6

Table 2 – Minimum requirement to be met by water-cooled process chillers

Operating temperature	**Cooling capacity**	**Option 1 Minimum COP**	**Option 2 Minimum SEPR**
Medium	<300kW	2.2	2.86
	>300kW	2.5	3.8
Low	>200kW	1.6	1.82
	<200 kW	1.9	2.1

January 1, 2017 onwards, remote condensing units falling into the scope of the present Regulation shall meet the following minimum requirements

Table 3 – Minimum requirement to be met by air-cooled process chillers

Operating temperature	**Cooling capacity**	**Option 1 Minimum COP**	**Option 2 Minimum SEPR**
Medium	<300kW	2.3	2.58
	>300kW	2.6	3.22
Low	<200kW	1.6	1.7
	>200 kW	1.85	1.84

Table 4 – Minimum COP to be met by water-cooled process chillers

Operating temperature	**Cooling capacity**	**Option 1 Minimum COP**	**Option 2 Minimum SEPR**
Medium	<300kW	2.65	3.29
	>300kW	2.95	4.37
Low	<200kW	1.9	2.09
	>200 kW	2.15	2.42

b) Product information requirements

January 1, 2014 onwards, the following parameters shall be reported in the product documentation accompanying refrigeration process chillers falling into the scope of the present Regulation:

- Intended operating temperature(s), expressed in °c
- COP at full load and +35°c ambient temperature, rounded to two decimal places, and corresponding cooling capacity and power input, expressed in kW and rounded to three decimal places
- SEPR, rounded to two decimal places, and corresponding cooling capacities and power inputs at all reference points A, B, C and D, expressed in kW and rounded to three decimal places

Annex II: Calculation methods

For the purpose of this Regulation, the following calculation formulae apply

COP is the coefficient of performance of a remote condensing unit, measured at full load, rounded to two decimal places, with

$$COP = \frac{P}{D}$$

Where
P is the cooling capacity, expressed in kW and rounded to two decimal places
D is the power input, expressed in kW and rounded to two decimal places

SEPR is the seasonal energy performance ratio of a remote condensing unit, rounded to two decimal places, with

$$SEPR = \frac{\sum_{j=1}^{n} h_j \cdot P_R(T_j)}{\sum_{j=1}^{n} h_j \cdot \left(\frac{P_R(T_j)}{COP_{PL}(T_j)} \right)}$$

Where
T_j = the bin temperature
j = the bin number, with $j \in \{1,2,\ldots n\}$
$P_R(T_j)$ = the refrigeration demand for the corresponding bin temperature T_j.
h_j = the number of bin hours occurring at the corresponding bin temperature T_j.
$COP_{PL}(T_j)$ = the COP values of the unit for the corresponding bin temperature T_j., which are determined through linear interpolation between the COP measured and calculated for the 4 reference points A, B, C and D, as indicated in Tables 1 and 2 below

Table 1- Part load conditions for reference points A, B, C, D for the SEPR calculation of air-cooled process chillers

Reference point	**Part load ratio (%)**	**Outdoor heat exchanger**	**Indoor heat exchanger**		
			Evaporator inlet/outlet temperatures (°C) Fixed outlet		
		Air dry bulb temperature (°C)	**Low operating temperature**	**Medium operating temperature**	**High operating temperature**
A	100%	35	-19 / -25	-2 / -8	12/ 6
B	93%	25	[a] / -25	[a] / -8	[a] / 6
C	87%	15	[a] / -25	[a] / -8	[a] / 6

D	80%	5	[a] / -25	[a] / -8	[a] / 6

[a] with the water flow rate as determined during "A" test for units with a fixed water flow rate or with a fixed ê T of 6K for units with a variable water flow rate and T_A,T_B,T_C and T_D temperatures at reference points A,B,C and D respectively.

Table 2- Part load conditions for reference points A, B, C, D for the SEPR calculation of water-cooled process chillers

Reference point	**Part load ratio (%)**	**Outdoor heat exchanger**	**Indoor heat exchanger**		
			Evaporator inlet/outlet temperatures (°C) Fixed outlet		
		Inlet/ outlet water temperatures (°C)	**Low operating temperature**	**Medium operating temperature**	**High operating temperature**
A	100%	30 / 35	-19 / -25	-2 / -8	12/ 6
B	93%	23 / [a]	[a] / -25	[a] / -8	[a] / 6
C	87%	16 / [a]	[a] / -25	[a] / -8	[a] / 6
D	80%	9 / [a]	[a] / -25	[a] / -8	[a] / 6

[a] with the water flow rate as determined during "A" test for units with a fixed water flow rate or with a fixed ê T of 6K for units with a variable water flow rate.

For load conditions above load conditions indicated for reference point A, the same COP value as for reference point A shall be reported

For load conditions below load conditions indicated for reference point D, the same COP value as for reference point D shall be used

Annex III: Measurement methods

For the purpose of compliance with the requirements of this Regulation, measurements shall be made using a reliable, accurate and reproducible measurement procedure, which takes into account the generally recognised state of the art measurement methods, including methods set out in documents the reference numbers of which have been published for that purpose in the Official Journal of the European Union.

Annex IV: Verification procedure for market surveillance purposes

For the purposes of checking conformity with the requirements laid down in Annex I, Member State authorities shall test a single refrigeration process chiller. If the measured parameters do not meet the values declared by the supplier within the ranges set out in Table 1, the measurements shall be carried out on three more refrigeration process chillers. The arithmetic mean of the measured values of these three refrigeration process chillers shall meet the values declared by the manufacturer within the range defined in Table 1.

Otherwise, the model and all other equivalent refrigeration process chiller models shall be considered not to comply with the requirements laid down in Annex I (Ecodesign requirements).

Member States authorities shall use reliable, accurate and reproducible measurement procedures, which take into account the generally recognised state-of-the-art measurement methods, including methods set out in documents the reference numbers of which have been published for that purpose in the Official Journal of the European Union.

Table 1.

Measured parameter	Verification tolerances
COP value (full load, +35°c ambient)	The measured value shall not be lower than the declared value by more than 10 % It shall not be lower than the minimum COP allowed in Annex 1 by 10% (Option 1)
Cooling capacity (full load, +35°c ambient)	The measured value shall not be lower than the declared value by more than 10 %
Power input (full load, +35°c ambient)	The measured value shall not be greater than the declared value by more than 5 %
SEPR value	The measured value of SEPR at the declared capacity shall not be lower than the declared value by more than 10 % It shall not be lower than the minimum SEPR allowed in Annex 1 by 10% (Option 2)
Cooling capacity at reference points A, B, C, D	The measured value shall not be lower than the declared value by more than 10 %
Power input at reference points A, B, C, D	The measured value shall not be greater than the declared value by more than 5 %