WORKING DOCUMENT ON

Possible requirements for air heating products, cooling products and high temperature process chillers

TRANSITIONAL METHODS

WORKING DOCUMENT

in the framework of the implementation of Commission Regulation (EU) No …/… implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for air heating products, cooling products and high temperature process chillers

(Publication of titles and references of transitional methods of measurement and calculation[1] *for the implementation of Regulation [number to be inserted after publication in the OJEU] and in particular Annexes III and IV thereof).*

(Text with EEA relevance)

1. References

Parameter	**ESO**	**Reference/Title**	**Notes**
Warm air heaters using gaseous fuel			
P_{nom}, heat output at nominal load, P_{min}, heat output at minimum load	CEN	[See note]	prEn1020:2007, EN 1319:2009, EN 1196:2011, EN 621:2009 and EN 778:2009 do not describe methods to establish the heat output. The efficiency is calculated on the basis of the flue gas loss and the heat input. The heat output P_{nom} can be calculated with the equation $P_{nom} = Q_{nom} * \eta_{th,nom}$, where Q_{nom} is the nominal heat input and $\eta_{th,nom}$ is the nominal efficiency. Pnom shall be based on the gross calorific value of the fuel. Similarly P_{min} can be calculated with the equation $P_{min} = Q_{min} * \eta_{th,min}$
$\eta_{th,nom}$ useful efficiency at nominal load		prEn1020:2007 - see clause 7.4.5 EN1319:2009 clause 7.4.4 EN 1196:2011, clause 6.8.2 EN621:2009 clause 7.4.5 EN 778:2009 clause 7.4.5	Efficiency can be determined as described in applicable standards, but shall be expressed on basis of gross calorific value of fuel
$\eta_{th,min}$ useful efficiency ar minimal load		prEn1020:2007 - see clause 7.4.6 EN1319:2009 clause 7.4.5 EN 1196:2011, clause 6.8.3 EN621:2009 clause 7.4.6 EN 778:2009 clause	Efficiency can be determined as described in applicable standards, but shall be expressed on basis of gross calorific value of fuel

[1] It is intended that these transitional methods will ultimately be replaced by harmonised standard(s). When available, reference(s) to the harmonised standard(s) will be published in the Official Journal of the European Union in accordance with Articles 9 and 10 of Directive 2009/125/EC.

Parameter	ESO	Reference/Title	Notes
		7.4.6	
AF_{nom} air flow at nominal load AF_{min} air flow at minimal load		[See note]	None of the standards describes methods to establish the warm air flow rate (or air delivery rate).
el_{nom} electric power consumption at nominal load el_{min} electric power consumption at minimum load		[See note]	According prEN1020:2007 the electric power input shall be expressed on the data plate (clause 8.1.2. f) in volts, amperes, etc. The manufacturer may convert the applicable values to Watts using known conventions. The electricity consumption of the fan for transport/distribution of warm air shall not be included in the electric power consumption.
el_{sb} electric power consumption at standby mode		IEC 62301:2011-01	IEC 62301:2011 applies to household appliancess
P_{pilot} permanent pilot flame power consumption		[See note]	According prEN1020:2007 clause 8.4.2 the technical instructions for installation and adjustment shall contain a technical table (that includes) heat input, heat output, rating of any ignition burner, (etc.), air delivery volumes, etc. The heat input by the permanent pilot flame can be determined in a way similar to the main energy input.
Emissions of nitrogen oxide (NO_x)	CEN	CEN Report CR 1404:1994 (currently revised by CEN/TC 238/WG2)	NO_x emission values are to be expressed in mg/kWh, based on gross calorific value GCV of the fuel.
Fenv envelope losses	Cen	EN 1886:2007	Insulation class according five classes, designated as T1-T5
IP rating (ingress protection rating)		EN 60529:2011	
Warm air heaters using liquid fuel			
P_{nom}, nominal load P_{min}, minimal load	CEN	EN 13842: 2004 Oil-fired convection air heaters - Stationary and transportable	EN 13842:2004 does not describe methods to establish the heat output. The heat output Pnom can be calculated with the equation Pnom = Q_N * $\eta_{th,nom}$, where Q_N is the nominal heat input (clause 6.3.2.2) and η_{nom} is the efficiency at nominal load. Q_N and η shall be based on the gross calorific value of the fuel. Similarly P_{min} can be calculated with the equation P_{min} = Q_{min} * $\eta_{th,min}$ where Q_{min} and $\eta_{th,min}$ are the heat input and efficiency at minimum load conditions
ηth,nom useful efficiency at nominal load ηth,min useful efficiency at minimal load		EN 13842: 2004 Clause 6.5.6, applicable to either nominal or minimum load	$\eta_{th,nom}$ equals η in clause 6.5.6
AFnom air flow at nominal load AFmin air flow at minimal load		[See note]	None of the standards describes methods to establish the warm air flow rate (or air delivery rate).

Parameter	ESO	Reference/Title	Notes
el_{nom} electric power consumption at nominal load el_{min} electric power consumption at minimum load el_{sb} electric power consumption at standby mode		[See note]	According prEN1020:2007 the electric power input shall be expressed on the data plate (clause 8.1.2. f) in volts, amperes, etc. The manufacturer may convert the applicable values to Watts using known conventions. Care should be taken not to include the fan for transport/distribution of warm air in the electric power consumption.
Emissions of nitrogen oxide (NO_x)	CEN	EN 267:2009 Automatic forced draught burners for liquid fuels; § 4.8.5. Emission limit values for NO_x and CO; § 5. Testing. ANNEX B. Emission measurements and corrections.	NO_x emission values are expressed on the basis of the gross calorific value of the fuel.
Fenv envelope losses	CEN	EN 1886:2007	Insulation class according five classes, designated as T1-T5
IP rating (ingress protection rating)		EN 60529:2011	
Warm air heaters using electric Joule effect			
P_{nom}, heat output at nominal load and P_{min}, heat output at minimal load	CEN	IEC/EN 60675 ed 2.1;1998 §16	P_{nom} and P_{min} correspond to the usable power in IEC 60675 ed. 2.1:1998 at nominal and minimum load, minus the power requirement for fans that distribute the warm air and the power requirement of electronic controls where relevant.
$\eta_{th,nom}$ useful efficiency at nominal load $\eta_{th,min}$ useful efficiency ar minimal load	n.a.	[See note]	The value is 100% per default.
AF_{nom} air flow at nominal load AF_{min} air flow at minimal load		[See note]	None of the standards describes methods to establish the warm air flow rate (or air delivery rate).
el_{sb} electric power consumption at standby mode		IEC 62301:2011-01	
F_{env} envelope losses	CEN	EN 1886:2007	Insulation class according five classes, designated as T1-T5
IP rating (ingress protection rating)		IEC 60529 (ed 2.1), clause 4.1.	
Comfort chillers, air conditioners and heat pumps			
Testing methods, vapour compression electrically driven heat pumps, chillers and air conditioners	CEN	EN 14825: 2012 Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling – Testing and rating at part load conditions and calculation of seasonal performance; Section 8: Test methods for testing capacities, EER and COP values during active mode at part load conditions	

Parameter	ESO	Reference/Title	Notes
		Section 9: Test methods for electric power consumption during thermostat off mode, standby mode and crankcase heater mode	
Testing methods, vapour compression liquid or gaseous fuel driven heat pumps, chillers and air conditioners	CEN	EN 14825:2012 Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling – Testing and rating at part load conditions and calculation of seasonal performance; Section 8: Test methods for testing capacities, EER and COP values during active mode at part load conditions; Section 9: Test methods for electric power consumption during thermostat off mode, standby mode and crankcase heater mode.	Until publication of the new European standard (see general comment).
Testing methods, liquid or gaseous fuel sorption heat pumps, chillers and air conditioners	CEN	prEN 12309 – 2 Gas-fired absorption and adsorption air-conditioning and/or heat pump appliances with a net heat input not exceeding 70 kW – Part 2: Rational use of energy; Section 6.1 Methods of test, General; Section 6.3 Heating mode tests (excluding Table 12. Rating test conditions for all appliances in the heating mode)	A working document dealing with testing methods at full load and part load is in progress within the CEN/TC299 WG2 experts group.
Vapour compression electrically and liquid or gaseous fuel engine driven chillers and air conditioners and liquid or gaseous fuel sorption chillers and air conditioners Test points for air-to-air and water/brine to air heat pumps and air conditioners; air-to-water chillers and water/brine-to-water chillers (air-cooled and water-cooled chillers); ; for calculation of seasonal energy efficiency ratio SEER for electrically driven products and seasonal primary energy ratio SPER for liquid or gaseous fuel engine driven	CEN	EN 14825:2012; For air-to-air air conditioners: Section 4.2, table 2 For water/brine-to-air air conditioners: Section 4.3, table 3 For air-to-water chillers: Section 4.4, table 4 For water/brine-to-water chillers: Section 4.5, table 5 Where the outlet temperatures set out in column "variable outlet" are to be applied for products that control the	For products other than vapour compression electrically driven EN 14825 applies until publication of a new European Standard. For fixed capacity units, tests are applied as indicated in EN 14825, section 8.4. Either the outlet temperatures during the tests are the ones to obtain the average outlet temperatures corresponding to the declaration points in EN 14825 or this data should be obtained by linear interpolation / extrapolation from the test points in EN 14511-2, complemented with test at other outlet temperatures when necessary.

Parameter	ESO	Reference/Title	Notes
products and liquid or gaseous fuel sorption products		outlet (flow) water temperature according to the cooling demand. For products that do not control the outlet (flow) water temperature according to the cooling demand but have a fixed outlet temperature, outlet temperature should be set according to the "fixed outlet".	For variable capacity units, EN 14825 section 8.5 are applied. Either the conditions during the tests are the same as for the declaration points specified in that standard or tests can be performed at other outlet temperatures and part load conditions and the results linearly interpolated, extrapolated, to determine the data for the declaration points in EN 14825.
Vapour compression electrically and liquid or gaseous fuel engine driven heat pumps and liquid or gaseous fuel sorption heat pumps Test points for air-to-air and water/brine to air heat pumps and air conditioners; air-to-water chillers and water/brine-to-water chillers (air-cooled and water-cooled chillers); ; for calculation of seasonal energy efficiency ratio SEER for electrically driven products and seasonal primary energy ratio SPER for liquid or gaseous fuel engine driven products and liquid or gaseous fuel sorption products	CEN	EN 14825:2012; For air-to-air heat pumps: Section 5.2, table 6 For water/brine-to-air heat pumps: Section 5.3, table 9	For products other than vapour compression electrically driven EN 14825 applies until publication of a new European Standard.
Vapour compression electrically driven and liquid or gaseous fuel engine driven heat pumps and liquid or gaseous fuel sorption heat pumps Calculation of seasonal coefficient of performance SCOP or $SPER_{heat}$		EN 14825: October 2012 Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling – Testing and rating at part load conditions and calculation of seasonal performance; Section 7: Calculation methods for reference SCOP, reference SCOPon and reference SCOPnet.	The $SPER_{heat}$ formulae for liquid or gaseous fuel heat pumps will be established in analogy to the SCOP formulae for vapour compression electrically driven heat pumps: COP, $SCOP_{net}$, $SCOP_{on}$ and SCOP will be replaced by $GUEGCV_{heat}$, PER_{heat}, $SPER_{net,heat}$, $SPER_{on,heat}$ and SPER. For liquid or gaseous fuel sorption heat pump, a working document including a SPER calculation method is in progress within the CEN/TC299 WG2 experts group.
Vapour compression liquid or gaseous fuel engine driven heat pump, Liquid or gaseous fuel sorption heat pump Calculation of seasonal primary energy ratio $SPER_{cool}$	CEN	New European Standards under development sorption: Revised version of part 2 of EN 12309	The $SPER_{cool}$ formulae for liquid or gaseous fuel heat pump will be established in analogy to the SEER formulae for vapour compression electrically driven heat pumps: EER, SEERnet, SEERon and SEER will be replaced by $GUEGCV_{cool}$, PER_{cool}, $SPER_{net,cool}$, $SPER_{on,cool}$ and $SPER_{cool}$. For liquid or gaseous fuel sorption heat pump, a working document including a $SPER_{cool}$ calculation method is in progress within the CEN/TC299 WG2 experts group.
Vapour compression liquid or	CEN	Revised version of part 2	Calculations for EER, COP to

Parameter	ESO	Reference/Title	Notes
gaseous fuel engine driven heat pumps, air conditioners and chillers, Liquid or gaseous fuel sorption heat pumps, air conditioners and chillers Auxiliary electricity consumption of fossil-fuel fired heat pump in active heating mode.		of EN 12309 for liquid or gaseous fuel sorption heat pump	include the water heat exchanger pressure loss for all generators in the seasonal efficiency calculation, and not by a default value but a calculation from measured pressure difference and flow in standard rating conditions.
Vapour compression electrically and liquid or gaseous fuel engine driven heat pump and liquid or gaseous fuel sorption heat pumps, air conditioners and chillers Fixed, staged and variable capacity, definition		EN 14825: June 2012 section 3.1.32 - capacity control Fixed capacity unit: air conditioner, heat pump or chiller, which does not have the possibility to change automatically (in minimum two steps or continuously) the amount of refrigerant flowing through the condenser Where no refrigerant is flowing through the indoor side (or one of the indoor units) it is not considered a capacity step. Variable capacity unit: air conditioner, heat pump or chiller, where the amount of refrigerant flowing through the condenser (when heating) or evaporator (when cooling) is varied or changed in a series of not more than two steps or increments.	The heating capacity comes from: condenser for vapour compression product or condenser plus absorber, or adsorber, plus eventually flue gas heat recovery exchanger for sorption product. For absorption products, all the refrigerant always flows through the system but only one part of it flows through the condenser, the rest of refrigerant having no heating effect. In consequence, in order to have a common definition for a fixed capacity unit, it seems preferable to refer to the refrigerant through the condenser (when heating) or the evaporator (when cooling). For reasons of consistency, it seems preferable to replace "capacity" by "amount of refrigerant flowing through the condenser".
Air heating products and/or cooling products Seasonal space heating energy efficiency or seasonal space cooling energy efficiency		Point [to be inserted] of this Communication (European Commission)	Additional elements for calculations related to the seasonal space heating energy efficiency or space cooling energy efficiency for air heating products and cooling products.
High temperature process chillers			
refrigeration load $P_{designR}$		As in EN14825:2012 - Section 3.1.3	
part load ratio		As in EN14825:2012 - Section 3.1.5	
declared capacity DC		As in EN14825:2012 - Section 3.1.6	
capacity ratio C_R		As in EN14825:2012 - Section 3.1.7	
bin hours		As defined in EC Regulation No ../.., Annex .. [to be completed]	
energy efficiency ratio at declared capacity EER_{DC}		EN 14511-1/-2/-3:2011 for the determination of	The EER includes degradation losses when the declared capacity of the

Parameter	ESO	Reference/Title	Notes
energy efficiency ratio at part load or full load conditions EER_{PL}		EER values at given conditions	chiller is higher than the cooling capacity demand
reference seasonal energy performance ratio reference SEPR		Point 6 of this Communication (European Commission)	
capacity control		As in EN14825:2012 - Section 3.1.32	See comments related to capacity control of air conditioners, chillers and heat pumps
degradation coefficient C_C		As in EN14825:2012 - Section 8.4.2	

Notes:

- There is no European standard dealing with vapour compression liquid or gaseous fuel engine driven heat pumps. A working group : CEN/TC 299 – WG3 is working on a standard.
- The European standards EN 12309 part 1 and part2, dealing with liquid or gaseous fuel sorption heat pumps are under revision in CEN/TC299 – WG2, particularly to calculate a seasonal energy efficiency.

2. Additional elements for measurements and calculations related to the seasonal space heating energy efficiency of warm air heaters:

2.1 Test points

The useful efficiency, the useful heat output, the electric power consumption and the air flow shall be measured at nominal and minimum heat output.

2.2 Calculation of the seasonal space heating energy efficiency of warm air heaters

(a) The seasonal space heating energy efficiency η_S for warm air heaters using fuels is defined as:

$$\eta_S = \eta_{S,on} - \sum F(i)$$

(b) The seasonal space heating energy efficiency η_S for warm air heaters using electricity is defined as:

$$\eta_S = \left(\frac{1}{CC}\right) \cdot \eta_{S,on} - \sum F(i)$$

Where:

– $\eta_{S,on}$ is the seasonal space heating energy efficiency in active mode, expressed in %;

– CC is the conversion coefficient as defined in Annex 1 of Regulation *[number to be inserted after publication in the OJEU]*;

– F(i) are corrections calculated according to point 2.7 below and expressed in %.

2.3 Calculation of the *seasonal space heating energy efficiency in active mode*

The seasonal space heating energy efficiency in active mode $\eta_{S,on}$ is calculated as follows:

$$\eta_{S,on} = \eta_{S,th} \cdot \eta_{S,flow}$$

Where:

– $\eta_{S,th}$ is the seasonal thermal energy efficiency in active mode, expressed in %;

– $\eta_{S,flow}$ is the emission efficiency for a specific air flow, expressed in %.

2.4 Calculation of the *seasonal thermal energy efficiency* $\eta_{S,th}$

The seasonal thermal energy efficiency $\eta_{S,th}$ is calculated as follows

$$\eta_{S,th} = \left(0.15 \cdot \eta_{th,nom} + 0.85 \cdot \eta_{th,min}\right) - F_{env}$$

Where:

– $\eta_{th,nom}$ is the useful efficiency at nominal (maximal) load, expressed in % and based on GCV;

– $\eta_{th,min}$ is the emission efficiency at minimum load, expressed in % and based on GCV;

– F_{env} is the envelope loss factor of the heat generator, expressed in %.

2.5 Calculation of the *Envelope loss*

The envelope loss factor F_{env} depends on the intended placement of the unit and is calculated as follows:

If the warm air heater is specified to be installed in the heated area:

$$F_{env} = 0$$

If the protection against ingress of water of the part of the product that incorporates the heat generator has a IP rating of x4 or higher (IP rating according IEC 60529 (ed 2.1), clause 4.1), the envelope loss factor depends on the thermal transmittance of the envelope of the heat generator according to Table 1.

Table 1

Envelope loss factor of the heat generator

Thermal transmittance (U) [W/m^2·K]	**Factor F_{env}**
$U \leq 0.5$	0.4 %
$0.5 < U \leq 1.0$	0.6 %
$1.0 < U \leq 1.4$	1.0 %
$1.4 < U \leq 2.0$	1.5 %
No requirements	5.0 %

2.6 Calculation of the *emission efficiency* $\eta_{S,flow}$

The emission efficiency $\eta_{S,flow}$ is calculated as follows:

$$\eta_{S,flow} = 1 - 9.78 \cdot \frac{0.15 \cdot P_{nom}}{AF_{nom}} + \frac{0.85 \cdot P_{min}}{AF_{min}}$$

Where:

– P_{nom} is the output power at nominal (maximal) load, expressed in kW;

– P_{min} is the output power at minimum load, expressed in kW;

– AF_{nom} is the air flow at nominal (maximal) load, expressed in kW/m^{3}h, corrected to 15ºC equivalent ($V_{15°C}$);

– AF_{min} is the air flow at minimal load, expressed in kW/m^{3}h, corrected to 15ºC equivalent.

The emission efficiency of the air flow is based on a 15ºC temperature increase. In case the unit is intended to produce a different temperature increase ("t") the actual air flow "V" shall be recalculated into an equivalent air flow "$V_{15ºC}$" as follows:

$$V_{15ºC} = V \cdot \frac{288}{273 + t}$$

– $V_{15ºC}$ is the equivalent air flow at 15°C;

– V is the actual delivered air flow,

– t is the actual delivered temperature increase.

2.7 Calculation of ∑F(i) for warm air heaters

∑F(i) is the summation of various correction factors, all expressed in percentage points.

$$\sum F(i) = F(1) + F(2) + F(3) + F(4)$$

(a) The correction factor F(1) for the adaptation of heat output takes into account the way the product adapts to a heat load (which can be either through single stage, two stage, modulating control) and the load range (1-(P_{min}/P_{nom}) the heater can work in related to the state-of-the-art load range of this technology.

For heaters with state-of-the-art or higher load ranges the full value of parameter B can be taken into account, leading to a lower value for correction factor F(1). For heaters with a smaller load range a smaller than maximum value of B is taken into account.

Table 2

Calculation of F(1) depending on heat output control and load range

Heat output control	**Calculation of F(1)**	**Where B is calculated as:**
Single stage (no load range)	$F(1) = 5\% - B$	B = 0%
Two stage (highest load range: 50%)		$B = \frac{1-\left(\frac{Pmin}{Pnom}\right)}{(100\% - 50\%)} \cdot 2.5\%$ $with\ B\ is\ maximum\ 2.5\%$
Modulating (highest load range: 70%)		$B = \frac{1 - \left(\frac{P_{min}}{P_{nom}}\right)}{(100\% - 30\%)} \cdot 5\%$ $with\ B\ is\ maximum\ 5\%$

(b) The correction F(2) accounts for a negative contribution to the seasonal space heating energy efficiency by auxiliary electricity consumption for warm air heaters, expressed in %, and is given as follows:

For warm air heaters using fuels:

$$F(2) = 2.5 \cdot \frac{0.15 \cdot el_{max} + 0.85 \cdot el_{min} + 1.3 \cdot el_{sb}}{P_{nom}}$$

For warm air heaters using electricity:

$$F(2) = 1.3 \cdot \frac{el_{sb}}{P_{nom} * CC}$$

Where:

– el_{max} is the electric power consumption when the products is providing the nominal heat output, excluding the energy needed for the transport fan, expressed in kW;

– el_{min} is the: electric power consumption when the products is providing the minimum heat output, excluding the energy needed for the transport fan, expressed in kW;

– el_{sb} is the electric power consumption when the product is in standby mode, expressed in kW.

OR a default value as set out in EN 15316-1 may be applied

(c) The correction F(3) accounts for a negative contribution to the seasonal space heating energy efficiency for gravity vented combustion systems (combustion air transported by natural draft) as additional thermal losses during time burner off have to be considered.

For warm air heaters in which transport of combustion air is by natural draught:

$$F(3) = 3\%$$

For warm air heaters in which transport of combustion air is by forced draught:

$$F(3) = 0\%$$

(d) The correction F(4) accounts for a negative contribution to the seasonal space heating energy efficiency by permanent pilot flame power consumption and is given as follows:

$$F(4) = 4 \cdot \frac{P_{ign}}{P_{nom}}$$

In which the value '4' is the ratio of the average heating period (4000 hrs/yr) by the average on-mode duration (1000 hrs/yr).

3. Additional elements for calculations related to the seasonal space heating and cooling efficiency of comfort chillers, air conditioners and heat pumps.

3.1 Calculation of the seasonal space heating energy efficiency for heat pumps

(a) For heat pumps using electricity, the seasonal space heating energy efficiency $\eta_{S,heat}$ is defined as:

$$\eta_{S,heat} = \frac{1}{CC} \cdot SCOP - \sum F(i)$$

(b) For heat pumps using fuels, the seasonal space heating energy efficiency $\eta_{S,heat}$ is defined as:

$$\eta_{S,heat} = SPER_{heat} - \sum F(i)$$

Where:

- SCOP is the seasonal space heating energy efficiency in active mode, expressed in %;
- $SPER_{heat}$ is the seasonal space heating energy efficiency in active mode, expressed in %;
- F(i) are the corrections calculated according to point 3.4, expressed in %.

3.2 Calculation of the seasonal space cooling energy efficiency for chillers and air conditioners

(a) For chillers and air conditioners using electricity, the seasonal space cooling energy efficiency $\eta_{S,cool}$ is defined as:

$$\eta_{S,cool} = SEER - \sum F(i)$$

(b) For chillers and air conditioners using fuels, the seasonal space cooling energy efficiency $\eta_{S,cool}$ is defined as:

$$\eta_{S,cool} = SPER_{cool} - \sum F(i)$$

Where:

- SEER is the seasonal space cooling energy efficiency in active mode, expressed in %;
- $SEER_{cool}$ is the seasonal space cooling energy efficiency in active mode, expressed in %;
- $F(i)$ are the corrections calculated according to point 3.4 expressed in %.

3.3 Calculation of F(i) for comfort chillers, air conditioners and heat pumps

(a) The correction F(1) accounts for a negative contribution to the seasonal space heating or cooling energy efficiency of products due to adjusted contributions of temperature controls to seasonal space heating and cooling energy efficiency.

For comfort chillers, air conditioners and heat pumps the correction is :

$$F(1) = 3\%$$

(b) The correction F(2) accounts for a negative contribution to the seasonal space heating or cooling efficiency by electricity consumption of ground water pump(s), expressed in %.

For water/brine-to-water chillers, or water/brine-to-air air conditioners and water/brine-to-air heat pumps:

$$F(2) = 5\%$$

4. Additional elements for calculations related to the seasonal energy performance ratio of high temperature process chillers.

4.1 Test points

4.2 Calculation of the reference seasonal energy performance ratio (reference SEPR) for high temperature process chillers.

(a) The reference SEPR is calculated as the reference annual refrigeration demand divided by the annual electricity consumption.

$$reference\ SEPR = \frac{\sum_{j=1}^{n}[h_j . P_R(T_j)]}{\sum_{j=1}^{n}\left[h_j . \frac{P_R(T_j)}{EER_{PL}(T_j)}\right]}$$

Where :

- T_j is the bin temperature;
- j is the bin number;
- n is the amount of bin;
- $PR(T_j)$ is the refrigeration demand of the application for the corresponding temperature T_j;
- h_j is the number of bin hours occurring at the corresponding temperature T_j;
- $EERPL(T_j)$ is the EER values of the unit for the corresponding temperature T_j. This includes part load conditions.

NOTE: This annual electricity consumption includes the power consumption during active mode. Off mode and standby modes are not relevant for process application as the appliance is assumed to be running all year long.

(b) The refrigeration demand $P_R(T_j)$ can be determined by multiplying the full load value ($Pdesign_R$) with the part load ratio % for each corresponding bin. These part load ratios % are calculated in Tables 1 and 2.

(c) The energy efficiency ratio $EER_{PL}(Tj)$ at part load conditions A, B, C, D is determined as explained below:

In part load condition A (full load), the declared capacity of a unit is considered equal to the refrigeration load ($P_{designR}$)

In part load conditions B,C,D, there can be two possibilities:

1) If the declared capacity (DC) of a unit matches with the required refrigeration loads, the corresponding EER_{DC} value of the unit is to be used. This may occur with variable capacity units.

$$EER_{PL}(T_{B,C\ or\ D}) = EER_{DC}$$

2) If the declared capacity of a unit is higher than the required refrigeration loads, the unit has to cycle on/off. This may occur with fixed capacity or variable capacity units. In such cases, a degradation coefficient (Cc) has to be used to calculate the corresponding EER_{PL} value. Such calculation is explained below.

   I. Calculation procedure for fixed capacity units

   In order to obtain a time averaged outlet temperature the inlet and outlet temperatures for the capacity test shall be determined using the equation below:

$$t_{outlet,average} = t_{inlet,capacity\ text} + (t_{outlet,capacity\ test} + t_{inlet,capacity\ test}) + C_R$$

Where

- $t_{inlet,\ capacity\ test}$ is the evaporator water inlet temperature (for conditions B, C or D as set out in regulation *[number to be inserted after publication in the OJEU]*, Annex III, table 23 and 24);
- $t_{outlet,\ capacity\ test}$ is the evaporator water outlet temperature (for conditions B, C or D as set out in regulation . *[number to be inserted after publication in the OJEU]*, Annex III, table 23 and 24);
- $t_{outlet,\ average}$ is the mean evaporator water average outlet temperature over a on/off cycle (for instance +7°C as set out in regulation *[number to be inserted after publication in the OJEU]*, Annex III, table 23 and 24);
- CR is the capacity ratio.

Then, for each part load conditions B,C,D the EER_{PL} is calculated as follows:

$$EER_{PL(B,C,D)} = EER_{DC\,(B,C,D)} \cdot \frac{CR_{(B,C,D)}}{CC_{(B,C,D)} \cdot CR_{(B,C,D)} + (1 - CC_{(B,C,D)})}$$

Where:

- EER_{DC} is the EER corresponding to the declared capacity (DC) of the unit at the same temperature conditions as for part load conditions B, C, D;
- Cc is the degradation coefficients for chillers for part load conditions B, C, D;
- CR is the capacity ratio for part load conditions B, C, D.

For chillers, the degradation due to the pressure equalization effect when the unit restarts can be considered as negligible.

The only effect that will impact the EER at cycling is the remaining power input when the compressor is switching off.

The electrical power input during the compressor off state of the unit is measured when the compressor is switched off for at least 10 min.

The degradation coefficient Cc is determined for each part load ratio as follows:

$$Cc = 1 - \frac{measured\ power\ of\ compressor\ off\ state}{total\ power\ input\ (full\ capacity\ at\ the\ part\ load\ conditions)}$$

If Cc is not determined by test then the default degradation coefficient Cc is 0,9.

II. Calculation procedure for variable capacity units

Determine the declared capacity and EER_{PL} at the closest step or increment of the capacity control of the unit to reach the required refrigeration load. If this step does not allow reaching the required refrigeration load within +/- □10 % (e.g. between 9,9 kW and 8,1 kW for a required cooling load of 9 kW), determine the capacity and EER_{PL} at the defined part load temperatures for the steps on either side of the required refrigeration load. The part load capacity and the EER_{PL} at the required refrigeration load are then determined by linear interpolation between the results obtained from these two steps.

If the smallest control step of the unit is higher than the required refrigeration load, the EER_{PL} at the required part load ratio is calculated using the equation for fixed capacity units.

(d) The energy efficiency ratio $EER_{PL}(Tj)$ at part load conditions, different than part load conditions A, B, C, D is determined as explained below:

The EER values at each bin are determined via interpolation of the EER values at part load conditions A,B,C,D as mentioned in the Tables 23 and 24 of regulation *[number to be inserted after publication in the OJEU]*.

For part load conditions above part load condition A, the same EER values as for condition A are used.

For part load conditions below part load condition D, the same EER values as for condition D are used.