WORKING DOCUMENT

Commission communication in the framework of the implementation of Commission Regulation (EU) No [*insert after publication*] 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

(2014/C …/…)

1. Publication of titles and references of transitional methods of measurement and calculation[1] for the implementation of Regulation (EU) No [*insert after publication*], and in particular Annexes III and IV thereof.

(Text with EEA relevance)

2. References

Parameter	ESO	Reference/Title	Notes
Warm air heaters using gaseous fuel			
P_{nom}, rated heating capacity P_{min}, minimum heating capacity	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 Pnom can be calculated with the equation Pnom = Qnom * ηth,nom, where Qnom is the nominal heat input and ηth,nom is the nominal efficiency. Pnom shall be based on the gross calorific value of the fuel. Similarly Pmin can be calculated with the equation Pmin = Qmin * ηth,min
$\eta_{th,nom}$ useful efficiency at rated heating capacity		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,	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
		clause 6.8.3 EN621:2009 clause 7.4.6 EN 778:2009 clause 7.4.6	
AF_{nom} air flow at rated heating capacity 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).
elnom electric power consumption at rated heating capacity elmin 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. Care should be taken not to include the fan for transport/distribution of warm air in the electric power consumption.
elsb electric power consumption at standby mode		IEC 62301:2011-01	IEC 62301:2011 applies to household appliances / issues to be discussed with relevant TC's
Ppilot 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 (NOx)	CEN	CEN Report CR 1404:1994 (currently revised by CEN/TC 238/WG2)	NOx 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			
Pnom, rated heating capacity Pmin, 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 = QN * ηth,nom, where QN is the nominal heat input (clause 6.3.2.2) and ηnom is the efficiency at rated heating capacity. Q_N and η shall be based on the gross calorific value of the fuel. Similarly Pmin can be calculated with the equation Pmin = Qmin * ηth,min where Qmin and ηth,min are the heat input and efficiency at minimum load conditions
ηth,nom useful efficiency at rated heating capacity 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

Parameter	ESO	Reference/Title	Notes
AFnom air flow at rated heating capacity 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).
el_{nom} electric power consumption at rated heating capacity 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 (NOx)	CEN	EN 267:2009 Automatic forced draught burners for liquid fuels; § 4.8.5. Emission limit values for NOx and CO; § 5. Testing. ANNEX B. Emission measurements and corrections.	NOx 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}, rated heating capacity and P_{min}, heat output at minimal load	CEN	IEC/EN 60675 ed 2.1;1998 §16	A standard for actual measurement of heat output of electric warm air heaters has not been identified. The electric power input at nominal or minimum load is considered representative for the nominal or minimum heat output. 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 rated heating capacity $\eta_{th,min}$ useful efficiency ar minimal load	n.a. n.a.	[See note]	According Annex ... of Regulation No ../.. the value is default 100%
AF_{nom} air flow at rated heating capacity 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.	
Electric driven comfort chillers, air conditioners and heat pumps			
SEER	CEN	EN 14825:2013, section 6.1	

Parameter	ESO	Reference/Title	Notes
Q_C		EN 14825:2013, section 6.2	
Q_{CE}		EN 14825:2013, section 6.3	
SEERon, part load ratio		EN 14825:2013, section 6.4	
EERbin(Tj), CRu, Cc, Cd		EN 14825:2013, section 6.5	
SCOP		EN 14825:2013, section 7.1	
Q_H		EN 14825:2013, section 7.2	
Q_{HE}		EN 14825:2013, section 7.3	
SCOPon, part load ratio		EN 14825:2013, section 7.4	
COPbin(Tj), CRu, Cc, Cd		EN 14825:2013, section 7.5	
Cc and Cd		EN 14825:2013, section 8.4 & 8.6	
Poff, Psb, Pck & Pto		EN 14825:2013, section 9	
Comfort chillers, air conditioners and heat pumps using internal combustion			
SPERc	CEN	CEN/TC299/WG3, part 6, section 6.8	
SGUEc		CEN/TC299/WG3, part 6, section 6.3	
SAEFc		CEN/TC299/WG3, part 6, section 6.4	
GUEcpl		CEN/TC299/WG3, part 6, section 6.7	
GUEd,c		CEN/TC299/WG3, part 6, section 6.2	
QEc & QEh		CEN/TC299/WG3, part 4, section 4.2.1.2	
QEhr		CEN/TC299/WG3, part 4, section 4.2.2.1	
Qgmc & Qgmh		CEN/TC299/WG3, part 4, section 4.2.3	
Qref,c & Qref,h		CEN/TC299/WG3, part 6, section 7.4	
SPERh		CEN/TC299/WG3, part 6, section 7.7	
SGUEh		CEN/TC299/WG3, part 6, section 7.2	
SAEFh		CEN/TC299/WG3, part 6, section 7.3	
SAEFhon		CEN/TC299/WG3, part 6, section 7.5	
AEFhpl		CEN/TC299/WG3, part 6, section 7.6	
AEFd,h		CEN/TC299/WG3, part 6, section 7.2	
PEc & PEh			
Comfort chillers, air conditioners and heat pumps using sorption cycle			
SGUEc	CEN	FprEN 12309-1:2013, Part 6, section 4.3	
SAEFc		FprEN 12309-1:2013, Part 6, , section 4.4	
Qref,c		FprEN 12309-1:2013, Part 6, , section 4.5	
SAEFC,on		FprEN 12309-1:2013, Part 6, , section 4.6	
GUEc & AEFc		FprEN 12309-1:2013, Part 6, , section 4.7	
SPERh		FprEN 12309-1:2013, Part 6, , section 5.3	
SGUEh		FprEN 12309-1:2013, Part 6, , section 5.4	
SAEFh		FprEN 12309-1:2013, Part 6, section 5.5	
Qref,h		FprEN 12309-1:2013, Part 6, section 5.6	
SAEFhon		FprEN 12309-1:2013, Part 6, section 5.7	
GUEh & AEFh		FprEN 12309-1:2013, Part 6, section 5.8	
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 EER values at given conditions	The EER includes degradation losses when the declared capacity of the chiller is higher than the cooling capacity
energy efficiency ratio at part load or full load conditions EER_{PL}			

Parameter	ESO	Reference/Title	Notes
			demand
seasonal energy performance ratio (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.

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

3.1 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.

3.2 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 %

3.3 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, expressed in %

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

3.4 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 useful efficiency at minimum load, expressed in % and based on GCV

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

3.5 Calculation of the *Envelope loss*

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

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

$$F_{env} = 0$$

(b) 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 ≤ 0.5	0.4 %
0.5 < U ≤ 1.0	0.6 %
1.0 < U ≤ 1.4	1.0 %
1.4 < U ≤ 2.0	1.5 %
No requirements	5.0 %

3.6 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/m³h, corrected to 15ºC equivalent ($V_{15ºC}$).

– AF_{min} is the air flow at minimal load, expressed in kW/m³h, 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

3.7 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).

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

4.1 Calculation of the **seasonal space heating energy efficiency** for heat pumps:

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

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

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

$$\eta_{S,h} = SPER_h - \sum F(i)$$

Where:

– SCOP is the seasonal coefficient of performance, expressed in %;

– $SPER_h$ is the seasonal primary energy ratio for heating, expressed in %

– F(i) are the corrections calculated according to point 3.3, expressed in %;

(c) Calculation of SCOP of heat pumps using electricity

$$SCOP = \frac{Q_H}{Q_{HE}}$$

Where:

$$Q_H = P_{designh} * H_{HE}$$

and:

$$Q_{HE} = \frac{Q_H}{SCOP_{on}} + (H_{TO} * P_{TO}) + (H_{SB} * P_{SB}) + (H_{CK} * P_{CK}) + (H_{OFF} * P_{OFF})$$

and:

$$SCOP_{on} = \frac{\sum_{j=i}^{n} hj * P_h(Tj)}{\sum_{j=i}^{n} hj * \left(\frac{P_h(Tj) - elbu(Tj)}{COP_{bin}(Tj)} + elbu(Tj)\right)}$$

and:

for fixed capacity units, in case the lowest declared heating capacity exceeds the part load for heating (or capacity ratio $CR_u \leq 1.0$):

$$COP_{bin(Tj)} = COP_d * \{1 - C_d * (1 - CR_u)\}$$

Where:

COPbin(Tj) = bin-specific coefficient of performance

COPd(Tj) = declared coefficient of performance

C_d = 0.25 (default value) or established by a cycling test

and:

$$CR_u = \frac{P_H}{P_d}$$

for staged or variable capacity units, determine the declared heating capacity and COPd(Tj) at the closest step or increment of the capacity control of the unit to reach the required heat load.

If this step does allows to reach the required heating load within ± 10 % (e.g. between 9,9 kW and 8,1 kW for a required heating load of 9 kW), then COPbin(Tj) is assumed to be equal to COPd(Tj).

If this step does not allow to reach the required heating load within ± 10 % (e.g. between 9,9 kW and 8,1 kW for a required heating load of 9 kW), determine the capacity and COPbin(Tj) at the defined part load temperatures for the steps on either side of the required heating load. The part load capacity and the COPbin(Tj) at the required heating load are then determined by linear interpolation between the results obtained from these two steps.

If the smallest control step of the unit only allows a declared heating capacity higher than the required heating load, the COPbin(Tj) at the required part load ratio is calculated using the approach laid out for fixed capacity units.

For bins representing other than above described operating conditions the COPbin shall be established by interpolation, except for part load conditions above part load condition A, for which the same values as for condition A shall be used and for part load conditions below part load condition D, for which the same values as for condition D shall be used.

(d) Calculation of SPERh of heat pumps using internal combustion

$$SPER_h = \frac{1}{\frac{1}{SGUE_h} + \frac{CC}{SAEF_h}}$$

Where:

$$SGUE_h = \frac{\sum_{j=i}^{n} hj * P_h(Tj)}{\sum_{j=i}^{n} hj * \left(\frac{P_h(Tj)}{GUE_{h,bin}(Tj)}\right)}$$

and:

$$GUE_{h,bin} = \frac{Q_{Eh} + Q_{Ehr,c}}{Q_{gmh}}$$

and

QEh = effective heating capacity, in kiloWatt

QEhr,c = effective heat recovery capacity, in kiloWatt

Qgmh = is the measured heating heat input, in kiloWatt

GUEh shall also take into account degradation effects due to cycling in a manner similar to that of electric heat pumps.

and:

$$SAEF_h = \frac{Q_{ref,h}}{\left(\frac{Q_{ref,h}}{SAEF_{h,on}} + (H_{TO} * P_{TO}) + (H_{SB} * P_{SB}) + (H_{CK} * P_{CK}) + (H_{OFF} * P_{OFF})\right)}$$

and:

$$Q_{ref,h} = P_{design,h} * H_{HE}$$

and:

$$SAEF_{h,on} = \frac{\sum_{j=i}^{n} hj * P_h(Tj)}{\sum_{j=i}^{n} hj * \left(\frac{P_h(Tj)}{AEF_{h,bin}(Tj)}\right)}$$

and:

$$AEF_{h,bin} = \frac{Q_{Eh} + Q_{Ehr,c}}{P_{Eh}}$$

and:

QEh = effective heating capacity, in kiloWatt

QEhr,c = effective heat recovery capacity, in kiloWatt

PEh = effective heating electrical power input, in kiloWatt

AEFh shall also take into account degradation effects due to cycling in a manner similar to that of electric heat pumps.

and:

for fixed capacity units, in case the lowest declared heating capacity exceeds the part load for heating (or capacity ratio $CR_u \leq 1.0$):

$$GUE_{h,bin(Tj)} = GUE_d * \{1 - C_d * (1 - CR_u)\}$$

and:

$$AEF_{h,bin(Tj)} = AEF_d * \{1 - C_d * (1 - CR_u)\}$$

Where:

GUEd(Tj) = declared gas utilization efficiency at outdoor temperature Tj

AEFd(Tj) = declared auxiliary energy factor at at outdoor temperature Tj

C_d = 0.25 (default value) or established by a cycling test

and:

$$CR_u = \frac{P_H}{Q_{Eh} + Q_{Ehr}}$$

for staged or variable capacity units, determine the declared heating capacity at the closest step or increment of the capacity control of the unit to reach the required heat load.

If this step allows the heating capacity to reach the required heating load within ± 10 % (e.g. between 9,9 kW and 8,1 kW for a required heating load of 9 kW), then GUEbin(Tj) is assumed to be equal to GUEd(Tj) and AEFbin(Tj) is assumed to be equal to AEFd(Tj).

If this step does not allow the heating capacity to reach the required heating load within ± 10 % (e.g. between 9,9 kW and 8,1 kW for a required heating load of 9 kW), determine the capacity and GUEbin(Tj) and AEFbin(Tj) at the defined part load temperatures for the steps on either side of the required heating load. The heating capacity in part load, the GUEbin(Tj) and the AEFbin(Tj) at the required heating load are then determined by linear interpolation between the results obtained from these two steps.

If the smallest control step of the unit only allows a declared heating capacity higher than the required heating load, the GUEbin(Tj) and AEFbin(Tj) at the required part load ratio is calculated using the approach laid out for fixed capacity units.

For bins representing other than above described operating conditions the GUEbin and AEFbin shall be established by interpolation, except for part load conditions above part load condition A, for which the same values as for condition A shall be used and for part load conditions below part load condition D, for which the same values as for condition D shall be used.

4.2 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:

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

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

$$\eta_{S,c} = SPER_c - \sum F(i)$$

Where:

– SEER is the seasonal space cooling energy efficiency in active mode, expressed in %;

– $SPER_c$ is the seasonal primary energy ratio for cooling, expressed in %

– $F(i)$ are the corrections calculated according to point 3.3 expressed in %;

Calculation of SEER

$$SEER = \frac{Q_C}{Q_{CE}}$$

Where

$$Q_C = P_{design,c} * H_{CE}$$

and

$$Q_{CE} = \frac{Q_C}{SEER_{on}} + (H_{TO} * P_{TO}) + (H_{SB} * P_{SB}) + (H_{CK} * P_{CK}) + (H_{OFF} * P_{OFF})$$

and

$$SEER_{on} = \frac{\sum_{j=i}^{n} hj * P_c(Tj)}{\sum_{j=i}^{n} hj * \left(\frac{P_c(Tj)}{EER_{bin}(Tj)}\right)}$$

and, for **electric air conditioners** (connected to an air-based cooling system) of which the capacity control is **fixed capacity**, in case the lowest declared heating capacity exceeds the part load for heating (or capacity ratio $CR_u \leq 1.0$):

$$EER_{bin(Tj)} = EER_d * \{1 - C_d * (1 - CR_u)\}$$

Where

EERd(Tj) = declared coefficient of performance

C_d = 0.25 (default value) or established by a cycling test

$$CR_u = \frac{P_C}{P_d}$$

and, for **electric comfort chillers and high temperature process chillers** (connected to a **water-based cooling system**) of which the capacity control is **fixed capacity**, in case the lowest declared heating capacity exceeds the part load for heating (or capacity ratio $CR_u \leq 1.0$):

$$EER_{bin(Tj)} = EER_{d(Tj)} * \left(\frac{CRu}{Cc * CRu + (1 - Cc)}\right)$$

Where

EERd(Tj) = declared coefficient of performance

C_c = 0.9 (default value) or established by a cycling test

$$CR_u = \frac{P_C}{P_d}$$

and, **for staged or variable capacity air conditioners, comfort chillers or high temperature process chillers**, determine the declared cooling capacity and EERd(Tj) at the closest step or increment of the capacity control of the unit to reach the required cooling load.

If this step does allows to reach the required cooling load within ± 10 % (e.g. between 9,9 kW and 8,1 kW for a required cooling load of 9 kW), then EERbin(Tj) is assumed to be equal to EERd(Tj).

If this step does not allow to reach the required cooling load within ± 10 % (e.g. between 9,9 kW and 8,1 kW for a required heating load of 9 kW), determine the capacity and EERbin(Tj) at the defined part load temperatures for the steps on either side of the required heating load. The part load capacity and the EERbin(Tj) at the required heating load are then determined by linear interpolation between the results obtained from these two steps.

If the smallest control step of the unit only allows a declared heating capacity higher than the required heating load, the EERbin(Tj) at the required part load ratio is calculated using the approach laid out for fixed capacity units.

For bins representing other than above described operating conditions the EERbin shall be established by interpolation, except for part load conditions above part load condition A, for which the same values as for condition A shall be used and for part load conditions below part load condition D, for which the same values as for condition D shall be used.

For air conditioners and comfort chillers using internal combustion

Calculation of SPERc

$$SPER_c = \frac{1}{\frac{1}{SGUE_c} + \frac{CC}{SAEF_c}}$$

Where

and

$$SGUE_c = \frac{\sum_{j=i}^{n} hj * P_c(Tj)}{\sum_{j=i}^{n} hj * \left(\frac{P_c(Tj)}{GUE_{c,bin}(Tj)}\right)}$$

and

$$SAEF_h = \frac{Q_{ref,c}}{\left(\frac{Q_{ref,c}}{SAEF_{c,on}} + (H_{TO} * P_{TO}) + (H_{SB} * P_{SB}) + (H_{CK} * P_{CK}) + (H_{OFF} * P_{OFF})\right)}$$

and

$$Q_{ref,c} = P_{design,c} * H_{CE}$$

and

$$SAEF_{c,on} = \frac{\sum_{j=i}^{n} hj * P_c(Tj)}{\sum_{j=i}^{n} hj * \left(\frac{P_c(Tj)}{AEF_{c,bin}(Tj)}\right)}$$

and, for **air conditioners with internal combustion** (connected to an air-based cooling system) of which the capacity control is **fixed capacity**, in case the lowest declared heating capacity exceeds the part load for heating (or capacity ratio $CR_u \leq$ 1.0):

$$GUE_{c,bin(Tj)} = GUE_d * \{1 - C_d * (1 - CR_u)\}$$

and

$$AEF_{c,bin(Tj)} = AEF_d * \{1 - C_d * (1 - CR_u)\}$$

Where

GUEd(Tj) = declared gas utilization efficiency at outdoor temperature Tj

AEFd(Tj) = declared auxiliary energy factor at at outdoor temperature Tj

C_d = 0.25 (default value) or established by a cycling test

$$CR_u = \frac{P_H}{Q_{Eh} + Q_{Ehr}}$$

and, for **comfort chillers with internal combustion** (connected to a water-based cooling system) of which the capacity control is **fixed capacity**, in case the lowest declared heating capacity exceeds the part load for heating (or capacity ratio $CR_u \leq$ 1.0):

$$EER_{bin(Tj)} = EER_{d(Tj)} * \left(\frac{CRu}{Cc * CRu + (1 - Cc)}\right)$$

Where

EERd(Tj) = declared coefficient of performance

C_c = 0.9 (default value) or established by a cycling test

$$CR_u = \frac{P_C}{P_d}$$

and, **for staged or variable capacity units**, determine the declared heating capacity at the closest step or increment of the capacity control of the unit to reach the required heat load.

If this step allows the heating capacity to reach the required heating load within ± 10 % (e.g. between 9,9 kW and 8,1 kW for a required heating load of 9 kW), then GUEbin(Tj) is assumed to be equal to GUEd(Tj) and AEFbin(Tj) is assumed to be equal to AEFd(Tj).

If this step does not allow the heating capacity to reach the required heating load within ± 10 % (e.g. between 9,9 kW and 8,1 kW for a required heating load of 9 kW), determine the capacity and GUEbin(Tj) and AEFbin(Tj) at the defined part load temperatures for the steps on either side of the required heating load. The heating capacity in part load, the GUEbin(Tj) and the AEFbin(Tj) at the required heating load are then determined by linear interpolation between the results obtained from these two steps.

If the smallest control step of the unit only allows a declared heating capacity higher than the required heating load, the GUEbin(Tj) and AEFbin(Tj) at the required part load ratio is calculated using the approach laid out for fixed capacity units.

For bins representing other than above described operating conditions the GUEbin and AEFbin shall be established by interpolation, except for part load conditions above part load condition A, for which the same values as for condition A shall be used and for part load conditions below part load condition D, for which the same values as for condition D shall be used.

and

$$GUE_d = \frac{Q_{Ec} + Q_{Ehr,c}}{Q_{gmc}}$$

and

QEc = effective cooling capacity, in kiloWatt

QEhr,c = effective heat recovery capacity, in kiloWatt

Qgmc = is the measured cooling heat input, in kiloWatt

and

$$AEF_d = \frac{Q_{Ec} + Q_{Ehr,c}}{P_{Ec}}$$

and

QEc = effective cooling capacity, in kiloWatt

QEhr,c = effective heat recovery capacity, in kiloWatt

PEc = effective cooling electrical power input, in kiloWatt

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, expressed in %;.

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

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

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

5.1 Test points

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

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

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

Where :

– Tj is the bin temperature

– j is the bin number,

– n is the amount of bins

– P_R(Tj) is the refrigeration demand of the application for the corresponding temperature Tj.

– hj is the number of bin hours occurring at the corresponding temperature Tj.

– $EER_{PL(Tj)}$ is the EER value of the unit for the corresponding temperature Tj. This includes part load conditions.

NOTE: This annual electricity consumption includes the power consumption during active mode. Other modes, such as Off mode and standby modes are not relevant for process applications 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 ($P_{designR}$) with the part load ratio (%) for each corresponding bin. These part load ratios are calculated using the formulas shown 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.

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

2) If the declared capacity of a unit is higher than the required refrigeration load, 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 equationbelow:

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

Where

$t_{inlet,\ capacity\ test}$ = 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)

$t_{outlet,\ capacity\ test}$ = 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)

$t_{outlet,\ average}$ = 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 = the capacity ratio, calculated as the refrigeration load (P_R) divided by the refrigeration capacity (Pd) at the same operating condition

$$CR = \frac{P_{R(Tj)}}{P_{d(Tj)}}$$

For determining $t_{outlet,\ average}$ an iterative procedure is required at all conditions (B, C, D) where the chiller cooling capacity (control step) is higher than the required refrigeration load.

a. Test at t_{outlet} from Table 23 or 24 with the water flow rate as determined for tests at condition “A” for chillers with a fixed water flow rate or with a fixed temperature difference for chillers with a variable flow rate;

b. Calculate CR;

c. Apply calculation for $T_{outlet\_average}$ to calculate the corrected toutlet,capacity test at which the test shall be performed in order to obtain toutlet,average equal to the outlet temperature as defined in Tables 23 or 24 of Annex III;

d. Retest with the corrected t_{outlet} and the same water flow rate;

e. Recalculate CR;

f. Repeat c. to e. until CR and $t_{outlet,capacity\ test}$ do not change any more.

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:

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

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.