



# TECHNICAL CERTIFICATION RULES OF THE EUROVENT CERTIFIED PERFORMANCE MARK



## HEAT EXCHANGERS

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[04 – November 2023](#)

(This version cancels and replaces any previous versions)

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The purpose of this Technical Certification Rules (TCR) is to prescribe procedures for the operation of the Eurovent Certified Performance (ECP) certification programme for Heat Exchangers (HE), in accordance with the Certification Manual.

**Modifications as against last version of TCR-02 HE 2022:**

No.	Modifications	Section	Page
1	Updating the list of refrigerants	I.1.1	5
2	Updating the Certify-all principle	I.1.2	5
3	Optimization of declaration list	III.1.1	7
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16	Updating campaign schedules	Appendix B	41

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## I. GENERAL INFORMATION

### I.1. Scope

#### I.1.1. General

The programme scope covers 5 groups of products using axial flow fans in the following groups:

- Direct Expansion Forced Convection Unit Air Coolers for Refrigeration, using HFC refrigerant, designated as “DX Air Coolers”;
- Direct Expansion Forced Convection Unit Air Coolers for Refrigeration using CO<sub>2</sub>, designated as “CO<sub>2</sub> DX Air Coolers”;
- Forced Convection Air Cooled Condensers for Refrigeration, using HFC refrigerant, designated as “Air Cooled Condensers”;
- Forced Convection Air Cooled Gas Cooler for Refrigeration using CO<sub>2</sub>, designated as “CO<sub>2</sub> Gas Coolers”.
- Forced Convection Air Cooled Liquid Coolers, designated as “Dry Coolers”.

The programme for Heat Exchangers is applicable to DX Air Coolers, Air Cooled Condensers, CO<sub>2</sub> DX Air Coolers, CO<sub>2</sub> Gas Coolers using the refrigerants that are listed below:

R134a	DX Air Coolers and Air Cooled Condensers
R407A	
R407C	
R407F	
R448A	
R449A	
R450A	
R452A	
R513A	
<i>R454A (New)</i>	
<i>R454B (New)</i>	
<i>R1234yf (New)</i>	
<i>R1234zeE (New)</i>	
R-507A <sup>1</sup>	
R404A <sup>2</sup>	
R744 (CO <sub>2</sub> )	CO <sub>2</sub> DX Air Coolers CO <sub>2</sub> Gas Coolers

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<sup>1</sup> R-507A will no longer be declared nor certified. It will only be used as the testing fluid by the laboratory until a new reference refrigerant is identified.

<sup>2</sup> R404A will no longer be declared nor certified. It will only be used as the reference for correction factor calculation until a new reference refrigerant is identified.

The programme for Heat Exchangers is applicable to Dry Coolers using the liquids that are listed below:

Water
Water + Ethylene Glycol 34 %
Water + Propylene Glycol 34 %

The following products are excluded from the programme:

- Products using centrifugal and radial type fans
- Product ranges of DX Air Coolers with maximum standard capacity SC2 below 1.5 kW
- Product ranges of CO<sub>2</sub> DX Air Coolers with maximum standard capacity SC2 below 2.0 kW
- Product ranges of Air Cooled Condensers with maximum standard capacity under TD1 15 K is below 2.0 kW
- Products ranges of CO<sub>2</sub> Gas Coolers with maximum standard capacity under SC20 below 2.0 kW
- Liquid sub-coolers
- Units working at 60 Hz
- Cooling and Heating Coils are excluded from the scope of the programme for Heat Exchangers (They are subject of another specific certification programme).

### **I.1.2. Certify-all principle**

Whenever a company participates in the programme for HE, all standard DX Air Coolers, Air Cooled Condensers, CO<sub>2</sub> Gas Coolers, Dry Coolers that are promoted by the applicant/participant to end-users, specifiers, trading companies, contractors by means of paper or electronic catalogue, price list or software within the scope of the programme, shall be certified, in accordance with this Technical Certification Rules. This includes all models in modular ranges. *For the HE programme, the certify-all requirement as defined in the Certification Manual shall be limited to the European market. This means that it will be mandatory to declare and certify the units promoted on the European market and participants will be free to certify or not the units promoted out of Europe. The European market includes EU-27 +Switzerland+ UK + Turkey + Norway.*

### **I.2. Certified performances**

Certified performance items:

- o Standard capacity [kW]
- o Fan power input [W]
- o Energy Ratio R [-]
- o Energy class [-]
- o Air volume flow [m<sup>3</sup>/h]
- o Liquid side pressure drop for Dry Coolers [kPa]
- o A-weighted sound pressure level for Air Cooled Condenser, CO<sub>2</sub> Gas Coolers and Dry Coolers [dB(A)]
- o A-weighted sound power level for Air Cooled Condensers, CO<sub>2</sub> Gas Coolers and Dry Coolers [dB(A)]

### I.3. Definitions

In addition to the definitions specified in the Certification Manual, the following definitions apply:

#### I.3.1. Product types and reference technical items

Direct Expansion Forced Convection Unit Air Cooler for Refrigeration ("DX Air Coolers" when using HFC refrigerant and "CO<sub>2</sub> DX Air Coolers"): As defined within EN 328:2014.

Forced Convection Air Cooled Condenser for Refrigeration ("Condenser" when using HFC and "CO<sub>2</sub> Gas Coolers"): As defined within EN 327:2014.

Forced Convection Air Cooled Liquid Cooler ("Dry Cooler"): As defined within EN 1048:2014.

DX Air Coolers Configuration: Arrangement of components in relationship with the airflow. The following abbreviation shall be used:

SD-B	Single Discharge, Blow through
SD-D	Single Discharge, Draw through
DD-B	Dual Discharge, Blow through
DD-D	Dual Discharge, Draw through

- **Modularity**: a range of Heat Exchanger is considered modular when each module is composed by a coil, a fan motor and a casing having the same following common data:
  - tube type and diameter
  - fin type
  - fin spacing
  - coil height and number of tubes
  - coil depth and number of rows
  - finned length (for reference module)
  - fan motor type
  - casing construction

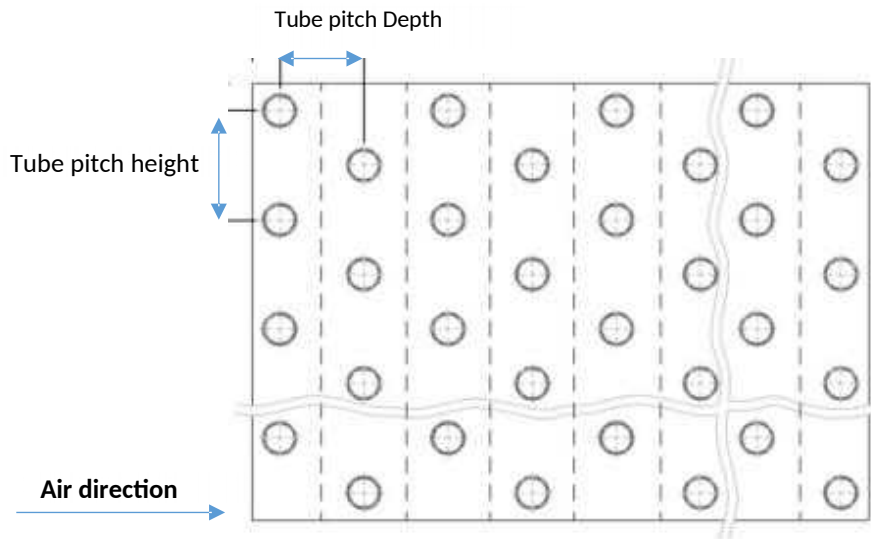
Modularity is used for allowing to choose a reference module to be tested instead of a bigger unit when performances or dimension of a full unit are higher than the limitation of the laboratory. It is also used for the re-rate of some performances such as Capacity and air flow rate.

#### - **Basic Model Group (BMG)**

Set of the same type of Heat Exchangers (COOL, COOL/CO<sub>2</sub>, COND, GASCOOLER and DCOOL), having the same reference geometry. The BMG is filled by Eurovent Certita Certification (ECC) based on reference Geometry for the Eurovent Certita Certification fees purpose. For a new Applicant or in a case of modification of the declaration list, Eurovent Certita Certification will send the explanation of how the number of BMG is calculated.

- A **reference geometry** is defined by equal:

- Tube size (diameter)
- Tube pitch height
- Tube pitch depth
- Tube type
- Tube configuration
- Fin shape



**Figure 1: Illustration of tube pitch depth and Tube pitch height according to air direction (2D representation)**

Tube pitch depth is defined as the center distance between tubes in air direction. Whereas, Tube pitch height is defined as the center distance between tubes perpendicular to the air direction.

- A **reference fin** is defined by equal fin spacing (and fin thickness).
- A **reference fan** is defined by equal:
  - Fan manufacturer
  - Fan diameter
  - Number of blades
  - Fan pitch
  - Motor manufacturer
  - Main Power Supply
  - Fan guard

### **I.3.2. Capacity and energy efficiency**

#### **Standard capacity:**

- For DX Air Coolers, dry cooling capacity for R404A of the DX Air Cooler at the standard conditions is stated in EN 328:2014
- For Air Cooled Condensers, capacity for R404A of the Air Cooled Condenser at the standard conditions is stated in EN 327:2014
- For Dry Coolers, capacity of the Dry Cooler for water at the standard conditions is stated in EN 1048:2014
- For CO<sub>2</sub> DX Air Coolers, dry cooling capacity for R744 of the CO<sub>2</sub> DX Air Cooler at the standard conditions is stated in EN 328:2014
- For CO<sub>2</sub> Gas Coolers, capacity for R744 of the CO<sub>2</sub> Gas Cooler at the “Eurovent standards conditions” (see also page 30). All other items according to EN 327:2014; but in that way final the test following EN 327:2014.

**Reference capacity of a modular range:** Average of the capacities (at SC2 condition for DX Air Coolers) of the models of the modular range that can be tested in the independent laboratory.

**Modular capacity:** Reference capacity multiplied by the number of modules (for modular units that cannot be tested in the independent laboratory).



### **Nominal capacity:**

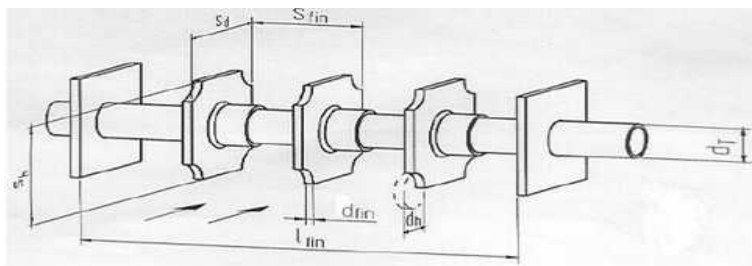
- Standard capacity of the DX Air Cooler corrected for refrigerant, operating temperature difference, humidity and fin material.
- Standard capacity of the Air Cooled Condenser corrected for refrigerant, operating temperature difference and fin material.
- Standard capacity of the Dry Cooler corrected for fluid, operating temperature difference and fin material.

### **I.3.3. Surface area**

#### **a) Tubes and fins**

**Surface area:** The Surface Area, SA, per tube, per meter-finned length is:

$$SA^3 = (2 / S_{fin} / 1000) \cdot r \cdot (S_h \cdot S_d - \frac{\pi}{4} \cdot (d_T^2 + n \times d_h^2)) + \pi \cdot d_T / 1000 \quad (1)$$



**Figure 2: Definitions for declared surface area calculation**

The Total Surface area, TSA [m<sup>2</sup>] is:

$$TSA = SA * l_{fin} * \text{Number of tubes} \quad (2)$$

Where:  $S_h$  = fin height per tube [mm]

$S_d$  = fin depth per tube [mm]

$S_{fin}$  = fin spacing [mm]

$r$  = ratio of enhanced fin surface area to flat, claimed by applicant (to be supported by drawing and calculations if greater than 1)

$d_T$  = tube outside diameter [mm]

$d_h$  = diameter of other holes in fin, e.g. heater holes [mm]

$l_{fin}$  = finned length [m]

$n$  = number of other holes ( $d_h$ ) per tube holes ( $d_T$ ).

A drawing shall be provided for each fin type submitted, clearly showing all holes or shapes that enhance or reduce the surface area, together with the calculation model used to calculate the surface area if this differs from that set out above.

<sup>3</sup> **Note:** The effect of fin thickness  $d_{fin}$  on the surface area is usually very small (less than 1%) and has, therefore, been excluded.

## b) Micro-channels

### Micro-channel Air-side Heat Transfer Surface

$$A = A_f + A_{Ta} \quad [m^2] \quad (3)$$

### Fin Surface $A_f$

$$A_f = 2 \cdot F_L \cdot T_d \cdot n_{LFP} \cdot n_r \quad [m^2] \quad (4)$$

$$n_{LFP} = \frac{B - 2c}{F_p} \quad [-] \quad (5)$$

$$F_L = \sqrt{H^2 + F_p^2} \quad [m] \quad (6)$$

### Flat Tube-Air-side Surface $A_{Ta}$

$$A_{Ta} = [2 \cdot (T_d - D_m) + D_m \cdot \pi] \cdot B \cdot n_T \quad [m^2] \quad (7)$$

Where:

$F_L$ = fin length [mm]

$n_r$ = number of fin rows [-]

$n_{LFP}$ =number of fin pitch widths [-]

$B$ = coil width without headers [mm]

$c$ =no fin area [mm]

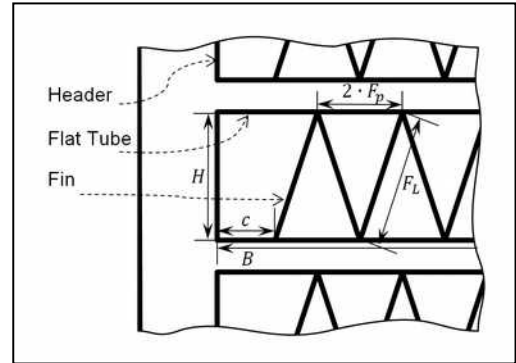
$F_p$ = fin pitch [mm]

$H$ =fin height [mm]

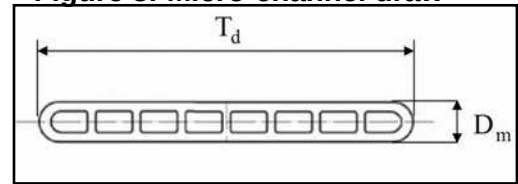
$T_d$ = flat tube width [mm]

$D_m$ =flat tube height [mm]

$n_T$ =number of flat tubes in coil [-]



**Figure 3: Micro-channel draw**



**Figure 4: Flat Tube draw**

### **I.3.4. Heat Flux**

Heat flux: Standard capacity divided by the total heat transfer surface area (air side).

### **I.4. Contributors**

Contributors are all external entities or individuals such as independent laboratories, external Auditors etc., who intervene in certification process.

The lists of contributors are given for information and may be modified by Eurovent Certita Certification whenever necessary.

### **I.5. Independent laboratory / test body**

When the checks carried out involve product tests, these are performed at the request of Eurovent Certita Certification by laboratories, known as Independent laboratory:

1. TÜV SÜD Industrie Service GmbH  
Center of Competence für Kälte- und Klimatechnik Olching  
Geiselbullacher Straße 2  
82140 Olching  
Deutschland / Germany
2. DMT GmbH & Co.KG  
Am TÜV 1, 45307 Essen, Germany

## II. REQUIREMENTS OF THE REFERENCE DOCUMENT

### II.1. Reference documents

#### II.1.1. Product and test standards

The test procedure is detailed in the technical appendix and in the product and test standards.

The applicable standards are as follow (non-exhaustive list):

- EN 328:2014 Heat Exchangers - Forced Convection Unit Air Coolers for Refrigeration - Test Procedures for Establishing the Performance
- EN 327:2014 Heat Exchangers - Forced Convection Air Cooled Refrigerant Condensers - Test Procedures for Establishing Performance
- EN 1048:2014 Air Cooled liquid Coolers ('Dry Coolers'). Test procedures for establishing the performance
- EN 13487:2019 Heat Exchangers - Forced Convection Air Cooled Refrigerant Condensers and Dry Coolers - Sound Measurement
- EN ISO 9614-1: 2009 Acoustics - Determination of Sound Power Levels of Noise Sources using Sound Intensity

#### II.1.2. Marking

It is highly recommended that the participating company indicates participation in the EUROVENT CERTIFIED PERFORMANCE (ECP) programme for Heat Exchangers by the following means.

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

The mark shall include "CERTIFY-ALL" and the name of the relevant group(s) of products that are certified: "AIR COOLED CONDENSER", "DX AIR COOLERS", "CO<sub>2</sub> DX AIR COOLERS", "CO<sub>2</sub> GAS COOLERS" and/or "DRY COOLERS".



**Figure 5: ECP mark specifications and ECP mark for Heat Exchangers**

When the participant manufacturers the 5 groups of products for which he is certified, he shall use the logo with mentions "Heat Exchangers +number of certificate" in the green part as indicated **Figure 6**.



**Figure 6: ECP mark for Heat Exchangers with 5 groups of products**

#### II.1.3. Display of Eurovent Certified Performance logo on production units

The provisions of the Certification Manual apply.

#### **II.1.4. Display of Eurovent Certified Performance logo on technical documentation**

The provisions of the Certification Manual apply.

### **III. CERTIFICATION PROCESS**

#### **III.1. Admission procedure**

##### **III.1.1. Declaration of data**

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

The Applicant, after signing the Certification Agreement, shall send to Eurovent Certita Certification all information required for the qualification, declaration file and relevant literature.

All characteristics and performances shall be expressed in SI units. Maximum of 5 significant digits shall be used for air flow. 3 significant digits shall be used for capacity, energy efficiency, pressure drop, power input and surface area. Integer shall be used for sound power.

For AC fans, star configuration shall be declared in the columns for low speed and delta in the columns for high speed.

Electronic fans and electronic regulation (EC fans) shall be declared either:

- with the same air flow conditions as the equivalent model using an AC fan
- as a different model with a different air flow and capacity.

*Eurovent Certita Certification recommends having at most 1000 models per product type and per brand. The list of declared models should be representative of the different variations and configurations in the software. All ranges which are available in the software shall be declared in the declaration list.*

*For DX Air Coolers and Air Cooled Condensers, the Applicant will declare only one (1) operating speed named "Main speed». It consists of the speed that the Applicant promote mainly. In addition, the capacity shall be declared for the three common fluids which are R448A, R449A and R450A. Capacities are to be given at the same number of circuits.*

*For DX Air Coolers, the declaration is done in standard condition SC2. If the unit is only used for standard condition SC1 then SC1 must be given instead of SC2. If the unit is only used for standard condition SC3 then SC3 must be given. The definition of these standard conditions are shown in the appendix A.2 of this document.*

To ensure the traceability of the products each certified product shall be marked to ensure traceability with respect to the plant (e.g. serial number) and factory address location. Information shall be reported in the declaration list too.

Submittal of data shall be made by filling in the forms provided by Eurovent Certita Certification as .xls or .xlsx files. The forms shall be sent by e-mail to Eurovent Certita Certification within the time limits specified in Certification Schedule (see Appendix B).

- Declaration file HE-1 will be used
  - o for manufacturing companies (Original Equipment Manufacturer – OEM) to declare ranges, Basic Model Groups (BMG), performance ratings and technical data.
  - o for Brand Name (BN) companies to identify the corresponding model's number of the original equipment manufacturer
- Technical data sheet HE-2 will be used to complete technical description of all raw material or incoming goods for the units selected.

- Reporting of test result: for models tested, Form HE-3 is sent by Eurovent Certita Certification, showing the deviations between claimed and measured data.

### **III.1.2. Admissibility of the application**

When the declaration file is completed, units selected by Eurovent Certita Certification shall be tested in an Independent Laboratory according to the procedure detailed in III.1.3.2. *In addition, an on-site audit will be performed systematically.* If the tests and on-site audit show conformity with the relevant Technical Certification Rules (TCR), certification is granted until delivery deadline of next testing campaign + 3 months. *The Applicant will choose whether the admission campaign is done once for all product types that s/he manufactures/promotes or in steps within three (3) years, in liaison with the annual testing campaign. In the case the Applicant chooses to run a campaign in more than one step, s/he shall send the whole list (including all product types) since the beginning of the admission campaign.* At the end of each year of testing, a diploma could be issued for (the) tested groups of Heat Exchangers.

### **III.1.3. Implementation of checking operations**

The provisions of the Certification Manual apply.

#### **III.1.3.1. Selection of units to be tested**

In addition to the provisions laid down in the Certification Manual, the following requirements apply: Eurovent Certita Certification shall select units to be tested based on its evaluation of the declaration file HE-1 communicated by the applicant.

At least one (1) unit per Basic Model Group (BMG) shall be selected to cover the declared variations of products (see BMG definition in § I.3.1).

Within the programme, tests may be conducted under the following procedures:

- Scheduled tests in admission campaign
- Scheduled tests in surveillance procedure campaign
- Penalty tests
- Complaint tests<sup>4</sup>

#### **a) Number of units to be tested**

*Eurovent Certita Certification shall select, at random, units to be tested, on the basis of their evaluation of the Applicant's declaration, in order to cover various options submitted (geometries, fins, materials).*

*For a new Applicant (and participant's new product type qualification), the number of units to be selected for the admission campaign shall be defined based on the number of reference geometries (BMG) from all declared product types in the declaration list with a minimum of 2 selected units, as the following:*

- Two (2) units for an applicant who has a list with 1 to 4 reference geometries
- Three (3) units for an applicant who has a list with 5 to 8 reference geometries
- Four (4) units for an applicant who has a list with 9 to 12 reference geometries
- Five (5) units for an applicant who has a list with 13 to 16 reference geometries
- Six (6) units for an applicant who has a list with more than 16 reference geometries

*In addition, an on-site audit will be performed systematically.*

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<sup>4</sup> Tests performed within the frame of a challenge procedure (refer to Certification Manual)

Selection will be based on technical analysis of the declared performances.

➤ **Example of number of units to be tested in the admission procedure:**

For the list with a total number of 5 different geometries , there will be:

**Table 1: Example of simulation for the selection during the admission campaign**

Model Name	BMG	REFERENCE GEOMETRY(REFGEO)	Number of BMG	Number of units to be selected	
Model1	BMG1	REFGEO1	1	2	
Model2	BMG1	REFGEO1	2	2	
Model3	BMG1	REFGEO1	3	2	
Model4	BMG1	REFGEO1	4	2	
Model5	BMG1	REFGEO1	5	3	+on-site audit
Model6	BMG1	REFGEO1	6	3	
Model7	BMG2	REFGEO2	7	3	
Model8	BMG2	REFGEO2	8	3	
Model9	BMG2	REFGEO2	9	4	
Model10	BMG2	REFGEO2	10	4	
Model11	BMG2	REFGEO2	11	4	
Model12	BMG2	REFGEO2	12	4	
Model13	BMG3	REFGEO3	13	5	
Model14	BMG3	REFGEO3	14	5	
Model15	BMG3	REFGEO3	15	5	
Model16	BMG3	REFGEO3	16	5	
Model17	BMG4	REFGEO4	17	6	
Model18	BMG4	REFGEO4	18	6	
Model19	BMG4	REFGEO4	19	6	
Model20	BMG4	REFGEO4	20	6	
Model21	BMG4	REFGEO4	21	6	
Model22	BMG5	REFGEO5	22	6	
Model23	BMG5	REFGEO5	23	6	
Model24	BMG5	REFGEO5	24	6	
Model25	BMG5	REFGEO5			

Consequently, an Applicant with a list of 5 different geometries will have 3 units to be tested + an on-site audit.

## b) Capacity and Modularity

### - Limits of TÜV SÜD laboratory:

The limits of the TÜV SÜD laboratory for unit testing are given below:

- Dry Coolers: 200 kW
- Air Cooled Condensers: 125 kW
- DX Air Coolers: SC1 40 kW SC2 35 kW  
SC3 30 kW SC4 25 kW

- CO<sub>2</sub> DX Air Coolers 40 kW
- CO<sub>2</sub> Gas Coolers 100 kW

These limits also depend on the pressure drop of the unit itself, especially for Dry Coolers. For such units, additional information with the pressure drop needs to be provided, in order to check the available capacity in the laboratory. In addition, the maximum testable air flow is around 34000 m<sup>3</sup>/h

In terms of dimensions, the main limit is the testing room door with 3 x 3 m for Dry Coolers and for large CO<sub>2</sub> devices and 2.5 x 2.5 m for Air Coolers and Condensers. The following is the summary of measurable unit dimensions in TÜV SÜD laboratory:

**Table 2: Summary of measurable unit dimension in TÜV SÜD**

Product	DX Air Cooler and Condenser (R-507A)	DX Air Cooler, Gas Cooler and Condenser (CO <sub>2</sub> )	Dry Cooler
Test location	Only in Munich possible	Olching	both test stands
Size of doors (m) L x B x H	5 x 2.45 x 2.35	5 x 2.9 x 2.9 (same for Sound testing)	chamber ATP2: 5 x 3.4 x 4.4

#### - Limits of DMT laboratory:

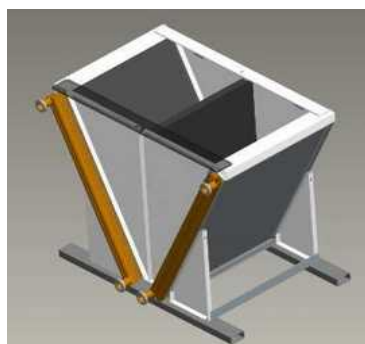
The maximum dimensions are (length<sup>5</sup> x width x height): 6.3 m x 2.4 m x 2.8 m  
The maximum capacity is approximately 1.3 MW ( more is possible with rental heat)  
The maximum air flow rate is 65.000 m<sup>3</sup>/h .

In any case, if Eurovent Certita Certification selects a unit with a higher capacity than the capacity of the laboratory the manufacturer could provide a non-standard testable unit from the modular range:

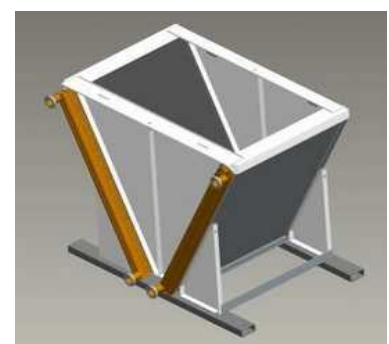
- In case of V unit and two rows of separate fans (**Figure 7** and **Figure 8**) the test could be done by connecting only one coil and one fan (**Figure 10**).



**Figure 7: Unit with fans motors**



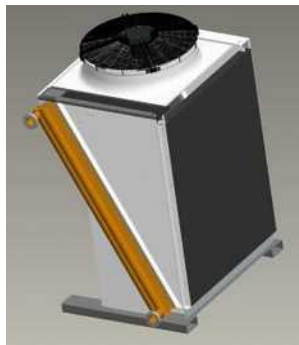
**Figure 8: without fans, with separate fans rows**



**Figure 9: with unseparate fans**

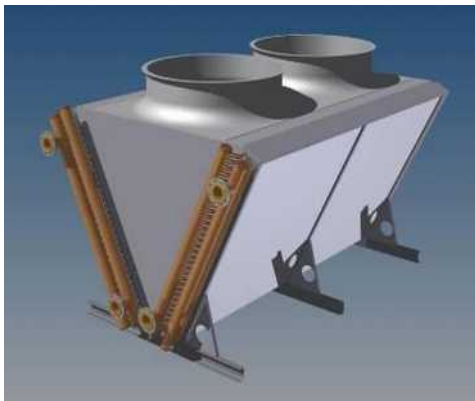
<sup>5</sup> For the units with a length > 6.30 m, the test is performed outside the chamber. An air flow measurement isn't possible with the required accuracy, and sound test outside is possible.

- In case of V unit and two rows of unseparated fans (**Figure 7** and **Figure 9**), the test could be done by connecting only one coil and both fans.



**Figure 10: Unit with only one coil and one fan**

- In case of V unit of two coil blocks and one row of fans (**Figure 7** and **Figure 11**), the test could be done by connecting only one coil block (**Figure 12**). The participant shall connect both coils and it is up to the lab to choose which side to be tested for capacity measurement. However, in any case, the test cost will remain the same as the full unit.

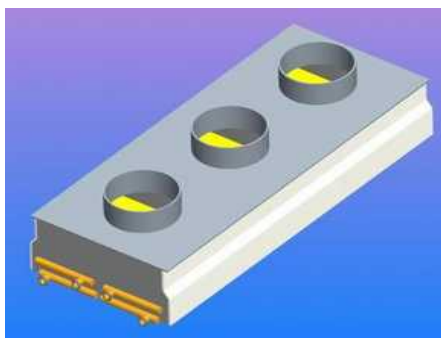


**Figure 11: Unit with two coil blocks**

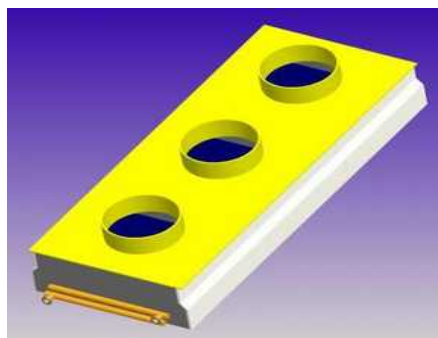


**Figure 12: Test with one coil block**

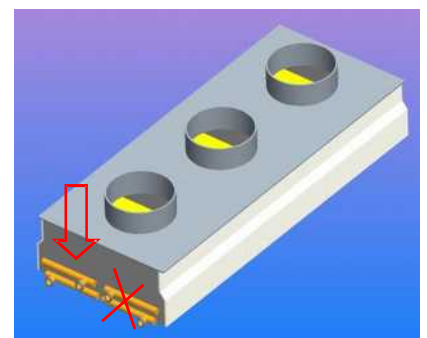
- In case of a product having two identical circuits in the same casing (**Figure 13**), the test could be done by connecting only one circuit section and all fans (**Figure 15**). The participant shall connect both coils and it is up to the lab to choose which side to be tested for capacity measurement. However, in any case, the test cost will remain the same as the full unit.



**Figure 13: Unit of a module with multiple unseparated fans**



**Figure 14: Unit of a module with multiple unseparated fans**



**Figure 15: Unit with a symmetrically split coil**



- In case of a module with multiple unseparated fans (**Figure 14**), a non-standard unit could be provided with a symmetrically split coil (**Figure 15**): the test could be done by connecting only one circuit section and all fans. The participant shall connect both coils and it is up to the lab to choose which side to be tested for capacity measurement. However, in any case, the test cost will remain the same as the full unit.

If none of the above descriptions are applicable, then the heat flux method can be used referring to the same tube, fin, rows and configurations in other certified ranges.

### **c) Unit with higher performances and dimensions than TÜV SÜD**

If the dimension of the selected unit is higher than the limitation of laboratory three solutions are proposed as following:

- Delivering the fan separately
- Removing the fan before bringing the unit inside the chamber and installing it again afterwards.
- Moving the unit into the chamber in a tilted position

The participant will choose one of them and will inform Eurovent Certita Certification prior the unit delivery.

If the selected unit has a thermal capacity higher than the limitation of laboratory, the following solution will be used:

#### **1. For DX Air Coolers:**

- For units with capacity is close to the lab limitation the solution will be to reduce DT1 (by 0.5K)
- For units with higher capacity, the coil will be split into two equals coils as stated in **Figure 15**.

#### **2. For Air Cooled Condensers**

The unit test will be done at DT10 instead of DT15. For those units with high capacity, Participants will declare the duty for both conditions 10 and 15.

#### **3. For Dry Coolers**

Dry Coolers with a capacity higher than 200 kW or/and with dimensions higher than those indicated in the **Table 2** will be systematically tested through DMT.

### **III.1.3.2. Tests at the independent laboratory**

#### **III.1.3.2.i. General**

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

Before testing, the laboratory shall check the product against the information declared in the technical datasheet to ensure that the unit corresponds to the selection.

The laboratory shall not perform the test and contact Eurovent Certita Certification in the following cases:

- one of the information is not compliant with the technical datasheet (see technical appendix),
- one of the units appears damaged

Eurovent Certita Certification will contact the applicant to give instructions regarding further actions.

The laboratory personnel shall install and check out the units. The manufacturer shall provide the laboratory with full information about the installation. Units shall be installed in the test facility in accordance with the manufacturer's published installation instructions. The procedures used shall be in accordance with the manufacturer's installation start-up and service instructions.

The laboratory shall have the responsibility of uncrating, handling, testing and re-crating the unit for shipment. When a unit is shipped back from the laboratory to manufacturer, connection tubes must be closed/sealed in some way.

The laboratory personnel shall be allowed to make only the following corrections to the test sample, prior to the tests, in agreement with the manufacturer:

- Repair leaks
- Repair or replace items damaged by shipping or handling.
- Assure correct refrigerant charge.
- Assure correct fan speed(s) where adjustable speed fans are used for reparation and not for setting up.

If the unit is not repairable, it shall be replaced by the Participant within four working weeks after the notification.

No manufacturer's personnel shall be allowed in the laboratory test facility for the first test of a selected model. The manufacturer may review the test set-up prior to a second test of the selected model. During this second test the manufacturer may be allowed upon justified request and ECC's permission to attend the preparation and installation of units but not the test itself. If a date has been proposed with a minimum of 4 weeks in advance, the laboratory has no obligation to propose a further date if the proposal is not suitable for the manufacturer. The setting-up of test conditions may also be witnessed by the participant until reaching the stable conditions according to the applicable standard.

#### **III.1.3.2.ii. Time limitation of acquisition and recovery of units**

The provisions of the Certification Manual apply.

The Participant shall notify Eurovent Certita Certification within 6 weeks after receiving the test report if he intends to recover the tested unit. The participant shall choose scrapping YES or NO and complete it in the Technical Data Sheet for each tested model.

In case the participant doesn't give his feedback on the unit the scrapping or retrieve within the deadline, the unit will be scrapped and the invoice will be sent to the participant for the disposal fee. The applicant/participant shall recover the samples at the latest 6 weeks after receiving the test reports and results.

### **III.1.3.2.iii. Unit dimensions measurement**

Before testing the unit, the laboratory shall proceed with the physical measurement of the unit. Different dimensions shall be checked: The finned length, coil depth, coil height, fin spacing...

The finned length will be measured as the length between two end plates of the unit.

For the coil height measurement, the finned height will be measured. In a case of non-connected tubes because of the prevention of mechanical damages (during transport), the coil height will be measured by including the non-connected (empty) tubes too.

In any case, the coil sketch indicating the instruction of measurement shall be included in each TDS of a selected unit.

### **III.1.3.2.iv. Test conditions**

The tests shall be conducted at the conditions stated in Appendix A.

### **III.1.3.2.v. Failure treatment**

#### **(i) Initial test failure**

In case of initial test failure (see definition in Certification Manual), the laboratory shall immediately inform Eurovent Certita Certification who will notify the applicant/participant.

In addition of the definition given by the Certification manual, in case the dimensions and number of fins of the delivered product, which are checked preliminary to the performances tests, are not correct, it is also considered as a "Initial test failure". The verification of the dimensions and number of fins is considered as an indirect check of the surface area.

In case of an initial test failure the unit may be repaired (under the responsibility of the manufacturer) or replaced by a new one of the same model within 4 weeks, which shall be tested then, according to normal schedule of the laboratory.

If during a test, one or more specified testing conditions cannot be met, then the test will be considered as failed and manufacturer has to restart the test procedure. In this case the applicant/participant shall examine the reasons of the failure.

#### **(ii) Unit failure**

For each test, a performance item fails when the difference between the declared value and the measurement differs by more than the acceptance criteria.

A test fails when one or more performance items fail.

For each failed test, the manufacturer has four working weeks from the notification of failure to choose between one of the following alternatives:

- Re-rate the tested model according to the measured performances
- Ask for a second test on the same unit.
- Ask for a second test on a new unit. The new unit shall be delivered within four weeks after reply.

**Re-rate** all products in accordance with test results following the re-rating procedure described below. Penalty tests will be required as described below.

The Participant shall correct his catalogues, website and software within 8 weeks.

Eurovent Certita Certification will continuously check Participant's technical documentation.

**Ask for a second test** on the same unit (already tested and kept in the laboratory). If the second test is unsuccessful, the Participant/Applicant shall re-rate all products in line with the second test results according to the re-rating procedure and penalty tests will be required.

**Ask for a second test on a new unit** the manufacturer can ask for a second test on a new unit (same model), in specific cases, after analysis of the non-conformity and implementation of actions if applicable. When the second test is carried out on another unit than the one already tested, then one penalty test will be required during the next campaign, whatever the result of the second test is. A tested unit which comes back to the participant and is sent again for test is considered as a new unit.

### (iii) **Re-rating procedure**

- **Air flow:** In case of failure, all products in the same modular group (modularity: same fan, same coil, same number of rows, and same type of fins, fin spacing and finned length per basic module) shall be re-rated by the deviation found for the tested model.
- **Sound power level:** In case of failure, all products (Dry Coolers, Condensers, and CO<sub>2</sub> Gas Coolers) using the same reference fan shall be re-rated for the tested/failed fan speed by the deviation found for the tested model.
- **Capacity:** In case of failure, all products in the same modular group (modularity: same fan, same coil, same number of rows, and same type of fins, fin spacing and finned length per basic module) shall be re-rated. For Air Cooled Condensers, CO<sub>2</sub> Gas Coolers and Dry Coolers, units of the module shall be re-rated by the deviation found for the tested model. If a CO<sub>2</sub> DX Air Cooler is tested, and capacity fails, then capacities at all the declared SC's of the units of the Module shall be re-rated by deviation found for the tested model..
- **Fan power:** In case of failure on fan power, all products using the same reference fan shall be re-rated for the tested/failed fan speed by the deviation found for the tested model.
- **Pressure drop:** In case of failure on pressure drop, only the tested model shall be re-rated to the measured one.

For a given performance, in case of different deviations for products having same component and module, the products are re-rated by the highest deviation.

For models already re-rated, the downgrade is allowed.

The re-rate process is closed after software check.

### **III.1.3.3. Special case for admission campaign**

If more than one third of the required number of capacity, air volume or noise measurements fails, the penalty tests will be required within the admission procedure, after application of the re-rating procedure when applicable. The number of penalty tests per type of products can't be higher than 5.

### **III.1.3.4. Software checking procedure**

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

#### **III.1.3.4.i. Software certification**

*For HE programme, the software shall be certified. In this case, each participant/applicant shall send the latest version of software for checking at the same time as the declaration list. After the certification of the software, it will be displayed on the Participant's certification diploma and on Eurovent Certita Certification website. This certification shall start from June 2024.*

#### **III.1.3.4.ii. Software checking due after re-rate**

For HE programme, the software checking will be implemented after a rerate. Eurovent Certita Certification will automatically check the software, website and all commercial documents of the manufacturers in case of a rerate. The software checking will be carried out during the next campaign (Campaign N+1).

Eurovent Certita Certification will systematically ask the manufacturer to send the last version of the software together with the rights of access and the password within the deadline defined by Eurovent Certita Certification. The selection software when installable must be usable under a common operating system.

The selection software name and version shall be clearly identifiable for no possible confusion between different releases.

The performances in the software must be equal to the declared performances.

In a case of non-conformities during the checking, the participant shall send the feedback (corrected software version) within one (1) month after report reception.

#### **III.1.3.4.iii. Software checking during the declaration list analysis**

To check the consistency between the declaration list and the Participant's software, Eurovent Certita Certification shall implement the two following actions:

- Implement a checking of all selection software from certified HE manufacturers to identify possible non-compliances regarding the certify-all principle.
- Implement a checking of the consistency of the performances listed in Eurovent Certita Certification directory and the performances provided in the selection software for all units selected for the tests campaigns and randomly a sample of other declared units.
- The units selection shall be done directly through the software to ensure that the performances to be tested are in line with the ones in the software.

For that reason, at the beginning of each campaigns, each participant shall send the updated declaration list and up-to-date software + access (if needed).

#### **III.1.3.4.iv. Manufacturer website and Catalogues checking**

Eurovent Certita Certification shall perform a quarterly checking of the manufacturers website and catalogues to ensure a steady respect of certify-all and certified performances.

### **III.1.4. Evaluation and decision**

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

The certification is granted on condition that:

- The aforementioned checks prove compliance with the requirements specified in Appendix A
- All the other requirements from the present Technical Certification Rules are fulfilled,
- All fees have been settled.

If not, the procedure for failure treatment shall be applied.

### **III.1.5. Penalty tests**

In case of established failure, units for penalty tests (full tests) must be ideally selected from the range which failed, as follows:

- Two units in case of failure on capacity
- One unit in case of failure on fan power or liquid pressure drop
- One unit in case of high failure (+/-15% of deviation) on air volume flow or sound performances (+3 dB(A))

The additional penalty tests shall be performed during the following surveillance test campaign.

**Note:** *If there are many penalty tests within the campaign N, the participant can request for a postponement of a part of penalty tests to the following campaign (N+1). Eurovent Certita Certification is entitled to accept or not the request based on the fulfilment of conditions and arguments provided by the participant.*

## **III.2. Surveillance procedure**

The provisions of the Certification Manual apply.

Every year, Eurovent Certita Certification checks whether the performances of the products still fulfill the requirements, in accordance with the campaign schedule (see Appendix B )

### **III.2.1. Implementation of surveillance operations**

#### **III.2.1.1. Surveillance audit**

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

#### **Purpose:**

The purpose of the audit is to verify that the participant produces Heat exchangers units in compliance with ECC certification rules (from Certification Manual and Technical Certification Rules) and quality management requirements.

#### **Timing:**

After the reception of the TDS of N testing campaign. Manufacturer will have at least two weeks after the unit's delivery to host an audit.

The duration of the on-site audit is one (1) day.

#### **Conditions to trigger an audit:**

- The MVF percentage threshold to apply Audit: 20%
- The percentage threshold for initial test failure (out of the total number of tested units) to apply audit is 10%<sup>6</sup>. The calculation of percentage for initial test failure is done on 3 years.

#### **Requirements:**

#### **Quality management ISO 9001 vs 2015:**

The auditor will perform a complete review of the quality management system to check that:

- The suppliers are regularly evaluated and that the corresponding evaluations are recorded;
- The raw material or incoming goods conformity with the manufacturer technical specifications is regularly evaluated and that the corresponding evaluations are recorded;

<sup>6</sup> Initial test failure due to the unit damage during the transportation (if confirmed by the laboratory) shall not be considered during the assessment of the Audit triggering.

- The manufacturing process key steps are submitted to a validation check which results are recorded.
- Performing a coil leakage test is required on each produced unit.
- The factory personnel are qualified to perform the specific tasks, in particular brazing/welding
- Every product traceability is ensured;
- Calibration of measuring devices is performed on a regular basis;
- Production non-conformities are recorded, and corrective actions initiated;
- Customer complaints are registered and treated
- ECP mark is displayed on the units and on the documentation in compliance with the requirements specified in the TCR.
- Consistency between what is declared and what is produced/ Consistency between what is declared and what is sold.

### **Physical inspection:**

- ✓ The auditor performs the physical inspection of 2 of the selected units for the N test campaign, and check if there are any discrepancies vs TDS.
- ✓ The auditor selects randomly 2 units from production or stock and check if there are any discrepancies vs the declaration list.

In case one or more dimensions are not within the acceptance criteria, it is considered as a non-conformity.

In case one or more characteristics are different from what is declared, it is considered as a non-conformity.

### **Important:**

If the company is certified ISO 9001, only the physical inspection is conducted.

### **Audit report and failure results:**

Based on the findings, the auditor will report any non-compliance and any evidence that may affect the conclusions of the manufacturer's level of responsibility in the audit report to be signed on site with the factory representative.

Then, the auditor shall send the signed Audit Report to Eurovent Certita Certification. After checking the audit report, Eurovent Certita Certification shall communicate audit conclusions and report to the manufacturer.

### **Classification of the non-conformities:**

The classification of non-conformities criticality is performed by the lead auditor in agreement with the members of the audit team. It depends on the certification scope (and the corresponding certification rules).

The non-conformity is classified as **critical (C)** when, based on impartial evidences,

- there is a significant risk<sup>7</sup> to the product conformity regarding specified requirements

or,

- there is a significant risk for the ability of management system to manage the conformity of the product regarding the specified requirements,

<sup>7</sup> The explanation of the risk must be written for each nonconformity, in the nonconformities sheet.

or,

- a specified requirement is systematically and repetitively unmet.

In other cases, the non-conformity is classified as **non-critical (NC)**.

- In case of non-conformity, the audit failure treatment consists of the following:
- The manufacturer sends within one month the filled out corrective actions report previously provided by Eurovent Certita Certification. In this way, corrective actions are proposed to solve detected non-conformities and deadlines.
- The auditor analyses the corrective actions report and validate the corrective actions and their deadline or ask for further information.
- At the end of each proposed deadline, accepted by Eurovent Certita Certification, the manufacturer provides evidences of the implementation of the corrective actions.
- The auditor validates the corrective actions regarding the provided evidences.
- The audit is considered as positive when all corrective actions and their evidences are validated by the auditor. However, the actual implementation of the corrective actions can be conducted during the next audit.
- If Eurovent Certita Certification is not able to validate corrective actions and their evidences for critical non-conformities:
- it can ask for an additional audit in order to check the implementation of corrective actions before the next yearly audit
- the certification can be suspended until the solving of non-conformities

#### **III.2.1.2. Selection of units to be tested**

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

*Eurovent Certita Certification shall, each year, randomly select from the declaration list a number of units to be tested based on the number of reference geometries in the declaration list as the following:*

- One (1) unit for a participant who has a list with 1 to 4 reference geometries
- Two (2) units for a participant who has a list with 5 to 8 reference geometries
- Three (3) units for a participant who has a list with 9 to 12 reference geometries
- Four (4) units for a participant who has a list with 13 to 16 reference geometries
- Five (5) units for a participant who has a list with more than 16 reference geometries

*Eurovent Certita Certification will ensure that the declaration list was completed accordingly based on the reference geometry definition in TCR. This selection rules for the surveillance campaign shall start from the 2024 campaign.*

#### **III.2.1.3. Surveillance tests**

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

For the surveillance procedure, the tests follow the same rules than the admission tests.



### III.2.1.4. Repeated treatment of failures

Mean Value of Failure (MVF), as defined in Certification Manual, is restricted to failure on capacity for each Heat Exchanger and considers three years if possible. According to this definition, failure is considered only once even if there are two measurements on the same unit.

$$MVF_{performances} = \frac{\sum_{\text{Number of considered years}} \text{Number of failed performances}}{\sum_{\text{Number of considered years}} \text{Number of tested performances}}$$

The following performances are considered for the calculation of the MVF:

- Pc: cooling capacity

Example: Manufacturer λ had in 3 years a total of 9 machines tested, 3 Condensers, 3 DX Air Coolers, 3 Dry Coolers with the following test results.

**Table 3: Example 1 of how to calculate the MVF**

Year	Capacity test 1	Capacity second test
2019	PASSED	
	PASSED	
	PASSED	
2020	PASSED	
	PASSED	
	PASSED	
2021	<b>FAILED</b>	<b>FAILED</b>
	PASSED	
	<b>FAILED</b>	

$$\text{Then MVF} = \frac{0+0+2}{3+3+3} = \frac{2}{9} = 22\%$$

**Table 4: Example 2 of how to calculate the MVF**

Year	Capacity test 1	Capacity second test
2019	<b>FAILED</b>	PASSED
	PASSED	
2020	<b>FAILED</b>	PASSED
	<b>FAILED</b>	
2021	<b>FAILED</b>	<b>FAILED</b>
	PASSED	
	PASSED	
	PASSED	

Then

$$MVF = \frac{0 + 1 + 1}{2 + 2 + 4} = \frac{2}{8} = 25\%$$

*The new thresholds of the MVF as the following:*

- MVF threshold for suspension: 25%
- MVF threshold for audit: 20%

If the MVF is strictly higher than 25%, manufacturer is suspended from the Certification Programme campaign until the MVF value comes back under the limit. If the MVF is strictly higher than 20%, the onsite audit will be triggered during the following certification campaign.

#### **III.2.1.5. Software checking procedure**

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

For HE programme, the software checking will be implemented after a re-rate. Eurovent Certita Certification will automatically check the software, website and all commercial documents of the manufacturers in case of a re-rate. The software checking will be carried out during the next campaign (Campaign N+1).

Eurovent Certita Certification will systematically ask the manufacturer to send the last version of the software together with the rights of access and the password within the deadline defined by Eurovent Certita Certification. The selection software when installable must be usable under a common operating system.

The selection software name and version shall be clearly identifiable for no possible confusion between different releases.

The participant shall send the feedback within one (1) month after report reception.

#### **III.2.1.6. Technical and commercial documentation check**

The provisions of the Certification Manual apply.

### **III.2.2. Evaluation and decision**

The provisions of the Certification Manual apply.

For the surveillance procedure the certification is renewed at the date specified in the Certification Schedules (see Appendix B) on condition that:

- The previous test campaign (N-1) has been successfully completed
- The product delivery together with the technical datasheet and the payment have been completed

The company receives a renewed certificate and the display of data is maintained on the Eurovent Certified Performance (ECP) website. If not, failure treatment shall be applied.

### **III.3. Declaration of modifications**

The provisions of the Certification Manual apply.

#### **III.3.1. Changes concerning the participant**

The provisions of the Certification Manual apply.

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### **III.3.2. Changes concerning production entities**

The provisions of the Certification Manual apply.

### **III.3.3. Additional admission for a new model and/or new range**

The provisions of the Certification Manual apply.

### **III.3.4. Changes concerning the certified products**

In addition to the provisions laid down in the Certification Manual, the following requirements apply:

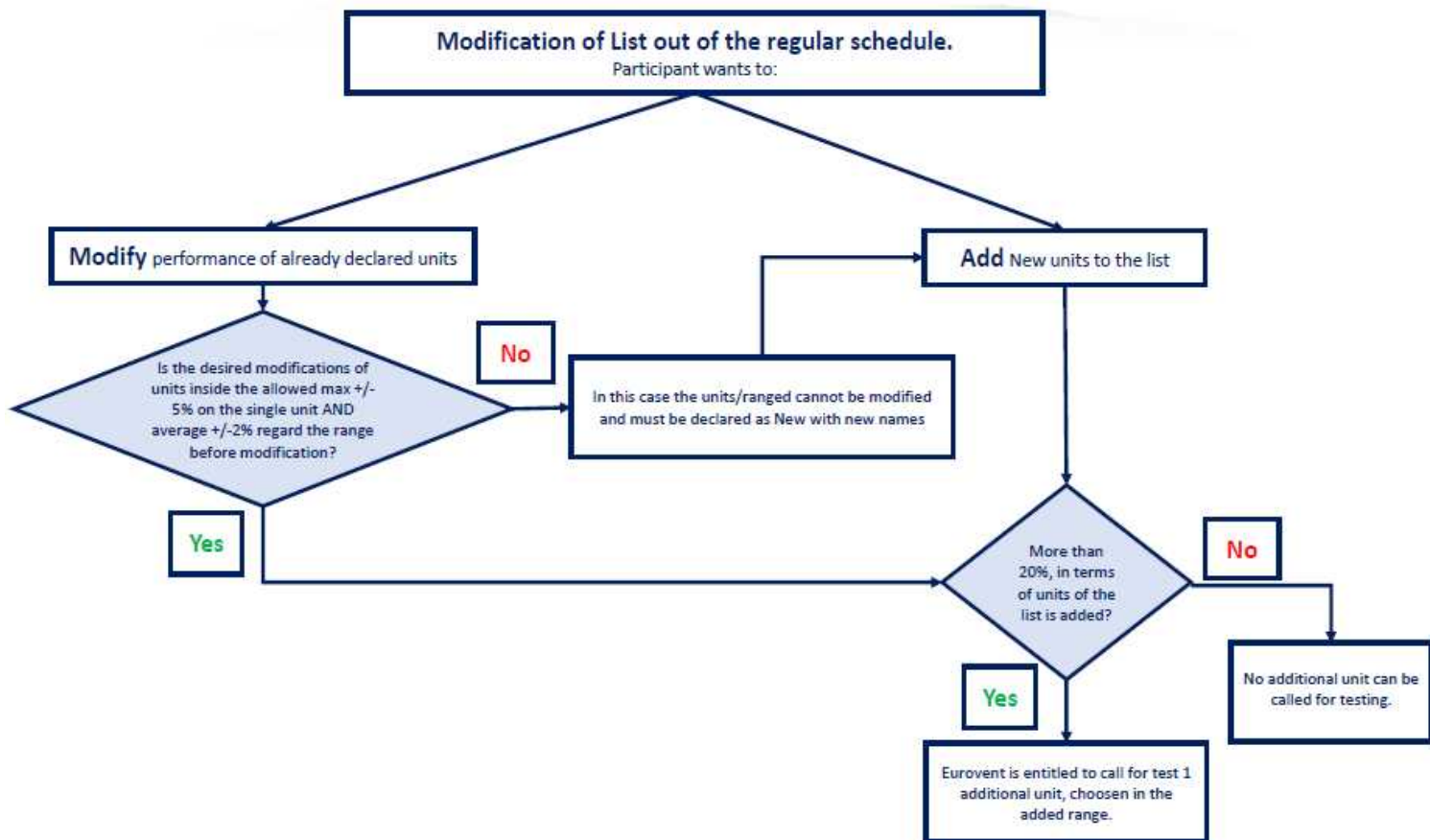
The applicant/participant shall inform Eurovent Certita Certification of any modification of the product portfolio by updating the declaration file (HE-1). Non-compliance of the applicant/participant is considered as non-application of procedures (see § III.2.1.2.).

Eurovent Certita Certification decides whether the modification is significant for the certified performance data or not. The declaration list is considered to have a significant modification if 20% of total units is added on the listing or performances of 20% of total units have been modified.

In that case, Eurovent Certita Certification is entitled to select 1 additional unit for testing during n-year campaign, chosen from the added range to check the influence on performance data. Eurovent Certita Certification will have 2 weeks to inform the participant about this decision. This test shall not be considered as a repetition one.

The modification is allowed only when new performance (*cooling capacity*) of the unit is within  $\pm 5\%$  from the original value and the average of the modification is within  $\pm 2\%$ . If the new performance exceeds the mentioned criteria, the modification is not allowed within the same unit. The Participant must declare the unit as new unit (i.e. the new line on the list).

The different scenarios of modification are summarized in the following figure:



**Figure 16: Different scenarios of modification of certified products**

**Nota Benne:** Due to the current situation of component shortage, participants can exceptionally, if requested, be authorized to change the fan in the case the existing one is no longer manufactured or is in shortage. In this case the participant shall send a request for fan replacement and the updated list with the new fan information to Eurovent Certita Certification. The Participant shall also provide with the impact report and the technical datasheets of both existing and new fans. The two fans shall have the same characteristics and performances. After the analysis, Eurovent Certita Certification is entitled to accept the new list or not depending on the fulfillment of the required conditions.

#### **III.3.4.1. Upgrade and downgrade**

The provisions of the Certification Manual apply.

#### **III.3.5. Temporary or permanent cessation of production of a certified product**

The provisions of the Certification Manual apply.

### **III.4. Suspension/cessation conditions**

The provisions of the Certification Manual apply.

## Appendix A. TECHNICAL APPENDIXES

### A.1 Purpose

The purpose of this technical appendix is to establish definitions and specifications for testing and rating of relevant products for the Heat exchangers -Programme.

### A.2 Testing requirements

#### (i) Refrigerant

Tests shall be performed with R-507A (*until the replacement fluid is identified*) for DX Air Coolers and Air Cooled Condensers, water for Dry Coolers, and R744 for CO<sub>2</sub> DX Air Coolers and CO<sub>2</sub> Gas Coolers.

#### (ii) Air flow and Thermal performance

Standard ratings shall be verified by tests conducted at standard rating conditions in accordance with:

- EN 328:2014 for DX Air Coolers
- EN 327:2014 for Air Cooled Condensers; CO<sub>2</sub> Gas Coolers: Testing following EN 327 because of special Eurovent test conditions; see page 31.
- EN 1048:2014 for Dry Coolers

#### > Standard Conditions for DX Air Coolers

**Table 5: Standard Conditions (SC's) for DX Air Coolers [EN 328]**

Standard Conditions for Refrigerants	Air Inlet Temperature (°C)	Evaporating Temperature (°C)	$\Delta T_{sup} / DT1$ -	Refrigerant Temperature at the inlet to the expansion device °C
SC1	10	0	0.65	30
SC2	0	-8	0.65	30
SC3	-18	-25	0.65	20
SC4	-25	-31	0.65	20

Where  $DT1$ : the temperature difference

$\Delta T_{sup}$ : superheating

**DX Air Coolers** shall be tested under one condition among (SC1, SC2, SC3 and SC4) according to EN 328:2014 Standard.

#### Notes:

- For admission campaign of CO<sub>2</sub> DX Air Cooler, tests will be done following the cases below:
- Unit Cooler that includes SC2 among possible working conditions, test only in SC2 (for certification). If SC4 is included, the test in SC4 (as information) will be included; If SC3 is included (and SC4 not), the test in SC3 (as information) will be included;
- CO<sub>2</sub> DX Air Cooler that excludes SC2 among possible working conditions; 2 options:
  - CO<sub>2</sub> DX Air Cooler declared only in SC1, test only in SC1 (for certification)

- CO<sub>2</sub> DX Air Cooler declared only in SC3 and/or SC4, test for certification only in SC3 (if declared) otherwise only in SC4”
- During the CO<sub>2</sub> DX Air Cooler tests, the super heating temperature could be partly out of the tolerances of the EN 328 standard (in case of a non-stable CO<sub>2</sub> DX Air Cooler in the super heating phase). For that reason, for all tests in SC3 and SC4 condition for CO<sub>2</sub> Air Coolers, TÜV SÜD will include a chart for the super heating temperature under test condition (1h) in the test report.
- For repetition campaign of CO<sub>2</sub> DX Air Cooler, tests will be done in SC2 if the unit is not operating in SC2, then operating standard condition will be tested with the priority as the following: SC1 or SC3.
- For DX Air Coolers, the declaration is done in SC2. If the unit is only used for SC1 then SC1 must be given instead of SC2. If the unit is only used for SC3 then SC3 must be given.
- For DX Air Coolers and Air Cooled Condensers, the common refrigerants for which the cooling capacity will be declared are R448A, R449A and R450A. Capacities are to be given at the same number of circuits. For a 1 year transition R404A is used as the reference refrigerant to see the consistency of the program to old data. The R404A column shall not be displayed on the Eurovent Certita Certification website.

#### ➤ Standard Conditions for Air Cooled Condensers and Dry Coolers

According to EN 327, the temperature difference (DT1) for the test on Air Cooled Condensers is 15 K, but can be reduced to 10 K in special cases. For Dry Coolers (according to EN 1048), the standard temperature difference (DT1) is always 15 K.

**Table 6: Testing Condition for Dry Coolers [EN 1048]**

Testing Condition for liquid (Water)	Air Inlet Temperature “T <sub>A1</sub> ” (°C)	Liquid Inlet Temperature (°C)	Liquid Outlet Temperature (°C)
SC15	25	40	35

**Table 7: Standard Condition for Air Cooled Condensers [EN 327]**

Testing Condition for Refrigerant	Air Inlet Temperature « T <sub>A1</sub> » (°C)	Temperature difference (DT1) (K)	Subcooling Temperature (K)
SC15	25	15	≤ 3
SC10	25	10	≤ 3

Superheating value for the refrigerant (R404A/R-507A) “ $\Delta T_{sup}$ ” is 25 K.

#### ➤ Standard Conditions for CO<sub>2</sub> Gas Coolers

CO<sub>2</sub> Gas Coolers shall be tested under Eurovent Standard Conditions for CO<sub>2</sub> Gas Coolers (both transcritical and subcritical conditions) as described below:

##### **-Transcritical mode:**

Standard condition	Air inlet temperature [± 1 K]	Gas Cooler inlet pressure [± 1 bar]	Gas Cooler inlet temperature [± 5 K]	Gas Cooler outlet temperature [± 1 K]
SC20	30°C	90 bar	110°C	35°C

### **-Subcritical mode:**

Standard condition	Air inlet temperature	Condensing temperature	Refrigerant inlet temperature	Subcooling
SC25	5°C	15°C	60°C	<3 K

#### **(iii) Sound performance**

Sound performance shall be verified by tests conducted with the following standard: EN 13487:2019 “Heat Exchanger - Forced convection Air Cooled refrigerant Condensers and Dry Coolers - sound measurement”.

EN ISO 9614-1: 2009 Acoustics shall be used for the determination of Sound Power Levels of Noise Sources using Sound Intensity.

Sound deviations shall be expressed as an integer following the below rounding rule:

2,4 -> 2

2,5 -> 2

2,6 -> 3

#### **(iv) Correction for Liquid Pressure Drop for Dry Coolers**

For evaluation of Liquid Pressure Drop, the following equation shall be used:

$$\Delta p_{L\_corrected} = \Delta p_{L\_measured} \cdot \left( \frac{q_{mL\_declared}}{q_{mL\_measured}} \right)^{1.8} \quad (14)$$

$$\Delta \Delta p_L = \frac{\Delta p_{L\_corrected} - \Delta p_{L\_declared}}{\Delta p_{L\_declared}} \quad (15)$$

Where:

$\Delta p_L$  : Liquid side pressure drop [kPa]

$q_{mL}$  : Mass flow rate of the liquid [kg/s]

$\Delta \Delta p_L$  : Liquid side pressure drop gap between tested and declared value [%]

#### **Additional requirements for products using CO<sub>2</sub>**

Each unit to be tested shall be affixed with a plate showing the maximum allowable pressure “PS”, as defined in the relevant EN Standard. This maximum allowable pressure “PS” should also be declared on the TDS. Each unit shall be accompanied by a pressure test protocol confirming that the unit has been successfully pressure tested with at least 1,1 x PS.

Each unit delivered for CO<sub>2</sub> testing needs to have a name plate with all the necessary data: conformity of the product to PED, PS min and PS max values, ...

Regarding CO<sub>2</sub> Gas Coolers, each unit to be tested shall have at least a PS of 120 bar.

### **A.3 Rating requirements**

#### **(i) Fan speeds**

For AC fans, the performance shall be declared under the low speed for a star configuration and the high speed for a delta configuration.

For EC fans, performance can be declared at up to 5 fan speeds for variable speed fans.

(ii) Sound data

Sound data levels shall be calculated in accordance with EN 13487:2019 at 10 m distance for Condensers, Gas Coolers and Dry Coolers.

For sound power, the test method that will be used is EN ISO 9614-1:2009.

(iii) Correction factors

iii.1. Correction for wet coil factors for DX Air Coolers

Standard capacities are measured under dry conditions, without condensation or frost formation on the DX Air Cooler surface.

A DX Air Cooler can be rated in literature with:

- Nominal capacities plus Standard capacities, or
- Nominal capacities plus Wet enhancement factors relating to the standard conditions covered.

The nominal capacities at standard conditions shall be calculated as:

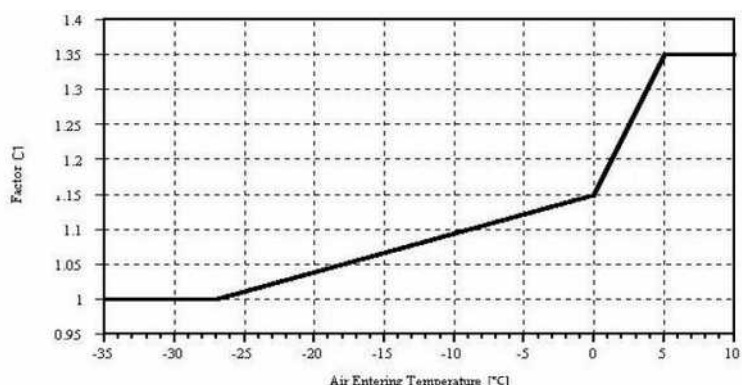
$$\text{Nominal Capacity Wet} = \text{Standard Capacity Dry} \times C1 \quad (16)$$

where the relationship factors C1 are given in **Table 8**.

**Table 8: Wet coil factor (C1) for DX Air Coolers at standard conditions**

Standard Conditions	RH	Wet Enhancement Factor
SC 1	85%	1.35
SC 2	85%	1.15
SC 3	95%	1.05
SC 4	95%	1.01

Under other conditions the wet factor enhancement shall be based on the following graph (**Figure 17**). In any case, the maximum enhancement factor, dry to wet, excluding any other correction for DT1, fin material etc., shall not exceed 1.35.



**Figure 17: Wet coil factor (C1) for DX Air Coolers at other conditions**

**Note:** The graph is based on the entering air and not on the dew point evaporating temperature.



iii.2. Correction for temperature differences (C2) for DX Air Coolers and Air Cooled Condensers

For refrigerants with low (below 1 K for DX Air Coolers and below 3 K for Air Cooled Condensers) or no glide, the capacity shall be assumed to vary directly with the temperature difference DT1 between the entering air and dew point evaporating temperature, i.e.:

$$\text{Nominal Capacity (2)} = \text{Nominal Capacity Wet (1)} \times C2 \quad (17)$$

where  $C2 = \text{Required DT1} / \text{Standard DT1}$

Standard DT1 = 15 for Air Cooled Condensers

iii.3. Refrigerant and Ethylene Glycol / Propylene Glycol correction factors (C3)

Unless independently substantiated, at standard conditions, the following average relationship shall exist between the capacities:

➤ **Refrigerant correction factors:**

**Table 9: Refrigerant correction factors (C3) (based on dew points)**

Product type Condition Refrigerant	DX Air Coolers				Air Cooled Condensers	Glide @ 40° C (information only)
	SC 1	SC 2	SC 3	SC 4	DT1 = 15 K or DT1 = 10 K	
R404A (reference)	1	1	1	1	1	0.5
R134a	0.93	0.91	0.85	-	0.96	0
R-507A [REFPROP 9.1]	0.97	0.97	0.97	0.97	1	0
R407A	1.19	1.24	1.28	1.32	0.89	4.5
R407C	1.21	1.26	1.31	1.36	0.87	5.06
R407F	1.19	1.24	1.29	1.35	0.89	4.52
R448A	1.23	1.26	1.28	1.31	0.89	4.82
R449A	1.21	1.23	1.24	1.26	0.89	4.65
R450A	0.92	0.91	0.84	-	0.93	0.63
R452A	1.1	1.12	1.13	1.15	0.93	3.43
R513A	0.91	0.91	0.85	-	0.95	0.17
R454A	1.26	1.30	1.35	1.39	0.88	5.03
R454B	1.10	1.12	1.15	1.17	0.98	1.29
R1234yf	0.92	0.88	0.83	0.80	0.96	0
R1234zeE	0.87	0.84	0.74	0.68	0.94	0

**Table 10: Refrigerant correction factors (C3) (based on mid points) \***

Product type Condition Refrigerant	DX Air Coolers				Air Cooled Condensers DT1 = 15 K or DT1 = 10 K	Glide @ 40° C (information only)
	SC 1	SC 2	SC 3	SC 4		
R404A (reference in dew point)	1	1	1	1	1	0.5
R448A	0.97	0.96	0.95	0.94	1.08	4.82
R449A	0.96	0.95	0.94	0.93	1.07	4.65
R452A	0.96	0.94	0.94	0.93	1.04	3.43
R450A	0.93	0.89	0.83	0.79	0.92	0.63
R513A	0.92	0.9	0.86	0.83	0.93	0
R454A	1.00	0.97	1.01	0.99	1.06	5.03
R454B	1.05	1.04	1.10	1.11	1.02	1.29

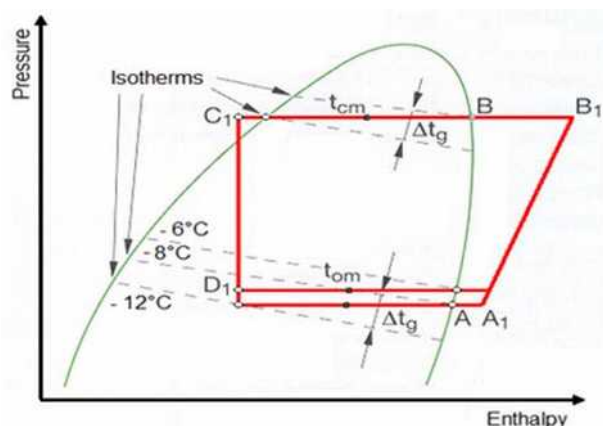
\* Mid-point temperature is defined as:

- **For DX Air Cooler:**

$t_{om}$  (mid-point evaporation temperature) is the arithmetic mean temperature between enthalpy inlet D1 temperature and the dew point temperature at constant pressure.

- **Air Cooled Condensers:**

$t_{cm'}$  (mid-point condensing temperature) is the arithmetic mean temperature between the dew point temperature and the bubble point temperature at constant pressure.



**Figure 18: Enthalpic cycle diagram**

The agreed tolerances on correction factors are the following:

- 0.10 for **DX Air Cooler and CO2 Gas Cooler**
- 0.05 for **Air Cooled Condenser**

These factors may, if required, be presented using a different base refrigerant.

$$\text{Nominal Capacity (3)} = \text{Nominal Capacity (2)} \times C3 \quad (18)$$

➤ **Ethylene Glycol / Propylene Glycol correction factors**

- For 34% Ethylene Glycol by volume, the capacity and pressure drop at the standard conditions shall be assumed to be:

$$\text{Nominal Capacity (3)} = \text{Standard Capacity (water)} \times C3, \text{ where } C3 = 0.95 \quad (19)$$

$$\text{Pressure Drop} = \text{Standard Pressure Drop (water)} \times 1.2 \quad (20)$$

- For 34% Propylene Glycol by volume, the capacity and pressure drop at the standard conditions shall be assumed to be:

$$\text{Nominal Capacity (3)} = \text{Standard Capacity (water)} \times C3, \text{ where } C3 = 0.92 \quad (21)$$

$$\text{Pressure Drop} = \text{Standard Pressure Drop (water)} \times 1.18 \quad (22)$$

iii.4. Correction for fin materials (C4)

For other fin materials where the thickness is not less than the standard thickness, the following relationship shall be assumed to apply. Other factors may be used if independently substantiated

**Table 11: Fin material correction factors (C4)**

Fin Material	Factor C4
Aluminium	1
Coated Aluminium	0.97
Copper	1.03

$$\text{Nominal Capacity (4)} = \text{Nominal Capacity (3)} \times C4 \quad (23)$$

iii.5. Correction for altitude (C5)

$$\text{Nominal Capacity (5)} = \text{Nominal Capacity (4)} \times C5 \quad (24)$$

$$\text{Where: } C5 = (1 - 0.000075 \times H)$$

$$H = \text{Altitude above sea level [m]}$$

This altitude correction may be presented if required.

iii.6. Correction factors on capacity for standard conditions for CO<sub>2</sub> Gas Coolers

Regarding the conversion from the real testing conditions in laboratory to the SC20 standard condition, it had been decided to use the following formula and to determine the constants a, b, c and d, taking into account the admissible tolerances:

$$P_{SC20} = P_{(\text{real testing conditions})} \times F_{SC20} \quad (25)$$

$$\text{where } F_{SC20} = \left(\frac{\Delta t_A}{5}\right)^a \times \left(\frac{t_{R1}}{110}\right)^b \times \left(\frac{P_{R1}}{90}\right)^c \times \left(\frac{t_{A1}}{30}\right)^d \quad (26)$$

Where:

$$t_{A1} = 30^\circ\text{C} \pm 1 \text{ K} \quad (\text{Air inlet temperature})$$

$$\Delta t_A = 5 \text{ K} \pm 1 \text{ K} \quad (\text{Approach temperature})$$

$$P_{R1} = 90 \text{ bar} \pm 1 \text{ bar} \quad (\text{Gas Cooler inlet pressure})$$

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$t_{R1} = 110^{\circ}\text{C} \pm 5 \text{ K}$  (Gas Cooler inlet temperature)

where  $a = -0.284625$

$b = -0.614198$

$c = -1.840351$

$d = 0.932296$

iii.7. Correction factors on capacity for standard conditions for CO<sub>2</sub> Gas Coolers (Condition in transcritical mode)

Correction factors to express cooling capacity of CO<sub>2</sub> Gas Coolers in transcritical mode from condition A5 (testing conditions) and conditions used on the Market.

**Table 12: Correction factors proposed for the pre-defined standard conditions used on the Market**

Condition in transcritical mode	Correction factor
A5 (SC20)	1.00
A3	0.82
A2	0.71
B5	1.08
B3	0.88
B2	0.76
C5	0.80
C3	0.62
C2	0.52

Where:

**Table 13: Standard conditions defined for Gas Coolers in transcritical mode**

Condition in transcritical mode	Gas Cooler inlet pressure	Gas Cooler inlet temperature	Air Inlet temperature	Gas Cooler outlet temperature	DT (temperature approach)
A5 (SC20)	90 bar	110 °C	30 °C	35 °C	5 K
A3	90 bar	110 °C	32 °C	35 °C	3 K
A2	90 bar	110 °C	33 °C	35 °C	2 K
B5	95 bar	120 °C	33 °C	38 °C	5 K
B3	95 bar	120 °C	35 °C	38 °C	3 K
B2	95 bar	120 °C	36 °C	38 °C	2 K
C5	80 bar	100 °C	27 °C	32 °C	5 K
C3	80 bar	100 °C	29 °C	32 °C	3 K
C2	80 bar	100 °C	30 °C	32 °C	2 K

$$\text{Nominal Capacity} = \text{Capacity at testing conditions} \times \text{correction factor} \quad (27)$$

Eurovent Certita Certification will make sure that the factors are applied accordingly before certifying Gas Cooler manufacturers.

(iv) Additional information for certification of CO<sub>2</sub> Gas Coolers

Additional information to the existing certification test method for CO<sub>2</sub> Gas Coolers is summarized as the following:

- Including the liquid pressure drop in the certification (trans-critical condition).
- Outlet temperature will be measured.
- The tolerance is enlarged to 10% for 2 years to ensure an easy starting.

(v) Additional temperature difference for Air Cooled Condensers

For all Air Cooled Condensers, if the proportionality to TD from 15K to 10K is respected, capacities under TD 10K can be published without supplementary test. If the proportionality is not respected, a test under 10K is mandatory.

(vi) Energy ratio and classes

Energy Ratio R:

- For DX Air Coolers: Nominal capacity [kW] divided by the total certified power input of the fan motors Fan power [kW] at the standard rating conditions, multiplied by the square root of (the fin spacing divided by 4.5).

If rated at SC2, standard capacity shall be at SC2 under wet conditions.

$$R_{\text{DXaircoolers}} = \frac{\text{Capacity @ SC2 wet}}{\text{Fan power}} \times \sqrt{\frac{\text{fin spacing}}{4.5}} \quad (28)$$

Otherwise, we will use minimum of the equation below between the different SCs, where  $C_{\text{label, wet}}$  is given in **Table 14**:

$$R_{\text{DXaircoolers}} = \frac{P_{\text{SC, wet}} \times C_{\text{label, wet}}}{\text{Fan power}} \times \sqrt{\frac{\text{fin spacing}}{4.5}} \quad (29)$$

**Table 14: Correction factor  $C_{\text{label, wet}}$  for determination of R for DX Air Coolers**

wet	C1	DT	$C_{\text{label, wet}}$ $1,15/C1*8/DT$
SC1	1.35	10	0.68
SC2	1.15	8	1
SC3	1.05	7	1.25
SC4	1.01	6	1.52

- For Air Cooled Condensers and Dry Coolers: Nominal capacity at DT1 = 15 K [kW] divided by the total certified power input of the fan motors [kW] at the standard rating conditions.

$$R_{\text{Condensers, Dry coolers}} = \frac{\text{Capacity @ DT1 =15K}}{\text{Fan power}} \quad (30)$$

- For CO<sub>2</sub> Gas Coolers: Nominal capacity at SC20 [kW] divided by the total certified power input of the fan motors [kW] at the standard rating conditions.

$$R_{\text{CO}_2 \text{ Gas Coolers}} = \frac{\text{Capacity @ SC20}}{\text{Fan power}} \quad (31)$$

**Energy Class:** Letter corresponding to an Energy Ratio in a range defined in **Table 15**.

Table 15: Energy classes thresholds

Energy class	Energy consumption	CO <sub>2</sub> DX Air coolers	DX Air Coolers	Condensers	Dry coolers
		$R_{\text{DX Air Coolers}} = \frac{P_{\text{SC,wet}} \times C_{\text{label,wet}}}{\text{Fan power cons}} \times \sqrt{\frac{\text{fin spacing}}{4.5}}$		$R_{\text{Condensers,Dry Coolers}} = \frac{\text{Capacity @ DT1 = 15K}}{\text{Fan power cons}}$	
A+	Extremely low	$R \geq 105$	$R \geq 73$	$R \geq 232$	$R \geq 226$
A	Very Low	$65 \leq R < 105$	$47 \leq R < 73$	$169 \leq R < 232$	$127 \leq R < 226$
B	Low	$45 \leq R < 65$	$35 \leq R < 47$	$106 \leq R < 169$	$70 \leq R < 127$
C	Medium	$29 \leq R < 45$	$25 \leq R < 35$	$62 \leq R < 106$	$42 \leq R < 70$
D	High	$23 \leq R < 29$	$20 \leq R < 25$	$42 \leq R < 62$	$32 \leq R < 42$
E	Very high	$R < 23$	$R < 20$	$R < 42$	$R < 32$

#### A.4 Acceptance criteria

When tested in independent laboratory, the characteristics obtained shall not differ from the claimed values by more than:

- Standard capacity (\*) -8 %  
(\*) -10% for CO<sub>2</sub> Gas Coolers for two years.
- Fan power input +10 % with a minimum of 3 W
- Air volume flow +/-10 %
- Dimensions and number of fins:
  - Finned length ± 0,5 %, with a minimum of 5 mm
  - Height of the coil ± 5 mm
  - Depth (width) of the coil ± 5 mm
  - Total number of fins\* ± 4 %, at least 2 fins
  - Diameter of (expanded) tube outside the coil\* ± 1 mm
- (\*) except for the micro-channels
- Liquid side pressure drop +20 % with a minimum of 5 kPa
- A-weighted sound power level +2 dB(A)

Only the sound power level ( $L_w$ ) is measured. The sound pressure level ( $L_{pd}$ ) is calculated by a numeric Formula (see below):

$$L_{pd} = L_w - 10 * \lg \left( \frac{S_e}{S_0} \right) \quad (31)$$

Where  $S_e$  and  $S_0$  refer respectively to the area covered by listener distance from the sound emitter and the surface area of the sound emitter.

For each model of a modular range, the capacity claimed by the Participants shall not differ from the modular capacity by more than +8%. The average of the positive differences between the modular capacities and claimed capacities shall not exceed +5%.



## Appendix B. CAMPAIGN SCHEDULE

### A. Repetition Campaign for Dry Coolers and certified CO<sub>2</sub> product types (valid for 2023 campaign only)<sup>8</sup>

<i>Eurovent Certita Certification asks for up-date of product list before</i>	<i>30/04/2023</i>
<i>The Participant confirms the update of their list of products before</i>	<i>30/05/2023</i>
<i>Eurovent Certita Certification sends the selection list of models to be tested before</i>	<i>31/07/2023</i>
<i>The Participant confirms its selection and sends all the technical datasheets before</i>	<i>15/08/2023</i>
<i>The Participant sends the purchase orders before</i>	<i>15/10/2023</i>
<i>All the units are received by the laboratory before</i>	<i>30/10/2023</i>
<i>Eurovent Certita Certification sends the diploma (only if the units and documentation are available) before</i>	<i>31/12/2023</i>
<i>The diplomas are valid until</i>	<i>31/01/2025</i>
<i>The Laboratory completes all first tests before</i>	<i>15/02/2024</i>
<i>Eurovent Certita Certification sends all the test reports before</i>	<i>15/03/2024</i>
<i>The Participant can ask for second tests before</i>	<i>15/04/2024</i>
<i>Eurovent Certita Certification sends the selection list of models to be re-tested before</i>	<i>30/04/2024</i>
<i>The Participant sends all the units, technical datasheets and orders for 2nd tests before</i>	<i>15/05/2024</i>
<i>The Laboratory completes all second tests before</i>	<i>30/06/2024</i>
<i>Eurovent Certita Certification sends the Participants a report on failure rate before</i>	<i>15/07/2024</i>

### B. Repetition Campaign for HFCs (DX Air Coolers and Air Cooled Condensers) (valid for 2023 campaign only)<sup>9</sup>

<i>Eurovent Certita Certification asks for up-date of product list before</i>	<i>16/06/2023</i>
<i>The Participant confirms the update of their list of products before</i>	<i>31/07/2023</i>
<i>Eurovent Certita Certification sends the selection list of models to be tested before</i>	<i>15/10/2023</i>
<i>The Participant confirms its selection and sends all the technical datasheets before</i>	<i>30/10/2023</i>
<i>The Participant sends the purchase orders before</i>	<i>30/11/2023</i>
<i>All the units are received by the laboratory before</i>	<i>31/01/2024</i>
<i>Eurovent Certita Certification sends the diploma (only if the units and documentation are available) before</i>	<i>31/12/2023</i>
<i>The diplomas are valid until</i>	<i>31/01/2025</i>
<i>The Laboratory completes all first tests before</i>	<i>15/05/2024</i>
<i>Eurovent Certita Certification sends all the test reports before</i>	<i>15/06/2024</i>
<i>The Participant can ask for second tests before</i>	<i>15/07/2024</i>
<i>Eurovent Certita Certification sends the selection list of models to be re-tested before</i>	<i>31/07/2024</i>
<i>The Participant sends all the units, technical datasheets and orders for 2nd tests before</i>	<i>15/08/2024</i>
<i>The Laboratory completes all second tests before</i>	<i>30/09/2024</i>
<i>Eurovent Certita Certification sends the Participants a report on failure rate before</i>	<i>15/10/2024</i>

<sup>8</sup> According to the Minutes of Programme Committee meeting held on 03 May 2023.

<sup>9</sup> According to the Minutes of the Programme Committee meeting held on 31 May 2023

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### C. General schedule for the Repetition Campaign

Eurovent Certita Certification asks for up-date of product list before	30/05/N
The Participant confirms the update of their list of products before	30/06/ N
Eurovent Certita Certification sends the selection list of models to be tested before	31/08/ N
The Participant confirms its selection and sends all the technical datasheets before	15/09/ N
The Participant sends the purchase orders before	15/11/ N
All the units are received by the laboratory before	30/11/ N
Eurovent Certita Certification sends the diploma (only if the units and documentation are available) before	31/12/ N
The diplomas are valid until	31/01/ N +2
The Laboratory completes all first tests before	15/03/ N +1
Eurovent Certita Certification sends all the test reports before	15/04/ N +1
The Participant can ask for second tests before	15/05/ N +1
Eurovent Certita Certification sends the selection list of models to be re-tested before	31/05/ N +1
The Participant sends all the units, technical datasheets and orders for 2nd tests before	30/06/ N +1
The Laboratory completes all second tests before	31/07/ N +1
Eurovent Certita Certification sends the Participants a report on failure rate before	15/08/ N +1

## Appendix C. FORMS

### C.I. Form HE-1 : Declaration file

The forms HE-1 (declaration file) to be filled and sent by Eurovent Certita Certification to:

- Applicants who have signed the license agreement
- Participants, on an annual basis before the deadline specified in the Certification schedule

A template is available for information and upon request.

### C.II. Form HE-2: Technical Data Sheet (TDS)

The form HE-2 (Technical Data Sheet) to be filled in shall be sent by Eurovent Certita Certification to applicants/participants who have returned the form HE-1 fully completed.

A template is available for information and upon request.

### C.III. Form HE-3 : Test result form

The HE-3 form is systematically sent together with the test reports.

## Appendix D. CHARACTERISTICS OF TUBES AND FIN FOR THE COIL GEOMETRY (FOR INFORMATION)

Tube configuration or Profile width (MC)	Tube type	Fin shape	Tube material	Fin material
Staggered	Inner-grooved	Flat	Copper	AL
In-line	Smooth	Louvered	Aluminium	AL/Epoxy
		Corrugated	Stainless steel	AL/Hydrophilic
				Copper
				Stainless steel
				ALMg



Performances on line  
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