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TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

Mechanical structures for electronic equipment – Design guide: Interface dimensions and provisions for water cooling of electronic equipment within cabinets of the IEC 60297 and IEC 60917 series

Structures mécaniques pour équipement électronique – Guide de conception: Dimensions d'interface et dispositions relatives au refroidissement par l'eau des équipements électroniques dans les armoires des séries CEI 60297 et CEI 60917

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MECHANICAL STRUCTURES FOR ELECTRONIC EQUIPMENT – DESIGN GUIDE: INTERFACE DIMENSIONS AND PROVISIONS FOR WATER COOLING OF ELECTRONIC EQUIPMENT WITHIN CABINETS OF THE IEC 60297 AND IEC 60917 SERIES

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 62454, which is a technical specification, has been prepared by subcommittee 48D: Mechanical structures for electronic equipment, of IEC technical committee 48: Electromechanical components and mechanical structures for electronic equipment.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
48D/357/DTS	48D/363/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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INTRODUCTION

The increasing computing performance of electronic devices with increasing electrical power consumption creates very high heat loads within electronic cabinets.

Next generations of electronic equipment built into cabinets require new ways of cooling. State of the art in office or data centre environments is the cooling by ambient air, within air conditioned rooms. The dimensioning of the heat loads was typically based on approximately 1 kW per cabinet. Next generation equipment cooling solutions, as described in this Technical specification, take heat loads of up to 35 kW per cabinet under consideration.

The heat management in such installations becomes difficult if the heat per cabinet reaches such levels or if the distribution across the multiple cabinets becomes extremely uneven.

In order to meet such heat spots or uneven heat concentration, it is necessary to conduct the heat to the outside of the room, instead of loading the room. The proposed solution uses water cooled heat exchangers within the individual cabinet.

Assuming that the chilled water supply is the easiest cooling opportunity within existing infrastructures and new installations, this Technical specification was initiated for the definition of dimensional interfaces and cooling performance guidelines.

Three different cooling arrangements for heat exchangers within cabinets have been regarded, called “interface levels”, where level 1 and 2 are described in detail in this Technical specification. The third level, which is per definition the component level on a single board is not described in detail due to the fact, that such an interface depends on too complex design details and that a water cooled heat sink is used, principally working by conduction cooling of the component (e.g. processor). Level 3 is described by some basic considerations of the interfaces.

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For a clear definition of interface dimensions and cooling performance guidelines, only cabinets have been regarded from the IEC 60297 (19 in) and IEC 60917 (25 mm) series.

Interface level 1: Cabinet with heat exchanger bottom or side mounted for the cooling of a whole cabinet.

Interface level 2: Cabinet with sectional heat exchanger, dedicated to individual subracks or groups of subracks.

Interface level 3: Cabinet with inbuilt subrack where the water pipe connects to components on individual boards.

In this Technical specification, the terms ‘Water’ and ‘Air’ require further definition in application specific standards or specifications.

MECHANICAL STRUCTURES FOR ELECTRONIC EQUIPMENT – DESIGN GUIDE: INTERFACE DIMENSIONS AND PROVISIONS FOR WATER COOLING OF ELECTRONIC EQUIPMENT WITHIN CABINETS OF THE IEC 60297 AND IEC 60917 SERIES

1 Scope and object

This technical specification provides interface dimensions and cooling performance guidelines for cabinets, using water supplied heat exchangers. For a clear definition of interface dimensions and cooling performance guidelines, only cabinets have been regarded from the IEC 60297 (19 in) and IEC 60917 (25 mm) series.

As the cooling performance is in direct relation to volume flows and temperatures of air and water, cooling performance guidelines are provided for two structural interface levels – Interface level 1 and 2 – of equipment built into cabinets.

The third interface level is only described by main interfaces, but without detailed dimensions and without cooling performance guidelines. This interface needs very complex details for the ducting of water supply within the cabinet and down to the component heat sinks on boards within subracks. Therefore, only the principle is shown usable for individual design solutions.

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2 Normative references

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IEC 60297-2, *Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 2: Cabinets and pitches of rack structures*

IEC 60917-2-1, *Modular order for the development of mechanical structures for electronic equipment practices – Part 2: Sectional specification – Interface coordination dimensions for the 25 mm equipment practice – Section 1: Detail specification – Dimensions for cabinets and racks*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*
Amendment 1 (1999)

ISO 228-1:2000, *Pipe threads where pressure tight joints are not made on the threads – Part 1: Dimensions, tolerances and designation*

ISO 11690-1, *Acoustics – Recommended practice for design of low-noise workplaces containing machinery – Part 1: Noise control strategies*

3 Arrangement overview

The arrangement overview shown in Figure 1 illustrates the typical interface levels.

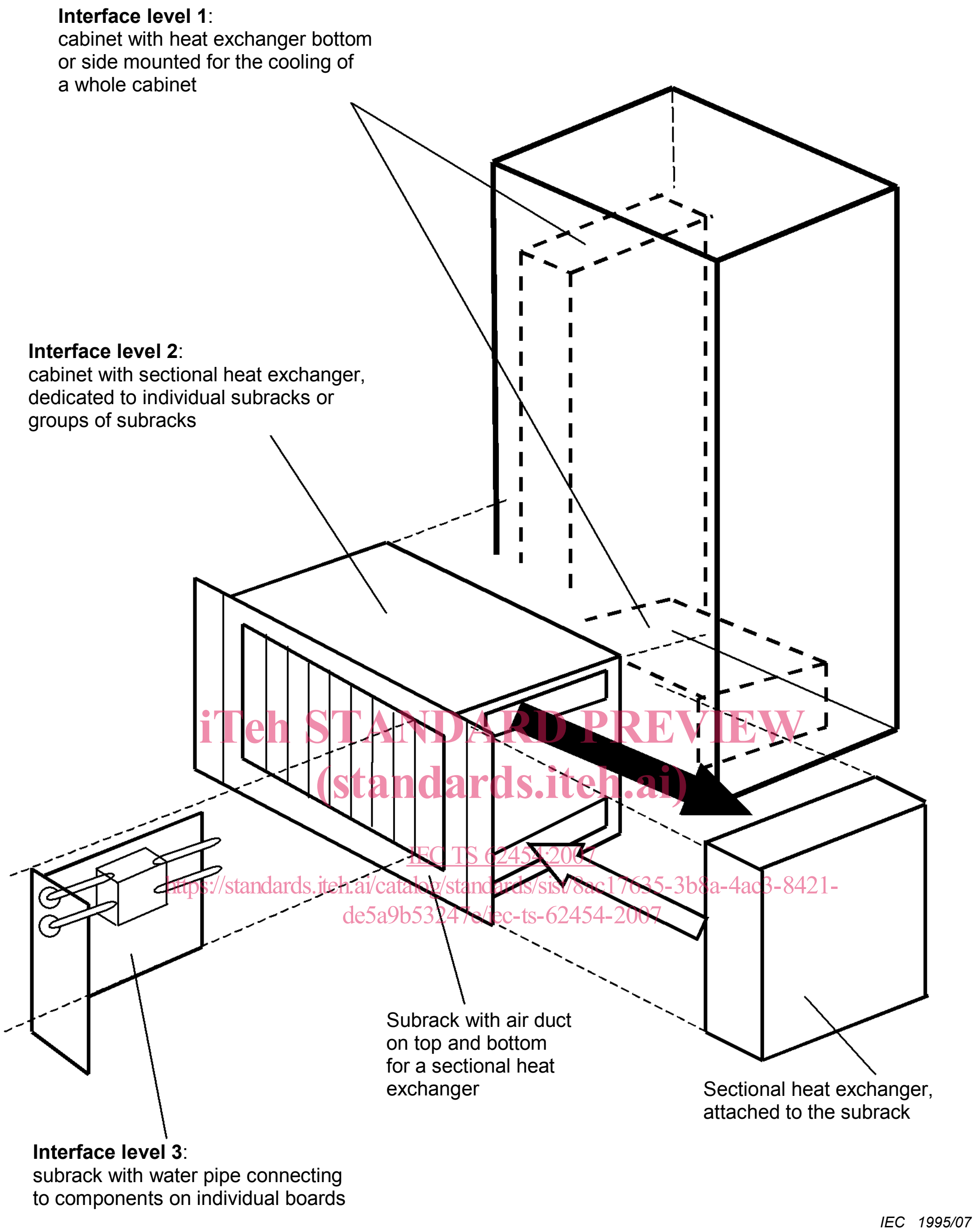

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Figure 1 – Arrangement overview: three interface levels for cooling of electronic devices, within a cabinet

4 Interface level 1: Cabinet with heat exchanger, bottom or side mounted

4.1 General

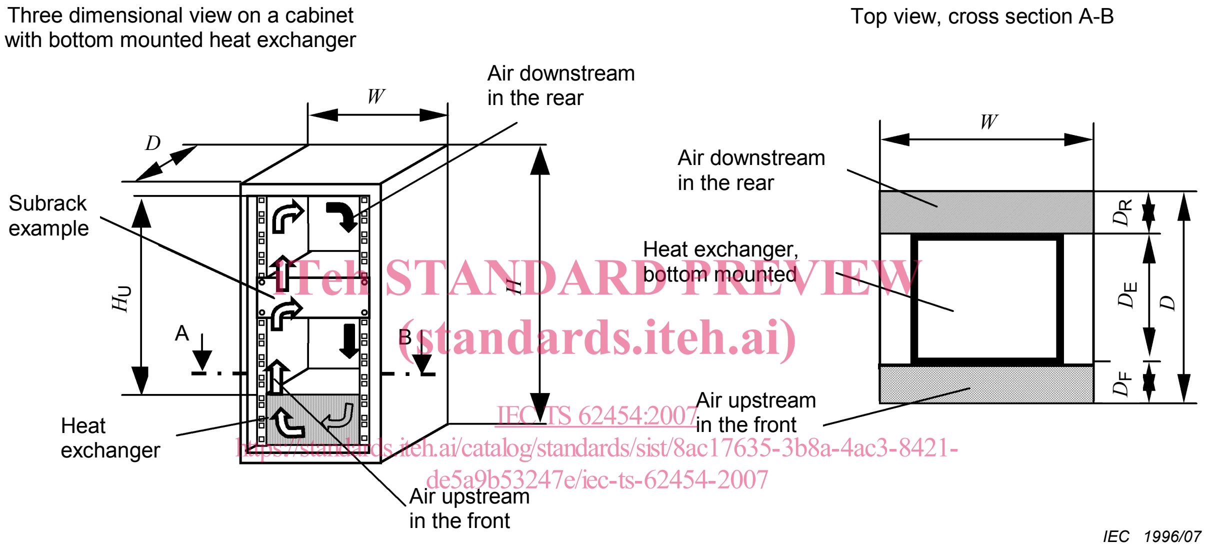
The following figures illustrate the mounting positions of the heat exchanger and the direction of the air circulation. For the individual application, the provided cabinet dimensions and dimensions relevant for the air volume shall be used as the reference.

4.2 Cabinet with heat exchanger, bottom mounted

4.2.1 Overview

Figure 2 illustrates the principal application of a bottom mounted heat exchanger. The air stream is in the vertical direction, on the front side upwards between the front door and the equipment face plate.

The principal drawing in the figure shows only one subrack as an example. The whole area above the heat exchanger may be assembled with subracks or electronic equipment to direct the air upwards along the face plates (or to be closed by filler panels in case of unused mounting sections). In such configurations, the heat exchanger systems most likely will have their own fans for the air circulation. The subracks or electronic equipment usually also have fans for the throughput from the front to the rear. All open sections in the face plate area (also on the side) should be closed to prevent air bypassing.



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Abbreviations:

W	Width of the cabinet
D	Depth of the front door and rear door
H	Height of the cabinet
H_U	Useable height for electronic equipment
D_F	Distance between the front of the equipment and the front door
D_R	Distance between the rear door and the rear of the equipment
D_E	Depth of the equipment

Figure 2 – Cabinet with bottom mounted heat exchanger

4.2.2 Cooling performance in cabinets with bottom mounted heat exchanger

Figure 3 illustrates the cooling performance guidelines of a cabinet with a bottom mounted heat exchanger as direct function of the air throughput defined by the available cross section at the front and rear of the installed equipment. The cross section ($W \times D_R$) times the air velocity determines the possible air volume, which in turn determines the possible heat transfer to the heat exchanger. The cabinet model to which this diagram belongs is assumed as H = 2 000 mm by W = 600 mm and variable depth from 600 mm to 1 200 mm.

The assumption is made, that 25 % of the rear area may be blocked by cabling. Therefore, the calculation includes 25 % more space at the rear than at the front. The same effect applies if the cabling restricts the front area or if both areas are blocked by 12,5 %. The air velocity of 3 m/s is taken as one example for the possibility to approach the acoustic noise pressure level of ≤ 45 dB(A) in accordance with ISO 11690-1.

Figure 4 illustrates the cooling performance for the same cabinet dimensions, but at 5 m/s air velocity. The cooling capacity of the suitable heat exchanger may be chosen in accordance with the required total heat load. The air velocity of 5 m/s is taken as one example for the possibility to approach the acoustic noise pressure level of ≤ 55 dB(A) in accordance with ISO 11690-1.

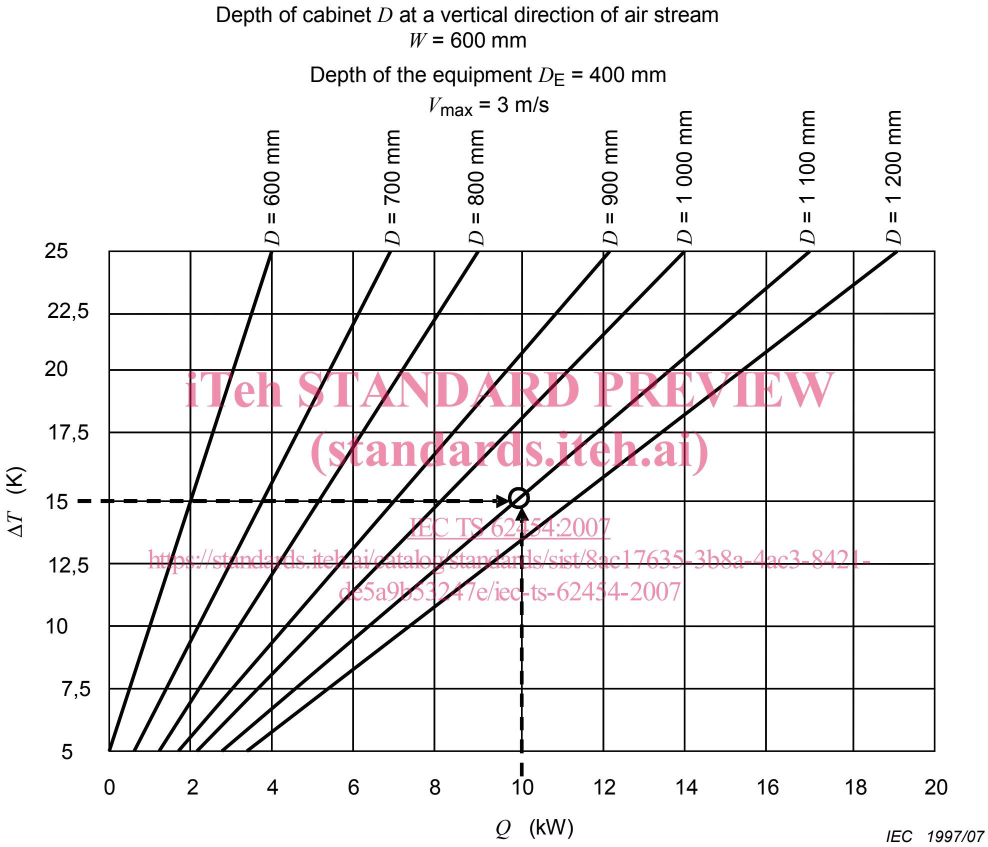

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Figure 3 – Diagram for the heat capacity transfer, dependent on air volume at air velocity of 3 m/s

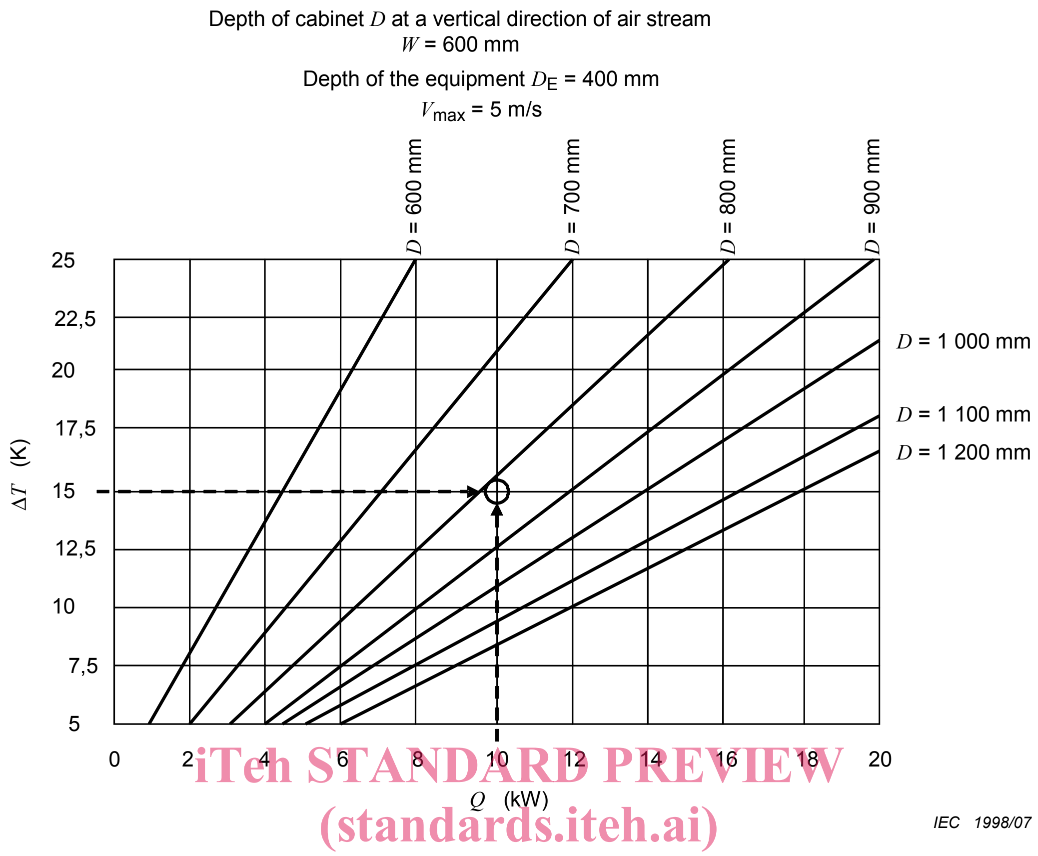

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Figure 4 – Diagram for the heat capacity transfer, dependent on air volume at air velocity of 5 m/s

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4.2.3 Cooling performance calculation for a cabinet with bottom mounted heat exchanger

The cooling performance of the above diagrams is calculated with the following formula. The results are not representative for the specific application, but are rather a guideline for the assessment of dimensional requirements for the air flow volume as an indicator for the possible heat capacity transfer to the heat exchanger.

$D = D_R + D_F + D_E$

where

$$D_F = \frac{\dot{Q}}{\rho_{air} \times \upsilon \times W \times Cp_{air} \times \Delta T}$$

Calculation example of the diagram in Figure 3:

$D_R = 1{,}25 \times D_F$

$D = 1{,}25 \times D_F + D_F + D_E$

$D = 2{,}25 \times D_F + D_E$

$$D = \frac{10\,[\text{kW}]}{1{,}2\,[\text{kg/m}^3] \times 3\,[\text{m/s}] \times 0{,}6\,[\text{m}] \times 1{,}007\,[\text{kJ/kg} \times \text{K}] \times 15\,[\text{K}]} \times 2{,}25 + 0{,}4\,[\text{m}]$$

D = 1 089,6 mm⇒ Selected cabinet depth: D = 1 100 mm

Default data of the calculation:

H = 2 000 mm Cabinet height

D = 600 mm to 1 200 mm Cabinet depth

W = 600 mm Cabinet width

D_E = 400 mm Depth of equipment

D_F = Depth between face plate of equipment and front door

D_R = Depth between rear door and equipment
(D_R is 1,25 × greater than D_F, with regard to space for cabling)

Q = Heat capacity (cooling performance)

V = air velocity at the front and rear of the equipment (3 m/s or 5 m/s)

ΔT = Temperature increase between front area and rear

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Cp_{air} = Air specific heat capacity/latent heat of air

ρ_{air} = Air density

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4.3 Cabinet cooling with side mounted heat exchanger

4.3.1 Overview

Figure 5 illustrates the principal application of a side mounted heat exchanger. The air stream is in horizontal direction and through the equipment from front to rear. The principal drawing in the figure shows only one subrack or electronic equipment as an example. The whole area above the heat exchanger may be assembled with subracks or electronic equipment or should be closed by filler panels in case of unused mounting sections. In such configurations, the heat exchanger system will most likely have its own fans for the air circulation; similarly the subracks usually have fans for the throughput from the front to the rear. All open sections in the face plate area (also on side) should be closed to prevent air bypassing.