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Environment Engineering (EE);
Thermal Management requirements for outdoor enclosures

Reference

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Foreword

This final draft ETSI Standard (ES) has been produced by ETSI Technical Committee Environmental Engineering (EE), and is now submitted for the ETSI standards Membership Approval Procedure.

Introduction

Outdoor enclosure suppliers are trying to overcome their thermal issues in different solutions being developed. When different equipments and outdoor enclosures from various suppliers are integrated, they can have a detrimental effect on each other. The present document specifies the thermal management requirements for outdoor enclosures (defined in EN 301 169-1 [i.4] and EN 301 169-2 [i.5]) to prevent outdoor enclosures having a detrimental thermal influence on equipments inside.

1 Scope

The present document describes the thermal management requirements for outdoor enclosures defined in EN 301 169-1 [i.4] and EN 301 169-2 [i.5]. These thermal management requirements to be defined include:

- a standardized definition of cooling capacity for outdoor enclosures;
- a maximum acceptable delta T between ambient temperature and inside temperature;
- the preferable rule for air flow inside outdoor enclosures;
- the environment class for equipment to be installed in outdoor enclosures.

Not all these requirement are applicable to outdoor enclosures defined in EN 301 169-1 [i.4] and EN 301 169-2 [i.5]; maximum acceptable delta T for equipment in line with EN 301 169-1 [i.4] should be considered as a guide to developer.

The purpose of the present document is to make it more easy to define the responsibility of equipment manufacturers, cabinet manufacturers and integrators.

The present document applies for those empty outdoor enclosures supplied for housing telecommunication equipment of wireline and wireless access network and other information technology equipment.

EMC, safety and acoustic noise requirements are not parts of this document. Guidance on these aspects are contained in annex D.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

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2.1 Normative references

The following referenced documents are necessary for the application of the present document.

[1] ETSI EN 300 019-1-4: "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-4: Classification of environmental conditions; Stationary use at non-weatherprotected locations".

[2] ETSI EN 300 019-1-3: "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-3: Classification of environmental conditions; Stationary use at weatherprotected locations".

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI EN 300 386: "Electromagnetic compatibility and Radio spectrum Matters (ERM);Telecommunication network equipment; ElectroMagnetic Compatibility (EMC) requirements".

[i.2] ETSI EN 301 489-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements".

[i.3] IEC 61969-3: " Mechanical structures for electronic equipment - Outdoor enclosures - Part 3: Sectional specification - Climatic, mechanical tests and safety aspects for cabinets and cases".

[i.4] ETSI EN 301 169-1: "Equipment practice; Engineering requirements for outdoor enclosures; Part 1: Equipped enclosures".

[i.5] ETSI EN 301 169-2: "Equipment practice; Engineering requirements for outdoor enclosures; Part 2: Unequipped enclosures".

[i.6] ETSI EN 300 119-5: "Environmental Engineering (EE); European telecommunication standard for equipment practice; Part 5: Thermal management".

[i.7] CENELEC EN 60950-1: "Information technology equipment - Safety - Part 1: General requirements".

[i.8] CENELEC EN 60950-22: "Information technology equipment - Safety - Part 22: Equipment installed outdoors".

[i.9] ETSI EN 300 753: "Environmental Engineering (EE); Acoustic noise emitted by telecommunications equipment".

[i.10] ETSI EN 300 019-2-4: "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 2-4: Specification of environmental tests; Stationary use at non-weatherprotected locations".

[i.11] ETSI TR 101 576: "Environmental Engineering (EE); Recommendation for the applicability of environmental classes in outdoor cabinet environment".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

air conditioning: cooling technology where an operating refrigerator system is used for cooling the internal air of the enclosure

ambient: spatial maximal temperature of the air entering the rack/cabinet

cabinet: free-standing and self-supporting enclosure for housing electrical and/or electronics equipment, usually fitted with doors and/or side panels which may or may not be removable

free cooling: cooling technology in which the external air is directly used for the inside heat removal; also called direct free cooling

heat exchanger: cooling technology in which the inside heat removal is provided (actively with fans or passively without fans) without directly use of outside air but using an exchange between two fluids (e.g. air to air or water to air)

integrator: end user/operator of telecommunication or IT equipment or their agent

NOTE: For example an equipment manufacturer could be an operator's agent.

micro-climate: conditions found within the rack/cabinet creating a local ambient for the subrack

outdoor enclosures: enclosure exposed for the outdoor environment, for stationary use at non-weatherprotected locations, for the protection of electronic equipment installed inside against outdoor environmental conditions (IEC 61969-3 [i.3]).

outdoor location: location for equipment where protection from the weather and other outdoor influences provided by a building or other structure is limited or non-existent

3.2 Symbols

For the purposes of the present document, the following symbols apply:

K	cooling capacity of outdoor enclosure [W/°C]
Q	heat dissipation from equipment inside cabinet [W]
$T_{ambient}$	surrounding ambient temperature [°C] in which the outdoor enclosure is positioned
T_{inlet}	temperature of air at the equipment inlet inside the cabinet [°C]
ΔT	temperature difference between T_{inlet} and $T_{ambient}$ [°C]

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

COP	Coefficient Of Performance
ICT	Information and Communication Technology
TCU	Temperature Control Unit (for example, fresh air cooling , heat- exchanger, air-conditioner)

4 General requirements

4.1 Thermal performance of outdoor enclosures

The supplier of outdoor enclosures shall design the cabinet so that the product fulfils the outdoor environment as detailed in EN 300 019-1-4 [1], class 4.1. And under this environment class, the cabinet can ensure the equipments whose environment class is defined in clause 4.2 othe present document to work in appropriate micro-climate.

To enable the operators/integrators to predict the thermal performance of outdoor enclosures and to decide the equipment configuration inside, The supplier of outdoor enclosures should provide the relevant thermal characteristics detailed in annex A of the present document.

4.2 Environmental class requirements for equipment installed in outdoor enclosures

Possible use of environmental class for equipment installed in outdoor enclosures is discussed in TR 101 576 [i.11].

The outdoor enclosure provides a weather protected environment for the inside equipment. For effective cooling, the equipment inlet air temperature, using some cooling technologies, is higher than the outdoor air temperature.

In the following is considered that the outdoor enclosure is required to meet EN 300 019-1-4 [1], class 4.1 with temperature range from -33 °C to +40 °C; in this case the climatic conditions for the equipment inside the outdoor cabinet shall be those defined in the following clauses.

4.2.1 Free cooling cabinet

- Climatic conditions in line with Class 3.3 (see EN 300 019-1-3 [2]).

4.2.2 Heat exchanger cabinet

- Climatic conditions in line with Class 3.3 (see EN 300 019-1-3 [2]).

4.2.3 Air conditioning cabinet

- Climatic conditions in line with Class 3.2 (see EN 300 019-1-3 [2]).

On request, the supplier of the equipment shall be able to provide relevant information about the equipment. This information should be described in a way that is specified in EN 300 119-5 [i.6], annex A.

The outdoor enclosure may need to provide an additional heating solution if the inside equipment cannot start up from cold in a low ambient temperature.

Air conditioning requires the use of refrigerants; caution when selecting a refrigerant that it shall not be harmful to the environment.

Air conditioning should be limited to critical case e.g. high power (heat) dissipation in related not big volume cabinet.

5 Thermal management

5.1 Standardized definition of cooling capacity

The purpose of a standardized definition of cooling capacity is to provide a unified standard to evaluate the cooling capacity of outdoor enclosures. Otherwise, it will lead to confusion if each cabinet vendor has its own definition on cooling capacity.

The cooling capacity of outdoor enclosures could be defined (or calculated) with the following equation:

$$K = \frac{Q}{T_{inlet} - T_{ambient}}$$

NOTE 1: K, Q, T_{inlet} and $T_{ambient}$ refer to the definition given in clause 3.2 of the present document.

The position to measure the temperature is shown in figure 1.

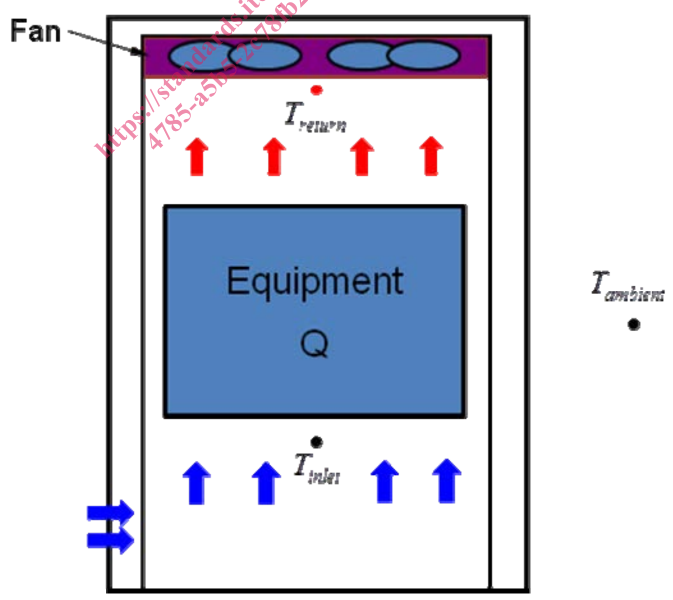

Figure 1: Temperature detecting position in outdoor enclosure

NOTE 2: Example of calculation using formula is reported here for clarification.

The cooling capacity of outdoor enclosure K may vary with the ambient temperature $T_{ambient}$ because of the auto-adjusted speed of fans. For example, one outdoor enclosure housing a 1 000 W heat load equipment, when the $T_{ambient}$ is 45 °C, the fans will work under 100 % speed to keep the ΔT in 10 °C, the K of this outdoor enclosure will be 100 W/ °C, however when the $T_{ambient}$ is 25 °C, the fans may work under 50 % speed to keep the ΔT in 15 °C, the K of this outdoor enclosure will be 66,7 W/ °C.

5.2 Maximum acceptable delta T

To create an appropriate micro-climate for equipment installed in outdoor cabinets, the cabinet should be designed to ensure the equipment installed in cabinet can work at its temperature limit. Moreover, the cabinet should be designed in a way to make the ΔT (the delta T between T_{inlet} and $T_{ambient}$ inside of the equipment, see figure 1) as small as possible (below +10 °C is recommended), while the equipment is operating at maximum temperature according to the environment class for equipment installed in outdoor cabinet.

NOTE 1: The integrators should be responsible for a good match between the air flow path of outdoor cabinet and the air flow path of equipment installed in the outdoor cabinet.

NOTE 2: The ΔT value depends on type of cooling mode applied (in air conditioning cabinet this value could be negative).

5.3 The preferable rule for air flow

The air flow path of equipment (or subrack) has been defined in EN 300 119-5 [i.6], clause 5.1: The preferred air flow route into a subrack is in at the left, front or bottom and out at the right, back or top.

It is also important to define a preferable air flow rule for outdoor enclosures, thus helping operators (or integrators) to match the equipment's (or subrack's) air flow path well with the outdoor enclosure's cooling system.

5.3.1 Air flow paths of outdoor enclosures

Three kinds of thermal control systems could be used in outdoor enclosures, they are fresh air cooling system, heat exchanger system and air-condition system respectively. The air flow path of fresh cooling system is a uniform air flow path that is continuous between outside and inside of enclosure. The air flow path of heat exchanger system or air-condition system is, however, separated into internal air circle and external air circle. The external air circle is consistent with ambient air, and the internal air circle consistent with inner equipment's air flow path, as shown in figure 2.

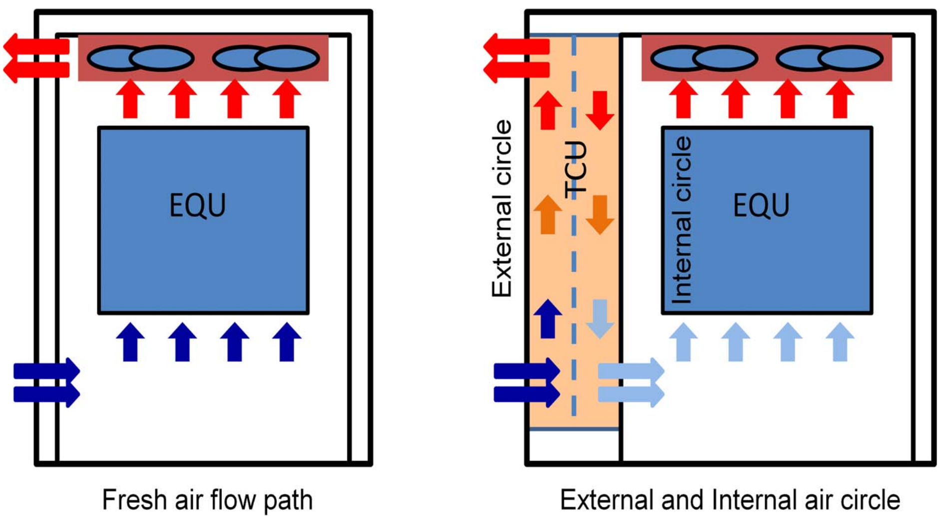

Figure 2: Air flow path of outdoor enclosure