ETSI TR 102 489 V1.4.1 (2015-10)

Environmental Engineering (EE);
European telecommunications standard for equipment practice;
Thermal management guidance for equipment and its deployment

Reference

RTR/EE-0164

Keywords

Energy Efficiency, environment, equipment practice, rack

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Environmental Engineering (EE).

The present document applies to all telecommunications racks/cabinets, miscellaneous racks/cabinets and subracks forming part of the public telecommunications network and defined in ETSI EN 300 119-1 [i.3], ETSI EN 300 119-2 [i.4], ETSI EN 300 119-3 [i.5], ETSI EN 300 119-4 [i.6] and ETSI EN 300 119-5 [i.7]

The present document applies also to telecom and data centre room installations.

Modal verbs terminology

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Abstract

It is often necessary to integrate different subracks into the same rack/cabinet and different racks/cabinets into a common equipment room sharing the common room environment. The integration between equipment and the room is increasingly more important. The present document is intended to provide assistance in integration of equipment and room environment to ensure that the equipment has the required environment and that each equipment rack/cabinet is not detrimental to the other equipment in the locality.

It should be an aid for all integrators and designers with their different elementary knowledge to integrate.

1 Scope

The present document is an aid for all integrators of Information and Communication Technologies (ICT) equipment to minimize thermal problems. It establishes recommendations for the thermal management of racks/cabinets, miscellaneous racks/cabinets and locations.

The present document considers telecommunication Central Office (CO) and Data Centers (DC) locations.

The present document considers only the thermal factors. The integrator should consider the thermal factors in conjunction with the ETSI EN 300 019-1-3 [i.1] and other non-thermal factors.

2 References

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

Not applicable.

2.2 Informative references

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

[i.2] CENELEC EN 60950-1 (2006): "Information technology equipment - Safety - Part 1: General requirements".

[i.3] ETSI EN 300 119-1: "Environmental Engineering (EE); European telecommunication standard for equipment practice; Part 1: Introduction and terminology".

[i.4] ETSI EN 300 119-2: "Environmental Engineering (EE); European telecommunication standard for equipment practice; Part 2: Engineering requirements for racks and cabinets".

[i.5] ETSI EN 300 119-3: "Environmental Engineering (EE); European telecommunication standard for equipment practice; Part 3: Engineering requirements for miscellaneous racks and cabinets".

[i.6] ETSI EN 300 119-4: "Environmental Engineering (EE); European telecommunication standard for equipment practice; Part 4: Engineering requirements for subracks in miscellaneous racks and cabinets".

[i.7] ETSI EN 300 119-5: "Environmental Engineering (EE); European telecommunication standard for equipment practice; Part 5: Thermal management".

[i.8] ETSI EN 300 386: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Telecommunication network equipment; ElectroMagnetic Compatibility (EMC) requirements".

[i.9] IEC TR 62380: "Reliability data handbook - Universal model for reliability prediction of electronics components, PCBs and equipment".

[i.10] Recommendation ITU-T L.1300: "Best practices for green data centers".

[i.11] ASHRAE TC9.9.

NOTE: Available at http://tc99.ashraetcs.org/.

[i.12] ETSI ES 202 336-12: "Environmental Engineering (EE); Monitoring and control interface for infrastructure equipment (power, cooling and building environment systems used in telecommunication networks); Part 12: ICT equipment power, energy and environmental parameters monitoring information model".

3 Definitions and abbreviations

3.1 Definitions

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

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

NOTE: As defined in ETSI EN 300 019-1-3 [i.1].

cabinet: free-standing and self-supporting enclosure for housing electrical and/or electronic equipment

NOTE: It is usually fitted with doors and/or panels which may or may not be removable.

equipment: equipped subracks, racks/cabinets and miscellaneous racks/cabinets

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/miscellaneous rack/cabinet creating a local ambient for the subrack

NOTE: In practice this will typically result in elevated temperatures and reduced relative humidities to those quoted in ETSI EN 300 019-1-3 [i.1].

Miscellaneous Rack/Cabinet (MRC): cabinet that accommodates subracks of several different types of equipment and suppliers

NOTE: It is freely configurable by the Integrator.

rack: free-standing or fixed structure for housing electrical and/or electronic equipment

3.2 Abbreviations

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

AC	Air Cooling
AHU	Air Handling Unit
ARCM	Any Rack, Cabinet and Miscellaneous rack/cabinet
ASHRAE	American Society of Heating, Refrigeration and Air-conditioning Engineers
CFM	Cubic Feet to Minute
CO	Central Office
CRAC	Computer Room Air Conditioner

DC	Data Centre
DT	Data Temperature
EMC	Electro Magnetic Compatibility
HVAC	Heating, Ventilation & Air Conditioning
ICT	Information and Communication Technology
MRC	Miscellaneous Rack/Cabinet
PDU	Poer Distribution Unit

4 ARCM integration overview

The integration can be broken down into:

- Positioning equipment in ARCMs including routing the cables.
- Analysing the possible impact of thermal issues on the configuration of racks/cabinets (e.g. location of racks/cabinets) and MRCs (e.g. location, openings, placement of baffles).
- Providing the cooling solutions.

During the integration the following parameters have to be taken into account:

- The available volume.
- The maximum ambient temperature/micro-climate.
- The provision of coherent air flow to avoid hot spots.
- The functional thermal limits of equipment.
- The cabling space.

The overall cooling effectiveness needed depends in principle on the type of equipment to be cooled and thermal requirements to be complied with.

Special attention should be taken to check the impact of the installation of different equipment in the same ARCM on their functional thermal limits.

It is often very helpful to check, by suitable hand calculation, thermal simulation and measurement, whether the integration is applicable for the purpose.

5 Subrack integration in the same ARCM

5.1 Configuring equipment in an ARCM

5.1.0 Introduction

This activity consists of choosing how to combine the different subracks and the cabling in the ARCM.

5.1.1 Subrack location

This phase consists of positioning the different subracks in the ARCM.

The distribution of subracks should take into account the following parameters:

- Maximum power dissipated by the equipment for the maximum traffic load or its intended operational state. For instance, knowledge of the maximum power dissipated will allow the integrator to locate the highest dissipating subracks at the top of the ARCM in order to minimize the increase of temperature experienced by the other subracks.
- Subracks working maximum temperature: For example, subracks which withstand high temperature can be installed at upper part of the ARCM (where generally the temperature is the highest).

- Thermal restrictions of each subrack. If possible, place the most restrictive subrack in an area not heated by other subracks, for example, at the bottom in an ARCM with natural convection cooling system, or in an area receiving fresh air with as high an air velocity as necessary.
- The position and area of air inlet and air outlet for the different subracks. The porosity of the surface and the obstacles to the airflow in front of the ventilation surface should also be taken into account.
- Air inlet velocity, air outlet velocity of different subracks and estimated air outlet velocity of the ARCM.
- Air velocity inside the ARCM: This should be enhanced as much as possible, by means of subrack distribution or additional subracks, e.g. fans, baffles, etc.
- Environmental class according to ETSI EN 300 019-1-3 [i.1] (for instance maximum air ambient temperature).
- Estimated direction of the airflow inside the ARCM. It is not recommended to have in the same ARCM two subrack types which blow the air in the opposite direction.
- Recirculation of the air. Where possible, the recirculation of a-9ir between subracks should be avoided, unless the design is specifically for serial cooling of the subrack. The risk of recirculation is higher when subracks with different airflow paths are installed together in the ARCM. For instance, where the increase of temperature is significant, the hot air exhausted by a subrack should be prevented from being reused to "cool" another one. Check also the possibility of introducing additional elements to enhance the airflow, such as baffles (to guide the air flows), vertical covers (to improve the performance of the convection, natural or forced), plates (to separate flows and minimize re-circulation).

It is sometimes necessary to assign some space between two adjacent subracks to accommodate the location of the air inlets or the air outlets. This information is generally provided by the manufacturers and detailed in the user's guides.

5.1.2 Cabling

It is recommended that cables within the ARCM are routed in order to minimize the impact on the airflow, without restricting access to other subracks and making best use of the side cable access channels.

Cables and cable bundles can represent a significant obstruction to airflow. When undertaking an analysis of thermal performance accounting for airflow in an ARCM it is important that the analysis takes into account the location of significant amounts of cabling (or wave guides) along with the significance of their obstruction.

5.2 Mechanical structure of ARCM

5.2.0 Introduction

The thermal issues may have an impact on the mechanical structure of the ARCM, i.e.:

- Opening geometry definition.
- Equipment fastening in the rack.
- Definition of the doors and side panels.

This may lead to the choice of a new kind of ARCM (well adapted to the specific application) or to reuse an existing product (generally, in this case, a compromise has to be found between requirements and performance of the ARCM).

5.2.1 Opening geometry for the airflow

To dissipate the power from the equipment the following parameters have to be considered:

- Position of openings.
- Shape of openings.
- Area and porosity of openings.
- Airflow direction due to the shape of the grid (with or without deflector of air inlet or outlet).

- Air inlet and air outlet temperature.

NOTE: In case of shielded racks, the openings may be well adapted to equipment frequencies.

5.2.2 Equipment fastening in the ARCM

The fastening elements should not obstruct the air circulation. For instance, in the case of transversal cooling, the mounting brackets should be well designed to allow the subrack to be cooled. For ETSI compliant equipment this should already be the case.

5.2.3 Doors

When it is necessary to cool the subracks, cabinet doors, when present, can be punched with a lot of small holes or a grid may be placed at lower part of the door, allowing air access to a front ventilation channel. The degree of perforation may be determined using any of the assessment techniques identified in clause 4.

5.3 ARCM cooling issues

5.3.0 Introduction

It is a primary requirement for all equipment to be cooled by natural convection. The mechanical architecture of the ARCM should be designed to promote natural convection. Assisted cooling methods should be employed only when natural convection methods are unable to deal with the relevant heat dissipation.

While defining the cooling issues of ARCM the integrator may check the different cooling possibilities:

- What types of cooling techniques have to be used?
- Is natural convection sufficient to provide enough cooling for the equipment and to ensure that the temperature of the issuing air does not exceed 75 ºC (in accordance with EN 60950-1 [i.2]) in worst-case conditions (specified in the ETSI EN 300 019-1-3 [i.1])?
- Are additional fan trays necessary to supply/extract the air to/from the ARCM?
- Is air filtration necessary?

5.3.1 Cooling equipment including fans

During the configuration of the cooling equipment, the following issues have to be taken into account:

- Power supply interface requirements.
- EMC performance (e.g. voltage dips and spikes generated into the power network).
- Acoustic noise.
- Safety requirements (including fire protection).

5.3.2 Air Cooling techniques

Many cooling solutions already exist but they fall into two main categories:

- Serial cooling.
- Parallel cooling.

Annex A presents cooling system examples. Other approaches are possible. The present document helps the integrator to mix different equipment in an ARCM.

5.3.3 Air filtering

In some instances (see ETSI EN 300 019-1-3 [i.1]) air filters (normally provided at the room level) could be required at the equipment inlets. Where air filters are used, precautions should be taken in order to clean or replace them periodically. If the filter is not cleaned or replaced, the micro-climate air inlet temperature for the subracks can increase dramatically, or the air volume through the equipment be reduced and these changes in ventilation performance can lead to equipment malfunction.

5.4 Impact of the implementation of subracks in an ARCM

When integrating a subrack in an ARCM, the integrator should implement subracks that fulfil environmental classes of ETSI EN 300 019-1-3 [i.1]. The environmental class applied to the ARCM should be the lowest environmental class of the subracks in the ARCM. For example if in the ARCM are integrated 1 subrack complying with class 3.1 of ETSI EN 300 019-1-3 [i.1] and 3 subracks complying with class 3.2 of ETSI EN 300 019-1-3 [i.1], the environmental class of the ARCM will be the class 3.1 of ETSI EN 300 019-1-3 [i.1].

The subracks installed in an ARCM maybe subject to highest temperatures depending on the adopted cooling technique. For instance with the serial cooling technique as shown in figure 5.4a the subracks in the upper positions of the ARCM are subjected to temperatures that may exceed the maximum temperature specified for the environmental class, as defined in ETSI EN 300 019-1-3 [i.1] standard, for which the subrack has been designed. If one of the subracks in the ARCM can be subject to a temperature higher than the maximum temperature of the environmental class for which the subracks have been designed, then the ARCM will not be considered to be compliant with the specified environmental class of ETSI EN 300 019-1-3 [i.1]. In this case the ARCM configuration has to be modified (for example installing in the upper positions the subracks that comply with higher environmental classes) or the cooling technique has to be changed (use the parallel cooling instead of the serial cooling).

EXAMPLES:

- Case 1: An ARCM with 3 subracks designed to operate in temperature conditions according class 3.1 of ETSI EN 300 019-1-3 [i.1] and intended to be used in telecom centres where the maximum temperature is set to 25 °C.

  Using the serial cooling technique as shown in figure 5.4a, the upper equipment in the MRC is not operating at temperature conditions of class 3.1 of ETSI EN 300 019-1-3 [i.1]. In this case it needs to use the parallel cooling techniques with the air deflectors between the subracks as shown in figure 5.4b.

- Case 2: An ARCM with 1 subrack designed to operate in temperature conditions according class 3.1 of ETSI EN 300 019-1-3 [i.1] and 1 subrack designed for class 3.2 of EN 300-019-1-3 [i.1] intended to be used in telecom centres.

  Where the maximum temperature is set to 25 °C. In this case the serial cooling technique can be used as shown in figure 5.4c and the upper equipment in the MRC is then operating at temperature conditions within the range of the class for which this subrack was designed. However in this case it needs to consider the impact on the equipment reliability because the upper shelf is operating permanently at high temperature conditions; see clause 5.5.

- Case 3: An ARCM with 2 subracks designed to operate in temperature conditions according class 3.1 of ETSI EN 300 019-1-3 [i.1] intended to be used in telecom centres where the maximum temperature can be up to 30 °C.

  The serial cooling technique, as shown in figure 5.4d, cannot be used.

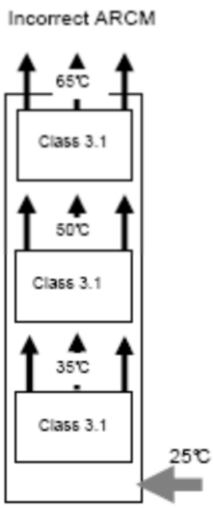

Figure 5.4a

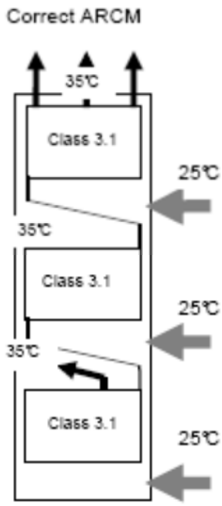

Figure 5.4b

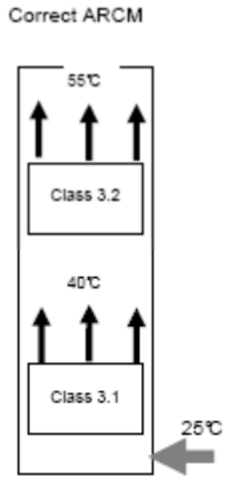

Figure 5.4c

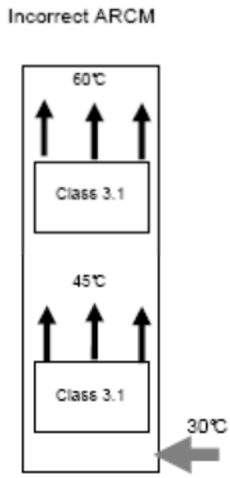

Figure 5.4d

In practice, the room will not deliver the cool air from the fresh air or mechanically cooled supply without some degree of mixing. Furthermore the room temperature is not the same in any point of the room and can increase during failure of the cooling system. It is good practice therefore, to design the cooling system for a normal high air temperature lower than the highest temperature specified by the reference environmental class (see ETSI EN 300 019-1-3 [i.1]) so that the temperature of the air entering all subracks in the ARCMs remains within the maximum temperature defined for the applicable environmental classes of ETSI EN 300 019-1-3 [i.1]. For telecom centres where the cooling system is without redundancy, it is not recommended to use the serial cooling technique. Where more space is required for increased airflow then a larger rack/cabinet could be used by the integrator, for example 900 mm width. In this case the 900 mm width racks offers the possibility of introducing equipment according to the ETSI EN 300 119-4 [i.6] leaving an increased space for airflow. In this case it is necessary to verify that this size is acceptable to the operator for their room layout.

5.5 Impact of the temperature on equipment reliability

It should be considered that the failure rate of an electronic circuit depends on the working temperature conditions. The IEC TR 62380 [i.9] provides a model for the reliability prediction of electronic components. The standard assumptions for the reliability prediction are an average room temperature of 20 °C and an average temperature surrounding the components of 40 °C. Then, if the room temperature is higher than 20 °C a higher failure rate can be expected for certain components that have the failure rate with high dependence on the temperature.

In the serial cooling the upper subracks in the ARCM are exposed to highest temperatures and then a higher failure rate may occur.

In order to get the reliability prediction in line with the ARCM configuration, it is recommended to perform the reliability prediction at the temperature condition of each subrack in the ARCM when the serial cooling technique is used (e.g. at or at the expected room temperature when the parallel cooling technique is used). The reliability data at the different room temperatures can be requested to the equipment supplier.

6 ARCM integration in the same telecommunications equipment or Data centre room

6.1 Positioning the ARCM in a room

6.1.0 Introduction

This involves positioning the different racks and the cabling in the room.