ETSI TR 102 489 V1.1.1 (2004-06)

Technical Report

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

Reference

DTR/EE-TMG001

Keywords

environment, management, equipment practice, rack

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Association à but non lucratif enregistrée à la
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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 EN 300 119 series [1].

Introduction

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 telecommunication and Information Technology (IT) equipment with less or no thermal problems.

1 Scope

The present document is an aid for all integrators of telecommunication and IT equipment to minimize thermal problems. It establishes recommendations for the thermal management of racks/cabinets, miscellaneous racks/cabinets and locations.

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

2 References

For the purposes of this Technical Report (TR) the following references apply:

[1] ETSI EN 300 019 (all parts): "Environmental Engineering (EE); Environmental conditions and environmental test for telecommunications equipment".

[2] CENELEC EN 60950-1 (2001): "Information technology equipment - Safety - Part 1: General requirements".

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

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

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

[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".

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

[8] IEC 60721: "Classification of environmental conditions".

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

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

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

[12] 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".

3 Definitions and abbreviations

3.1 Definitions

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

ambient: ambient is the spatial maximal (as defined in EN 300 019 [1]) temperature of the air entering the rack/cabinet

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: for the purposes of TR 102 489 the term equipment means equipped subracks, racks/cabinets and miscellaneous racks/cabinets

integrator: end user/operator of telecommunication or IT equipment or their agent (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 EN 300 019 [1].

Miscellaneous Rack/Cabinet (MRC): 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:

AHU	Air Handling Unit
ARCM	Any Rack, Cabinet and Miscellaneous rack/cabinet
EMC	Electro Magnetic Compatibility
IT	Information Technology
MRC	Miscellaneous Rack/Cabinet

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 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

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 EN 300 019 [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 air 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

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.
- 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 must 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 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

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

- Is natural convection sufficient to provide enough cooling for the equipment and to ensure that the temperature of the issuing air does not exceed 75ºC (in accordance with EN 60950-1 [2]) in worst-case conditions (specified in the EN 300 019 [1] series)?
- 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.

- Are additional fan trays necessary to supply/extract the air to/from the ARCM?
- What type of cooling techniques have to be used?
- 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:

- EMC performance.
- Acoustic noise.
- Anti-fire protection.

5.3.2 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 EN 300 019 [1] series) 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 EN 300 019 [1] series.

Once implemented in the ARCM these subracks (mainly the ones located at the upper part of the ARCM) are subjected to temperatures which may exceed the maximum temperature specified in the EN 300 019 [1] standards. If this subrack does not withstand temperature higher than the maximal temperature specified in the EN 300 019 [1] standards, then, the ARCM will not be considered to be compliant with the EN 300 019 [1] series. In this case the configuration should be modified, for example, a subrack may be moved, removed or the subrack configuration itself be modified.

As an example, in EN 300 019-1-3 [12] class 3.1 for a normal controlled environment the ambient temperature will be 40ºC or less for 99 % of the year. Using serial cooling of equipment shown in figure 5.4a is likely to result in the equipment in the MRC not operating in an environment that is in accordance with EN 300 019-1-3 [12]. This would be true unless the temperature rise of the subracks is reduced (perhaps by increasing airflows, figure 5.4b) so that the inlet temperatures to all subracks is less than 45ºC. This can be resolved by configuring the MRC with parallel airflow (figure 5.4c) or limiting the number of subracks in the MRC (figure 5.4d).

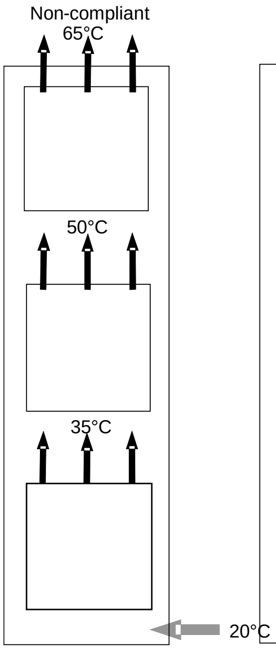

Figure 5.4a

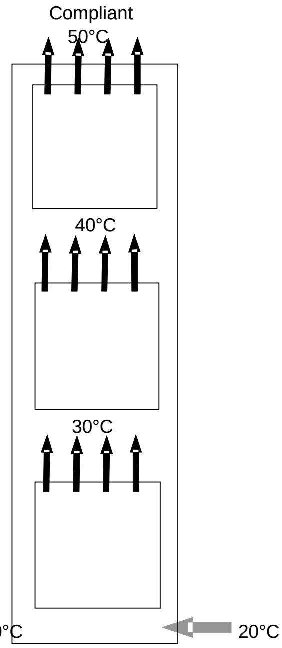

Figure 5.4b

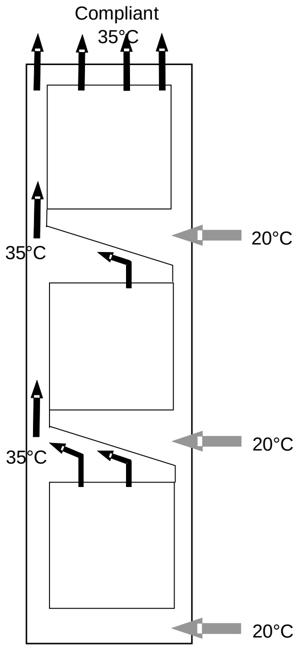

Figure 5.4c

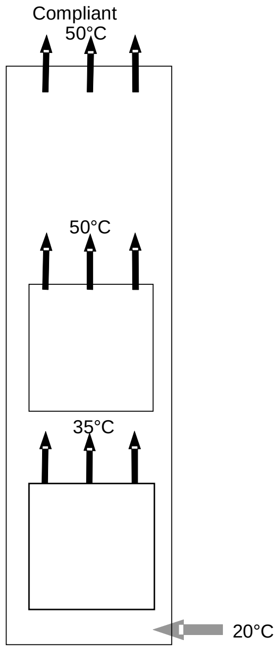

Figure 5.4d

In practice, the room will not deliver the cool air from the fresh air or mechanically cooled supply without some degree of mixing. It is normal practice therefore, to design the cooling system for a normal high air temperature (see EN 300 019-1-3 [12] table 1) lower than 40ºC, say 30ºC to 35ºC, so that the temperature of the air entering all ARCMs remains less than 40ºC (see clause 6).

The objective is to configure the MRC through the use of appropriate cooling strategies or careful equipment selection, so that the combination of subracks still satisfy the EN 300 019 [1] series.

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 EN 300 119-4 [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.

6 ARCM integration in the same telecommunications equipment room

6.1 Positioning the ARCM in a room

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

6.1.1 Room layout

In a room, it is recommended to line up the ARCM in rows, which will be separated by aisles as stated in EN 300 119-2 [4]. As an example see the room layout shown below in figure 6.1.1.

Space for cooling equipment is determined by the operator's requirement.

The minimum aisle width is 750 mm as stated in EN 300 119-2 [4], but any aisle width can be larger as determined by the operator's requirement or as required to satisfy health and safety requirements.

300 mm deep equipment is normally placed back to back (or to a wall) as stated in EN 300 119-2 [4]. In this case all aisles are to the front of the equipment and therefore will require cool air supply so that they are cold aisle.

Where 600 mm equipment is used then a cold aisle is normally created with cool air being supplied in front of the equipment with a hot aisle to the rear of the equipment. For this approach to be effective it is important that alternate rows or equipment face opposite directions so that they are all "front to front" (cold aisle) or "back to back" (hot aisle).

Two types of ARCM installation can be encountered:

- ARCMs installed on a raised floor. In this case the cool air may be introduced from the floor void directly into the room to create a room environment compliant with EN 300 019 [1]. Cool air can also be introduced directly into the ARCM. However this can lead to air distribution problems, e.g. some equipment has too much air while others have insufficient air. This is not preferred unless the integrator can guarantee the correct balancing of the cool air distribution at the raised floor outlets whenever new equipment is installed or equipment is removed. External connections are via the bottom or top of the ARCM.

- ARCMs installed directly on the ground (without raised floor), external connections are via the top of the ARCM and cooling is normally provided via the room.

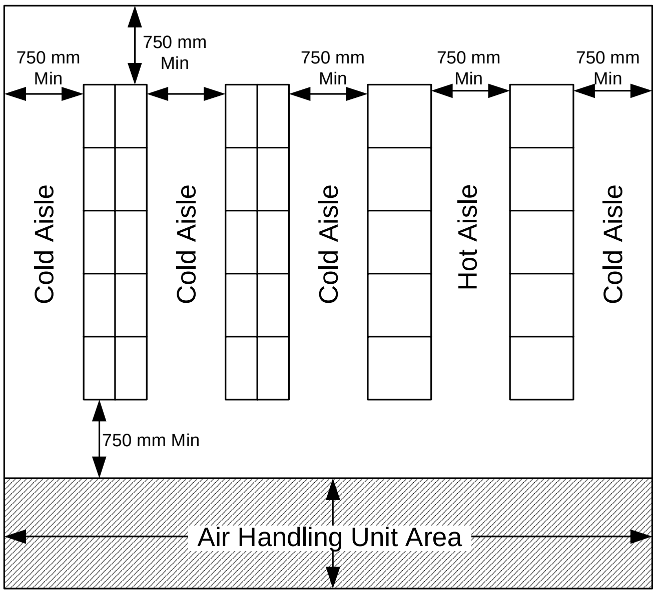

Figure 6.1.1: Room Layout

When determining the layout of ARCMs in a room, the thermal effects of one ARCM on another or of one ARCM row to another need to be considered. ARCMs are positioned in the rows in order to facilitate the inter-rack wiring and to make a complete EMC enclosure for the entire system.

6.1.2 Cabling

The cables are generally routed either over a cable support structure or under a raised floor.

In both cases the cables and the cable support structure should be placed in a way that minimizes the effect on air flow. Placing cables parallel to the ventilation airflow in the main room, or floor void, generally minimizes the effect on airflow. Cables placed perpendicular to the supply airflow into the room (or floor void) are best placed at the opposite end of the room to the ventilation air supply.

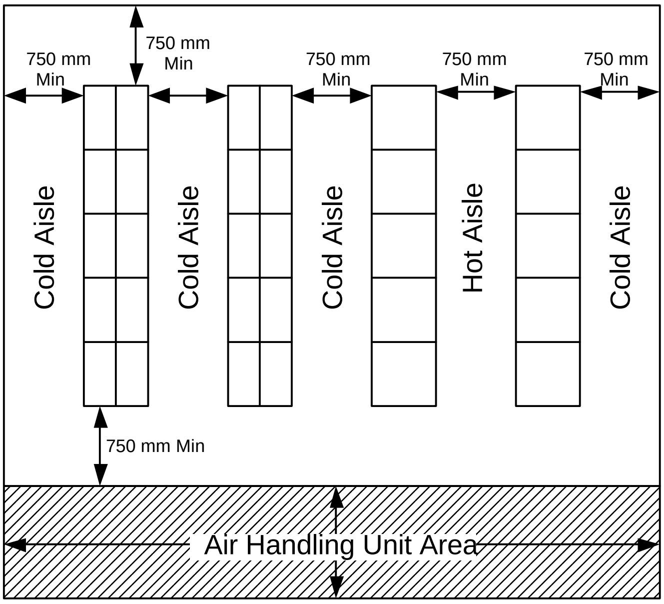

Figure 6.1.2: Cable position in a floor void

It is important that the cable depth be carefully considered when the cables are in the main air path. Cables in the perimeter zone could be allowed to virtually fill the depth of the air path. However, cables in the air path from the Air Handling Units (AHUs) to the equipment may significantly restrict cooling effectiveness if the proportion of the air path blocked is not controlled. In general cable obstructions can be greater when the cable routes are parallel to the air paths rather than perpendicular.

NOTE: Where possible wave guides should be treated in a similar manner to cables.

6.1.3 Cooling systems

Two cases can be encountered:

- Cooling system exists: in this case, the room layout of the ARCMs has to take into account the existing situation.
- Cooling system does not exist: therefore, the cooling system should be co-ordinated with the room layout. Due to the increase of power dissipated in the equipment, the provision of cooling should be taken into account.

Consideration should be given in the room cooling design to allow for cooling system component failure. This does not necessarily mean allowing totally redundant systems, e.g. N+1.

6.2 Mechanical structure of ARCMs in the rows

6.2.1 Opening geometry for the airflow

In order to facilitate the cooling of the room, it is recommended that the air outlet of the ARCMs are located in a similar way, in terms of position and direction of airflow.

The recommended configuration is for air to enter the front of the ARCM and leave through the top.

6.3 Cooling systems for a room

6.3.1 General design considerations

The air normally needs to be filtered to remove particles that may be harmful to the equipment. Filtration should achieve contaminant levels (for biological conditions, chemically and mechanically active substances) less than or equal to the limits specified in EN 300 019-1-3 [12].

Electrostatic discharge is managed by wearing earthed wristbands. See EN 300 386 [11] for further details. Some cooling systems also offer the potential to control humidity and thus reduce the risk of electrostatic discharge (see clause 6.3.2.3).

Where it is considered that corrosion can damage equipment due to high humidity and/or pollution the control of the humidity level should be considered in the design of the cooling system.

Acoustic noise may need to be controlled using acoustic louvers, lined ductwork to meet local environmental regulations.

Where batteries are installed in the facility, then care should be taken to ensure adequate ventilation to adequately dilute and remove any fumes.

In practice, the room will not deliver the cool air from the fresh air or mechanically cooled supply without some degree of mixing. It is normal practice therefore, to design the cooling system for a normal high air temperature (see EN 300 019-1-3 [12], table 1) lower than 40ºC, say 30ºC to 35ºC, so that the temperature of the air entering all ARCMs remains less than 40ºC.

6.3.2 Cooling techniques

The following typical cooling techniques can be identified.

6.3.2.1 Passive cooling

For low power applications natural convection can be used where the room airflow is driven by hot air from the equipment rising. An air inlet allowing air into the facility at low level and an air outlet at high level to allow the warm air to leave are required. The inlet and outlet are normally best placed at opposite ends of the facility. Where there is more than one row of equipment then the facility should be configured so that the airflow from the inlet to the outlet is along the aisles. Care should be taken to avoid air filtration overly restricting the airflow.

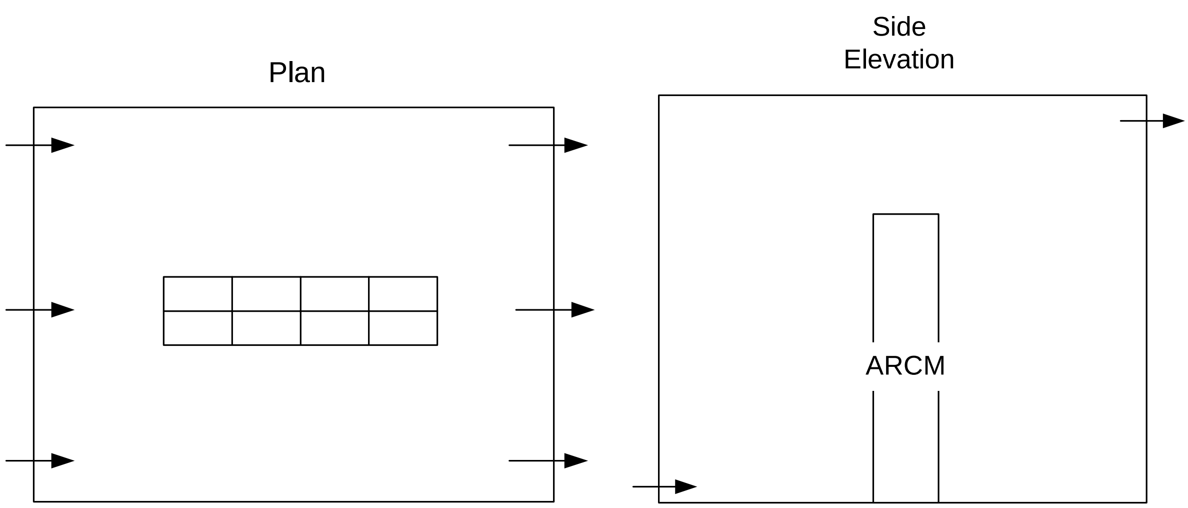

Figure 6.3.2.1a: Option A Passive Cooling

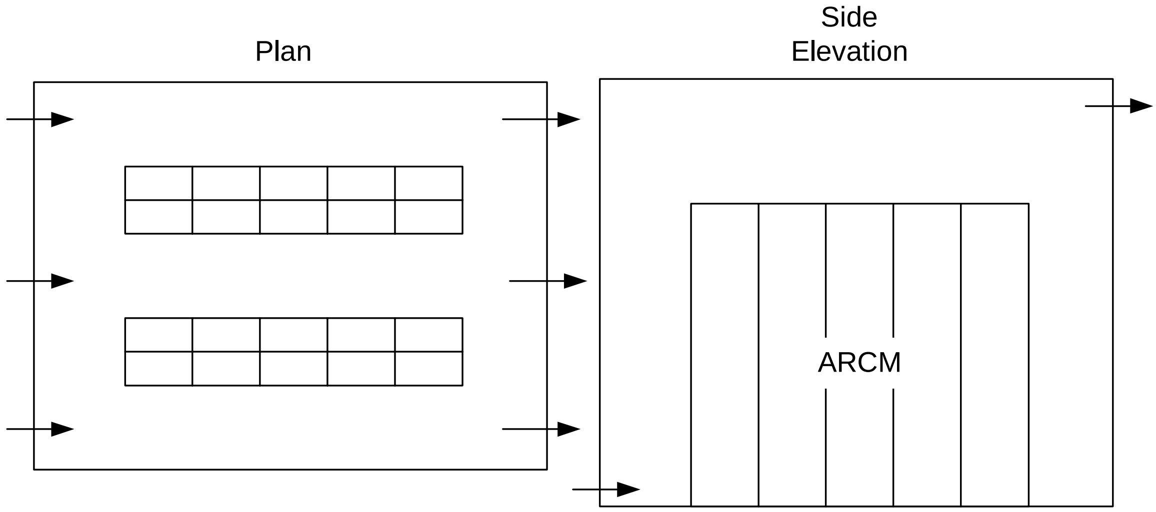

Figure 6.3.2.1b: Option B Passive Cooling

6.3.2.2 Warm air extraction (without cool air)

The room air flow is driven by fans drawing air out of the facility. The fans or ductwork are normally placed at high level in order to remove the warmest air from the facility. Fresh air is drawn in from outside through louvres, normally at low level, to replace the extracted air. The following design issues should be considered.

There is no opportunity for relative humidity control and so the local environmental humidity variations should be considered.

There is no opportunity for control of the incoming air temperature and so the local external ambient temperature variations should be considered.

The ductwork design can be optimized to extract air from local hotspots.

There is no opportunity to distribute the fresh air about the facility.

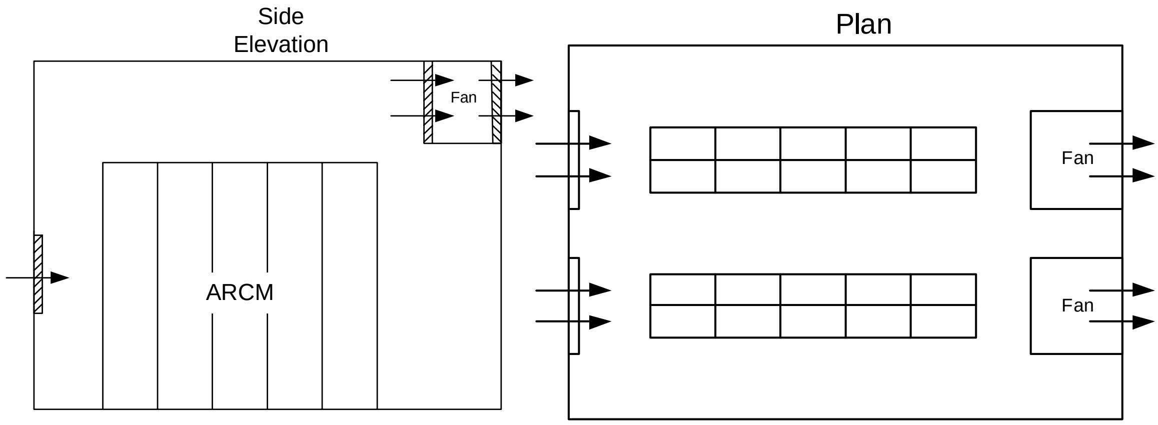

Figure 6.3.2.2a: Option A Warm air extraction (without cool air)

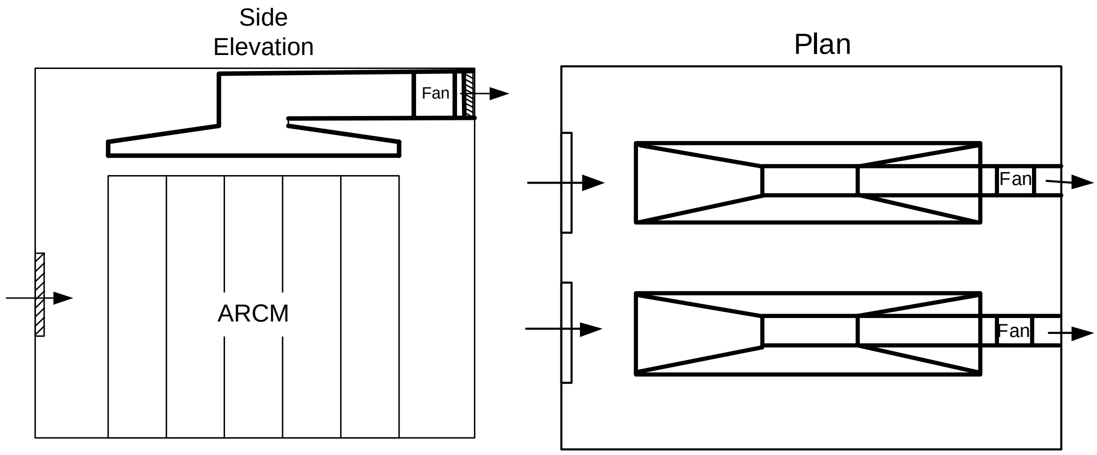

Figure 6.3.2.2b: Option B Warm air extraction (without cool air)

6.3.2.3 Fresh air supply with natural release via pressure relief ventilators

This is the opposite concept to warm air extraction. The airflow in the room is provided by fans blowing fresh air into the facility (note that supply to every aisle as shown in figure 6.3.2.3 may not be required). Air normally leaves through louvers at high level. The following design issues should be considered.

There is no opportunity for relative humidity control and so the local environmental humidity variations should be considered.

There is no opportunity for control of the incoming air temperature and so the local external ambient temperature variations should be considered.

There is no opportunity to collect air directly from hotspots.

Ductwork can be used to deliver the fresh air to locations in the facility where it is most needed.

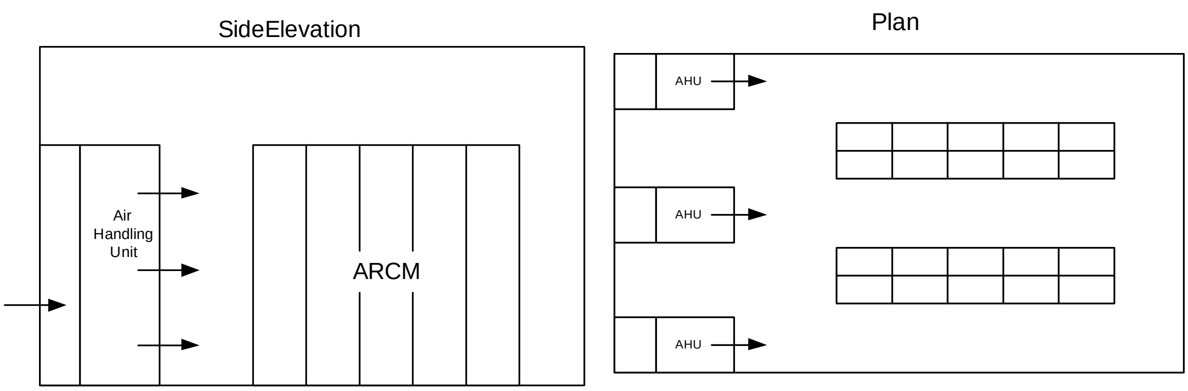

Figure 6.3.2.3: Fresh air supply with natural release via pressure relief ventilators

6.3.2.4 Cool air blowing (with or without relative humidity control)

Cool air blowing is a general term describing a number of implementations where the air supplied to the facility is cooled by a cooling unit before being distributed around the space to cool the equipment. There are a number of different approaches to the cool air distribution as follows:

- Free-blow.
- Overhead distribution.
- Raised floor distribution.

Note that supply to every aisle as shown in 6.3.2.4 figures may not be required.

Warm air can be removed in a number of ways as follows:

- Direct return to side walls at side/end of room.
- Overhead return.

The following design issues should be considered:

- The use of a combination of fresh air and re-circulated air to maximize energy efficiency.
- Humidity control can be incorporated to prevent the risk of static discharge due to the dry atmosphere that can be produced through cooling or where specific equipment requires it. If humidity control is adopted, the design should address whether the volume of fresh air needs to be reduced.
- The choice of air supply and air return system will depend upon the facility construction and the anticipated equipment configuration and heat load.
- When the air is cooled, care should be taken to ensure that it does not fall to near or below the dew point unless humidity control is introduced to eliminate the risk of condensation.

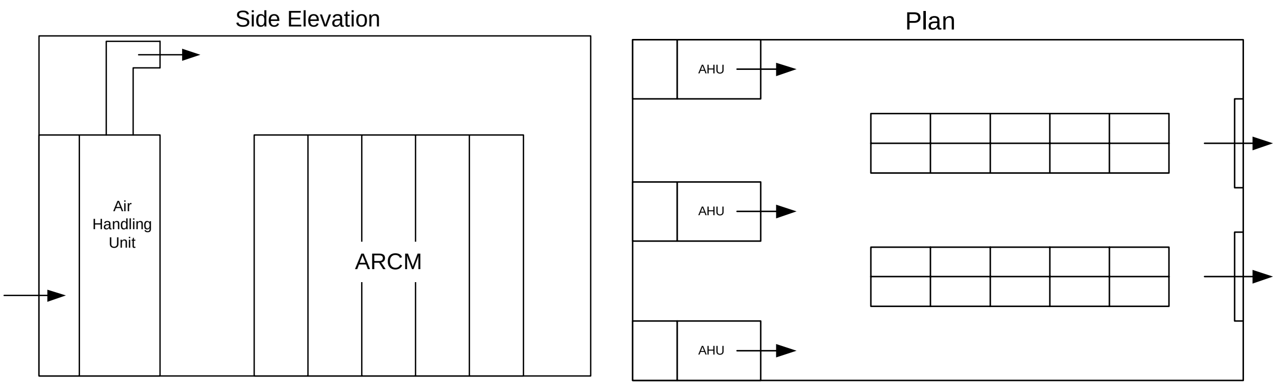

Figure 6.3.2.4a: Option A Free blow at high level

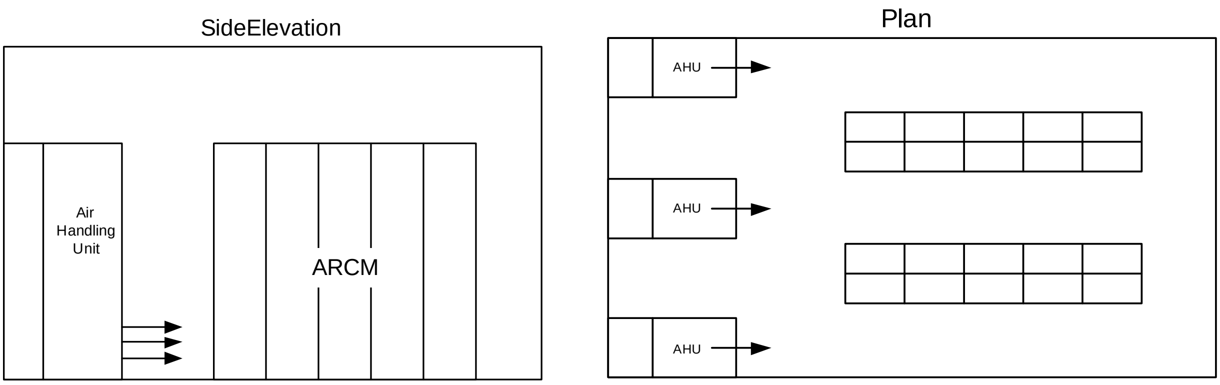

Figure 6.3.2.4b: Option B Free Blow along the aisles

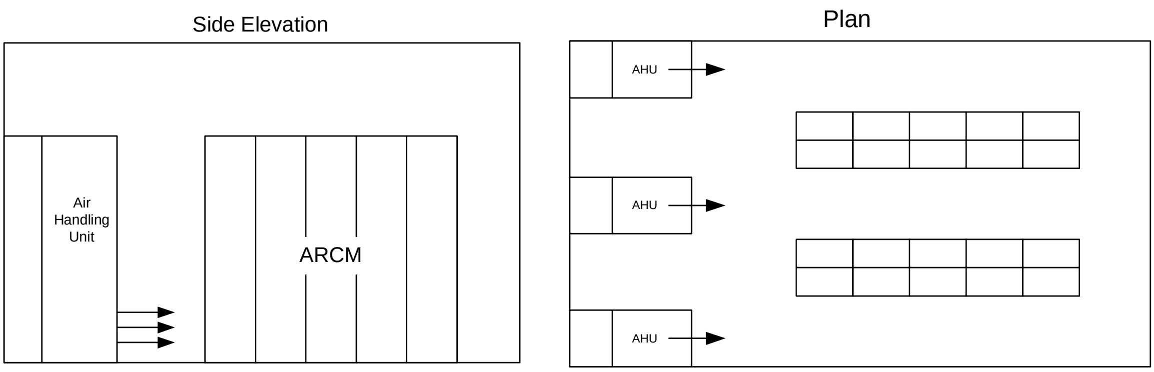

Figure 6.3.2.4c: Option A Overhead Distribution via a ventilated ceiling

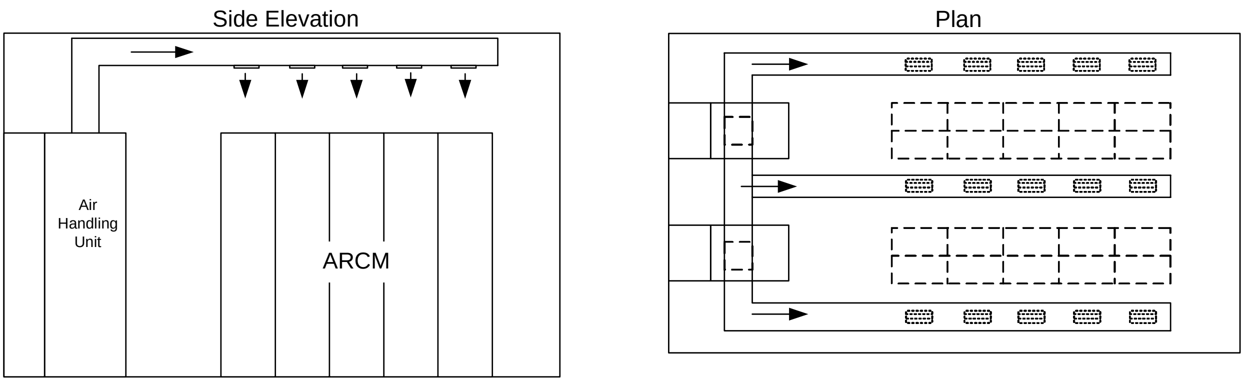

Figure 6.3.2.4d: Option B Overhead Distribution via a network of ducts

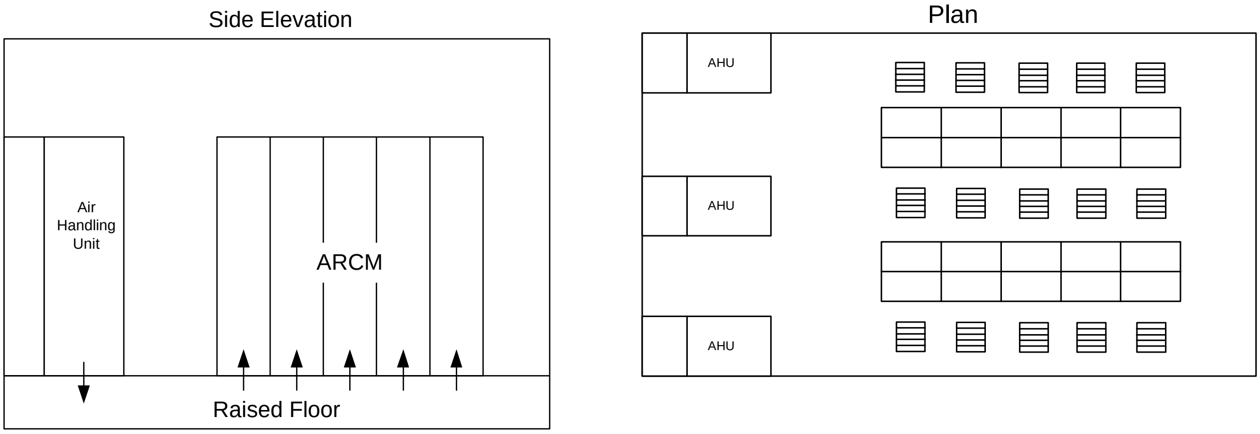

Figure 6.3.2.4e: Floor Distribution

6.3.3 Room air paths

6.3.3.1 Room air supply

One of three different strategies can be adopted to deliver the cooling to the facility.

6.3.3.1.1 Free blow

Free blow is the term used for systems that deliver the cool air to the room through grilles/louvres normally placed at the perimeter of the room. Although the discharge is commonly horizontal and perpendicular to the grille, the grilles may have adjustable blades fitted that can be used to modify the direction of the air and the volume flow rate. Care needs to be taken to ensure that there are no obstructions restricting delivery of the cool air to the equipment. The obstructions can consist of physical obstructions such as equipment, cable trays, etc. or thermal obstructions such as the hot air discharge from the equipment.

There are essentially two configurations:

- Free blow above the equipment (see figure 6.3.2.4a).
- Free blow along the aisles (see figure 6.3.2.4b).

By using large supply air terminals for the cool air entry to the room, the air velocity can be reduced (to less than 1,0 m/s) allowing the cool air to fall and create a "pool" of cool air on the floor of the room. The higher power equipment then draws cool air from the "pool" and carries the heat to high level. This approach is often termed displacement ventilation since the cool air finds and displaces the warm air from the hot equipment. The advantage of this system is that it is less sensitive to changes in equipment configuration. This is because high heat loads naturally attract the cool air and the low velocity means that high vertical temperature stratification is produced with little mixing between the hot air at high level and cool air at low level. The overall result is the potential of higher efficiency for the cooling system.

6.3.3.1.2 Overhead distribution

Overhead distribution is the term used to describe the method where the air is distributed above the equipment in a duct (see figure 6.3.2.4c) or network of ducts (see figure 6.3.2.4d) before being discharged into the facility at strategic locations to cool the equipment. The type of air terminal used to discharge the air into the facility can significantly influence the effectiveness of the air in cooling the equipment and so their type and location should carefully considered. The design should be such that it is compatible with the other infrastructure to be installed above the equipment.

A ducted installation normally refers to a system using a network of ducts to distribute the air. Commonly there will be a separate duct for each row or pair of rows of equipment. From each duct there will normally be fixed or flexible periodic connections between the ductwork and the grilles or diffusers to deliver cool air to the area in front of the equipment as required.

A plenum refers to a special case of a ducted system where the installation has a single large duct normally covering all of the equipped area. The plenum commonly consists of a ventilated ceiling on the lower face with diffusers discharging air vertically down in front of the equipment or offset from the vertical to avoid discomfort for transitory occupants.

6.3.3.1.3 Raised floor distribution

Raised floor distribution is the term used to describe the method where the equipment is placed on a raised floor. The space created below the floor (the floor void) can then be used for distribution of the cool air to the room or equipment and for the delivery of other services (see figure 6.3.2.4e). The design of the air distribution system should be compatible with any other services installed in the void such as cable trays, pipe-work, etc.

NOTE 1: The design of the air supply into the floor void and the size of the floor void can significantly affect the uniformity of air distribution to the room.

NOTE 2: Care should be taken to ensure that the floor is strong enough to support the weight of the equipment to be installed.

NOTE 3: As the raised floor normally comprises an array of removable tiles, the size of the tiles can be varied to accommodate the needs of different use in the room. For example different size tiles may be installed for the equipment row and the aisle.

NOTE 4: Care should be taken to ensure that there are not unplanned openings in the raised floor that allow the air to pass into the room or equipment in undesirable locations and reduce the cool airflow where it is really required. The same issue exists where cables enter or leave the floor void - care should be taken to limit leakage possibly by using brushes, EMC gaskets or some other method to fill the gap around the cables.

NOTE 5: When using a raised floor ventilation scheme, care should be taken to avoid placing ventilated tiles or direct cooled equipment too close to the cool air entering the void. This is to avoid warm air being drawn back down into the floor void. This happens because close to the air entry the air has high velocity and there is little static pressure.

There are two ways of delivering the cooling to the equipment:

- Via the room where the air passes from the floor void to the room through perforated tiles or floor grilles, the majority of which are normally placed in the aisles in front of the equipment. As the raised floor normally comprises an array of removable tiles this offers the flexibility of adding or removing ventilated tiles as required as and when the equipment configuration changes. These ventilated tiles may also have modulating dampers fitted to allow the operator to balance the airflows and achieve the required cool air distribution.

- Direct cabinet cooling from floor is where the air passes directly from the floor void into the equipment. Although this offers the advantage that the cool air does not have the opportunity to mix with warmer room air before reaching the equipment it should be noted that this can lead to air distribution problems, e.g. some equipment has too much air while others have insufficient air. This is not preferred unless the integrator can guarantee the correct balancing of the cool air distribution at the raised floor outlets whenever new equipment is installed or equipment is removed.

6.3.3.2 Return air path

6.3.3.2.1 Direct return to side walls at side/end of room

This approach represents the simplest way to remove the warm air from the room. It comprises grilles or louvres placed around the perimeter of the room for the exhaust air to be expelled or returned to the air conditioning system. Care should be taken to avoid locations that draw the warmer air past equipment intakes. For example, if the return air is on the top of a down-flow unit, the return air grille should be higher than the top of the equipment nearby. This will avoid the hot stratified layer being drawn down and into the equipment.

6.3.3.2.2 Overhead return

This is a method where a network of ducts or a single duct collect the hot air from above the equipment. There are two alternatives:

- The network of ducts offers the opportunity for the distributed grilles to collect the warm air from every row or pair of rows of equipment separately. In particular it allows the hot air from high heat dissipation equipment to be collected more efficiently and thus it can address hot spots effectively.
- The plenum approach is essentially a large single duct covering the entire equipment area with grilles distributed on the lower face to collect the warmer air.

The disadvantage of these systems is the higher capital cost associated with their supply and installation compared with the direct return approach.

7 Thermal evaluation of the equipment/room architecture

As well as normal hand calculation and other design practices the integrator could also use thermal simulation software to check, before installation, that the chosen architecture of the complete system will meet the thermal requirements.

By using both the thermal information (the equipment suppliers have this information available) and the ARCM and room layout, the ARCM and room thermal parameters could be estimated.

The information used for this thermal evaluation is provided by the equipment manufacturer and a minimum set is identified in annex A of EN 300 119-5 [7].

If thermal simulation software is available, the integrator can use this information in the following way:

- Build a simple simulation model of the equipment from the mechanical information provided by the manufacturer (physical geometry from annex A).
- Adjust this simulation model in order to obtain the air temperature increase provided by the manufacturer so that it is consistent with total power dissipation.

This adjusted model of the equipment can be used to represent in the simulation either:

- the subrack in an ARCM housing various subracks; or
- an ARCM in a room housing various ARCMs;

as appropriate.

NOTE 1: The characterization data will provide velocity and temperature of the air leaving the equipment. This can be provided for the circumstance when an obstruction is placed 20mm from the equipment outlet(s) as well as when the equipment is placed in open space. When simulating the performance of subracks from characterization data, it is important that the cable blockage in the 20mm gap is accounted for. Where the equipment is such that the cables significantly affect the free area for the airflow, any model must account for the obstruction in order to achieve a good pressure dependant characteristic.

NOTE 2: In some circumstances significant airflow may enter the ARCM from the room through the bottom of the cabinet via a gap between the floor and the sides/front/back of the ARCM. This can be considered equivalent to ventilation from below, provided that both aisles are cooled, and so this could represent a compliant configuration. This gap should be accurately represented in any simulations undertaken.

The evaluation of results, which can be obtained with sufficient confidence, are as follows:

- Air temperature in different places of the ARCM and the room.
- Air velocity and direction of the airflow in different positions in the ARCM and the room.
- Operating point of the ARCM fan tray (air flow, pressure) for the resistance curve of the equipment, to check it lies within the normal operating range of that fan. If not, the fan tray should be changed.
- For ARCMs cooled by natural convection it allows the integrator to verify that natural convection is sufficient to cool the subracks. If not the integrator should revise the configuration or add fan trays in the ARCM.

These results may help the integrator optimize the ARCM and room layout (modification of equipment location, adding a fan unit or additional fan units, changing the type of fan, adding baffles, etc.).

Annex A: Examples of cooling systems in an ARCM in use prior to EN 300 119-5

The examples given in annex A can be applied to ARCMs installed as specified in EN 300 119-2 [4].

For reference, the figures indicate cooler air in light grey and hotter air in dark grey.

Table A.1 presents the status of the configurations shown in this annex with reference to EN 300 119-5 [7] that comes into force from April 2005 for all new equipment designs.

Table A.1: Configuration status with reference to EN 300 119-5

Annex	Figure	Compliance with EN 300 119-5 [7]
A.1 Single subrack cooling		
A.1.1 Air outlet located at the top of the ARCM	A.1.1a	Compliant
	A.1.1b	Compliant
	A.1.1c	Not preferred (see clause 6.1.1)
A.1.2 Air outlet located at the front of the ARCM	A.1.2a	Not preferred (air outlet at the front and air flow from top to bottom)
	A.1.2b	Not preferred (air outlet at the front)
A.2 Multiple subrack cooling		
A.2.1 Serial cooling	A.2.1a	Compliant
	A.2.1b	Compliant
	A.2.1c	Compliant
A.2.2 Parallel cooling with air inlet at the front or the bottom	A.2.2a	Compliant
	A.2.2b	Compliant (Option not preferred)
	A.2.2c	Compliant
	A.2.2d	Compliant
A.2.3 Parallel cooling with air inlet at the sides	A.2.3a	Compliant
	A.2.3b	Compliant
	A.2.3c	Not preferred (air outlet at the front)

Configurations with perforated front door(s) can operate with or without the front door(s) present.

A.1 Single subrack cooling

This clause describes the commonly used cooling systems of a subrack or a rack designed by a same supplier. The air outlet is located at the top or at the front.

A.1.1 Air outlet located at the top of the ARCM

Figures A.1.1a to A.1.1c present three configurations of ARCMs designed to have the air outlet located at the top of the ARCM. The air inlet can be located at the bottom or at the front. In some cases, the equipment is installed on a raised floor, so the air inlet can be located under the ARCM (care should be taken - see clause 6.1.1). Hereafter the three configurations are described.

In figure A.1.1a, the room air is taken in at the bottom of the ARCM front, up through the subrack and discharged out of the top of the ARCM.

In figure A.1.1b, the room air is taken in at the front of the ARCM via the door (small holes are punched on the door panels or inlet grilles installed in the doors). The air is discharged out of the top of the ARCM.

In figure A.1.1c, the room air is taken in at the bottom of the ARCM through the raised floor. Passing through the subrack it is discharged out of the top of the ARCM.

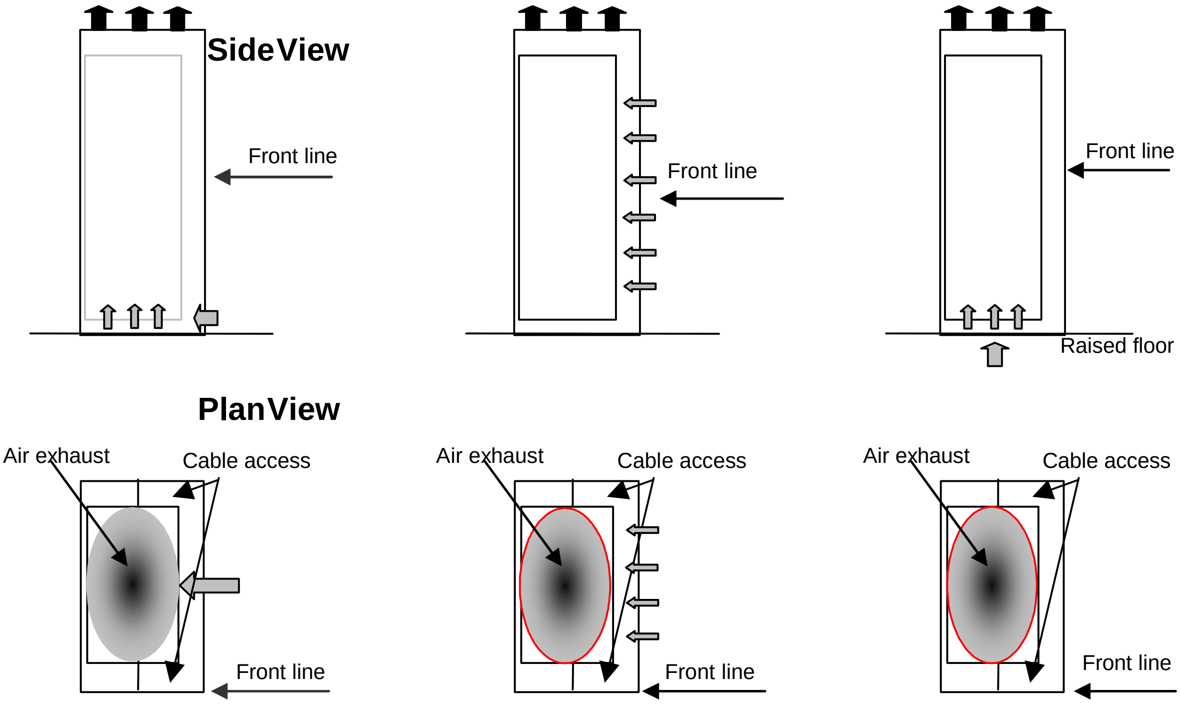

Figure A.1.1a Figure A.1.1b Figure A.1.1c

Combinations of the air inlet configurations shown above have also been used. Any of the above configurations can be placed on a raised floor with or without an air inlet in the bottom of the ARCM.

A.1.2 Air outlet located at the front of the ARCM

Figures A.1.2a to A.1.2b presents two configurations of ARCMs where air inlet and outlet are located in the front of the rack.

In figure A.1.2a, the room air is taken in at the top of the ARCM front, down through the subrack and discharged out of the bottom of the ARCM front.

In figure A.1.2b, the room air is taken in at the bottom of the ARCM front, up through the subrack and discharged out of the top of the ARCM front.

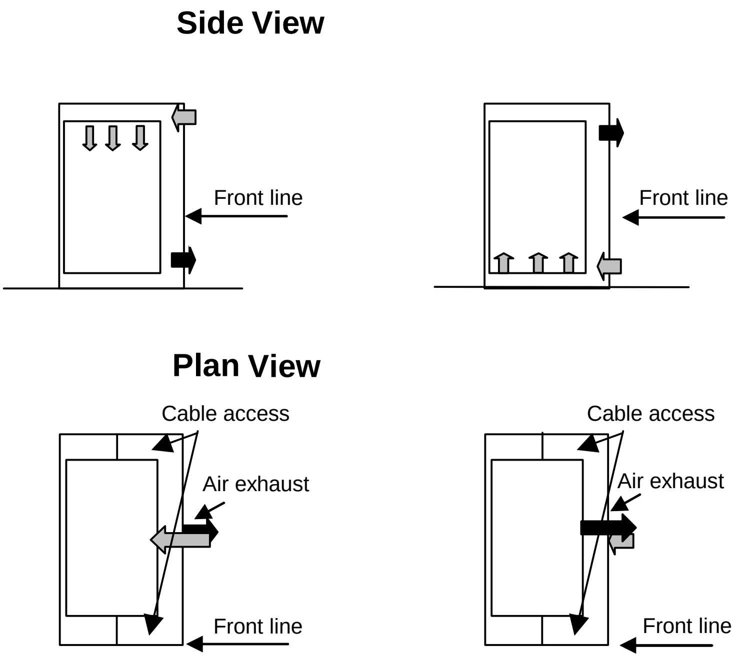

Figure A.1.2a Figure A.1.2b

Either of the above configurations can be placed on a raised floor. The configuration in figure A.1.2b can also use an air inlet in the bottom of the ARCM.

A.2 Multiple subrack cooling

Clause A.2 describes ventilation schemes used for ARCMs with 2 or more subracks installed. The diagrams are examples only and should not be taken to indicate any preference for a particular number of subracks.

A.2.1 Serial cooling

In figure A.2.1a the room air is taken in at the bottom of the ARCM front, up through each subrack and discharged out of the top of the ARCM.

In figure A.2.1b the room air is taken in at the bottom of the ARCM front, up through each subrack and discharged out of the top of the ARCM. There is additional air intake at the base of each subrack.

In figure A.2.1c the room air is taken in at the front of the ARCM via the doors (small holes are punched on the door panels), up through each subrack and discharged out of the top of the ARCM.

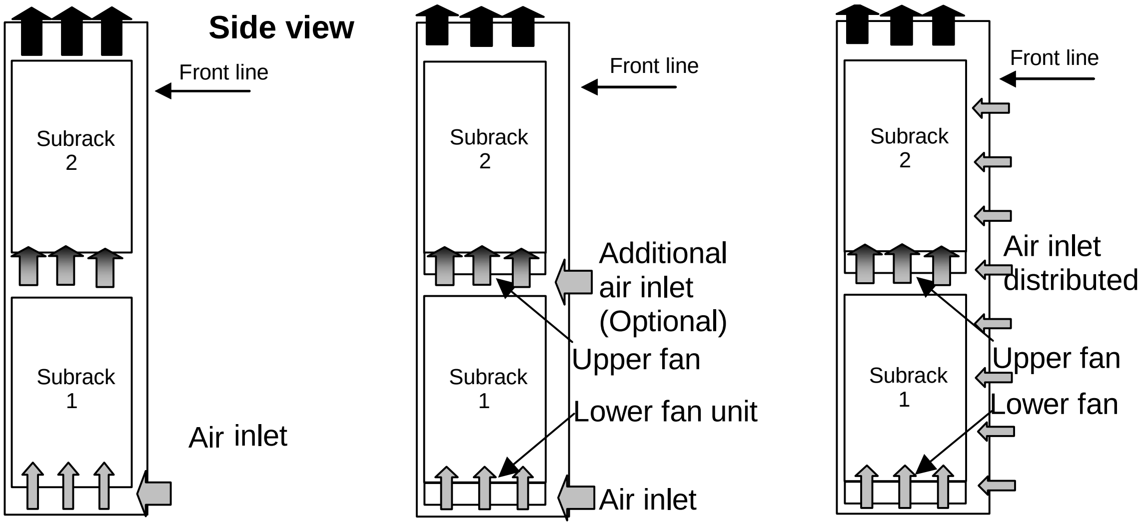

Figure A.2.1a Figure A.2.1b Figure A.2.1c

Any of the above configurations could also have an air inlet in the bottom of the ARCM.

A.2.2 Parallel airflow with air inlet located at the front or the bottom of the ARCM

Figures A.2.2a and A.2.2b present two configurations of ARCMs where air inlet are in front or bottom of the ARCM and outlet are located at the top of the ARCM.

In figure A.2.2a the room air is taken in at the front bottom of the ARCM and discharged from the subracks, mainly to the sides of the ARCM, and is discharged out of the top of the ARCM.

In figure A.2.2b the room air is taken in at the front of each subrack and discharged from the subracks, mainly to the rear of the ARCM, and is discharged out of the top of the ARCM.

NOTE 1: Air from lower subracks is prevented from entering the higher subracks by baffles. Air from the top subrack may be discharged out of the top of the ARCM.

NOTE 2: In both figures, the room air could be taken in from the bottom of the front of the ARCM; figure A.2.2b represents the option of air supplied directly from the raised floor.

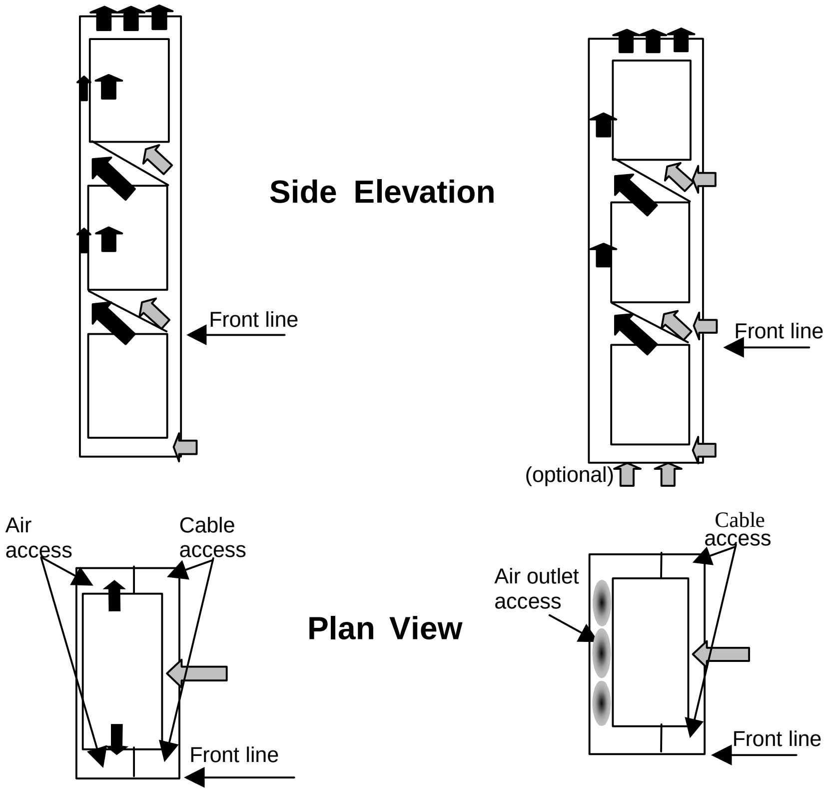

Figure A.2.2a

Figure A.2.2b

Figures A.2.2c and A.2.2d present two configurations of ARCMs where air inlet is in through the front of the ARCM and outlet is located at the top of the ARCM.

In figure A.2.2c the room air is taken in at the front of each subrack and discharged from the subracks, mainly to the sides of the ARCM, and is discharged out of the top of the ARCM.

Figure A.2.2d presents an integration, housing miscellaneous equipment in the same ARCM. The air inlets are located in various places (on the right side, on the front, on the left side, to the bottom). This leads to a complex airflow circulation. For instance, in figure A.2.2d the lower subrack airflow is transversal. For the other subracks the room air is taken in at the front. For the three lower subracks, the air is discharged at the left side, for the others, the air is discharged at the top (with baffles). As a result of this layout the main airflow is discharged at the top of the ARCM between the back of the subracks and the rear of the ARCM. An additional fan unit may be necessary, to enhance the airflow, in this application.

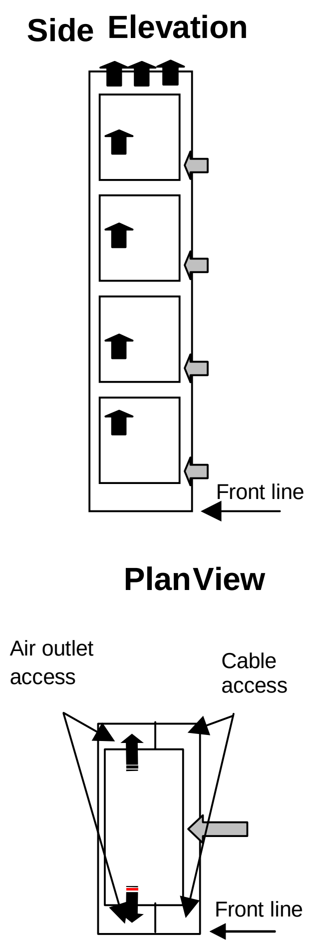

Figure A.2.2c

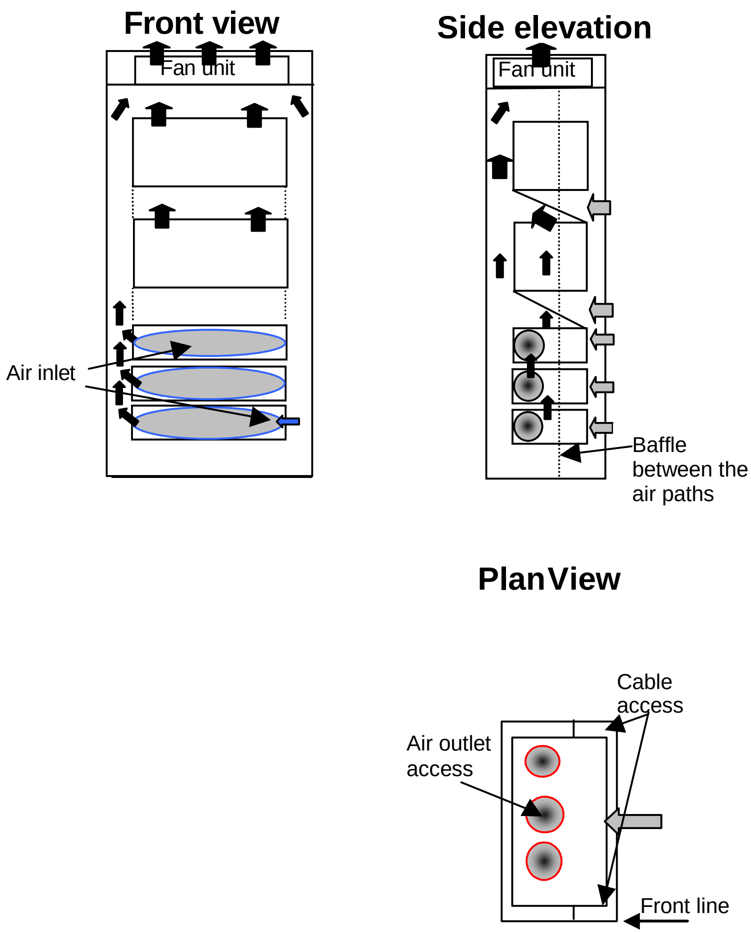

Figure A.2.2d

A.2.3 Parallel airflow with air inlet located at the sides of the rack

Figures A.2.3a to A.2.3c present three configurations of ARCM where air inlet are located at the sides of the ARCM and outlet are located at the top of the ARCM.

In the configuration A.2.3a the room air is taken in at each subrack from the sides of the ARCM (additional extension panel, the rack width is not changed) and discharged from the subrack to the space between the subrack and the front door of the ARCM (it assumed that doors are fitted) from where it is discharged out of the top of the ARCM.

The configuration A.2.3b is similar to figure A.2.3a without extension panel. The side air inlet surface being smaller the power dissipated in the ARCM could be less.

In the configuration A.2.3c the room air is taken in at each subrack from the sides of the ARCM (additional extension panel) and discharged from the subrack to the front (it assumed that no doors are fitted). This option is not recommended.

NOTE: Air from lower subracks is prevented from entering higher subracks by baffles. Air from the top subrack may be discharged out of the top of the ARCM.

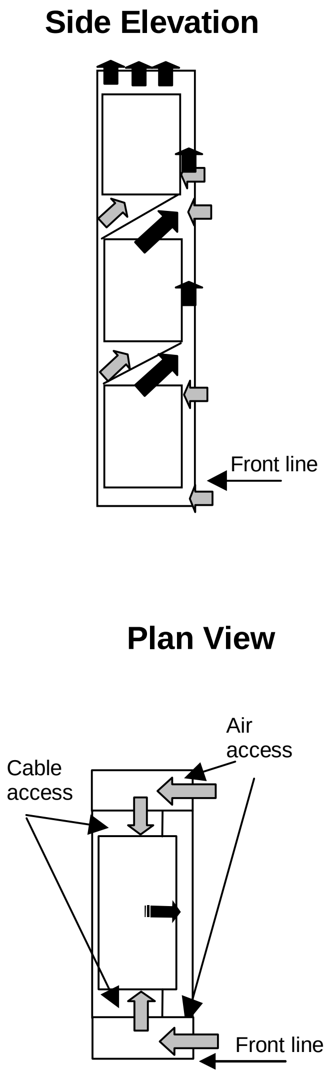

Figure A.2.3a

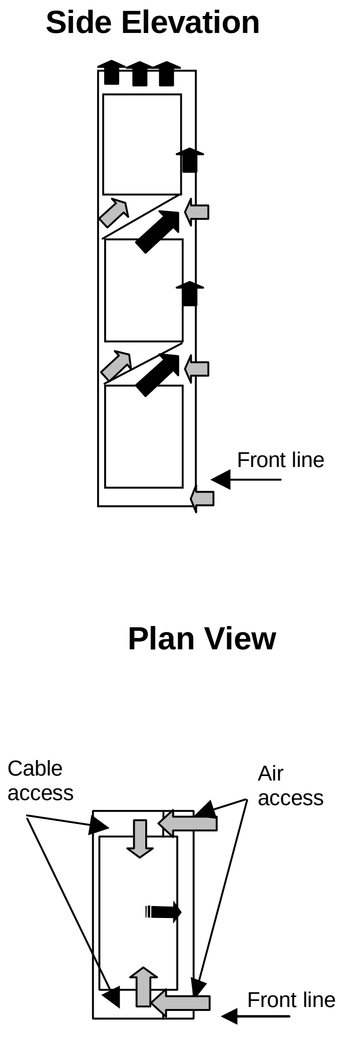

Figure A.2.3b

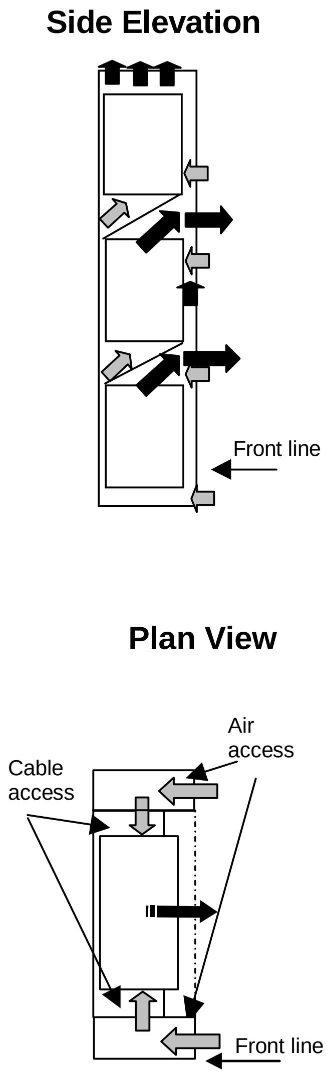

Figure A.2.3c

Annex B: Example of ARCM cooling systems in a room

B.1 Room - serial cooling

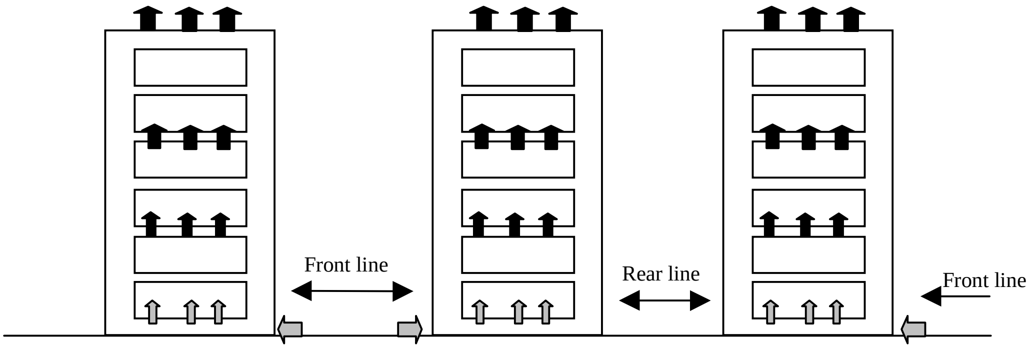

Figure B.1a

In this configuration the room air is taken in at the bottom of the ARCM front, up through each subrack and out of the top of the ARCM.

Air may also be discharged to the top rear of the ARCM.

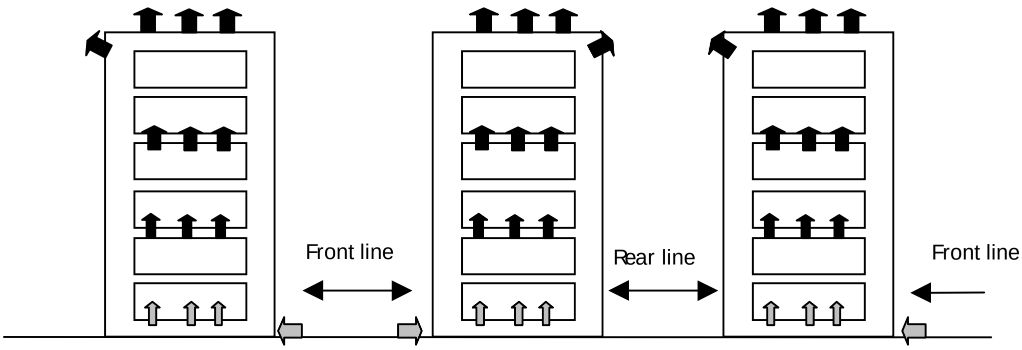

Figure B.1b

B.2 Room - parallel cooling

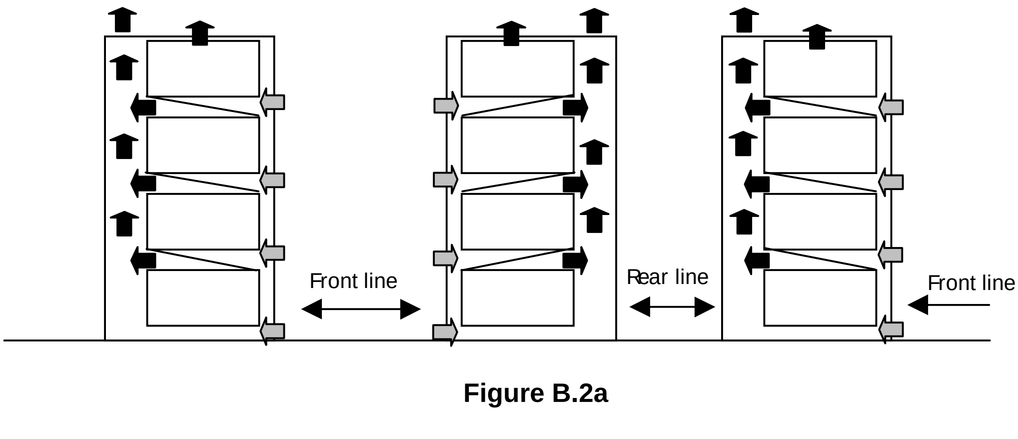

Figure B.2a

In this configuration the room air is taken in at each subrack and discharged out of the top of the subrack to the back of the ARCM and is discharged out of the top of the ARCM. Air from the lower subrack is prevented from entering the higher subrack by baffles. Air from the top subrack may be discharged out of the top of the ARCM.

History

Document history		
V1.1.1	June 2004	Publication