Requirements for the Design of ICT rooms

Best Practice Document

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Executive Summary

This document provides specification of the Norwegian HE sector's recommended requirements for the design of ICT rooms.

An important condition for the efficient functioning of ICT systems is that ICT rooms are of satisfactory quality. Inadequate quality can lead to reduced productivity on the part of the institution's personnel.

The type and number of ICT rooms must be suited to the needs of the institution, whether they be large, advanced server rooms or store-rooms for ICT equipment. In building projects, the allocation of space will often generate conflict between different interests. It is therefore important to analyse the institution's current and future space requirements so that these can be clarified and justified. Space which is allocated will often be fixed for the entire lifetime of the building and it may be difficult to get additional space allocated at a later date.

ICT rooms need to be optimally located in the building complex. In addition to the size of the rooms, one must consider factors related to cable security, fire resistance, noise, heating, electrical fields, conduit paths, equipment transport, floor loads and any extrinsic general building structures.

When fitting out ICT rooms it is important to be actively involved in the design of the rooms in terms of width/depth/height, raised floors, location of equipment racks and room cooling units (including spare capacity), internal conduits, (generic cabling systems and power), control of air currents, lighting, surface treatment of walls, ceilings and floors, access control and fire prevention.

1 Introduction

This document provides specification of the Norwegian HE sector's recommended standards for the design of ICT rooms, and is a revision of Version 2, originally released on 2 July 2008. A revision log will be found in Chapter 6.

The target group comprises IT managers and IT operations personnel in the HE sector. The aim of this document is to raise personnel awareness, and to improve the quality of design of ICT rooms within the sector. Furthermore, it is intended that the recommendations in this document will form the basis of expansion, renovation and new building projects, and that they will be applied in everyday work contexts.

2 General information

In connection with new buildings and renovations it is very important that IT departments are actively involved in the planning process and express their own requirements for space, conduit paths and technology as early as possible. If necessary, technical assistance should be obtained from UNINETT or others. Traditionally, building projects involve struggles for space and funding for equipment, and various interests will often be in conflict. By the time a building is becoming a reality it is often too late to make one's needs known. Hence, in order to ensure the establishment of a well-functioning IT environment it is important that the IT department at an early stage of project planning presents a well-founded argument for being allocated the space, conduit paths and funding for equipment needed to enable the establishment of a well-functioning IT environment. Relevant UFS documents shall be used to form the basis of planning work.

To document space requirements it may be appropriate to carry out a needs analysis, with a list and plan drawings of the different rooms and their furnishing. It is very difficult for other parties to raise objections to an argument which provides documentation of requirements right down to rack level.

In general, it can be said that:

1. Communications rooms and pathways shall last for the lifetime of a building and the institution will have to live for many years with decisions made regarding a building project.
2. Generic cabling systems will have a lifetime of 10-15 years.
3. Network electronics, servers, and so on, have a depreciation period of 3-5 years.

In view of the above, it may be wise in connection with a building project to prioritise areas and conduit paths which will be used throughout the building's lifetime, rather than cables, routers, switches and servers which have a short depreciation period and which sooner or later will have to be replaced.

3 Functional Description of ICT Rooms

The types and number of rooms needed often depend on the institution's size, organisation and requirements for network structure. Basic conditions for room design are also defined by Norwegian standard NEK EN 50173 (Information technology – Generic cabling systems). Below, an attempt has been made to provide an overview of the types of rooms which may be of interest in higher education institutions. It should be pointed out that in smaller establishments, one room or a small number of rooms may be adequate. Most commonly, the functions of a server room, an equipment room and an entrance room are combined in a single room.

3.1 Server room

Server rooms shall generally house servers, backup robots (if no dedicated backup room is provided) and the necessary network electronics for establishing a local computer network in the server room. We recommend the provision of one main and one standby server room, equipped to maintain the necessary functions in the event of the main room being put out of action. If possible the rooms should be located in different buildings. In principle, network electronics relating to the backbone network and the horizontal cabling, as well as auxiliary systems such as access control systems, building management systems and so on, should not be installed in server rooms. Server rooms may also be referred to as "computer rooms".

3.2 Equipment Room – ER

The main function of an equipment room (ER) is to house the termination of cabling to and from campus and building distributors (cf. Norwegian standard NEK NS 50173) located in telecommunications rooms, server rooms and entrance facilities and associated network electronics. Depending on the size of a building or campus, an ER may often be set up in each building. In addition, an ER may also house the termination of horizontal cabling (floor distributor) and be used for the installation of building systems equipment such as access control and fire alarm panels. Equipment rooms may also be referred to as "main telecommunications rooms".

3.3 Telecommunications Room/bay – TR

A telecommunications room (TR) or bay is used mainly to set up floor distributors for the termination of horizontal and building backbone cables, as well as for associated network electronics (edge switches). The number of such rooms is determined by the layout of the building and the maximum extent of horizontal cabling (90 m). In larger buildings one telecommunications room or bay per floor may be appropriate. As a result of the introduction of such technology as PoE and PoE Plus, as well as functions like IP telephony, the telecommunications room is acquiring an increasingly important role in institutions' computing infrastructure. This means that more attention must be paid to infrastructure such as power supply and cooling systems in telecommunications rooms or bays than was previously the case. Telecommunications rooms or bays may also be referred to as "telematics rooms". It is generally not desirable to use bays since these will be of limited capacity which may make the installation of necessary equipment difficult. In a small rooms or bays where it is not possible to set up normal cooling facilities, inadequate cooling may be remedied by means of a fan or ventilation opening in a door.

3.4 Entrance room

An entrance room is used for terminating cable from external network operators (e.g. TDC, BaneTele, etc.). Different communications or service suppliers (PSTN/ISP) may often install networks electronics (operating equipment) which forms the interface with other private or public sector institutions. The construction of separate entrance rooms prevents unauthorised persons from obtaining access to rooms which are of vital importance to the institution and hence contributes to improving the general level of security. In large institutions two entrance rooms are recommended.

3.5 Backup room

In most institutions it may be necessary to create separate rooms for backup facilities, i.e. for housing disks and tape robots. The provision of a dedicated backup room must be seen in the context of the possible creation of an alternative server room (server room 2). The provision of more than one server room allows disks and tape robots to be located in these instead of creating dedicated backup rooms.

The ideal configuration would be two server rooms and two backup rooms.

3.6 UPS/battery room

This room is for the installation of UPS units and batteries for data and telephony installations. Large UPS installations (providing more than 50 kVA and with long discharge time) should be located in dedicated UPS and battery rooms.

Battery rooms shall be designed according to the requirements of NEK EN 50272, "Safety requirements for secondary batteries and battery installations – Part 2: Stationary batteries" Locating UPS units in ICT rooms is not recommended. The use of separate UPS/battery rooms prevents important equipment from being exposed to electrical fields and gases and promotes better uptime and operational stability. UPS rooms shall be equipped with cooling systems.

Smaller UPS units (typically ones intended for rack installation) may be established in computer rooms.

3.7 Generator room

This room shall house a generator for the production of standby power. The room should be located close to the UPS battery room and if possible the room housing the electrical panel. The room must be ventilated and be equipped with an exhaust removal system. The provision of an exhaust outlet may present problems and thus dictate the location of the room. If sufficient space is not available for the installation of generators, they may be installed outdoors with noise-suppressing covers or in containers.

3.8 Electrical panel room for ICT rooms

In larger installations it may be appropriate to provide a separate room or rooms for electrical panels (normal power supply, standby power supply and uninterruptible power supply). The room should be constructed in the immediate vicinity of the UPS/battery room, generator room and electrical panel room.

3.9 Storage room

With storage room we mean a dedicated room for storage of computer equipment. Experience shows that server rooms or telecommunications rooms are often used as storage rooms. This is an undesirable situation which may result in operational interruptions and reduced uptime. For fire safety reasons, rooms adjacent to computer rooms should not be used for storage.

3.10 Support staff room

A support staff room may also be referred to as a console room and enables the configuration of equipment without the need for personnel to enter the server room. A separate support staff room is often needed because the working environment in the server room may be unsuitable for prolonged work sessions. It may also be possible to operate equipment from office workplaces and the need for a support staff room must be assessed based on the individual institution’s requirements.

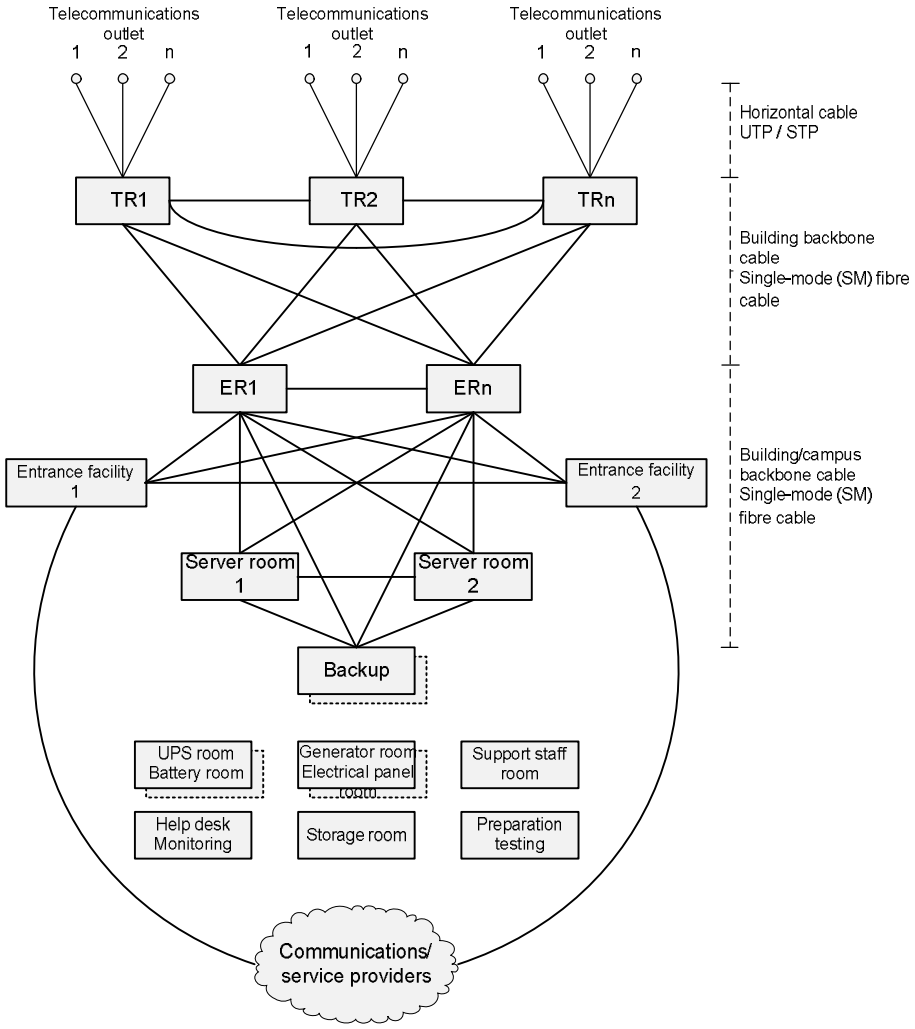
3.11 Preparation / testing room

This room is used for the unpacking, preparation and testing of equipment before it is put into regular operation. The room should be furnished so that equipment can be tested at ER/TR level. The room should also contain a small number of racks for equipment storage, work benches, shelves and some PC workplaces.

3.12 Help desk / monitoring room

In some institutions it may be desirable to create a separate area or room for help desk and operational monitoring functions, i.e. for receiving enquiries from employees and students and for monitoring technical equipment. Help desk and monitoring will normally be seen as a function which can be handled from the IT staff's ordinary workplaces.

The plan drawing below illustrates the various types of room and the connections between them. Note that this diagram shows an ideal situation for a large institution. For smaller institutions one room may often contain several functions but it is important to endeavour to create some redundancy as indicated in the diagram.



4 General Requirements for ICT Rooms

The following is a list of issues which should be taken into account when allocating space for ICT installations. In this section no distinction is made between the different room types and the rooms defined in Chapter 2 are often referred to by the general designation of “ICT rooms”.

1. The sizes of the various types of rooms are determined on the basis of the institution’s space requirements for installing essential equipment such as network electronics, servers, backup robots, telephone exchanges, cooling systems, electrical distribution panels, generic cabling systems, and so on.

2. All ICT rooms should be planned for a minimum of 15 years’ potential growth, i.e. unoccupied space should be set aside in the ICT rooms or adjacent rooms on the same floor plan. In addition, spare space should be pre-fitted with pipes for future room cooling/ice water units. The rooms should be given a suitable, secure location in the building complex, i.e.:

    a. In a basement (above the groundwater line – flooding must be avoided), on a lower ground floor or in a central area. Drains with non-return valves shall be fitted in basement rooms.
    b. Windows should be avoided since these may provide access to intruders (alternatively, windows may be fitted with bullet-proof glass).
    c. The rooms should be located close to the building’s main conduit paths (vertical cable shafts with risers or racks for cable routing and horizontal cable racks) cf. UFS 102 “Requirements for Generic Cabling Systems”.
    d. Solar heating (through roofs or outside walls) should be avoided as it may necessitate additional cooling system capacity and higher operational costs. Ice water machines on roofs should be located in shaded areas behind lift houses if possible, thereby reducing the solar heating of the units themselves as well as heat radiated from roofing felt close to coolant intakes.
    e. Walls, roofs and floors must be of sufficiently solid construction to prevent unauthorised access and to bear the requisite loads. Rooms requiring high load levels (up to 1,500 kg/m²) should be located at basement level, rather than on upper floors which would involve reinforcement of the building’s load-bearing structure (and increased costs). Note that the requirements for soundproofing and fire protection do not automatically mean that a room will be sufficiently robust to prevent unauthorised access. For these purposes, reinforced concrete, reinforced Leca walls or a combination of plywood/plasterboard and steel sheet should be considered.
    f. If free air cooling is to be used to cool small rooms, those rooms should be located close to outside walls to provide the simplest possible access to external air.

External air should also be extracted from the shady side of the building. (The principles of free air cooling are presented in Figure 1 “Principles for free air cooling” in UFS 108 “Ventilation and Cooling Requirements for ICT Rooms”. Free cooling refers to a system in which cold outdoor air, for example in winter, partly or completely replaces compressor-based cooling, cf. UFS 108 “Ventilation and Cooling Requirements for ICT Rooms”. It should be noted that free air cooling is not compatible with the use of hypoxic air venting as a form of fire prevention.

3. Because of fan noise from operating equipment the rooms should be located at a safe distance from permanent workplaces, classrooms, laboratories, and so on. In general, the sound level in server rooms may be high and experience shows that intensity levels exceeding 70 dB have been recorded. The maximum sound intensity threshold level for classrooms is 30 dB. This means that walls abutting to classrooms should have soundproofing with an attenuation corresponding to 50 dB. Penetrations for cable or pipe entry are not permitted in walls with a requirement for 50 dB soundproofing. Supply of 230 V power by way of concealed wiring can be problematical. Ceilings in server rooms should also be fitted with sound-absorbing materials, provided that those materials satisfy the requirements for dust-proofing and can be fitted in such a way that they do not loosen if a fire extinguishing system is set off.

4. ICT rooms and conduit paths for IT cables should be located at a safe distance from installations which emit electrical fields (water, heating and sanitation motors, transformers, lift motors, large electrical distribution grids, and so on). The threshold value for low-frequency magnetic fields in ICT rooms is determined by the requirements of the EMC product standards for IT equipment (ITE) and is defined as 1 A/m ≈ 1.25μT in EN 55024 (CISPR 24). Reference should also be made to UFS 102 “Requirements for Generic Cabling Systems”.

5. According to the guidelines to the technical regulations for the Norwegian Planning and Building Act (VTEK), educational buildings must, irrespective of size, number of floors, and so on, be categorised as Fire Class 1-3. The fire classification is determined on the basis of the potential consequences of a fire in the structure. The consequences depend on the building’s scope of use (risk classification), size and floor plan.

   The fire resistance of the elements of a building is determined on the basis of the building’s fire classification. Constructional elements may have a load-bearing or separating function, or a combination of the two. The fire resistance of building separating elements is designated by the letters R, E or I, and a figure specifying fire resistance in minutes. The fire resistance of structural elements with load-bearing function is designated by the letter R and those with separating function by the letters E and I. The letter R signifies load-bearing capacity, E signifies integrity and I signifies insulation.
   A structural element which only has a load-bearing function, such as a column or beam, may have fire resistance classification R30, while an element with only a separating function may be classified as EI30. A structural element which has both load-bearing and separating function may be classified as REI30.

   All structural elements which abut onto an institution’s ICT rooms shall be constructed as a separate fire cell and shall at all times satisfy the current regulations pursuant to the Planning and Building Act.
   a. The fire resistance of load-bearing structural elements depends on their fire classification:
      i. Fire Class 1: R30 [B30]
      ii. Fire Class 2: R60 [B60]
      iii. Fire Class 3: R90 [A90], non-combustible materials.

b. The fire resistance of separating structural elements (floors, walls and ceilings) depends on their fire classification:
    i. Fire Class 1: EI30 [B30]
    ii. Fire Class 2: EI60 [B60]
    iii. Fire Class 3: EI60 A2-s1-d0 [A60], non-combustible materials.

6. The minimum ceiling height shall be 2,600 mm from the upper surface of a completed floor (ordinary floor or raised floor) to the underside of any ceiling-mounted installations (cable racks, sprinkler heads, light fittings, air ducts, etc.). The only exception is for wire racks for patch cables. There shall be at least 400 mm clearance from the tops of cable racks to the underside of any ceiling-mounted installations. In practice there may be problems fitting out server rooms with a minimum ceiling height of 2,600 mm and the overall height must be assessed based on the number of racks, ventilation ducts and so on. Cf. Figures 4.2 and 4.3. For separation requirements between power supply cables and telephony/data cables, refer to UFS 102 “Requirements for Generic Cabling Systems”.

7. Doors shall be provided which permit the installation of essential equipment. Tape robots are often larger than the following minimum specifications:
    a. Server rooms: Double door, 1200×2400 mm (W×H), without sill. The design of the door and floor must allow the transport of euro pallets.
    b. ER/TR: 900×2100 mm (B×H)

    Doors in separating structural elements must be of the same fire classification as the walls, i.e.:
    a. Fire Class 1: EI_2 30-Sa [B30]
    b. Fire Class 2: EI_2 60-Sa [B60]
    c. Fire Class 3: EI_2 60-Sa – non-combustible [A60].

    Hydraulic door closers are recommended but only obligatory in stairwells.

8. The design of transport areas (height and width of doors, corridors and lifts, strength of floors, etc.) must be such that equipment can be transported between ICT rooms using euro pallets and hand pallet trucks. The height shall be approximately 2,400 mm.

9. In all ICT rooms, walls, ceilings, floors and floors beneath raised floors shall be treated with anti-dust agents and have smooth, washable surfaces. Floor coverings shall have anti-static or conductive properties and shall be earthed to prevent the accumulation of static charges. The resistance between any point in the floor covering and earth shall be from 1 to 10 MΩ, cf. NEK EN 50174-1:2009.

10. All ICT rooms shall be fitted with good work lighting. Light fittings shall be installed so as to illuminate the outsides and insides of racks as well as between racks. Some light fittings should function as emergency lighting in the event of failure of the normal power supply. Requirements for light intensity:
    a. Horizontal plane: 500-800 lux.
    b. Vertical plane: 200 lux.

11. With respect to EMC, all cable penetrations shall be limited to a small area of a wall. Separation requirements are as specified in NEK EN 50174-2, cf. UFS 102 “Requirements for Generic Cabling Systems”. External and internal conduit paths (cable racks) shall be electrically isolated from each other. (cf. UFS 107 “Power Supply Requirements for ICT Rooms”).

12. In ICT rooms classified as server rooms, ERs and TRs, separate conduit paths (racks) shall be constructed for electrical power supply, generic cabling and patch cords. Separation requirements are as specified in NEK EN 50174-2, cf. UFS 102 “Requirements for Generic

Cabling Systems". In larger server rooms it is often standard practice to lay telephony/data cables on racks beneath the ceiling and power cables on racks beneath the raised floor (as this provides good separation). Routing of cables must be assessed in connection with the transport of cooling air and the routing of pipes to the room cooling units. It is important that installations beneath raised floors do not block the circulation of cooling air. Cf. the diagrams in Chapter 4.

13. Raised floors are recommended in larger server rooms to facilitate the distribution of cooling air, electrical power, telephony/data cables and water for room cooling units. The heights of floors are designed on the basis of the requirements for the supply of air, electrical cables and pipes. Separation requirements are as specified in NEK EN 50174-2, cf. UFS 102 "Requirements for Generic Cabling Systems". The recommended minimum height is 400 mm (the actual height must be calculated on the basis of cooling requirements or the circulation of cooling air, cf. UFS 108 "Ventilation and Cooling Requirements for ICT Rooms". When constructing a raised floor, the sub-floor should be lowered so that the raised floor is at the same height as the floors in adjacent rooms, such as corridors. Ramps for access should be avoided as these hinder the transport of equipment on euro pallets using a hand pallet truck. Raised floors should be designed with the necessary quality to withstand the weight of equipment which is to be installed or transported. In important ICT rooms the load may approach 1,500 kg/m². Normally, floors in teaching or office buildings are designed for loads of 300 kg/m².

    It should be noted that it is possible to establish fully-functional computer rooms without using raised floors, i.e. by using cooling racks and chambers for collecting warm air, cf. Figure 5.10 in UFS 108 "Ventilation and cooling requirements for ICT Rooms". This may be particularly applicable if a traditional raised floor cannot be used because of limited ceiling height at the location.

14. All types of water penetration must be avoided. Pressurised water pipes present the greatest risk. The use of water is only permitted in connection with cooling installations. Floor drains may be fitted but will present a risk of flooding in the event of backing up, and odours if the U-bend dries out. If drains are used, they shall be fitted with non-return valves. Humidity sensors should be installed in floors close to cooling units (to detect any condensation or water leakage) and near any "forbidden through pipes" and drains. Humidity sensors should transmit signals to the building management system. Note that local fire authorities may require water sprinkler installations in ICT rooms if these do not constitute separate fire cells or are not fitted with some other automatic fire extinguishing system (it is expected that ICT rooms will normally be locked and not used by the public).

15. Any through-going water pipes and pipes serving cooling units should be insulated to prevent condensation and the risk of introducing extrinsic earth potential, cf. UFS 107 "Power Supply Requirements for ICT Rooms". If extrinsic installations cannot be avoided or insulated, they should have the same earth potential as the remaining ICT installations.

16. All operating computer equipment, distribution networks and backbone cables shall be installed in racks with access from the front. The following recommendations apply to racks:

    a. Clearance at front: 1500 mm
    b. Clearance at back: 1000 mm
    c. Rack dimensions in server rooms and similar rooms: 800×1000 mm (W×D)
    d. Rack dimensions in ER, TR, bays and similar rooms: 800×800 mm (W×D).

    The amount of clearance is dictated by NEK EN 50174 which states that the "smallest clearance at all surfaces on racks and cabinets where access is required shall be 1.2 m". In small rooms (bays) it may be appropriate to install racks against walls. Before a decision is

made one should ensure that all installation and future expansion can be carried out by access from the front of the rack. In general, the use of bays is not recommended. Figures 4.6 and 4.7 show examples of bays.

Greater depth may be necessary and it is therefore important to check the depth of equipment which is to be installed before selecting racks. The use of open racks as opposed to racks with sidewalls and doors (at front and back) must be assessed according to need, i.e. the type of equipment to be installed and the regulation of cooling air circulation. The distance between racks should also be assessed in connection with ventilation via raised floors.

Note that 800 mm wide server racks may present a challenge with regard to undesirable warm air flowing from the warm to the cold side of the interior of the racks (short-circuiting the desired air flow). This air flow can be difficult to block. In a rack of 600 mm width there is less room for air to pass along the side of the servers and the problem of undesirable warm air is therefore reduced.

17. Cooling units and electrical distribution panels can be installed against walls. There must be sufficient clearance to enable normal servicing and the removal and insertion of defective and new units. With regard to EMC the distance between electrical distribution panel and active or passive ICT equipment should be at least 1,000 mm. If in doubt, the EMC requirements of the equipment should be checked. It is important to make allowance for future expansions by reserving space for new cooling units, larger electrical distribution grids and the laying of cooling pipes and outlets.

18. A large server room may be divided into smaller rooms to achieve better security (cooling, fire protection, etc.).

19. UPS units use valve-regulated batteries which emit gases (hydrogen and oxygen) when the internal pressure exceeds a certain level. When hydrogen and oxygen issue into the battery room, an explosive mixture may arise if the hydrogen concentration in the air exceeds 4% by volume. Battery rooms shall be ventilated so that the hydrogen concentration is always below this level. Battery rooms shall be designed according to the requirements of NEK EN 50272, “Safety requirements for secondary batteries and battery installations – Part 2: Stationary batteries”. Cf. UFS 108 “Ventilation and Cooling Requirements for ICT Rooms”.

    The normal operating temperature for batteries is 20 °C, compared with computer equipment which requires 20-25°C. An increase in temperature of 10°C halves the lifetime of a battery. A shared room for batteries and computer equipment will not be economical owing to the need for increased cooling capacity. Moreover, a shared room will require ventilation which would be unfavourable with regard to fire extinguishing (hypoxic air venting and gas-based extinguishing systems call for airtight rooms).

    In larger battery rooms the use of explosion-proof (EX rated) 230 V equipment should be considered.

20. Only authorised personnel shall have access to the various rooms. Traffic in and out should be logged. It is recommended to provide an access control system which serves all the rooms. Should strict security be required, the need for burglar alarm and video surveillance systems (inside and outside the rooms) should be considered.

21. ICT rooms containing active equipment shall **never** be used as storerooms. Only rooms designated as storerooms shall be used for storing ICT equipment. Inflammable materials should not be stored in rooms abutting to ICT rooms. Automatic sprinkler systems should

also be installed in adjacent rooms and can normally be part of the building's sprinkler system.

22. All ICT rooms should be airtight, i.e. any ventilation must be facilitated using regulated ventilation systems. The use of automatic fire extinguishing systems demands airtight rooms. All cable penetrations shall be fireproofed using approved products and the installation shall be documented. Cf. UFS 108 "Ventilation and Cooling Requirements for ICT Rooms" and UFS 104 "Fire Prevention Requirements for ICT Rooms".

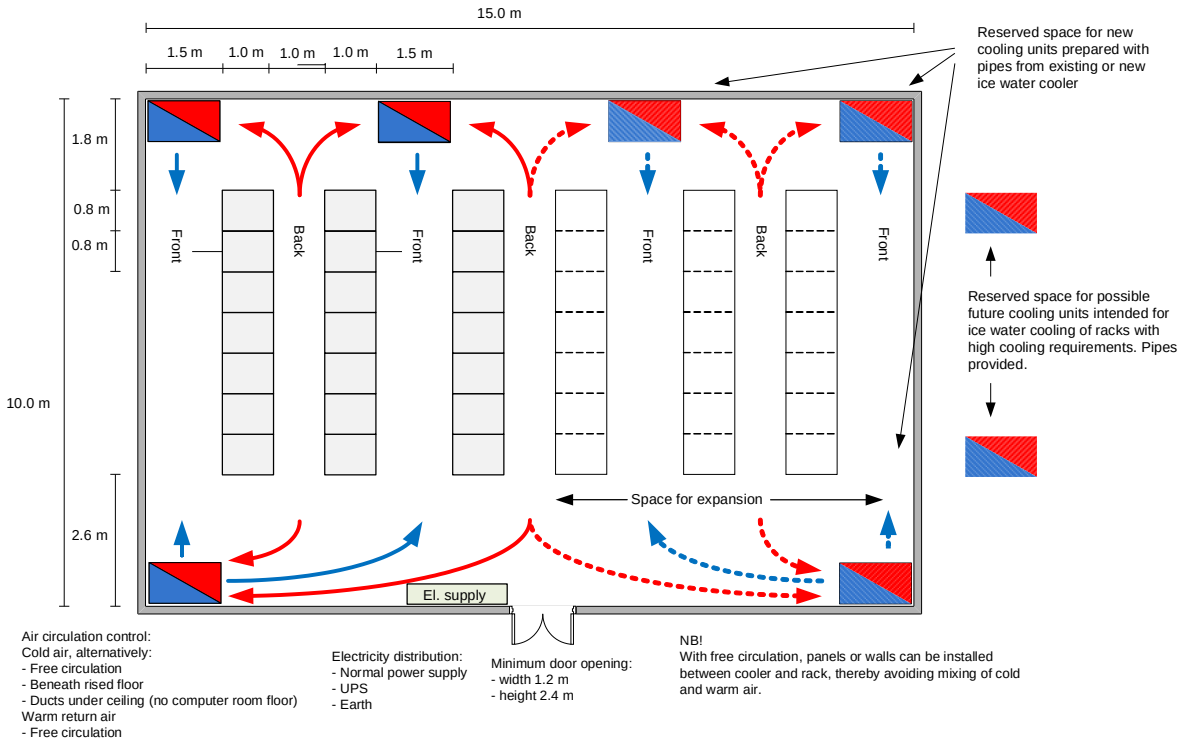
23. Fire extinguisher systems will be particularly relevant in cases where passive measures are unsatisfactory, such as in buildings with high fire energy, in buildings with shafts and channels which are difficult to access and in buildings with large, non-sectionalised floor spaces. For example, a sprinkler system is required if the largest gross area of non-sectionalised floor is greater than 1,800 m² (on condition that fire alarms are installed). A sprinkler system is also required if an open fire cell extends over three floor levels and the combined gross area is greater than 800 m².
    Large buildings are often equipped with sprinklers because this provides greater flexibility with regard to the floor plan.
    In rooms or areas which are not suited to the use of sprinkler systems, other types of extinguishing systems must be used.
    Cf. UFS 104 "Fire Prevention Requirements for ICT Rooms".

5 Schematic drawings of server rooms, ERs, TRs and bays

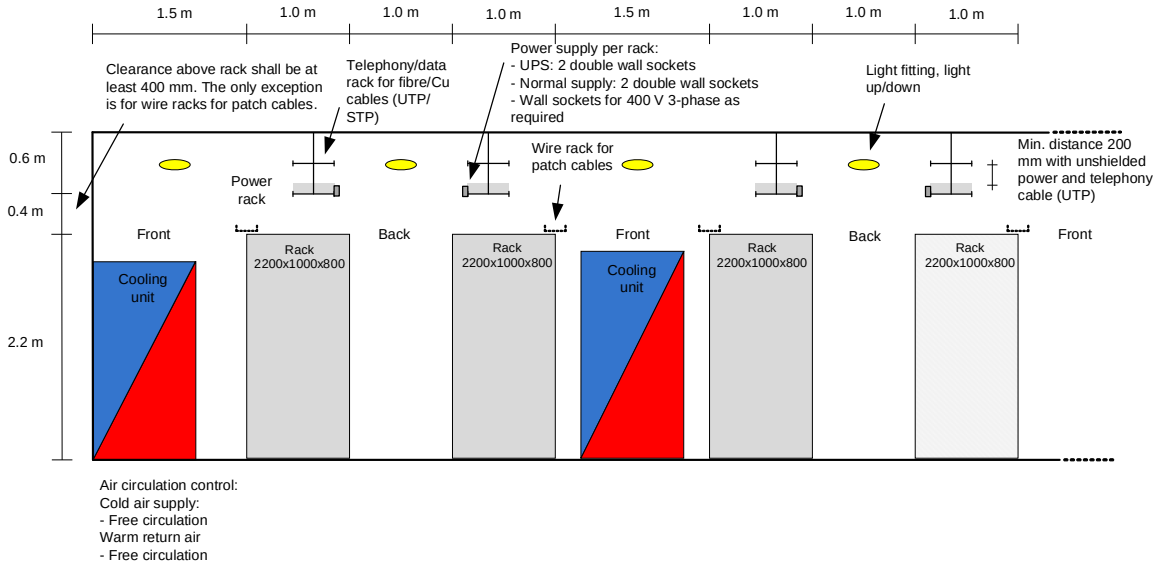
The following plan drawings are intended as examples or illustrations of how server rooms, equipment rooms, telecommunications rooms and bays may be furnished. Information about power supply can be found in UFS 107 “Power Supply Requirements for ICT Rooms” and information about ventilation and cooling in UFS 108 “Ventilation and Cooling Requirements for ICT Rooms”.

In general, the use of bays is not recommended, but may be necessary in connection with rebuilding or renovation. In principle the same requirements apply to bays as to ERs and TRs. NEK EN 50174 places requirements on a free space of 1.2 metres between all rack surfaces to which access is required. In connection with the use of bays, one must therefore ensure that all work can be carried out from the front of the rack. Moreover, bays must provide space for cooling equipment, light fittings, fire detectors, cable racks, etc. As a result of limited area it may be difficult to locate redundant electrical distributors and room coolers.

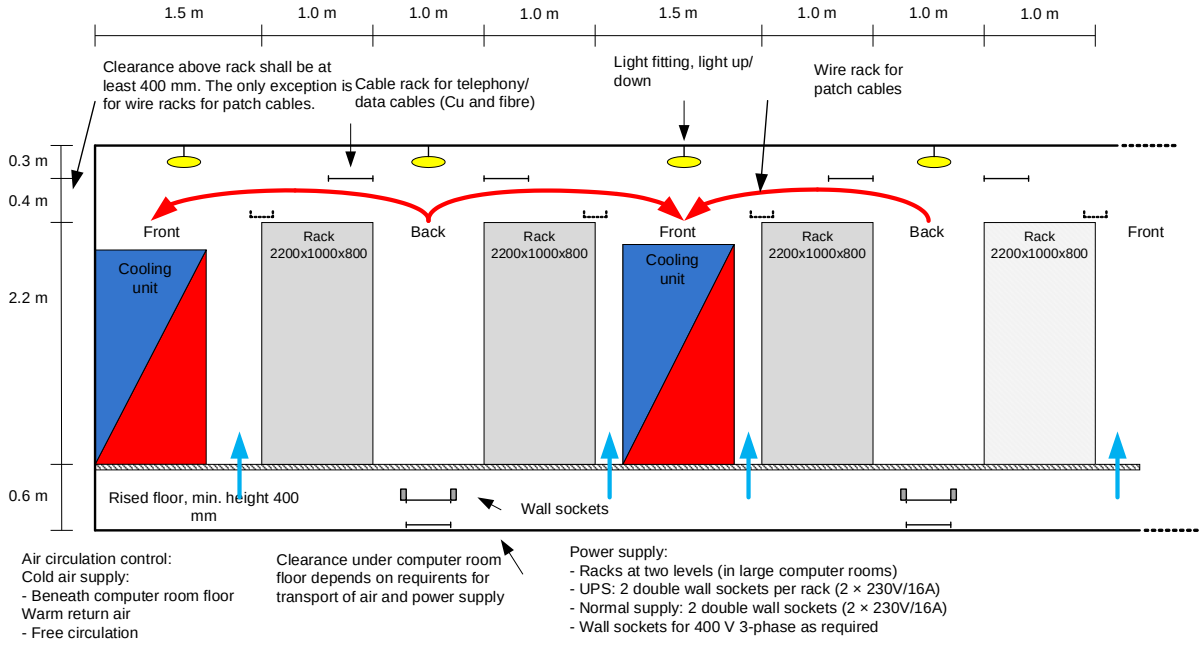
4.1 Server room plan



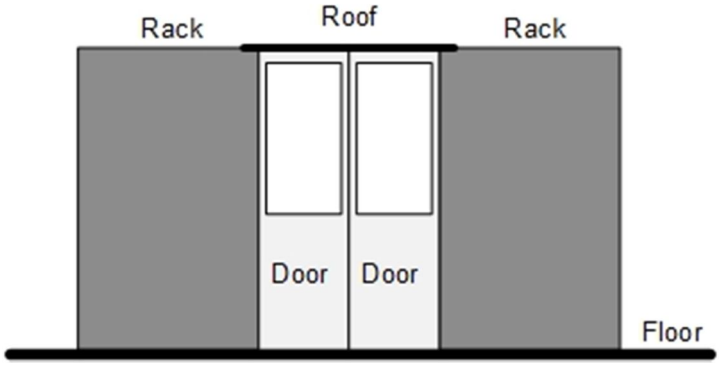
4.2 Server room cross-section, free air circulation



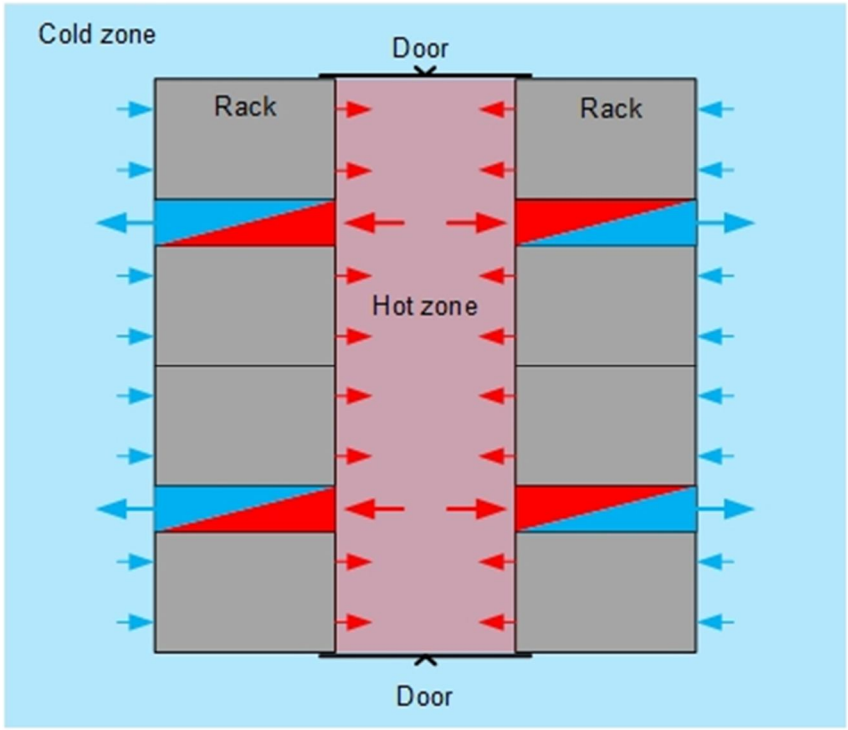
4.3 Server room cross-section, air supply controlled through raised floor



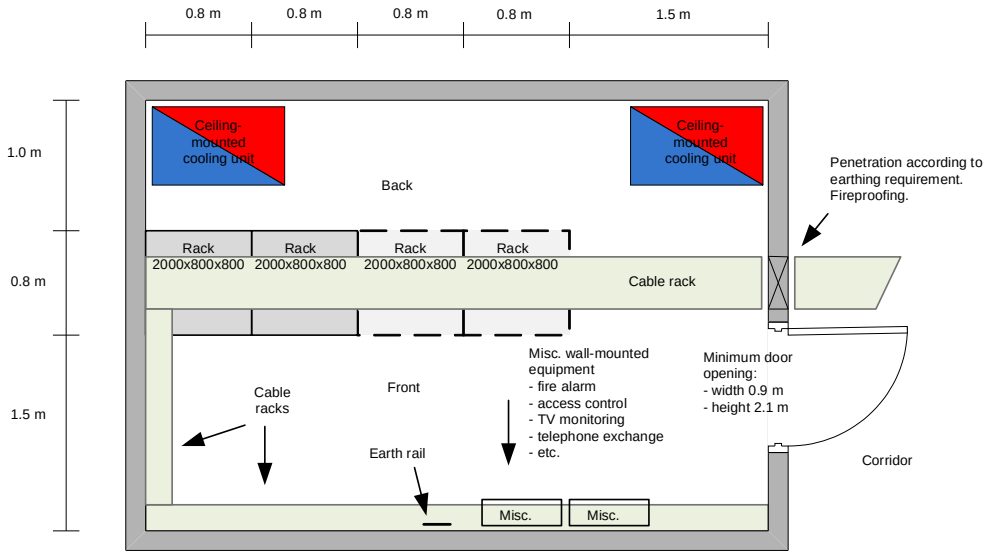
4.4 Alternative server room cross-section, not needing traditional raised floor. Normally there is a cold zone on the outside and a central warm zone. Perspex is used as a “roof” above the warm zone, ensuring a distinct division between it and the cold zone. All pipe and cable pathways will come down from the ceiling.



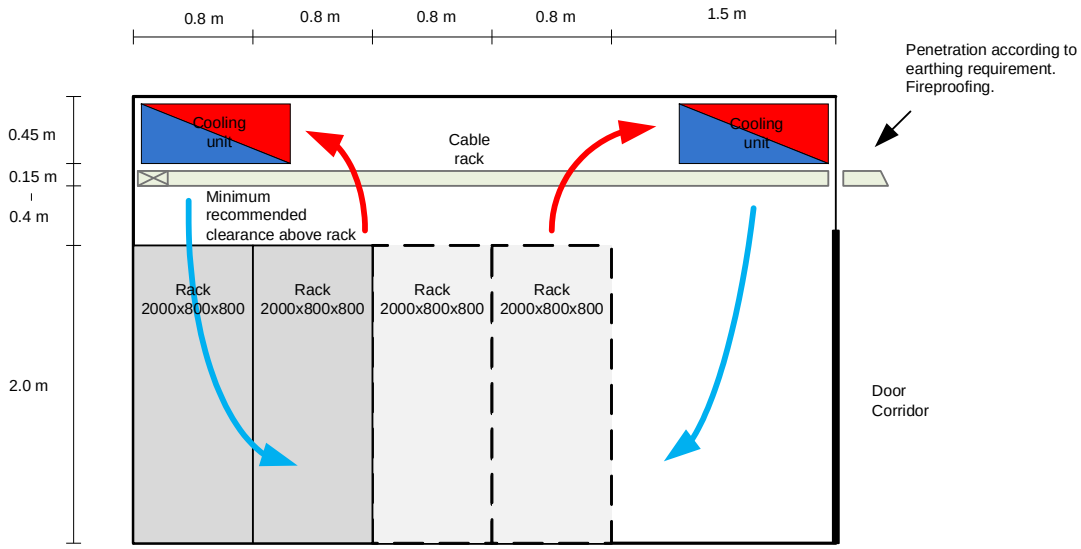
4.5 Server room – a typical example using four in-row coolers, typically scaled as one cooler per 2-3 server racks.



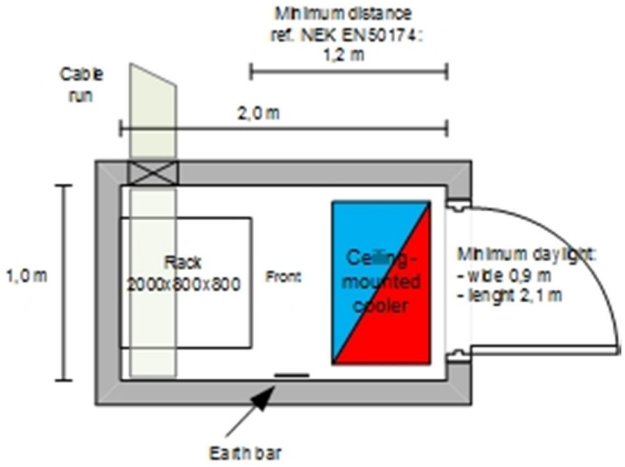
4.6 ER/TR plan



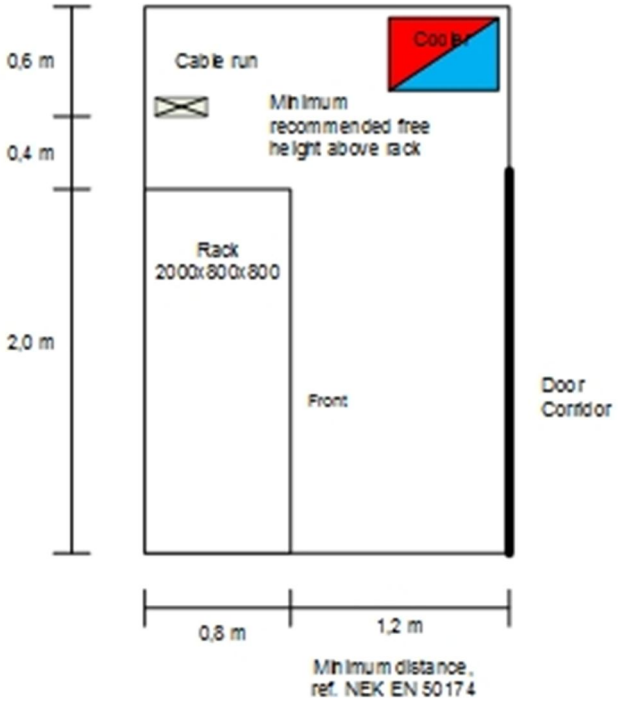
4.7 ER/TR cross-section



4.8 Bay plan



4.9 Bay cross-section



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Revisions

This version includes the following amendments to Version 3:

1. General revision and adjustment of text as a result of experience reported by the sector and technological development.

2. Definition of bay, cf. Chapter 4, Figures 4.6 and 4.7.

Glossary

CISPR	Comité International Spécial des Perturbations Radioélectriques – the Special international committee on radio interference
EMC	Electromagnetic compatibility
ITE	IT Equipment
kVA	KiloVolt Ampere – unit of power for alternating current equipment
Lux	Unit of luminance
NEK EN	Norwegian Electrotechnical Committee European Norm
TDC	Tele Danmark Communication – Danish telephony service provider
The HE sector	The Norwegian higher education sector
UPS	Uninterruptible power supply
VTEK	Guidelines to technical regulations – Norwegian Planning and Building Act
WHS	Water, heating and sanitation
Ω	Ohm – unit of electrical impedance or resistance

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