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# General

## Scope and objectives

This Leading Practice document describes the general design of Electrical Rooms.

The scope of this Leading Practice is to specify general requirements for engineering, design, and construction of new Electrical Rooms, either in new plants or in major expansions of existing facilities.

For existing Electrical Rooms, the requirements in this Leading Practice are recommended.

The scope of this Leading Practice is limited to Electrical Rooms (HV rooms, LV rooms, MCC rooms, transformer rooms, etc.), see attachment A (room type 2-9); it is not dealing with control rooms, IT rooms and outdoor/field installations.

## General Rules

The general rules defined in the Cargill standard "General Specifications" are also part of this specification. The supplier has to inform himself about the content of this specification.

## Normative references

The design, material and performance shall conform to the latest applicable IEC recommendations as well as relevant local/national standards, regulations and codes.

All national standards and legal requirements shall apply.

International, among others especially the following normative documents shall apply:

IEC 62271, High-voltage switchgear and controlgear

IEC 60364, Electrical installations of buildings

IEC 60721, Classification of environmental conditions

IEC 60721-2-2, Classification of environmental conditions – Part 2-2: Environmental conditions appearing in nature – Precipitation and wind

IEC 60721-2-4, Classification of environmental conditions – Part 2-4: Environmental conditions appearing in nature – Solar radiation and temperature

IEC 61936, Power installations - Common rules

ISO/IEC Guide 51, Safety aspects - Guidelines for their inclusion in standards

IEC 61010, Safety requirements for electrical equipment

# Definitions

**Electrical operating area**

Rooms or areas, which are mainly used for operating electrical installations and which are as a rule only entered by instructed persons.

**Closed Electrical operating areas (Electrical, instrumentation or DCS/PLC rooms)**

Room or location only for operation of electrical installations and equipment to which access is to be restricted to skilled or instructed persons or to lay personnel under the supervision of skilled or instructed persons, e.g. by opening of a door or removal of protective barrier only by the use of a key or tool, and which is clearly marked by appropriate warning. Equipment which don’t have a relation to the electrical room or equipment are not allowed to be installed in electrical rooms e.g. process item, drawings cabinets, storing of material, etc.

**Electrical equipment**

Any item used for such purposes as generation, conversion, transmission, distribution and utilization of electrical energy, such as machines, transformers, apparatus, measuring instruments, protective devices, and equipment for wiring systems, appliances

**Types of installations - outdoor**

Outdoor installations: Electrical installations which are outdoors

Outdoor installations of open design

* Installations where the equipment does not have complete protection against direct contact and is directly exposed to the weather

Outdoor installations of enclosed design

* Installations which provide full protection against direct contact and whose enclosure provides direct protection from the weather

**Types of installations - indoor**

Indoor installations

* Electrical installations within a building or room in which the equipment is protected against the weather

Indoor installations of open design

* Installations where the equipment does not have complete protection against direct contact

Indoor installations of enclosed design

* Installations where the equipment has complete protection against direct contact

**Crash bar**

A crash bar is a mechanism for unlatching a door, consisting of a metal bar fixed horizontally to the front of the door and hinged. It is operated by pushing on it, which unlatches and opens the door. The alternate term "panic bar" to Crash bar implies a similar meaning.

**Computer floor (Raised Access Floor)**

Computer, false or raised floor is a system consisting of panels and supports. Each panel is carried by the supports and may be opened to gain access to the space under the floor.

# Design

## General Design rules

All electrical power installations and control equipment must be installed in dedicated rooms with physical access controls as defined in this standard.

Exceptions are electrical installations of package units, although it’s also highly recommended to install these cabinets also in Electrical Rooms.

Rooms of different electrical functionality should not be mixed e.g. separate rooms for transformers, batteries, HV, LV and instrumentation are needed.

Access to restricted areas (e.g., instrumentation, DCS, MCC, HV switch rooms, etc) shall be controlled in such a manner that access is allowed only to authorize people, by locking.

Electrical rooms shall be located in areas that are unlikely to experience serious man-made accidents (chemical spills, dangerous release of hazardous materials, etc.) and related problems.

## Room Dimensions

**General remarks for the selection of the width, length, and height of the room**

An Electrical room cannot properly be design before the switchgear and support requirements are established. Always consider transport of switchgear parts when selecting height and width:

* Door width, height
* Transport aisle; width; angles, Lighting fixtures height
* e.g. hoist system with a lifting capacity equal to the heaviest installation components

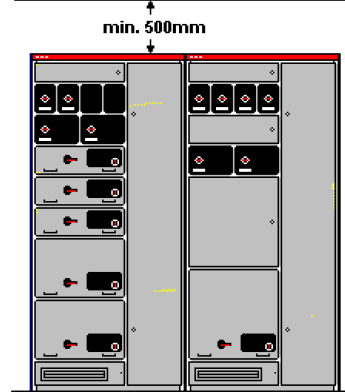
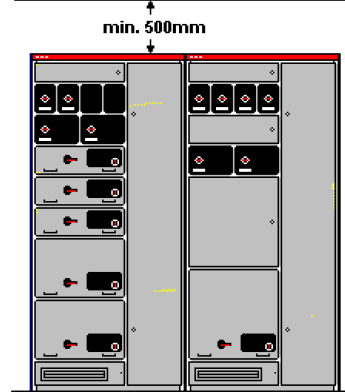
Take into account extension possibilities (e.g. one bay for LV/HV switchboards).   
Always allow for later exchange by devices other manufacturers (especially for transformers) with different output, more weight, other dimensions and different noise generation.  
The minimum distance wall to switchgear is 80 mm or more if required by a LV switchboard manufacture (e.g. Siemens Switchgear S8 minimum distance is 100 mm). This to prevent corrosion protection and increase heat exchange.  
No reduction of the minimum aisle width is allowed by any objects projecting into it, e.g. fixed-mounted operating mechanisms, switchgear trucks in disconnected position.  
For extensions: aisle width of existing switchgear is admissible.

**General remarks for the selection of the height of the room**

Always observe direction of pressure relief in case of internal faults when selecting the height (especially for HV)

A minimum vertical clearance of 500mm shall be present above the highest equipment section measured to the bottom of the lowest roof beam.

To be able to mount the last left (or right) cubicle, the distance between the end cubicle and the left (or right) wall must be at least 150 mm or more is needed



Cable floor Min. 800 mm

Installation aisle behind closed switchgear or switchboard 600 mm recommended  
(Germany > 500 mm)

closed cabinets

front access

front access

Doors must close in escape direction or must only be opened so wide that an aisle width of min. 500 mm (Italy > 900 mm) remains.

Min. operational aisles of 1200 mm (legal requirements are different per country) due to add. safety and maintenance friendliness for take-out of drawer, circuit-breakers, etc.

The distance from the upper edge of the (highest) cubicle to the ceiling shall be at least 500 mm for cubicles, which are resistant to accidental arcs

To be able to install or remove the last cubicle, the distance between the and cubical and the next object (the wall or other MCC) must be at least 150mm

> 80 mm distance to wall in case of metal-enclosed switchgear or more if required

*Note: For CASC EMEA/ GEOS EMEA area, the minimum cable floor height can be 2 meters and shall be discuss with Cargill engineering team/user. See for examples Appendix B.*

## Location and Installation of Electrical room

Electrical room location inside a plant must be:

* Not affected by groundwater to be above 500-year flood zones, rooms must be always dry and sealed against penetrated water.
* Close vicinity of MCC’s to transformer rooms for economic reasons (less cables, lower installation expenditure) and for technical reasons (less losses).
* Room shall be in/close to the load centre of the serviced process area for short distances to consumer, e.g. MCC - motor
* Low noise emission on surrounding (avoid cost extensive noise filters), specially for transformers
* Free from vibrations and shocks. Avoiding the neighbourhood of vibrating machinery
* Where applicable, requirements for earth quakes shall be considered, according to local rules.
* In a safe zone e.g. no Atex zone. Protected from harmful gases, vapours (e.g. chlorine) and dust. If an MCC or I/O rooms has a wall adjacent to an Atex zone than the design must follow the 203J document

Easy access from outside:

* Easy and safe transport of electrical equipment (adequate size of doors and routes; less corners)
* Especial attention is needed for landing platforms for equipment. This must be specified.
* Good and safe accessibility for installation, operation, regular checks and maintenance
* Considering later exchange/replacement/extension of equipment (spec. for transformers, batteries, switchboards)
* Adequate transit clearance
* Consideration of opportunities for cable routes and entrances
* Easy access for fire fighting
* Electrical rooms shall be located so that there is no necessity to enter but for purposes that are directly involved with the equipment inside. Only entering only for installation, maintenance or operational reasons and not for “normal traffic” from one process area to another area.

Room shall have at least one outside wall for:

* Transportation of cubicles (installation, extension)
* HVAC and fresh air ventilation equipment
* Feeding lines from other cables do not need to cross process buildings
* Explosion relief

Personal entrances shall be from outside only1 (w/o crossing process area)

* Less contamination in the room
* Electrical room cannot be used as shortcut – no unnecessary crossing of electrical rooms
* No unnecessary crossing of process area for electricians (safety)

*Note1: not applicable for control rooms*

No process area on top of electrical rooms because problem with water, chemical spills, dangerous release of hazardous materials entering through ceiling and/or vibrations. Very wet processes (e.g. hot well tanks that are designed to overflow) shall not be located adjacent to MCC walls.

Ground floor preferred because of direct access to ground cables and safety (no stairs necessary)

Electrical rooms ground- or cable floor should be elevated above any flood zone and external ground, with a min. height of 10 cm or more:

* Reduced flooding risk (process water, river, rain)
* No digging work during construction phase necessary

No process equipment shall be mounted close to the electrical room (minimum distance from the wall required, e.g. 0,5 m) for to provide free space for cable trays. Also, there will less contamination or heat from the process to the electrical room.

Especially for battery rooms the floor shall be resistant to the effects of spilled electrolytes (sulphuric acid, potassium acid)

|  |  |  |
| --- | --- | --- |
| Preferred | Pro:   * Complete separated * Entrance from outside process area * Not usable as short-cut to the  process area via the electrical room | Process area  Electrical room |
| Acceptable | Pro:   * At least one outside wall * Entrance from outside process area * Not usable as short-cut to the  process area via the electrical room | Electrical room  Process area |
| Not acceptable | Pro:   * At least one outside wall   Cons:   * Entrance from inside process area * Usable as short-cut to the process  area via the electrical room | Electrical room  Process area |
| Cons:   * No outside wall * Entrance from inside process area | Electrical room  Process area |
| Cons:   * No outside wall * Entrance from inside process area * Usable as short-cut to the process  area via the electrical room | Electrical room  Process area |

|  |  |  |
| --- | --- | --- |
| Preferred | Pro:   * The electrical room is built on ground level, which is preferred. * Cable floor is higher than ground level | Electrical  Room  Cable floor |
| Not acceptable | Pro:   * The electrical room is built on ground level, which is preferred.   Cons:   * Cable floor is lower or equal to  ground level | Electrical  Room  Cable floor |
| Preferred | Pro:   * The electrical room is built on ground level, which is preferred. * A second electrical room on top of an electrical room is allowed. | Electrical  Rooms |
| Not acceptable | Cons:   * It is not allowed to have process  area’s above electrical rooms due to leakage from process areas * Electrical rooms are preferred on the ground floor due to entrants of  ground cables. | Process area  Process area |

## Construction of Rooms

The electrical room has to be constructed that:

* All safety aspects are considered, e.g.
  + Fire resistance of walls, floors, ceiling and openings
  + Limited length of escape routes
  + Only even floor/no steps inside electrical room
  + Escape doors
* All GMP-aspects are realized, e.g. smooth walls and roofs, no openings in the ceiling.
* All functional aspects are considered, e.g. height, width, length, cable floors and pressure relief.

### General structural information to discuss with Cargill Civil Engineering

An Electrical room cannot properly be design before the switchgear and support requirements are established:

* Aisle widths for control, transport and assembly
* Operation and maintenance areas, i.e. aisles, escape/transport/access routes
* Landing platforms for equipment (for getting equipment in and out)
* Main dimensions of the station components
* Load specifications
* Doors, gates with type of opening and type of fire-preventive or fire-resistant design
* Walls, roofs and ceilings
* Ceiling and wall openings for cables, pipes or conduits
* Information on compartments with special equipment
* Information on building services
* Ventilation, air-conditioning information
* Floors including steel base frames. Space in front of dry transformer must be reserved. The floor shall be able to carry the load of the transformer when placing or to pull the transformer out.)
* Foundation and building earth switches
* Lightning protection
* Drainage
* Further requirements if dielectric fluids are used (protective measures)

### Material and Construction

The room shall be constructed to provide:

* To fulfil the requirements of the Cargill ‘Fire Protection Guideline’ from EHS and GRC for example 203J
* Only non-flammable materials must be used for all load/stress-bearing parts.
* All openings in walls and floors shall be protected with approved fire doors or shutters rated at least equal to the fire rating of the wall or floor containing the opening
* Construction must withstand mechanical stresses to be expected and internal pressure, which might be caused by internal fault.
* Materials for walls, ceilings and floors must not be damaged by moisture.
* The walls shall be insulated against high temperature differences to avoid condensation.
* No penetration by water, condensation restricted to minimum.

### Walls

* Adequate mechanical strength regarding static and dynamic loads during normal operation and in case of internal faults. Walls and load-bearing structures must be of solid construction.
* Passages for drain, process equipment, ducts, pipes etc are not allowed.
* Outside panelling of walls must be secured against removal and made of materials resistant to atmospheric influences (i.e. rain, sun, corrosive atmosphere etc.)
* Surfaces of walls as smooth as possible to prevent dust from accumulating
* Brickwork must be plastered
* Concrete walls can remain unfinished but shall be smoothened out and painted
* Surfaces of walls abrasion -resistant
* Walls shall be painted
* Especially for battery rooms walls shall be painted with acid-resistant coating that does not release toxic vapours.

### Openings

* All openings shall be protected with approved fire doors or shutters rated at least to the fire rating of the wall, floor or ceiling containing the opening.
* Any openings created to accommodate pipes tubes, conduits, vents, wires, electrical cables and other penetrates must be fire stopped by filling the openings with concrete, to the full thickness of the wall or floor shall be protected by the use of a properly installed and approved penetration seals. There shall be no openings in the roof.
* Cargill Specification “Holes and Penetrations” describes the minimum requirements of Cargill for these works

### Roof and Ceiling

* Adequate mechanical strength regarding static and dynamic loads during normal operation and in case of internal faults. Roofs, ceilings and load-bearing structures of solid Construction. No plaster under the Roof, so switchgear parts are not subject to falling plaster. The ceiling must be Smooth and abrasion-resistant. Concrete ceilings can remain raw. Especially for battery rooms walls shall be painted with acid-resistant coating that does not release toxic vapours.
* Painted with an acid-resistant coating that does not release toxic vapours

### Window

Electrical rooms shall not have windows, except type 11 and 12 control rooms. Windows are not allowed for:

* Operational reasons
* Natural ventilation,
* Lighting reasons
* Pressure relief (in case of internal failure).

### Doors

There are only two types of doors defined:

* Personal Access door standard size.
* Double leaf equipment doors with a minimum height of 2500 mm and width of 2000 mm or as big as the largest assembled unit.

All doors shall have:

* Safety locks to prevent unauthorized access
* Opening direction: outward, air-tight when closed
* To be opened from inside without key by crash bar ("panic bar") even when door is locked from outside.
* Opening of doors shall be free of obstacles. e.g. with a shelter in case of snow.
* Safety /warning signs outside
* Full perimeter seals, including sweeps to prevent bugs and rodents from entering.
* Automatic closers.
* Fire-resistant material according to EN 13501-1 B and according to EN 13501-2 EI 60-S or EI 90-S (acc. Fire Protection Guideline; see also material and construction)
* Proper gasketing and sealing of doors is needed to prevent air infiltration into a zone during a fire.

For inside doors between same types of room (e.g. LV LV or HV HV) no locks required but all other requirements are still valid.

See for detail information ‘Specification Doors for Electrical Rooms’

The requirement for an “escape door” electrical room are:

* Locations and numbers of the doors shall facilitate the requirements of the emergency exit as defined by local code. Some local codes have specified a maximum length and width of the emergency exit way out of a room and,
* It has to be ensured that an escape route is existing that is not passing or crossing any area with an arc flash energy Cargill Hazard Risk Category 2 (CHRC 2) or greater as defined in E-EP-J100, see [link](https://cargillonline.sharepoint.com/:w:/r/sites/BOSC/ME/PSC/Electrical/E-EP-J100%20-%20Job%20Aid%20-%20Electrical%20Studies%20-%20Rev%201.1.docx?d=w57b687bd0e2b465da599429e6f931de8&csf=1)
* If the escape path includes an electrical hazard that is equal to CHRC 2 or higher, than another escape path is required.Depending on the layout of equipment in the room, this may require two or more doors. The purpose of the doors is to always allow a safe egress. *See Appendix A for examples of escape routes.*
* Generally, a safe escape route should be:
  + At least 1/2-metre-wide and doesn’t infringe upon the space of an open electrical panel door or of a circuit breaker in the maximum extracted position.
  + If the escape route passes the electrical hazard, the ½-meter-wide space cannot infringe upon the CHRC 2 arc flash zone *(Note: escape route passes a CHRC 2 location, assuming the space (isle width) at that location is big enough (isle wide enough) that somebody could pass this area and staying outside the boundary of the CHRC2).*
* The escape route should lead to a place of safety, normally outside and *away* from the building.
* Doors on escape routes must always be available for use without the use of a key.
* Exception on the two-door requirement apply for installations that are usually not accessed while being energized and exposed e.g. oil or dry transformer installed in transformer box area.

### Key System management1

All doors for electrical rooms shall be according the master key plan. The system shall be discussed and agree to fit the plant location.

All keys shall be registered and recorded. Keys shall be prevented of unauthorized key copying

Example of Access key system

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | | **Master key** | **Sub Master key** | **Group key 1** | **Group key 2** | **Group key 3** |
| HV rooms | |  |  |  |  |  |
| LV rooms Plant 1 | |  |  |  |  |  |
| LV rooms Plant 2 | |  |  |  |  |  |
| LV rooms Plant 3 | |  |  |  |  |  |
| Key | Responsible | | | | | |
| **Master key** | The master key typically operates all the locks of all E&I HV and LV  electrical rooms. This key is carried by the people who are responsible for LV  and HV operation like maintenance or engineering personnel. | | | | | |
| **Sub Master Key** | The master key typically operates all the locks of all E&I HV and LV  electrical rooms. This key is carried by the people who are responsible for only LV operation like maintenance or engineering personnel | | | | | |
| **Group key 1** | For operators which after training are allowed to access these rooms | | | | | |
| **Group key 2** | For operators which after training are allowed to access these rooms | | | | | |
| **Group key 3** | For operators which after training are allowed to access these rooms | | | | | |

Note 1: For CASC/GEOS Europe / CSST-Europe and Malt the preferred solution is integrated plant access control system (card access system).

### Pressure relief

In case of an internal failure (arc fault) the arising pressure has to be taken into account for the design of switchboards and buildings.

Dimensions and required pressure relief openings and ducts depend on the switchgear type (open, closed, gas-insulated) and on the short-circuit current.

In most of the cases no expensive additional measures must be taken, as the openings (ventilation) provided for other purposes can be used for pressure relief.

The manufacturer and the user of the switchgear must agree upon the measures to be taken for pressure relief of the building during the planning stage.

### Floors

* Even (steps of sloping floor areas must always be avoided)
* Solid and durable (layer of steel girders, slabs of reinforced concrete)
* Suitable for static and dynamic loads transport of station components
* Floor covering easy to clean, pressure-resistant, non-slippery and abrasion-proof (e.g. stoneware tiles, plastic covering, gravel set in concrete with abrasion-resistant protective coating to reduce dust formation)
* Rubber mats shall only be used for working under tension; no permanent installation
* Different types of floor design:

1. Ground floor installations (for small installation, e.g. SDP, small rooms: width <   
   2.00 m)
2. Cable floor installations (for larger installation, e.g. MCC with 1600 kVA)
3. Cable levels/rooms (for larger installations, e.g. power plants with enough room/available space)

* Minimum load ground floor:
* LV board 1200kg/m2
* HV board 1200kg/m2
* Transformers 3000kg/m2
* Especially for battery rooms:
* Additional requirements for load, esp. point loads to be considered
* Resistant to effects of electrolytes
* Drain for large compartments (cleaning purposes!)
* Sloping floor (drain)
* Neutralization trap between drain outlet and containment system
* Ground leakage resistance ≤ 108 Ω

### Raised floor system

See for detail information Cargill ‘Specification Raised floors’

### Cable Levels/Rooms

* Height between the floor and raised floor or the cable room depending on cable installation but shall be minimum height of 800mm. For CASC/GEOS EMEA and CSST Europe see appendix B
* The cable floor shall be an even concrete floor
* No wall or ceiling plaster (in case of a cable room) required, light coating recommended for dust prevention.
* Partitioning of cable feeds by walls and ceilings (use of fire-resistant barriers with the same class e.g. F60 – as for the wall)
* Power cable conduits must allow space for heat dissipation
* Separate laying of power and control cables (minimum distance 300 mm)
* Holes in the walls must be closed with appropriate means (e.g. hard plaster, fire barrier mortar)
* Cable exit of cabinets at the bottom
* Cable exit of the building shall above ground level

Only

mechanical

protection

cable floor

cable floor

Only

mechanical

protection

### Installation of cable racks in cable floors

Cables must be installed on cables racks in the cable floor:

* to avoid overheating by structured installation; no "spaghetti" of wires
* to reduce fire risk (heat dissipation)
* to be able to add and/or dismantle cables

Installation of cable racks only in two directions (x- and y-direction). Considered enough spare for future extension (cable racks according room size, not amount of cabinets)

MCC1

MCC2

### Earthing/ Equipotential bonding,

Proper earthing must be ensured. Each electrical room must have a connection to the building earthing rod and an equipotential bonding strip.

The equipotential bonding has to be connected to the building earthing rod. This connection shall be marked as ‘building earth’.

All cabinets have to be connected to the equipotential bonding strip.

All metallic structures like supports of cable floors, cable trays, protective screens, etc. have to be connected to the equipotential bonding strip.

Further details see ‘Cargill Specifications Earthing’

### Lighting fixtures

Each electrical room must have proper lighting according to the requirement of the workplace and the safety requirements (emergency escape routes).   
Following criteria for lighting installations have to be considered:

* Size of the room, arrangement of the cabinets.
* Maintenance and operation gangways
* Colour of the surfaces (dark or reflecting surfaces)
* Functionality (normal or emergency lighting)
* Obstacles (duct work, cable trays, etc.)

Special attention shall be given to the placement of the light fixtures towards the location of electrical cabinets but also the accessibility to the fixtures for maintenance and repair. E.g. don’t install lighting fixture above open transformers. The minimum lighting level must be 200 lux, see also “Cargill Lighting Leading Practice”.  
The lighting fixtures in one electrical room must be feed from at least two independent power sources (two different transformers). At each entrance door there must be a switch(es) to turn on/off all lighting.  
The height of the lighting fixtures > 2800 mm.

### Emergency lights

Prior to the location of any safety or emergency exit fixtures, a pre-determined escape route from electrical rooms shall be established.  
This route shall be the safest and quickest means of way out from an electrical room.  
The location of safety and emergency exit fixtures shall be undertaken with a common-sense approach and may require modifications following the complete installation of the room.

Further details see ‘Cargill Specifications Emergency lighting’

### Power outlet sockets

At each entrance door there must be a power outlet socket. The outlet socket system shall be designed such that any working area can be reached with a 20 m flexible cable without passing through doors. The sockets shall be rated 16A, 230V, 1 phase + neutral.  
The sockets shall be protected by 30-mA-RCD (residual-current-protection device).

### Telephone – Communication

Telephone is preferred in all electrical rooms, at least in every building  
Connection to internal net (fileserver) is required, especially where intelligent components are installed (digital protection devices, smart MCC, control rooms, card access system, etc.)

## Environmental Condition and requirements for electrical installations

For electrical rooms type 2-9 (see attachment A) the environment in which electrical systems and parts of systems may be exposed could have a major impact to the lifetime and reliability of the systems.

The key parameters are:

* Temperature
* Humidity
* Dust5
* Vapours (corrosive gasses)

The wrong environment can cause and support the development of corrosion, which at the end could result in e.g. overheating of contacts, malfunction of protection circuits, short-circuits by whiskers.

Adequate cooling, ventilation, heating and proper design of the building as means for creating an indoor climate to prevent condensation, corrosion, reduction of creepage distance and reduction of lifetime of the installed equipment. A proper climatic will give a reliable operation of the equipment.

*Note 5: Pressurization is only required for dust and corrosive atmospheres*

### Standards

The HVAC shall comply with at least the most important and internationally accepted regulations (standards) which are listed below:

* EN 15243 Ventilation for buildings - Calculation of room temperatures and of load and energy for buildings with room conditioning systems
* EN 12599 Ventilation for buildings - Test procedures and measuring methods for handing over installed ventilation and air conditioning systems
* EN 12792 Ventilation for buildings. Symbols, terminology and graphical symbols
* EN 13180 ventilation for buildings - Ductwork - Dimensions and mechanical requirements for flexible ducts.
* EN 13829 Thermal performance of buildings - Determination of air permeability of buildings - Fan pressurization method (ISO 9972:1996, modified)
* EN 779 Particulate air filters for general ventilation - Determination of the filtration performance
* The IEC 60721-1 Classification of environmental conditions lists environmental parameters within the range of conditions met by electrotechnical products when being installed and used.

### General requirements

Design of ventilation ducts and openings must not place personnel in danger of contacting live parts and prevent dangerous penetration of foreign matter/impurities. It shall be possible to do standard maintenance e.g. exchanging a filter without switch off switchboard, transformers etc. duct and HVAC installation shall not be installed above switchboards.

Air vents must be protected against rain or spray water and by anti-bird grates.

Sheet metal covers must also be installed over the vents at heights to about 2.50 m above ground

### Temperature/ Humidity Electrical Room Environment.

Electrical rooms have at least to follow these conditions:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Type of room | Temperature | | | Humidity |
| Max. | max. over 24h | min. |
| LV Rooms HV Rooms | 30ºC | 25ºC | 5ºC | < 70% |
| Auxiliary Rooms IT Rooms | 30ºC | 25ºC | 10ºC | < 70% |
| Battery Rooms | 25ºC | 20ºC | 15ºC | < 70% |
| Transformer Rooms (Indoor) | 40ºC | 35ºC | -5ºC | < 95% |

### Humidity

The average value of the relative humidity, measured over a period of 24 h, does not exceed 70%  
Only for transformer room higher level of humidity is allowed (<95%).  
Condensation can be expected where sudden temperature changes occur in periods of high humidity.  
To avoid breakdown of insulation and/or corrosion of metallic parts due to high humidity and condensation, equipment designed for such conditions and tested accordingly shall be used.   
Condensation may be prevented by special design of the building or housing, by suitable ventilation and heating of the station or by the use of dehumidifying equipment.” (IEC 60721)  
Equipment product standards shall be taken into account.

### Pollution Degree

The pollution degree refers to the environmental conditions for which the assembly is intended.  
For switching devices and components inside an enclosure, the pollution degree of the environmental conditions in the enclosure is applicable. For the purpose of evaluating clearances and creepage distances the following three degrees of pollution in the microenvironment are relevant.

* **Pollution degree 1**: No pollution or only dry, non-conductive pollution occurs.
* **Pollution degree 2**: Normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation may be expected.
* **Pollution degree 3**: Conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation. Standard pollution degree of industrial applications: Unless otherwise stated, assemblies for industrial applications are generally for use in a pollution degree 3 environment. However, other pollution degrees may be considered to apply, depending upon applications or the micro-environment.

The pollution degree shall be pollution degree 1.

### Room Pressurization1,2

Electrical rooms shall be positively pressurized when the access door is closed to prevent dust and vapours entering the room. The standard air pressure shall be 10-15 Pa. The pressurization fan must be equipped with a bag filter assembly. Air shall be drawn from a “clean, dry, dust free, etc.” environment. Not from a hazardous areas or areas with contaminated air. If the air pollutions degree of the “fresh” is too high, then an activated Carbon filtering should be considered. The filter shall be monitored by a delta pressure measurement. An alarm of the Delta pressurement shall be show on the local control cabinet. The control cabinet must be installed in an electrical room. The Fire detection system shall interlock and shutdown all air fans. Also, all openings like air intake and exhaust vents shall be automatic closed. The openings shall have the same fire resistance class (e.g. F60) as the total electrical room.

*Note 1: for transformer rooms with natural ventilation, no positively pressurized room is required.*

*Note 2: for Malt only as recommendation, shall be discuss*

*Note 5:* *Pressurization is only required for dust and corrosive atmospheres*

### Temperature measurement

The electrical rooms must be equipped with continue analogue temperature and humidity measurement, connected to the DCS system. Locally in the electrical room there shall be a temperature indication. Temperature calculation shall be done with the enthalpy method (for take in consideration the ambient temperature in the control loop).

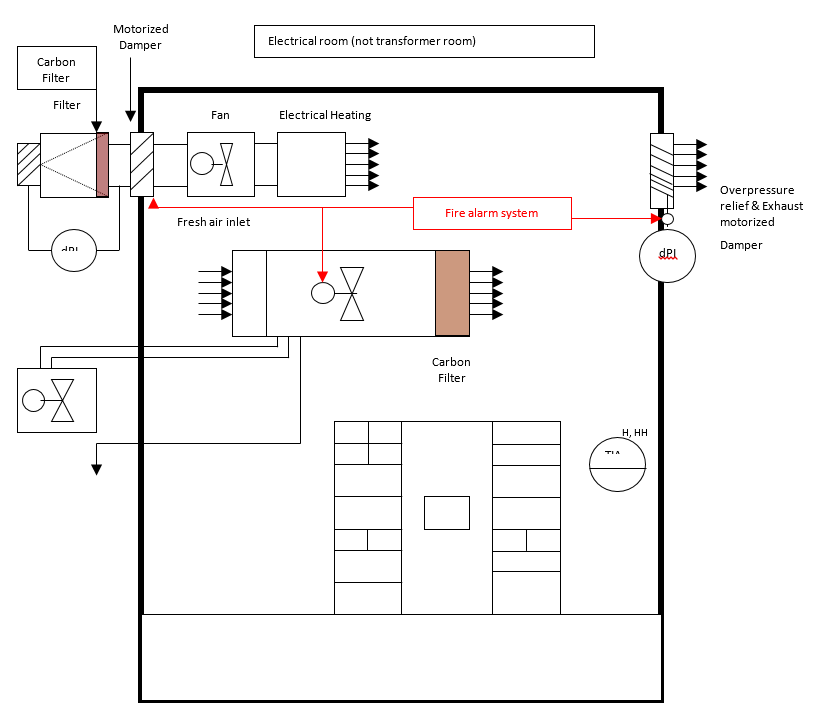
### Air-conditioning units and installations for air-conditioning

HVAC is normally needed to provide specific ambient climate conditions (temperature, humidity, air quality etc) except for transformer rooms where, if possible, force air cooling is preferred.

HVAC shall be of a spilt unit type.

**Central monitoring and control**

The HVAC system shall as a minimum have the following control/monitoring facilities:

* Auto/manual operation selecting
* Start/stop of fans
* Fan and damper status/alarm
* Alarm for loss of pressurisation/flow
* Auto/stand-by selecting facilities for fans
* Facilities for change of setpoints for heaters, coolers, etc
* The system logic shall be equipped with manual reset.

**Field Instrumentation**

The HVAC system shall as a minimum have the following field instruments:

* Monitoring of pressure-drop across filters.
* Temperature indicators in main supply ducts and temperature sensitive areas.

#### **The Fire detection**

The HVAC control systems shall interface with fire detection systems. Signals from the fire system are used to take action to minimize the fire and/or provide safe shut down of equipment and fire dampers.  
Standard sequences shall be:

1. Explosion
2. Pressure relief
3. Stopping ventilation
4. Closing openings/dampers
5. Fire extinguishing

Note: if the stopping of ventilation or the dampers doesn’t close this shall not prevent the Fire extinguishing to be triggered.

**Fire dampers**

All firedampers shall be:

* Actuator operated with spring return (fail safe) via a fuseable link melts and permits the damper to close.
* Closed by direct activation of the temperature sensor.
* Extern operate via fire diction system.

Limit switch for closed indication shall be provided on firedampers.  
The exhaust damper shall also be suitable for pressure relief.

**Metal ducts**

Metal ducts which supply cooling air must be insulated. Duct systems must be tested for leaks and cleaned before being put into service.

## Ventilation flow

### With cable floor

AC

AC

X

X

In principle, no ventilation is needed under the cable floor. Cabinets shall have no ventilation slots at the bottom (avoidance of dust from the cable floor inside the cabinet).

Cabinets shall have ventilation slots at the bottom in the front air conditioning unit over gangways/ beside cabinets ventilation slots at the top (with cover for IP 41)

AC

AC

### Without cable floor

Cabinets shall have ventilation slots at the bottom in the front.

Air conditioning unit over gangways/ beside cabinets with duct to the cable floor.

Ventilation slots at the top (with cover for IP 41)

### Heating

Temperature in Electrical Rooms shall be always above 5°C - to avoid condensation.

Normally the power losses shall always ensure a room temperature above 5 °C. and no electrical heating is required. This shall be checked in any case, but especially for:

* Battery rooms. The lifetime of batteries depends extremely on the temperature range of the environment.
* In areas with extreme climate (outside temperatures below -10 °C)
* When longer shut-down is to be expected (no self-heating by power losses).

Electrical heating:

* Surface temperature of heating elements must not exceed 200 °C. Position of heating elements in such a way that temperature differences > 10 Kelvin are avoided.
* It has to be ensured that the power supply is independent from installed equipment (separate power supply).

### Exceptions requirements on a standard electrical room

#### **Special requirements for SF6 installation**

Natural transverse ventilation in case of switchgear above ground; half of the ventilation section shall be close to the floor (SF6 is heavier than air). Non-manned switchgear rooms are exempted.

It must be possible to ventilate compartments, conduits and the like under/ in connection with compartments with SF6 installations.

Forced ventilation is not required when the gas volume of the largest gas chamber at atmospheric pressure is at most 10% of the room volume. This also includes the gas storage tanks.

Underground rooms require facilities for forced ventilation in case gas shall accumulate in dangerous quantities.

Rooms, wells, pits and ducts that are in connection with the switchgear room must also be ventilated.

Any gas-air mixture close to the floor must also be drawn off.

#### **Special requirements for indoor transformer rooms**

The preferred system for a transformer room is forced ventilation using a clean air source that is not HVAC controlled. If corrosive gases can be near the air intake (forced ventilation) a HVAC system shall be considered.

The fans shall be temperature control. The fans must be assembly with an air filter. The air filter of the filter assembly unit shall able to exchange without power down the transformer.

#### **Special requirements for battery rooms.**

**Safety:**The main objectives of any ventilation system are management of environmental air temperature, humidity and air quality. Where lead acid battery systems are installed, the ventilation system must address:

* Health safety - The air must be free of pollutants that could be toxic, corrosive, poisonous, or carcinogenic
* Fire safety - The system must prevent and safely remove the accumulation of gasses or aerosols that could be flammable or explosive.
* Equipment reliability and safety - The system must provide an environment that optimizes the performance of equipment (including both batteries and electronic equipment) and maximizes their life expectancy
* Human comfort

Battery rooms must have natural or forced ventilation to prevent **Hazardous Gasses.** In general, battery installations could potentially be exposed to the following types of Gasses to some degree:

* **Explosive gas** is hydrogen (H2), which can be emitted by all lead-acid batteries.
* **Toxic gas** emissions are miniscule, but can include arsine, stibine, and hydrogen sulfide.
* **Aerosols and corrosive vapour** that can be emitted during a severe venting event include electrolyte vapour

**Ventilation**

The requirements of a ventilation system must be coordinated with the requirements of a fire prevention and suppression system.

* **Cleanliness of Air.**
* The air intake shall be filter to prevent dust build up on the batteries.
* **Air Changes**
* Measured airflow volume complies with the numerical comparison below  
  (applicable for ventilation of rooms, containers or cabinets in which batteries are operated)
* Q = 0,05 · n · l [m³/h] (n = number of cells, I = current value in A that initiates the development of hydrogen)
* A minimum of two air changes per hour to remove gases generated by vented batteries during charging or caused by equipment malfunction.
* **Natural convection ventilation is preferable above mechanical ventilation:**
* Air ducts (acid-resistant material)
* Chimneys (must not be connected to any sources of fire – danger of explosion)
* The battery room is to be provided with an effective air inlet near the floor surface.
* Incoming/outgoing air vents against prevailing wind (protection from harmful gases, vapours etc.)
* Air inlets are to be provided on at least two opposite sides of the box.
* **Forced ventilation (mechanical ventilation):**
* Fan motors must be protected against explosion and acid-resistant (or installed outside the hazard zone)
* Material of fan blades
* Free of static charge
* Ventilating fans are to be so constructed and be of a material such as not to result in sparking in the event of the impeller touching the fan casing.
* Shall include extractor fans (forced-air fans not advisable (reasons of ventilation technology))
* Monitors are shall be install to detect loss of air movement, fan failure and/or closure of fire/smoke dampers. Any alarm system shall be connected to DCS system

**Weight**

Lead acid batteries are very heavy. Floor loading and ease of handling shall be considered with the building structural engineer.

**Battery Placement:**

**Flooded batteries** are placed into large open racks, which allow heat to dissipate into the room.

**Valve regulated Lead Acid batteries** are usually installed in a cabinet. The cabinet shall allow airflow around each battery container to allow removal of heat by convection or fan cooling. Avoid placing battery racks and/or cabinets near heat-generating sources.

For Valve regulated Lead Acid batteries, nickel-cadmium battery (NiCd) and Nickel metal hydride (NiMH) batteries are allowed to install in all electrical rooms if the ventilation is fulfilling.

Flooded Lead acid batteries shall always be installed in separated battery room due to the “high” gas output.

# Fire Protection / CCTV

Fire protection is a key element to ensure safety and reliability of our plants. Fire protection starts with the selection of the right building materials. In case of a fire, a key element to limit the damage is the earliest possible detection, a quick reaction and the possibility to de-energize the electrical room. The following section describes the requirements for fire protection of the electrical room:

* Fire protection shall follow the recommendations as laid down by the Cargill insurance company in document 203J1 and local code requirements for Electrical Rooms. This requires in particular to have a highly sensitive fire/smoke detection system.
* A camera to allow a remote monitoring of the electrical room should be considered if the required emergency response time as laid down by document 203J cannot be met. This will provide secondary verification of a fire when the fire alarm system goes into alarm.
* The room shall be equipped with the possibility to de-energize the room either remotely (on site) or locally (outside of the room) for non-electricians. The de-energization does not need to be limited to the equipment inside the specific room (e.g. it is possible to de-energizes all transformers in a specific plant area instead). This will provide a method to turn off power before firefighting starts.
* The facility shall have a written response procedure on what to do in case of a fire alarm, which includes criteria when and how to turn off power to the room.
* Cargill’s minimum fire rating of the walls and doors is 1 hour. In some applications and geographies, the minimum requirement is 2 hours.

The following installations are generally not recommended and should only be allowed after separate, written approval:

* Installation of fire suppression system – this is because electrical arcing will continue until the power is turned off.  After power is turned off and the fire is detected in time, local portable fire extinguishers should be able to extinguish the fire quickly.
* Interlock of the fire detection system with the electrical feeder to the room – this is because Cargill has experienced multiple nuisance alarms of fire detection systems and the impact to the production could be very high.

*Note 1: See BU requirements and Cargill Insurance requirements are* [*here*](https://sites.cargill.com/sites/Finance/CFOLinks/insurance/Documents/Forms/AllItems.aspx?RootFolder=%2Fsites%2FFinance%2FCFOLinks%2Finsurance%2FDocuments%2FEngineering%20and%20Inspections&FolderCTID=0x012000614B3D5BC739534A97983A207A969308&View=%7B5D5B32AF-8517-4A66-A711-6F636308D1BA%7D)*.*

* + *Look in folder Guidelines by processing plant type*
  + *Look at document 203J…..*

# Documentation

A proper set of documentation shall be delivered together with the electrical room. The documentation shall be divided into chapters as detailed below and shall have one set of paper and one electronic version per type of switch and delivery. All drawings shall be sizes as readable A4 size.

All documents shall also be available in electronic format as follows:

* Drawings Autocad and Adobe PDF (not read protected)
* Specifications Microsoft Word for Windows,
* Lists Microsoft Excel for Windows,
* Calculations Microsoft Excel for Windows,
* Datasheets Microsoft Excel for Windows,
* Manuals, certificates, declarations Adobe PDF (not read protected)

In case that a document exists in paper format only, it has to be scanned in and stored in PDF format.

1. Examples of excape routes







*Note It is assumed that you would only have one problem at one switchboard a time, so at MCC 1* ***or*** *MCC 2 but not simultaneous. For example, if there is a problem at the first switchboard you could escape at the 2nd switchboard.*







1. Types of electrical rooms

General remark: where mention electrical room it can one of the 12 items

**Item 1, Oil Transformers, outside:**

Areas outside of buildings for oil-liquid-transformers or reactance coils, e.g.:

* Distribution transformers, 0.5 kV or higher
* Block transformers, 5 kV or higher
* Net coupling transformers
* Reactance coils, Etc.

**Item 2, Oil Transformers, inside:**

Rooms inside of buildings for oil-liquid-transformers or reactance coils, e.g.:

* Distribution transformers 0.5 kV or higher
* Reactance coils, Etc.

**Item 3, Dry Transformers:**

Rooms inside of buildings for dry transformers, reactance coils or similar MV-Equipment, e.g.:

* Distribution transformers 0. KV or higher
* Reactance coils
* Short-circuit-limiters, Etc.

**Item 4, High Voltage:**

Rooms for electrical equipment with a normal voltage above 1000 V, e.g.:”

* MV-switchboards like main distribution stations (MDS) or sub distribution stations Stations (SDS)
* Power factor compensation equipment (capacitors and control units), Etc.

**Item 5, Low Voltage:**

Rooms for electrical equipment with nominal voltage above 50 V and below 1000V, eg:

* LV-switchboards like motor control centre (MCC), main distribution panels (MDP) or sub
* Distribution panels (SDP)
* Power factor compensation equipment (capacitors and control units), Etc.

**Item 6, Battery Room:**

Rooms for electrical equipment, which consists under other out of battery systems like:

* Uninterruptible power supply
* Battery systems/units, Etc.

**Item 7, I/O Rooms:**

Rooms for electrical equipment used for instrumentation and input-/output of digital and

Analogue signals like:

* Instrument cabinets
* Marshalling cabinets/ I/O-cabinets
* Auxiliary voltage cabinets, Etc.

**Item 8, DCS Room:**

Rooms for control equipment, which consists under other out:

* Controller cabinets
* Server cabinets
* Bus couplers, Etc.

But also:

* Control units for turbines, burners, etc.
* Protection units e.g. generators, synchronisation, etc.

**Item 9, Cable Basement or Computer Floor:**

Closed areas or rooms mainly used for cable installations, e.g.

* Separate cable rooms
* Inside LV/HV Rooms
* Inside UPS rooms
* Inside I/O Rooms
* Inside DCS rooms
* Inside IT Rooms
* Inside Control Rooms, Etc.

**Item 10, IT Rooms:**

Rooms for IT equipment for office and automation purposes like:

* Computer terminals
* Server cabinets/ Bus couplers/ Network
* Central Telephone
* Cameras
* Access control, Etc.

**Item 11, Unmanned control rooms:**

Rooms, which are normally unmanned, for operating, monitoring and controlling process areas or certain equipment like:

* Process control room
* Power station
* Etc.

**Item 12: Manned control rooms:**

Rooms, which are normally manned, for operating, monitoring and controlling process areas or certain equipment like:

* Process control room
* Power station, Etc.

1. CASC/GEOS EMEA cable floor 2 meters

The cable floor design for BU’s CASC EMEA and GEOS EMEA shall be discuss on for hand with EMEA Engineering & Build Project Organization and/or end users. In general, for large MCC rooms the preferred installation method is cable floor room with a height of 2 meter and shall be discuss with the project team.

* Leading Practice ‘Electrical Room - Raised Asses Floor’ shall not be used for cable floor height above 1 meter, but a self-supporting (steel) construction. See picture examples below.
* In general, the cable floor with a height of 2 meters needs to fulfill all requirements mention in chapter 3 Design of this document for example:
* The floor steel construction shall have an equivalent fire resistance rating as the MCC wall rating.
* an access door and an escape door
* any openings created to accommodate electrical cables and other penetrates must be fire stopped by filling the openings with a properly installed and approved penetration seals
* fire detection

See below some examples of CASC/GEOS EMEA cable floor 2 meters.

Note: *photos below the cable floor height is > 2 meters. The default height shall be 2 meters*



