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VENTILATION AND AIR-CONDITIONING IN ELECTRICAL EQUIPMENT ROOMS

Purpose

This document describes the main features of design and construction of ventilation and air conditioning of electrical equipment rooms in industrial applications.

The purpose of this recommendation is to give the decision-makers an overview of the construction process, and guidance to sources of more detailed information.

Introduction

There has been a lack of "common language" for the design, construction and operation of air-conditioning of industrial electric-, electrotechnical- and control rooms. Requirements for the equipment and its environmental conditions are presented in different standards and guidelines in such a way that many interpretations are possible. For example, a given temperature limit can have been regarded by the end user as an absolute maximum, while the equipment supplier could allow it to be exceeded (within another range) for a short period.

As a result of this,

-in some rooms the environment is too severe, resulting in operational errors and equipment failures, which really can be worth more than the whole equipment

-some rooms are conditioned unnecessarily well in relation to the actual environmental requirements, resulting in high investment costs, due to oversized (or unnecessarily double) air-conditioning equipment, or in high operation costs.

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**EUROPEAN COMMITTEE OF
AIR HANDLING, AIR CONDITIONING AND REFRIGERATION
EQUIPMENT MANUFACTURERS**

Project execution, critical stages

The requirements of ventilation and air conditioning are generally taken into account too late in the design process. Also the design criteria for ventilation and air-conditioning can generally be interpreted in an ambiguous way, or they are too vaguely expressed. This can result in

---unsatisfactory climatic conditions in the equipment rooms, resulting in disturbances or even failures in production processes, or in

---oversizing of the systems, resulting in uneconomical operation

Modern electrical equipment is sensitive to its environment, and if the conditions of the equipment rooms are not properly controlled, there is an obvious risk to even a complete failure in the production process.

How serious can a failure be? In a highly automated process a failure may cause losses in production many times greater than the equipment itself. For example a breakdown of a paper machine can cost up to 30.000 € in one hour.

It is therefore important to

-have the HVAC designer involved from the beginning of the planning process

-define the basic parameters in the very beginning: location and size of the equipment rooms, and also the environmental classes required for the equipment

-in the design process discuss all possible changes in these basic parameters

-to make sure that, at the time of purchase of all electrical equipment, all essential data for system design are included in delivery: heating and cooling loads, target levels for temperature and other indoor air parameters. The target values make the basis for all guarantee values for the systems

-reserve proper time to start-up and commissioning of the HVAC equipment, including all functional and performance checks.

-to update all documentation before the handing over of the HVAC systems, and to go through the documentation and all changes made during the design and construction process.

In its details, the design and construction process shall follow the Design Methodology for Industrial Air Technology.

Main factors in system selection

For electrical equipment rooms, the following items are in normal cases the most essential ones:

-to specify the equipment according to the standardized IEC classification

-to specify the design parameters clearly according to the IEC classification in order to select the most appropriate air-conditioning system and equipment

-to arrange, by structural and ventilation measures, a proper overpressure in the equipment room, to prevent leakages of contaminated air from adjacent spaces

Many other important factors have to be taken into account aswell:

- environmental conditions
- heat loads
- reliability if use of the equipment
- space requirements
- fire protection
- future need of extension
- life cycle costs

Special questions in decision-making

Legislation, standards, guidelines, recommendations

In the "bibliography" the common international references are listed. In addition to this, national norms and standards have to be taken into account.

Fire safety

These issues are described in national regulations and in instructions of insurance companies. Some of the most important details include the spreading of poisonous gases from e.g. cable insulation materials in the case of fire, and reactions during fire extinguishing which may cause additional damage to the equipment. More information e.g. in IEC 721-2-8.

Insurances and reliability

The ventilation and air conditioning shall be planned so that disturbances in the system do not harm the electrical equipment and/or production process. Therefore a risk analysis should be included in the system design. This issue is important in industrial applications like this, because the consequences of failures can cost lots of money. If failures result in a short-time breakdown, the consequences of which partly or completely fall under the owner's responsibility depending on the terms of insurance, attention has to be paid in measures which prevent failures or minimise the risk of a breakdown.

It is essential to assess the risks carefully in advance and make a plan to eliminate or minimise the risks. Depending on the insurance policy, there are different options:

- to duplicate or even triplicate the critical components
- to build a complete reserve system
- to build two or even three parallel systems, each dimensioned for e.g. 80% of the maximum heating or cooling load

Reserve space for later extension

Usually the number of equipment in an electrical equipment room increases in the course of time. This should be

taken into account in design of both the room and the systems. Again, there are different options:

- to design for a later maximum load and to make sure that the HVAC equipment works efficiently also during partial loads
- to add parallel HVAC equipment according to the increased load (modular units)

Permanent workplace in equipment room

This is very seldom the case, but in case this is possible the following has to be taken into account:

- legal minimum requirements for permanent workplace:
- comfort criteria
- IAQ
- acoustic requirements

...vs. target values required for the electrical equipment.

For example, to fulfil the most stringent category for electrical equipment means automatically that the IAQ is sufficient for a workplace, also the temperature is within the required range, but attention has to be paid also on air velocity and noise level.

Structural issues

Pressure conditions play a very important role, because generally all leakages from adjacent spaces increase the contaminant load. The designer shall therefore pay attention to other than HVAC aspects, such as location in relation to spaces with more contaminated air

- penetrations
- doors, windows

Other important structural issues are:

- Thermal insulation in construction materials and equipment
- Structural fire safety in construction materials and sealants

Air conditioning

Basic systems

Basic system solutions are:

- 1. natural ventilation**
- 2. forced extract ventilation**
- 3. over-pressure ventilation**
- 4. cooling with circulated air**
- 5. separate cooling placed to the room.**

Factors that affect on system selection are the position, layout and structures of the room, environmental conditions, heat load in the room, reliability of use of the equipment, need of space, fire areas and costs. If necessary, the need of extension has to be noticed too. A summary about the condition classes that will be reached with different systems is shown in table 1.

Pressure balance

To control indoor air parameters in the electrical equipment room it is necessary to have positive pressure in the room in relation to adjacent rooms. A suitable overpressure is approximately 20 Pa.

Selection of air-conditioning equipment

Items to be considered:

- filter selection
- need for chemical filtering...
- selection of mechanical filtering
- cooling (and its control)
- selection of air diffusion and other equipment

Commissioning

The commissioning includes many stages which have to be carefully planned and scheduled in the design stage, considering the dependence of different measures. These stages include:

- structural, device and installation checks
- performance tests
- test run

Operation, service and maintenance

Key items are:

- Operation and maintenance plan
- Controls and monitoring
 - spare part design is an essential feature in operation and maintenance planning.

Table 1 Condition classes according to IEC 721 standards that are reached with different air conditioning systems (number of system refers to clause 5.1)

CONDITION CLASS	AIR CONDITIONING SYSTEM				
	1	2	3	4	5
3K1	-	-	-	+	+
3K2	-	-	-	+	+
3K3	+ ^{**))}	+ ^{**))}	+ ^{**))}	+	+
3K4	+ ^{**))}	+ ^{**))}	+ ^{**))}	+	+
3K5	+ ^{**))}	+ ^{**))}	+ ^{**))}	+	+
3S1	-	-	+	+	+
3S2-4	+ ^{***))}	+ ^{***))}	+	+	+
3C1 ^{****))}	-	-	+	+	+
3C2 ^{*****))}	+	+	+	+	+

* Attention has to be paid to the cooling control.

** Depending on the maximum temperature and heat loads

*** Depending on the location

**** Requires a chemical filtering in areas with highly polluted outdoor air

***** Not close to process emissions without a chemical filtering

Bibliography

-International standards

ISO 9223. Corrosion of metals and alloys, Classification of corrosivity and atmospheres, 1989.

IEC 68-1 Basic environmental testing procedures. Part 1: General

IEC 721-2-8 Classification of environmental conditions. Environmental conditions appearing in nature. Fire exposure.

IEC 721-3-0 Classification of environmental conditions. Introduction

IEC 721-3-3 Classification of environmental conditions. Stationary use at weatherprotected locations

- European standards

EN 50081-1 Electromagnetic compatibility (EMC) - generic emission standard, part 1: residential, commercial and light industry

EN 50081-2 Electromagnetic compatibility (EMC) - generic emission standard, part 2: industrial environment

EN 50082-1 Electromagnetic compatibility (EMC) - generic immunity standard, part 1: residential, commercial and light industry

EN 50082-2 Electromagnetic compatibility (EMC) - generic immunity standard, part 2: industrial environment

- Other standards

ISA 571.04-85 Environmental conditions for process measurements and control systems: Airborne contaminants.

For more information, see

<http://www.invent.hut.fi/ThermieB/index.html>

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