SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Task 38
Solar Air-Conditioning
and Refrigeration

B5:

Commissioning

A technical report of subtask B5

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Definition of the Commissioning Process in US Understanding

The Commissioning Process (Cx Process) makes sure that new or reconstructed buildings will be of the same specifications as have been agreed upon in the Contract Documents during the planning stage and in the Owner's Project Requirements. Ideally, the criteria to be met are established and documented in the pre-planning stage in the form of the Basis of Design. They are then verified during the planning, construction, operating and utilization stages by way of extensive plausibility checks, test scenarios and performance documentation. According to that, the Cx Process is described as an "umbrella" process that bundles all issues centrally in one place during the planning stage and offers a platform for all parties involved.

Development of the Commissioning Process

The US understanding of the Cx Process was defined as from 1982. ASHRAE published the first Cx guideline in 1989 and a revised and extended version in 1996. The Cx Process that is described in these guidelines in much detail is based on experience from projects that require systems and components to be functional from Day 1 on, i.e., as soon as the project has been handed over to the owner. Beyond that, the Cx Process rests on the project experiences from those cases where the requirements of owners, users, operating staff and maintenance and facility managers had to be met on a high level, thus reducing costs.

The Commissioning Process

The Cx Process includes the usual constituent parts of planning reviews and is complemented by the following measures: facility components to be taken into operation, system adjustments, approaches in functional testing, documentation of facility components as well as user training. Ideally, the process is maintained over the entire life cycle of the facilities.

At the beginning of the Cx Process, the Cx Authority or Cx Agent is appointed, that is responsible, during the further planning routine, for materializing the owners' and planners' requests and perspectives. He is to establish the Basis of Design from these requirements and expectations. The additional requirements resulting from this are included in the assigned planners' scope of performance. In the further course of the project, the Cx Agent will be responsible for the inspection of the technical facilities of the building and of components. Upon completion of the project, he and the contractor will perform extensive performance testing. The process is actually finalized by training the operating and

maintenance personnel in order to guarantee optimal operation of the building and maintenance of the facilities installed.

Basic Goals of the Commissioning

The Cx aims at the following basic objectives:

- clearly defined Owner's Requirements,
- extensive documentation and application of auxiliary tools for increasing the quality during project implementation,
- confirmation and documentation of systems and components to work in accordance with Owner's Requirements,
- confirmation that satisfactory and flawless documentation is issued to the owner,
- confirmation that operating and maintenance personnel as well as users of the installed facilities are trained accordingly,
- guaranteeing a constant and effective process during project implementation,
- construction of a building with facilities that meet the owner's requirements at the time of completion,
- application of quality-based, random check methods in order to uncover problems during project implementation, and
- safeguarding appropriate coordination between the systems and their components and among all building contractors, sub-contractors, suppliers and craftsmen.

Benefits of Commissioning

Energy savings in view of functional buildings are seen as the biggest advantage of Cx, since the energy savings predicted by the planner and his idea are properly implemented. The Cx makes sure that newly set up buildings start their lifecycle at optimal productivity and keeps this performance level throughout.

But there are further advantages:

- adjusted and efficient facility operation,
- improved coordination between planning, construction and utilization,
- improved quality of interior rooms,

- improved user comfort and, thereby, increased productivity,
- reduced liabilities with view of the quality of interior rooms or other issues that could be caused by the ventilation or air conditioning facilities, and
- reduced operational and maintenance cost.

Conclusion

The Cx Process increases the value of the building. Well accorded facility engineering maintains its value longer and keeps the building in a good state of repair. Also, the omni-potent issue relating to comfort and a healthy workplace is tackled. The systems work more efficiently, have fewer downtimes and require less maintenance, which helps the owner of the building save capital.

Costs of Commissioning

Currently, there is no standard way of naming the costs and savings achieved by Cx.

Very few projects list Cx-relevant costs as separate items. In cases where this has been done, several methods have been adopted to make these costs transparent. Table 1 presents an overview of the range of costs to be expected. Thereby, it is of no concern which cost estimate approach has been chosen: the costs for Cx amount to only a small share of the overall building costs.

Application area of Commissioning	Range of costs expected
Entire buildings (control, regulation, electrical system, facility construction) Commissioning from the planning stage to the operating and utilization stage	0.5 to 3 % of total building costs
Only HVAC&R system with control and regulation technology	1.5 to 2.5 % of facility building costs
Electrical system only	1.0 to 1.5 % of electrical installation costs

Table 1: Commissioning costs (source: [3])

Savings of Commissioning

The building owners' foremost interest is aimed at optimal and more economic operation facilitated by Cx [3]. Additionally, owners are interested in the amount of money that may be saved by using Cx during operation and maintenance. Savings differ from project to project, as well as Cx costs do.

Many owners wonder how to pay for Cx costs with a limited planning and construction budget. The Cx Process identifies potential problems at an early stage, which may lead to lower total building costs, fewer disputes between contract parties and lower operation costs. If the planning and Cx Team is financed by these obvious savings, the costs accruing to the owner equal the costs of projects that are not subject to any Cx Process.

Commissioning Process acc. to ASHRAE

Correlating the individual guidelines

ASHRAE guideline 0-2005 [1] is an essential part of the entire series of Cx guidelines published by the National Institute of Building Sciences (NIBS).

ASHRAE guideline 0-2005 [1] contains generally accepted details concerning the Cx Process without dealing with special systems and their components. Therefore, additional technical guidelines are developed to present special and detailed information explaining the execution of the Cx Process for each building facility and its components.

ASHRAE guideline 0-2005 describes, for example, which contents are required for a high-quality and efficiently applicable user manual and when it has to be developed, whereas a technical guideline describes, which specific information on an installed system or its components has to be included in the user manual.

In order to concentrate on technical requirements, technical guidelines intentionally exclude general contents of the Cx Process, which are completely covered in ASHRAE guideline 0-2005 [1].

The application of generally accepted contents and additional technical specifications from the individual guidelines results in a reasonable and easy to handle number of documents that may be applied to adjust to the various requirements of each single owner.

ASHRAE Guideline 0-2005

Contents and scope of application

The application of this guideline depends on the Owner's Requirements and on the conditions under which the project is planned, constructed and operated. The generally accepted process described in this guideline may be transferred to any other project.

Below, a short overview from the pre-planning to the utilization and operating stage is presented and the goals of each Cx stage are stated. The overview leads to Figure 5 "Course of the Commissioning Process acc. to ASHRAE".

Pre-planning stage

Preliminary planning is the preparation stage during the project in which the Owner's Requirements are developed and defined. Basic evaluation is carried out; information, such as local regulations, laws and provisions, the location and climate, the parameters and functions of facilities to be designed, considerations regarding sustainability, cost estimates, the project schedule and requirements of the owners, the users and the operating and maintenance staff, is compiled.

The pre-planning stage is the most critical stage of the Cx Process, because the Owner's Requirements are the basis for planning, construction, utilization and operation of the facilities as well as for the Cx Plan and the project schedule.

If the Cx Process begins during the pre-planning stage, communication within the project is simplified by observing the Owner's Requirements from the pre-planning stage to the planning, construction as well as the utilization and operating stages and by checking the decisions in these stages and the documents containing the Owner's Requirements and the Basis of Design.

Planning stage

During the planning stage of the project, the Owner's Requirements are transformed into Construction Documents. The Basis of Design, one of the most important documents of the process, is prepared. It contains the assumptions required for developing a planning solution containing the intentions and criteria of the Owner's Requirements. Explanatory reports on the systems and their components are prepared and attached to the Basis of Design. Furthermore, the Cx Plan is extended by steps to be taken during the construction, operation and utilization stages.

Construction stage

During the construction stage of the project, the systems and their components are installed, checked, tested and included into the scope of service and maintenance in order to meet the Owner's Requirements. This stage also includes the submission of a bid, acceptance of the bid and conclusion of the contract. The Systems Manual is prepared in this stage and necessary instruction courses are planned.

Operation and utilization stage

The operation and utilization stage of the Cx Process begins upon the completion of the project. As a basic requirement, the Cx should be in operation during the warranty phase or, ideally, during the entire life cycle of the facility. This allows maintenance and the modification of systems, their components and related documents to be in accordance with the updated Owner's Requirements at all times.

ASHRAE Guideline 1-200X

Contents and scope of application

ASHRAE guideline 1-200X [2] describes technical requirements for the application of the Cx Process that is generally explained in ASHRAE guideline 0-2005 [1], which should guarantee that the installed HVAC&R systems meet the Owner's Requirements. Application of this guideline depends on the Owner's Requirements and on the planning, construction and operation of the project. This guideline applies only in connection with ASHRAE guideline 0-2005 [1], it is not to be seen as a solely applicable document.

Guideline 1-200X [2] explains the application of the Cx Process for each planning stage, from the pre-planning stage to the operation and utilization stage for HVAC&R systems of any kind and size. It especially contains requirements for documentation, instructions for test procedures and checklists for individual facility components.

Due to the integration of and correlation between most of the systems within one building, deficiencies in one system may lead to non-optimal performance in another system. Although this guideline focuses on HVAC&R systems, only an overall Cx Process covers the interfaces of building facilities and their impact on each other.

Commissioning Process acc. to GSA

Beside the definition acc. to ASHRAE, there is another Cx Process description. The General Service Administrations (GSA) issued the guideline “The building commissioning guide” [4].

The GSA is a federal authority that especially deals with Cx for public and federal construction projects and buildings and that defines the public and federal contracting authorities’ interests and, therefore, carries out the Cx for their buildings itself or is integrated in the process.

However, the GSA process is not focused on certain building or facility components. The entire building including all facilities and components is considered and the Cx is applied. The GSA carries out the Cx Process with view of compliance with comfort, comfortability, productivity and work satisfaction of the building’s users. Furthermore, environmental, cost-relevant and energetic factors of the building and the facilities, such as the reduction of operating costs, the improvement of energy efficiency and the increase of operational safety, are considered.

The GSA guideline describes in detail the Building Cx Process steps, the project management and the specific responsibilities of the entire Cx Team. Supporting tools and aids for project planning, handing over and final inspection are defined and proposed.

Acc. to GSA, additional costs of the Cx Process primarily arise from the employment of a Cx expert. The share of “Total Building Commissioning” costs for this service amounts, acc. to GSA, to between 0.5% and 1.5% of the total project costs. GSA adds additional project costs to these costs, mostly for the salary of the site manager, the contractors, architects and engineers as well as the owner’s personnel.

The benefit-cost analysis for Cx shows that savings in operating costs may be achieved by means of Cx. According to this, the operating costs after Cx or in Cx buildings are 8 to 20 % lower than normal operating costs of non-Cx buildings. Energy savings of 20 to 50 % and reduction of maintenance requirements of 15 to 35 % are indicated. Apart from the operating efficiency, a reduction of user complaints and an increase of user productivity are, acc. to GSA, important for a successful Cx. A productivity increase of 10 to 20 % is indicated.

REHVA Commissioning CD-ROM (2001)

Four members of the REHVA (Federation of European Heating and Air-conditioning Associations), England, France, Italy and the Netherlands, have pooled their knowledge and experiences concerning Cx in an intensive partnership and published the results in the "REHVA Commissioning CD-ROM" [5]. This project is the first step towards a European Cx Standard. Thereby, the focus is not on the Cx procedure for one European country, but on developing general methods, which may be transformed into the European Standard.

The following organizations have contributed to creating this CD-ROM. Further information and the possibility to order the "REHVA Commissioning CD-ROM" may be found on their websites:

REHVA (Federation of European Heating and Air-conditioning Associations): www.rehva.com,

CIBSE (Chartered Institution of Building Services Engineers) – England: http://www.cibse.org,

AICVF (Association des Ingénieurs en Climatice, Ventilation et Froid) – France: http://www.aicvf.com,

AICARR (Associazione Italiana Condizionamento dell'Aria Riscaldamento Refrigerazione) – Italy: http://www.aicarr.it and

TVVL (Nederlandse technische vereniging voor installaties in gebouwen) – Netherlands: http://www.tvvl.com.

IEA ECBCS Annex 40 (2001 – 2004)

This project, "IEA (International Energy Agency) ECBCS (Energy Conservation in Buildings and Community Systems Programme) Annex 40", dealt with the topic of "Commissioning of Building HVAC Systems for Improved Energy Performance" [6]. Its goal was to compare and to define Cx Processes on an international level with view of standardization and to suggest appropriate minimum requirements. The project linked project monitoring and control systems together and carried out a more global consideration of the entire life cycle of a building facility. Additionally, strict separation was made between systems and procedures of conventional controlling and controlling by means of measurement, control and regulation technology (MCR technology). Of particular interest with the latter case was the supporting application of MCR technology for start-up and final inspection. Furthermore, first mathematical models were developed to enable deducing, from the measuring data of

building facilities, to which extent the facilities are working properly and energy-efficiently without having to test and measure the facility in detail. It is profitable to consider the Cx as a quality assurance tool. As a basis for this, so-called Standard Model Cx Plans have been defined to structure Cx elements acc. to their requirements. The Planning and realization of simple building facilities (such as ventilation systems of conference rooms) may be checked acc. to a min. inspection plan, whereas more complex facilities (such as clean room technology) demand for more comprehensive inspection plans.

The following countries participated in this project: Belgium, China, Germany, Finland, France, the Netherlands, Japan, Canada, Korea, Norway, Sweden, Switzerland, Hungary and the USA.

Further information, the final report “IEA ECBCS Annex 40” [6] as well as the CD-ROM with a web-based database may be found on http://www.commissioning-hvac.org.

Betreiberkompetenz (2002 – 2005)

The project “Betreiberkompetenz” (operator competence) is a Swiss project supporting the “IEA ECBCS Annex 40”. A guideline has been developed, showing which decision processes, interfaces and influence factors are energetically relevant in the life cycle of building facilities and how these factors may be considered and influenced by the operator to achieve his goals.

The project strategy of “Betreiberkompetenz” is based on the results and experiences of operation-optimizating systems from the projects “E2000” and “EnergieSchweiz”. The results of the project “IEA ECBCS Annex 40” have also been taken into account.

Market research of the project “E2000“ suggests that the people responsible for the efficient operation of building facilities are usually not aware of the fact that they have to have a decisive influence to positively affect the energy consumption of buildings or facilities. It has been discovered, however, that the efficient use of energy in companies is not a technical, but a management problem. If the life cycle of facilities and buildings is taken into account when considering the building operation, the aspect of operator competence becomes more and more important. Therefore, it is of energy-strategic importance that building operators are provided with conditions that lead to higher efficiency of buildings and facilities and simpler processes and procedures. Therefore, it has been of prime concern that operators are provided with results and aids that may be utilized in practice. For that purpose, facility managers of leading Swiss companies and public companies have been closely integrated in the project.

Further information and the guideline “Betreiberkompetenz” may be found on http://www.ifma.com.

Bestellerkompetenz (2002 – 2004)

The main goal of the “Bestellerkompetenz” (purchaser competence) project is to provide building principals, planners and contracting companies with instruments for creating energetically ideal new or reconstructed buildings [7]. This enables building principals to compose energetically clear orders and to supervise the planning and realization process to make sure that the facilities are planned, realized and operated in accordance with the order.

Prospective publication forms of the “Bestellerkompetenz” know-how have been intensively discussed [8]. Thereby, publication as a homepage instead of the conventional manual has been preferred. The goal is to enable simple handling and availability of the documents by integration in the homepage “Bestellerkompetenz”, which may be found on http://www.bestellerkompetenz.ch.

IEA ECBCS Annex 47 (from 2005)

The project “IEA ECBCS Annex 40” is primarily concerned with Cx in new buildings, i.e. from the specification sheet for planning and via planning to final inspection, with or without an MCR system, which are discussed in detail.

In this project “IEA ECBCS Annex 47”, that goes beyond and deals with “Cost-effective Commissioning for Existing and Low Energy Buildings”, Cx is considered in operation [7].

The following countries decided to take part in the project: Belgium, Germany, Finland, France, the Netherlands, Japan, Canada, Norway, Sweden, the Czech Republic, Hungary and the USA.

Further information concerning “IEA ECBCS Annex 47” may be found on http://www.iea-annex47.org.

Commissioning within the Framework of IEA Task 38

Basic understanding of Subtask B5 within IEA Task 38 is that Commissioning is only a stage within the start-up itself. This requires that the previous planning stages have been carried out at a qualitatively high level. It is assumed that the interfaces between air-conditioning, the chiller, solar heat generation and the regulation technology are clearly described.

It is characteristic for solar air conditioning that, at the installation stage, many different technical trades have to cooperate. However, the technical understanding of specific problems of solar air conditioning is not yet sufficient.

Because of unsteady marginal solar conditions, it is impossible to check the performance of each company with justifiable technical effort.

Essential questions concerning assurance or examination of functionality are compiled into a checklist to achieve top-quality and secure facilities despite these troubles. This checklist enables planners and facility installers to examine or question essential aspects of dimension and design.

The checklist covers the following sections:

- Building
- Room components
- Air conditioning
- Solar plant
- Refrigeration plant
- Storage and distribution
- Recooling
- MCR technology

The basis for the examination is the room book. This document contains descriptions of essential requirements and expectations of the user for the building and the technical equipment.

The following tables are quoted from VDI guideline 6028 and represent one possibility to retrieve this data.

The analysis of solar air conditioning systems used in the past shows that either absorption chillers or DEC plants have mostly been used.

An installation layout for the DEC plant, which shows how to retrieve the most important functional and thermodynamical values, is presented below. This scheme helps to increase plant plausibility.

Bibliography

[1] ASHRAE (2005): ASHRAE Guideline 0-2005. The Commissioning Process. Atlanta.

[2] ASHRAE (2006): ASHRAE Guideline 1-200X. Proposed Revision of Guideline 1-1996, HVAC&R Technical Requirements for The Commissioning Process. Atlanta (First Public Review)

[3] Portland Energy Conservation, Inc. (PECI) (2001): Energy Design Resources Building Commissioning Guidelines. Portland

[4] General Services Administration (GSA) (2005): The building commissioning guide. Washington

[5] Federation of European Heating and Air-conditioning Associations (REHVA): REHVA Commissioning CD-ROM. Brüssel

[6] Visier, JC (2005): Commissioning tools for improved energy performance. Results of IEA ECBCS Annex 40.

[7] Chuard, Jean-Marc (2005): Commissioning of Building HVAC Systems for Improvement of Energy Performance. Teilnahme IEA ECBCA Annex 40 (Betreiberkompetenz). Bern

[8] Eicher, Hanspeter/Tresch, Robert/Kaufmann, Urs/Weilenmann, Jürg (2003): Bestellerkompetenz im Gebäudebereich. Jahresbericht 2003. Liestal

VDI 6028 Part 1 Annex A. Building requirements

Building requirements for the building services for the building measure:							
Designation of building:				**Location and address:**			
Position of the building:		Groundwater level: _____ m		Height of site above mean s. l.: _____ m		Main wind direction: _____	
Building structure:	Number of floors: _____	Area: _____m^2___BGF		Area: _____m^2___HNF		Height: _____ m	
❒Upper floors _____	❒Groundfloor _____	❒Basements _____		❒Underground garage _____ Parking Levels, _____Parking places			
Days in use: ❒ Mon–Fri except public holidays ❒ Mon ❒ Tues ❒ Wed ❒ Thurs ❒ Fri ❒ Sat ❒ Sun				Building used by _____ people			
Periode of use from ____:____ hours to ____:____ hours		❒ External air quality (dust, pollutant concentration)				❒ Openable windows	
Requirements from development: Power supply: ❒ Present ❒ To be planned							
❒ Central power supply and distribution				❒ Decentralised power supply and distribution			
❒ HP-steam	❒ LP-steam	❒ Remote heat	❒ Oil	❒ Gas	❒ 10 kV electricity	❒ 400 V electricity	❒ Refrigeration
❒ Compressed air	❒ Industrial water	❒ Drinking water	❒	❒ Other power supply:			
Requirements imposed the room air:		❒ No special requirements		❒ Ventilation/air-conditioning systems ne.		❒ Refrigeration systems needed	
❒ Room temperature (as per DIN 4701)			❒ Room temperatures to be stipulated individually			❒ Humidity to be stipulated individually	
Requirements imposed the thermal insulation:			❒ Thermal insulation complying with WschVO 1994			❒ Thermal insulation better than WschVO 1994 ____ %	
❒ k-value of windows _____ W/ m² K			❒ k-value of walls _____ W/ m² K			❒ k-value of the doors _____ W/ m² K	
❒ k-value of the roof _____ W/ m² K			❒ k-value of the floor slab _____ W/ m² K			❒ Deviating insulation in basement	
Requirements imposed the fire precautions:			❒ No special requirements			❒ Heat and smok escape systems for escape routes	
❒ Smoke extractor systems for special rooms			❒ Automatic extinguishing systems			❒ Extinguishing water reservoir needed	
Requirements imposed the sound insul.:		❒ No special requirements		❒ Special requirements, max. ____ dB (A)		❒ Outside noise level _____ dB(A)	
Installation of special systems:		❒ Anti-dazzle	❒ Sun protection	❒ Black-out	❒ Building automation (e.g. for faciltiy management)		
Lifts:	❒ Lifts (people, cargo)		❒ Fire-brigade lifts	❒ Facade access system (facade lift)		❒ Small goods lifts/ transport systems	
Ecological requirements:		❒ Solar heating systems		❒ Photovoltaic		❒ Use of rainwater	
		❒ Linking of power-heat-refrigeration		❒ Use of wind power		❒ Micro-sewage treatment system	
		❒ Geothermal systems		❒ Bio-heat		❒	

❒ **Further discriptions see page** _____ **Compiled:** _____ **Approved:** _____

VDI 6028 Part 1 Annex B. Room requirements - Page 1

Room requirements for the services for the building measure:					
Designation of the room:		**Room no.:**		Useful height: ___ m unobstructed height: ___ m	Aria:___m^2___HNF
Period of use from ____:____ hours to ____:____ hours		**Days in use:** ❒ Mon–Fri (except public holidays) ❒ Mon ❒ Tues ❒ Wed ❒ Thurs ❒ Fri ❒ Sat ❒ Sun			
Room used by _____ **people**	**Noise level:**	❒ No special requirements		❒ Special requirements max. _____ dB (A)	
❒ **Sun protection**	❒ **Anti-dazzle**			❒ **Black-out**	
Requirements imposed the room	❒ Room temperature (as per DIN 4701) ____°C			❒ normal humidity (no special requirements)	
❒ Deviating room temperatures:	Winter: _____°C tolerance: ± ____ °C			Summer: _____°C tolerance: ± ____ °C	
❒ Deviating relative humidity:	Winter: ____% - ____% tolerance: ± ____ °C			Summer: ____% - ____% tolerance: ± ____ °C	

410 Effluent-water-gas-systems	**Note: (e.g. quantity)**	**420 Heat suppply systems/ 430 Ventilation/air-conditioning systems**	**Note: (e.g. quantity)**		**Note: (e.g. quantity)**
❒ Tapping point cold water		❒ Heating requirement		❒ Lighting of single work areas	
❒ Tapping point hot water		❒ Cooling requirement		❒ Emergancy lighting	
❒ Connections, thierd party		❒ Internal heat loads		❒ Lighting to supplement daylight	
❒ Gas connection		❒ Conection of third party systems		❒ Lighting for computer workstations	
❒ Hand basin/vanity unit		❒ Heating surfaces		❒	
❒ Urinals/WC		❒ Pollutant disposal (ventilation)		❒	
❒ Sink unit		❒ Air renewal			
❒ Floor drains		❒ Number of people		**450 Telecommunications + IT systems**	
❒ Discharge		❒ Waste air from machines			
❒		❒		❒ Telecom-connections	
412 Fire-extinguishing-systems		**440 Heavy current installation**		❒ DP/ LAN connections	
❒ Dry/wet fire-extinguishing		❒ AC-sockets, 230 V		❒ Aerial connections	
❒ Wall hydrants		❒ DP-sockets, 230 V		❒ Public address system	
❒ Fire-extinguishing		❒ 3-phase sockets, 400 V/....A		❒ Fire alarm device	
❒ Automatic fire-extinguishing		❒ Fixed connections for machines and installed equipment		❒ Hazard warning device	
❒				❒ Time clock	
❒		❒ Gene. replacement power supply		❒ Intercom	
		❒ Spec. replacement power supply		❒	
		❒ Emergency cut-out		**Other notes:**	
		❒ General lighting			

❒ **Information on codes 460 – 490 see** ❒ **overleaf** ❒ **Page** _____ ❒ **Further systems/descriptions see page** _____

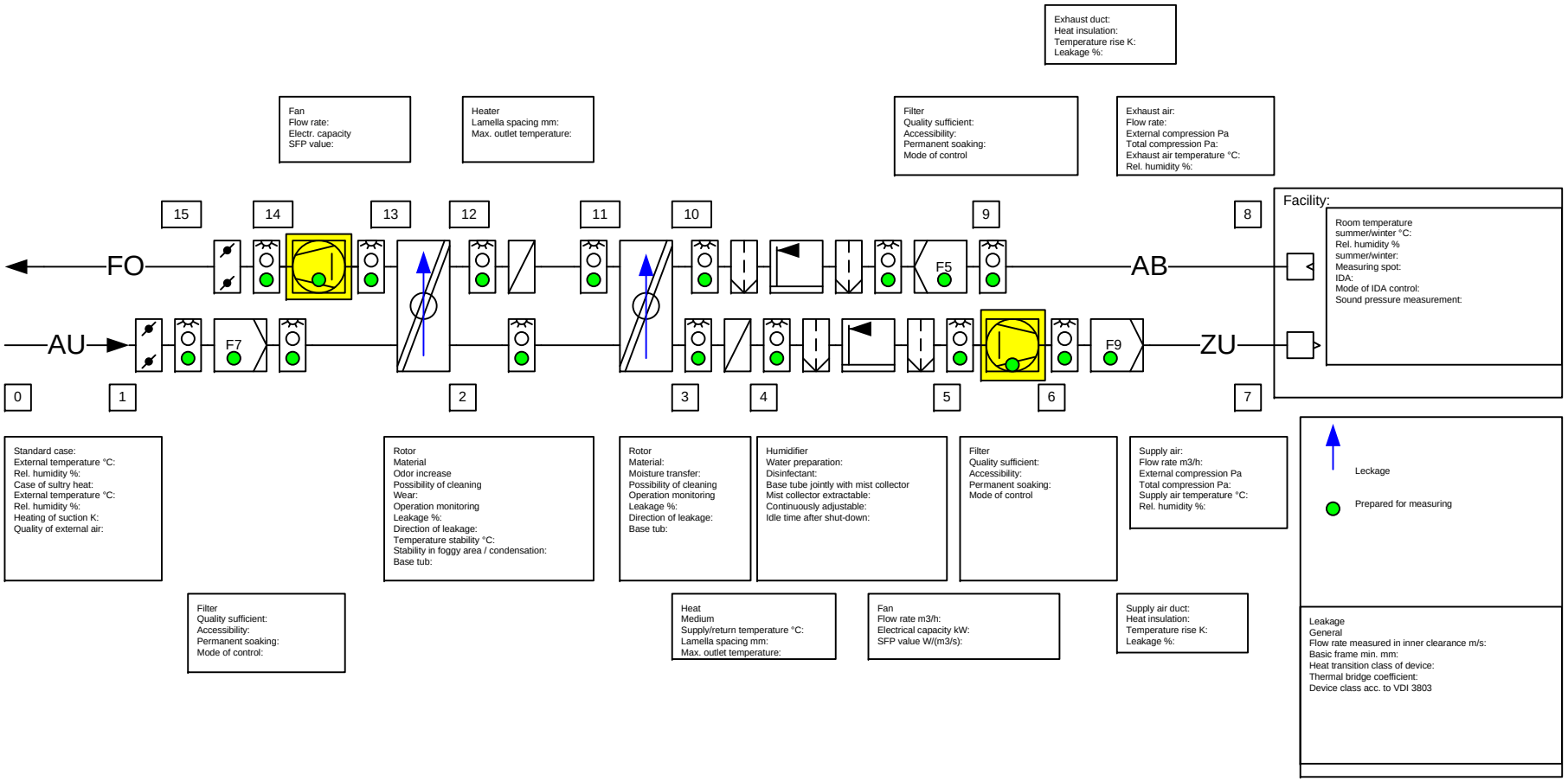
❒ **General standard requirement see page** _____ **Compiled:** _____ **Approved:** _____

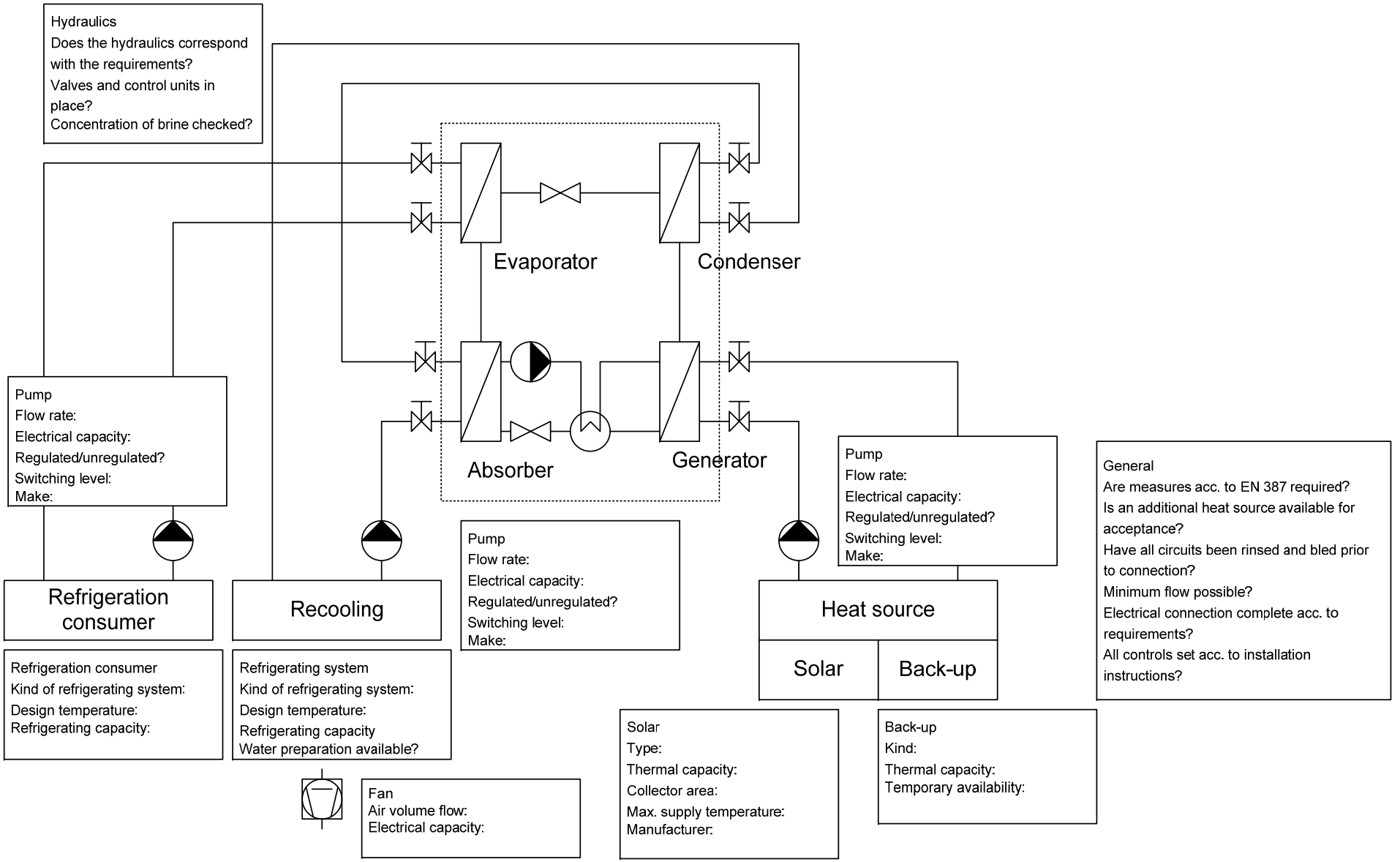
Room requirements for the services for the building measure:					
Designation of the room:		**Room no.:**		Useful height: ___ m unobstructed height: ___	Aria:___m^2___HNF
Period of use from ____:____ hours to ____:____ hours		**Days in use:** ❒ Mon–Fri (except public holidays) ❒ Mon ❒ Tues ❒ Wed ❒ Thurs ❒ Fri ❒ Sat ❒ Sun			
Room used by ____ people	**Noise level:**	❒ No special requirements		❒ Special requirements max. _____ dB (A)	
❒ **Sun protection**	❒ **Anti-dazzle**			❒ **Black-out**	
Requirements imposed the room	❒ Room temperature (as per DIN 4701) ____°C			❒ normal humidity (no special requirements)	
❒ Deviating room temperatures:	Winter: _____ °C tolerance: ± ____ °C			Summer: _____ °C tolerance: ± ____ °C	
❒ Deviating relative humidity:	Winter: ____% - ____% tolerance: ± ____ °C			Summer: ____% - ____% tolerance: ± ____ °C	

460 Conveying systems	**Note: (e.g. quantity)**	**475 Laboratory systems**	**Note: (e.g. quantity)**	**490 Other requirements**	**Note: (e.g. quantity)**
❒ Tubular post systems		❒ Laboratory bench		❒ Explosion-protection/potential rail	
❒ Passenger lift		❒ Laboratory sink		❒ Specific earthing	
❒ Cargo lift		❒ Chemicals cabinet		❒ EMC technology	
❒		❒ Media strip		❒ Vibration protection	
470 System for spec. Purposes		❒ Fume cupboard		❒ Sound insulation	
❒ Process refrigeration/heat		❒ Shower/eye-bathing systems		❒	
❒ Kitchen systems		❒ Gas bottle cabinet		**Other notes:**	
❒ Process refrigeration/heat		❒			
❒ Laundry systems		**480 Building automation**			
❒ Process water treatment		❒ Connection to building control technology			
❒					
473 Media supply - technical gases		❒ Displays from building control technology			
❒ Compressed air		❒ Special alarm signals			
❒ Technical gases		❒			
❒ Medical gases					
❒					

❒ **Information on codes 410 – 450 see** ❒ **overleaf** ❒ **Page** _____ ❒ **Further systems/descriptions see page** _____

❒ **General standard requirement see page** _____ **Compiled:** _____ **Approved:** _____


Exhaust duct:
Heat insulation:
Temperature rise K:
Leakage %:
Fan
Flow rate:
Electr. capacity
SFP value:
Heater
Lamella spacing mm:
Max. outlet temperature:
Filter
Quality sufficient:
Accessibility:
Permanent soaking:
Mode of control
Exhaust air:
Flow rate:
External compression Pa
Total compression Pa:
Exhaust air temperature °C:
Rel. humidity %:
Facility:
Room temperature
summer/winter °C:
Rel. humidity %
summer/winter:
Measuring spot:
IDA:
Mode of IDA control:
Sound pressure measurement:
15
14
13
12
11
10
9
8
FO
AB
F5
AU
ZU
F7
F9
0
1
2
3
4
5
6
7
Standard case:
External temperature °C:
Rel. humidity %:
Case of sultry heat:
External temperature °C:
Rel. humidity %:
Heating of suction K:
Quality of external air:
Rotor
Material
Odor increase
Possibility of cleaning
Wear:
Operation monitoring
Leakage %:
Direction of leakage:
Temperature stability °C:
Stability in foggy area / condensation:
Base tub:
Rotor
Material:
Moisture transfer:
Possibility of cleaning
Operation monitoring
Leakage %:
Direction of leakage:
Base tub:
Humidifier
Water preparation:
Disinfectant:
Base tube jointly with mist collector
Mist collector extractable:
Continuously adjustable:
Idle time after shut-down:
Filter
Quality sufficient:
Accessibility:
Permanent soaking:
Mode of control
Supply air:
Flow rate m3/h:
External compression Pa
Total compression Pa:
Supply air temperature °C:
Rel. humidity %:
Leckage
Prepared for measuring
Filter
Quality sufficient:
Accessibility:
Permanent soaking:
Mode of control:
Heat
Medium
Supply/return temperature °C:
Lamella spacing mm:
Max. outlet temperature:
Fan
Flow rate m3/h:
Electrical capacity kW:
SFP value W/(m3/s):
Supply air duct:
Heat insulation:
Temperature rise K:
Leakage %:
Leakage
General
Flow rate measured in inner clearance m/s:
Basic frame min. mm:
Heat transition class of device:
Thermal bridge coefficient:
Device class acc. to VDI 3803


Hydraulics
Does the hydraulics correspond with the requirements?
Valves and control units in place?
Concentration of brine checked?
Evaporator
Condenser
Absorber
Generator
Pump
Flow rate:
Electrical capacity:
Regulated/unregulated?
Switching level:
Make:
Refrigeration consumer
Recooling
Pump
Flow rate:
Electrical capacity:
Regulated/unregulated?
Switching level:
Make:
Heat source
Solar
Back-up
Pump
Flow rate:
Electrical capacity:
Regulated/unregulated?
Switching level:
Make:
General
Are measures acc. to EN 387 required?
Is an additional heat source available for acceptance?
Have all circuits been rinsed and bled prior to connection?
Minimum flow possible?
Electrical connection complete acc. to requirements?
All controls set acc. to installation instructions?
Refrigeration consumer
Kind of refrigerating system:
Design temperature:
Refrigerating capacity:
Refrigerating system
Kind of refrigerating system:
Design temperature:
Refrigerating capacity
Water preparation available?
Fan
Air volume flow:
Electrical capacity:
Solar
Type:
Thermal capacity:
Collector area:
Max. supply temperature:
Manufacturer:
Back-up
Kind:
Thermal capacity:
Temporary availability: