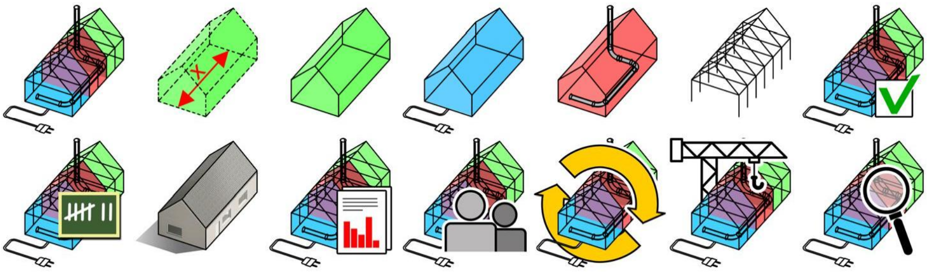
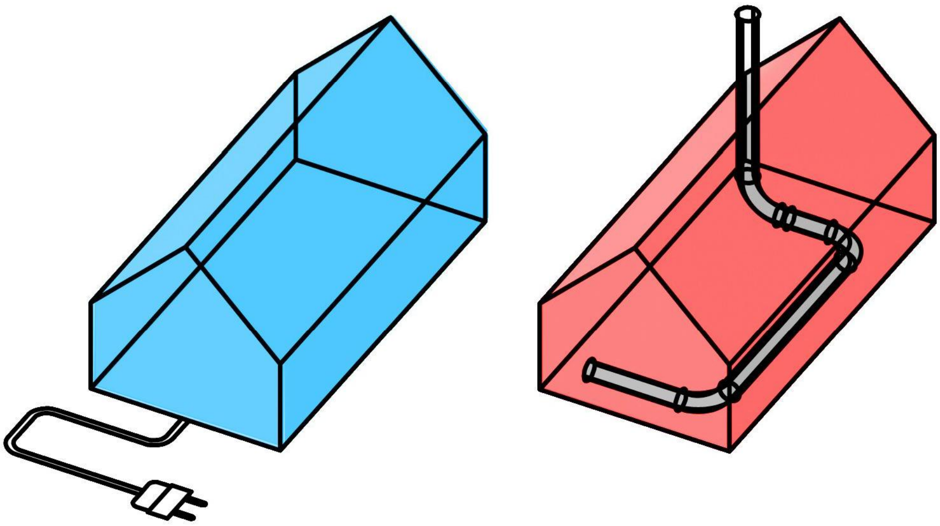


COBIM

Common BIM Requirements
2012

v 1.0



Series 4

MEP design

Volume 4 compiled by Olof Granlund Oy

Tero Järvinen, Tuomas Laine, Kari Kaleva, Kimmo Heljomaa

Foreword

The publication series “CommonBIM Requirements 2012” is the result of a broad-based development project entitled *COBIM*. The need for these requirements arises from the rapidly growing use of building information modeling in the construction industry. During all phases of a construction project, the parties to the project have a need to define more precisely than before what is being modeled and how the modeling is done. “Common BIMRequirements 2012” is based on the previous instructions of the ownerorganizations and the user experiences derived from them, along with the thorough experience the writersof the instructions possess on model-based operations.

The parties to the project are: **Funding providers:** Aitta Oy, Larkas & Laine Architects Ltd, buildingSMART Finland, City of Espoo Technical and Environment Services, Future CAD Oy, City of Helsinki Housing Production Office, City of Helsinki Premises Centre, University of Helsinki, Helsingin Yliopistokiinteistöt Oy, HUS Kiinteistöt Oy, HUS Premises Centre, ISS Palvelut Oy, City of Kuopio Premises Centre, Lemminkäinen Talo Oy, Micro Aided Design Ltd. (M.A.D.), NCC companies, Sebicon Oy, Senate Properties, Skanska Oy, SRV Group Plc, Sweco PM Oy, City of Tampere, City of Vantaa Premises Centre, Ministry of the Environment. **Authors:** Finnmap Consulting Oy, Gravicon Oy, Olof Granlund Oy, Lemminkäinen Talo Oy, NCC companies, Pöyry CM Oy, Skanska Oyj/VTT Technical Research Centre of Finland, Solibri, Inc., SRV Rakennus Oy, Tietoa Finland Oy. **Management:** The Building Information Foundation RTS.

The requirements were approved by an executive group consisting of parties to the project. The executive group acted as committee TK 320 of the Building Information Foundation RTS, and as such, participated actively in developing the content of the requirements and in asking for comments from the members of the executive group and from interest groups.

Parties to the © COBIM project.

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1 Main objectives of building information modeling

Property and construction modeling aims to support a design and construction lifecycle process that is of high quality, efficient, safe and in compliance with sustainable development. Building information models are utilized throughout the building's life cycle, starting from initial design and continuing even during use and facility management (FM) after the construction project has concluded.

Building information models enable the following, for example:

- Provision of support to the investment decisions by comparing the functionality, scope and costs of the solutions.
- Energy, environment and lifecycle analyses for the purpose of comparing solutions, design and objectives of facility management follow-up.
- Design visualization and analysis of construction feasibility.
- Enhancement of quality-assurance and data exchange and making the design process more effective.
- Utilization of building project data during use and facility management activities.

To make modeling successful, project-specific priorities and objectives must be set for models and model utilization. Project-specific requirements will be defined and documented on the basis of the objectives and general requirements set in this publication series.

General objectives of building information modeling include, for example, the following:

- To provide support for the project's decision-making processes.
- To have the parties commit to the project objectives by means of using the building information model.
- To visualize design solutions.
- To assist in design and the coordination of designs
- To increase and secure the quality of the building process and the final product.
- To make the processes during construction more effective.
- To improve safety during construction and throughout the building's lifecycle.
- To support the cost and life-cycle analyses of the project.
- To support the transfer of project data into data management during operation.

"Common BIM Requirements 2012" covers targets for new construction and renovation, as well as the use and facility management of buildings. The minimum requirements for modeling and the information content of models are included in the modeling requirements. The minimum requirements are intended to be observed in all construction projects where the use of these requirements is advantageous. Besides the minimum requirements, additional requirements can be presented on a case-specific basis. Modeling requirements and content must be presented in all design contracts in a binding and consistent manner.

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The publication series “Common BIM Requirements 2012” consists of the following documents:

1. General part
2. Modeling of the starting situation
3. Architectural design
4. MEP design
5. Structural design
6. Quality assurance
7. Quantity take-off
8. Use of models for visualization
9. Use of models in MEP analyses
10. Energy analysis
11. Management of a BIM project
12. Use of models in facility management
13. Use of models in construction
14. Use of models in building supervision

In addition to the requirements in his or her field, each party to a building information modeling project must be acquainted at a minimum with the general part (Series 1) and the principles of quality assurance (Series 6). The person in charge of the project or the project's data management must have comprehensive command of the principles of building information modeling requirements.

2 Introduction

This document addresses mechanical, electrical and plumbing (MEP) modeling and the information content required of the BIMs produced from mechanical, electrical and plumbing design. The requirements do not take sides with regard to the tools or methods used to carry out the modeling.

BIMs are used to achieve controlled decision-making and support of the information flow within the design group and between other designers and the client.

When MEP BIMs are published, they must not include the BIMs of other designers, even if such BIMs were used as references. The MEP BIMs may only include objects that are part of the MEP BIM designs.

The designer is responsible for verifying that his or her own work complies with the requirements and agreements. The BIMs can also be inspected by a third party during the process, as outlined in Series 6, "Quality assurance" of the Common BIM Requirements 2012 publication series.

Common BIM Requirements Requirements 2012, Series 4, "MEP design" presents BIM-based working methods for different purposes of use. Series 4 also contains references to the "MEP design task allocation list (Scope of Work, MEP-design 2012) " – design task allocation list and chapter-specific references to the publication in question.

It should be taken into account that the building information modeling requirements described in this publication can be requested to be carried out when the relevant work has been commissioned from the designer – either according to the "Scope of Work, MEP-design" or separate design development documentation individualized specifically to each task.

2.1 MEP design phases

MEP modeling is divided in two different sub-areas:

1. "Schematic design" and "Design development" stages

The "Schematic design" and "Design development" -stage consists of design that supports other participants in the design process. The goal is to produce sufficient data to produce the Architectural and the Structural BIM. To obtain this data, energy and condition simulations, for example, are conducted along with other mathematical calculations presented in Seriess 9 and 10 of the publication series.

At the "Schematic design" and "Design development" -stage, MEP-design does not produce a system model covering the entire building; instead, the focus is on system choices, service-area diagrams and MEP spatial reservations.

At the "Schematic design" stage, alternative solutions are prepared according to the MEP-design task allocation list. It is not absolutely necessary to use building information modeling for all of the preliminary design stage tasks. An appropriate scope for the building information modeling is agreed in the project or the design development documents.

2. Detailed design

System models covering the entire building are prepared at the Detailed design stage.

Reference to the task allocation list (Scope of Work, MEP-design) project information card:

- *Item 2.2, Design software requirement level*
  General Building Information Modeling Requirements are followed if Level 3 is chosen.

  "The design is completed on the basis of data models and CAD software is used."

2.2 BIM specification

Requirements

A BIM specification document is maintained during modeling, general- and Detailed design phases and construction. The BIM specification states the objects that have been modeled and which geometric accuracy and information content were used for the modeling.

The BIM specification states the software and the versions used to design the BIMs.

Guideline

Objects that were not modeled are also stated in the BIM specification (including ventilation machinery radiator mixing groups, equipment inside the heat distribution center, switches, sockets, distribution boxes, etc.).

A proposal for the contents of the BIM specification is included in Appendix 3 (Available only on Finnish version of Cobim 2012).

2.3 Objects and data transfer

Requirements

The software used must be IFC-compatible. BIM data transfer between different applications is conducted through IFC files.

If the file format in the software used for modeling (native BIM) includes references to objects or data outside the BIM, all necessary reference data should be delivered along with the native BIM when the BIM is published. Use of references must be indicated in the BIM specification.

Guideline

Not all product objects are transferred in connection with IFC data transfer. Components that are essential for the production of an IFC file are presented primarily through objects available in the modeling tool's equipment library, or secondarily as simple 3D objects (box, cylinder, etc.) whose geometry corresponds to the component's external measurements.

Such components may include, for example, ventilation machines, condensers and heat distribution centers. A project- and stage-specific agreement regarding the list of objects to be processed in this manner must be reached with other project participants before starting IFC data transfer.

It must be evident from the names or attribute information of the 3D objects which device the object represents. The names and attributes used, and their actual meaning, will be documented in the BIM specification.

2.4 Naming conventions

2.4.1 IFC models

Requirements

The main systems (Chapters 5.2 – 5.5) are saved in IFC files as agreed upon within the project and recorded in the BIM specification.

Absolute elevations are used as the IFC files' elevation, following the story-specific elevations in the architect's BIM.

Guideline

Files are named according to the client's instructions, if available.

Alternative ways of compiling IFC files include, for example, the following:

1. Main systems are modeled as independent models by story.

2. Main systems are combined into one story-specific BIM.

3. Main-system BIMs are made as independent, separate BIMs covering the entire property.

4. Main systems are combined into one BIM covering the entire property

Alternative 1 has been found to be the most functional during design and work-site activities because it enables simple updating of changes.

In all of the alternative ways of creating IFC files, the objects must follow the IFC hierarchy, i.e. the objects must contain information regarding to which building, story and subsystem they belong.

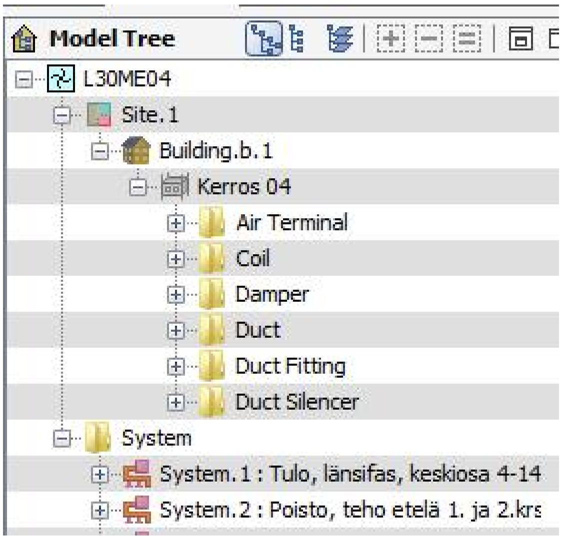

Figure 2.1: Example of a story-specific ventilation BIM where the components are located on the 4th floor, and are divided into independent systems (levels under the System –tree)

File names must clearly indicate which system model and building story is in question. File names must not contain spaces, special symbols or umlauts.

IFC file names must not be changed in the middle of the project and dates cannot be added to file names.

It is recommended that the first symbols in the file names describe the design discipline. In addition, it is recommended that the file name should state the building story whose system model it contains.

It is recommended that application software revision functions are used to change the object attributes, rather than removing and adding the object. When the object is revised, its internal ID (GUID) probably remains, enabling verification afterwards of which objects have been changed or which have been added to the system model as new objects.

2.4.2 Subsystems

Requirements

Equipment IDs of electric systems, ventilation machinery, fans and networks are used to name subsystems.

Guideline

The subsystem name must contain a clear description of the subsystem in question, e.g. "301AHU01 Incoming air, offices, part A" or "401CB01, Cooling beam network".

Depending on the software used, it should be ensured that the name is also transferred to the IFC file.

In renovation and extension projects, care must be taken to ensure that the names of the new systems' parts do not overlap with those of the existing systems to be retained.

2.4.3 Components and equipment

Requirements

The client's naming convention and instructions are followed in naming the equipment.

If instructions are not available from the client, the designer will compile proposed instructions and submit them to the client for approval.

Components and equipment that are given an individual identifier, that identifier should be assigned as attribute information.

Guideline

A component is individualized, for example, by the fact that directions or data collection from the building automation system must be targeted to it. Typical individual components include control valves, air flow regulators, motorized fire dampers and smoke detectors.

3 MEP requirement model

Requirements

The MEP designer must meet the demand for requirements definition and maintenance within the scope of the design development documents.

The MEP requirement model is maintained throughout the design process. The designs must be evaluated at the end of each design stage to determine whether they fulfill the requirements set for the spaces' target values.

Minimum requirements according to the Common BIM Requirements:

Level 1, Document-based requirement model

Guideline

MEP design involves numerous detailed requirements concerning, for example, the spatial indoor air conditions, level of electro-technical failure protection, equipment and lighting conditions. These can be presented in the general requirement model, or their final definition can be included as part of the MEP designer's tasks.

Using suitable software, the MEP designer can include these requirements as part of the spatial BIM produced by the architect, utilizing the BIM created in assessing compliance with and management of the requirements. This enhances the visualization of design functionality to the client, users of the facilities, and other designers at different stages of design. It also facilitates seeing if requirements aremet.

At the final stages of design, a possible change in target values can be effected, if the changes can be justified on the grounds of the final result of simulations or another decision-making process (e.g. cost-level analysis).

The MEP requirement model can be implemented either as a BIM-based or document-based model. Even a document-based MEP requirement model can be utilized later as source data for numerous BIM-based analyses. However, in that instance transfer of requirement data is always performed manually. When the BIM-based MEP requirement model is chosen as the implementation method, requirement data is forwarded through the BIM, enabling the simultaneous, continuous monitoring to reach the objectives.

One of two alternatives, each at a different level, can be chosen as the implementation method for the MEP requirement model:

***Level 1**, Document-based MEP requirement model*

- *Spatial types and the requirements targeted at them are recorded in a chosen document (e.g. spreadsheet software).*

***Level 2**, BIM-based MEP requirement model*

- *MEP-requirements are included as part of the room object as IFC Property Sets agreed to be used for this purpose, or by means of data linked to the space by other means.*

- *The BIM-based requirement model is published as an independent, separate IFC model, including the space objects and the service areas linked to them (IfcZone).*

The most commonly used MEP requirements for spatial types include the following:

- *airflow per square meter*
- *spatial type target temperature in summer and winter*
- *relative humidity*
- *spatial type maximum sound level*
- *spatial type cleanliness category*
- *spatial type negative / positive pressure*

The most commonly used electrical requirements for spatial types include the following:

- *lighting level in the work area / immediate surroundings*
- *lighting method (direct, indirect)*
- *methods of directing lighting*
- *electro-technical protection categories*
- *failure-protection-level requirements (UPS distribution, reserve-power distribution, etc.)*
- *equipment-level requirements (electrical, telecommunications, safety, audiovisual equipment, etc.)*

Requirements set for the property can include, among others:

- *energy consumption, kWh/m2*
- *environmental classification systems(LEED / BREEAM)*

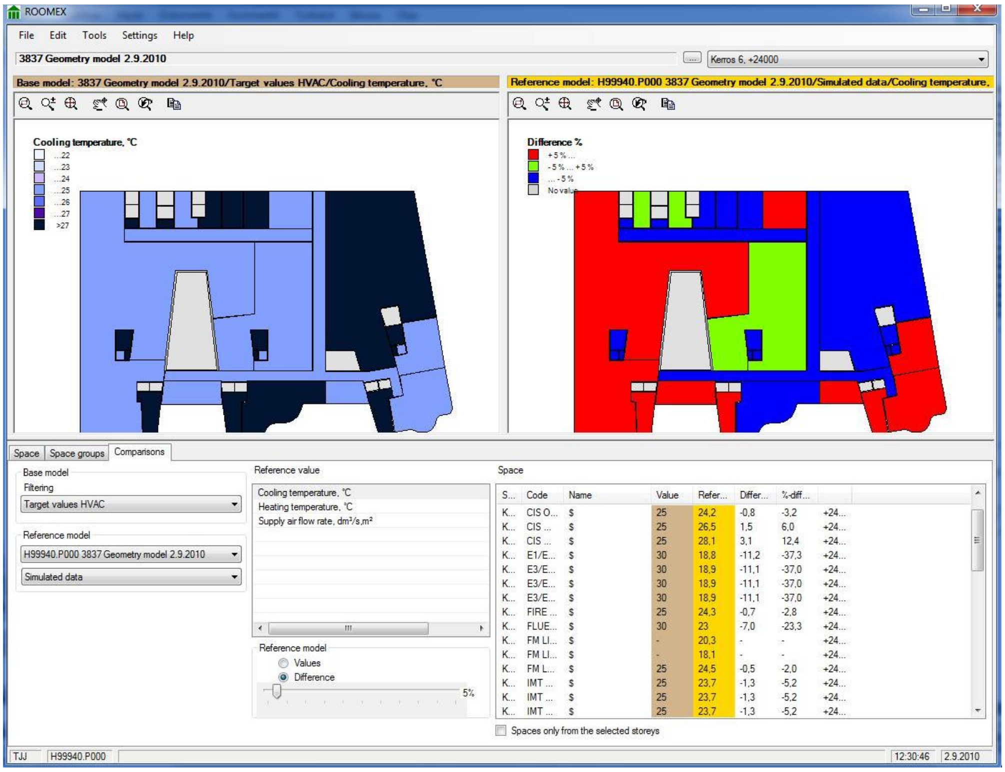

Figure 3.1: Example 1 of a BIM-based requirement model; the view at left shows spatial target temperatures in summer; the view at right shows the temperatures generated through simulation. Automatic comparison of target / simulation in the software colors the space red if the simulated temperature exceeds the target by 5 %.

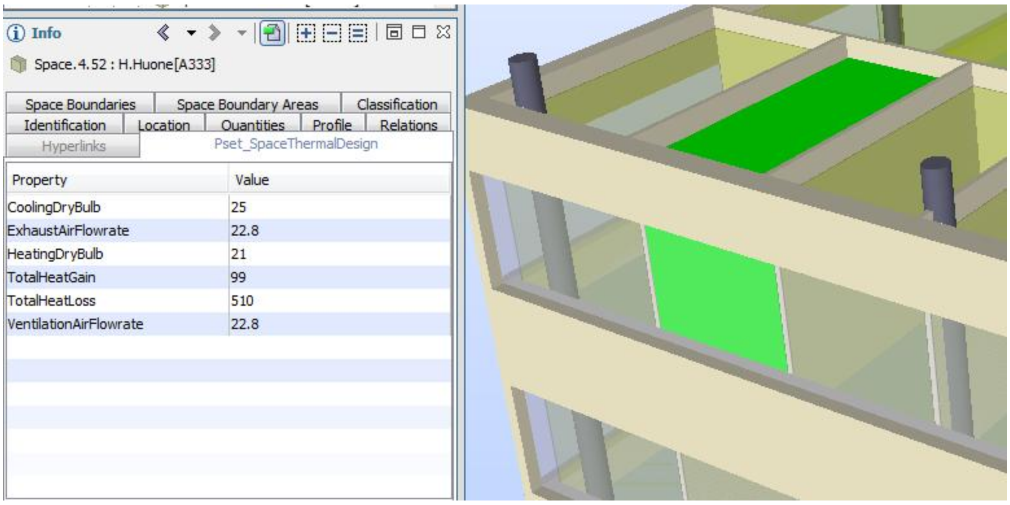

Figure 3.2: Example 2 of a BIM-based requirement model; spatial requirements and simulation results have been transferred into the IFC spatial object as Property set data.

Sisäilmastotyyppi	Sisälämpötila, °C		Suht. kosteus, %		Ilman nopeus, m/s		Ulkoilma-virta min.	Äänitaso	Suodatin-luokka
	Kesä	Talvi	Kesä	Talvi	Kesä	Talvi	(dm³/s)/m²	dB(A)	EU
Taukotila, vaativa	24,0	21,0	55,0	25,0	0,20	0,14	5,0	35	8
Taukotila, hyvä	26,0	21,0	xx	xx	0,25	0,17	5,0	38	7
Taukotila, perus	aa	21,0	xx	xx	0,30	0,20	5,0	38	7
Toimistohuone, vaativa	24,0	21,0	55,0	25,0	0,20	0,14	2,0	30	8
Toimistohuone, hyvä	26,0	21,0	xx	xx	0,25	0,17	1,5	33	7
Toimistohuone, perus	aa	21,0	xx	xx	0,30	0,20	1,5	33	7
Toimistokäytävä, vaativa	24,0	21,0	55,0	25,0	0,20	0,14	1,0	33	8
Toimistokäytävä, hyvä	26,0	21,0	xx	xx	0,25	0,17	1,0	35	7
Toimistokäytävä, perus	aa	21,0	xx	xx	0,30	0,20	0,5	38	7
Tupakkahuone	aa	21,0	xx	xx	0,30	0,30	T10 / P20	38	7
Varasto	xx	21,0	xx	xx	xx	xx	0,5	38	7
WC	xx	21,0	xx	xx	xx	xx	20 l/s / wc	38	
Yleisö WC	xx	21,0	xx	xx	xx	xx	30 l/s / wc	38	

Figure 3.3: Example 3 of a document-based MEP requirement model.

It should be taken into consideration that requirements that follow the conventional room-card concept – regarding, for example, the equipment in the space – can also be combined with the requirement model concept. Matters of this type can also be combined with the requirement model, as needed.

Chapter 3 References to the task allocation list (Scope of Work, MEP-design):

B Project planning, discretionary expert tasks:

Item B 3.1, Operational goals set for MEP design

D 0 Preliminary design, basic tasks:

Item D 2.7, Design objectives

E 0 Schematic design, basic tasks:

E 5.1 Schematic design's compliance with objectives, realization of objectives

G 0 Detailed design, basic tasks:

G 5.1 Compliance with objectives and quality assurance

Project information card:

Item C1.11, Project goals

4 Spatial ProvisionBIMs

At the **preliminary and Design Development stage**, the MEP designer reserves adequate space for technology and the necessary technical space, taking into consideration the maintenance areas and space required for equipment and installations.

From the data modeling perspective, spatial provisions related to MEP technology are divided into two groups:

1. Spatialprovisions, spaces
2. Horizontal story networks

4.1 Spatialprovisions, spaces

Requirements

At the Design Development stage and as needed, at the preliminary design stage, MEP spatial provisionsare reviewed with the architect, using regular design methods. The MEP designer states the estimated spatial needs and an assessment regarding the area where the spaces will be placed.

Guideline

The architect models the needed spaces into his or her own model as regular technical spaces, using spatial objects.

The spaces to be reserved include shafts, flues, engine rooms, distribution substations, central spaces, etc., and other areas classified as spaces that are reserved from top to bottom for MEP technology systems.

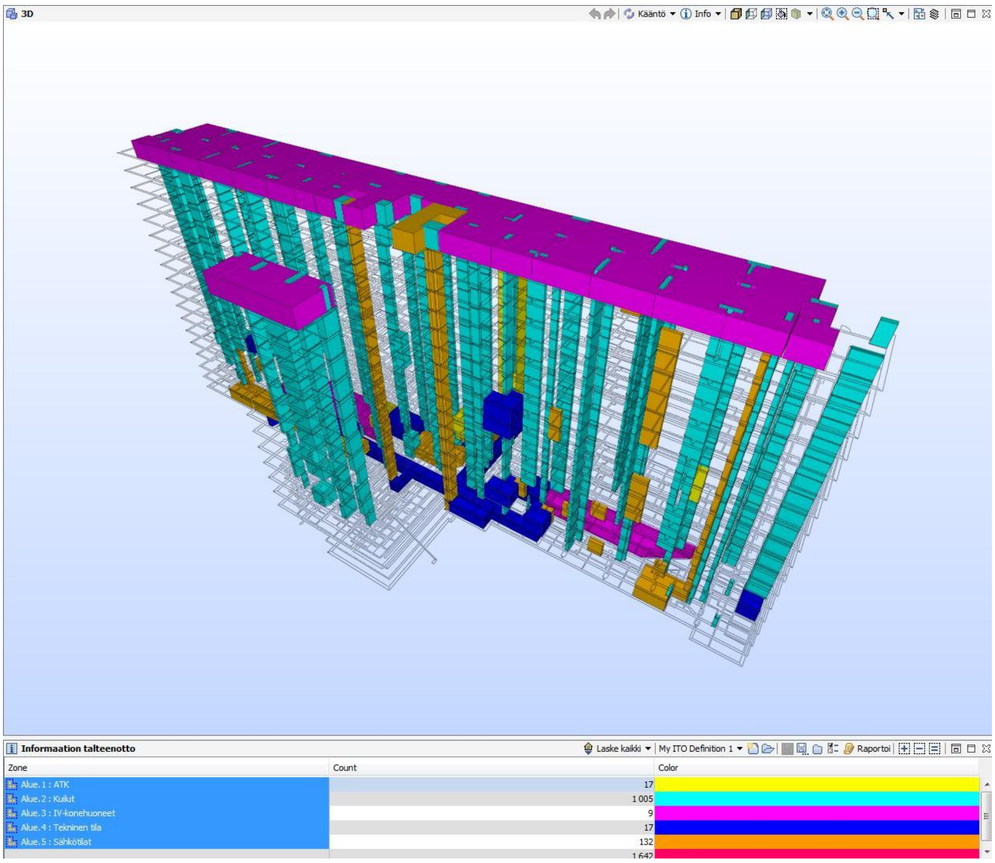

Figure 4.1: Spatial reservation BIM showing the MEP spaces in colors.

4.2 Horizontal story networks

Requirements

At the Design Development stage, horizontal story networks are modeled by the MEP designer. The purpose of the modeling is to present through geometry the location of the main routes – no requirements are set for information content.

The accuracy requirement for horizontal trunk networks is presented in Appendix 1. They must be situated in the building so that the main route necessary for MEP technology is clearly visible.

More precise locations of the networks are defined in the 2D intersections developed through conventional design methodology (corridors, shaft exits, challenging installation sites, etc.).

2D intersections show how the networks are supported; they also ensure that the networks can be installed and maintained.

Guideline

The main routes of horizontal spatial provisions are modeled using regular MEP modeling tools; pipes, ducts, cable shelves and pipe chutes. The purpose of the modeling is to present the main routes of the networks. The dimensions of the duct or pipe systems are chosen on the basis of their suitability for the purpose.

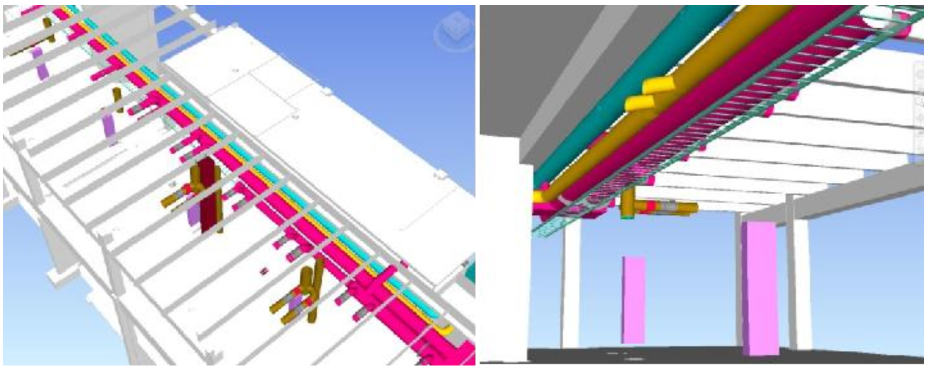

Figure 4.2: Example: Images of horizontal trunk networks and the Structural BIM in the Design Development phase.

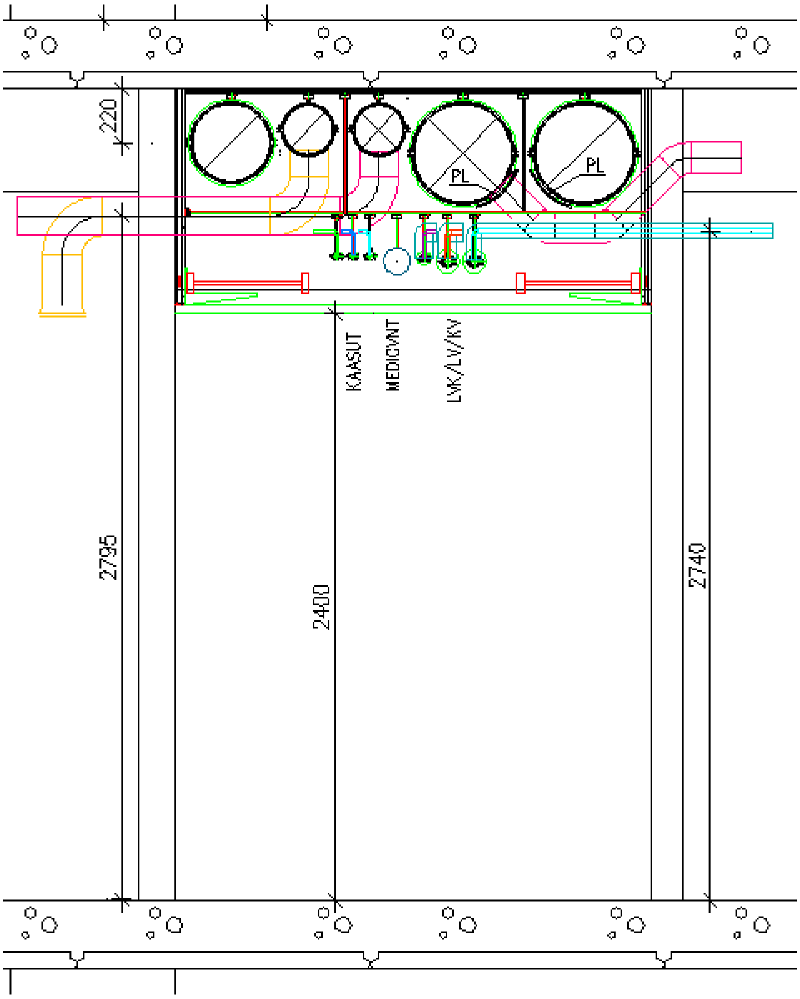

Figure 4.3: Example of a conventional 2D intersection used as the basis for 3D modeling of the area.

Chapters 4.1 and 4.2 References to the task allocation list (Scope of Work, MEP-design):

D 0 Preliminary design, basic tasks:
Item D.3.9, Preliminary need for technical spaces

E 0 Design Development , basic tasks:
Item E 3.2 Routing needs, alternative solutions for space types and system integration
Item E 4.1 Design Development documents
Item E 4.2 Integration and quality assurance of different design disciplines

4.3 Mock-up rooms and areas

Requirements

At the Design Development stage, a room or area is chosen as a mock-up room or area for building information modeling. The MEP-modeling accuracy level is such that it can be used to ensure that the components fit in the relevant area.

In order to accurate model MEP technology a sufficiently precise Architectural and Structural BIM are required.

Guideline

Based on the model, visualizations of the target can be made to demonstrate the installation technique according to separate visualization guidelines.

Mock-up rooms or areas are selected specifically to suit the needs of each target. Replicated space types should be modeled accurately at the general design stage.

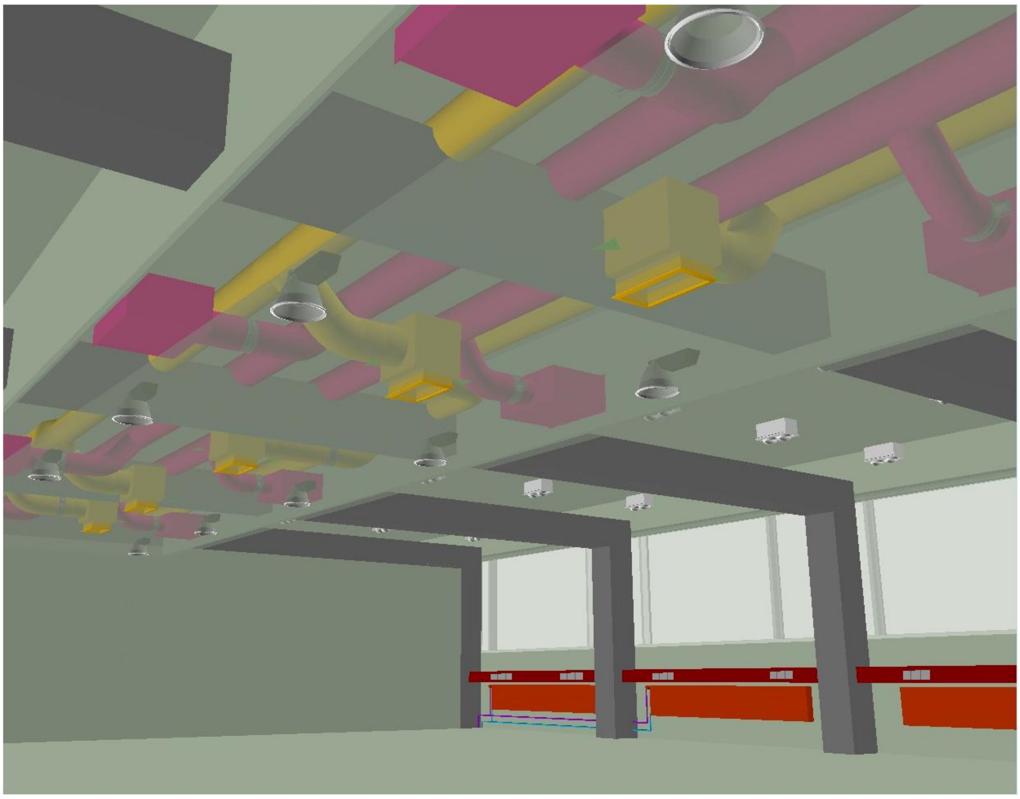

Figure 4.4: Example of sample-area MEP installations.

All MEP technology that has a spatial provisionsor functional significance is modeled into the sample room or area. The sample room contains models of sockets, switches, terminal devices, pipe chutes and similar components.

Chapter 4.3 References to the task allocation list (Scope of Work, MEP-design):

E 0 Design Development , basic tasks:

Item E 3.2 Routing needs, alternative solutions for space types and system integration
Item E 4.1 Design Development documents
Item E 4.2 Integration and quality assurance of different design disciplines

4.4 Service area charts

Requirements

At the Design Development stage, service area charts are drawn up of the ventilation machinery service areas.

Minimum requirements according to the Common BIM Requirements:

Level 1, Service area chart documents

Guideline

Spatial objects in the architect's BIM can be utilized in drawing up service area charts. They can be made in the conventional manner, coloring areas in the building element base, for example, by hatching them.

In drawing up service-area charts, the level of building information modeling can be chosen from the following alternatives:

***Level 1**, Service area charts documents*

Service area charts are drawn up as documents using conventional methods, for example, by means of hatches in CAD applications.

***Level 2**, BIM-based service-area charts*

Spatial objects in the architect's BIM are grouped into MEP service areas, which are written back into the BIM which is read into the application program (IfcZone). This enables utilization of service-area information in other applications, for example, in energy analyses, or data transfers into facility management data systems.

At a minimum, MEP service-area charts are drawn up of the ventilation machinery. It is recommended that such charts are also drawn up of the following systems:

- *Areas / rooms with separate cooling*
- *Information network service areas*
- *Electrical distribution center service areas*
- *Energy measurement service areas*

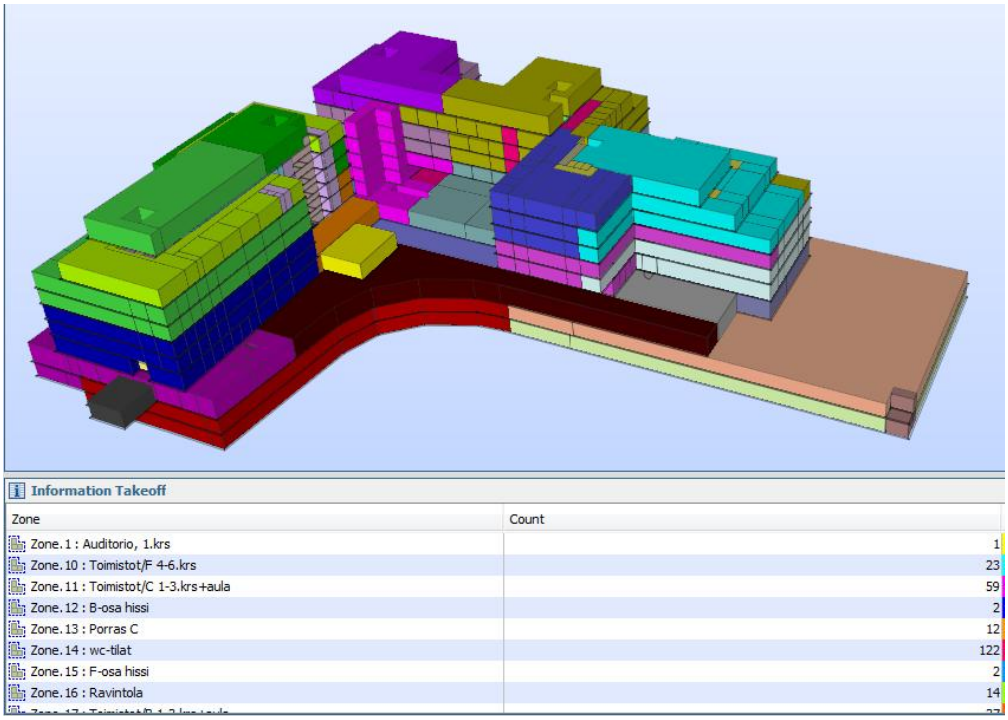

Figure 4.5: Example of a browser view where ventilation machinery service areas transferred into the IFC file are visualized in color. Each color represents the service area of one ventilation machine. The service area (IfcZone) is formed of spatial objects (IfcSpace).

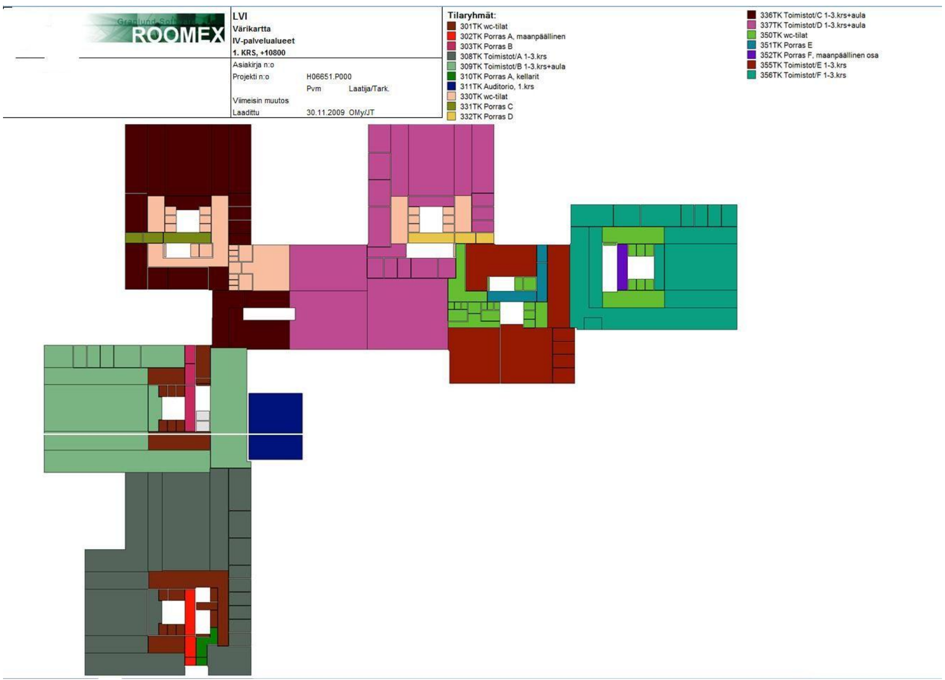

Figure 4.6: Example of the storey-specific ventilation service area chart of the same building; here the presentation method is 2D.

Chapter 4.4 References to the task allocation list (Scope of Work, MEP-design):

E0 Design Development , basic tasks:

Item E 4.1 Design Development documents

5 System BIMs for MEP design

5.1 Modeling principles at the Detailed design stage

Chapters 5.1– 5.6 References to the task allocation list (Scope of Work, MEP-design):

G 0 Detailed design, basic tasks:
G 3.1 MEP routing needs
G 3.2 Verification of the placement of points and field equipment as depicted in the design
G 4.1 Designs geared to procurement, according to Appendix 2 (MEP)
G 4.18 Designs geared to Detailed, according to Appendix 2 (MEP)

5.1.1 Fluid mechanic systems

Requirements

Each main system (Chapters 5.2 – 5.5) must be modeled as a separate BIM.

The systems must be modeled as functional, in other words so that the calculation and analysis functions of the design software can be used. All of the components that are significant in terms of the functional whole must be modeled.

The parts of networks that are located in different stories must be connected to form fluid-mechanically consistent systems.

Guideline

As regards the machine room, separate equipment groups are not presented for individual equipment, such as ventilation machines, heat exchangers, radiators, and the like; instead, they are presented in more detail in the functional diagram of the respective system.

The calculation and analysis features of the design software, such as flow rate, balancing and sound calculations, must be used for the systems when possible. The calculation generates essential information content in the original model and serves as part of the design quality assurance. The calculation and analysis features can be supplemented by standalone software applications as needed.

The branches of the systems modified in renovated and extended buildings must be modeled up to the central unit if the intention is to enable the verification of system functionality by means of simulation concerning the entire system (the new and the old part). The possible modeling of existing systems, even partial, must be defined in the design agreements.

In modeling existing systems, it is recommended that a "status" or other definition is used. In this way, each system component is assigned an additional definition to indicate that the component in question is part of the "old network", for example. Depending on the application software, the status definition can be used to indicate the networks or sections to be dismantled, as well as separate procurement packages. When status is used, information of the meaning of the network can be transmitted through the IFC file also to other parties, and they can also be itemized in mass lists, for example.

It should be taken into consideration that all application software programs do not support the saving of "status" information into the system BIMs.

5.1.2 Breakdown of systems into subsystems

Requirements

Main systems must be broken down into subsystems (see sections 5.2 –5.5 for details) so that the calculation tools of the design software can be used separately for each subsystem independent of the others.

Guideline

All subsystem components must indicate the subsystem to which they belong. This information must also be transferred into the IFC model.

To improve clarity, different systems should be displayed in the BIM using different colors, if this is allowed in the modeling tool.

Terminology:
Main system = Heating system, Cooling system, Sewer system, Ventilation system

Subsystem = Radiator network, ventilation machinery radiator network, cooling beam network, rainwater sewer network, ventilation-machine incoming air network, ventilation machine exhaust-air network

5.1.3 Realistic modeling

Requirements

Components must be modeled using objects that correspond to the real objects (plastic pipe with a plastic pipe object, copper pipe with a copper pipe object, etc.). Commercial product libraries are used to the extent allowed by the modeling software.

Fastenings shall not be modeled.

Guideline

An effort is made to use standard parts for modeling, if possible, i.e. 90 degree pipe angles, 90 or 45 degree ventilation graphs, etc.

5.1.4 Modeling of insulation

Requirements

Piping and duct insulation are modeled using methods that conform to the application programs to make the BIM useful for clash detection and material lists.

Insulation is coded to indicate its purpose of use (soundproofing, heat insulation, fire proofing, etc.), thickness and the material used.

The coatings of the insulation are added to the insulation code, if sheet metal or another material clearly affecting costs is used. Aluminum laminate or plastic coating is not required to be coded in the insulation attribute data.

Guideline

Insulation should be modeled according to the appropriate level of detail; for example when the pipes inside the room's suspended ceiling must be insulated while the pipe that is visible on the wall does not, it is permissible to leave without insulation also that part of the pipe which is on the wall going in a downward direction inside the suspended ceiling.

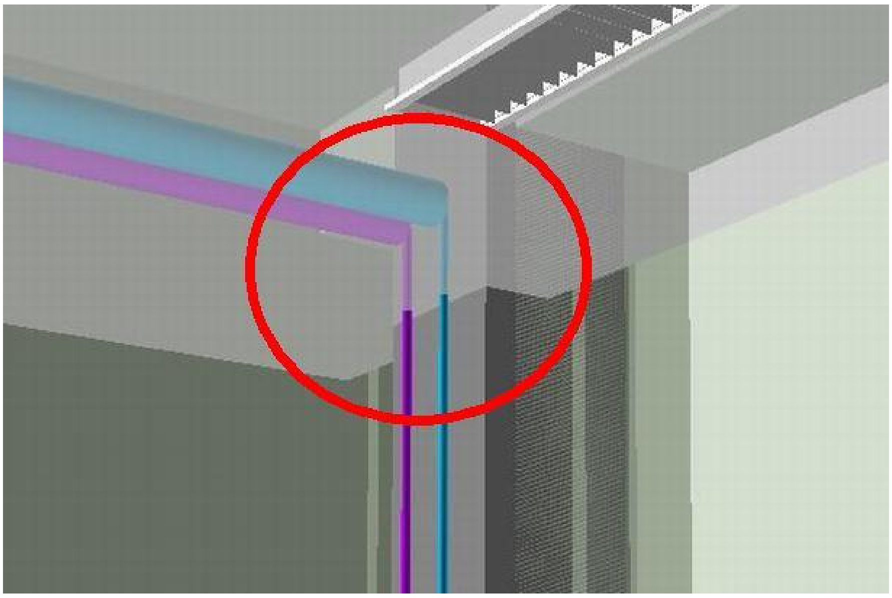

Figure 5.1: Example of pipes in a suspended ceiling where the horizontal part of the pipes is insulated but the part going downward (inside the suspended ceiling) is not.

5.2 Domestic water and sewer systems

Requirements

Central units, piping systems, piping system equipment, floor drains and service-water equipment are modeled taking into consideration the guidelines given in Section 5.1. and the Appendix 1. Modeling of roof outlets is part of the MEP designer's work.

Different types of networks (e.g. rainwater, waste water) are modeled as separate subsystems.

Sewer dumps must be modeled as they actually are, excluding:

- local decompositions located in different stories, for example, toilet space groups

- yard-area sewer networks that are within the area of the plot plan.

Guideline

Modeling of dumps refers to, for example, bottom sewers inside the foundation wall on the ground, and other trunk sewer networks modeled into the stories.

Yard-area sewer dumps outside the foundation wall are not required to be modeled, even though modeling them is highly recommended.

3D modeling of yard-area wells; see Appendix 1.

The MEP designer is responsible for ensuring that the dumps of shorter pipe sections are also taken into consideration in clash detections and space reservation design, even if dumps are not modeled.

Networks that differ from the regular network pressure (e.g. a network equipped with elevated pressure) are modeled with the attributes of the application program used, so that pressure calculations can be carried out.

5.3 Ventilation systems

Requirements

Central units, duct systems, duct system equipment and terminal devices are modeled taking into consideration the guidelines given in Section 5.1. and Appendix 1 thereto.

Each ventilation machine and fan, together with their networks, must be modeled as separate subsystems.

Guideline

Fresh- and extract-air chambers of enclosed ventilation machines can be modeled into one or, when appropriate, several subsystems. Creation of machine-specific subsystems for these networks is not required.

5.4 Heating and cooling systems

Requirements

Central units, piping systems, piping system equipment and terminal devices are modeled taking into consideration the guidelines given in Section 5.1 and Appendix 1 thereto.

The heating and cooling systems must be modeled as separate subsystems.

Guideline

A pump or heat exchanger, for example, can be considered as a separating subsystem factor.

If the building will be equipped with direct electrical heating, modeling of the heating system should be carried out by the electrical designer.

The designer is not required to model under-floor heating pipes onto the floor in their entirety; however, sufficiently clear information content must be evident from the model (the power of the under-floor heating circuit, fluid flow, pre-setting value, service area and installation interval).

It should be noted, however, that modeling of the under-floor heating pipes is not prohibited – instead, it is recommended, especially if the under- floor *heating pipe supplier's actual piping-route data can be transferred into the designs.*

5.5 Fire extinguishing systems

Requirements

Sprinkler equipment (the entire equipment that provides sprinkler protection and includes one or several sprinkler installations with piping systems, water sources and other devices) is modeled taking into consideration the guidelines given in Section 5.1 and Appendix 1 with the moderation that the sprinkler designer can also use a separate software program to perform pressure and flow calculations.

Sprinkler installations (part of the sprinkler equipment which includes one installation valve and the piping systems, sprinklers and other devices attached to it) are modeled as separate subsystems.

Other fire-extinguishing systems shall also be modeled (for example, gas extinguishing equipment, high- and low-pressure equipment).

Guideline

With the exception of the sprinkler system, pressure-loss calculations are not required to be performed through the BIM or separate calculation software. These extinguishing systems include, for example, gas extinguishing equipment and low- and high-pressure equipment.

5.6 Special systems

Special systems include, for example:

- gas piping systems (e.g. hospitals, laboratories, industrial facilities)
- compressed air networks
- steam pipes
- smoke ventilation systems
- sawdust removal systems
- swimming pool equipment
- central vacuum cleaner systems

Requirements

For the examination of space requirements and clash detections, it is important that all special systems needing a considerable amount of space are modeled. Since objects reserved for this purpose may not be available in the authoring software, special systems must be modeled by applying the modeling guidelines for other systems.

The modeling of special systems will be agreed upon separately in the design agreements. If a special system has been defined in the MEP task allocation list as falling within the sphere of design, the networks for that system must be designed through modeling.

Guideline

With regard to piping and duct systems, other applicable components can be used for modeling, when necessary, and central units can be depicted using self-made 3D objects.

Parts that are "impossible" to model shall be modeled as simplified, or the component that most resembles the part in question and is available in the design software program library, should be used. Changes of this type shall be recorded in the BIM specification

Use of calculation tools is not required. Supplementary information can be documented outside the model. Special modeling solutions and data outside of the model are documented in the BIM specification. Any insulations or dumps are modeled in the manner presented in connection with other systems.

5.7 Network balancing drawings

Compilation of network balancing drawings is a separate assignment which is ordered from the MEP designer on a case-specific basis.

Guideline

When the MEP technical BIM has been updated to include the actual products and route changes chosen by the contractor (see Chapters 9.1 and 9.2), subsystem-specific balancing drawings can be made of the building that are more precise than usual.

The information content of the balancing drawings described in this chapter varies from one application software to the next. For example, balancing-technical information is not transferred into the IFC model in all application programs or balancing -related data are not available for all components.

Balancing drawings are compiled such that, at a minimum, the pre-control value, pressure loss and volume flow for the controlling components are indicated with a grid line. As regards the ventilation machinery discharge chamber and pressure sensors within the network, the static pressure level of the duct systems is stated.

The terminal device / valve for the route within the network that is the most difficult in terms of compression technology is indicated, for example, with a grid line in the balancing drawings.

Balancing drawings are compiled in a manner similar to that used in the case of level drawings, so that the designs covering the entire network will be available to the contractor. The contractor can indicate the separate, measured values affecting the network values (pressure levels and differences, air quantities, etc.) on the drawings. The drawings can be compiled on a system-specific basis, making carrying out of the balancing work more illustrative.

Separate balancing tables can be compiled to support the balancing drawings, for example, of the zonevalve and radiator-valve values.

Use of the combined model to support the balancing drawings is recommended. The balancing data calculated by the MEP application can be transferred to the components, enabling the observation of, for example, *network pressure levels and component pre-setting values in the combined model.*

Info

Damper.1.15

Identification | Location | Relations | Classification | Hyperlinks | MagiCAD Pset_FlowDamper

Property	Value
ConnectionSize_mm	125
DamperPosition	0
Description	VIV P15.213.1
Manufacturer	Halton
NationalCode	
ObjectId	
PartType	Flow damper
ProductCode	RMC/I-125
Productvariable	VIV1
Productvariable1	
Productvariable2	
Productvariable3	
Productvariable4	
Productvariable5	
RunningIndex	-
Status	Not defined
User Code	VIV1
UserVar1	
UserVar2	
dpTot_SizingFlow_Pa	155.629
pTot_SizingFlow_Pa	25.28
qv_SizingFlow_ls	35
v_SizingFlow_ms	2.85

Figure 5.2: Example of the flow damper, dimensioning values calculated by the modeling application and saved in the IFC file.

If balancing drawings and an as-built model were ordered for the building (see Chapter 9), the values verified, adjusted and measured by the contractor, along with their pre-settingl data, can be written into the BIM-modeled control valve or damper as attribute data.

<u>Chapter 5.7 References to the task allocation list (Scope of Work, MEP-design):</u>

I Construction, discretionary tasks:

14.17, HVAC system model balancing drawings

6 System BIMs for electrical and telecommunications design

6.1 General modeling principles at the Detailed design stage

Chapters 6.1– 6.8 References to the task allocation list (Scope of Work, MEP-design):

G 0 Detailed design, basic tasks:
G 3.1 MEP routing needs
G 3.2 Verification of the placement of points and field equipment as depicted in the design
G 4.1 Designs geared to procurement, Appendix 2 (Electrical, Telecommunications, Security, Building automation)
G 4.18 Designs geared to Detailed, Appendix 2 (Electrical, Telecommunications, Security, Building automation)

Requirements

3D geometry of the parts in the systems that require space is modeled in conformance with Appendix 1.

The modeling principles are presented by system component in Chapters 6.2 – 6.8.

Guideline

Building Automation System key components can also be modeled in the Electrical System BIM. Such components include, among others, sub-control centers, the existence and location of which is relevant information for property management. The dimensioning of the sub-control centers, along with defining their location is, according to the task allocation list, within the job description of the building automation designer. The building automation designer delivers his or her modeled components either as a separate partial model, or has a discussion with the electrical designer concerning whether these components should be modeled as a partial entity into the electrical designer's BIM.

Product libraries shall be utilized in the modeling to the extent covered by the modeling software. If the BIM contains references to objects or information located outside of the BIM, all required reference information must be supplied when the BIM is published. Use of references must be indicated in the BIM specification.

6.2 Distribution of electricity

Requirements

Transformers, switch plants, main exchanges, busbar systems and other similar equipment are modeled through simple 3D objects which correspond at least to the actual measurements of the equipment, or when necessary, to those estimated by the designer.

Guideline

If the equipment supplier has delivered 3D objects that correspond to the product, these should be used within the scope permitted by the design software.

6.3 Distribution center

Requirements

Distribution and group centers, cross-connection cabinets and other comparable equipment are modeled through simple 3D objects which correspond at least to the actual measurements of the equipment, or when necessary, to those estimated by the designer.

6.4 Conductor conduits

Requirements

Cable shelves, suspension rails, wire chutes and floor ducts are modeled through objects that correspond to their actual dimensions.

Guideline

Fastenings are not required to be modeled. If this is required in special cases, the matter shall be agreed upon separately.

6.5 Lighting fixtures

Requirements

Lighting fixtures are modeled primarily by using the manufacturer's object library available in the application program. If the relevant object is not found, a lighting fixture of the type that corresponds to the dimensions of the sought-for lighting fixture type, or a 3D object, should be used.

Guideline

If lighting-fixture manufacturers' object libraries of adequate scope are available in the design program, the 3D object that looks like the actual selected lighting fixture should be used.

6.6 Installation fittings

Requirements

It is not mandatory to model the 3D geometry of switches, sockets, detectors and other components that do not require much space, except for separately agreed upon sample rooms and, in conformance with Appendix 1, in installations of suspended ceilings, for example.

The 3D geometry of installation cables and piping systems is not required to be modeled even in sample rooms.

Installation fittings are not taken into consideration in clash detection.

Guideline

An exception can be made on a project-specific basis when separately agreed upon (for example, in element construction targets). In such instances, the need for 3D modeling of installation fittings within the entire building area must be clearly stated in the design agreement.

If the intention is to model the geometry of the installation cables and piping systems within the entire building area, that should also be commissioned separately on a project-specific basis.

6.7 Security systems

Requirements

If a decision is made in the project that security and surveillance systems are to be modeled, they must be modeled in separate BIMs, and the respective IFC files must also be kept separate from other systems. In all cases, the client will decide upon the protection and publishing of information and files concerning security systems.

Guideline

As a rule, access to this information will only be granted to separately designated individuals, and any information related to security and surveillance systems must not even be transferred through unprotected connections.

The client shall provide a project-specific security attachment which clarifies the processing of BIMs for security-classified projects.

6.8 Building contract purchases

Requirements

Smoke-outlet control centers, door control centers and other equipment that is not a part of the electrical contract are modeled using simple 3D objects. The dimensions used shall be based on the designer's knowledge or estimate at that time.

If this equipment is required to be modeled using the dimensions of the actual equipment to be installed and/or 3D objects, this must be separately agreed upon.

7 System BIMs for building automation design

The data modeling tasks of the building automation designer include reservation of the needed space, preparation of service area diagrams and placement of field equipment.

The geometrical and information content of the Building Automation BIM is presented in Appendix 1.

Requirements

The building automation designer has the responsibility to reserve the needed space, for example, a property surveillance room when the building schedule shows it is time to make the space reservations for MEP.

The cooperation between the building automation designer and electrical designer with regard to modeling is agreed upon on a project-specific basis.

The building automation designer is responsible, for example, for modeling the building automation system sub-control centers, the sensors in the sample rooms and areas, control and routing equipment housing, and any other equipment housing that may be part of the system.

Guideline

Usually, projects use the practice of the electrical designer modeling the relevant components as part of a separate Electrical BIM. When this course of action is followed, it is the building automation designer's duty to give precise instructions to the electrical designer regarding the placements of the components, along with their identifiers and external dimensions. In this way, the electrical designer will be able place the components in the right place at one time.

The building automation designer is responsible for the correct placement of the components, regardless of whether this is included in the Electrical BIM or in a separate, partial Building Automation BIM.

8 Combined model

If required, combined models can be prepared from the models of individual designers during the project, and used for visualizing the designs and assessing their compatibility. Examples include the assessment of space provisionsand theverification of the sufficiency of the reserved spaces, examination of the MEP terminal devices as part of the building architecture, clash detections of the MEP systems, and void provisiondesign.

8.1 Geometric accuracy and information content of network modeling

8.1.1 Geometric accuracy

Requirements

Geometric accuracy requirements are presented on a component-specific basis in Appendix 1.

The geometric accuracy of networks must be such that the MEP installations in the building can be carried out on the basis of the BIM. The objective of geometric modeling is to create a BIM without any intersections. In this endeavor, the combined model is helpful.

The objects in a combined model must be located at the level of absolute elevation.

Guideline

A more precise modeling procedure can be agreed upon on a project-specific basis than what is presented in these requirements. When this course of action is followed, the project-specific requirements, in writing, must be appended to the tender documents and delivered to the MEP designers.

The systems are modeled in the 3D format such that the ducts and piping systems bypass one another. In regard to connecting pipes, mutually intersecting DN10-25 piping systems are permitted. Such targets include, for example, connecting pipes to radiators, cooling beams, water fixtures, etc.

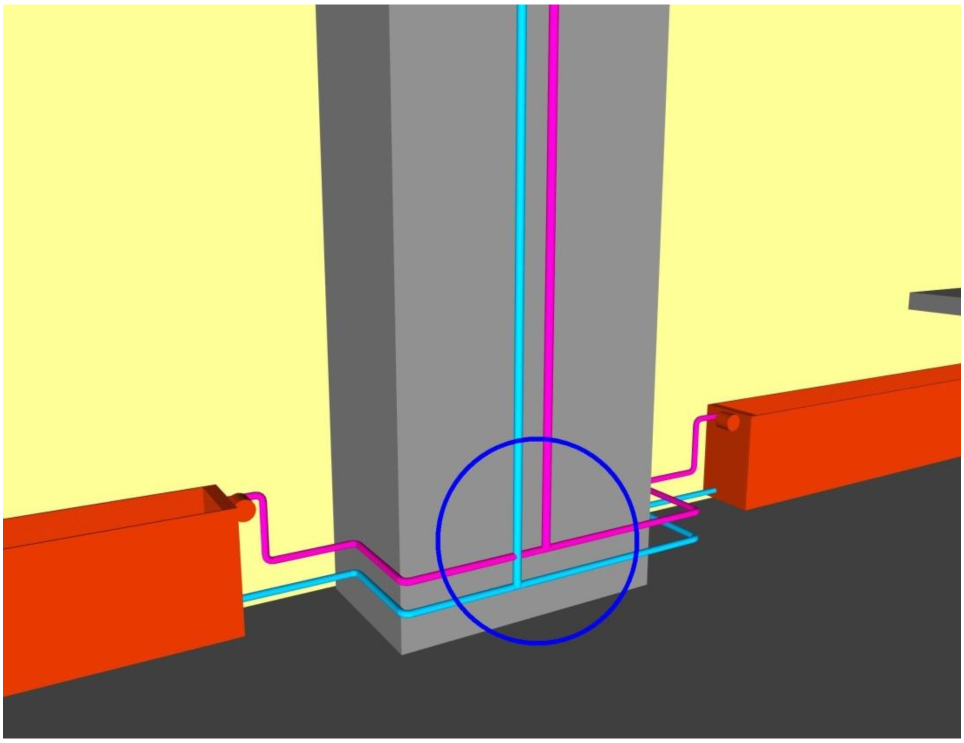

Figure 8.1: Example of radiator connecting pipes which penetrate one another in a permissible manner.

With regard to distribution and trunk pipes, the modeling must be more precise. The more small-dimensioned trunk piping systems (see Appendix 1) are permitted to intersect, although this is not hoped for. The piping-system's start from the trunk pipes must be modeled in a manner that corresponds to reality (the T-fork should be pointing upward or downward).

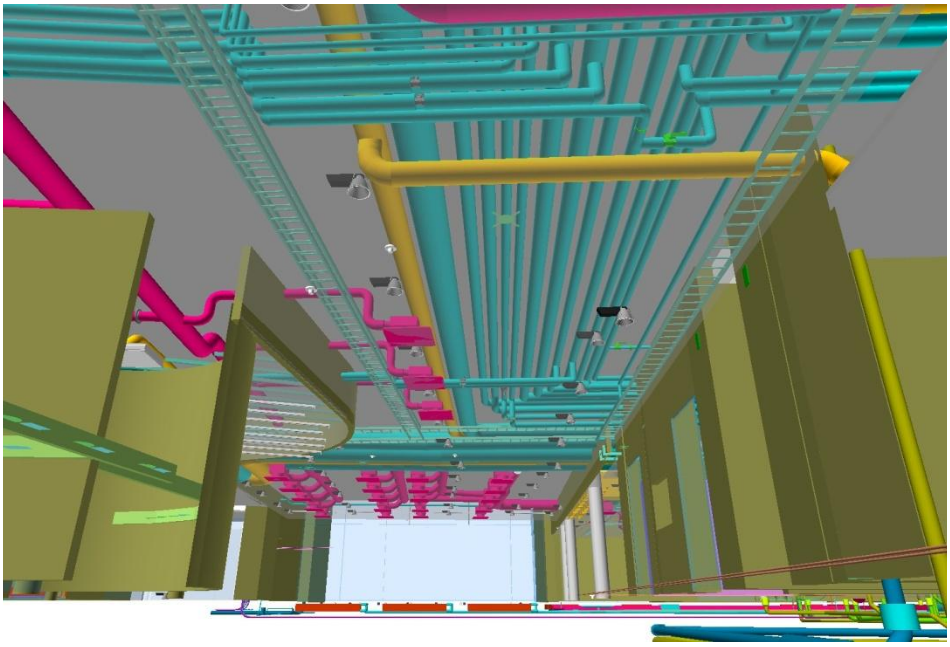

Figure 8.2: Example of piping where the distribution pipes start, as they should, from the trunk, bypassing the other pipes.

The accuracy level required of geometric modeling of networks permits the objects to touch one another slightly, as long as the networks can be installed in work-site conditions without affecting costs and schedules. It must also be taken into consideration that networks are modeled insulated.

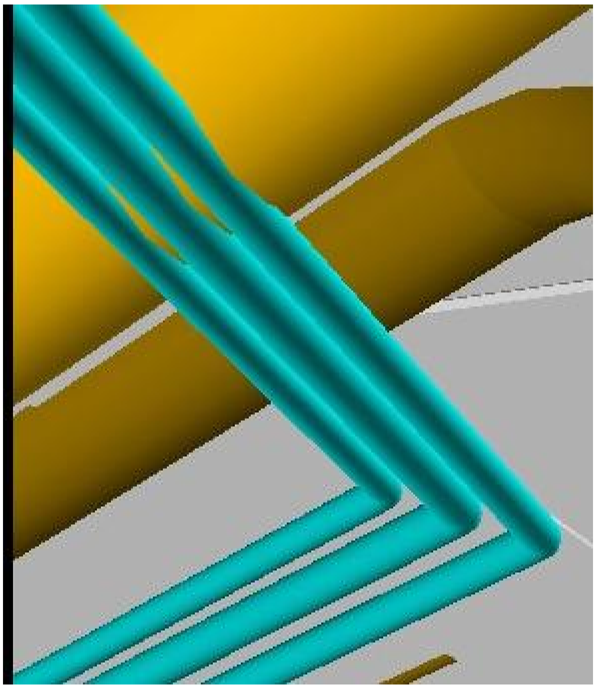

Figure 8.3: Example of permissible – although not hoped-for – touching. The networks can be installed when the piping is moved a little lower.

Geometric modeling does not permit overlapping or clashing of networks, as these would indicate that clash detection has been neglected.

Representatives of each design discipline must conduct separate inspections of the models and report their findings, so that clash detection can be conducted before the networks are delivered to the other party.

It must be taken into account that before MEP networks can be modeled at the required level of accuracy, the MEP designer must have at his or her disposal a structural model of the target which corresponds to the actual target in terms of its main geometry (slab thickness and beam elevations). In addition, the model of the building's suspended ceiling should be available to the MEP designer for the installation of terminal devices and lighting fixtures, along with the suspended ceiling grid distribution (e.g. a 2D drawing of the suspended ceiling).

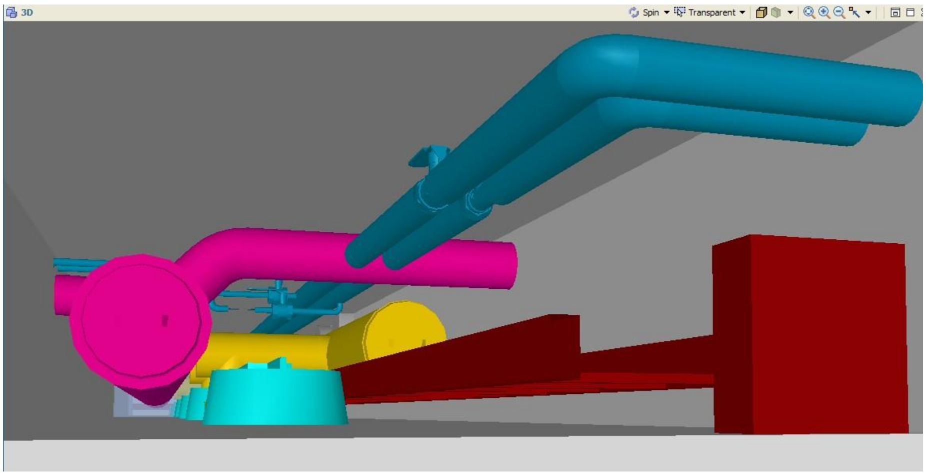

Figure 8.4: Example of an intersection that is not permitted. The model shows that after the ventilation connecting duct is lowered, it is still uncertain whether there is sufficient room for the duct to pass under the pipes.

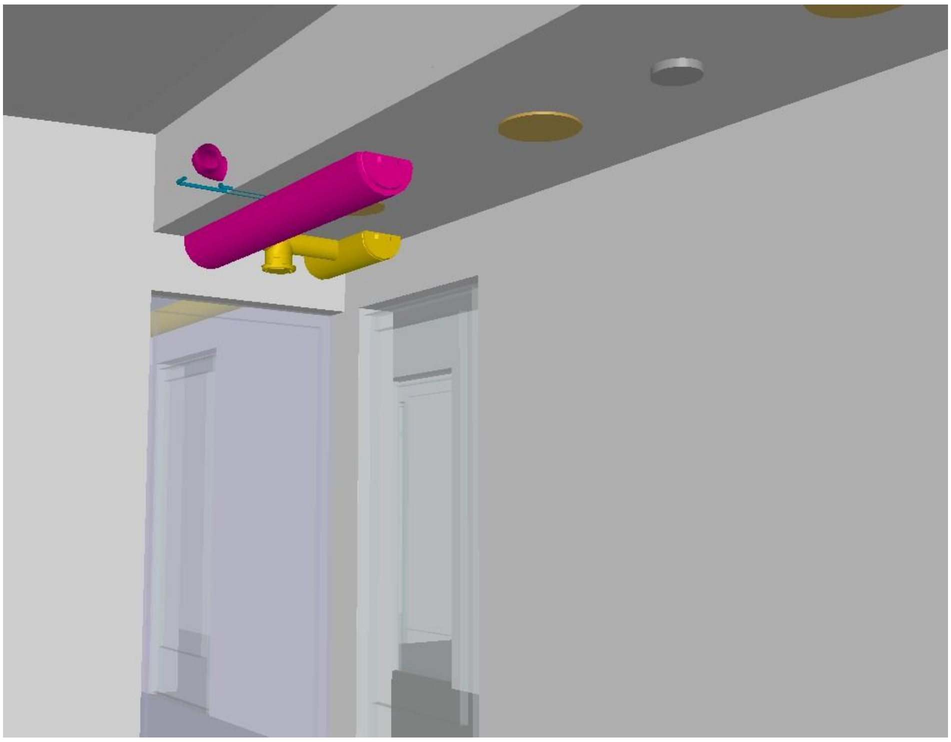

Figure 8.5: Example of modeling that is not permitted. Either the ventilation ducts must be hoisted up, or the suspended ceiling must be lowered.

8.1.2 Information content

Requirements

The information content requirement is presented on a component-specific basis in Appendix 1.

The information content of system models must be reliable. Equipment coding must have identifiers that correspond to those used in other design documentation. When coding, for example, the ventilation terminal device "T1", the product data must be included in the BIM (within the limitations permitted by the software program's equipment databases).

Guideline

If the relevant product is not found in the program's equipment database, the one that is most similar to it should be used. In that instance, the data concerning the relevant product are written in the equipment's free data field (attribute data, property data, etc.) to allow retrieval of the relevant product's model and symbol, if necessary.

The principle of the above-mentioned procedure also applies to, for example, lighting fixtures, water fixtures, piping and duct-system fixtures and other components which contain a common identifier.

When individually coded components are used (e.g. motorized fire damper, airflow regulator, general cabling points, fire detectors, etc.), the individual identifier must be written in the object in a field that allows it to be shown on listings generated from the BIM. Such listings may include, for example, lists of motorized fire dampers, the list of automatic data processing dots, and various checklists during the receiving phase, etc.

Compilation and fulfillment of the components' information content is dependent on the application program used. Individual identifiers, among others, cannot be assigned to all relevant components in all programs.

					Suunnittelijan tiedot:		Ilmav.	Paineh.	Nopeus	Ääni	
Kerros	Huone	Käyttötarkoitus	Systeemi	Tunnu	Laitekoodi	Valmistaja	l/s	Pa	m/s	dB(A)	Esisäätö
2. kerros	H2106	turvavalvomo	310PK	P5	URH/A-160	Halton	20	10	0.99	7	17.19
2. kerros	H2106	turvavalvomo	310PK	P5	URH/A-160	Halton	20	11	0.99	8	15.73
2. kerros	H2106	turvavalvomo	310TK	T7	LPKa2-160-400-	Swegon AB	40	20	3.26	26	1.00

Figure 8.6: Example of a room-specific ventilation terminal device list and balancing information taken from the BIM.

Floor name	Room	Product code	Heating power W	Sizing flow (l/s)	Pressureloss, sizing flow (Pa)	Damper position/ Presetting value	kv-value
5. kerros	5010	PC21S-450-800	700	0,006	13349	1	0,06
5. kerros	5012	PP11-500-1600	800	0,006	4037	2,5	0,12
5. kerros	5012	PP11-500-1600	700	0,006	4198	2	0,1

Figure 8.7: Example of a room-specific radiator balancing list taken from the BIM.

8.2 Integration through the combined model

Requirements

MEP designers must conduct an integration inspection of the technical models among all MEP system models. This is followed by inspecting them against the structural and architectural models.

Guideline

An official inspection is carried out as collaboration between designers or by a third party. Distribution of work shall be agreed upon separately at the beginning of the project. The MEP designer must deliver the IFC files required *for clash detections to the parties conducting the inspection, at a minimum, at the end of each design phase.*

Please take note of the handling during the clash detection procedure of the electrical and telecommunications system components requiring little space (item 6.6).

In addition, each designer has the obligation to conduct separate inspections of the area's modeling accuracy as the design work progresses.

Chapter 8.2 References to the task allocation list (Scope of Work, MEP-design):

G 0 Detailed design, basic tasks:

G 4.5 Integration of designs of different design disciplines
G 5.4 Integration through the combined *model*

8.3 Void Provisions

Requirements

The use of a void provision model and the preparation and responsibility for creating the void provision drawings should always be agreed upon on a project-specific basis.

Guideline

Merging the MEP System BIMs and the structural designer's BIM, and the architect's Building Element BIM, as needed, allows the use of the BIM-based clash-detection procedure to facilitate the location and design of voids..

It should be taken into consideration that automatically generated void provisionsobjects do not always produce the desired end result – the manual procedure is recommended to be used for creating MEP void provisions.

In BIM-based provisions, the structural designer produces the model in the agreed format. The MEP designer uses the model to create void provisions. The model should be story-specific, including the slabs above and the related load-bearing walls.

The MEP designer prepares an IFC-based voidmodel which includes provisionsobjects only. This voidmodel IFC is submitted to the structural designer in a story-specific format.

Each provisionobject must indicate whose provisionsobject it is. The size and IDs of the provisions should be included in the provisionobject as attribute data. The provisions are modeled in the voidmodel such that they are correctly placed in terms of their size and location.

Absolute elevation is used as elevation.

To facilitate visual examination and the preparation of the provisions by the structural designer, the provisionsobjects should be modeled thicker than the structures they penetrate.

The structural designer uses the data from the provisions voidsobjects to prepare the voids and other provisionsin the structures, if structurally possible. If preparation of a void is structurally impossible, the structural designer should inform the MEP designer to that effect. The MEP designer then prepares a new version of the provisions voidobjects based on the structural designer's suggestions and delivers them to the structural designer.

From the technical perspective, it is recommended that when altering already prepared provisions voidsobjects, the provisionsobject is not removed and replaced with a new one. Instead, the object already modeled is altered (for example, by altering its size or location). The reason is that in this way, the software tools identify the provisions voidobject as an altered provision void object, and not as a new object.

In the preparation of element provisiondrawings, BIM-based provision void design is not required for electro-technical piping systems, box holes or other routes traversing the element (lack of MEP application software support for processing element holes). However, provisionswhich penetrate the element completely must be delivered as provision voidobjects. The MEP designer presents the holes and other provisions to the structural designer by means of conventional design methods.

Chapter 8.3 References to the task allocation list (Scope of Work, MEP-design):

G 0 Detailed design, basic tasks:

G 4.4 Provisiondata for load-bearing structures

G Detailed design, discretionary tasks

G 4.17 Further clarification of provisiondata for load-bearing structures

8.3.1 The preparation process of voiddrawings

Requirements

When using BIM-based void provisiondesign, void provisiondrawings, areas of responsibility and operating methods between Structural design and MEP design must be agreed upon on a project-specific basis. The author of 2D void provisions drawings should be cleared with the client at the point of entering into a design contract.

The compatibility of the application programs used by the structural and MEP designers must also be verified on a project-specific basis.

Guideline

BIM-based void provision design can be utilized in different ways in making 2D voiddrawings.

These operating methods or variations thereof can be considered for use when 2D voiddrawings are needed in a building. Operating as described in Chapter 8.3 is the starting point for all operating methods.

Alternative 1:

- *The structural designer delivers 2D and 3D voiddrawing templates to MEP.*
- *MEP utilizes the void provision objects it has created as the basis for compiling a 2D drawing, including grid lines.*
- *Void Provisions are dimensioned primarily in the module network; another alternative used in renovation projects is to dimension them in the existing structures.*
- *2D void provision files are delivered to the structural designer.*
- *The structural designer plots them out and sends the drawings to be distributed.*

Alternative 2:

- *The structural designer delivers the 3D voiddrawing templates to MEP in a story-specific format, using absolute elevation.*
- *MEP prepares the void provisionobjects for the elevation used in the model, and delivers them to the structural designer in the IFC format.*
- *The structural designer prepares 2D penetration drawings, including grid lines and dimensions, based on the void provisionobjects delivered by MEP. The structural designer plots out the drawings and sends them to be distributed.*

Alternative 3:

- *The structural designer delivers the 3D voiddrawing templates to MEP in a story-specific format, using absolute elevation.*
- *MEP prepares the void provisionobjects for the elevation used in the model, and delivers them to the structural designer in the IFC format.*
- *The structural designer prepares the 2D voidimage templates showing the penetration reservations delivered by MEP.*
- *The structural designer places the void provisioninformation grid line in the drawing (e.g. "VC, 300x200, CL=+25.3"). This information is taken from the void provisionobjects delivered by MEP.*
- *The structural designer places in the 2D drawing a dimension line level for the different design disciplines, using the preferred color for the printouts of the dimension lines (= line thickness in a black and white printout).*
- *The structural designer delivers the above-mentioned 2D voidimage templates to MEP.*
- *MEP prepares the dimension lines at the level indicated by the structural designer, using the regular dimensionning tools in the CAD software program.*

- *Void Provisionsare dimensioned primarily in the module network; another alternative used in renovation projects is to dimension them in the existing structures.*
- *2D void provisionfiles equipped with grid lines are delivered to the structural designer.*
- *The structural designer plots them out and sends the drawings to be distributed.*

8.4 Bills of quantities generated from MEP BIMs

Requirements

The MEP BIMs are used for generating quantity information when the task has been ordered from the designer.

The structure of the bill of quantities is agreed upon on a project-specific basis with the client. The designer submits a proposal concerning the structure of the bill of quantities (for example, using a spreadsheet format) and sends it to the client for approval / makes any changes and additions.

The delimitation of the quantity information generated from the model or by other means must be agreed upon separately.

Guideline

For example, when delivering flue elements, adding information content to the element's internal networks, using a separate "status" attribute, has been found a good way to distinguish them from the material listings as separate purchases.

The project's contract limitation enclosure designates purchases and work performances to different contractors. The information in the BIM supports the contract limitation enclosure.

The designer is not required to make component-specific, separately modeled contract markings.

Component- or area-specific markings can be implemented separately when so agreed, for example, to separate technical spaces, shafts, corridor areas, installation scheduling, etc.

Quantity information can also be read directly from the IFC files using applications specifically made for this purpose.

The bill of quantities must be accompanied by a BIM specification that complies with Chapter 2.2.

Chapter 8.4 References to the task allocation list (Scope of Work, MEP-design):

G Detailed design, discretionary tasks:
G 4.11 Bills of quantities

8.5 MEP prefabricated products

The BIM prepared by the MEP designer cannot be used as such for preparing prefabricated parts.

When it is appropriate to make prefabricated products of a given sub-area (e.g. corridor areas, flue systems, shafts, technical areas' piping systems, rectangular duct systems, etc.), the modeling accuracy, methods and software must be suitable for the preparation of prefabricated product models of the intended sub-area..

The design of prefabricated parts is not a part of a MEP designer's regular assignment; however, when separately agreed upon, the designer's BIM can be utilized for modeling prefabricated products.

9 As-built model

Requirements

The MEP designer may be requested to update the System BIM to match the constructed status of the building in the tendering documents, in which case the BIM is referred to as the as-built-model.

Guideline

The as-built model is an updated version of the System BIM. Its information content requirements correspond to those of the System BIM.

The as-built model must include the product data the contractors have selected for the components that are equipped with product data, within the limitations permitted by the MEP design software program's product database's contents.

"Scope of Work, MEP-design" project information card:

Item 2.3 Facility management data management requirements, level 3

9.1 Updating the information content of networks to include contractor information

Requirements

When the design agreement includes an order to update the design-stage network components to correspond to the components selected by the contractor, the designer shall replace the actual products selected by the contractor with the system model.

Guideline

If the right product is not found in the application program database, the designer shall select one that bears the closest resemblance to it. When this course of action is followed, the designer assigns the actual product's type and other necessary data as the attribute data for the selected product.

The intended purpose of use of the BIM shall be clarified before the components are exchanged. If there is no clear purpose of use for the benefit derived from the component exchange, the significance of this work is questionable.

If the BIM will be used in facility management, a project-specific list of the components to be updated shall be drafted (including shut-off valves and lighting fixtures).

When separate MEP-network control drawings are made for the building (Chapter 5.8), the update must apply, at a minimum, to all the components affecting control, for example:

Ventilation:
Ventilation terminal devices, dampers (also air-flow regulators and steady flow regulators, etc.), sound dampers and fire dampers.

Piping systems:
Line control valves, pre-controlled valves with control characteristics, service water points.

Chapter 9.1 References to the task allocation list (Scope of Work, MEP-design):

I Construction, discretionary tasks:
I 4.14 System BIM maintenance at the equipment approval stage
14.15 System BIM maintenance using the final data

9.2 Updating the network geometry to include contractor information

Requirements

When the design agreement includes the preparation of what are known as "red ink drawings" for the purpose of generating geometric models at the as-built level (=as-built model), the MEP contractors shall jointly deliver to the MEP designer the information concerning the changed network routes.

The MEP designer shall model the BIM's geometry based on this information.

Guideline

The contractors have a mutual responsibility to check from each other's drawings or models that the network changes are included in the red ink drawings of all contractors.

For example, a ventilation routing change may mean that the plumbing and electrical contractor's drawings also need to be changed. These changes must be presented to the designer so that they are included in the drawings of each contractor to enable the updating of the 3D model.

Alternatively, the changed part can be photographed by the contractors, and the photograph used to determine the principles that apply to the changes.

Chapter 9.2 References to the task allocation list (Scope of Work, MEP-design):

I Construction, discretionary tasks:
I 4.15 Combined *model maintenance using final data*
J Commissioning, discretionary tasks
J 4.3 Delivery drawings

MEP-BIM, components to be modeled, information content and geometric accuracy level by design stage

2D: presentation in 2D-drawings or schematic diagrams
BIM: Modelling according designphase geometryinformation
Empty cell= No modelling or information requirements

Even some componens are not required to be modelled, it is not forbidden to do so
More information for data content in end of this chart
Every component has to have network or system identifier in data content

Conditions for achieving succesful geometry accuracylevel: Structural and Architectural 3D-models available for MEP-designer before MEP modelling starts

Component / Funktion	Design Development				Detailed Design			
	2D	BIM	Accuracy of geometry	Information content	2D	BIM	Accuracy of geometry	Information content within main networks and systems
MEP (common)								
MEP Requirement model			Chapter 3	Chapter 3			Chapter 3	Chapter 3
2D-section drawings	x		Piping, ducts, cable trays, lighting fixtures etc tolerance 1 cm, with pipe/duct insulation	Corridors, shaft exits etc. HVAC-designer coordinates section drawing content	x		Piping, ducts, cable trays, lighting fixtures etc tolerance 1 cm, with pipe/duct insulation and brackets / supports	Window sills, corridors, shaft exits etc. HVAC-designer coordinates section drawing content
Void provisions					x	x	Correct placement, tolerance 0cm	Dimensions, information of contractor, absolute height
Suspended ceiling components					x	x	In place seen in architectural suspended ceiling drawing /model. All components involveld with suspended ceilings will be modelled..	For succesful MEP modelling architectural 3D-ceiling and 2D-drawing with panel framing needed.
Mock-up rooms and -areas		x	Chapter 4.3, tolerance 5cm	Chapter 4.3		x	Tolerance 5cm	For succesful MEP modelling, architectural and structural 3D-model needed.
Service area charts	x		According the spaces. If space object has to be splitted, the work belongs to MEP-designer	Service area identifier (for example, AHU-zone "301AHU01", Service area "Offices")	x		According the spaces. If space object has to be splitted, the work belongs to MEP-designer	Service area identifier (for example, AHU-zone "301AHU01", Service area "Offices")

Component / Funktion	**Design Development**				**Detailed Design**			
	2D	BIM	Accuracy of geometry	Information content	2D	BIM	Accuracy of geometry	Information content within main networks and systems
BIM specification				Chapter 2.2				Chapter 2.2
Service hatchs					x		Informational location. Real location is made in constraction site according architectural drawings. Sufficient access for serviceable components has to be fulfilled	
Prefabricatred products				Chapter 8.5				Chapter 8.5
Components outside of BIM-software catalog, so-called "selfmodelled 3D-parts"					x	x	Outer diameters according designers estimate	Label, network system information

Component / Funktion	Design Development				Detailed Design			
	2D	BIM	Accuracy of geometry	Information content	2D	BIM	Accuracy of geometry	Information content within main networks and systems
Piping networks								
Main pipe routes DN20 - DN32 Cu18 - Cu35	x	x	Under the slab, demonstrating routing. Cannot be used for void provisions nor bill of quantities.		x	x	In place of the 2D-section drawings. Must be possible to make installation according the combied model analysis	Material DN-size, Volume flow, Pressure level
Main pipe routes DN40 -> Cu42 ->	x	x	Under the slab, demonstrating routing. Cannot be used for void provisions nor bill of quantities.		x	x	In place of the 2D-section drawings. Must be possible to make installation according the combied model analysis	Material, DN-size, Volume flow, Pressure level. In 2D-drawings, absolute height level in dimension line (to center of pipe)
Connecting pipes					x	x	Must be possible to make installation according the combied model analysis. Pipes of DN10-25 can intersect each others	Material, DN-size, Volume flow, Pressure level
Insulation						x	No requirement for seperate insulation object on pipe. Pipe outer diameter has to contain insulation thickness	Type of insulation and thickness. If Sheet metal or another material clearly affecting costs, information has to be in data content of pipe and in dimension line.
Stop valve					x	x	Outer diameter according to chosen component	Model, DN-size, Pressureloss
Valve with pre-setting					x	x	Outer diameter according to chosen component	Model, DN-size, Volume flow, Pressureloss, Pre-setting value, Label
Control valve					x	x	Outer diameter according to chosen component	DN-size, Volume flow, Pressureloss, Label
Other valves					x	x	Outer diameter according to chosen component	DN-size, Pressureloss
Air vent					x	x	Outer diameter according to chosen component	DN-size, Label
Strainer					x	x	Outer diameter according to chosen component	DN-size, Label
Elastic joint					x			DN-size
Safety valve					x			DN-size, Label
Expansion tank					x	x	Over 100 dm3 tanks must be modelled	Volume
Heat exchanger					x	x		Power or Volume flow, Pressureloss
Heat distribution center	x	x	Suggestive placement		x	x	Outer diameter according to chosen device	Power or Volume flow of connecting networks, Pressureloss
Water cooling unit	x	x	Suggestive placement		x	x	Outer diameter according to chosen device	Power or Volume flow of connecting networks, Pressureloss
Components or equipments on the roof or fasade	x	x	Suggestive placement		x	x	Outer diameter according to chosen component or device	Label
Other main units	x	x	Suggestive placement		x	x		Label
Fluid containers					x	x	Over 100 dm3 tanks must be modelled	Volume
Manifold					x	x		Label
Underfloor heating pipes					x		Chapter 5.4	Material, DN-size, Volume flow, Pressure level. Look at Chapter 5.4
Radiators and convectors					x	x	Outer diameter according to chosen device	Model, Power (look also "Valve with presetting")

Component / Funktion	Design Development				Detailed Design			
	2D	BIM	Accuracy of geometry	Information content	2D	BIM	Accuracy of geometry	Information content within main networks and systems
Fancoil					x	x	Outer diameter according to chosen device	The need of Power or Volume flow, Pressureloss, Label
Ducted coils					x	x		The need of Power or Volume flow, Pressureloss, Label
Water tap					x	x	In place seen in architectural model	Model, nominal flow, Pressureloss, Label
Washbasin, toilet-seat etc.							In place seen in architectural model	No requirement for presentation. According architectural model
Fire hydrants, hose reels					x	x	In place seen in architectural model, outer diameter according to chosen component	Model, Designflow, Pressureloss, Label
Sewer without dumps	x	x	Informational location, Cannot be used for void provisions nor bill of quantities.		x	x		Material, DN-size
Sewers according Chapter 5.2					x	x	In place of the 2D-section drawings. Must be possible to make installation according the combied model analysis.	Material, DN-size
Fire valve					x	x		DN-size, Label
Inspection pipes / components					x	x		DN-size, Label
Floor drain					x	x	In place seen in architectural model	Model, DN-size, nominal flow, Label
Roof outlet					x	x	In place seen in architectural roof drawing / model	DN-size, Label
Rain and sewer water gullys in courtyard					x		In place seen in courtyard drawing / model	Minimum Label presentation: 2D-dimensionline
Trapping devices in courtyard (sand or oil traps etc.)	x		Suggestive placement		x	x	In place seen in courtyard drawing / model	Minimum Label presentation: 2D-dimensionline
Inspection pipes in courtyard					x		In place seen in courtyard drawing / model	Minimum Label presentation: 2D-dimensionline
Gullys inside foundation wall					x	x		Minimum Label presentation: 2D-dimensionline
Trapping devices inside foundation wall	x		Suggestive placement		x	x		Minimum Label presentation: 2D-dimensionline
Inspection pipes inside foundataion wall					x	x		Minimum Label presentation: 2D-dimensionline
Network drainage valves							Presentation in schematic diagrams	
Flanges, joints and connection types							Presentation in other documents	
Sensors (TI, PI, TE, PE, PDE etc.)							Presentation in schematic diagrams	
Sensor pockets (pipes)							No presentation	
Piping supports, brackets							Presentation in 2D-section drawings	
Srinkler hoses					x	x	Presentation according to the suspended ceiling drawings	K-value, DN-size
Piping inside heat distribution room					x	x	Main pipe routes will be modelled	Material, DN-size, Volume flow, Pressure level
Piping inside water cooling unit room					x	x	Main pipe routes will be modelled	Material, DN-size, Volume flow, Pressure level
Water cooling unit pumps					x	x	Suggestive placement will be modelled	Label

Component / Funktion	Design Development				Detailed Design			
	2D	BIM	Accuracy of geometry	Information content	2D	BIM	Accuracy of geometry	Information content within main networks and systems
Water cooling unit room mixing units and components					x		Presentation in schematic diagrams	
Main pipe routes inside air handling unit room						x	In place of the 2D-section drawings. Must be possible to make installation according the combied model analysis.	Material, DN-size, Volume flow, Pressure level
Connectinpipes inside air handling unit room						x	In place of the 2D-section drawings. Must be possible to make installation according the combied model analysis.	Material, DN-size, Volume flow, Pressure level
Air handling unit pumps and water mixing units					x		Operative presentation in schematic diagrams, suggestive placement of "box-object" will be modelled	Unitlabel presentation in 2D-drawings with dimensionline
Other technical rooms					x	x	Main pipe routes will be modelled	Material, DN-size, Volume flow, Pressure level
Mixing units and components inside of other technical rooms					x		Operative presentation in schematic diagrams, suggestive placement of "box-object" will be modelled	
Shafts and flues			Chapter 4.1		x	x	Main piping will be modelled with insulations. Must be possible to make installation according the combied model analysis.	Like main pipe routes

Component / Funktion	**Design Development**				**Detailed Design**			
	2D	BIM	Accuracy of geometry	Information content	2D	BIM	Accuracy of geometry	Information content within main networks and systems
Ventilation								
Main air duct routes	x	x	Under the slab, demonstrating routing. Cannot be used for void provisions nor bill of quantities..		x	x	In place of the 2D-section drawings. Must be possible to make installation according the combied model analysis	Material, koko, Volume flow, Pressure level. In 2D-drawings, absolute height level in dimension line (to center of duct)
Connecting duct					x	x	In place of the 2D-section drawings. Must be possible to make installation according the combied model analysis	Material, koko, Volume flow, Pressure level
Insulation					x	x	No requirement for seperate insulation object on duct Duct outer diameter has to contain insulation thickness	Type of insulation and thickness. If Sheet metal or another material clearily affecting costs, information has to be in data content of pipe and in dimension line.
Enclosed airhandling units	x	x	Suggestive placement and outer diameters		x	x	Designer makes dimensioning using AHU manufacturer software and uses primarily 3D-AHU object produced by software	Label
Roof exhaust fan	x	x	Suggestive placement and outer diameters		x	x	In place of façade and / or roof drawings. Outer diameters according to chosen product	Label, Dimensions
Duct fan	x				x	x		Label, Dimensions
Extract louvres and cowls	x	x	Suggestive placement and outer diameters		x	x	In place of façade and / or roof drawings. Outer diameters according to chosen product	Label, Dimensions
Air intake louvres	x	x	Suggestive placement and outer diameters		x	x	In place of façade and / or roof drawings. Outer diameters according to chosen product	Label, Dimensions
Terminal device					x	x	In place of suspended ceiling drawing and -model. Outer diameters according to chosen product	Model, Dimensions, Label , Air volume flowrate, Pressureloss, Sound level, Pre-setting value
Transfer air device					x	x	Outer diameters according to chosen product	Model, Dimensions, Label
Flow damper					x	x	Outer diameters according to chosen product	Model, Dimensions, Label, Air volume flowrate, Pressureloss, Pre-setting value
Air flow management damper					x	x	Outer diameters according to chosen product	Model, Dimensions, Air volume flow rate, Pressureloss, Unique Label
Firedamper					x	x	Outer diameters according to chosen product	Model, Dimensions, Pressureloss, Label
Firedamper with motor					x	x	Outer diameters according to chosen product	Model, Dimensions, Pressureloss, Unique Label
Duct silencer					x	x	Outer diameters according to chosen product	Model, Dimensions, Air volume flowrate, Pressureloss, Label
Cleaning cover					x	x		Label
Coils in ducts	x				x	x	Outer diameters according to chosen product with correct face velocity	Dimensions, Label
Components affecting air quality (filters etc.)	x				x	x	Outer diameters according to chosen product with correct face velocity	Dimensions, Label
Elastic joint					x			Label

Component / Funktion	**Design Development**				**Detailed Design**			
	2D	BIM	Accuracy of geometry	Information content	2D	BIM	Accuracy of geometry	Information content within main networks and systems
Supports, brackets							Presentation in 2D-section drawings	HVAC-designer coordinates section drawing content
Sensors							Presentetation in Building Automation System diagrams	
Duct connection types (butt joints, flanged plates etc)							No presentation required, connection type information listed in other documents	
Shafts and flues			Chapter 4.1		x	x	Ducts and components will be modelled with insulation	Data content of Ducts and components like elsewhere in this chart

Component / Funktion	Design Development				Detailed Design			
	2D	BIM	Accuracy of geometry	Information content	2D	BIM	Accuracy of geometry	Information content within main networks and systems
Electrical design								
Transformer	x	x			x	x		Label
Switchgear	x	x			x	x		Label
Main exchange	x	x			x	x		Label
Conductor rail					x	x		Dimensions
Compensating batteries	x	x			x	x		Label
Accumulators	x	x			x	x		Label
Distribution center	x	x	Within distribution mains		x	x		Label
Crossconnection frame	x	x			x	x		Label
Mainframes of communication systems	x	x			x	x		Label
Mainframes of security systems	x	x			x	x		Label
Cable trays and suspensions	x	x	Within main routes		x	x		Dimensions, Type (ladder/platetray). Absolute height value in dimension line from bottom of cable tray
Floor ducts and casings	x	x	Within main routes		x	x		Dimensions
Risers			Chapter 4		x	x		Dimensions
Supports, brackets							Presentation in 2D-section drawings	HVAC-designer coordinates section drawing
Lighting fixtures	x		Level in Mock-up rooms: BIM		x	x		Label
Escape lighting fixtures			Level in Mock-up rooms: BIM		x	x		Label
Safety lighting fixtures			Level in Mock-up rooms: BIM		x	x		Label
Switch			Level in Mock-up rooms: BIM		x		Level in Mock-up rooms: BIM	Type
Sockets			Level in Mock-up rooms: BIM		x		Level in Mock-up rooms: BIM	Type e.g. "Grounded socket"
Movement- or presense detectors			Level in Mock-up rooms: BIM		x		Level in Mock-up rooms: BIM	Label
Safety coupling			Level in Mock-up rooms: BIM		x		Level in Mock-up rooms: BIM	Type, e.g. "Safetyswitch"
Distribution box					x			
Loudspeaker			Level in Mock-up rooms: BIM		x	x		Type
Camera			Level in Mock-up rooms: BIM		x		Level in Mock-up rooms: BIM	Type
Fire detector			Level in Mock-up rooms: BIM		x		Level in Mock-up rooms: BIM	Type, Address
Fire buttons			Level in Mock-up rooms: BIM		x		Level in Mock-up rooms: BIM	Type, Address
Signaling device			Level in Mock-up rooms: BIM		x		Level in Mock-up rooms: BIM	Type
Other communication system sensors and devices			Level in Mock-up rooms: BIM		x		Level in Mock-up rooms: BIM	Type
Other safety system sensors and devices			Level in Mock-up rooms: BIM		x		Level in Mock-up rooms: BIM	Type
Data sockets			Level in Mock-up rooms: BIM		x		Level in Mock-up rooms: BIM	Type, Label, Address
Rising mains			Within main routes, presentation in schematic diagrams				Presentation in schematic diagrams	
Communication main feeds			Within main routes, presentation in schematic diagrams				Presentation in schematic diagrams	

Component / Funktion	Design Development				Detailed Design			
	2D	BIM	Accuracy of geometry	Information content	2D	BIM	Accuracy of geometry	Information content within main networks and systems
Cabling of electric devices / sockets					x			
Cabling of comminivation devices / sockets					x		"Star networks" presentation in schematic diagrams	
Cadling of safety systems					x		Star networks presentation in schematic diagrams	
End users equipments							No requirement for designing, to be noticed in connections	
Equipments outside electric acquistion					x	x		Type
Building automation systems								
Sub-control units	x	x			x	x		Label
Visible sensors					x		Level in Mock-up rooms: BIM	Label
Sensor in MEP-networks, not visible					x			Label
Control equipment boxes					x		Level in Mock-up rooms: BIM	Label
Regulating unit					x			Label

"2D" in chart above means:

- Functionalities are presented in schematic diagrams
- Component locations are presented in 2D-drawings
- 2D-symbolpresentation is acceptable

"BIM" in chart above means:

- 3D-components are primaly from softwares product libraries, with IFC-compatible information and geometry
- Minimum information content of IFC-files according chart above

Location:				
Time:				
Auditor:				
Target Model:				
Versions:				
Date of Model Versions:				
Checklist for HVAC System BIM	Passed	issues	Not Relevant	Comments
BIM Specification				
Models are in Agreed File formats (IFC and other agreed files)				
Model has Floors				
Components Belong to Correct Floor				
Agreed/Required Components are Modeled				
Components are Modeled Using Correct Tools				
System is Defined for all Components				
System Names are According to Agreed List				
System Colors are as Agreed				
Model Doesn't Have Extra Components				
Model Doesn't Have Components Inside Each Other or Duplicate Components				
Model Doesn't Have Significant Intersections Between Components				
Air Handling Units are Included				
No Significant Intersections With Electrical Components				
No Significatn Intersections With Building Elements				
Only Agreed Intersections Between HVAC and Architectural BIM				
System Components Have Balancing Information (at least volume flow and pressure levels)				
Components Have Identification Data According to Part 4/Appendix 1				

Signature:

Location:				
Time:				
Auditor:				
Target Model:				
Version:				
Date of Model Versions:				
Checklist for Electrical Element BIM	Passed	Issues	Not Relevant	Comment
BIM Specification				
Models are in Agreed File Formats (IFC and other agreed files)				
Model has Floors				
Components Belong to Correct Floor				
Agreed/Required Components are Modeled				
Components are Modeled Using Correct Tools				
Model Doesn't Have Extra Components				
Model Doesn't Have Components Inside Each Other or Duplicate Components				
Model Doesn't Have Significant Intersections Between Components				
No Significant Intersections With HVAC Components				
No Significant Intersections With Building Elements				
Only Agreed Intersections Between Electrical and Architectural BIM				
Components Have Identification Data According to Part 4/Appendix 1				

Signature: