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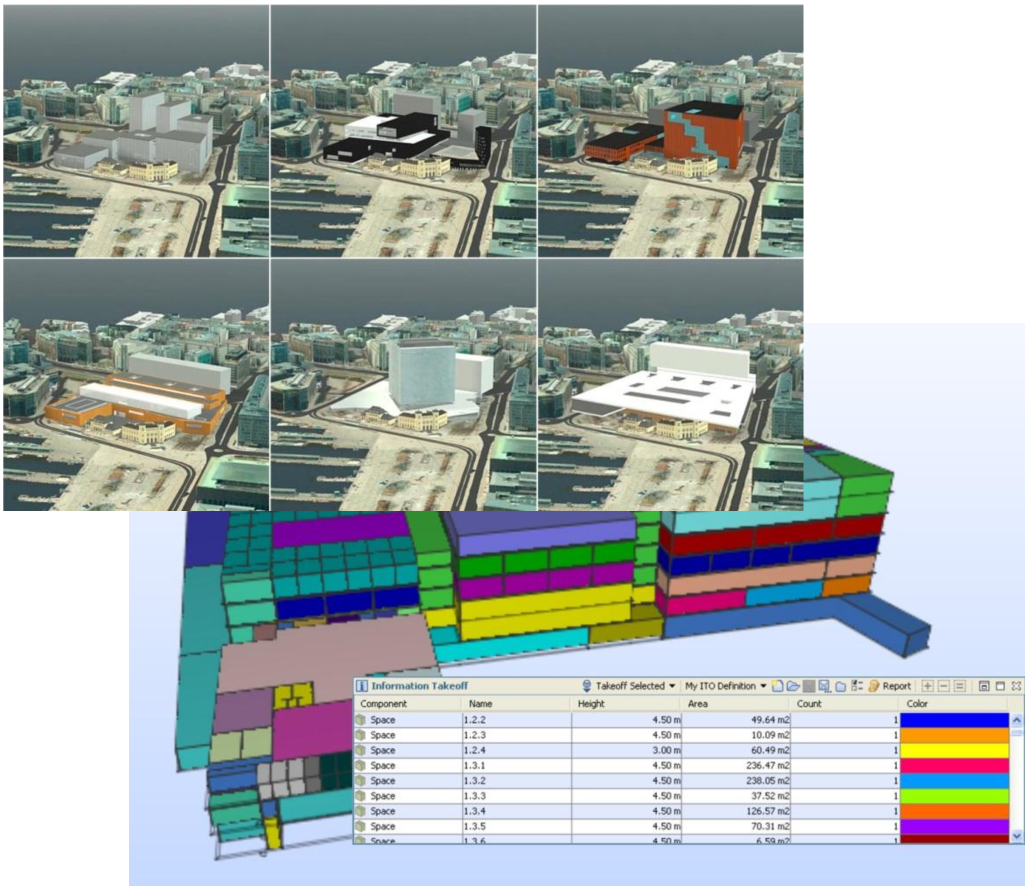
ENGLISH VERSION

Statsbygg BIM Manual 1.2



Illustrations: From Architectural Competition for new National Museum at Vestbanen, Oslo

Statsbygg Building Information Modelling Manual

Version 1.2 (SBM1.2) – Date: 2011-10-24

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A. Introduction

A.1 Scope (Informative)

This document is designated as the "Statsbygg Building Information Modelling Manual - version 1.2", and is also referenced by the acronym "SBM1.2". The acronym "SBM" is used to reference the most recent version of the manual at any given time.

SBM1.2 contains Statsbygg's generic requirements for Building Information Modelling (BIM) in projects and at facilities. The manual is based on the previous versions 1.0 and 1.1 of the manual, experience acquired from actual Statsbygg building projects and R&D projects.

This manual and prior versions of the manual can be downloaded from www.statsbygg.no/bim.

INFO: Prior versions of SBM exist only in Norwegian.

Feedback is welcomed at bim@statsbygg.no.

Statsbygg's BIM website is http://www.statsbygg.no/bim (most of the text is currently in Norwegian).

The purpose of SBM is to describe Statsbygg's requirements in respect of Building Information Models (BIM) in the open Industry Foundation Classes (IFC) format– both generic requirements and discipline specific requirements. The requirements may be supplemented or altered during operational projects.

The main target audiences for SBM are design teams, client project and facility managers, and domain practitioners involved in BIM processes. SBM may also be relevant in order to provide guidance for software application providers.

It is intended that any supplements will be merged into or appended at the end, published as numbered amendments.

A.2 Out of Scope (Informative)

SBM is not intended to be a CAD manual – i.e. requirements relating to the production of CAD *drawings* (plans, sections, elevations, etc.). For CAD requirements please refer to Statsbygg document "*PA 0603 DAK-tegninger*" (Norwegian version only).

SBM does not describe BIM processes as such – however certain aspects of BIM processes are mentioned in context with requirements relating to BIM deliverables.

SBM does not describe legal contractual conditions – however, clauses, chapters or the entire manual may be specifically *assigned* a legal role in individual projects by the project management.

SBM is not intended to contain open BIM textbook information. However, some short introductory texts are included as INFO in some clauses where it is believed that this will ease understanding of the context of the requirements for the reader.

For basic IFC-based open BIM information, please refer to any of a number of open BIM related websites and their links, including http://buildingsmart.com, http://www.buildingsmart-tech.org, and http://www.ifcwiki.org. Norwegian language BIM pages include http://www.buildingsmart.no, and http://www.iai.no.

A.3 References (Normative)

The following referenced documents are relevant for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/TS 12911 Framework for Building Information Modelling Guidance (acronym: **FBG**)

ISO 29481-1 Building information modelling -- Information delivery manual -- Part 1: Methodology and format (acronym: **IDM**)

ISO/PAS 16739:2005 Industry Foundation Classes, Release 2x, Platform Specification (IFC2x Platform) (A revision is being developed) (acronym: **IFC**)

> INFO: The Acronym "IFC" is used to reference both the ISO platform specification and the actual release of the IFC standard, e.g. "IFC 2x3". When referenced only as "IFC" and unless otherwise specified, the term shall be interpreted as "the most recent release based on the ISO platform specification".

ISO 12006-2 Building construction -- Organization of information about construction work -- Part 2: Framework for classification of information

ISO 12006-3 Building construction -- Organization of information about construction work -- Part 3: Framework for object-oriented information (acronym: **IFD**)

NS 3451 Table of building elements [no: *Bygningsdelstabell*] (acronym: **NS 3451**)

> INFO: The NS 3451 contents roughly correspond to element tables such as 'OmniClass Table 21 – Elements'.

NS 3940 Areas and volumes of buildings [no:*Areal- og volumberegning av bygninger*] (acronym: **NS 3940**)

NS 8351 Building drawings - Computer aided design (CAD) – Layers [no:*Byggetegninger - Datamaskinassistert konstruksjon (DAK) – Lagdeling*] (acronym: **NS 8351**)

> INFO: Norwegian standards can be obtained from Standards Norway – *www.standard.no*.

A.4 Terms and definitions (Normative)

For the purposes of this document, the following terms and definitions apply.

BIM Objective

The specific goals/purpose of BIM usage in a defined context (phase, participant role set, analysis/simulation, etc.) are termed BIM Objectives.

Phase

Phases are defined by mapping *Statsbygg Project Model Phases* (and *Stages*) to *Process Protocol* (http://www.processprotocol.com) Reference Phases. Both *stages* and *phases* are applicable for defining deliverables.

Discipline

Disciplines are defined by using a Statsbygg selected subset of *OmniClass Table 33 – Disciplines* (http://www.omniclass.org).

Participant role

Participant Roles are defined by using a Statsbygg selected subset of *OmniClass Table 34 – Organzsational Roles* (http://www.omniclass.org).

Entity

Entities are "things" in the modelled world that has a distinct, separate existence, although it need not be a material existence. Statsbygg has specific requirements relating to a number of IFC entities, their object existence, attributes, properties and relationships. The requirements may be mandatory in every context ("basic BIM") or they may be valid only for specific contexts (BIM objectives, phases, disciplines, participant roles, etc.). Entity requirements take precedence over more generic / "higher level" requirements only when they prescribe a more detailed solution.

A.5 Table Conventions

All requirements in the tables are tagged with a requirement ID number (Ref#) for easy reference (e.g. "Ref#6").

Defined requirement types are categorised as:

MAND = Mandatory requirement that *shall/must* be met; an absolute requirement of the specification.

REC = Recommended requirement that *should* be met; means that there be valid reasons in particular circumstances for ignoring this, but the full implications must be understood and carefully weighed before choosing a different course.

OPT = Optional requirement that may or can be taken into account - means that this is truly optional, i.e. it is admissible and possible to take this into account, or to refrain from doing so.

NOT REC = Discouraged action/solution that should be avoided; means that there may be valid reasons in particular circumstances when the particular behaviour is acceptable or even useful, but the full implications should be understood and the case carefully weighed before choosing this course.

NOT = Prohibitive action/solution that shall/must *NOT* be carried out; means that the definition is an absolute prohibition of the specification.

INFO = Information that should be noted.

(…) = Bracketed requirements are *conditional*; they indicate that IF one of several described alternative solutions represents the current situation, THEN it is required according to the requirement type (MAND or REC).

All requirement types are not necessarily used actively in this version of the document, but may be used in future amendments.

A.6 Norwegian phrases and acronyms

For some phrases (terms) or acronyms the Norwegian wording is provided for reference when working on Statsbygg projects. They are expressed in *italics* in square brackets, prefixed with "no:" – e.g. [no:*BTA*].

B. Generic Requirements (Normative)

B.1 Basic BIM requirements

Statsbygg has defined the following set of "Basic BIM" requirements that apply to *all* BIM deliverables, regardless of the BIM objective, Phase, Discipline, etc. – unless otherwise agreed in the project.

BIM deliverables – Main targets

Ref.#	Subject	Type	Requirement and description
1.	Open BIM deliverable	MAND	A digital 3D building information model (subsequently denoted as "the BIM" or similar) based on object-based design (using objects with properties and relationships) and using open BIM standards/formats is a main deliverable. This implies that the Model Element Authors (MEA) must use a suitable object-oriented BIM authoring tool that efficiently supports the specified open standards as defined in this specification.
2.	BIM objective(s)	MAND	The Basic BIM requirements shall be met regardless of the BIM objective(s). The BIM shall be modelled for the specific BIM objective(s) specified in the project – expressed or implied. If for some reason any of the BIM requirements cannot be met by the modelling author or the BIM authoring tools used by the modelling author, the client shall be notified and a stopgap solution for providing the BIM information shall be suggested by the modelling author.

BIM – Generic requirements

Ref.#	Subject	Type	Requirement and description
3.	Open digital storage format for BIM to be submitted to client	MAND	The BIM authoring tool must efficiently support import and export in the open *Industry Foundation Classes* (IFC) BIM format. The core model of IFC is an ISO specification – ISO/PAS 16739. The BIM shall be submitted to the client in IFC 2x3 format. Both IFC STEP, Part 21 (**.ifc** extension) and ifcXML, Part 28 (**.xml** or **.ifcxml** extensions) files are accepted.
4.	IFC release to be used	MAND	Unless otherwise stated, IFC Release 2x3 (subsequently denoted as IFC 2x3) open BIM format shall be used. The client may opt to accept newer IFC versions than IFC 2x3, provided all relevant modelling author disciplines are capable of efficiently supporting the newer version.
5.	Entire IFC model allowed	INFO	It is permissible to use the *entire* IFC 2x3 model as published on the following website: http://www.buildingsmart-tech.org/ifc/IFC2x3/TC1/html/index.htm

Ref.#	Subject	Type	Requirement and description
6.	BIM authoring tool information	MAND	At project start-up MEAs shall inform the client about which BIM authoring tool(s) that efficiently support IFC they are intending to use for the project. This information shall include: 1.1. Name of commercial CAD/BIM product 1.2. Version/release/build of product (e.g. “8.2”) 1.3. Any plugin/add-on relevant to IFC-based BIM generation (e.g. “IFC Plugin v 2.3”) that may apply 1.4. OS/platform used (e.g. 64 bit MS-Windows 7) 1.5. If there are plans for upgrading or replacing existing products/platforms during the project period, an indication shall be provided of what/when/how 1.6. If *multiple* products are used, an indication shall be provided of the scope of use and information as indicated above for *each* product. If the modelling author intends to change BIM authoring tools during the project period, the client must be informed about such changes in advance. Any BIM authoring tool that does *not* efficiently support IFC import/export for fulfilling client BIM requirements can be rejected by the client for use on the project.
7.	Original digital storage format for BIM to be submitted to client	MAND	In addition to the IFC open format BIM – which is the main deliverable - the *original* modelling format from the BIM authoring tool used (e.g. ***.rvt** files from Revit or **.pla** from Archicad) , inclusive of library objects in active use in the model, shall also be submitted to the client.

Ref.#	Subject	Type	Requirement and description
8.	BIM file naming conventions	MAND	Unless otherwise stated in the project BIM file, names shall conform to the following naming scheme: **SB_PN_PH_DI_SD_n_t** where **SB** = An acronym for Statsbygg. **PNr** = The Client's Project Number or other Project Reference ID. Statsbygg uses a 5-digit project number for its building construction projects (e.g. "11096"). **PH** = The Client's Phase Number ID. Statsbygg Phase Numbers (Statsbygg_PhaseNumber) are integer values in the range 1-15, and are mapped to *Process Protocol* (PP) reference phases, as provided in an appendix. **DI** = Discipline ID. Statsbygg normally applies local Norwegian acronyms that are well established in the Norwegian AEC sector, e.g. "ARK" for Architecture and "RIE" for Electrical Engineering. An English/Norwegian enumeration list is provided in another chapter, based on a subset of OmniClass Table 33. **SD** = Any relevant subdivision (one or multiple) agreed in the project, e.g. if IFC files are submitted by building storey, the storey number may be a subdivision. If the project consists of several buildings, the building name or number may be a subdivision. The SD may be "empty" if no subdividing of the model is relevant. **n** = 1, 2, 3, … if multiple files are submitted within the subdivision. If only one file is submitted the number can be set to "1" or preferably omitted. **t**= Any optional text string agreed in the project further describing the file content - with a subset of the ASCII character set consisting of the letters **a-z** , **A-Z**, the numbers **0-9**, and the underscore (_) character. Nordic characters "æäøöå/ÆÄØÖÅ" and other special characters should not be used in order to avoid unnecessary character set issues in the file exchange. Nordic characters can be replaced as follows: æä/ÆÄ→ae/AE, øö/ØÖ→oe/OE, å/Å→aa/AA.

Ref.#	Subject	Type	Requirement and description
			File extensions are .ifc, .xml, or .ifcxml for IFC files, and "normal" application specific extensions for original format BIMs (like .rvt, .pla, etc.). Example file names (IFC and original BIM): Sb_11096_5 _RIE_2_Laboratory.ifc Sb_11096_5 _RIE_2_Laboratory.pla
9.	Project units	MAND	Relevant measurement units must be defined at **IfcProject** level in the model (attribute **UnitsInContext**). Metric SI units are required unless otherwise stated. "Imperial Units" (inches, feet, square feet, etc.) are not normally used.
		REC	Lengths should be assigned in millimetres or metres, areas in m2 and volumes in m3.
10.	Defining and geo-referencing the project zero	MAND	A defined project zero / origin – with local x,y,z coordinates 0,0,0 shall be defined and used throughout the project.
		MAND	The project zero/origin shall be geo-referenced according to the *buildingSMART* draft document *Exchange Requirement (ER) for Geo-referencing and Creation of Site Local Geometric Representation* (file name **20100415_ER_GeoRef.xls**) unless otherwise agreed in the project.
		MAND	The ER document can be obtained from buildingSMART (ftp://ftp.buildingsmart.no/pub/Georeferencing/).This draft ER may change requirements in its final version. If so, the final version shall be used unless otherwise agreed in the project.

B.2 BIM – Generic model structure requirements

Ref.#	Subject	Type	Requirement and description
11.	Project	MAND	One and only one project object (**IfcProject)** shall be present for each project. The project name (**IfcProject.Name**) shall contain the Client's project Number or other Project reference ID. Statsbygg uses a 5-digit project number for its building construction projects (e.g. "**11096**").

Ref.#	Subject	Type	Requirement and description
		REC	All files in the same project should be assigned the *same* **GUID** (Global Unique Identifier) and **Name** for **IfcProject** – preferably by *preserving* the **IfcProject.GUID** provided in the client's Spatial Program IFC file – or by using the architect's GUID, for example.
		MAND	If the BIM Authoring tool does not support the preservation of the GUID and hence the use of *GUID* as a primary key for identifying the project is not possible, preserving a unique project *name* is required. The project name can then be used as a secondary key on a model server, for example, when merging models in the same project, but with different project GUIDs.
12.	Site	MAND	Unless otherwise agreed in the project one and only one site object (**IfcSite)** shall be present for each project.
		MAND	The site name (**IfcSite.LandTitleNumber**) shall contain the official ID of the Cadastre [no:*Matrikkel*] - the *Cadastral Number*.
		INFO	In Norway the government register "*Matrikkelen*" is held by the Norwegian Mapping Authority [no:*Statens kartverk*].
		INFO	A complete Cadastral number [no:*Matrikkelnummer*] in Norway consists of the following components: **knr** – Municipality number [no:*Kommunenummer*] **gnr** – Estate Registration Number [no:*gårdsnummer*] **bnr** – Title Number [no:*bruksnummer*] **fnr** – Leasehold Number [no:*festenummer*] **snr** – Section Number [no:*seksjonsnummer*]
		MAND	The **knr**, **gnr** and **bnr** are mandatory parts of the Cadastral Number.

Ref.#	Subject	Type	Requirement and description
		MAND	In the **IfcSite.LandTitleNumber** the Cadastral number shall be expressed according to the following naming scheme: **knr gnr bnr fnr snr** The format shall always follow this layout: - The **knr** always has *four* digits, possibly with leading zeros - The **gnr**, **bnr**, **fnr** and **snr** must *not* have leading zeros - All fields must be included - Fields not in active use shall be defined by a zero (0). - **knr**, **snr**, **bnr**, and **fnr** fields are separated by a white space - Do *not* use characters other than spaces and numbers
		INFO	Examples: **0904 200 2430 0 14** (fnr is unused) **0904 200 2430 1 0** (snr is unused) **0904 200 2430 0 0** (fnr and snr are both unused)
		(REC)	Unless otherwise stated in the project, the site shall contain the *proposed/designed* site geometry for the entire site. In certain cases one may want to express the *present* site geometry (before making alterations to the project). In such cases a naming convention expressing this should be agreed.
		REC	If partial models are created (e.g. for separate buildings) and submitted as separate model files, all files should be assigned the *same* **GUID** (Global Unique Identifier) and **Name** for **IfcSite** – preferably by *preserving* the **IfcProject.GUID** provided in the client's Spatial Program IFC file.
		(MAND)	The site may additionally have a Statsbygg "complex number" [no.***Kompleksnummer***] if so required in the project. If required this naming shall be captured in **IfcSite.Longname**.
		REC	The *Kompleksnummer* is used as the traditional Statsbygg grouping of buildings within a local area that is used for a defined purpose, typically the campus of a university, a prison area, etc. It is desirable to maintain this reference in the BIM.
13.	Buildings	MAND	One or more building objects (I**fcBuilding**) present on the site shall reflect the number of distinct physical building structures / blocks on the site.

Ref.#	Subject	Type	Requirement and description
		REC	Generic guidelines for the creation of a building object: • Detached building / building block : Separate IfcBuilding • Extension building work when building construction is added immediately above, below or adjacent (contiguous) to the existing building: same IfcBuilding as existing building • Extension building work when building construction is added close to the existing building, but with a clearly defined building envelope of its own: separate IfcBuilding • Transitional building construction between separate building blocks: Separate IfcBuilding If in doubt about the separation of building structures into IfcBuilding objects, the client should be noted before commencing modelling.
		MAND	The building ID shall be modelled using **IfcBuilding Pset_BuildingCommon.BuildingID** and contain the official ID / Building number [no:*Bygningsnummer*] as assigned by the relevant government body.
		MAND	In Norway the Building number is assigned by the municipality in which the building is located. Each municipality has assigned a numbering range that can be used for the registration of new buildings.
		INFO	A complete Building number consists of the **knr** (Municipality number) and the **gbnr** - Building number.
		INFO	Example: **1601 10469228** means ”1601 Trondheim Municipality”, gbnr””10469228”.
		MAND	In the **Pset_BuildingCommon.BuildingID** the Building number shall be expressed according to the following naming scheme: **knr gbnr** The format shall always follow this layout: - The **knr** always has *four* digits, possibly with leading zeros - The **gbnr** must *not* have leading zeros - Both fields must be included - **knr** and **gbnr** fields are separated by a white space - Do *not* use characters other than spaces and numbers

Ref.#	Subject	Type	Requirement and description
		REC	If the BIM Authoring tool does not support the naming of buildings, the building names (**IfcBuilding.Name**) can be left blank or set to "default" or similar. In such cases the naming of the building can be added to the IFC file on a model server or in a suitable application/viewer that supports it. It can even by added directly in an ASCII text editor for MEAs familiar with the IFC schema.
		REC	The building should be given a descriptive name in **IfcBuilding.Name**.
		INFO	Example: "Bergen Courthouse"
		(MAND)	The building may additionally have a Statsbygg building number" [no.***Byggnummer***] if so required in the project. If required this naming shall be captured in **IfcBuilding.Longname**.
		(REC)	The *Byggummer* is used as the traditional Statsbygg ID for buildings within a complex number [no: *Kompleksnummer]*. It is desirable to maintain this reference in the BIM.
14.	Storeys	MAND	One or more storey objects (**IfcBuidingStorey)** shall be present for each building, reflecting the number of floor levels in the building, including mezzanine floors and similar structures that cover only parts of a full storey.
		REC	For mezzanines, stair landings and other "levels" in the building where it is not obvious that a separate storey should be defined, a project agreement must be drawn up in respect of the conditions required for defining a new storey. Normally a small mezzanine should not trigger a new storey definition.
		REC	For mezzanine floors we recommend: • External walls are modelled in the underlying storey. • Internal walls, spaces, etc. that belong to the mezzanine shall be modelled in the mezzanine floor.
		MAND	The storey names (**IfcBuidlingStorey.Name**) shall be an integer number starting from "1" at the lowest floor level and incrementing by one for each floor level – i.e. storey numbers must not be negative even for storeys below ground.

Ref.#	Subject	Type	Requirement and description
		INFO	Example: **2** = Second lowest floor level; this level may be below, at, or above terrain level.
		(MAND)	The storey may additionally have a Statsbygg document “PA0602” type naming scheme if so required in the project. If required this naming shall be captured in **IfcBuidlingStorey.Longname**.
		INFO	The main principles for such naming of “PA0602” involve a double leading zero (00) for storeys below terrain level, counting “downwards” (with the lowest number for the storey closest to terrain level), “01” for the first storey above terrain (counting upwards above terrain level), and trailing characters “M” for mezzanine, “K” for basement [no:*kjeller*], “U” for sub-terrain storey [no:*underetasje*], “T” for roof storey [no:*takplan*], and “S” for underground floor [no:*sokkeletasje*]. Please refer to the actual “PA0602” document for details.
		REC	The “PA0602” naming should also contain a descriptive text for the storey, in the **IfcBuidlingStorey.Longname**.
		INFO	Example: **IfcBuidlingStorey.Longname**=5M Mezzanine on the 5th Floor
		MAND	The entrance level shall be referenced by applying a property set to the storey object **Pset_BuildingStoreyCommon.EntranceLevel** and setting this to **TRUE** for the *main* entrance storey. If multiple entrances at different storey levels have the same status as “main”, one and only one entrance must nevertheless be selected as the entrance level.
		INFO	Normally this will be at terrain level on one side of the building. If one entrance is used for the majority of public access traffic, this entrance will normally be selected as “main”.
		REC	Storeys above ground should be referenced by applying a property set to the storey object **Pset_BuildingStoreyCommon.AboveGround** and setting this to **TRUE** for floor levels above ground (terrain level).

Ref.#	Subject	Type	Requirement and description
15.	Spaces – in general	MAND	Spaces shall be modelled with 3-dimensional space objects (**IfcSpace**). Spaces shall exist for all areas that represent a defined function, regardless of whether the space is delimited by physical walls/slabs, cubicles or open space areas.
		MAND	Unless otherwise specified spaces shall be modelled when they fulfil the conditions for being "worthy of measurement" according to the measurement rules contained in Norwegian Standard *NS 3940 Areal- og volumberegning av bygninger* (areas and volumes of buildings).
		INFO	Please refer to the detailed requirements for different types of spaces below.
16.	Spaces - functional	INFO	The client's spatial program lists the programmed (required) functional spaces (FUA) [no:*funksjonsareal*] with their functional space net areas (NTA) [no:*nettoareal*].
		INFO	The client's spatial program is provided as an IFC file to enable the designer's BIM Authoring tool (BIM/CAD program) to import the space objects and drag&drop them within the space areas of the design solution, and preserve the space function's ID.
		MAND	Functional Spaces shall have the "*Room Function Number*" (*RFN*) of the spatial program set in **IfcSpace.Name** (e.g. "02.01.005").
		INFO	The RFN represents the functional hierarchy of the project, regardless of whether this is a single (only main functions) or multiple level (main functions with one or more levels of sub- functions). The spaces are represented within the lowest level space sub-function.
		INFO	Example: A space "02.01.005" is the fifth space function defined within sub-function 01 of main function 02.
		INFO	It is permissible to have multiple identical space names, if multiple physical spaces are designed in the proposed design to fulfil the space *function* of the RFN space program.

Ref.#	Subject	Type	Requirement and description
17.	Spaces - technical	REC	Service and technical spaces may be programmed in the client's spatial program. If they are not, important technical and service spaces that affect inter-disciplinary planning should be modelled (**IfcSpace**) as early as possible during design, typically spaces like: Refrigeration plant Heating plant Main ventilation room Electrical transformer room Main electrical distribution room Diesel generator room UPS supply room They should be given a descriptive name in the Longname attribute (**IfcSpace.Longname**).
18.	Spaces – the gross area object	MAND	For each storey, information about the total gross area [no:*BTA – Bruttoareal*] must be contained in a "BTA space object" (**IfcSpace**). BTA is the area of each storey reaching out to the exterior of all enveloping building parts (walls, etc.). The precise definition is found in *NS 3940*. The sole purpose of this "BTA" object is to express the total storey area, including walls.
		INFO	The "BTA space object" will naturally overlap ("clash") with all other spaces in the storey.
		(MAND)	If the BIM Authoring tool does not support such an object as being legal in the IFC export, the gross area for each storey shall be expressed in the storey object or its property sets.
19.	Spaces - external	REC	Outdoor space functions should be modelled in the BIM as spaces (**IfcSpace**) even though they may not be physically delimited by walls, etc., e.g. ground level parking spaces, park and garden area functions, etc.
20.	Spaces – without a programmed area	INFO	Some space functions (**IfcSpace**) in the client's spatial program may be listed without a programmed area when no specific space area requirement has been set for the function.

Ref.#	Subject	Type	Requirement and description
		MAND	These areas will have the planned net and gross area set to zero in the **Pset_SpaceCommon** property set. When these program spaces are modelled in the design, the BIM real design area shall be updated for the spacces.
21.	Spaces – additions in the design process	INFO	Some functions in the client's space program may be listed with only their *main* functions, i.e. their sub-functions may need to be added / suggested by the design team architect.
		MAND	In such cases the architect shall generate relevant Room Function Numbers (RFN) in the series of the relevant function (e.g. "9.1.1.3" if this happened to be a non-RFN sub-function in Chapter 9.1.1 of the spatial program).
		MAND	The design architect may also feel that some main functions or sub-functions are missing and need to be added. In such cases functions shall be added by allocating unused RFNs. Such functions must be briefly *described* – preferably by adding such in the **IfcSpace.Longname** attribute.
22.	Spaces - functional space heights	MAND	Functional spaces (**IfcSpace** objects) shall be modelled with *functional room heights as assumed*, i.e. space allocated for technical installations, etc. *above* modelled suspended ceilings, etc. shall *not* be included in the height of the space object. This means that the height of the space objects may typically be lower than the height between the upper edge of a floor slab and the lower edge of the floor slab of the storey above when suspended ceilings are modelled.
		INFO	The project may opt to model spaces "from slab to slab" anyway, and then discard the presence of suspended ceilings.
23.	Volumes	REC	For the whole building (**IfcBuilding**) a *gross* volume should be expressed in the BIM if the BIM authoring tool supports this. This can be done by adding an **IfcBuilding.GrossVolume** attribute.
		REC	Gross volume for building storeys above and below ground should also be expressed in the BIM if the BIM authoring tool supports this. This can be done by adding an **IfcBuildingStorey.GrossVolume** attribute, combined by setting the property set **Pset_BuildingStoreyCommon.AboveGround**=TRUE for storeys above ground.

Ref.#	Subject	Type	Requirement and description
		(REC)	Alternatively if the BIM authoring tool enables a separate report for the gross volume of the building this should be submitted.
24.	Roof cornice and roof ridge	REC	The height of the roof cornice [*no:gesimshøyde*] and roof ridge [*no:mønehøyde*] referenced to "average levelled terrain" [no:*gjennomsnittlig planert terreng*] should be provided - in the BIM if the BIM authoring tool enables this, or as a separate report (PDF, spreadsheet, etc.).
		INFO	Please see (http://www.be.no/beweb/regler/veil/REN2003/ill/fig4-24.gif) for an illustration.
25.	Physical building elements	MAND	For the requirements relating to the physical building elements, please refer to the BIM Requirements by Discipline table clauses.
26.	Zones	MAND	Zones (**IfcZone**) are considered as aggregates of spaces (**IfcSpace**) or other zones. A space can be a "member" of several *different* zones at the same time. Zones shall be used to express the grouping of spaces for different defined purposes (fire zones, security zones, functional zones, accessibility, thermal, lighting, acoustics zones, etc.)
27.	Systems	INFO	Systems (**IfcSystem**) are combinations of related parts within an AEC product, for a common purpose/function/service. The use of IfcSystem often applies to the representation of building service-related systems, such as ductwork systems.
		MAND	Unless otherwise stated, the use of IfcSystem shall in general be applied to building service-systems from Full Conceptional Design Phase.
28.	Spatial zones	INFO	Spatial zones (**IfcSpatialZone** may be used to define a spatial structure (optionally with its own geometry) independently of the hierarchical structure, to express some functional considerations.
		REC	As an **IfcZone** is restricted to the geometry of its underlying IfcSpaces, the **IfcSpatialZone** should be used when it is important to express geometry independently of the defined spaces.

Ref.#	Subject	Type	Requirement and description
		INFO	Example: IfcSpatialZone can be used to express the geometry of the parts of an existing wall that needs to be 4kept under observation due to fungal growth. IfcSpatialZone is supported from IFC 2x4 (“IFC 4”).
29.	Modelling with both occurrence and type objects	INFO	All entities are modelled as occurrences (instances) of the “thing” they represent (e.g. door, duct). Entities should also contain a type.
		MAND	For entities that possess both *occurrence* (the individual object) and *type* properties, the entity shall be represented with both an occurrence and a type object from *The Full Conceptual Design* phase.
		INFO	Occurrence properties contain information about each individual entity (e.g. a ventilation duct), like location and relation to space, etc. Type properties contain information about the *type* of entity, like the manufacturer and product type number.
		INFO	Example: a ventilation duct segment **IfcFlowSegment** (occurrence) **IfcDuctSegmentType** (type)
		MAND	For each occurrence (e.g. the individual duct segment) the GUID for its defined *type* object shall be *identical*.
		INFO	Example: Two ventilation duct segments of the same *type*: Segment 1: **IfcFlowSegment.GUID**= 3SY_hhw$P7xOyg0$CxruKE **IfcDuctSegmentType.GUID**= 32LF0qsHPChwCP0g$H3TYJ Segment 2: **IfcFlowSegment.GUID**= 2tjoTk$WL6cBkoI9siTij3 **IfcDuctSegmentType.GUID**= 32LF0qsHPChwCP0g$H3TYJ
30.	Naming of entities in general	MAND	Naming (**.Name**) of entities shall use the relevant building element part numbers contained in Norwegian Standard NS3451 *Table of building elements [no: Bygningsdelstabell]* unless otherwise specified - or otherwise agreed in the project. This will enable easy identification and QTO of the building parts. 2-digit and partial 3-digit part numbers are listed in the discipline sections of this document.

Ref.#	Subject	Type	Requirement and description
		INFO	Example: the building element part number 23 in NS3451:2009 is “External walls” [*no:Yttervegger*], so “23” is the relevant NS3451 designation for external walls. Further detailing (3-digit or 4-digit) of the NS3451 part numbers can be used where applicable.
31.	Base quantities of spatial structure elements and building elements	MAND	“Base quantities” (areas, volumes, etc.) of spatial structure elements like buildings, floors and spaces - and building elements like walls and slabs - shall be assigned to the elements by using **IfcElementQuantity**
		MAND	Base quantities for spaces (IfcSpace) shall be expressed by using **IfcSpace.IfcElementQuantity.GrossFloorArea** for the functional area of the space. The footprint area of columns and internal partition walls within the space, etc. are included in this functional area.
		REC	**.NetFloorArea** should then also be set, excluding the footprint area of columns and internal partition walls within the space.
32.	CAD layers	REC	If the BIM Authoring tool supports it, layers (**IfcPresentationLayerAssignment**) should be applied in the BIM, according to the standard decided in the project.
		INFO	Examples of layer standards are BS 1192, AIA Cad Layer Guidelines and ISO 13567-1/3.
		REC	In Norwegian projects the standard *NS 8351:2010 Byggetegninger - Datamaskinassistert konstruksjon (DAK) - Lagdeling* (Building drawings - Computer aided design (CAD) – Layers) should be applied unless otherwise agreed.

B.3 The Requirement BIM from the client

In its capacity as a client, Statsbygg will in most cases provide a “Requirement BIM” that basically contains the spatial program’s required spaces (**IfcSpace**), functional grouping (**IfcZone**) of the spaces and any requirements that are defined for each space, group or accompanying Furniture, Fittings & Equipment (FF&E) (**IfcFurniture**).

INFO: Statsbygg currently uses the database/client program tool *dRofus* – http://www.drofus.no for expressing the Requirement BIM. The actual tools used by Statsbygg may be changed at any given time.

Ref.#	Subject	Type	Requirement and description
33.	Project	INFO	One and only one **IfcProject** shall be present, according to the IFC schema. Naming of the project shall be Statsbygg's five-digit project number (pnr), *optionally* followed by a space and project name (pname). IfcProject.Name=<pnr> <pname> Example 1: **11645** Example 2: **11645 University of Nowhere – Building K2**
		MAND	The project *naming* shall be preserved during the project lifetime by all modelling participants in the project.
		REC	Preferably the **GUID** (Global Unique Identifier) of the IfcProject should also be preserved if the BIM Authoring tool (CAD system) supports it.
		INFO	Example GUID: **36x8IF4Qv15w55CfQl5iib**
34.	Site	INFO	At least one **IfcSite** should be present, containing basic Cadastre information about the site. IfcSite.Name=<Cadastre number> Example cadastre number: **0904 200 2430 0 00**
		MAND	If given, the site *cadastre* shall be preserved during the project's lifetime by all modelling participants in the project.
		REC	Preferably the **GUID** (Global Unique Identifier) of the **IfcSite** should also be preserved if the BIM Authoring tool (CAD system) supports it.

Ref.#	Subject	Type	Requirement and description
35.	Functional zones	INFO	Statsbygg's requirement database uses the zone object – **IfcZone** – for grouping spaces that belong to the same main function or sub-function. IfcZone.Name=<Functional Level Number> The "functional level number" is a concatenation of the functional level numbers for main, sub, and possibly sub-sub… functions, divided by periods. Example: **02.04** denotes functional level numbering for "Main function 02", "Sub function 04". IfcZone.Description=<Functional Level Name> "Functional Level Name" is the name of the function in the requirement database. Example: Library functions IfcZone.Object Type=Functional Zone The entity "Object Type" shall be set to "**Functional Zone**".

Ref.#	Subject	Type	Requirement and description
36.	Spaces	INFO	Statsbygg's requirement database uses the space object – **IfcSpace** – for expressing the spatial program functions. IfcSpace.Name=<Space Function Name> The "Space Function Number" (no:*Romfunksjonsnummer*) (RFNR) is a number that uniquely identifies the space function required by the client, including the programmed area. Example: IfcSpace.Name=**03.02.016** for space function number 016 of sub-function 02 of main function 03. IfcSpace.Longname =<Space Function Name> "Space Function Name" is the name of the space function in the requirement database. Example: Long-term archive IPSet_SpaceCommon.NetPlannedArea =<Programmed area> "Programmed area" is the required functional area in the client's spatial program. Example: **12** (unit depending on defined project units, usually square metres for area)
37.	"Dummy" geometry of spaces	INFO	Statsbygg's requirement database can export "dummy" geometry for the space objects (**IfcSpace**). This implies that a simple geometric "Lego block" is visualising each space function's programmed area, to make it easier for BIM Authoring tools (CAD systems) to "select and drag" the required spaces to the correct location in the design model. The space names will then be preserved in the architect design model, and program vs. design spaces will be compared and synchronised after export from the CAD system back to the requirement database. Example: A space function with a programmed area 16 square metres will be represented in "dummy" geometry by a 4 by 4 metre "Lego block".

Ref.#	Subject	Type	Requirement and description
38.	Requirements relating to zones	INFO	Statsbygg's requirement database can export **Property Sets** (**PSet_**) expressing requirements to the functional zones. Presently most of these PSets are client defined. Whenever it is possible to use properties in PSets already defined in the IFC release (like **PSet_SpaceCommon**.xxx) for expressing the requirements they will be exported using the IFC PSets.
39.	Requirements relating to spaces	INFO	Statsbygg's requirement database can export **Property Sets** (PSet) expressing requirements to the functional spaces. Example PSet: dRofus_room_core Example PSet and requirement: **Pset_SpaceElectricalRequirements.SpaceOutlets=6** (number of required electrical power points in the space are 6)

INFO: Statsbygg's long-term objective is to standardise the "requirement PSets" through *buildingSMART*, to gain software implementation support. In the short-term Statsbygg would encourage "implementer agreements" and agreements between clients to support requirement PSets.

C. Domain Specific Requirements (Normative)

C.1 Architecture Modelling [no:*ARK*]

Architectural modelling in Norwegian practice usually includes programming, visualisation and presentation for users, granting authorities and other stakeholders. This involves equipment planning, cultural monument preservation and cost control, etc.

In a BIM design process the architectural model usually contains most of the other domains, such as structural elements and electrical and mechanical equipment. The model is also the main holder of spatial information, such as user requirements. It is extremely important that the architectural model remains interdisciplinary. This means that it should always be coordinated with other domains in respect of space demands.

Relevant Architectural part numbers of NS3451:

20	Generic structure
21	Site and foundation
22	Superstructure
23	External enclosure
24	Internal enclosure
25	Floor slabs
26	External roofing
27	Equipment and furnishings
28	Stairs and balconies, etc.
29	Special structure
66	Fixed equipment and furnishings for business operation
69	Special Facility Services

Outline conceptual design - default modelling requirements

Ref.#	Subject	Type	Requirement and description
40.	Geometric accuracy	MAND	Geometry shall be approximate in respect of shape, size (length, width, height, area and volume), location and orientation.
41.	External enclosure/building envelope	MAND	All spaces with climate/comfort requirements shall be encircled by the building envelope.
		REC	The building envelope should be “airtight”.
		MAND	**IfcWall.Name** = Building code (no: NS3451) + User defined wall type (e.g: *231 YV-01*, or *231.01*)

Ref.#	Subject	Type	Requirement and description
		REC	Type should be set according to defined types in the project. User defined wall type description can be set in **IfcWall.Description, .Material** or in a separate wall scheme.
		MAND	Objects in the building envelope like roof, exterior walls, windows and doors (**IfcWall, IfcCurtainWall, etc.)** shall be identified as external elements (e.g. **IfcWallCommon|IsExternal=true**)
		MAND	The following properties shall not differ within the same wall type: • Wall thickness • Material
		MAND	External wall height shall be according to planned floor height, and modelled from the top surface floor slab in storey n, to the bottom surface of slab in storey n+1.
42.	Superstructure	REC	The following load bearing building elements should be modelled if the project or design requires it at such an early phase: • Reinforced walls • Frameworks • Columns and beams • Footings
		(MAND)	These objects require the use of naming conventions or object type including building code [no: NS3451] Example: IfcFooting.ObjectType=*214.1 pelefundament*, IcfColumn.ObjectType=*222.1 søyler* IfcWall.ObjectType= *224.3 avstivet vegg*
43.	Internal enclosure walls	REC	Internal walls should be included in the model. This requirement is not mandatory because the project might focus on overall volumes and design.
		(MAND)	Wall types should be set according to defined wall types in the project. The following properties shall not differ within the same wall type: • Wall thickness • Material
		REC	User defined wall type description should be set in **IfcWall.Description** or in a separate wall schema.

Ref.#	Subject	Type	Requirement and description
		REC	Internal wall height should be modelled from the top surface floor slab in storey n, to the bottom surface of slab in storey n+1.
		REC	Internal doors should be included in this phase, primarily for visualisation purposes. **IfcDoor.Name** = door code (e.g. 10M) **IfcDoor.Type** = user defined label (e.g. ID-01) **PSet_IfcDoorCommon|IsExternal** = false **PSet_IfcDoorCommon|FireExit** = true/false
44.	Floor slabs	MAND	At least one floor slab for each storey according to the structural engineer [no: RIB] Set type to correct IfcSlabTypeEnumeration= • ’baseslab’ for slab on ground • ‘floor’ for slab(s) between storeys • ‘roof’ for top or roof slabs
		MAND	The following properties shall not differ within the same slab type: • Slab thickness • Material
45.	Major equipment/inventory objects	REC	Equipment or inventory that are space-intensive, heavy and prone to vibration or noise generation, have potential structural consequences, etc. and thus affect inter-disciplinary planning /design / engineering, should be modelled using the relevant object entity types, with the basic geometry at the approximate location.
		INFO	If component geometry is product specific and hard to predict, ”bounding box” geometry should be applied for space planning purposes.
		REC	For example, a laboratory unit, like a water tank, should be modelled as: **IfcObject** **IfcObject.Name** = *Water tank* **IfcObject.ObjectType** = Planned article number [*01.242*]

Ref.#	Subject	Type	Requirement and description
46.	Stairs, elevators	MAND	Main stairs shall be modelled. Geometry is most relevant, but circulation and/or regress analysis tests could be carried out during this phase. **IfcStair.Name** = User defined type (e.g. Stair 01) **IfcStair.Tag** = *User defined tag* (e.g. F for FireExit) **IfcStair.Type** = *IfcStairTypeEnum /1/*
		MAND	Elevator shafts shall be modelled. Elevator shafts must contain a space object within the shaft walls. Example: **IfcSpace.Name = Elevator [no: Heis]** Elevator shafts are part of the gross area of each storey
		REC	The elevator car should be modelled, preferably with type enumeration. Example: **IfcTransportElement** **IfcTransportElementTypeEnum** = *ELEVATOR*
		INFO	Net functional dimensions inside the elevator car are set in **Pset_TransportElementElevator** • ClearWidth • ClearHeight • ClearLength
47.	Functional area spaces	MAND	Model contains all programmed areas with **IfcSpace.Name** = *RoomFunctionNumber (e.g. 01.02.019)*
		MAND	Room name is set in **IfcSpace.LongName**
48.	Technical area, circulation and gross area	MAND	In addition to functional spaces (NS3940:FUA), the following spaces must be modelled in this phase: • Technical room (NS3940:TEA)for ventilation (e.g.: IfcSpace.LongName = *Main ventilation room)* • Vertical ducts • Gross area [NS3940: BTA] for each storey • Circulation area (NS3940:KOA).
49.	Zones	INFO	Requirements for zones are handled under the generic requirements section.

Ref.#	Subject	Type	Requirement and description
		REC	If a zone denotes a (fire) compartment, the following types should be used, if applicable, as values of the ObjectType attribute: • FireCompartment - a zone of spaces, collected to represent a single fire compartment. • ElevatorShaft - a collection of spaces within an elevator, potentially going through many storeys. • RisingDuct • RunningDuct
50.	Space boundaries	INFO	Space boundaries (**IfcRelSpaceBoundary**) are virtual objects used to calculate quantities for various forms of analysis relating to spaces (**IfcSpace**) in buildings. Analyses that use space boundaries include: • Quantity takeoff for Cost Estimating – In the early stages of design, many objects have not yet been modelled. During this phase of a project, space boundaries (and other measurements based on the space object) are used to estimate such things as finished materials (i.e. carpeting, tiles, paint) and casework. • Energy Analysis – i.e. estimating the amount of energy that will be used by a building during operation. Space boundary energy flows between a space and other spaces or the outside air. • Facilities Management Work Package Estimating – During the operational phase of a building's life cycle, space boundaries can be used to estimate areas for facilities management work packages such as re-painting, carpet cleaning and the cleaning of other building element surfaces. "**First level**" space boundaries are the boundaries of a space defined by the surfaces of building elements bordering this space (physical space boundaries) or by virtual surfaces provided by an adjacent space with no dividing wall. "**Second level**" level space boundaries still represent building elements that border the space, but are more granular in that they are subdivided in any of the following cases: (a) Contained openings (with or without fillings like doors and windows), (b) Differences in materials and/or material assemblies (e.g. a wainscot or panelling on the lower portion of a wall), and (c) Differences in spaces or zones ***on the other side*** of the building element (or virtual boundary) represented by the space boundary (e.g. two different spaces on the other side of a wall).

Ref.#	Subject	Type	Requirement and description
		REC	Space boundaries should be included in the BIM whenever the aim is to serve relevant purposes where space boundaries are essential – second level if the BIM authoring tool supports it.

Full Conceptual Design – Default modelling requirements

Ref.#	Subject	Type	Requirement and description
51.	Basis	MAND	All architectural requirements from the Outline Conceptual Design Phase apply as a basis for this phase.
52.	Geometric accuracy	MAND	Geometry shall be accurate in respect of shape, size (length, width, height, area, volume), location and orientation.
53.	Building envelope, superstructure and façade	MAND	All building elements shall be modelled with the relevant object entities for occurrences (e.g. **IfcWall**) and type objects (e.g. **IfcWallType**).
		INFO	Two windows of the same *type (example)*: Window 1: **IfcWindow.GUID**= 3SY_hhw$P7xOyg0$CxruKE **IfcWindowType.GUID**= 32LF0qsHPChwCP0g$H3TYJ Window 2: **IfcWindow.GUID**= 2tjoTk$WL6cBkoI9siTij3 **IfcWindowType.GUID**= 32LF0qsHPChwCP0g$H3TYJ
		MAND	Models shall contain cost-demanding coverings and special equipment in the façade such as an external sun shield.
		INFO	How to model a sun protection system: **IfcBuildingElementProxyType.Name** = *Enum* (no: *solavkjerming*)
54.	Internal enclosure, walls and doors	MAND	All internal walls shall be modelled with the following attribute properties in **PSet_WallCommon**: • FireRating = FireEnum (e.g. EI60) • LoadBearing = TRUE/FALSE • IsExternal = TRUE/FALSE • AcusticRating = AcusticEnum (e.g. R’40) • Compartmentation = TRUE/FALSE
		REC	Other properties are optional. For definitions please visit IAI-tech /2/
		MAND	All load bearing elements shall contain block-outs [no: utsparinger] for technical ducts and shafts. Coordinate with construction and mechanical domain.

Ref.#	Subject	Type	Requirement and description
		(MAND)	Internal doors must have the object type, and the following attribute properties in **PSet_WallCommon /2/:** • FireRating = FireEnum (e.g. REI60) • FireExit = TRUE/FALSE • Other properties are optional.
55.	Structure	MAND	Columns are modelled with correct placement and dimensions according to the construction domain.
		(MAND)	Column front cover [no: *søyleforkant*] has own wall type: e.g. IfcWallType.Name = *222.1 column front cover*
		INFO	There must be a 100 % overlap of columns when undertaking a collision check between an architectural and a structural model.
56.	Suspended ceilings	MAND	Suspended ceilings must be modelled at right height and coordinated with the mechanical domain. Ceiling thickness is approximate.
57.	Sanitary equipment	MAND	Placement of sanitary equipment like water closet, sink and kitchenette, etc.
		REC	Coordinate need for supply and outlets with mechanical domain.
58.	Inventory, equipment and other building elements	MAND	Furniture is modelled as IfcFurnishingElement. The name of the type of furniture is defined using the **IfcFurnitureType.Name** attribute e.g. **IfcFurnitureType.Name** = *spisebord,garderobeskap, kjøleskap, lampe,*
		(MAND)	If using an article registry, such as *dRofus equipment database,* the database number is set in tag: **IfcFurnitureType.Tag** = *60.02.003*
		(MAND)	If using **IfcBuildingElementProxy** objects, the following naming scheme according to the infrastructure type shall be used: Building code (no: NS 3451) + Name of object e.g. **IfcBuildingElementProxy.Name** = 265.X Cornice (no: *gesims*)
59.	Spaces	MAND	All planned spaces shall contain the room function number and be placed in the model.

Ref.#	Subject	Type	Requirement and description
		MAND	In addition to functional spaces ,the following spaces must be modelled in this phase: • All main technical areas • Vertical ducts [no: *vertikale sjakter*] • Running ducts [no: *horisontale sjakter*] • Gross area [no:*BTA*] for each storey • Circulation area
60.	Zones	MAND	The model shall contain following zone types: • Fire zone
		REC	Other zone types should be used, such as: • Security zone • Heating zone • Cooling zone
61.	Stairs and elevators	MAND	All stairs, ramps, elevators and escalators shall be modelled.
		(MAND)	Properties and type definitions as in previous phase.

Coordinated design, procurement and full financial authority – Default modelling requirements

Ref.#	Subject	Type	Requirement and description
62.	Basis	MAND	All architectural requirements from the Full Conceptual Design Phase apply as a basis.
63.	Generic model	MAND	Complete assemblies of all components shall be modelled at a detailed *generic* (non-product specific) level, suitable for tendering purposes.
64.	Geometric accuracy	MAND	Geometry shall be accurate in respect of shape, size (length, width, height, area, volume), location and orientation. "Location" includes precise positioning within spaces for relevant equipment and furniture.
65.	External walls	MAND	Wall objects shall contain material layers. Texture is described in IfcWallType.Description Slab and column front cover [no: *dekke-, søyleforkant*] and roof cornice have their own wall type: e.g. **IfcWallType.Name** = *226.3 slab front cover*
66.	Internal walls	MAND	Wall objects contain material layers and the final height.

Ref.#	Subject	Type	Requirement and description
67.	Suspended ceilings	REC	Suspended ceiling should be modelled as a slab with **IfcSlabType.Name** = *257.X suspended ceiling*
		INFO	Suspended ceilings do not contain a grid. This can be formulated in **IfcSlabType.Description**
		INFO	[no: *Skjørt*] can be modelled in various approaches. Either by wall or slab tools. Proxy elements can be used, but with correct naming conventions e.g.: **IfcBuildingElementType.Name** = *245.X Skjørt* or **IfcWallType.Name** = *245.X Skjørt*
68.	Windows and doors	MAND REC	The model shall contain internal and external doors, modelled with the correct dimensions and placement. Window (and door) fittings can be modelled as proxy elements.
69.	Spaces	MAND	All spaces in the model shall contain the room function number, generated by the requirements database.
70.	Zones	MAND OPT	The model shall contain the following zone types: • Fire zone (fire compartments) • Heating zone • Cooling zone Other zone types should be used, such as: • Security zone

C.2 Landscape Architecture Modelling [no:LARK]

Generic requirements

Ref.#	Subject	Type	Requirement and description
71.	Landscape architectural requirements in general	REC	Statsbygg currently does not have very specific BIM requirements for Landscape Architecture deliverables, as the integration of landscaping into BIM is considered an emerging technology. In general Statsbygg recommends that at least the *geometry* of the landscaping elements should be exported to IFC by the use of CAD systems that can import the format used for landscaping and then export it to IFC geometry.

Ref.#	Subject	Type	Requirement and description
		REC	Statsbygg also recommends that the landscaping elements are referenced to the same project zero as the other design disciplines' models, to enable merging of the models for common visualisation.
		INFO	An overview is provided in the ASLA report entitled "*Integrating BIM Technology Into Landscape Architecture*" by James L. Sipes, ASLA – available for purchase or member download from their website (http://www.asla.org)
72.	Landscaping element open formats	REC	Statsbygg encourages the use of open standard formats whenever available and suitable for a purpose. A number of open formats may be candidates for capturing landscaping elements as objects, their attributes/properties and relationships, like LandXML and CityGML – maybe also IFC in a future release that incorporates specific landscaping object types.
73.	Landscaping element properties	REC	If the Landscape Architecture model can be made available as an object model with a generic object type ("proxy object") we recommend that a *descriptive* naming convention for the objects is established in the project, with an enumeration list of agreed object types.
		INFO	An example of a Landscape Architecture design glossary that can be used to shortlist object types, can be found at "Landscape Design Advisor" [1]

C.3 Interior Design Modelling [no:*IARK*]

Generic requirements

Ref.#	Subject	Type	Requirement and description
74.	Furniture, Fixtures & Equipment (FF&E)	INFO	Interior Design may or may not have its own deliverables into the BIM. Furniture, Fixtures & Equipment (FF&E) may be required in the project, located correctly in spaces in the BIM.
		(MAND)	FF&E (if required) shall be represented in the BIM by its type object **IfcFurnitureType**, with naming enumeration (**IfcFurnitureType.Name**) as agreed in the project or with reference to a named classification system (like Uniclass), e.g. "Lectern", "Chair", "Table", "Soap dispenser", "Clock",

[1] http://www.landscape-design-advisor.com/landscape-architecture-design-glossary.html

Ref.#	Subject	Type	Requirement and description
			etc.
		(MAND)	FF&E shall have a relationship established to the space (**IfcSpace**) in which it is situated, and - if relevant - to the system (**IfcSystem**) it belongs to (e.g. a clock in a Time Synchronisation & Master Clock System).

C.4 Geotechnical Engineering Modelling [no:*RIG*]

Geotechnical modelling is still an area in which Statsbygg has limited experience, and where limited software options are available that are suitable for the purpose and support "openBIM" by the means of BuildingSMART standards.

There are ongoing studies and development in progress in order to bridge the gap between geotechnical/civil engineering and Building Information Models, e.g. the "IDM for georeferencing"[2].

It is possible to create a Construction Site BIM, usually from architectural tools that do not support other geotechnical engineering processes. The Construction Site BIM should correspond with or be based on foundations in the Structural BIM.

It is also possible to import "openBIM" (IFC) to different GIS formats, but ideally these "worlds" should merge and enable complete analysis of the load transfer between man-made structures and the earth materials and behaviour.

Generic requirements

Ref.#	Subject	Type	Requirement and description
75.	Geotechincal modelling process	MAND	Review of project needs to define the required material properties.
		MAND	Site investigation/survey.
		MAND	Determine the earth materials engineering properties, including how they will interact with, on or in a proposed construction.
		MAND	Determine and design the type of foundations, earthworks, and/or pavement sub-grades required for the intended man-made structures to be built (ref. structural engineering).

[2] ftp://ftp.buildingsmart.no/pub/Georeferencing/

C.5 Structural Engineering Modelling [no:*RIB*]

Structural modelling covers (in general terms) all load-bearing elements such as concrete, wood and steel structures, as well as non-load-bearing concrete structures. The structural domain is complex in the sense that the objects involved are usually “owned” by different participants throughout the process.

The structural designer also produces both a design model and an analysis model. These models should be developed in parallel through an iterative process. Unfortunately an interoperability problem still exists between structural design and analysis tools; hence today this is a manual process.

BIM deliverables are limited to the structural design model with the following main objectives: coordination, QTO/costing and production/construction model.

The relevant Structural Engineering part numbers in NS3451 are described in Chapter 2 Building Elements, referred below at two digit level (load-bearing elements are present in 21, 22, 23, 24, 25, 26 and 28) and the most relevant codes at three digit level:

20	*Generic structure*
21	Site and foundation
214	Supporting/protecting structures (sheet piles, stabilisers)
215	Pile foundation
216	Base foundation
22	Superstructure
222	Columns
223	Beams
23	External enclosure
231	Load bearing external walls
24	Internal enclosure
241	Load bearing internal walls
25	Slabs
251	Floor slabs
252	Base slabs (a floor slab against the ground)
26	External roofing
261	Structural elements of the roof
27	*Equipment and furnishings (considered less relevant)*
28	Stairs and balconies, etc.
29	Special structure

Outline Conceptual Design – Default modelling requirements

Ref.#	Subject	Type	Requirement and description
76.	Preliminary investigations and external conditions	MAND	In cases where the building has any unusual characteristics, space requirements or functions that are “load-intensive”, the structural engineer should be heavily involved in the early stage assessment of the design alternatives. This might not require a separate structural BIM at this stage, but rather be reflected in the architect’s model.

Ref.#	Subject	Type	Requirement and description
		MAND	Geotechnical investigation data and constructability assessment shall also be prepared (by the geotechnical designer) prior to structural modelling
77.	Process	REC	At this stage the main objective is to investigate the alternatives for load bearing systems in the building, including different frame and foundation alternatives and assessment of the architect's alternatives.
		REC	The first "structural BIMs" are produced by the architect's design suggestions. Hence the Structural designer's expertise should influence the architect's BIM, i.e. some simple advice concerning slab thickness and the placement of important "structural design elements", e.g. staircases and elevators.
		REC	Based on experience it is not recommended that the actual modelling should start too early during this stage, as it is easy to become too focused on what has been modelled rather than seeking a better alternative.
78.	Model structure and consistency	MAND	Structural BIMs must only contain objects belonging to the structural design.
		MAND	The origin and true north of the model shall correspond to the project's chosen origin (usually defined by/in the architect's BIM).
		INFO	For structural BIM, structures that penetrate several stories can also be modelled as single continuous objects at this stage (if they "production vice" will be produced in one piece).
		MAND	Structural BIM shall be consistent with the architectural BIM and objects modelled/designed by the MEP designers with potential structural impact.
79.	Foundations, ground floor slabs, slabs, columns, beams and structural frame	MAND	The structural BIM shall contain the main structure of the building, including the foundations and structural frame.
		MAND	The structural designer must submit information concerning types and the main materials in use for all modelled components. Naming conventions following Norwegian Standard shall be used. e.g. using Name, Type or Number

Ref.#	Subject	Type	Requirement and description
		INFO	It must be possible to use the structural BIM in the integration of the BIMs for preliminary coordination. It will also be used for input for quantity take-off and cost estimation.

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Ref.#	Subject	Type	Requirement and description
80.	Structural requirements	MAND	All structural requirements from the Outline Conceptual Design Phase apply as a basis.
		MAND	Geometry shall be approximate in respect of shape, size (length, width, height, area and volume), location and orientation.
81.	Objective	INFO	The main objective for the structural BIM is to provide the input for a detailed quantity take-off and cost estimation.
82.	Model structure and consistency	MAND	Ensure consistency with the architect's model and communicate types and locations of structures to the architect.
		MAND	Ensure that there are no conflicts with the modelled MEP elements at this stage (with potential structural impact).
		MAND	Columns and beams shall interconnect and there shall be no discontinuities in the structural system.
83.	Component identification	MAND	For the purpose of QTO and costing, all elements must have a type object so they can be identified by type for the purpose of linking to costing recopies. e.g. a column shall be modelled holding both the occurrence/instance- and type object: **IfcColumn** **IfcColumnType**
84.	Foundations	MAND	All foundation structures, pilings and ground wall constructions shall be modelled.
85.	Ground floor slabs, slabs, columns, beams, structural	MAND	All load-bearing vertical and horizontal structures shall be modelled holding type, material, geometry, location and preliminary structural dimensioning data.

Ref.#	Subject	Type	Requirement and description
	frame and all other load-bearing elements	MAND	All load bearing objects shall be labelled as load-bearing using **Pset*Objecttype*Common** e.g. a column shall have **PsetColumnCommon.IsExternal=True**

Coordinated design, procurement and full financial authority – Default modelling requirements

Ref.#	Subject	Type	Requirement and description
86.	Structural requirements	MAND	All structural requirements from the Full Conceptual Design Phase apply as a basis.
87.	Objective	INFO	The main objective for the structural BIM is to provide the input for procurement and the detailed design solution. The model shall be used for item-based QTO and costing, manufacturing and production.
88.	Foundations	MAND	Joining foundations to the constructions above shall be modelled.
89.	All load-bearing elements	MAND	All load-bearing vertical and horizontal structures shall be modelled holding type, material, geometry, location, joining and structural dimensioning data.
		INFO	The level of detail to which the model shall be developed is somewhat dependent on the contract and must be agreed in the project (dependent on the contractor/sub-contractor and when they enter the project).
90.	Connection points and joinings	MAND	All **types** of joinings shall be modelled (also for visualisation purposes), i.e. it is not necessary to model all occurrences/instances of the connection point/joining types, but it must be clear where the types are intended to be used.

C.6 Mechanical Engineering Modelling [no:*RIV*]

Mechanical modelling involves the modelling of systems for plumbing, fire protection (sprinklers, etc.), heating, ventilation, air conditioning, refrigeration, energy monitoring and control. In Norwegian practice it also includes gas and pressurised air systems, water treatment, waste handling and vacuum cleaning systems, and connections to public mechanical infrastructure.

Relevant Mechanical Engineering part numbers contained in NS3451 are:

30	Generic mechanical
31	Plumbing
32	Heating
33	Fire protection
34	Gas and pressurised air
35	Process cooling
36	Air handling
37	Comfort cooling
38	Water treatment
39	Special mechanical
65	Waste handling and vacuum cleaning
73	Outdoor mechanical
78	Outdoor infrastructure

Outline Conceptual Design – Default modelling requirements

Ref.#	Subject	Type	Requirement and description
91.	Spaces – Technical spaces, shafts, external pipe/duct traces (culverts) etc.	MAND	Technical spaces and shafts shall be modelled with **IfcSpace**, with geometry indicative of shape, size (length, width, height, area, volume), location and orientation. The functional zone and space IDs from programming shall be retained where applicable.
		MAND	For multi-storey technical spaces an **IfcSpace** object shall exist for each storey. The height of the space shall be modelled from the upper edge of the slab in the storey to the lower edge of the storey slab in the storey above.
		MAND	Outdoor traces (culverts) below ground shall be modelled with IfcSpace, setting **IfcSpace.InteriorOrExteriorSpace**=True
		INFO	The space objects shall be modelled by the architect, but the size and location, etc. are the responsibility of Mechanical Engineering.
92.	Entry points for technical infrastructure	MAND	The assumed approximate site or building entry points for relevant public technical infrastructure shall be modelled using the relevant object entity types when applicable (e.g. **IfcPipeFittingTypeEnum**=Entry) or with named proxy elements.
		MAND	Geometry shall be indicative of shape, size (length, width, height, area, volume), location and orientation.

Ref.#	Subject	Type	Requirement and description
		(MAND)	If using **IfcBuildingElemenProxy** objects, the following naming scheme (**Ifc IfcBuildingElemenProxy.Name**) according to the infrastructure type shall be used: WaterSupply Drainage GasSupply DistrictHeating DistrictCooling MechanicalInfrastrutureOther MechanicalUserDefined
93.	Major mechanical components	MAND	Mechanical objects such as major air handlers, chillers, boilers and heat plants, etc. that are space-intensive, heavy, prone to vibration or noise generation, have potential structural consequences, etc. and thus affect inter disciplinary planning / design / engineering, shall be modelled using the relevant object entity types.
		MAND	Geometry shall be indicative of shape, size (length, width, height, area, volume), location and orientation.
		REC	If component geometry is product specific, “worst case bounding box” geometry should be applied for planning purposes.
		INFO	For example, an air handler unit should be modelled as: IfcEnergyConversionDevice (the chiller unit *occurrence*) IfcUnitaryEquipmentType.Objectype=AirHandler
94.	Main ductwork and pipework at critical locations	MAND	Main ducts, main pipes (or *bundles* of smaller ducts/pipes) at “critical locations” that affect inter-disciplinary planning / design / engineering shall be modelled using the relevant object entity types, with basic geometry at approximate locations. Typically the entry and exit points of main technical spaces, and in the vicinity of these – where duct/pipe crossings will be required – shall be regarded as “critical locations”.
		INFO	For example, a duct should be modelled as: IfcFlowSegment (the duct *occurrence*) IfcDuctSegmentTypeEnum=Rigidsegment Pset_DuctSegmentTypeCommon.Shape=Rectangular

Full Conceptual Design – Default modelling requirements

Ref.#	Subject	Type	Requirement and description
95.	Mechanical requirements as in Outline Conceptual Design	MAND	All mechanical requirements from the Outline Conceptual Design Phase apply as a basis.
		MAND	Geometry shall be approximate of shape, size (length, width, height, area, volume), location and orientation.
96.	All mechanical components in technical spaces, shafts, external pipe/duct traces (culverts) etc.	MAND	Mechanical components (ductwork, pipework etc.) in technical spaces, shafts, external pipe/duct route paths (culverts) etc. shall be modelled using the relevant object entities for occurrences (e.g. **IfcFlowSegment**) and type objects (e.g. **IfcDuctSegmentType**).
		MAND	All objects shall be assigned to relevant systems (**IfcSystem**).
		REC	Separate system entities shall be defined for the supply and exhaust/drainage side of each mechanical system (e.g. supply air and exhaust air).
		MAND	Naming of the systems (**IfcSystem.Name**) shall describe the function and supply/exhaust type, if specified. Examples: **IfcSystem.Name**=Ventilation_3_Supply **IfcSystem.Name**=Ventilation_3_Exhaust
97.	All mechanical components in defined "type room" spaces	MAND	Requirements for technical spaces. The identification of "type rooms" should be defined in each project. If such have not been defined they shall be interpreted as spaces that represent important functional area types with multiple occurrences, typically "Standard Office", "Small Meeting Room", "Large Meeting Room", etc. For each "type room" *one occurrence* of the room type (i.e. one actual room of this type) shall be modelled with complete assemblies and all components (as in Coordinated Design).
98.	All mechanical components in defined "special" spaces	MAND	Requirements for technical spaces. The identification of "special spaces" should be defined in each project. If such have not been defined they should be interpreted as all spaces with a high density of mechanical components and accompanying duct/pipe traces, etc.

Coordinated design, procurement and full financial authority – Default modelling requirements

Ref.#	Subject	Type	Requirement and description
99.	Mechanical requirements as in Full Conceptual Design	MAND	All mechanical requirements from the Full Conceptual Design Phase apply as a basis.
		MAND	Complete assemblies of all components shall be modelled at a detailed *generic* (non-product specific) level, suitable for tendering purposes.
		MAND	If product specific solutions for certain components need to be specified and defined in the "Name" field of the component, the product specific nature of the component shall be indicated in the "Tag" attribute, e.g. **IfcDuctSegmentType.Tag**=ProductSpecific
		MAND	Geometry shall be accurate in respect of shape, size (length, width, height, area, volume), location and orientation.
		MAND	"Location" includes precise positioning within spaces for relevant mechanical equipment.
100	All mechanical components in all spaces	MAND	Mechanical components (ductwork and pipework, etc.) in all spaces shall be modelled with relevant object entities for occurrences and type objects.
		MAND	The objects shall be assigned to relevant systems (**IfcSystem**). Separate system entities shall be defined for the supply and exhaust/drainage side of each mechanical system (e.g. supply air and exhaust air).
		MAND	Naming of the systems (**IfcSystem.Name**) shall describe the function and supply/exhaust type. Examples: **IfcSystem.Name**=Ventilation_3_Supply **IfcSystem.Name**=Ventilation_3_Exhaust
101	All mechanical route paths in all spaces	MAND	Route paths in all spaces shall "in principle" be modelled. For mechanical systems like ductwork, however, the route path *is* the ductwork itself, apart from some fixtures. If these fixtures affect inter disciplinary planning / design / engineering, they shall be modelled using the relevant object entity types. If not they can be omitted.

Ref.#	Subject	Type	Requirement and description
102	Positioning mechanical components in suspended ceiling grids	MAND	When the suspended ceiling grids from the architect have been finalised (project specific milestone), positioning of the relevant mechanical components in the suspended ceilings (sprinkler outlet nozzles and air diffusers, etc.) shall be precisely positioned within the grid, and inter-disciplinarily coordinated (e.g. with lighting fixtures and fire alarm detectors, etc.).

C.7 Electrical and Communications Engineering Modelling [no:*RIE*]

Electrical and Communications modelling in Norwegian practice is usually *one* engineering discipline and involves the modelling of systems for high, medium and low voltage electrical supply and distribution, electrical lighting and heating, standby power, computer networks and alarm, detection and audiovisual systems – as well as building automation (the control parts and electrical components, not the mechanical components), instrumentation, conveying systems (elevators, escalators and lifting tables, etc.), theatre and stage systems and connections to public electrical and communications infrastructure.

Relevant Electrical and Communications Engineering part numbers contained in NS3451 are:

40	Generic electrical
41	Electrical support systems
42	High voltage electrical power supply
43	Low voltage electrical distribution
44	Lighting
45	Electrical heating
46	Standby power
49	Special electrical
50	Generic communications
51	Communications support systems
52	Integrated communications systems
53	Telephony and paging
54	Alarms and signalling
55	Audiovisual
56	Building automation
57	Instrumentation
59	Special communications
62	Conveying systems
63	Dumbwaiter elevators, etc.
64	Theatre and stage equipment
74	Outdoor electrical

75	Outdoor communications
78	Outdoor infrastructure

Outline Conceptual Design – Default modelling requirements

Ref.#	Subject	Type	Requirement and description
103.	Spaces –technical spaces, shafts, external cable traces (culverts), etc.	MAND	Technical spaces and shafts shall be modelled with **IfcSpace**, with geometry indicative of shape, size (length, width, height, area, volume), location and orientation. The functional zone and space IDs from programming shall be retained where applicable.
		MAND	For multi-storey technical spaces an **IfcSpace** object shall exist for each storey. The height of the space shall be modelled from the upper edge of the slab in the storey to the lower edge of the storey slab in the storey above.
		MAND	Outdoor traces (culverts) below ground shall be modelled with IfcSpace, setting **IfcSpace.InteriorOrExteriorSpace**=True
		INFO	The space objects shall be modelled by the architect, but size and location, etc. are the responsibility of Electrical and Communications Engineering.
104.	Entry points for technical infrastructure	MAND	The assumed approximate site or building entry points for relevant public technical infrastructure shall be modelled with relevant object entity types when applicable (e.g. **IfcPipeFittingTypeEnum**=Entry) or with named proxy elements.
		MAND	Geometry shall be indicative of shape, size (length, width, height, area, volume), location and orientation.
		(MAND)	If using **IfcBuildingElemenProxy** objects, the following naming scheme (**Ifc IfcBuildingElemenProxy.Name**) according to the infrastructure type shall be used: ElectricalSupply CommunicationsSupply SafetyAndFireAlarmHandling SecurityAlarmHandling CableTV BuildingAutomation ElectricalCommunicationsInfrastrutureOther ElectricalCommunicationsUserDefined

Ref.#	Subject	Type	Requirement and description
105.	Major electrical and communications components	MAND	Electrical and communications objects like major power transformers, main distribution boards, diesel generator sets, large UPSes and central computer installations, etc. that are space-intensive, heavy, prone to electromagnetic field or noise generation, have potential structural consequences, etc. and thus affect inter-disciplinary planning / design / engineering, shall be modelled with relevant object entity types.
		MAND	Geometry shall be indicative of shape, size (length, width, height, area, volume), location and orientation.
		REC	If component geometry is product specific, "worst case bounding box" geometry should be applied for planning purposes.
		INFO	For example, an electric diesel generator set for standby power should be modelled as: **IfcEnergyConversionDevice** (the unit *occurrence*) **IfcElectricGeneratorType.Name**=DieselGeneratorSet (a user defined unit *type*)
106.	Main electrical and communications system components at critical locations	MAND	Distribution boards, main cable carriers and other electrical and communications system components at "critical locations" that affect inter-disciplinary planning / design / engineering shall be modelled using the relevant object entity types, with basic geometry at approximate locations. Typically the entry and exit points of main technical spaces, and in the vicinity of these – where technical crossings are required – are regarded as "critical locations".
		INFO	For example, a cable ladder should be modelled as: IfcFlowSegment (the cable carrier *occurrence*) IfcCableCarrierSegmentType.PredefinedType=Cableladdersegment

Full Conceptual Design – Default modelling requirements

Ref.#	Subject	Type	Requirement and description
107.	Electrical and communications	MAND	All electrical and communications requirements from the Outline Conceptual Design Phase apply as a basis.

Ref.#	Subject	Type	Requirement and description
	requirements as in Outline Conceptual Design	MAND	Geometry shall be approximate of shape, size (length, width, height, area, volume), location and orientation.
108.	All electrical and communications components in technical spaces, shafts, external pipe/duct traces (culverts), etc.	MAND	Electrical and communications components in technical spaces, shafts and external cabling route paths (culverts), etc. shall be modelled using the relevant object entities for occurrences (e.g. **IfcFlowSegment**) and type objects (e.g. **IfcCableSegmentType**).
		MAND	The objects shall be assigned to relevant electrical systems (**IfcElectricalCircuit**). Naming of the electrical systems (**IfcElectricalCircuit.Name**) shall describe the function, Example: **IfcElectricalCircuit.Name**=EmergencyLighting_2
109.	All electrical and communications components in defined "special" spaces	MAND	Requirements for technical spaces. The identification of "special spaces" should be defined in each project. If such have not been defined they should be interpreted as all spaces with a high density of electrical and communications components and accompanying cable carrier systems, etc.
110.	All electrical and communications components in defined "type room" spaces	MAND	Requirements for technical spaces. The identification of "type rooms" should be defined in each project. If such have not been defined they shall be interpreted as spaces that represent important functional area types with multiple occurrences, typically "Standard Office", "Small Meeting Room" and "Large Meeting Room", etc. For each "type room" *one occurrence* of the room type (i.e. one actual room of this type) shall be modelled with complete assemblies and all components (as in Coordinated Design).

Coordinated design, procurement and full financial authority – Default modelling requirements

Ref.#	Subject	Type	Requirement and description
111.	Electrical and communications requirements as in Full Conceptual Design	MAND	All electrical and communications requirements from the Full Conceptual Design Phase apply as a basis.
		MAND	Complete assemblies of all components shall be modelled at a detailed *generic* (non-product specific) level, suitable for tendering purposes.

Ref.#	Subject	Type	Requirement and description
		MAND	If product specific solutions for certain components need to be specified and defined in the “Name” field of the component, the product specific nature of the component shall be indicated in the “Tag” attribute, e.g. **IfcLightFixtureType.Tag**=ProductSpecific
		MAND	Geometry shall be accurate in respect of shape, size (length, width, height, area, volume), location and orientation.
		MAND	“Location” includes precise positioning within spaces for relevant electrical and communications equipment.
112.	All electrical and communications components in all spaces	MAND	Electrical and communications components in all spaces shall be modelled using the relevant object entities for occurrences and type objects.
		MAND	The objects shall be assigned to relevant electrical systems (**IfcElectricalCircuit**). Naming of the systems: (**IfcElectricalCircuit.Name**) shall describe the function. Example: **IfcElectricalCircuit.Name**= EmergencyLighting_2
113.	All electrical and communications route paths in all spaces	MAND	Route paths (with cable ladders, cable trays and cable conduits, etc. as **IfcCableCarrierSegmentType**) in all spaces shall be modelled.
114.	Positioning electrical and communications components in suspended ceiling grids	MAND	When the suspended ceiling grids from the architect have been finalised (project specific milestone), positioning of the relevant electrical and communications components in the suspended ceilings (lighting fixtures and fire alarm detectors, etc.) shall be precisely positioned within the grid, and inter-disciplinarily coordinated (e.g. with sprinkler outlet nozzles and air diffusers, etc.).

C.8 Acoustical Engineering Modelling [no:*RIAKU*]

Acoustical modelling involves the modelling of acoustic properties for building elements such as constructions, coverings, assemblies, installations and equipment. Another important function is indicating to other design team disciplines acoustic conditions that should apply to their model entities (e.g. shape, size, location, orientation, assembly/installation practice, noise and vibration avoidance, etc.).

In Norwegian practice the acoustic engineer does *not* model entities in the BIM itself, but sets the acoustic conditions for other design team disciplines that *they* include in their BIM.

Please refer to the “Acoustical Analyses” chapter in this manual for a more informative in-depth discussion.

Outline Conceptual Design – Default modelling requirements

Ref.#	Subject	Type	Requirement and description
115.	Acoustic zones	(MAND)	For projects where relevant and agreed main principles for acoustic zoning of the *spaces* shall be modelled by using zones (**IfcZone**). All indoor spaces shall be included in one and only one acoustic zone.
		REC	Unless otherwise agreed in the project the architect (ARK) shall model the zones in the BIM based on information provided by the acoustic engineer (RIBR).
		INFO	At this stage the modelling of the acoustic properties of the *physical* building parts (walls, doors and windows, etc.) is not necessary, unless otherwise agreed in the project.
116.	Simplified geometry models for selected space areas	REC	For projects where relevant and agreed selected spaces (such as a main hall, a large auditorium or a stage, etc.) are to be exported as a partial model covering the space and surrounding physical building elements (or space boundaries). The purpose of such export would be simple acoustic simulation (see also the BIM Objective chapter). In such a case a reasonable simplification of the model geometry would be desirable, avoiding very complex geometry objects (e.g. ornaments). Major mechanical components (e.g. large main ducts) should be included in the model. The export format for the simplified model could be **IFC**, or it could be one of several non-BIM 3D geometry formats, as the case for using acoustic simulation would not involve BIM information, only geometry.
		INFO	Example: one possible practical "production line" could be **CAD system native format → IFC 2x3 → Google Sketchup plugin IFC2SKP → Google Sketchup format (.skp) →Google Sketchup plugin SU2Odeon (or similar for other acoustic programs) → Odeon (.par) (or similar acoustic program) for running the actual simulation.**

Full Conceptual Design – Default modelling requirements

Ref.#	Subject	Type	Requirement and description
117.	Acoustic related properties of	MAND	All requirements from the Outline Conceptual Design Phase apply as a basis.

Ref.#	Subject	Type	Requirement and description
	building parts and components	MAND	*Main* objects (building parts / components) that possess identified acoustic design elements shall be modelled with their relevant acoustic properties. Typically this is modelled by the **AcousticRating** property of PSet_XXXCommon, where XXX = wall, window, door, i.e. the physical building parts enveloping acoustic zones.
		INFO	Example: **Pset_WallCommon.AcousticRating**=45dB for a wall with an acoustic rating of Rw>45dB.
		MAND	Unless otherwise agreed in the project the architect (ARK) shall model the acoustic properties in the BIM based on information provided by the acoustic engineer (RIAKU).

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Ref.#	Subject	Type	Requirement and description
118.	Fire related properties of building parts and components	MAND	All requirements from the Full Conceptual Design Phase apply as a basis.
		MAND	*All* objects (building parts / components) that possess identified acoustic design elements shall be modelled with their relevant acoustic properties.
		MAND	Unless otherwise agreed in the project the Architect (ARK) shall model the acoustic properties in the BIM based on information given from the Acoustic Engineer (RIAKU).

C.9 Fire Safety Engineering Modelling [no:*RIBR*]

Fire Safety Engineering modelling involves the modelling of fire safety properties in order to protect people and their environments from the destructive effects of fire and smoke. This discipline includes, but is not exclusive to, active fire protection (fire suppression systems, fire alarms), passive fire protection (fire and smoke barriers, space separation),smoke control and management, escape facilities (emergency exits and fire elevators, etc.), fire safe building design, layout and space planning, fire prevention programs, fire dynamics and fire modelling, human behaviour during fire-related events and risk analysis, including economic factors.

In Norwegian practice the fire safety engineer does *not* model entities in the BIM itself, but sets the fire safety conditions for other design team disciplines that *they* include in their BIM.

Outline Conceptual Design – Default modelling requirements

Ref.#	Subject	Type	Requirement and description
119.	Fire compartments as zones	MAND	The main principles for fire compartmentation of the *spaces* shall be modelled by using zones (**IfcZone**). All indoor spaces shall be included in one and only one fire compartmentation zone.
		REC	Unless otherwise agreed in the project the architect (ARK) shall model the zones in the BIM based on provided by the fire safety engineer (RIBR).
		INFO	At this stage modelling of fire-related properties of the *physical* building parts (walls, doors and windows, etc.) is not necessary, unless otherwise agreed in the project.

Full Conceptual Design – Default modelling requirements

Ref.#	Subject	Type	Requirement and description
120.	Fire-related properties of building parts and components	MAND	All requirements from the Outline Conceptual Design Phase apply as a basis.
		MAND	*Main* objects (building parts / components) that possess identified design safeguards that aid in preventing, controlling and mitigating the effects of fire shall be modelled with their relevant fire properties. Typically this is modelled by the **FireRating** property of PSet_XXXCommon, where XXX = wall, window, door, i.e. the physical building parts enveloping fire compartmentation zones.
		INFO	Example: **Pset_WallCommon.FireRating**=EI60 for a wall with a fire rating of “EI60” according to EN 13501.
		MAND	Unless otherwise agreed in the project the architect (ARK) shall model the fire properties in the BIM based on information provided by the fire safety engineer (RIBR).
121.	Fire Exits	MAND	Spaces that serve as an exit space (e.g. a corridor) for fire escape purposes shall be modelled with the property **Pset_SpaceFireSafetyRequirements.FireExit**=True.

Coordinated design, procurement and full financial authority – Default modelling requirements

Ref.#	Subject	Type	Requirement and description

Ref.#	Subject	Type	Requirement and description
122.	Fire-related properties of building parts and components	MAND	All requirements from the Full Conceptual Design Phase apply as a basis.
		MAND	*All* objects (building parts / components) that possess identified design safeguards that aid in preventing, controlling and mitigating the effects of fire shall be modelled with their relevant fire properties.
		MAND	Unless otherwise agreed in the project the architect (ARK) shall model the fire properties in the BIM based on information provided by the fire safety engineer (RIBR).
123.	Sprinkler protection coverage	REC	Spaces that are protected by automatic sprinklers should be modelled with the property **Pset_SpaceFireSafetyRequirements .SprinklerProtectionAutomatic**=True.

C.10 Other Design and Engineering Modelling [no:RIX]

Generic requirements

Ref.#	Subject	Type	Requirement and description
124.	Other disciplines and special requirements	INFO	Other special disciplines may be involved in projects, some of which may be environmental, transportation, hydraulic and other engineering branches – or kitchen, laundry, hospital, equipment or other types of special planners.
		REC	Any requirements relating to BIM information that are relevant to the disciplines must be determined on a project basis and should be listed.

C.11 BIM Construction and As Built Requirements

Generic requirements

Ref.#	Subject	Type	Requirement and description
125.	BIM during construction - in general	INFO	Currently Statsbygg has limited experience in respect of using BIM *during* construction. Statsbygg's requirements are mainly relevant during design – and for project close-out. During construction the contractor is in principle free to use the BIM as he chooses, unless specific requirements (analyses, etc.) are set in the project.

Ref.#	Subject	Type	Requirement and description
		REC	As a starting point the contractor should receive the finalised "generic" (product neutral) design-BIM, as an open IFC file.
		INFO	Normally the proprietary source BIM / native BIM (.rvt., .pla etc.) will not be available to the contractor. The final deliverable from the contractor to the client / facility manager is the "as built" BIM as an IFC file.
126.	Keeping track of changes during construction until "as built" – **Deliverable 1**	INFO	Normally (depending on contract type) the contractor will report changes (client initiated and on site initiated) to the design team at regular intervals or when specified changes occur. These are "generic" (non-product specific) changes to the individual entities (occurrences) or to the generic *type*s of objects - like moving a door *position* or swing direction *property*, changing a wall covering material property, adding a fire rating property to a window, repositioning sprinklers in the suspended ceiling grid, changing the number of power outlets in a space and removing a partition wall, etc.
		REC	The design team should then update the native BIM with the changes until the "as built" status is obtained. IFC exports can be made any time during construction according to client requirements, and finally as the "as built" BIM. This is still a "generic" (non-product specific) BIM, but with correct geometry, object classes, attributes, properties and relationships. This is normally **the first of two deliverables** from the contractor to the client.

Ref.#	Subject	Type	Requirement and description
127.	Adding product and solution specific information during construction until "as built" – **Deliverable 2**	INFO	**The second deliverable** from the contractor to the client is adding the specific information about the actual built / installed products on site and their system configuration specific to this building solution. This is typically *type* information (e.g. relevant to the *type* of lighting fixture, not the individual fixture occurrences). As BIM skills and software tools for this purpose are still immature, Statsbygg has currently opted *not* to require that the contractor should add this information to the BIM directly. In projects where the contractor and design team *do* have sufficient skills and tools to add specific system and product info to the BIM, such may be agreed.
		REC	Instead Statsbygg requires that the contractor should use a specific software solution to key in specific product and system information for his products. Currently the software used for this purpose at Statsbygg is the *TIDA* (Technical Information Database) module of the *dRofus* package[3], consisting of an SQL DBMS and a free client application. The free client can be downloaded[4] from their website. As TIDA has IFC import capabilities, the finished design BIM can be used as a starting point for entering the contractor's information. In the import dialog of TIDA, the *grouping* of objects can be carried out according to specifications (e.g. if pipes should be grouped on the basis of dimensions, materials, feed or return functions, etc.). The BIM then ensures that correct and appropriate input fields for the products are available in TIDA *before* the contractor starts keying in the data. Any additional FM documentation (typically PDFs) for the product, such as user manual, datasheet and Environmental Product Declaration (EPD), etc. can also be attached to the products and systems.

[3] http://www.drofus.no/index.php?page=home&set-lang=en

[4] http://www.drofus.no/index.php?page=download&lang=en

Ref.#	Subject	Type	Requirement and description
128.	Final merge to complete "as built BIM"	INFO	"As built" the two deliverables to Statsbygg are then (a) A generic BIM that is updated in respect of all geometry, generic objects and their properties and relationships, and (b) A database of system and product specific information – related by unique IDs to objects in the generic BIM. TIDA still does not provide an IFC export, but this is planned for an upcoming release. By then Statsbygg should be able to use an IFC model server to *merge* the two deliverables into a complete "as built" BIM.

C.12 BIM for Facility Management and Operations

Generic requirements

Ref.#	Subject	Type	Requirement and description
129.	Adapting the FM&O BIM from the "as built" BIM	INFO	The "as built" BIM does not necessarily contain the relevant information required for Facility Management and Operations (FM&O) purposes. Some parts of the BIM information may be relevant for design and construction purposes only. Other parts are in a sense relevant, but may not be within the scope of what FM&O is designed to update and maintain over time. For these reasons the "as built" BIM will typically need to be transformed into a "FM&O BIM" – i.e. create a partial extract model for relevant FM&O use. This will typically be carried out on a model server.
130.	FM&O BIM utilisation	INFO	The topic of specifying FM&O BIM requirements is a major one - that involves a large number of possible uses of the BIM within the range of operations, maintenance, renovations and alterations throughout the facility lifecycle. Currently Statsbygg does not have sufficient FM&O BIM experience to state specific requirements in this BIM manual, but it is anticipated that this will change gradually and may result in amendments to this manual. The General Services Administration (GSA) in the U.S. is

Ref.#	Subject	Type	Requirement and description
			formulating the BIM Guide Series “Series 08 - Facility Management”[5] – this document is expected to provide good guidance when issued.

C.13 BIM for Decommissioning and Disposal

Generic requirements

Ref.#	Subject	Type	Requirement and description
131.	Decommissioning and Disposal BIM utilisation	INFO	At the end of the facility lifecycle the BIM may be utilised in order to extract QTO type information for different object types and material fractions which may be useful for handling reuse and waste fractions, etc. Currently Statsbygg does not have sufficient Decommissioning and Disposal BIM experience to state specific requirements in this BIM manual, but it is anticipated that this will change gradually and may result in amendments to this manual.

[5] http://www.gsa.gov/bim

D. Modelling quality and practice

D.1 Defining BIM Objectives (Informative)

Statsbygg has currently identified the BIM objectives listed below – some of which are discussed while others are headliners only.

The identified objectives are currently not all implemented and in use at Statsbygg, but rather a collection of objectives identified and considered relevant to consider in projects. They appear on the list because they have a potential “productivity effect” utilising open BIM data exchange for one or more stakeholders in the AEC value chain.

Pre-Design stage

1. **Alternative sites analysis** (multiple sites assessment) [this is mainly GIS related]. The main objective for this analysis is to find the best location for the facility to support its future production. Important aspects are environmental impact over its lifecycle and proximity assessments (e.g. distance to public transport and other relevant public services).

2. **Site analyses** (for a defined site). Volumes, location (placement, orientation) of the building(s) on site. The main objective of the analysis is to identify the best placement of the facility and the project’s possibilities/limits with the given framework (municipality regulations, geotechnical conditions, important lines of sight and axes).

3. **Building Survey** (of existing conditions). Can be a Building Survey conducted by using traditional geometrical measuring of points and corner points, etc., using photogrammetry, 3D Laser Scans, or a technical condition survey (in Norway according to Norwegian Standard NS 3424 Condition Survey of Construction Works - Contents and Execution.

4. **Building Programming**. Complete client brief with spatial, functional and proximity requirements, and stakeholder and project framework constraints, etc. The result of this activity will ultimately be the **“Requirement BIM”.**

   4.1. Building Functional programming (functional requirements and proximity, etc.). Defines functional needs to support the purpose of a facility and its future production.

   4.2. **Building Spatial Programming**. Spatial requirements. Defines the functional and physical requirements for each spatial element in a building or facility. Both spatial requirements for the future occupant’s activities and relevant building and/or user required equipment. Usually requirements are limited to the net functional areas as the starting point of design, but as “supporting” areas appear (e.g. circulation areas and washrooms, etc.), requirements can be assigned.

   4.3. **Building Technical Programming**. Technical requirements, in Norway usually stated according to NS3451. Defines requirements for all supporting building elements and systems to support the future occupant’s activities.

Design Stage

1. **Architectural design competition and evaluation**. The main objective for BIM requirements in an architectural competition is to achieve easy, fast and equal assessment of the competition proposal. BIM is used for evaluating spatial layout, generic area, volume and quantity measurements, and also visualisation with a 3D terrain model (GIS).

   Note: BIM is NOT used for evaluation of the architect's "aestetic expression".

2. **Basic BIM Design Authoring** (baseline BIM for basic outline and starting situation, etc.). As a starting point for Design, Statsbygg exports a Requirement BIM with the project's Spatial program containing requirements set to functions and spaces. Defined spaces with requirements are given a "dummy" geometry and will appear as a line of cube space object, e.g. a space with a programmed net area of 25 m^2 will be exported as a space of 5x5m. Requirements relating to the space are assigned to the space as Property sets (Pset). Requirements set on a main and sub-functions level or other groups of spaces (e.g. security zones) are exported as IfcZone.

   2.1. For architectural competitions, Statsbygg has provided a basic BIM as a modelling starting point for the contestants. The basic BIM has been made available as an IfcSite object of the competition area, usually also containing existing buildings as a reference for the competitors. In the Site, project origin and orientation has been set and neither of these should be moved by the contestants. This for geo-referencing purposes in order to enable objective 3 (and 4).

3. **BIM – GIS Integration analysis and visualisation**. BIM - GIS integration is mainly used in a very early conceptual stage of the projects, e.g. in architectural competitions. The analysis is (at Statsbygg) performed in a GIS tool, after referencing the BIM into the GIS file/database. The objective is to put the new building envelope/volumes and entry points in the planned landscape/context, for checking axes, lines of sight and the main entrance, etc.

4. **Architectural Visualisation**. A photorealistic presentation of the architectural design. Usually produced in the native CAD/BIM tool, or further developed in special software for the purpose. The objective to communicate the design to the audience and stakeholders, including the artistic/aesthetic aspects of the design.

5. **BIM validation/Consistency check**. For utilising BIM, it is important that the starting point for downstream analysis is a consistent BIM. Unless you know that the models are consistent, information derived from them cannot be trusted. Hence validation of the models that are to be used in analysis is the predecessor of most of the objectives in this chapter. Models should be consistent with regard to model structure, relationships and use of object classes/types and they should be checked for duplicates and intersections.

6. **Quantity takeoff (QTO)**. QTO is performed at many different levels, at different design stages and for different purposes throughout the project's/building's lifespan. A properly authored BIM enables high quality and fast quantity surveillance. However, the quality of the quantities produced always depends on the quality of the input information, hence the most important characteristic of a BIM for QTO is consistency. The deliverable from quantity take-off is a bill of quantities, which is delivered for both cost estimating and other purposes. The results of quantity take-off are used in, for example, cost estimating, life cycle costing/assessment, scheduling and the calculation

of CO_2 emissions from materials in use, etc. There are two ways of identifying quantities from an open BIM. They can either be measured / analysed from the geometry of the objects or they can be read from the attributes of the object. There are advantages and disadvantages associated with both methods: while the first method is more complex, the latter one is more dependent on the BIM authoring tool having implemented the correct way of writing quantities to the different objects and the BIM author having modelled a consistent BIM. Rules of measurement are often subject to local regulations and standards, i.e. the quantities read from attributes will not necessarily be directly applicable for their purpose. The purpose of the QTO decides the requirement for the models, e.g. for costing you need, in addition to a consistent BIM, the correct quantities and adequate identification of the objects. For calculating CO_2 emissions from materials, you need to identify the volume or weight of each material in use, hence you need to know each object type's material layers (and the geometry of each layer). In the conceptual stages, identification for QTO shall as a minimum be possible to obtain from naming the objects. For coordinated design, there shall be a type object following every instance. The name attribute of the type object shall be used (e.g. IfcWallType.Name), and all type names shall be unique for all types in use, i.e. all equal objects shall have the same type name, and all objects with the same type name shall be exactly the same building object type.

7. **Designed Geometric 3D Inter-disciplinary Coordination.**
8. **Structural analysis**.
9. **Acoustical analysis**.
10. **Security and circulation analysis**.
11. **Fire safety analysis**.
12. **Energy analysis (energy use and thermal comfort)**.
13. **Lighting analysis**.
14. **Accessibility analysis**.
15. **Environmental analysis (for certification like BREEAM and LEED, etc.)**.
16. **Planned project scheduling and resource allocation ("4D" analysis)**.
17. **Basic cost analysis ("5D" analysis)**.
18. **Detailed cost analysis ("5D" analysis)**.
19. **Building Code analysis**.

Construction Stage

1. **Construction adapted geometric 3D Inter-disciplinary Coordination**.
2. **Construction adapted quantity takeoff (QTO)**.
3. **Planned vs. actual project scheduling and resource allocation ("4D" analysis)**.

4. **Construction adapted cost analysis ("5D" analysis)**.

5. **Project close-out deliverables analysis**.

FM and operations stage

1. **FM handover analysis**.

2. **Building operations scheduling analysis**.

3. **Building preventive maintenance analysis**.

4. **Asset management (space area and equipment inventory, etc.)**.

5. **Contingency planning analysis**.

6. **Environmentally hazardous products analysis**.

7. **Building disposal analysis**.

D.2 Analyses applied by Statsbygg (Informative)

As a client Statsbygg is a buyer of design services and facilities that (within project limits and budget) shall support our customers'/tenants' needs and production in the best possible way. The ability to verify and check that we receive what we purchase is one of the key factors of production and success. The transparency in BIM projects enables us to do this in a better way.

Below we describe some of the possible analyses that can be carried out by using BIM, what experiences Statsbygg has in these areas and the BIM requirements that we regard as being relevant for successful analysis.

Typical modelling requirements that are important for downstream analyses include

- Modelling *structure* (is the model assembled and exported correctly?)
- Modelling *consistency* (has the modeller been modelling correctly?)
- Requirements relating to the *objects* that shall be present in the model
- Requirements relating to object *information* (attributes, properties, relations …), where naming conventions / classifications (tags) for unambiguous identification and type data are important

*

Analyses and BIM quality assurance processes in use at Statsbygg are:

Consistency check (Architectural and Structural)

Checking consistency in the models is an important "preparation" and predecessor for many of *other downstream* analyses. Unless you can be sure that the analysed model is consistent, you cannot really trust the results. A consistent model in this setting is a model with the correct/agreed structure that follows naming conventions/classifications and has no (unintentional) duplicate or overlapping objects (unless intended), etc.

Control of the individual discipline model should first be carried out in the native CAD/BIM authoring tool in order to check that the correct tool/object type has been used (e.g. that a stair has been modelled as a *stair* object, not as a series of *slab* objects), that *layer* and *storey* structures have been used correctly, and as a visual check in order to ensure that any "draft objects" temporarily placed outside the building envelope have been removed before export. Some CAD/BIM tools have built-in features for checking for double / overlapping objects – they should be *used* if available (check with your local CAD reseller if in doubt).

After export (to IFC) the individual discipline model should also be checked – as a visual check in an IFC viewer and/or in a checking tool like Autodesk Navisworks and Solibri Model Checker (SMC).

Statsbygg will check the Architectural and Structural models in SMC for:

- **Model structure**: The models shall have a correct building and storey structure, and the building parts / objects shall have correct relations. All building parts shall have defined relations to the storey in which they reside, a window shall have relation to the wall in which it is placed (through an opening object in the wall) and the wall and window in the wall shall have relation to the same storey, etc.
- **Required components / objects** (and object *type* where relevant) shall be present. Requirements for objects will differ from phase to phase and from project to project, but should comply with the BIM manual for the client/project.
- **"Legal" dimensions** for certain object types should be observed (see figure). The "legal" dimensions and their tolerances can easily be adapted by changing the parameters in the rule set. Dimensions that can be checked include height, length, width, cross-sections/diameters, footprints and distance to next storey, etc. In principle all geometrical parameters are "checkable". For the Architectural model minimum openings for windows and doors are checked.

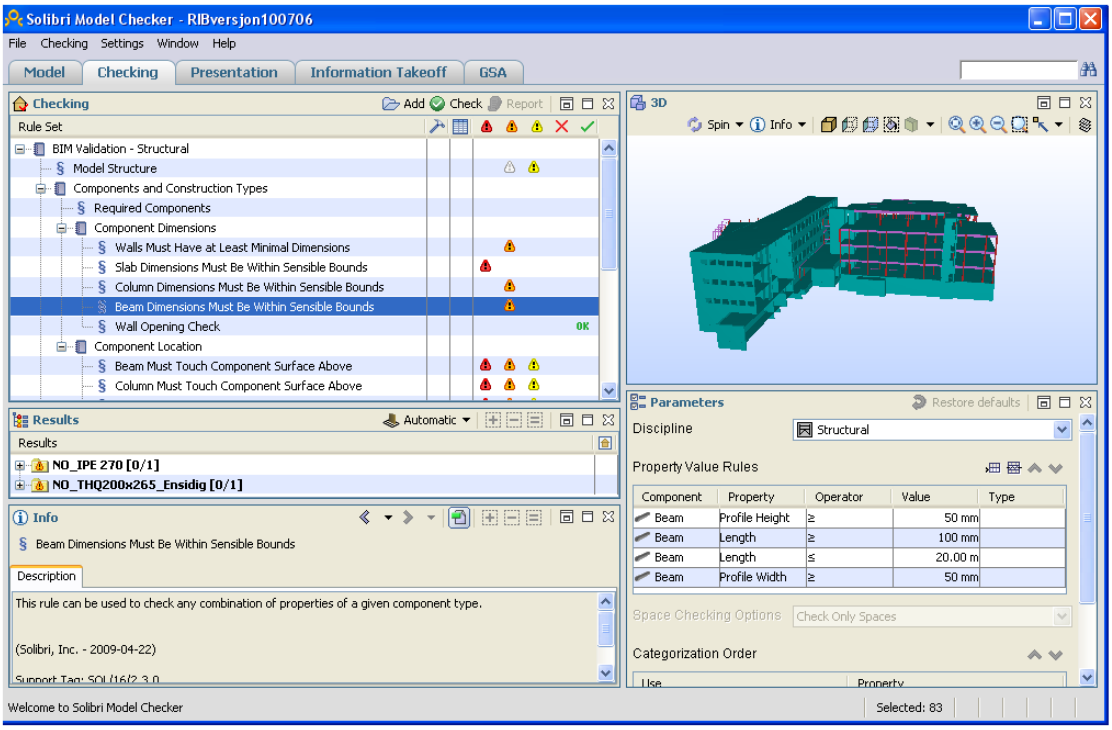


Figure: The illustration shows the "legal" dimensions a beam should have. In this case the parameters are set to a minimum height/width of 50 mm, a minimum length of 100 mm, and *a maximum length of 20 metres. These parameter values are set according to need.*

- **The *placement* of components / objects** (relative to other components): checks are made to ensure that objects do not "hang in mid-air" but are supported, e.g. that walls, columns and beams are supported (have touching objects) above and below them. The tolerances can be set as parameters (the default in SMC is usually 20 mm).
- In the rule set there is also a check for the distance between slabs, that can be used for setting **minimum or maximum requirements** for storey heights, e.g. for checking sufficient space for technical installations, or for checking government requirements for floor space ratios. For instance, a maximum permitted storey height may be set in the local area development plan (zoning plan). If the distance between slabs (storey height) exceeds a given height, a *theoretical* plan is defined for zoning plan calculations [no*: Utnyttelsesgrad*]. The consequence of this is that the *real* plans may be counted twice in the zoning plan calculations. Revealing this at an early stage could prove valuable for incorporating necessary changes in the design.
- **Collisions / overlapping objects** in the model: the rule set checks to ensure if there are double or overlapping objects in the model. This check is essential as a pre-check

Report

Component	Type	Total Component Volume	Intersection Volume	Percentage
Wall	AV10T	5.60 m3	0.34 m3	6%
Wall	AV52T lecaforblending gesims	1.79 m3	0.05 m3	3%
Wall	AV58T Glassvegg	23.38 m3	0.53 m3	2%
Wall	Rockwool8.17	0.61 m3	0.01 m3	1%
Wall	AV11aT	0.73 m3	0.01 m3	1%
Wall	AV57T 148mm bindingsverk	10.24 m3	0.09 m3	1%
Wall	AV14T	38.51 m3	0.17 m3	0%
Wall	AV57T	7.53 m3	0.03 m3	0%
Wall	AV58T	4.28 m3	0.02 m3	0%
Wall	Betong bærende	396.33 m3	1.60 m3	0%
Wall	AV04T	76.45 m3	0.12 m3	0%
Wall	AV51T	21.71 m3	0.05 m3	0%
Wall	Undefined	2.34 m3	0.01 m3	0%
Wall	AV01T	14.77 m3	0.01 m3	0%
Wall	AV03T	78.77 m3	0.13 m3	0%
Wall	AV19T	23.34 m3	0.03 m3	0%

Intersection volume report

for quantity take-off and cost calculations, as quantity take-offs are based on the geometry of the individual object and do not take into consideration any overlapping or doubled objects. We have seen examples of double floor slabs of more than 9000 m^3. Such volumes of concrete that are calculated twice obviously have a major impact on cost calculations. It is therefore very important that overlapping and doubled objects are identified and – if the deviations pass a certain level – are corrected in the model before making calculations. The rule set reports (as a table) the amount of overlapping that exists in respect of the different object types. The table shows the total volume of the overlapping object type, the overlapping volume and the percentage this represents.
- The Architectural model can also be checked for **clashes with furniture, equipment** and other modelled objects.
- **Space object checks** (Architectural model): this is an important pre-check before undertaking the area check – based on space geometry. The rule set checks that the Architectural model has space objects, whether the space objects overlap (with other spaces or building parts), whether they possess unique identifiers (numbers and/or names), whether the spaces have a minimum size (height and area, etc.). The analysis also checks whether all "cavities" in the model have been "filled" with space objects, and lists the amount of area that is *not* covered by space objects for each storey. Warnings are provided for spaces that do not touch the floor slab or do not

extend to the bottom of the next storey floor slab. All parameters, tolerances and type of objects included in the check are configurable.

- If gross area space objects (“BTA” objects) are present in the model (usually a requirement in Statsbygg projects), we can also **check that all spaces are located within the (gross area) BTA object**. A space object is not allowed to be located outside of the BTA object or to be partly located in two different BTA objects.
- In Statsbygg projects a check will normally be made for “**legal space denominations**” – i.e. that the space objects have names **according to an approved space name enumeration list**. The space names (and their classification) is important in analyses for Accessibility [no:*UU – Universell Utforming*], security/circulation and fire egress analyses.

In SMC predefined consistency rule sets exist for the Architect and Structural models. For the MEP models there is currently no rule set for checking consistency.

For the Architect model two versions of the rule set exist – “conceptual” and “final”, roughly corresponding to the outline conceptual and final conceptual phases. For the Structural model only one version exists. The rule sets may be used “as is”, but more advanced multiple time users may opt to configure their own rule sets (using SMC’s “Ruleset Manager”) according to their own BIM manual.

It is recommended that individual architects / structural engineers carry out separate consistency checks on their own models at an early stage during the modelling process, as this will probably provide an indication about whether one is “doing the right thing” when modelling – and early corrective action will always be easier and cheaper than corrective action that is forced later on during the modelling process.

Certain consistency problems may also be due to the IFC export of the CAD tool, but certified software is expected to be able to export models that comply with the requirements mentioned. Some modelling tools have internal features for checking their own model consistency and collisions.

Verifying design area (all projects)

Below we describe a simple check for Statsbygg’s BIM projects that can be carried out in two different ways – each with its strengths and weaknesses. Individually – and particularly in combination – they represent a major added value in projects and increase the efficiency of internal work processes.

1. Checking design area in Solibri Model Checker (SMC)

The primary strength of an SMC area check is the possibility available for checking the *entire* model while simultaneously running a consistency check of the architectural model. After quality checking, areas can be extracted by using the “Information Takeoff” (ITO) functionality of SMC.

This provides a quick and convenient overview of areas that *are* modelled as space objects, areas that *lack* space objects and any *overlapping* space objects – as well as revealing the area of wall “footprints”. Usually when planning such analyses we request a “gross area object” [no:*BTA*] to be present for each storey, covering the entire space of the storey/elevation, including the area of external walls/curtain walls. This provides a precise overview of the total area per storey in the architect-designed model. The drawback is that it does not include direct access to the *programmed* area, so checking to ensure that the design proposal meets the area *requirements* is a retrospective "spreadsheet exercise".

This analysis depends on the models complying with naming conventions and/or numbering schemes according to the client's spatial program. If they do not do so, collating / connecting designed and programmed areas will be a cumbersome and labour- intensive exercise. Required name/numbering conventions can be gathered from synchronisation with the *dRofus* database that Statsbygg uses for expressing its spatial/functional/building program requirements. The space names and numbering will then be overwritten in the IFC file that is synchronised with the correct space function name/number.

2. Checking area by synchronising the architect design BIM with the spatial program in dRofus

The strength of this area check is the ability to list side-by-side programmed and design areas for each function and space, with deviations also listed. The main disadvantage is that it does not reveal whether the areas have been consistently modelled, i.e. that all designed areas have been covered by space objects (IfcSpace), or whether space objects overlap. The check is limited to the *footprint* area of the spaces, hence we are only able to check functional areas (and gross areas if modelled) – *not* the designed "usable area" [no:*BRA*] (all area *inside* external walls) and gross areas [no:*BTA*] that are *not* modelled in the BIM.

This check requires that the models follow agreed naming or numbering conventions according to the spatial program. If they do not do so, collating designs to the program area will be a labour- intensive exercise. It is recommended that the model is also checked for consistency regarding "empty" and overlapping areas in SMC.

<u>Recommendation</u>: Both A (SMC) and B (dRofus) interacting is preferable.

Clash Detection / Coordination

Clash Detection / "Collision Control" is an analysis that has since long provided added value in BIM projects. It is a rather low-hanging fruit that does *not* require information-rich objects. Basically the only requirement is to keep track of the object geometry of the different disciplines (usually Architectural, Structural and MEP).

Three main categories of this analysis are usually carried out:

1. **Clash between the Architectural/MEP models or Structural/MEP models**: the main purpose of this analysis is to ensure sufficient space for technical installations / objects within the building shell. During the early phases it is important to clarify that the technical components that affect building construction do not clash with load-bearing elements. It is of course also important to ensure that technical components have sufficient space around them (for assembly and servicing), e.g. above suspended ceilings.

2. **Clash between the Architectural and Structural models**: the architect and the structural engineer are partly working with the *same* objects in the building, so in this particular analysis the objects are *supposed* to clash; ideally Structural slabs and Architectural slabs shall be located at the exact same spots, similarly for columns, etc.
3. **Clash detection between Technical models**: This analysis checks clashes between the technical models – Mechanical and Electrical (HVAC, piping, electrical power distribution and communications, etc.).

For these analyses to be meaningful it is of paramount importance that all disciplines work within the same coordinate system – i.e. that all models use the same *origin* (x,y,z=0,0,0), the same *orientation* (Northing) and the same axes. It is strongly recommended that the designers test the exchange of the discipline models at a very early stage and merge them to ensure a correct "starting situation".

Accessibility analysis – Designing for Accessibility for All

This analysis mainly checks *geometry* requirements related to the design of buildings for the purpose of ensuring practicability / accessibility for *all* people – including people with disabilities. The is denoted as "Universal Design" [no:*Universell utforming* – acronym "UU"].

UU requirements that are related to the use of colours, lighting conditions and acoustics, etc. are not so straight forward to check as geometry requirements, as they are more difficult / time-consuming to model, and are not presently covered by this analysis.

The analysis checks requirements for stairs (riser height and tread length, number of steps between landings, and minimum widths and lengths for stretcher transport, etc.), requirements for ramps (width, length, degree of slope), turning circles for wheelchairs and swing direction, etc.

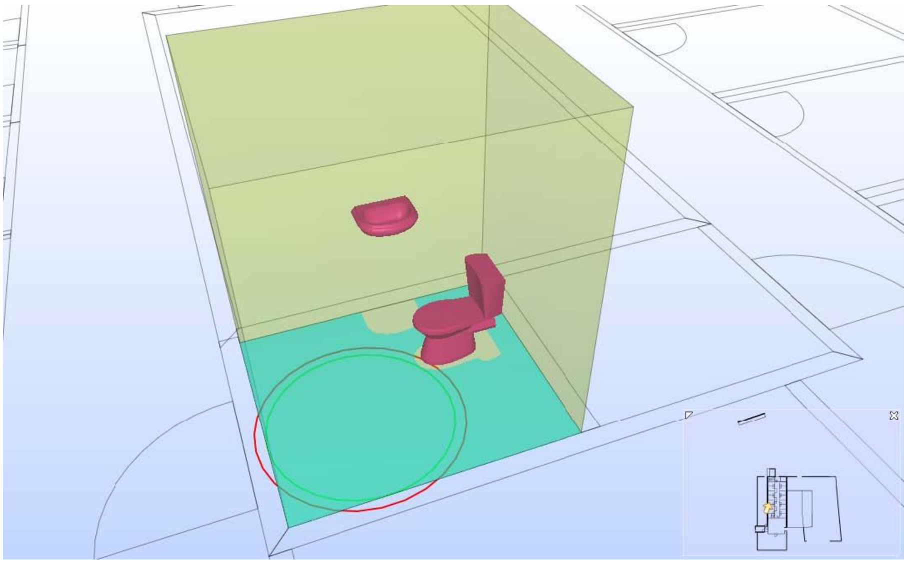


Figure: Checking the turning circle for a wheelchair in a handicap toilet

Proximity analysis

For certain functions proximity to other functions is important. The requirement may be of a rather approximate kind (“should be relatively close to”), but in projects more precise definitions of proximity between functions / spaces may be relevant – e.g. “adjacent”, “maximum 10 metres away from”, “directly above” and “on the same storey”, etc. Proximity may also include *inverse* requirements like “not on the same storey” and “*more* than 20 metres away”, etc., due to requirements in respect of noise or vibration reduction, infection control and security requirements, etc. In the later example you might want to check the direct linear distance (not walking distance).

To identify the start space and destination space you can either use Space usage classification, space type, name or number.

In addition to the distance requirements (max/min), three additional requirements can also be assigned; Direct access, Linear measurement on the same floor.

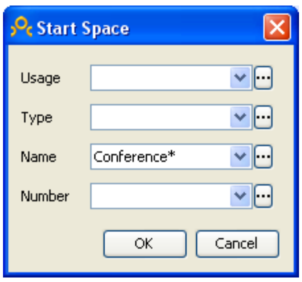
Example: the start space identified from Space usage “Office” must have a maximum distance of 20 m to the destination “WC”. The analysis will identify when the travelling distance from all offices in the building exceeds 20 m to the WC and provide you with the exact distance for those offices that fail to comply with this criterion.

To identify vertical circulation spaces and to use other space usage classifications for identification, the space names must accord with Statsbygg’s permitted “space names”.

Security and circulation

This analysis has been developed in the Concept Design BIM 2010 (CDB2010), a co-sponsored project between the US General Services Administration (GSA), the Finnish Senate Properties and Statsbygg. It is based on the GSA’s “US Court Design Guide (2007)”, and the rule set has been developed by the Georgia Institute of Technology.

If a building has defined security zones, the analysis evaluates the architect’s circulation design, provides rapid feedback and allows for more time to be spent on good design, rather than checking circulation paths.



Circulation rule checking by using start, target and transit space conditions. Rules can be assigned according to project/user needs in respect of circulation in building movement in and between security zones, etc.

Examples:

- You must be able to reach every area (space) within a security zone without passing through the security zone of a higher security level.
- You must be able to reach every area (space) within a security zone without passing through a security zone with a different security level.
- To move from security zone 1 to security zone 3, you must pass through security level 2.
- In a courthouse, a judge must be able to travel from the judge’s office to the

courtroom without leaving security level “3”.

The analysis requires the use of legal space names, and for security analysis spaces must be assigned to a security zone.

- Proper naming conventions for space names
- Consistent BIM object types including: spaces, walls, doors, elevators, stairs, ramps
- Proper designation of security level (zones). This can also be manually assigned in SMC, but should be defined in the BIM authoring tool or in the client’s requirements database (for Statsbygg, dRofus).

Acoustical Analyses

Statsbygg currently does not have experience with BIM-based acoustical analysis, but some of the acoustical analysis tools in common use are now able to read geometry exported from CAD/BIM design tools. This implies that 3D geometry from a BIM can now be reused in acoustical analysis.

These analyses are often based on reflection from – or transmission through - simple surfaces. It is hence expected that the architect’s models need to be *simplified* rather than detailed before an analysis, as complex / detailed geometry does not necessarily produce better / more correct results than a simplified surface model. On the contrary, it often the case that too many details in a model may lead to less accurate acoustical prediction results.

In the following description the acoustical analyses are divided into two parts: room acoustics and sound insulation. Noise control from internal or external noise sources can be treated together with either part, but currently no experience of this exists in relation to BIM.

Room acoustics

For a successful room acoustical analysis the model of the space in question needs to be “watertight”. In order to prevent acoustic waves from “leaking”, all internal spaces must be “closed” in a way that resembles how the design solution is intended to be built. A “simplified geometric model” implies that equipment, furniture, slender columns, window frames, door handles and railings, etc. should *not* be included in a model exported for acoustic purposes, unless the sheer size of such components is such that it can be expected to influence the acoustics of the space in question. In such cases the geometry should be simplified using suitable CAD tools before export. Examples of this may be bookshelves in a library or a large sculpture in a hall. Curved surfaces should be divided / exploded into a suitable set of plane surfaces. For such purposes some kind of “middleware”, like *Google SketchUp* or similar, may be suitable if such features are not available from within the CAD system in use in the project.

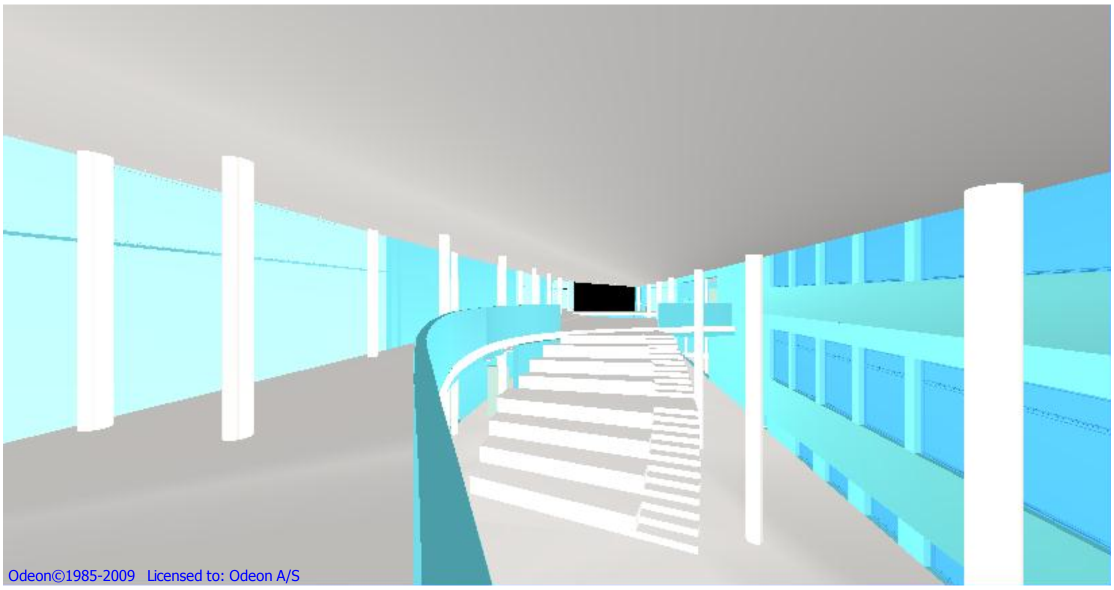


Figure 1: Example of a room acoustical analysis model (in ODEON) imported from IFC via SketchUp. Curved surfaces are simplified to produce a suitable set of plane surfaces. The colours indicate materials with different sound absorption data. (From BIM project: "Midtbygda skole")

Possible "production track"*: a simple BIM containing walls, slabs, doors, windows and space objects is exported to IFC (.ifc file). In some models it may be necessary to include more objects, e.g. beams, columns, stairs. The model is imported in SketchUp for pre-processing / simplification (converting curved surface and, removing insignificant geometry, etc.), and then exported to ODEON in a text format (.Par file) for acoustical analysis. For very large building models a part of the preparation may involve cutting out the relevant space from the total model. The selection of surface materials is currently assumed to be made within the acoustical analysis tool because the related acoustical data are normally provided by the acoustician (RIAKU).The description of intended surface materials is potentially information that could be included in the BIM and extracted from the BIM. The material data for room acoustical analysis are absorption coefficients in octave bands and scattering coefficients (in octave bands or as a single number at mid-frequencies).*

Sound insulation

For an acoustical analysis of sound insulation a simplified 3D building model with walls and floors is needed. This can be created from a 2D plan or by exporting the space objects in the IFC format to the acoustical software for sound insulation calculations. Currently, some of the more advanced software for sound insulation analysis may be SONarchitect ISO (http://www.soundofnumbers.net/).

The acoustical requirements may vary from room to room, and also depend on the types of neighbouring rooms (e.g. living room, kitchen, stairway and common areas, room for building services equipment). All or part of this information can be contained in the BIM (in the ifcSpace object) and exported to the acoustical software. This requires:

- Each room having a room type
- Each room type having a collection of requirements
- Each requirement may be associated with another room type, with Outdoor, or with any room space
- Each requirement must be associated with a parameter. A parameter is the evaluation of any acoustic quantity, either a weighted value or a single frequency band.
- Each requirement must be associated with a limit, i.e. a constraint value that the calculation must not exceed.

For the acoustical analysis of sound insulation the simplified 3D building model must be supplemented with data for the acoustic properties of all the BuildingElements:

- All vertical BuildingElements (IfcWall, IfcDoor, IfcWindow) must have an associated one-third octave band sound reduction index *R*
- All horizontal BuildingElements IifcSlab,IifcRoof, IfcStair, IfcRamp) must have both one-third octave band sound reduction index *R* and normalised impact sound pressure level L_n
- All vertical coverings (IfcCovering) must have an associated one-third octave band improvement of the sound reduction index Δ*R*
- All horizontal coverings IifcCovering) must have both one-third octave band improvement of the sound reduction index Δ*R* and reduction of the impact sound pressure level Δ*L*
- All ventilation ducts must have either an associated one-third octave band sound reduction index *R* or a normalised level difference $D_{n,e}$
- The faces of all BuildingElements with significant areas must have an associated one-third octave band absorption coefficient *α*

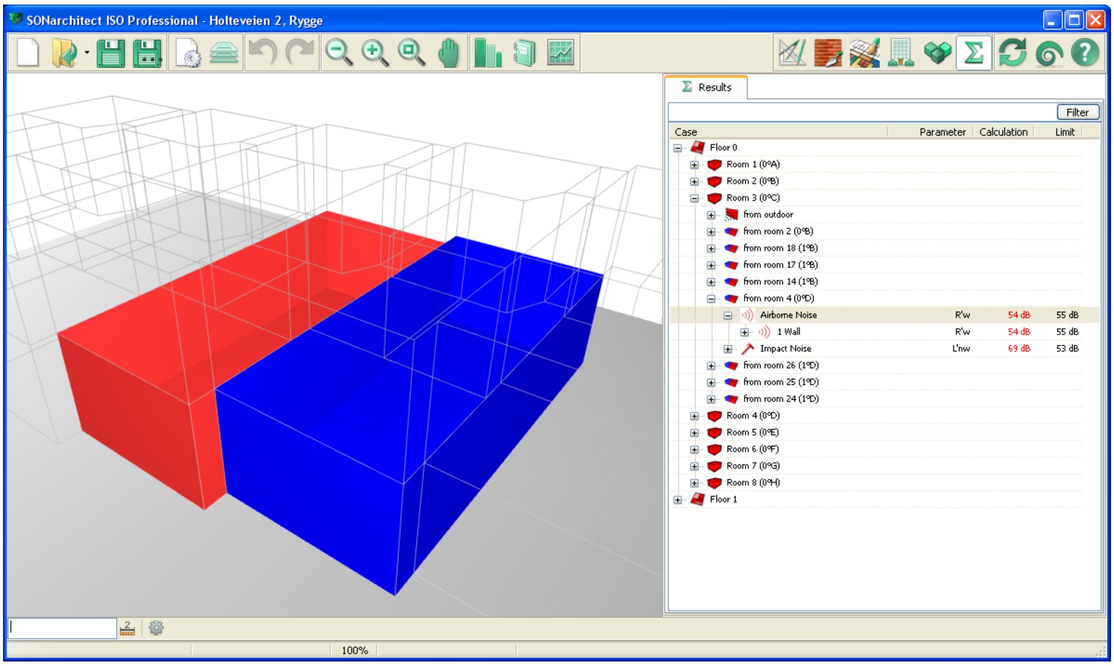


Figure 2: Example of an acoustical analysis model of sound insulation between two rooms in a series of two-storey terraced houses (SONarchitect ISO).

***Possible "production track"**: a simple BIM containing walls, slabs, doors, windows and space objects is exported to IFC (.ifc file). A simplified building model is created, e.g. based on the space objects. Each room is assigned a room type, which is used for the definition of the acoustical requirements. The room type and the acoustical requirements can either be integrated in the BIM or assigned by the acoustician as part of the acoustical analysis.*

The selection of surface materials is currently assumed to be made within the acoustical analysis tool because the related acoustical data are normally provided by the acoustician (RIAKU).The description of intended materials is potentially information that could be included in the BIM and extracted from the BIM.

In addition to the above mentioned BuildingElement data, the acoustician can apply different solutions for the junctions, either rigid or elastic. This can influence the calculation results significantly, and thus this represents additional information that must be reported together with the results of the acoustical analysis.

Currently it is not clear how the data for junctions should be contained in the BIM.

Model requirements:

- For acoustical analysis each space in the model must be ”closed” / ”watertight”
- The following objects shall be included:
  - From Full Conceptual Design: walls with acoustical properties (airborne sound insulation and sound absorption)
  - From Full Conceptual Design: slabs with acoustical properties (airborne and impact sound insulation and sound absorption)
  - From Full Conceptual Design: windows and doors with acoustical properties (airborne sound insulation and sound absorption)
  - Stairs
- The following objects may be included, if important for the acoustical simulation:
  - Major columns and beams (assumed to have acoustical impact)
  - Equipment and furniture shall - generally speaking - *not* be included. However, if they have ”large” dimensions assumed to have acoustical impact, they should be included
- Objects with detailed geometry should be removed or simplified before export
  - Objects with “small” dimensions should *not* be included in the model for acoustical analysis, as this complicates the analysis, can increase calculation time drastically, and may require more follow-up work / housekeeping in the analysis tool. Typically this will include “slender” columns and beams, equipment and furniture and railings, etc.

*

INFO: Translation of terms from Norwegian to English – reference (ISO 717-1 and ISO 717-2):

- NO: Veid feltmålt lydreduksjonstall, R'_{w}
- NO: Veid feltmålt normalisert trinnlydnivå, $L'_{n,w}$
- EN: Weighted apparent sound reduction index, R'_{w}
- EN: Weighted normalised impact sound pressure level, $L'_{n,w}$

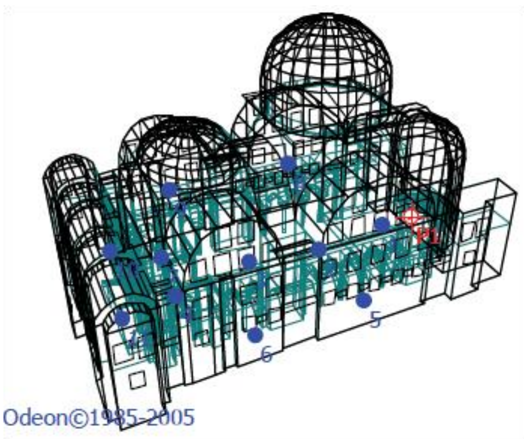


Figure: Example of an acoustic analysis model (in Odeon) - curved surfaces are simplified to produce a suitable set of plane surfaces.

D.3 Building Information Modelling Practice (Normative)

This chapter contains Statsbygg's view of what is regarded as being normative BIM practice wherever feasible, subject to project constraints and approved CAD/BIM tools.

Because a BIM (a digital model or a process) always serves a purpose, it is crucial that the model is unambiguous with the expected components in place. This is managed by the requirements set in every phase or in a business process.

To enable sufficient benefits to be derived from the BIM during the production phase (construction), the model should have a production centric logical structure – i.e. the model should mimic the way the contractor actually *constructs* – e.g. walls are built floor by floor and should not be modelled over multiple stories. Key information for the contractor includes quantities and geometry (production centric logical modelling).

Before starting modelling

1. Examine the BIM delivery plan for the project.
2. Check to ensure that BIM deliverables and requirements are *relevant* for defined project *decision* points.
3. Check to ensure that BIM objectives (the intended purpose / usage of the BIM) are communicated and understood by the project participants, including the modellers.
4. Check to ensure that the modelling tools (CAD tools, etc.) have relevant and sufficient support for fulfilling the BIM requirements.
5. Organise a session where all disciplines/domains are present and interact by exchanging models across selected software tools in the project.
6. Make a test model involving all disciplines. Check that it is feasible to model according to the requirements in the intended modelling tools. Find alternative approaches for requirements that cannot readily be accounted for.
7. The session shall basically solve any plausible technical issues and ensure that all disciplines can start modelling. However the exchange of known issue experiences is just as important.
8. Establish a contact list for the software solution providers involved, to ensure intended use of the software and continuous documentation of technical errors and deficiencies if any problems arise.
9. Establish an interaction platform where all project participants can access the latest version of the model(s). This may be file-based through a web hotel or similar structure – or it can be done by using a model server where the entire model is handled up-to-date and locks objects that are being edited.
10. Clarify all interfaces between disciplines / participants, including the content information of each of the partial (discipline) models.
11. Try to enable new, more efficient working processes when working with BIM. Good communication and interaction between participants are key conditions for succeeding with BIM. Both formal and informal lines of communication should be strengthened from the outset of the project.

How to make a good model

1. Consider the consistency / structure / composition of the model.

2. Model consistency is the key for making it useable and *useful* for downstream processes. If the model has critical structure errors the model information cannot be trusted.
3. Use the correct object *type* – reflecting the actual *function* of the object. It is *possible* to model an entire building using only the *wall* type object, but doing so will render the model almost useless for downstream processes.
4. All objects in the model shall be sensibly *grouped*.
5. The model shall distinguish between *type* objects and *occurrence* (instance) objects.
6. The model shall distinguish between generic and product specific information (properties etc.).
7. The model shall be without "loose ends" or objects without relation to other objects.
8. Duplicated and overlapping objects shall be avoided. This should preferably be checked within the modelling tool before BIM export.
9. The GUID (global unique identifier) shall be *preserved* when updating the model by moving an object or exchanging the object with another type. This will make model versioning and tracking changes in the model easier. Some CAD tools may currently not fully comply with this requirement – actions to mitigate this in the project must be planned, and accepted by project management.
10. Observe correct *relations* between objects. Most relations will probably be automatically generated in the CAD tool, so using the CAD tools correctly is important. In practical modelling selecting the correct object *tool* for the intended *function* (wall tool, slab tool, stair tool and space tool, etc.) and working from the correct *floor* when placing the objects may be important.
11. Other important relations are *zones* (the grouping of space objects) and *systems* (the grouping of (mainly technical) objects).
12. Observe the use of *text fields* in object attributes and properties – if naming conventions for object names and type names, etc. are be used in the project, it is important to comply carefully and strictly with the established standards and enumeration lists, etc. to enable downstream use of the BIM.
13. Restrict the use of *object properties* to the actual requirements / detailing in each phase of the project. The use of excess properties in early phases will "clog up" the model by making it unnecessarily large and complex, and may trigger unnecessary re-design in the project.
14. *Check* the model in-house before it is exported and shared with other disciplines. Most CAD tools have some sort of quality checking features – they should be *used*! A third party model viewer or model checker may often prove useful for "weeding out" the worst errors. The acquisition of a tool for finding model errors is highly recommended.

Common modelling mistakes and misconceptions

By modelling mistakes we mean deviance from our BIM requirements, usually elements in the IFC model. The source of errors either comes for the user or the CAD-software. A mistake made by the user is often the result of ignorance about the BIM deliverables and the following requirements or how to use the CAD software in the best possible way. This can be solved by providing good documentation and guidelines for the user.

Model errors caused by the CAD software could be bugs or poor implementation of the IFC-schema. However, the main source of deviance usually relates to the fact that our requirements are not always compatible with the internal processing of models in every CAD system. The ideal world is too far from the real version. This results in frustration and filling the gap in the middle of the project is a very time-consuming process. Some of this can be fixed by following the advice in the chapters above.

This chapter will address some of the mistakes we see in our everyday projects. The list is not complete (we suggest that a website forum or wiki could deal with such common mistakes by serving as a “how to” database for projects using open BIM). However, we will try to focus on those user-initiated mistakes that can be fixed.

Object Identification

Statsbygg intends to pursue the current requirements relating to identification of IfcProject, IfcSite, IfcBuilding and IfcBuildingStorey. These are common object types where GUID and the name must be the same in all models. We are aware of problems regarding keeping the IFC-GUID in some applications. However, this will make correct naming essential.

Identification and naming conventions for objects like IfcProject, IfcBuilding and IfcBuildingStorey can easily be resolved by exporting all the elements with the right conventions from one model to IFC and then importing the file into all other models as groundwork. This procedure can also help with the coordination of defining the project zero and adjusting floor heights, etc.

Since the IFC specification does not cover every construction type or element, naming conventions and/or proxy elements are useful. But this implies that other attributes must contain valid names and codes. Please ensure that you apply the right set of names/codes if such is specified. Please be aware of case sensitivity.

Naming and numbering of spaces

The rooms object (IfcSpace) is used in several databases. The primary key is the *room function number* (RFN), which is a database ID for every planned room. This is handled in the requirement chapter.

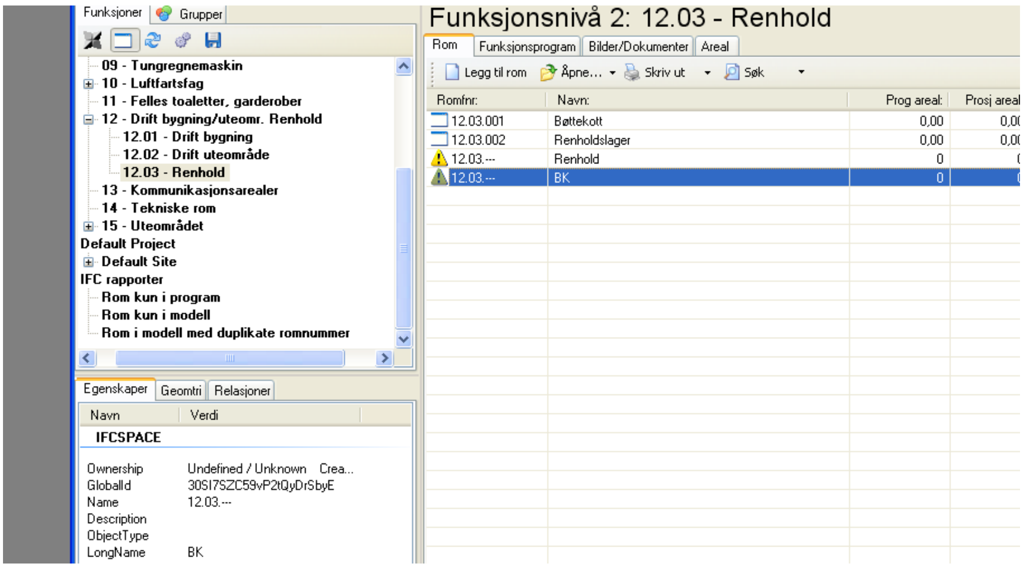


Figure 1: Spaces are not recognised due to incorrect naming/numbering

Tidying up around the model

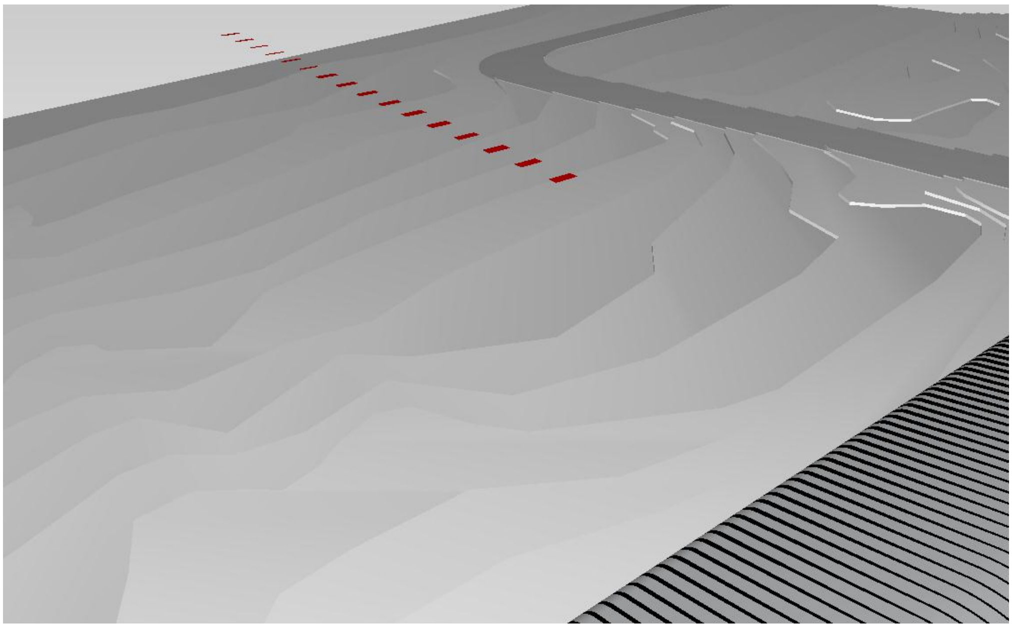


Figure 2: Irrelevant objects "scattered" around the model should be removed before IFC export. This may imply removing certain CAD layers before IFC export

Relations between objects

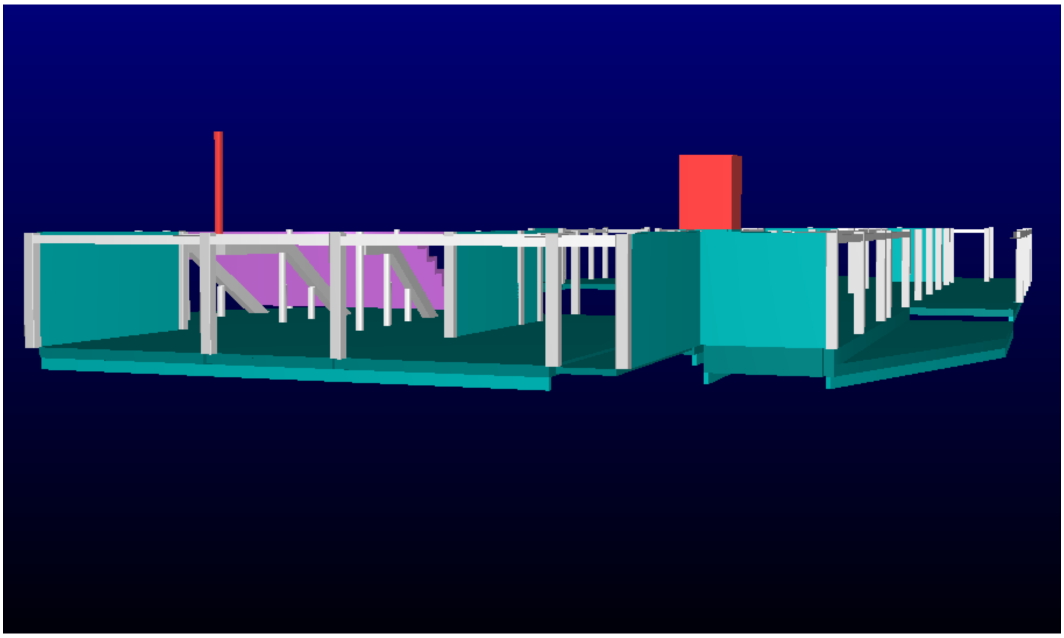


Figure 3: Column and wall are not related to the floor on which they physically belong

The object consists of multiple construction building parts

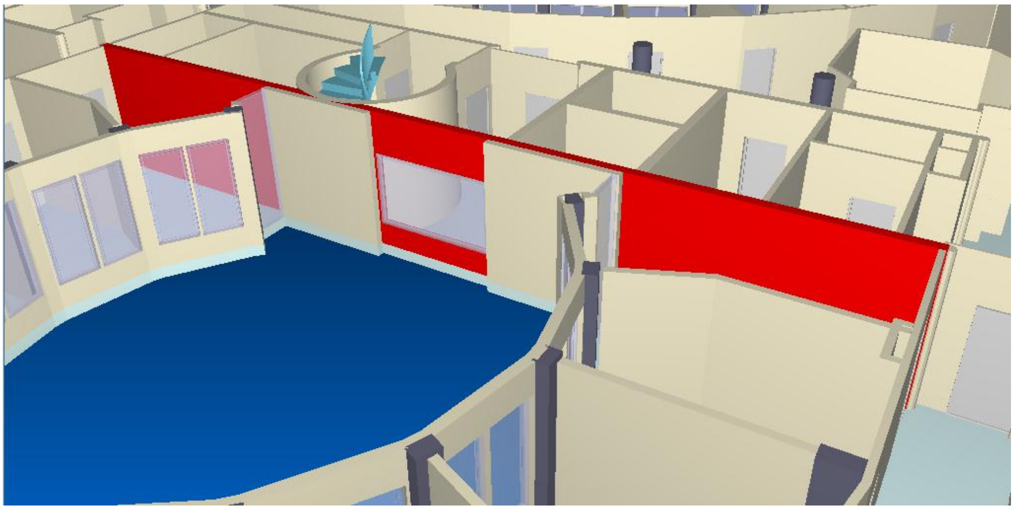


Figure 4: Wall object is both external and internal wall, causing errors in QTO and energy analysis

Object class/type based on function

When modelling an object, it might not be obvious what kind of entity it represents in the IFC schema. We recommend that the modeller should use an entity based on the function of the object. If a building has a glass floor, the entity is IfcSlab, not IfcWindow.

Inlet cover [no:*inntaksrist*] – IfcFlowTerminal, IfcDuctFittingType - enumeration entry

Roof window [no:*overlysvindu*] – IfcWindow

Inspection hatch [no:*inspeksjonsluke*] – IfcDoor

In other examples the object type is completely wrong, and has obviously been created in another tool than the intended one.

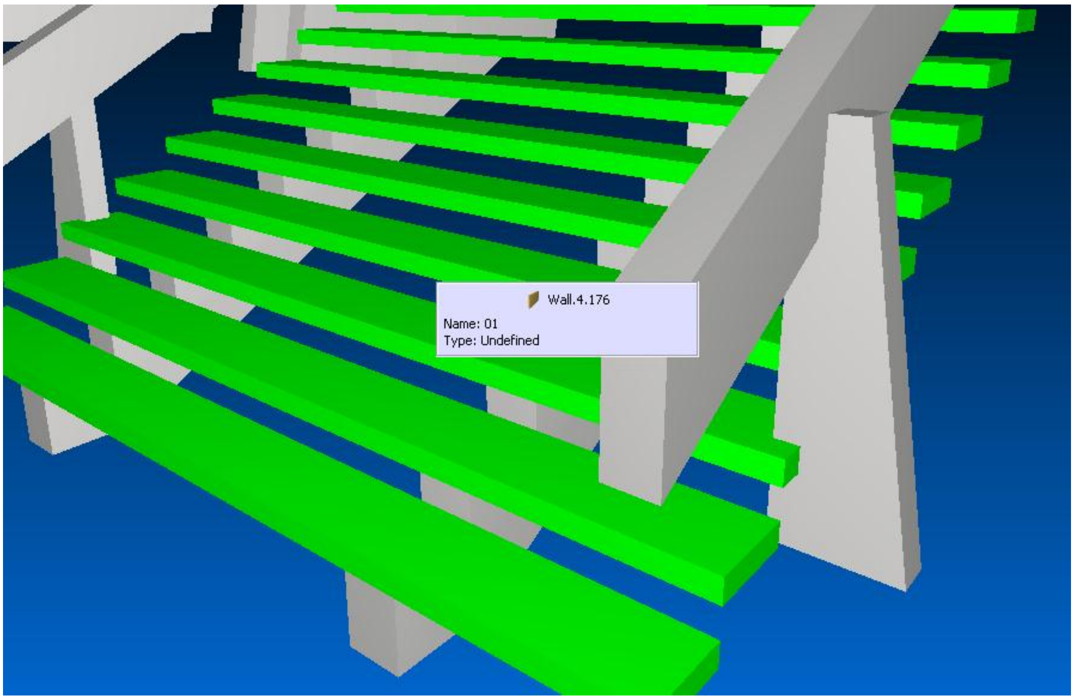


Figure 5: If the object has an incorrect object class it may still produce a decent 3D representation, but the model quality is reduced, creating a detrimental impact on QTO, egress, security and circulation analyses

Property Sets

Use of proprietary PSets (such as "PSet_CAD_Application_Dimensions"), when there is a standardised property in the IFC specification, is not a very interoperable way to work with data. Mapping tables and export filters should be used to avoid superfluous properties and information.

Dispense with proxy elements in the model

By Proxy elements (**IfcBuildingElementProxy)** we mean objects without classification. This can be a part of other construction elements or technical objects, but often they appear as furniture and other inventory.

The good thing about Proxy elements is that they are very flexible can represent anything in the model, e.g. if space-intensive units like art installations and machinery for production, etc. can be given a geometrical boundary representation to ensure enough space during the early design stages.

The catch with using proxy elements is that they do not have any built in properties or relations that are useful in a downstream process.

Space program vs. Space functions

Space programs are not a standard hierarchy of functions, and the space programs can vary between projects, e.g. spaces can be oriented by department and section, building and story, main functions and sub-functions. For example, WC can be a part of a the main function, Administration.

If the space program differs from space functions in the model, the space classification must be done manually. Either by generating functions in the CAD application and tag spaces, or by sorting the spaces in Functional zones.

E. Building Information Modelling spin-off deliverables (Informative)

In addition to the BIM deliverables a number of "reports" from the BIM may be required.

Ref.#	Subject	Type	Requirement and description
A.	Drawings in general	INFO INFO	Please refer to Statsbygg CAD Manual "*PA 0603 DAK-tegninger*" (Design Guide 0603 CAD Drawings) for requirements relating to CAD drawings. http://www.statsbygg.no/Dokumenter/Prosjekteringsanvisninger/0-Generelle/ In addition other drawings may be required at specific phases during the project, in specific formats (e.g. DWG, DXF, PDF, DGN, PLT (plotter files) etc.), for specific purposes.
B.	Export of other model formats	INFO	The BIM may spin-off special other models for various purposes, like self-contained "run-time" type visualisation models (e.g. VBE models and 3D-PDF models), models for use and analysis in specific software applications (e.g. NWC models for Autodesk Navisworks, SMC models for Solibri Model Checker), animation / visualisation models like 3DS (3D Studio) or VRML, and "for a narrow purpose" type exports like gbXML for environmental analyses.
C.	"Zero-D" (0D) data	INFO	Non-geometric tabular / spreadsheet data may be extracted from the BIM (typically for QTO and costing), and exported in a number of formats, like XLS, ODS, CSV, TXT.

Ref.#	Subject	Type	Requirement and description
D.	Open "Issue" format BCF	INFO	A recent addition to open BIM standards is "*BIM Collaboration Format*" (BCF), developed by Tekla Corp. and Solibri Inc., now supported by buildingSMART and gaining support from other participants (Autodesk, DDS, Eurostep, Gehry Technologies and Progman, etc.). The BCF format specifies means by which designers and other stakeholders are able to relate messages, action items, viewpoints and snapshots to specific components in a BIM and transmit them to other participants. The receiving party then uses this information in its own BIM authoring tool to identify and locate the component(s) and view them from the same viewpoint established by the sender. Status reporting from the participants involved is supported, so it can be used in BIM processes.

F. Classifications (Informative)

The use of naming / numbering conventions as “classifications” in a BIM is a simple approach that may contribute towards omitting problems caused, for example, by the CAD tool not being able to preserve GUIDs.

An alternative and more future-oriented approach is the use of open standard IFD (International Framework for Dictionaries - http://www.ifd-library.org) GUIDs. Statsbygg supports the use of IFD and will welcome design teams that want to utilise IFD in BIM projects. We currently do not *require* the use of IFD due to limited software support, but will support design teams that use software that does and are willing to test the use of IFD.

F.1 Technical spaces

Recommended naming for Technical spaces in Statsbygg projects unless otherwise agreed in the project.

English	Norwegian
AirHandlerRoom	Ventilasjonsaggregatrom
BackupPowerGeneratorRoom	Reserveaggregatrom
BatteryRoom	Batterirom
BoilerRoom	Fyrrom
ChillerRoom	Kjølemaskinrom
ComputingCentreRoom	Datasentralrom
ElectricalSpaceOther	ElektroAnnetRom
ElectricalSpaceUserDefined	ElektroBrukerdefinertRom
MainDistributionBoardRoom	Hovedfordelingsrom
MechanicalSpaceOther	VVSAnnetRom
MechanicalSpaceUserDefined	VVSBrukerdefinertRom
PBXRoom	Telefonsentralrom
PowerTransformerRoom	Tranformatorrom
ServerRoom	Serverrom
SubDistributionBoardRoom	Underfordelingsrom
UPSPowerRoom	UPS-rom
… should be supplemented …	*… bør suppleres …*

F.2 Mechanical entities

Recommended naming for Mechanical entities in Statsbygg projects unless otherwise agreed in the project.

Entry Points for Mechanical infrastructure

English	Norwegian
DistrictCooling	Fjernkjøling
DistrictHeating	Fjernvarme
Drainage	Avløp
GasSupply	Gassforsyning
MechanicalInfrastrutureOther	VVSAnnenInfrastruktur

English	Norwegian
MechanicalUserDefined	VVSBrukerdefinert
WaterSupply	Vannforsyning
… should be supplemented …	*… bør suppleres …*

Mechanical components

English	Norwegian
Air Handler	Ventilasjonsaggregat
Chiller	Kjølemaskin
Duct Silencer	Lydfelle
Ductwork	Rørnett
Pipework	Kanalnett
… should be supplemented …	*… bør suppleres …*

F.3 Electrical entities

Recommended naming for Electrical entities in Statsbygg projects unless otherwise agreed in the project.

Entry Points for Electrical infrastructure

English	Norwegian
BuildingAutomation	Byggautomasjon
CableTV	Kabel-TV
CommunicationsSupply	IKT-forsyning
ElectricalCommunicationsInfrastrutureOther	ElektroAnnenInfrastruktur
ElectricalCommunicationsUserDefined	ElektroBrukerdefinert
ElectricalSupply	Elforsyning
SafetyAndFireAlarmHandling	SikringsOgBrannalarmhåndtering
SecurityAlarmHandling	Sikkerhetsalarmhåndtering
… should be supplemented …	*… bør suppleres …*

Electrical components

English	Norwegian
MainDistributionBoard	Hovedfordeling
SubDistributionBoard	Underfordeling
PowerOutlet	Elkraftuttak
LightingFixture	Lysarmatur
CommunicationsOutlet	IKT-uttak
FireAlarmDetector	Brannalarmdetektor
FireAlarmPullStation	Brannmelder
EmergencyLightingFixture	Nødlysarmatur
… should be supplemented …	*… bør suppleres …*

F.4 Phases

Mapping of Statsbygg Phase/Stage Numbers/Names for *Process protocol* (PP)[6] Reference phases.

[6] See http://www.processprotocol.com/ppguide/phase.htm from University of Salford, UK.

ProcessProtocol_PhaseNumber	ProcessProtocol_PhaseName	Statsbygg_StageName[EN]	Statsbygg_StageName[NO]	Statsbygg_PhaseNumber	Statsbygg_Mapped_PhaseName[EN]	Statsbygg_Mapped_PhaseName[NO]
0	Demonstrating the need	Initiation	Initisering	1	Project initiation	Prosjektetablering
1	Conception of need	Programming	Programfase	1	Project initiation	Prosjektetablering
2	Outline feasibility	Programming	Programfase	2	Project report	Prosjektutredning
3	Substative feasibility study and outline financial authority	Programming	Programfase	3	Client brief. Functional an spatial program development	Byggeprogram. Plan- og programutvikling
4	Outline conceptual design	Concept Design	Forprosjektfase	4	Selection of Design Professionals	Kontrahering av rådgivere
4	Outline conceptual design	Concept Design	Forprosjektfase	5	Schematic Design	Skisseprosjektering
5	Full conceptual design	Concept Design	Forprosjektfase	6	Design Development	Forprosjektering
6	Coordinated design, procurement and full financial authority	Detailed Design	Detaljprosjektfase	7	Coordinated Design	Detaljprosjektering
6	Coordinated design, procurement and full financial authority	Detailed Design	Detaljprosjektfase	8	Selection of Contractors	Kontrahering av entreprenør
7	Production Information	Construction	Byggefase	9	Construction	Bygging
8	Construction	Construction	Byggefase	9	Construction	Bygging
8	Construction	Construction	Byggefase	10	Construction handover	Overtakelse av bygg
9	Operation and maintenance	Contract Claims	Reklamasjonsfase	11	Technical services trial operation	Teknisk prøvedrift
9	Operation and maintenance	Contract Claims	Reklamasjonsfase	12	Technical services handover	Overtakelse teknisk
9	Operation and maintenance	Contract Claims	Reklamasjonsfase	13	Contract claim period	Reklamasjon
9	Operation and maintenance	FM and operations	FDV-fase	14	Facility management and operations	Forvaltning, drift, vedlikehold
10	Disposal	Decommissioning	Avhendingsfase	15	Decommissioning	Avhending

–

F.5 Disciplines

Mapping of Statsbygg Discipline Names to a subset of OmniClass Table 33[7] (where possible).

Acronyms used	English – OmniClass Table 33 subset	Norwegian – Statsbygg Names
ARK	Architecture	Arkitektur
IARK	Interior Design	Interiørarkitektur
LARK	Landscape Architecture	Landskapsartektur
RIAKU	Acoustical Engineering	Akustikk
RIB	Structural Engineering	Bygningsteknikk
RIBR	Fire Safety Engineering	Brannteknikk
RIE	Electrical Engineering [8]	Elektroteknikk [9]
RIG	Geotechnical Engineering	Geoteknikk
RIV	Mechanical Engineering	VVS-teknikk
RIX	Other Design and Engineering	Annen prosjektering
…	… may need supplements …	… kan trenge supplementer …

F.6 Participant Roles

Mapping of Statsbygg Participant Roles *partly* to a subset of OmniClass Table 34 (where possible).

Acronyms used	English – OmniClass Table 34 subset	Norwegian – Statsbygg Names
ARK	Architect	Arkitekt
BH	Client / Owner	Byggherre / Tiltakshaver
DIV	Miscellaneous participant roles (must be specified)	Diverse andre roller (må spesifiseres)
ENT	Contractor (in general)	Entreprenør (generelt)
FORV	Facility Manager	Forvalter
IARK	Interior Designer	Interiørarkitekt
KJK	Kitchen Designer / Consultant	Prosjekterende kjøkkenkonsulent
LARK	Landscape Architect	Landskapsartekt
LEV	Supplier (in general)	Leverandør av varer og tjenester til byggverket (generelt)
(MERGE)	"Merge" is not actually a participant role for *persons*, but is used to indicate that a BIM consists of models from more than one discipline that have	"Merge" er ikke egentlig en rolle for *personer*, men benyttes for å angi at en BIM består av en samenslått modell med flere enn ett fagområde - normalt

[7] http://www.omniclass.org

[8] Electrical Engineering includes Electrical Power Engineering, Communications Engineering, Building Automation Engineering and Vertical Transport Engineering (elevators etc.)

[9] Elektroteknikk inkluderer Elektroteknikk, Tele- og automatiseringsteknikk, og Interntransport (heiser mv)

Acronyms used	English – OmniClass Table 34 subset	Norwegian – Statsbygg Names
	been *merged* (collated / united) – usually a merged BIM consists of models from all relevant disciplines in the situation.	består en *merget* BIM av modeller fra *alle* relevante fag i den aktuelle situasjonen.
MPRO	Multi Discipline Designer / Engineer	Prosjekterende med ansvar for flere fag
PL	Project Management (in general)	Projektledelse (generelt)
PLAN	Planning (in general)	Planlegger (generelt)
PRO	Designer / Engineer (in general)	Prosjekterende (generelt)
PROG	Client Programming	Programmering (av bygg)
RIAKU	Acoustical Engineer	Akustiker
RIB	Structural Engineer	Bygningstekniker
RIBR	Fire Safety Engineer	Branntekniker
RIBR	Fire Safety Engineer	Branntekniker
RIE	Electrical Engineer	Elektrotekniker
RIG	Geotechnical Engineer	Geotekniker
RIV	Mechanical Engineer	VVS-tekniker
RIX	Other Designer or Engineer	Annen prosjekterende
RIX	Other Designer or Engineer	Annen prosjekterende
TENT	Design-Build Contractor	Totalentreprenør
TPRO	All Discipline Designer / Engineer	Prosjekterende med totalansvar (alle fag)
UENT	Sub-contractor (in general)	Underentreprenør (generelt)
ULEV	Sub-supplier (in general)	Underleverandør av varer og tjenester til byggverket (generelt)
UTF	Executing participant on construction site (in general)	Utførende part på byggeplass (generelt)
UTS	Furniture, Fittings & Equipment (FF&E) Consultant	Prosjekterende utstyrskonsulent
(V)	Optional – i.e. who takes the participant role can be freely decided	Valgfritt, dvs at det kan bestemmes fritt hvem som påtar seg rollen
(X)	Variant, may involve multiple disciplines, interdisciplinary, situation dependent	Varierende, kan involvere flere fag, tverrfaglighet, situasjonsavhengig
…	… may need supplements …	… kan trenge supplementer …

G. Project Specific Contract Addendum (Informative)

To make it simpler to identify relevant BIM requirements in actual projects the following form may be filled out by Project Management if the BIM Manual (as a whole or in part) is to be used as a legal document in the project.

In the "Ref." column, numbered clauses (Ref.# in tables, numbered chapters and/or whole parts) from the requirements in this BIM Manual can be entered. If ticked in the "Apply in project" column without further specifications in the "Notes, and/or external document references" column, the requirements of the referenced Chapter/Clause apply as defaults as described, i.e. all MAND clauses are mandatory ("shall") in the project, and all REC are recommended ("should"). INFO text is read and noted.

If alterations are made in the project by ticking in the "Apply in project" column, but with further specifications in the "Notes, and/or external document references" column, the notes and referenced documents take precedence over this BIM Manual wherever they differ.

Notes can be made by referencing the individual requirement clauses (Ref.#) in the requirements tables. Notes may specify further at which specific phase (or phases) of the project analyses are required.

If NOT is ticked in the "Apply in project" column, the Chapter/Clause does NOT apply in the project.

Ref.	Topic	Apply in project	Notes, and/or external document references
	Basic BIM requirements	❑	
	BIM – Generic requirements	❑	
	BIM – Generic model structure requirements	❑	

Ref.	Topic	Apply in project	Notes, and/or external document references
	The Requirement BIM from the client *[tick if Statsbygg provides a requirement BIM as described in the project]*	❑	
	Architecture Modelling	❑	
	Landscape Architecture Modelling	❑	
	Interior Design Modelling	❑	
	Geotechnical Engineering Modelling	❑	
	Structural Engineering Modelling	❑	
	Mechanical Engineering Modelling	❑	
	Electrical and Communications Engineering Modelling	❑	

Ref.	Topic	Apply in project	Notes, and/or external document references
	Acoustical Engineering Modelling	❑	
	Fire Safety Engineering Modelling	❑	
	Other Design and Engineering Modelling *[if used specify what disciplines apply and refer to external document(s) for requirements]*	❑	
	Pre-Design Stage – Alternative sites analysis	❑	
	Pre-Design Stage – Site analysis	❑	
	Pre-Design Stage – Building Survey	❑	
	Pre-Design Stage – Building Programming – Building Functional Programming	❑	
	Pre-Design Stage – Building Programming – Building Spatial Programming	❑	

Ref.	Topic	Apply in project	Notes, and/or external document references
	Pre-Design Stage – Building Programming – Building Technical Programming	❑	
	Design Stage – Architectural design competition and evaluation	❑	
	Design Stage – Design Authoring	❑	
	Design Stage – BIM – GIS Integration analysis and visualisation	❑	
	Design Stage – Architectural Visualisation	❑	
	Design Stage – BIM validation/Consistency check	❑	
	Design Stage – Quantity takeoff (QTO)	❑	
	Design Stage – Detailed Quantity takeoff (QTO)	❑	

Ref.	Topic	Apply in project	Notes, and/or external document references
	Design Stage – Designed Geometric 3D Interdisciplinary Coordination	❑	
	Design Stage – Structural analysis	❑	
	Design Stage – Acoustical analysis	❑	
	Design Stage – Security and circulation analysis	❑	
	Design Stage – Fire safety analysis	❑	
	Design Stage – Energy analysis (energy use and thermal comfort)	❑	
	Design Stage – Lighting analysis	❑	
	Design Stage – Accessibility analysis	❑	

Ref.	Topic	Apply in project	Notes, and/or external document references
	Design Stage – Environmental analysis (for certification like BREEAM, LEED, etc.)	❑	
	Design Stage – Planned project scheduling and resource allocation ("4D" analysis)	❑	
	Design Stage – Basic cost analysis ("5D" analysis)	❑	
	Design Stage – Detailed cost analysis ("5D" analysis)	❑	
	Design Stage – Building Code analysis	❑	
	Construction Stage – Construction adapted geometric 3D Interdisciplinary Coordination	❑	
	Construction Stage – Construction adapted quantity takeoff (QTO)	❑	
	Construction Stage – Planned vs. actual project scheduling and resource allocation ("4D" analysis	❑	

Ref.	Topic	Apply in project	Notes, and/or external document references
	Construction Stage – Construction adapted cost analysis (“5D” analysis)	❑	
	Construction Stage – Project close-out deliverables analysis	❑	
	FM and operations stage – FM handover analysis	❑	
	FM and operations stage – Building operations scheduling analysis	❑	
	FM and operations stage – Building preventive maintenance analysis	❑	
	FM and operations stage – Asset management (space area, equipment inventory, etc.)	❑	
	FM and operations stage – Contingency planning analysis	❑	

Ref.	Topic	Apply in project	Notes, and/or external document references
	FM and operations stage – Environmentally hazardous products analysis	❑	
	FM and operations stage – Building disposal analysis	❑	

References

In order of appearance.

A.1 Scope (Informative)

Statsbygg's BIM site: www.statsbygg.no/bim

A.2 Out of Scope

"PA 0603 DAK-tegninger":
http://www.statsbygg.no/FilSystem/files/Dokumenter/prosjekteringsanvisninger/0GenerellePA/PA_0802_TFM.pdf

BuildingSMART International home of open BIM: http://buildingsmart.com

BuildingSMART Technical: http://www.buildingsmart-tech.org

IFC Wiki (International): http://www.ifcwiki.org.

BuildingSMART Norge http://www.buildingsmart.no and http://www.iai.no

A.3 References (Normative)

Standard Norge: www.standard.no

A.4 Terms and definitions (Normative)

Process Protocol : http://www.processprotocol.com

OmniClass Table 33 – Disciplines: http://www.omniclass.org

OmniClass Table 34 – Organisational Roles: http://www.omniclass.org

B.1 Basic BIM requirements

Entire IFC model: http://www.buildingsmart-tech.org/ifc/IFC2x3/TC1/html/index.htm

Georeferencing: ftp://ftp.buildingsmart.no/pub/Georeferencing/

B.3 Generic model structure requirements

Illustration: http://www.be.no/beweb/regler/veil/REN2003/ill/fig4-24.gif

B.3 The Requirement BIM from the client

dRofus: http:// www.drofus.no

C.2 Landscape Architecture Modelling [no:LARK]

American Society of Landscape Architects: http://www.asla.org

Landscape design advisor: http://www.landscape-design-advisor.com/landscape-architecture-design-glossary.html

C.4 Geotechnical Engineering Modelling [no:*RIG*]

IDM for Georeferencing: ftp://ftp.buildingsmart.no/pub/Georeferencing/

C.11 BIM Construction and As Built Requirements

dRofus TIDA: http://www.drofus.no/en/product/modules/tida.html

dRofus download: http://www.drofus.no/en/support-services/download.html

C.12 BIM for Facility Management and Operations

General Service Administration BIM Guide Series http://www.gsa.gov/bim

D.2 Analyses applied by Statsbygg (Informative)

Odeon plugin for Google Sketchup : http://www.odeon.dk/su2odeon-plugin-google-sketchup

SONarchitect ISO: http://www.soundofnumbers.net/

E Building Information Modelling spin-off deliverables (Informative)

"*PA 0603 DAK-tegninger*":
http://www.statsbygg.no/Dokumenter/Prosjekteringsanvisninger/0-Generelle/

F Classifications (Informative)

International Framework for Dictionaries: http://www.ifd-library.org

F.4 Phases

Process Protocol: http://www.processprotocol.com/ppguide/phase.htm

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