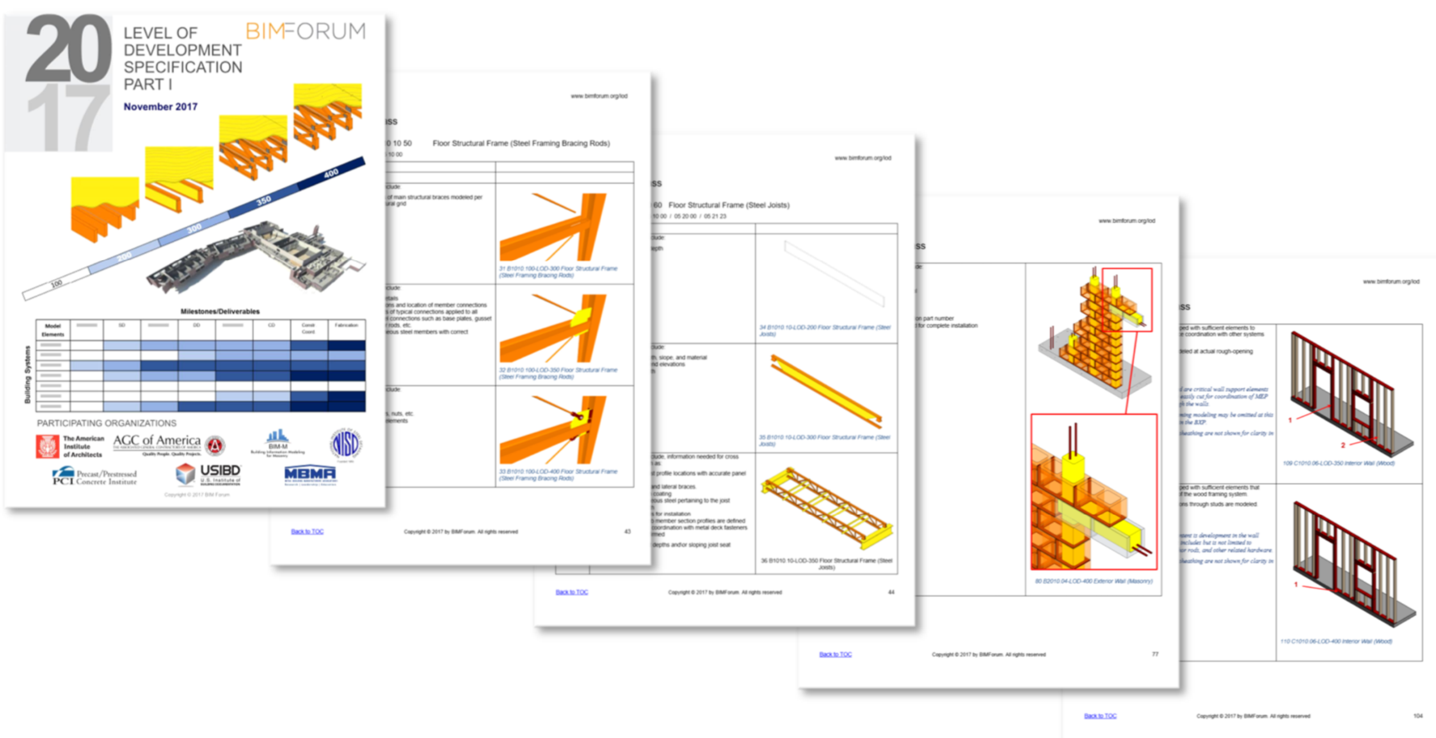
2017 LEVEL OF DEVELOPMENT SPECIFICATION GUIDE

BIMFORUM

November 2017



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National Institute of Steel Detailing — Founded 1969

PCI Precast/Prestressed Concrete Institute

USIBD U.S. Institute of Building Documentation

MBMA Metal Building Manufacturers Association — Research | Leadership | Education

LOD Spec 2017 Guide

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November 2017

For Building Information Models

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EXECUTIVE SUMMARY

The Level of Development (LOD) Specification is a reference tool intended to improve the quality of communication among users of Building Information Models (BIMs) about the characteristics of elements in models. The LOD Specification expands upon the LOD schema developed by the American Institute of Architects (AIA) for its E202-2009 BIM and Digital Data Exhibit and updated for the AIA's G202-2013 Project BIM Protocol Form by providing definitions and illustrations of BIM elements of different building systems at different stages of their development and use in the design and construction process.

Building Information Modeling presents information about a construction project or structure in the form of three-dimensional graphical representations of elements (e.g., doors, beams, etc.), which can be further associated with information about other characteristics of those elements. It is possible for the graphical representation of an element, taken alone, to suggest that greater accuracy or intention can be attributed to the element than is in fact the case. The AIA's LOD Schema was developed to provide a more systematic way of conveying the extent of reliance that may be placed on an element. Many participants in the design and construction process felt, however, that the AIA's brief narrative definitions left too much room for interpretation.

Discussions within the BIMForum led to the creation by a multi-disciplinary task force of the LOD Specification. The LOD Specification is an organized collection of interpretations of the AIA's LOD definitions describing input and information requirements and providing graphical examples of the different levels of development of a broad variety of building element classes.

Users of the LOD Specification are cautioned that the LOD Specification does not prescribe the necessary levels of development for different steps in the construction process. That determination is left to each project team. It is believed, however, that the availability of more precise definitions will reduce the risks of miscommunication among members of project teams when the expectations for different stages in the design and construction process are established, through easier identification of what each member of the team is expected to deliver and greater predictability of the level of effort that is required to create each member's deliverables.

The LOD Specification is organized by CSI Uniformat 2010, with the subclasses expanded to Level 4 (and in a few cases to Level 5) to provide detail and clarity to the element definitions. The LOD Specification addresses only LOD 100 through LOD 400 of the AIA's LOD Schema, along with a new level – LOD 350 – which was added between LOD 300 and LOD 400 to better address the information levels required for effective trade coordination. The LOD Specification does not address LOD 500 since that LOD relates to field verification and is not an indication of progression to a higher level of geometry or information.

The BIMForum's interpretation of the LOD definitions are as follows:

> LOD 100 elements are not geometric presentations. They may be symbols or other generic representations of information that can be derived from other model elements. Any information derived from LOD 100 elements must be considered approximate.
>
> LOD 200 elements are represented graphically but are generic placeholders, e.g., volume, quantity, location, or orientation. Any information derived from LOD 200 elements must be considered approximate.
>
> LOD 300 elements are graphically represented as specific systems, objects, or assemblies from which quantity, shape, size, location, and orientation can be measured directly, without having to refer to non-modeled information such as notes or dimension call-outs.
>
> LOD 350 elements are enhanced beyond LOD 300 by the addition of information regarding interfaces with other building systems. For example, an LOD 350 masonry wall element would include jamb conditions, bond beams, grouted cells, dowel locations, and joints – information that enables the model user to coordinate the wall element with other systems in the structure.
>
> LOD 400 elements are modeled at sufficient detail and accuracy for fabrication of the represented component.

The LOD Specification does not prescribe who the author of a particular component at a given LOD should be, as that will vary from one project to another. However, the document does provide a concise schematic means through the spreadsheet in Part II for a project team to identify model element authors, again in the interest of improving communication among model users. In addition, the LOD Specification task force has been working with software developers to provide a means within the software of tagging individual elements within a model with their current LOD level.

The LOD Specification is intended as a reference standard, but is also intended to evolve as the use of BIM develops. The Specification is updated annually, and previous versions are maintained on the BIMForum website (www.bimforum.org/lod). Users are invited to provide comments and recommendations for consideration in future editions.

1 Overview

1.1 Description

The *Level of Development (LOD) Specification* is a reference that enables practitioners in the AEC Industry to specify and articulate with a high degree of clarity the content and reliability of Building Information Models (BIMs) at various stages in the design and construction process.

The Specification is a detailed interpretation of the LOD schema developed by the American Institute of Architects (AIA) for its *E202-2009 BIM and Digital Data Exhibit* and updated for its *G202-2013 Project BIM Protocol Form*[1], defining and illustrating[2] characteristics of model elements of different building systems at different Levels of Development, organized according to CSI Uniformat 2010[3]. Its intent is to help explain the LOD framework and standardize its use so that it becomes more useful as a communication tool.

The LOD Specification adheres to the intent of the LOD schema as developed by the AIA, and as such it is important to emphasize several points here.

1.1.1 LODs and Design Phase

The LODs are not defined by design phases. Rather, design phase completion, as well as any other milestone or deliverable, can be defined through the LOD language. There are several important reasons for this approach:

1) There is currently no detailed standard for the design phases. Many architects have created in-house standards, but these differ from one firm to the next, and even within a single firm the requirements are sometimes adjusted to the needs of a project.
2) Building systems progress from concept to precise definition at different rates, so at any given time different elements will be at different points along this progression. At completion of the Schematic Design phase, for example, the model will include many elements at LOD 200, but will also include many at LOD 100, as well as some at LOD 300, and possibly even LOD 400.

1.1.2 LODs and Model Definition

There is no such thing as an "LOD ### model." As previously noted, project models at any stage of delivery will invariably contain elements and assemblies at various levels of development. As an example, it is not logical to require an "LOD 200 model" at the completion of the schematic design phase. Instead, the "100% SD Model" will contain modeled elements at various levels of development.

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[1] AIA Contract Document *G202-2013, Building Information Modeling Protocol Form* is part of a series of digital practice documents the AIA published in June 2013. This series consists of *AIA E203™–2013, Building Information Modeling and Digital Data Exhibit, AIA G201™–2013, Project Digital Data Protocol Form*, and *AIA G202™–2013, Project Building Information Modeling Protocol Form*. For general information on the documents and downloadable samples see www.aia.org/digitaldocs. For executable versions of the documents see http://www.aia.org/contractdocs.

[2] All images are intended to illustrate building conditions in compliance with common building codes. However, the images do not take into account site specific conditions, regional building codes and other important information that may require a material change for specific projects. These illustrations do not make representation for fitness for a particular project nor for code or design compliance.

[3] UniFormat™ Numbers and Titles used in this publication are from UniFormat™, published by CSI and Construction Specifications Canada (CSC), and are used with permission from CSI. For a more in-depth explanation of UniFormat™ and its use in the construction industry visit http://www.csinet.org or contact CSI, 110 South Union Street, Suite 100, Alexandria, VA 22314. (800) 689-2900.

1.2 Intent

1.2.1 Not a set of Requirements

The Specification is not a set of requirements as to what is modeled when or by whom. Rather it is a language by which users can define these requirements for their own firms or projects. This clear articulation allows model authors to define what their models can be relied on for, and allows downstream users to clearly understand the usability and the limitations of models they are receiving.

To accomplish the Specification's intent, its primary objectives are:

1) To help teams, including owners, to specify BIM deliverables and to get a clear picture of what will be included in a BIM deliverable
2) To help design managers explain to their teams the information and detail that needs to be provided at various points in the design process, and to track progress of their models
3) To allow downstream users to rely on specific information in models they receive from others.
4) To provide a standard that can be referenced by contracts and BIM execution plans.

1.2.2 Complements a BIM Execution Plan (BIMXP)

This Specification does not replace a project BIMXP, but rather is intended to be used in conjunction with such a plan, providing a means of defining models for specific information exchanges, milestones in a design work plan, and deliverables for specific functions.

1.3 Background

1.3.1 AIA Effort

In 2008, the AIA published its first set of Level of Development definitions in AIA Document *E202™-2008 Building Information Modeling Protocol*. Due to the rapidly evolving nature of the use of BIM, the AIA evaluated the *E202–2008*, including the LOD definitions. The result is the updated and reconfigured Digital Practice documents, *AIA E203™–2013, Building Information Modeling and Digital Data Exhibit*, *AIA G201™–2013, Project Digital Data Protocol Form*, and *AIA G202™–2013, Project Building Information Modeling Protocol Form*, which are accompanied by a detailed guide document entitled *Guide and Instructions to the AIA Digital Practice Documents*. The AIA's updated Digital Practice documents include revised LOD definitions.

1.3.2 BIMForum Effort

In 2011 the BIMForum initiated the development of this LOD Specification and formed a working group comprising contributors from both the design and construction sides of the major disciplines. To help further the standardization and consistent use of the LOD schema, and to increase its usefulness as a foundation for collaboration, the AIA licensed the BIMForum to utilize its latest LOD definitions in this Specification. The BIMForum working group first interpreted the AIA's basic LOD definitions for each building system, and then compiled examples to illustrate the interpretations. Because BIM is being put to an ever-increasing number of uses, the group decided that it was beyond the initial scope to address all of them. Instead, the definitions were developed to address model element geometry, with three of the most common uses in mind – quantity take-off, 3D coordination and 3D control and planning. The group felt that in taking this approach the interpretations would be complete enough to support other uses.

1.3.3 LOD Definitions

The LOD definitions that are used in this Specification are identical to those published in the AIA's updated Digital Practice Documents, with two exceptions.

1) First, the working group identified the need for an LOD that would define model elements sufficiently developed to enable detailed coordination between disciplines – e.g. clash detection/avoidance, layout, etc. The requirements for this level are higher than those for 300, but not as high as those for 400, thus it was designated LOD 350. The AIA documents do not include LOD 350, but the associated *Guide and Instructions* references it.
2) Second, while LOD 500 is included in the AIA's LOD definitions, the working group did not feel it was necessary to further define and illustrate LOD 500 in this Specification because it relates to field verification. Accordingly, the expanded descriptions and graphic illustrations in this Specification are limited to LOD 100-400.

2 Levels of Development

2.1 BIM as a Communication Tool

The LOD schema addresses several issues that arise when a BIM is used as a communication or collaboration tool, i.e., when someone other than the author extracts information from it:

1) During the design process, building systems and components progress from a vague conceptual idea to a precise description. In the past, there has been no simple way to designate where a model element is along this path. The author knows, but others often don't.
2) It's easy to misinterpret the precision at which an element is modeled. Hand drawings range from pen strokes on a napkin to hard lines with dimensions called out, and the precision of the drawing can be inferred from its appearance. In a model though, a generic component placed approximately can look exactly the same as a specific component located precisely, so we need something besides appearance to tell the difference.
3) It is possible to infer or extract information from a BIM that the author doesn't intend – unconfirmed dimensions can be measured with precision, assembly information often exists before it's been finalized, etc. In the past, this issue has been sidestepped with all-encompassing disclaimers that basically say, "Since some of the information in the model is unreliable, you may not rely on any of it." The LOD framework allows model authors to clearly state the reliability of given model elements, so the concept becomes "Since some of the information in the model is unreliable, you may only rely on it for what I specifically say you can."
4) In a collaborative environment, where people other than the model author are depending on information from the model in order to move their own work forward, the design work plan takes on high importance – it is necessary for the model users to know when information will be available in order to plan their work. The LOD framework facilitates this.

The LOD Framework addresses these issues by providing an industry-developed standard to describe the state of development of various systems, assemblies, and components within a BIM. This standard enables consistency in communication and execution by facilitating the detailed definition of BIM milestones and deliverables.

2.2 Level of Development vs. Level of Detail

LOD is sometimes interpreted as Level of *Detail* rather than Level of *Development*. This Specification uses the concept of Level of *Development*. There are important differences.

Level of *Detail* is essentially how *much* detail is included in the model element. Level of *Development* is the *degree to which the element's geometry and attached information has been thought through* – the degree to which project team members may rely on the information when using the model.

In essence, Level of Detail can be thought of as input to the element, while Level of Development is reliable output.

2.3 Fundamental LOD Definitions [4]

2.3.1 LOD 100

The Model Element may be graphically represented in the Model with a symbol or other generic representation, but does not satisfy the requirements for LOD 200. Information related to the Model Element (i.e. cost per square foot, tonnage of HVAC, etc.) can be derived from other Model Elements.

BIMForum Interpretation: LOD 100 elements are not geometric representations. Examples are information attached to other model elements or symbols showing the existence of a component but not its shape, size, or precise location. Any information derived from LOD 100 elements must be considered approximate.

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[4] The definitions for LOD 100, 200, 300, 400, and 500 included in this Specification represent the updated language that appears in the AIA's most recent BIM protocol document, *G202–2013, Building Information Modeling Protocol Form*. The LOD 100, 200, 300, 400 and 500 definitions are produced by the AIA and have been used by permission. Copyright © 2013. The American Institute of Architects. All rights reserved. LOD 350 was developed by the BIMForum working group. Copyright © 2013. The BIMForum and the American Institute of Architects. All rights reserved.

2.3.2 LOD 200

The Model Element is graphically represented within the Model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.

BIMForum interpretation: At this LOD elements are generic placeholders. They may be recognizable as the components they represent, or they may be volumes for space reservation. Any information derived from LOD 200 elements must be considered approximate.

2.3.3 LOD 300

The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.

BIMForum interpretation: The quantity, size, shape, location, and orientation of the element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call-outs. The project origin is defined and the element is located accurately with respect to the project origin.

2.3.4 LOD 350

The Model Element is graphically represented within the Model as a specific system, object, or assembly in terms of quantity, size, shape, location, orientation, and interfaces with other building systems. Non-graphic information may also be attached to the Model Element.

BIMForum interpretation. Parts necessary for coordination of the element with nearby or attached elements are modeled. These parts will include such items as supports and connections. The quantity, size, shape, location, and orientation of the element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call-outs.

2.3.5 LOD 400

The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the Model Element.

BIMForum interpretation. An LOD 400 element is modeled at sufficient detail and accuracy for fabrication of the represented component. The quantity, size, shape, location, and orientation of the element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call-outs.

2.3.6 LOD 500

The Model Element is a field verified representation in terms of size, shape, location, quantity, and orientation. Non-graphic information may also be attached to the Model Elements.

BIMForum interpretation. Since LOD 500 relates to field verification and is not an indication of progression to a higher level of model element geometry or non-graphic information, this Specification does not define or illustrate it.

2.4 Example – Light Fixture:

- 100 cost/sf attached to floor slabs
- 200 light fixture, generic/approximate size/shape/location
- 300 Design specified 2x4 troffer, specific size/shape/location
- 350 Actual model, Lightolier DPA2G12LS232, specific size/shape/location
- 400 As 350, plus special mounting details, as in a decorative soffit

3 Using the Specification

3.1 Glossary

The expanded definitions in this Specification use the following interpretations of these terms:

3.1.1 Actual:

The model element includes all the qualities of a specific element and is representative of the manufacturer's model to be installed or the construction intent of an assembly.

3.1.2 BXP

BIM Execution Plan

1.1.1 Specific:

The quantity, size, shape, location, and orientation of the element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call-outs.

3.2 Details

3.2.1 Order of Precedence

The body of this Specification expands on the Fundamental Definitions as they apply to specific building systems and sub-systems. In the event of any conflict, more specific expansions take precedence over less specific expansions and Fundamental Definitions, e.g. the expanded definitions for C1010 take precedence over those for C10, which in turn take precedence over the Fundamental Definitions.

3.2.2 LOD Definitions as Minimum Requirements

The LODs provide five snapshots of the progression of an element from conceptual to specified – there are many steps in this progression between the defined LODs. The LOD definitions, then, should be considered minimum requirements – i.e. an element has progressed to a given LOD only when all the requirements stated in the definition have been met.

3.2.3 LOD Definitions are Cumulative

For a given element each LOD definition includes the requirements of all previous LODs. Thus, for an element to qualify for LOD 300 it must meet all the requirements for 200 and 100 as well as those stated in the LOD 300 definition.

3.2.4 Model Element Author

This document does not prescribe who the author of a particular component at a given LOD should be – the sequence of responsibility for modeling various systems will vary from one project to another. To accommodate this variation this document defers to the concept of Model Element Author (MEA) as defined in the *AIA E203-2013*: "The Model Element Author is the entity (or individual) responsible for managing and coordinating the development of a specific Model Element to the LOD required for an identified Project milestone, regardless of who is responsible for providing the content in the Model Element." [5]

[5] AIA Document *E203-2013 Building Information Modeling and Digital Data Exhibit,* Article 1.4.6. Copyright © American Institute of Architects 2013. All rights reserved. Definition quoted here by permission.

3.2.5 2D Supplementary Drawings

In current practice models are often supplemented with 2D information such as detail drawings. This Specification does not address this supplementation, but rather deals only with what is modeled in 3D and non-graphic information associated with the modeled elements.

3.3 Project-Specific Information

As mentioned in the Overview above, this Specification is intended to be used in conjunction with a project BIMXP. Many information needs will vary from project to project, even for identical elements. This kind of information is therefore not included in the LOD definitions specified here, but rather is left to be addressed in individual BIMXPs. The following are some notable examples.

3.3.1 Size Thresholds

In most projects, a determination is made to model certain elements only if they are over a specified size – e.g. conduit less than 1/2" (10 mm) diameter is not modeled. These size thresholds do not consistently correspond to certain LODs, and they vary from project to project. Thus, they are not specified in the LOD definitions but rather in the project's BIMXP, for example through the "Notes" cells in the Model Element Table of the *AIA G202-2013*.

3.4 Using the Specification with a BIMXP

Most BIMXPs include a section that details milestones as well as information exchanges – models to be produced to exchange specific information at specific points in a specific BIM use. In most cases, though, current practice is to accompany these models with the common "for reference only" disclaimer, diluting the effectiveness of the exchange. Referencing this Specification in the BIMXP and using it to concisely define the milestone and information exchange models brings many efficiencies to the process – among them:

3.4.1 Reliance

As noted above (see "BIM as a Communication Tool"), a major problem with allowing others to rely on a BIM is that it can contain information the author doesn't intend. By defining a model through the LOD Specification the author can limit reliance to only what he/she specifically states.

3.4.2 Multiple uses

Much model information is common across several information exchanges. This Specification facilitates the definition of models that will support multiple exchanges.

3.4.3 Efficient sequencing

The development of models as the design and construction process progresses follows logical sequences – much information depending on the prior development of other information. The definition of milestones, information exchanges, and other deliverables through this Specification facilitates the orderly sequencing of models to align with efficient development of information.

3.4.4 Avoidance of over-modeling

The LOD Specification facilitates the application of a pull-planning process to the modeling effort, limiting the development of model elements and information to that which the team identifies as useful.

Note that the definition and sequencing of models usually cannot be set in stone when the BIMXP is first developed. In most cases the modeling plan must evolve as the project progresses.

3.5 Implementation of the Specification

Currently, two methods of implementation have been developed.

3.5.1 Rely on the Model Element Table

Project team refers to the model element table included in an AIA G202 document or a BIM execution plan for the LODs of model elements. In this method, all elements referred to in a given model element table line item are assumed to be at the LOD stated there. E.g. if the table lists interior doors as LOD 200 for a given model, all interior doors within the model are assumed to be at LOD 200.

3.5.2 Include LOD Designations as Attributes of Individual Model Elements

All elements within the model are provided with two attributes – Current LOD (the actual LOD of the element) and Target LOD (the LOD specified for that element in the model element table). Elements default to a Current LOD of 100 or 200 as appropriate, and this attribute is elevated as the element is more fully developed. This method offers more flexibility and reliability, allowing differentiation between individual elements within a single model element table line item. Several software offerings provide the functionality of highlighting elements of various LODs or elements whose Current LOD is less than the Target LOD.

4 Organization of the Specification

4.1 Geometric and Attribute Information

To facilitate use of this Specification Attachment 1, Model Development Specification (MDS) has been provided. This attachment is a set of spreadsheets that can be used to collect and correlate LOD Information for a specific project.

A model element can contain two types of information: a) the element's geometry and b) associated numeric and/or textual attributes. To address these types of information this Specification contains two parts:

4.1.1 Part I: Element Geometry

Part I consists of narrative descriptions and illustrations of specific model elements at each LOD. Part I forms the bulk of this document.

4.1.2 Part II: Associated Attribute Information

Part II is contained in Attachment 1, a workbook that begins with the Model Element Table which mirrors the layout of the Model Element Table in the AIA *G202-2013 Building Information Modeling Protocol Form*, and can be referenced by that document. The Model Element Table references Attribute Tables that contain attribute information for various building systems.

4.1.3 Model Element Table

Figure 1

4.1.4 Building Systems

The rows of the Model Element Table (Figure 1) are building elements listed in accordance with CSI Uniformat 2010. The table also lists Relevant Attribute Tables for each system, referring to the tabs containing attribute information for the associated system(s). If desired, users can add Attribute Tables for specific line items.

4.1.5 Milestones/Deliverables

The table includes columns for defining the LODs for various milestones within a project. Each milestone column has three sub-columns: Level of Development (LOD), Model Element Author (MEA), and Notes. The table in Attachment 1 shows standard milestones for the completion of the traditional design phases as well as examples of Project-Specific Milestones for interim reviews, specific deliverables, BIM-Use information exchanges, etc. Users are encouraged to modify and add to these milestones as necessary. Once the milestones for a project have been determined, they can be re-ordered into a logical sequence as in Figure 2.

				Use on this project			SD			Estimating			DD			LEED Cert.			CD			Estimating			LEED Cert				
										Est. 1						Check						Bid Pkg.			Submittal				
UniFormat Level							Date			Date			Date			Date			Date			Date			Date				
1	2	3	4			Relevant Attribute Tables	LOD	MEA	Notes	LOD	MEA	Notes	LOD	MEA	Notes	LOD	MEA	Notes	LOD	MEA	Notes	LOD	MEA	Notes	LOD	MEA	Notes		
A					**SUBSTRUCTURE**																								
A	10				**Foundations**	A, B Concrete; A, B Wood; A, B Masonry; A, B Precast Concrete																							
A	10	10			**Standard Foundations**	A, B Concrete; A, B Wood; A, B Masonry; A, B Precast Concrete																							
A	10	10	.10		Wall Foundations	A, B Concrete; A, B Wood; A, B Masonry; A, B Precast Concrete																							
A	10	10	.30		Column Foundations	A, B Concrete; A, B Wood; A, B Masonry; A, B Precast Concrete																							
A	10	20			**Special Foundations**	A, B Concrete; A, B Wood; A, B Masonry; A, B Precast Concrete																							
A	10	20	.80		Grade Beams	A, B Concrete; A, B Wood; A, B Masonry; A, B Precast Concrete																							
A	20				**Subgrade Enclosures**	A, B Concrete; A, B Wood; A, B Masonry; A, B Precast Concrete																							
A	20	10			**Walls for Subgrade Enclosures**	A, B Concrete; A, B Wood; A, B Masonry; A, B Precast Concrete																							
A	40				**Slabs-on-Grade**	A, B - Str. Concrete																							
A	40	10			**Standard Slabs-on-Grade**	A, B Concrete																							
A	40	20			**Structural Slabs-on-Grade**	A, B Concrete																							
B					**SHELL**																								
B	10				**Superstructure**																								
B	10	10			**Floor Construction**	A, B Cold Formed Metal Framing; A, B Masonry; A, B Metal Deck; A, B Precast Concrete; A,B Steel Joist; A, B Structural Steel; A, B Concrete; A, B Wood																							
B	10	10	.10		Floor Structural Frame																								
B	10	10	.10		*Concrete*	A, B Concrete																							
B	10	10	.10		*Masonry*	A, B Masonry																							

Figure 2

4.1.6 Attribute Tables

B – Ext. Glazed Openings													
Baseline	Part 1 - Attribute Description				Part 2 - LOD Profile					Part 3 - Project-Specific Milestones (Examples)			
Additional										Estimating	Estimating	LEED Cert.	LEED Cert
Attribute	**Data Type**	**Units**	**Option Examples**	**Commentary**	**100**	**200**	**300**	**350**	**400**	Est. 1	Bid Pkg.	Check	Submittal
Construction	Text		options:[Unitized (combined glass and frame), Stick Built, Structural Glass]			x	x	x	x				
Material	Text		options:[Aluminium Framed, Bronze Framed, Stainless Steel Framed, Channel Glass]				x	x	x				
Thermal Resistance	Number	R-Value					x	x	x				
Condensation Resistance			options:[yes, no, class]										
Windbourne Debris Resistance		psf											
Wind Load Capacity		psf											
Glazing Method			options:[Conventional, Two Sided, Three Sided, Four Sided, Pint Supported]										
Glass - Material			options:[Glass, Plastic]										
Glass - Configuration			options:[Monolithic, Insulating]										
Glass - Condition			options, multiple:[Annealed, Heat Strengthend, Tempered, Laminated, Bent]										
Glass - Coatings			options, multiple:[Purolytic (hard coat), Sputter (soft coat), Low E, Metallic, Ceramic Frit, Opaci Coat, Digital Printed]										
Glass - Use			options, multiple:[Glazing into conventional application, Glazing into structurally glazed application, Mirror, Decorative, Fire Resistant, Huricane Resistant, Cable Suspended, Switchable Glass, Elecrronically Controlled switchable Glass, Pressure Resistant, Radiation Resistant, Security, Ballistics										

Figure 3

4.1.7 Attribute Table Anatomy

Attribute Tables consist of three parts.

1) Part 1, Attribute Description, lists Attributes relevant to the associated building system(s). Attributes are grouped into two categories as shown – Baseline and Additional.
    - The Baseline is the suggested list of attributes to be populated when no other requirements are known (BIM Uses, specific deliverables, etc.).
    - The Additional category may be thought of as a "shopping list" – a list of possible attributes the team may want to consider.
2) Part 2, LOD Profile, correlates Attribute requirements with LODs from the Model Element Table. Attributes with pre-populated LOD Profiles show a correlation between Attributes and LODs that represents current practices of proficient BIM users. An "X" can be entered in these cells to indicate simply that the attribute is required at a given LOD, or an Attribute Author can be entered to indicate not only that the attribute is required but also who is responsible for providing it.
3) Part 3, Milestones, is used to mark the attributes required for specific milestones and deliverables. The tables in Attachment 1 include example milestones, but users will customize the tables by copying the milestones they created for the Model Element Table.

4.1.8 MEPF Attribute Tables

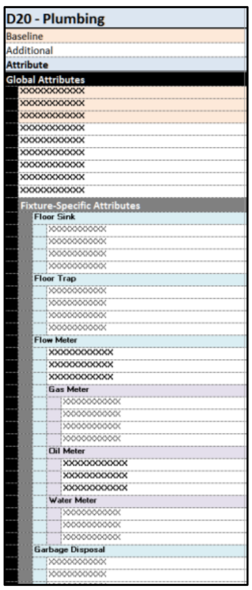


Figure 4

The MEPF attribute tables use a somewhat different format than other sections, since components from multiple systems might be used to make up a specific element. Case in point, an air handler is primarily a D30 HVAC element, but can include plumbing, fire protection and electrical elements as well.

The MEP Systems tabs are grouped into two types:

- System component elements: D20 Plumbing, D30 HVAC, D40 Fire Protection and D50 Electrical.
- System distribution elements such as ducts, pipes, and cables: D Air Distribution, D Fluid Gas Distribution and D Electrical Distribution.

MEPF attribute tables are broken down into two main sections

- Global: Attributes that are common to all elements within the table
- Item-Specific: The suggested set of additional attributes that are specific to an individual type of element. In many tables, the Individual elements are organized into a hierarchy of classes and sub-classes. In these cases, the attributes applicable to a specific element include those listed for the element itself plus those listed in any of the classes above it in the hierarchy. E.g. as Figure 4 shows, the attributes for an oil meter include all those shown in bold.

Note: System Component elements use both the Global and Item-Specific attributes sections, while System Distribution elements use only the Item-Specific attribute section.

4.1.9 Using the Attribute Tables

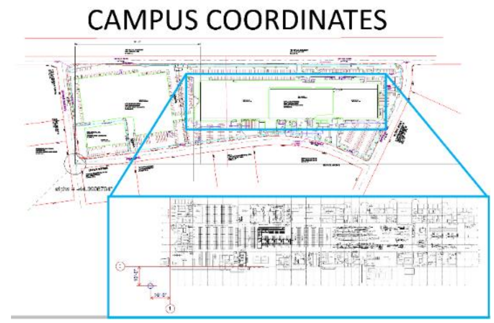
There are many ways to use the Attribute Tables – three are shown here.

1) Project teams adopt the Baseline attribute lists. The pre-populated correlation between Attributes and LODs represents current practices of proficient BIM users in the AEC industry.
2) Project teams create a custom correlation between LODs and Attribute population requirements. In this case the project team would edit the LOD Profile section to reflect the specific requirements of the project.
3) Project teams create new, project specific milestones and define Attribute population requirements in the Milestones sections. This approach will give project teams the greatest flexibility for defining Attribute population requirements.

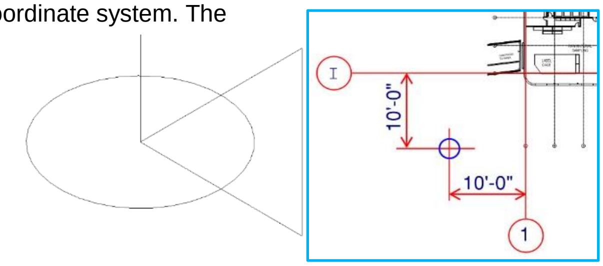
Note that the element attribute author can be entered in the LOD profile instead of an "x" to indicate who is responsible for providing the information.

5 Supplementary Guidelines

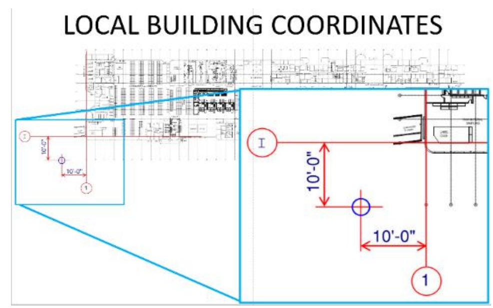
5.1 Clearly Define the Local X,Y,Z Origin: Basis for all LOD



This is the simplest rule to implement and sadly the most common and costly single item that goes unaddressed in ignorance on projects. The project general notes of the design drawings and specification should clearly define the local relative Building X, Y, Z coordinates that other trades will use in construction that are coordinated with the structural model. It is recommended to define the X,Y coordinates of the origin (Revit Project Internal 0,0) relative to the Southwest most column grid intersection with a South and West offset of 10, 100 or 1000 feet depending on the project size. The Southwest column intersection is chosen so the structure is in a positive X-Y coordinate system. The offsets of 10, 100 or 1000 feet South and West of the origin are so that any portions of the building that extend South or West of the project origin grid intersections will also be within a positive X-Y coordinate system. The Z elevation should be defined as 0, 100' or absolute elevation depending on firm preference. It is common to use a relative 100' elevation. Plan North is established as being in the positive Y direction.



These rules above form the basis of the project's "local" relative Building coordinate system that becomes part of the legal definition in contracts related to the model and references to LOD. This process aids linking the structural model to third party applications that are based on traditional CAD coordinate systems. A benefit of defining the local relative origin early and stating it in the project's general notes is other models that are developed for shop drawings from the construction documents have a point of reference to follow when they are submitted for review. This local relative building coordinate system is also tied back to the civil engineers' state plane coordinate system referred to as the Civil coordinates in Civil 3D. Larger products will also have a Campus coordinate system normally near the Southwest corner of the project site. There can also be an Object coordinate system used for items such as equipment models. This Object coordinate system is typically referenced relative to the Local Building coordinate system in the form of a grid line offset and floor elevation offset. The Civil coordinate system defined by the state plane absolute coordinate system will then have a set relationship with the structural local Building coordinate system of an X, Y, and Z offset and a Z-axis rotation. Using this set relationship between the Civil absolute and relative Building coordinate system, all federated project models can be easily converted to absolute or relative systems depending on the owner's preference in their facility management models. Ideally, the owner will have a clearly written documentation in the BIM Execution Plan that accurately defines the relationship between Object, Building, Campus and Civil coordinate systems.



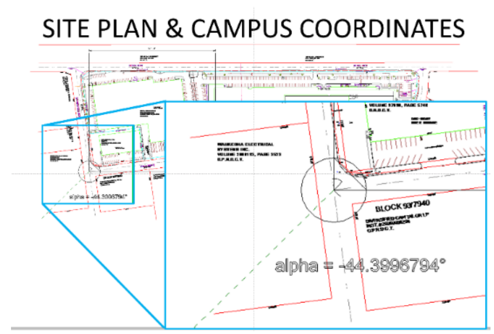
In summary, these 4 coordinate systems are:

Object: relative system that defines items such as assemblies and equipment in the structure. For example, the Air Handler Unit will have a relative Object coordinate that reference the Local Building coordinate which defines the mechanical room it resides in.

Building, Local: relative building coordinate system normally defined so that the entire structure is in positive point coordinates. For structure, this should be defined in the construction documents.

Campus, Site: relative coordinate system of the building's site defined so that the entire site is in positive point coordinates.

Civil (State Plane): Absolute coordinate system with Northing and Easting used by surveyors and civil engineers. This is also used by owners tying in their BIM to GIS applications for example.



Steps and Jobs to be done:
Structural engineer needs to be able to set the LOD of the origin of the project with the Architect at the start of the DD phase of the project. This needs to be coordinated with the civil engineer and site surveyors state plane coordinates. Following this, any manufacture will reference the building coordinates for the placing of their content.