OBO LOD & MMDR Training

PROJECT MANAGERS AND AE COURSE
Overview

On most projects OBO requires the AEs to generate the 2D submittal drawings from Building Information Models (BIMs) – designing with BIM has some huge advantages over designing in two dimensions, including:

• Better visualization of the facility throughout the design process
• Better collaboration between disciplines
• Better coordination of the drawings
• Better integration of schedules
• More consistency in expectations for each design stage.
Overview

• In order for OBO to reap the most benefit from BIM it is necessary for OBO Project Managers and AEs to understand some basics of the process.

• This course overviews the fundamentals and concepts that OBO Project Managers and AEs should know in order to better manage the BIM process.
Learning Objectives

1. Describe general LOD concepts, framework, and logic at a practical level.
2. Describe the problems the LOD Framework solves.
3. Describe the evolution of the LOD Framework as an industry standard.
4. Efficiently find needed information in the *LOD Specification (LOD Spec)*
5. Understand OBO’s Minimum Modeling and Data Requirements (MMDR).
6. Describe the impact of the LOD framework on the reliability of models.
7. Be able to evaluate design review submittals for compliance with modeling requirements.
Agenda

1. What is Level of Development?
2. What problems does it solve?
3. Evolution of LOD as an industry standard
4. Tour of the BIM Forum LOD Spec
5. Introduction to OBO’s Minimum Modeling and Data Requirements (MMDR)
6. How it all fits together
7. LOD and reliability of models
8. LOD and design review
What is Level of Development (LOD)?
Designers use models to generate the drawings required in the design submittals – in a model or the drawings it generates it is often impossible to tell where an element is along the path from concept to precise definition by its appearance. Placeholders often show more detail than the designer has finalized and although they appear precise their location may be approximate.
LOD Framework

While various systems progress along the path from concept to precise definition at different rates (e.g. structure is often finalized while casework is still at a conceptual stage) most tend to pass through several common milestones:

- **Conceptual**
- **Generic Placeholders**
- **Specific Assemblies**
- **Details**

Steel Braced Frame
$20-26 /sf

Image source: Webcor Builders
The American Institute of Architects (AIA) developed definitions for these milestones for its E202-2008 Building Information Modeling Protocol Exhibit and then updated them for its G202-2013 Building Information Modeling Protocol Form, designating them as Level of Development (LOD) 100 through 400:

100: Conceptual
200: Generic Placeholders
300: Specific Assemblies
400: Details

Image source: Webcor Builders
LOD Definitions

**100 Conceptual.** 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.

**200 Generic Placeholders.** 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.

**300 Specific Assemblies.** 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.

**400 Detailed Assemblies.** 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.

The Definitions of LOD 100, 200, 300, and 400 are produced by the AIA and have been used here by permission. Copyright © 2013. The American Institute of Architects. All rights reserved.

See Module 120.2 for an in-depth discussion of the LOD Framework.
What Problems does LOD Solve?
Advantages - BIM

Designing with BIM has some huge advantages over designing in two dimensions, but there are some challenges - the LOD framework was developed to address them.
Which one is a BIM?
Challenges - BIM

• How can the Owner get the BIM(s) it wants?

• How can the Owner evaluate BIM deliverables?

• How does the model author know it is meeting its deliverables?
Practices - BIM

• How much effort will it take (What is a reasonable price?)

• How much information needs to be in a model and when?

• Which model uses are supported?

• Who’s going to rely on it for what?

Image source: SOM
Paper vs. BIM

Precision

With paper drawings we can’t measure with the precision necessary for construction purposes, so we must rely on called-out dimensions. With CAD or BIM, we can measure, but the element may not be in exactly the right place.
We’re familiar with the set of paper drawings needed for various purposes, but we may not know what models are required.
Paper vs. BIM

All Information is Vetted

The architect made a conscious effort to call out the floor elevation at a specific point. In a BIM the elevation can be measured at any point, but if, for example, the floor is sloped but modeled as flat the measurement will often be wrong.

Image source: Webcor Builders
Paper vs. BIM

Federated models - who’s responsible for what when?

Images source: Webcor Builders
Paper vs. BIM

Over-detailing

Often people model things simply because they can, regardless of whether it’s needed. Sometimes details like those shown are necessary, but often they’re a waste of time and money.

Image source: Webcor Builders
Paper vs. BIM

Visual cues about state of development

In a napkin sketch we know everything is approximate, but a BIM can look like the illustration on the right whether it’s early Schematic Design or 100% CD. The LOD framework provides for more accurate interpretation of models and the drawings they generate.

Image source: Webcor Builders
Common Industry Response to these Challenges

The Disclaimer:

This model looks great so you can look at it but you can’t use it for anything or rely on it for anything which includes, but is not limited to, everything.

If you use it for anything anyway then you have to pay my lawyers anything they want if I get sued for anything related to your use of the model for anything.

Have a nice day.
Industry Response to these Challenges

Disclaimer Approach:

Some of the information is not reliable so don’t rely on any of it.

Specified-Use Approach:

Some of the information is not reliable so only rely on

- what I say you can,
- for the purposes I say you can,
- to the degree of precision I say you can.

The disclaimer approach negates much of BIM’s utility as a communication, coordination, and collaboration tool, and therefore much of the potential benefit to design quality and submittal consistency and clarity. So the AIA developed the specified-use approach. If the model author must tell users specifically what they can rely on no unintended information or precision can be used.
Industry Response to these Challenges

The LOD framework is the embodiment of the specified-use approach. By following the LOD profiles laid out in OBO’s Minimum Modeling and Data Requirement AEs are better focused on the information required at the current submittal.

By understanding the LOD framework OBO reviewers have a better picture of the information presented in the submittal and understanding of what to focus on in their reviews.
What’s the LOD Framework Good for?

OBO’s MMDR specifies Level of Development (rather than Level of Detail) because it indicates the reliability of model elements. The LOD framework is used to:

- Define deliverables by concisely specifying their content.
- Define milestones by specifying the degree of completeness of the design of various systems and components.
- Define information exchanges by concisely specifying the content of a model.
- Enable reliance by specifying the level of precision of models element by element.
- Enables reviewers to focus on the appropriate stage of the design regardless of over-detailed placeholders.
Evolution of LOD as an Industry Standard
The Level of Detail concept was first developed by Graphisoft to define requirements for its own modeling teams.

Graphisoft first developed the idea of Level of Detail to specify models for their in-house modeling team.
In developing the E202-2008 Building Information Modeling Protocol Exhibit, the AIA adapted the concept to a contractual environment, morphing it into Level of Development.
Level of Development vs. Level of Detail

Level of **Detail** addresses what an element looks like. But you can’t tell from appearance how well the element has been developed.

Level of **Development** addresses how much the element has been thought through.

**Level of Detail**
- Looks like specific steel shapes
- Location can be measured precisely

**Level of Development**
- Have the shapes been engineered?
- Are they in the final locations?

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<th>LOD 300</th>
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Image source: Webcor Builders
Tour of the BIM Forum LOD Spec

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Level of Development (LOD) Definitions

100 Conceptual. 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.

200 Generic Placeholders. 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.

300 Specific Assemblies. 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.

400 Detailed Assemblies. 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.

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BIMForum LOD Specification

Practitioners found that the basic LOD definitions could be widely interpreted - e.g. does a truss modeled at LOD 300 include the flanges modeled as separate elements? The web?
This reduced their usefulness in communicating model requirements and reliability outside a single firm. So the American Institute of Architects (AIA) and the Associated General Contractors of America (AGC) executed an agreement which licensed the BIMForum, an interdisciplinary organization supported by both, to use the AIA definitions in a publication that would concisely interpret them for some 400 building assemblies and components.

The BIMForum convened a working group comprising designers and builders from all major disciplines to develop these interpretations.
The BIMForum LOD Specification shows examples with descriptions and graphics of some 400 building assemblies and components at all LODs.

The specification’s broad industry acceptance makes it extremely useful in communicating model and drawing requirements.
Creation Process – Domain Groups

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<td>Walt Cichonski L F Driscoll</td>
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<td>Interior</td>
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<td>Brian Filkins Beck</td>
</tr>
<tr>
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<td>Ken Flannigan Kone</td>
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<tr>
<td>Services</td>
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<td>David Francis Murray Company</td>
</tr>
<tr>
<td>Civil</td>
<td>Jake Fears Wier and Associates</td>
<td>Gregg Madsen Wier and Associates</td>
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</tbody>
</table>
LOD Definitions

Roof = 200
Structure = 100
LOD Definitions

Roof = 200
Structure = 200
LOD Definitions
LOD Definitions

**LOD 300**

The BIMForum LOD Spec working group found that there was need for an intermediate LOD between 300 and 400 to define geometry for coordination between building elements without needing to develop a full fabrication-level model element.

This illustration shows a steel connection at LOD 300.

Image source: Ikerd Consulting
LOD Definitions

LOD 400

At LOD 400 full fabrication detail is shown – gusset plates, clip angles, studs, etc.

Image source: Ikerd Consulting
For most construction purposes LOD 400 shows more detail than is useful, so LOD 350 was developed. Here the clip angles and studs have been removed, but the gusset plates and slab-edge angle remain – they are often needed for coordination in tight locations.
Level of Development (LOD) Definitions

LOD 350 is LOD 300 plus interfaces with other building systems:

300 **Specific Assemblies.** 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.

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

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BIM Forum Interpretations

The BIM Forum working group developed basic interpretations of the AIA definitions, the most important being the interpretation of LOD 300. The spec states that the quantity, size, shape, location, and orientation of an LOD 300 element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call-outs.
Organization of the LOD Spec

The Spec contains specific definitions of over 400 systems and assemblies at each LOD. It is organized according to the Construction Specification Institute’s (CSI) Uniformat 2010 rather than the more familiar Masterformat – the 50-division Framework by which construction specifications are organized – for the following reasons:

• Masterformat is trade based. Many elements in a BIM represent work by multiple trades – e.g. an exterior wall modeled as one element.

• Uniformat is system-based, so the breakdown is very similar to the breakdown of model elements.

• Note that many current model authoring tools come out-of-the-box with fields pre-populated with the Uniformat 2010 classification of the element.
Organization of the Spec

Unisformat 2010 Breakdown

Unisformat 2010 is broken down into 7 major divisions:

<table>
<thead>
<tr>
<th>A</th>
<th>SUBSTRUCTURE</th>
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<tbody>
<tr>
<td>B</td>
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<tr>
<td>G</td>
<td>BUILDING SITEWORK</td>
</tr>
</tbody>
</table>
Organization of the Spec

Omniclass designations are also included in the LOD Spec

CSI also publishes Omniclass, a more internationally accepted framework based on ISO 12006-2, that contains multiple tables that organize construction information according to multiple logical approaches. Omniclass Table 21 corresponds one-to-one with Uniformat 2010, with a slightly different numbering format.
Organization

• Part I contains narrative descriptions of the LOD interpretations as well as graphic examples.

• Over 400 building systems and assemblies are represented here.
Part II – Model Development Specification

- Provides a spreadsheet for specification of models at various design milestones, for specific information exchanges, and for asset data

- OBO’s Minimum Modeling and Data Requirements (MDMR) is an adaptation of this format configured for OBO use
Note that in order to maintain its usefulness as a reference standard the LOD Specification, Part I, may not be modified.

The MMDR, however, is a template and will be configured by OBO for each project. Once finalized by OBO, the requirements stated in the MMDR become contractual.
# Anatomy of Part I

## From Uniformat 2010

<table>
<thead>
<tr>
<th>Uniformat Number</th>
<th>Description</th>
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<td>Image source: BIMForum</td>
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</table>
Exercise

• What system/LOD would you specify to get accurate rough openings in interior walls?

• What system/LOD would you specify to get roof trusses with accurate profiles and panel points?
BIMForum LOD Specification

- The Spec is not a set of requirements
- It’s a framework that provides a language for setting requirements
- The user sets requirements by developing the MMDR – see Module 120.4

[Image source: BIM Forum]

www.bimforum.org/lod

Image source: BIM Forum
BIMForum LOD Specification

Due to its inclusion of broad interdisciplinary input the LOD Spec has gained wide industry acceptance. In its effort to align with industry standards OBO has adopted this specification to define its use of the LOD framework.
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Introduction to OBO’s Minimum Modeling and Data Requirements (MMDR)
The MMDR Workbook

• OBO’s Minimum Modeling and Data Requirements (MMDR) sets standards for the content of the AEs’ models and the drawings and schedules generated from them for the design submittals. The workbook includes 6 tabs.

• **Tab 1: Instructions**, shown here. This tab includes instructions for use of the workbook in defining model requirements and capturing data.

• **Tab 6: Definitions and Glossary.** Provides a reference for terms used in the workbook. This tab states that the BIMForum LOD Spec version 2019 will be used.
The MMDR Workbook

- Tab 2 is an expansion and replacement of OBO’s previous Minimum Modeling Requirement (MMR).
- The MMR addressed model geometry in detail. It only indicated whether or not data was required for a particular element. In addition to the geometry requirements the MMDR sets requirements for what data is required.
- The next slides show the function of each column.
The MMDR Workbook

- **Col. C & D – Omniclass/Uniformat ID:** Defined in the Construction Specification Institute’s (CSI) Omniclass Table 21 and Uniformat 2010.
The MMDR Workbook

- Col. E – Included in Facility or Site: A “Yes” in this column indicates a contractual obligation to model the element per the requirements specified in this spreadsheet.
The MMDR Workbook

• Col. F – Major Phase: Design or Construction
The MMDR Workbook

- **Col. G – Minor Phase**: The phase designations here are as defined for OBO’s Integrated Design Review (IDR) process. The entries in Columns F and G indicate the phase at which the element must first be modeled. Note that for phases prior to CD-3 the LOD of an element may be lower than the final LOD specified in Col. H.

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<th>Level</th>
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<th>LOD</th>
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<th>IDR Process</th>
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</table>
The MMDR Workbook

- **Col. H – LOD**: The final LOD (as defined by the BIMForum LOD Spec) for the CD-3 deliverable. Col. H is pre-populated with typical default values but these should be reviewed and adjusted as appropriate by the OBO team.
The MMDR Workbook

• **Col. H – LOD:** The final LOD (as defined by the BIMForum LOD Spec) for the CD-3 deliverable. Col. H is pre-populated with typical default values but these should be reviewed and adjusted as appropriate by the OBO team.

• Note that elements in a model and the drawing set it generates will be at various LODs. While in a CD model or drawing set many components will be modeled with elements at LOD 300, in many cases LOD 200 elements (generic placeholders) or even LOD 100 (symbols, information attached to other elements) are sufficient.

• Note also that LOD 300 is usually as high as AEs will go, since often LOD 350 and 400 require craft or trade knowledge.

• The LOD Specification is revised annually, but all versions are kept available on the BIMForum website. Tab 6 of the MMDR, “Definitions & Glossary,” specifies the 2019 version.
The MMDR Workbook

- **Col. I – Model/Drawing Reqs:** This column indicates whether the element must be modeled in 3 dimensions (3D) or may be shown by linework (2D) as shown in slide 6.
**Col. J – Additional Requirements:** Requirements that are in addition to those defined in the BIM Forum LOD Specification.
The MMDR Workbook

• **Col. K – Primary Discipline:** The discipline (e.g. architect, mechanical engineer) with primary responsibility for modeling the element. Note that this is not a contractual requirement and may vary from one project to another.

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UNCLASSIFIED
The MMDR Workbook

- **Col. L – Notes:** Space for desired information not covered elsewhere. Entries in this column are not contractual requirements.
Elements are not all modeled at the same LOD.

## LOD Logic

### LOD Requirements (Scope-L0D)

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<td>Yes</td>
<td>Yes</td>
<td>Design</td>
<td>Yes</td>
<td>Structural</td>
</tr>
<tr>
<td>Level 3</td>
<td>Columns</td>
<td>21.01.03.10.00</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Design</td>
<td>Yes</td>
<td>Structural</td>
</tr>
<tr>
<td>Level 4</td>
<td>Purlins</td>
<td>21.01.04.10.00</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Design</td>
<td>Yes</td>
<td>Structural</td>
</tr>
<tr>
<td>Level 5</td>
<td>Beam</td>
<td>21.01.05.10.00</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Design</td>
<td>Yes</td>
<td>Structural</td>
</tr>
<tr>
<td>Level 6</td>
<td>Door Frames</td>
<td>21.01.06.10.00</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Design</td>
<td>Yes</td>
<td>Structural</td>
</tr>
</tbody>
</table>

### Additional Requirements

- Change to NC/FNS part of Level 205
- Additional requirements for Level 206
- Architectural
- Structural
- Electrical/Plumbing
- HVAC/Mechanical
- Fire Protection
- Communication

### Notes

- This table is for agency use only, not for contractual requirements.
There’s no such thing as an LOD ### model.
**LOD Logic**

LOD is not a value Judgement.
LOD Logic

LOD does not indicate who authors the element.
Specification of Asset Data

- In addition to defining modeling requirements, Tab 2 automatically populates Tab 3 with the asset data requirements for the project.
Specification of Asset Data

- In Tab 2, selecting “Yes” in Column E for a line item automatically puts “Yes” in Tab 3, Column F for all items under that Uniformat code that are listed in OBO’s Global Maintenance Management System (GMMS).

- Line items with “NA” in Column F are not listed in the GMMS and do not require data.
Specification of Asset Data

• Tab 3, Column I shows the specific components listed in the GMMS, e.g. transformers.

• Tabs 4 and 5 list the data needed for these components.
Specification of Asset Data

- Tab 4 lists required Type data for the element – e.g. data required for all transformers in the project.
Specification of Asset Data

• Tab 5 lists required instance data for the element – e.g. data required for each individual transformer in the project.
Specification of Asset Data

• Note that a “Yes” in Tab 2, Column E, results in a “Yes” in Tab 3, Column F, for all items listed in the GMMS regardless of their LOD.

• The LOD entries on Tab 2 relate to geometric requirements for element modeling only. Data can be linked to any element of any LOD, even an LOD 100 symbol.
Conceptual Introduction to COBie
(Construction Operations Building information exchange)
The COBie Submittal

• OBO requires asset data identified in the MMDR to be delivered in a COBie submittal.

• COBie is a standardized format for the collection and transmission of asset data that can be imported into OBO’s Maintenance Management and Portfolio Management System.
The COBie Submittal

- OBO provides a checklist to aid reviewers in reviewing COBie submittals and AEs in checking their submittals.
- More about the COBie framework and process can be found at https://www.nibs.org/page/bsa_cobie
How It All Fits Together

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How It All Fits Together

• The Project Scope of Work (SOW), BIM Requirements, BEP, and MMDR with the LOD framework form an integrated system with the purpose of making model and drawing requirements more explicit so OBO gets more information when it needs it by:

  • Ensuring that the AEs understand precisely what is needed for each design submittal

  • Ensuring that OBO’s review requirements align with efficient design practice

  • Helping the reviewers make better use of their time by focusing their attention on the most important issues at the level of detail appropriate to the current design phase
How It All Fits Together

What to design

Statement of Work

How to model the design

BIM Requirements

MMDR

Design Submittal
Models and Drawings

Building Information Modeling (BIM) Management Requirements

Design Submittal

Models and Drawings

What to design

BIM
LOD and Reliability of Models

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Measuring Drawings or Models

Precision

Recall that it’s impractical to measure paper drawings, but CAD drawings and BIMs can be measured with extremely high precision. But if the author of the drawing or model doesn’t expect someone to measure, elements may not be in precisely the right place.
The BIMForum working group developed basic interpretations of the AIA definitions, the most important being the interpretation of LOD 300. The spec states that the quantity, size, shape, location, and orientation of an LOD 300 element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call-outs.
Reliance

Thus OBO’s MMDR requires that certain model elements be located with sufficient precision that they can be directly measured. This enables several design and construction processes that bring efficiency and reliability to the project, among them:

• Much more effective collaboration between disciplines
• Automated layout processes that significantly reduce time and errors
• Precise coordination of systems in crowded locations, reducing costly rework
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LOD and Design Review
LOD and Project Management

OBO’s MMDR supported by the LOD Spec enables concise, objective evaluation of project deliverables.
Example checks for LOD 300

- In a model:
  - Element must have an attribute stating its Uniformat 2010 or Omniclass Table 211D.
  - A column must be connected to its floor and the deck above

- In a drawing as well as in a model:
  - A column must indicate its construction.
  - A column must be shown at the intended size and location.

Note that an element can meet all these requirements and still not qualify for LOD 300 if, for example, a column:

- Is not of the construction the design team intends.
- Is not in the exact location the design team intends.
MMDR Compliance

• A model element or its representation in a drawing will meet the requirements for LOD 300 only if it shows the complete and accurate design intent for the represented building component.

• The OBO project management team must confirm that the AEs understand that they must create model elements with the standard of care corresponding to the required LOD.

• For example, an LOD 300 model element, and thus its representation on a drawing, must be located with the same standard of care required for calculation of its layout dimensions.
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Summary
Summary

• The LOD framework is a tool for concisely defining models at the element level.

• It improves efficiency and effectiveness of the BIM process in several ways, some of which are:
  • It enables concise definition of BIM deliverables
  • It enables project team members to rely on each others’ models
  • It greatly improves BIM as a coordination and communication tool

• The **LOD Specification** greatly improves the usefulness of the LOD framework by providing precise definitions of model elements of over 400 building systems, assemblies, and components at each LOD

• The LOD Specification is a widely-accepted industry standard

• OBO’s Minimum Modeling and Data Requirements (MMDR) is a set of modeling requirements stated in system, assembly, and component LOD requirements as defined by the LOD Spec.

• The MMDR supports design and construction project management by enabling clear and objective definition and evaluation of BIM deliverables
Review of Learning Objectives

1. Describe general LOD concepts, framework, and logic at a practical level.
2. Describe the problems the LOD Framework solves.
3. Describe the evolution of the LOD Framework as an industry standard.
4. Efficiently find needed information in the *LOD Specification (LOD Spec)*
5. Understand OBO’s Minimum Modeling and Data Requirements (MMDR).
6. Describe the impact of the LOD framework on the reliability of models.
7. Be able to evaluate design review submittals for compliance with modeling requirements.
THANK YOU

For more information contact BIM@state.gov