Virginia Commonwealth University

BUILDING INFORMATION MODELING (BIM) GUIDELINES and STANDARDS

FOR ARCHITECTS, ENGINEERS, and CONTRACTORS

09.20.2013

BIM Guidelines

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1. VCU BIM Guidelines Executive Summary

The utilization of BIM (Building Information Modeling) technology for design and construction of new building and major renovation projects has been recognized as a valuable asset for Virginia Commonwealth University (VCU) construction projects and records management. The ability to model a design in a virtual environment has produced new tools to aid in design collaboration and construction methodology that has been largely unchanged for many years prior to the concept of BIM. VCU understands that this technology can be useful for certain projects, and consistent standards need to be identified for projects that pursue the use of BIM. The purpose of the VCU BIM Guideline and Standards is to define and outline the BIM requirements for design and construction services to help generate a formal process and set of deliverables. The modeling guidelines established within this document outline the benefits associated with BIM utilization that support a higher degree of informed decision making through visual and technical design tools. These standards also provide a more collaborative process, which VCU will use to engage design and construction teams to meet expectations and deliverables set forth by the VCU Facilities Management Division.

Included within the guidelines is a project specific execution plan that will be used by all design and construction partners to help define unique project characteristics and expectations. This tool will be shared among the selected members of the project team better transparency. The tools are best supported by delivery methods that utilize preconstruction services or varying levels of design assist with subcontractor involvement. The model becomes a key tool for the basis of collaboration between all parties, and the Level of Development Matrix becomes the gauge for quality model generation at different points in design development and construction coordination.   These models facilitate the development of useful deliverables for VCU that will provide certainty to projects, facilities planning, and future renovations.

2. University & Project Benefits

The utilization of BIM for design and construction has become a standard for some new construction and major renovation projects on the Monroe Park and extended campus sites. The development of BIM Guidelines provides benefits to all parties involved in the process, which can directly affect the quality of the work.

Benefits of using BIM include:

- A clearly defined process for design & construction partners working at the University.
- Standards and requirements for University projects utilizing BIM.
- A platform for information exchange between the designers and the constructors.
- Design and construction model reviews that provide consistent quality on University projects.
- A recognizable level of anticipated model development and coordination for models developed for VCU.
- The ability to evaluate the to-be-built environment in three dimensions and better understand the design.
- The ability to make changes through the design process based on end-user operability.
- Visual tools for end-user approval, and acceptance among stakeholders.
- Marketing tools through renderings of designed spaces for fund raising, and tenant evaluation.
- More reliable cost estimates earlier in the design phase.
- Reduced design schedules and increased design coordination through model reviews.
- Development model based schedules and quantities for early asset management and planning of the new facility.
- The ability to evaluate the building components and develop an efficient plan for the construction of the project eliminating the potential for rework.
- Cost savings by supporting prefabricated building components, thus reducing waste and inefficiencies.
- The ability to utilize prefabricated components that are produced in a controlled environment reducing installation time and field labor, while increasing quality of work.
- Efficient construction sequencing for a quality installation and project flow.
- The ability to communicate with subcontractors using a visual tool.
- Building system coordination that reduces conflicts in the field, saving time lost with RFI's and costs incurred through change orders.
- Model based safety reviews that assure safety measures are in place throughout the construction schedule, reducing project risk while assuring the construction schedule.
- Established standards for document turnover, model turnover, and data organization.
- The ability to collect project data in a consistent manner with which the University can begin to plan for the future use of models for support of facilities maintenance and management.

3. Frequently Used Terms

Term	Definition
Aggregate Design Model	Collaborative BIM model composed of individual **design system models** to include the engineering disciplines, and the architectural model used for system compliance in a BIM environment, constructability, validity, and scheduling.
As-Built Model (Construction Model)	Master Construction Model developed, archived, and delivered to the client at the completion of the project, along with the final As-Built Documents, that contains the actual installed conditions for all modeled elements to the construction LOD.
BIM Coordinator (BIM Manager/Virtual Construction Manager)	Designated model manager, who will be assigned to the project from the beginning for oversight of the entire BIM modeling process and to utilize BIM applications and tools for reaching the required deliverables.
BIM Execution Plan	A plan template provided by VCU for the project design and construction teams to use for defining roles, responsibilities, file types & formats, the model elements level of development, and the overall process that will be adhered to for the project team, including deliverables.
Building Information Modeling	The process and technology used to create the Model, via programs like Revit or NavisWorks.
Building Information Model(s)	A digital representation of the physical and functional characteristics of the project and is referred to in this document as the "Model(s)." This term may be used to describe a Model Element, a single Model or multiple Models used as the aggregate project Model.
Clash Resolution Meeting	Meetings between the design team, contractor, consultants, and trade contractors to review the collision reports that were generated from the different system models. The objective is to review the collisions and make intelligent decisions for a more coordinated design, reduced field conflicts, and to optimize the cost effectiveness of prefabricated building systems. Reports are to be shared between team members.
Construction Coordination Model	Collaborative BIM model developed by the Contractor with trade system models by trade contractors for the purposes of developing models that can be used for fabrication, layout, and collision detection, with the purpose of developing a **Master Construction Model**.
Design System Model	Individual engineering discipline models developed in a separate file for the purposes of evaluating a single system, keeping file sizes manageable, and reducing the ability to edit other portions of the model.
Fabrication/Trade System Model	Individual trade discipline models developed for the purposes of performing clash detection within the **aggregate construction model**, fabricating material, providing product information, and coordinating with other trades for the development of the **Master Construction Model**.
Level of Development (LOD)	Level of Development indicates the degree at which the element's geometry and attached information has been thought through, and the degree at which the project members can rely on the information within the model. E.g. – light fixture, type, manufacturer, model, height, clearances, supports, etc.
Level of Development (LOD) Matrix	Describes the level of completeness to which a Model Element is developed for the different divisions and systems of a design. A standard matrix is provided to both design and construction professionals for defining the development of the model for design, and the additional requirements required for construction coordination needs. Also used as a tool for model quality control in design, construction, and turnover.
Linked Model	Any Revit of Navisworks model file w/ references and visible overlays brought into a model file for reference, but cannot be maniputlated within the same file.
Master Construction Model	Model developed by the Contractor with the assistance of the trade contractors to include each building system free of clashes, and signed off by each trade and the design disciplines of record.

Term	Definition
Model Based Design Reviews	Design review, by the contractor, done in conjunction with the 2D design progress documents that provides an analysis of the LOD Matrix, the coordination issues that need to be addressed in design, and areas that may require increased detail within the model. This review can be done at varying points within the design development, with or without design assist subcontractor support. Reports are to be shared between team members.
Model Element	A portion of the Building Information Model representing a component, system or assembly within a building or building site. For the purposes of the VCU Project Execution Plan, Model Elements are represented by system in the Level of Development Matrix (Appendix B).
Model Element Author (MEA)	The party responsible for developing the content of a specific Model Element to the LOD required for a particular phase of the Project. Model Element Authors are identified in the Level of Development Matrix (Appendix B).
Model User	Refers to any individual or entity authorized to use the Model on the Project. This should include all design partners, contractors associated with model development, and VCU FMD staff.
Record Model (Design Model)	Aggregate Design Model developed, archived, and delivered to the client at the completion of the project along with the final Record Documents that is the legal representation of the project, signed and sealed by the Architect and Engineer(s) of Record.
VCU BIM Guidelines	*Virginia Commonwealth University Building Information Modeling Guidelines* is a document developed to outline the intended benefits, uses, modeling guidelines, and turnover documentation for design and construction projects utilizing BIM. This document is to be included in the VCU Project Execution Plan.
VCU Project Execution Plan	Project specific execution plan that outlines the file management procedures, technology used, & project modeling deliverables for design and construction that support a collaborative process between design and construction.

4. Requirements

4.1 Design Team Software

Building information models shall be created to include all geometry, physical characteristics and product data needed to describe the design and construction work of a project. All drawings, schedules, simulations, and services required for assessment, review, bidding and construction shall be extractions from this model. The Design Team shall follow the guidelines and requirements detailed in this document for BIM related services. Deliverable requirements are as specified in this document, including Appendix C the Turnover Documentation Outline, and software should be selected in a manner that supports the requirements.

4.2 Civil Engineering Software

Models shall be created that include all geometry, physical characteristics and product data needed to describe the design and construction work to within 5' of building envelope. Drawings and schedules required for assessment, review, bidding and construction shall be extractions from this model. Software shall be capable of interfacing with The Design Teams BIM authored software. In all cases, model building and infrastructure systems to a level that allows the team to verify clearances, analyze conflicts/clashes and properly coordinate the work with all other aspects of the project. The Design Team shall follow the guidelines and requirements detailed in this document for BIM related services. Deliverable requirements are as specified in this document, including Appendix C the Turnover Documentation Outline, and software should be selected in a manner that supports the requirements.

4.3 BIM Authoring Software

The design team is required to use BIM authoring software that is compatible and has interoperability with the rest of the design team. These conditions should be discussed and vetted through the Project Execution Planning process. VCU utilizes and requests that all BIM project models be delivered on a platform that is most effective for the project team and VCU's Facilities Management Department. The department currently utilizes the Autodesk platform including Revit, Navisworks, and Autocad in the latest versions.

4.4 GIS & Geo-referencing

The design team shall coordinate with VCU to determine the GIS application and information required for the project. Geo referencing of the project within the university's GIS system will be reviewed on a case by case basis with the project teams.

4.5 Project Collaboration Tools

The design and construction teams are responsible for developing, managing, and securing all files during the design and construction of the project. The collaboration standards and practices should be a part of the Project Execution Plan. It is preferred that the project team utilizes a file sharing and data management site that includes versioning,

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backups, and archiving strategies. Standards and platforms are not dictated by the university, but it is a requirement to allow VCU's project team and VCU Facilities access to the files in at least a limited manner. Project information should be transparent for the university throughout design development through completion and delivery.

5. Process

5.1 Project Execution Plan

Depending on the delivery method utilized for the project, the Project Execution Plan should be developed in the most collaborative and transparent method possible. The plan should be submitted to VCU within thirty (30) working days of contract award of the primary parties involved in the model development. The Project Execution Plan will be reviewed and approved by VCU within fifteen (15) working days. The Project Execution Plan should identify the entire project team and their roles and responsibilities related to the model. Considerations regarding the type of project, the goals associated with the project by VCU, the trade contractor's involvement, and the complexity of the project should be considered when developing the Project Execution Plan. All proposed initiatives by the design and construction teams through the RFP process should be included in the comprehensive document. Additionally, Project Execution Planning meetings should be held and VCU staff should be a part of the planning process for assuring the highest value from model development.

5.2 Level of Development, Quality, and Handoff

Building Information Modeling best practices should be utilized throughout the projects to ensure that the project is not only coordinated, but constructable and maintainable. VCU has provided a detailed list of generic systems broken down by design and construction responsibilities in section XXX of this document. This should be reviewed by all parties, and it is assumed that these basic systems are included in the modeling scope and development of a standard design and construction team. Elements should generally be designed to a level 300 for the design team and progressed to a level 400 for construction fabrication by the contractor and trades based on the AIA/AGC specification put out through BIMforum.org. This same quality should be included in the data management side of the any characteristics defined on a project by project basis, but at a minimum the room and departmental associations of space should be in accordance with VCU room numbering protocols. Additionally, it is expected that the model handoff between design and construction be seamless and the quality outlined in the LOD Matrix within the Project Execution Plan is consistent with the deliverable.

5.3 Energy Requirements

The design team shall work with VCU to establish project specific energy goals for each project. The design team shall review the use and capabilities associated with energy modeling and use the tools for the betterment and performance of the project based on the criteria set forth by VCU through programming. The Project Execution Plan will detail how the energy modeling will be accomplished and the responsibilities associated with development of the energy model. Any software utilized should be accepted by the US Department of Energy, Energy Efficiency and Renewable Energy.

5.4 Deliverable Schedule and Milestones

The design and construction teams through the Project Execution Planning process should identify the deliverables of the team and milestones associated with design development, fabrication of systems, and redline incorporation into As-built's and Record Documents/Models. The team should layout the anticipated schedule and use the milestone measures as a method of tracking the completion of the tasks developed through the Project Execution Planning process to ensure quality deliverables at the completion of the project.

Example

[Project X] Deliverable Schedule and Milestones

Milestone	Deliverable	Date
Conceptual Phase	Architectural Massing Model	
	Preliminary Energy Model	
	Floor plate model for programming validation	
	Project Execution Plan	
Schematic Design Model	Architectural Model	
	Schematic Energy Model	
	Civil Model	
	MEP Layout/Narrative	
	Structural Layout/Narrative	
	SD Collision Report/Analysis	
	Equipment Tracking Matrices	
Design Development	Architectural Model	
	MEP Model(s)	
	Structural Model	
	Civil Model	
	Discipline Collision Report/Analysis	
	Program Validation Report	
	Equipment lists and definition of systems	
Construction Documents	Architectural Model	
	MEP Model(s)	
	Structural Model	
	Civil Model	
	Discipline Collision Report/Analysis	
Fabrication Documents	By Level coordination milestones	
	Shop drawing submissions	
	Trade based collision report and resolution	
Turnover Documentation		
	Design Record Models	

Milestone	Deliverable	Date
	PDF Documentation	
	O&M Manuals	
	Warranty Information	
	Turnover Folder Structure	

6. Ownership and Data Rights

Virginia Commonwealth University is a state run institution that has sole ownership of all data generated for state projects and facilities. All Building Information Models, CAD files, GIS data, facility data or product information developed or purchased for the project is the property of VCU Facilities Management Department. All files should be provided to the archives office in its original and complete format. All sheets, families, schedules, and views should be preserved in model files, and all fabrication files, sheets, views, and quantities should be provided to the university for record and potential future use.

7. Standard Design Modeling – By System

7.1 Systems Modeled and Level of Detail

The generic systems defined below in each section are provided to assist the design team in helping to understand the intended model elements required by VCU. In no manner should this list be considered the minimal requirement. It is the design team's responsibility to accurately represent the design through documentation and through a BIM based design tool. Greater detail than the minimum should be incorporated in the model whenever possible.

System specific modeling requirements which present a conflict in either the design intent or the procurement nature of the project should be deferred to the contractor for detailed coordination modeling. **Refer to the Level of Development Matrix (Appendix B) for an outlined University guidelines. This document will need to be reviewed and updated by the design team to reflect project specifics with the schematic design package. It should be provided and reviewed in conjunction with the construction team for defining the modeling required for construction.** This should be a collaborative discussion that supports the best interests of the project.

7.2 Architectural Design Modeling:

Elements of the building skin and interior elements that are critical to coordination with the building systems will be modeled by the Architect of Record and/or consultants to include but not limited to:

- All exterior skin elements including exterior skin features using composite wall, roof, and floor types
- All exterior skin types should be modeled with different wall types or as a separate element
- All architectural precast elements
- Composite roofing elements including green roof
- Curtainwall, storefront, and window systems including skylights, glass trellis, and entrance features
- Doors, frames, roll-up, coiling, and folding doors or partitions
- All interior partitions and walls
- Fire rated partitions & ceiling systems (rated partitions should be color coordinated for BCOM submission)
- Rated partition assemblies should reflect the individual components for construction assurance
- Acoustical elements that are considered part of the wall type
- Any abnormal wall and ceiling layout
- Ceilings modeled by type and material
- Soffit ceilings, overhangs, trim edges, and support walls from structure above
- Stairs, stairwells, railings, decorative handrails, roof ladders, and hatches
- Areas that need finish level modeling for coordination
- Elevators, shafts, supports, & pits

- Interior glass partitions including demountable wall systems & accent features

- **Furniture, Fixtures, & Equipment should be coordinated with the interior design scope**

- Flooring systems, finishes, and raised access scheduled through the model

- Casework, fixed furniture systems, and architectural woodwork

- Specialties as required for coordination

- Plumbing fixtures, light fixtures, and roof drains to be coordinated with MEP design scope

- Life Safety modeling requirements are included in the Fire Protection/Life Safety Design Modeling section

- ADA/ADAAG, and code required clearances should be outlined and included in the model

- All Equipment and mechanical access zones should be modeled & coordinated with architectural

- All Shafts should be coordinated with

7.3 Structural Design Modeling:

Elements of the building structural design should be modeled for coordination between building systems and design disciplines by the structural engineer of record to include but not limited to:

- Footings (Strip & Pad), grade beams, & pile caps coordinated with utilities and site grading

- Caissons to the depth of the deepest utilities (actual depths should be indicated in the documents)

- Foundation & retaining walls

- Shear walls

- Shaft walls & various pits

- Concrete columns and piers

- Structural composite decks, hollow core slab systems, and cast-in-place slab systems

- Cast-in-place framing members and floor systems

- All precast concrete elements for structural and architectural purposes

- Steel trusses and truss systems

- Beams, girders, joists, slab supports and structural framing members

- Steel columns for all shapes and sizes

- Shear load bracing, cross bracing, and turnbuckles

- Edges of all slabs and penetrations of structural systems

- Equipment support framing

- Miscellaneous metals as required for necessary coordination of key elements, i.e. Operable Partitions

7.4 Mechanical HVAC Design Modeling:

Elements of the building Mechanical HVAC design should be modeled for coordination between building systems and design disciplines by the MEP engineer of record to include but not limited to:

- Model all ductwork with correct sizing – annotations should be provided as tags only
- External insulation on piping and ductwork must be modeled to scale, and internal insulated duct is to be noted with proper outside length and width
- Grease duct considerations for slope should be taken into account
- Model all grilles, registers, louvers and diffusers for scheduling through the model
- Model all fire and smoke dampers
- Identify duct balance dampers and model service access requirements as solid objects
- Model all Mechanical Equipment: Fans, AHUs, Built-Up AHUs, VRF units, pumps, tanks, valves, control panels, heat exchangers, all valves, gauges & control valves, high & low point drains, etc.
- All hydronic piping should be modeled to the standards detailed within the "Plumbing" section
- Equipment pads should be coordinated between disciplines
- Architectural access doors coordinated as required

7.5 Plumbing Design Modeling:

Elements of the building plumbing design should be modeled for coordination between building systems and design disciplines by the MEP engineer of record to include but not limited to:

- Model all gravity piping systems – storm, sanitary, special waste systems
- Model all mechanical piping systems and coordinate racks of pipe
- All small diameter piping should be modeled to the intended location
- All piping 2" in diameter and larger should be coordinated with the design
- Model all valves, drains, and cleanouts in the desired access location
- External insulation should be modeled for spatial coordination
- Model all underground piping to the civil connection locations
- All inverts on piping should be accurately coordinated with structural foundations
- Model all plumbing equipment: Water heaters, pumps, control panels, heat exchangers, mechanical boilers, mechanical chillers, grease & lint interceptors, floor drains, back flow preventers, etc.

7.6 High & Low Voltage Electrical/Data/IT Design Modeling:

Elements of the building electrical/IT design should be modeled for coordination between building systems and design disciplines by the MEP engineer of record to include but not limited to:

- Model all electrical equipment: panels, transformers, switch/paralleling gear, ATS, generators, data racks, starters, VFDs, exit signs, AV equipment, recessed electrical devices, etc.
- Model all grouped conduit raceways with support structure
- Model all cable trays
- Model all light fixtures and switching devices – coordinate between electrical & architectural
- Model all fire alarm devices by Fire Protection/Life Safety
- Model phone/data ports
- Model all audio speakers and equipment
- Model all major conduit systems with integral pathways greater than 3" in diameter
- **Elements such as projection screens, projectors, smart boards, and televisions should be coordinated between architectural and electrical design models**

7.7 Fire Protection/Life Safety Design Modeling:

Elements of the building fire protection/life safety design should be modeled for coordination between building systems and design disciplines by the System Specific Engineer of Record and the Architect of Record to include but not limited to:

- **Fire protection performance specifications will require additional modeling services with the contractor. Review of the Level of Development Matrix is to be provided to the contractor and fire protection design builder that outlines the anticipated LOD taken for the design team.**
- **Fire alarm performance specifications will require additional modeling services to be reviewed by the contractor.**
- Model all fire protection equipment: pre-action system, dry system, and main fire protection systems, valve assemblies, drain valves, fire department valves, fire department connections, fire pumps, compressors, etc.
- Model all sprinkler head locations and sprinkler head types
- Model all tanks, assemblies, valves, control panels, pads and supports
- Model and indicate all test connections and drain points
- Model all flow switch locations, system valves, etc.
- Model all horns, strobes, smoke & heat detectors, duct detectors, pull stations, specialty equipment, and all fire alarm devices
- Emergency phones and other features associated with emergency communications

7.8 Interior Design Modeling:

Elements of the interior design model should be developed for coordination between architectural features, finishes, furniture and furniture systems for producing design documentation to include, but not limited to:

- Furniture, fixtures, & equipment for development of a model coordinated design
- Models should be produced for FF&E asset list development & scheduling
- Casework modeled for design coordination

7.9 Other Elements for Design Consideration:

- Food service equipment modeling
- Medical service equipment modeling
- Laboratory casework & equipment modeling

8. Standard Construction Modeling – By System

8.1 Systems Modeled and Level of Detail

The generic systems defined below in each section are provided to assist the construction team in helping to understand the intended model elements required by Virginia Commonwealth University. In no manner should this list be considered the minimal requirement. It is the contractor's responsibility to accurately model for coordination building systems that will support the installation of the various building systems. Design models should be used for review and assistance in evaluating the design intent, and construction models should be developed to support the prefabrication and installation of systems. The models developed should produce shop drawings or fabrication documents through a BIM based coordination tool. Greater detail than the minimum should be incorporated in the model whenever possible.

The contractor is responsible for identifying the gaps in model development required to support coordination with the design team. The contractor shall review models and identify any additional areas that need model progression for system coordination. **Refer to the Level of Development Matrix (Appendix B) for an outlined University standard. This document will need to be reviewed and updated by the contractor to reflect project specific requirements for supporting a coordinated installation of building systems. It should be provided and reviewed in conjunction with the construction team for defining the design deliverables, the model uses, and the additional modeling required for construction.** This should be a collaborative discussion that supports the best interests of the project.

8.2 Architectural:

The design architectural model will be provided to the contractor as a supplemental tool for assisting in the coordination of building systems. A thorough review of the models and the Level of Development Matrix should be taken into consideration for contractor coordination.

8.3 Structural Steel Fabrication Modeling:

Elements of the structural steel fabrication model should be modeled for coordination between building systems and development of the steel fabrication shop drawings to include but not limited to:

- Beams, girders, joists, trusses and truss systems, slab supports and structural framing members
- Steel columns, column plates, anchor bolts, and ties
- Shear load bracing, cross bracing, and turnbuckles
- Edges of all slabs and penetrations of structural systems
- Gusset plates, bracing, & knife plates
- Perimeter/exterior support framing, cantilever framing & canopy framing
- Slab edge angle, bent plate, and light gauge decking slab edge

- Brick angles, lintels, cast weld plates, light gauge weld plates
- Architectural metal feature framing to include all members, supports, and bracing
- Miscellaneous metals to include: Toilet & operable partition framing, MEP support framing, etc.
- Rooftop equipment & penetration support framing & roof screens
- Davits and permanent safety features
- Miscellaneous metals as required for necessary coordination of key elements, i.e. Operable Partitions

8.4 Structural Concrete Modeling:

The design structural model will be provided to the contractor as a supplemental tool for assisting in the coordination of structural foundation systems. A thorough review of the models and the Level of Development Matrix should be taken into consideration for contractor coordination. Construction modeling should only take place for elements that are not already represented or accurately depicted. Construction coordination modeling of cast-in-place and precast concrete structural elements should be modeled for coordination between building systems and the development of shop drawings to include but not limited to:

- Modeling should only take place for elements
- Footings (Strip & Pad), grade beams, & pile caps coordinated with utilities and site grading
- Caissons to the depth of the deepest utilities (actual depths should be indicated in the documents)
- Foundation & retaining walls
- Shear walls
- Shaft walls & various pits
- Concrete columns and piers
- Structural composite decks, hollow core slab systems, and cast-in-place slab systems
- Cast-in-place framing members and floor systems
- All precast concrete elements for structural and architectural purposes
- Rebar in areas with a high level of coordination requirements for concrete sleeves
- All slab edge embeds, lintels, and sleeve locations

8.5 Mechanical HVAC Fabrication Modeling:

Elements of the mechanical HVAC fabrication model should be modeled for coordination between building systems, development of the HVAC system shop drawings, and to optimize prefabrication on the project to include but not limited to:

- Model all ductwork to the actual size with sheet metal type, flanges, and connection points
- Model all external insulation to the appropriate thickness required by the specification
- Model all grilles, registers, louvers and diffusers

- Model all fire and smoke dampers with service and access clearances through the ceiling height
- Include coordination and location of horizontal dampers within slab penetrations
- Identify duct balance dampers and model service access clearances through the ceiling height
- Model coil pull areas, maintenance clearances, & service clearances for all equipment
- Model duct hangers and supports for supports that cannot be adjusted in the field
- Model all mechanical piping guides and supports
- Model all Mechanical Equipment: Fans, AHUs, Built-Up AHUs, VRF units, pumps, tanks, control panels, heat exchangers, ball valves, gauges & control valves, high & low point drains, starters, etc.
- All hydronic or VRF piping will be modeled to the standards detailed within the "Plumbing" section
- Model all curbs, supports, and non-steel framing
- The HVAC contractor shall also include concrete equipment pads, inertia pads and access doors
- Model all access doors and accessibility requirements related to system specific needs or code requirements

8.6 Plumbing & Piping Fabrication Modeling:

Elements of the plumbing & piping fabrication model should be modeled for coordination between building systems, development of the plumbing & piping system shop drawings, and to optimize prefabrication on the project to include but not limited to:

- Model all piping 1/2" and larger to the control valves, mixing valves, or equipment
- Model all valves, gauges, and control valves and service access to the ceiling height
- Model pipe hangers and supports that cannot be shifted in the field
- Model all piping guides and seismic bracing for plumbing lines
- Model all medical gas and piping systems to include valves, gauges, and controls
- External insulation on piping must be modeled to meet the design specifications
- Model all drip legs, drain pipes, blow down valves, and cleanouts
- Model all underground piping to the civil connection points, coordinate and verify invert elevations
- Model all plumbing equipment: Water heaters, pumps, control panels, heat exchangers, mechanical boilers, mechanical chillers, grease & lint interceptors, floor drains, back flow preventers, etc.
- The model shall also include concrete equipment pads, inertia pads and access doors for coordination
- Model all access doors and accessibility requirements related to system specific needs in order to protect the 3D space when performing clash resolution on the aggregate project model

8.7 High & Low Voltage Electrical:

- Model all electrical equipment: panels, transformers, switch/paralleling gear, ATS, generators, data racks, starters, VFDs, exit signs, AV equipment, recessed electrical devices, etc.

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- Model all low voltage transformers, motors, and supports
- Model all conduit 1 1/2" and larger to the termination point or the required junction box
- Model all grouped conduit raceways with 3 or more conduit greater than ¾" in diameter
- Model all cable trays and supports required
- Model hangers and supports that cannot be field coordinated
- Model all light fixtures and supports and immovable supports
- Model all major junction boxes and pull locations with clearance down to ceiling height
- Model all data conduit 1 ½" and larger to the termination point or required junction box
- Model all disconnects and access points for above ceiling mounted equipment

8.8 Fire Protection/Life Safety Fabrication Modeling:

Elements of the building fire protection/life safety design should be modeled for coordination between building systems and design disciplines by the System Specific Engineer of Record and the Architect of Record to include but not limited to:

8.9 Other Modeling Considerations:

The construction team should consider the added value to the coordination effort to support construction by taking into account other modeling needs such as:

- Structural light gauge framing systems & extensive light gauge framing supports
- Glass and glazing systems
- Food service equipment considerations
- Equipment service platforms, catwalks, and interstitial space considerations
- Prefabricated assemblies – headwalls, media walls, display cases, etc.

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9. Documentation Requirements

9.1 Design Requirements

It is Virginia Commonwealth University's intent to utilize the model for generation of all sheets with minimal use of CAD or 2D files inserted or linked into the model, except for standard details or disciplines such as Civil design that do not utilize a model authoring tool. All floor plans, sections, elevations, reflected ceiling plans, and project specific details should be developed within the model. The University recognizes many benefits associated with model based document development such as color coordinated sheets for room types, building systems, and wall types which provide great value to the construction team and University maintenance staff.

Leveraging model tools for deriving quantities and schedules of items such as glass and glazing systems, metal panels, masonry, doors, finishes, & mechanical, electrical and plumbing equipment is the preferred method for scheduling. The scheduling tools can be used for model based design reviews to help the construction team more quickly and accurately assess the work to be performed. This also helps ensure that the project stays within a suitable budget for the University. Additionally, upon project completion, the schedules and quantities derived from the model should be exported to assist in asset tracking and planning for the University.

Construction documents should be generated in the traditional manner. The 3D model is intended to provide enhanced collaboration to help support a more coordinated set of documents, and should be used to produce an effective deliverable that meets the project Level of Development Matrix and the agreed upon. As the project transitions from design to construction, all design changes should be recorded in the model for development of the Record Documents and Record Models. The Contractor will provide As-Built Documents via redline Shop Drawings/Fabrication Documents with any field deviations from the construction coordination models. The design team is to incorporate all major changes or redlines that affect the appearance of the 2D documentation. Accurately addressing all deviations to match the construction coordination model is not viewed as an efficient or cost appropriate measure.

It is expected that all models and files will be provided to the University, and delivered in their complete form with all notes, comments, annotations, sheets, and sketches without purging of project specific data. All models and files generated for University projects are to be delivered to the Planning and Design Office for use on future renovations, construction projects, and facility maintenance. A preferred file structure and checklist will be delivered to the design and construction teams for packaging files for submission to VCU's Planning and Design Office.

For specific documentation requirements please see Appendix C of the VCU BIM Guidelines, Turnover Documentation Outline.

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9.2 Construction Requirements

It is the Contractor's and associated subcontractor's responsibility to provide traditional Shop Drawings/Fabrication Documents for all required specifications that are outlined regardless of Construction Model coordination requirements established through the project execution plan. These documents should be developed in a model format to support construction coordination. All additional plans and models developed for Construction Coordination should be submitted to the design team and VCU for record prior to installation. Any equipment scheduled through the model should also be provided in an excel format to the client for use in asset tracking and planning for facilities management.

All construction teams should note, the design models are provided for review and assistance in determining the routing of the work in a three dimensional model. Notes and details provided from the 2D PDF construction documents or the progress prints shall be included in the project, and are considered the contract documents. The design model is for visualization, assistance, and supplemental information with fabrication model development only. Any schedules, quantities or values derived from the model for pricing purposes outside of the design team provided values are at the risk of the subcontractor. Contractor's shall refer to the Construction Documents and Specifications for traditional estimating and procurement practices. Recognize that details provided in the Revit model may not be actual sections through the model, and could be typical details.

Shop Drawing or Fabrication Documents should be provided to the field to help support a coordinated installation and assure prefabricated assemblies on site. Deviations to the Construction Model made by the field staff should be redlined and updated in the model as soon as possible. All major building systems should be redlined at the completion of ceiling framing and prior to installation of ceiling tiles and finishes. The redline documentation will need to be provided to the design team in an easily readable format for incorporation of deviations not already captured from the Shop Drawing/Fabrication Document submissions. The aggregate As-Built Construction model will be used as a document for viewing in conjunction with the design record documentation to support future renovations, construction, and facilities maintenance work. It is highly important that all major equipment and valves be located above the ceiling and documented in the as-built. Emergency Quick Access documents will need to be generated by the contractor on a system specific basis to support facility maintenance and management.

It is expected that all models and files will be provided to the University, and delivered in their complete form with all notes, comments, annotations, sheets, and sketches without purging of project specific data. All models and files generated for University projects are to be delivered to the Planning and Design Office at VCU for use on future renovations, construction projects, or facility maintenance. A preferred file structure and checklist will be delivered to the design and construction teams for packaging files for submission to VCU's Facilities Management Division.

For specific documentation requirements please see Appendix C of the VCU BIM Standards, Turnover Documentation Outline.

Appendix A – VCU Project Execution Plan

Included in the VCU BIM Guidelines should be a design and construction partners to complete a project specific BIM execution plan. This document shall be reviewed and completed by both design & construction teams with the timing related to the delivery method utilized for construction. Portions of the plan that have been edited, specifically the Level of Development Matrix, will need to be included with each design deliverable submission and shared with the Contractor. The project approach should be outlined by the design and construction team that best suits the requirements and goals of the project through the planning process.

Through the proposal process the design team should review the BIM Guidelines and provide in the submitted Design Services Proposal any services related to BIM or model development that would be greater than or less than the standards outlined in this document. The Project Execution Plan will be updated by the selected design team with all information related to the proposal, and the updated plan will be provided within the Construction Services Request for Proposals, and vice versa depending on the procurement method for the project. The successful project team partners will work collaboratively to update the execution plan, and both design and construction teams will work towards the management and submission of the appropriate deliverables.

The goal of the planning process is to provide transparency between design and construction teams, and to clearly define the expectations for model development. It is the University's intent to provide the most efficient design and construction modeling process that meets the required deliverables for permitting, BCOM evaluation, and proper building documentation. The University recognizes the value of producing models for design and construction that maximizes the return on the invested time, minimizes duplicated efforts, and supports a more collaborative process through design, preconstruction, and construction. Additionally, it is the University's goal to formalize and make consistent the level of deliverables provided and the outputs obtained to include more accurate record and as-built documentation.

Upon completion and review of the Project Execution Plan by the VCU Project Manager, the project teams will be required to sign-off on the Execution Plan and deliver a finalized copy to VCU and all parties involved in the modeling efforts related to the project. This document will be the road map and project strategy for delivering the project to VCU.

Appendix B – Level of Development Matrix

The Level of Development Matrix is the guide for system by system and element by element development of the model and the responsible party for the individual elements. This document is expandable and can be gauged by phases through schematic design, design development, construction documents, fabrication documents, and as-built/records. The project team shall review this matrix and add appropriately provided the known standards for design and construction modeling provided in the VCU BIM Guidelines and Standards Document. A sample matrix has been provided for generalities, but will need to be customized on a project by project basis. This matrix should be provided as part of the Project Execution Plan to VCU, and VCU should be involved in the discussions related to the project specific development.

This document should also be used for checks and balances related to the design and construction teams. If elements do not meet the agreed upon development for the appropriate phase of the project this should be used as a matrix for providing feedback and comments to the project team partners for assuring the deliverables are met.

Please download Development Matrix template from project website

Appendix C – Turnover Documentation Outline

The standards listed below, within Appendix C, are the minimum deliverables required by the VCU Plan Room archive for any project completed on the Monroe Park of VCUHS campus. These deliverables shall be submitted to the Plan Room within 30 days of project completion. All electronic requirements may be submitted on a CD, DVD, or flash drive with all files organized in the appropriate folder structure provided by VCU. ***Please download the turnover Folder Structure template from project website***

RECORD DRAWINGS – (Defined as the set of documents that include redline adjustments from the Architect/Engineer of Record.)

PRINT:

- (1) Complete full of half size drawing set labeled "VCU Plan Room Copy" on the cover page
    - o Each drawing in the set should be labeled "Record Document"
    - o Each drawing must contain the Architect/Engineer of Record Virginia State Seal
    - o Must be on paper or bond (no Mylar or Sepia will be accepted)
- Spreadsheets containing the following for all rooms:
    - o Column A: Building number (provided by VCU)
    - o Column B: Floor Number (2 digits, Ex: 0B,01,02,03,etc.)
    - o Column C: Room Numbers (assigned by VCU through the hoteling system document)
    - o *Column D: Room Name (Assigned through Revit Model)*
    - o *Column E: Room Use Type (Office, Conf. Room, Janitor/Cust., Classroom, Lab, Lecture, Stairs, Elevator, Lobby, Reception, Corridor, Other)*
    - o *Column F: Square Footage (Derived from Revit Record Model)*

ELECTRONIC:

- (1) Complete set of drawing files and the associated building models in the following formats (See naming conventions below):
    - o DWG
        - ▪ DO NOT include X-REF on any drawings
            - • For models UNCHECK box at DWG export for "Export views on sheets and links as external references"
        - ▪ Must be purged of all layers, blocks, etc.
            - • For models export model views without sheets
        - ▪ Do not use the color yellow on any drawings
            - • Model based DWG's will need the settings adjusted at export

- There must be a continuous and closed "polyline" around each room. This line should extend from inside wall to inside wall within the room and reside on the layer "P-Space-Polyline." This layer's color should be "(3) Green" and line type should be "Continuous."
- All other layers should be based on the AIA CAD Layer Guidelines

o PDF
- A full set of drawings should be provided in black/white (monochrome)
- For Revit model designs an additional set of floor plans should be provided with color coordinated wall types
  - Include project specific color legend with 2HR, 1HR, SMOKE, and Acoustic Rated partitions
- All drawings should be to the scale designated on the set
- When printed from Adobe Acrobat, all drawings should be the exact size of the printed set

o JPEG
- Each individual JPEG file should be 300dpi resolution

o REVIT/NATIVE DESIGN RECORD MODELS
- (1) Final copy of the model in its native format (Revit, Sketch-Up, Tekla, Rhino, etc.)
- Models should be provided with all sheets, details, and links
- Models should contain all families & components used for model generation
- Data should be maintained and not purged from the model
- Views should be generated to support the Room spreadsheets
- Spreadsheets should be developed and derived from the model to support the hoteling system used by VCU
- Spreadsheets should be developed for all scheduled elements derived from the model for Construction Documents

o NAVISWORKS AGGREGATE DESIGN RECORD MODEL
- (1) Export of Navisworks .NWC files for each design discipline model
- (1) Copy of all .XML files (Search Sets, Viewpoints, Etc.)
- (1) Final copy of the Navisworks Model in .NWD format with all design files (.NWC) linked and published

o RENDERINGS
- (2) Printed final renderings in color, size 24"x36"
- (1) Complete set of all final renderings on a CD or flash drive in TIFF format, minimum 600dpi resolution

o SPREADSHEETS

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- Spreadsheets should be provided in .xls, and .xlsx format
- All Revit models should have spreadsheets with model driven values
- Spreadsheets containing the following for all rooms:
  - Column A: Building number (provided by VCU)
  - Column B: Floor Number (2 digits, Ex: 0B,01,02,03,etc.)
  - Column C: Room Numbers (assigned by VCU through the hoteling system document)
  - *Column D: Room Name (Assigned through Revit Model)*
  - *Column E: Room Use Type (Office, Conf. Room, Janitor/Cust., Classroom, Lab, Lecture, Stairs, Elevator, Lobby, Reception, Corridor, Other)*
  - *Column F: Square Footage (Derived from Revit Record Model)*

AS-BUILT DOCUMENTS – (Defined as the set of documents that include redline adjustments by the Contractor and trade contractors responsible for install.)

PRINT:

- (1) Complete full or half size drawing set labeled "VCU Plan Room Copy" on the cover page
  - Each drawing in the set should be labeled "As-Built Document"
  - Must be on paper or bond (no Mylar or Sepia will be accepted)
  - Redline As-Built documentation and notes should be included

ELECTRONIC:

- (1) Complete set of drawing files and the associated building models in the following formats (See naming conventions below):
  - PDF
    - A full set of drawings should be provided in black/white (monochrome)
    - All drawings should be to the scale designated on the set
    - When printed from Adobe Acrobat, all drawings should be the exact size of the printed set
  - SPECIALIZED AS-BUILT DOCUMENTS (PDF)
    - Emergency Quick Access Plans should be developed with the accurate As-built construction coordination models to accurately locate all elements of the facility for turnover documentation.
      - Emergency Mechanical Quick Access
        - Plan view indicating accurate location of all major mechanical, plumbing, & fire protection equipment or valves.

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- System routing is to be "ghosted" or transparent
- All valves must be accurately located and identified for the system on the plan
- Units must be accurately located on the plan

- Emergency Response Quick Access Plans
  - All Fire Alarm, pull stations, panels, equipment, strobes, detectors, FDC connections, pumps, flow switches, etc.
  - All Equipment must be accurately located
  - All Extinguisher locations
  - Sprinkler system "ghosted" w/ all isolation valves shown and noted on the plans

- Lab Space Quick Access Plans
  - Include all med-gas valves and curoff locations
  - Hoods with system designations indicated
  - All specialty lab casework associated

- Electrical Quick Access Plans
  - Color coordinated electrical documents
  - Red – Emergency Power (Generator)
  - Orange – Emergency Power (UPS)
  - Brown – Normal Power
  - Blue – Data
  - Green – Security
  - Floor Plan "ghosted" and all panels and electrical equipment shown

- REVIT/DWG/NATIVE FABRICATION AS-BUILT MODELS
  - (1) Final copy of the model in its native format (Revit, Sketch-Up, Tekla, Rhino, etc.)
  - Models should be provided with all sheets, details, and links
  - Models should contain all families & components used for model generation
  - Data should be maintained and not purged from the model

- NAVISWORKS AGGREGATE DESIGN RECORD MODEL
  - (1) Export of Navisworks .NWC files for each trade model or discipline
  - (1) Copy of all .XML files (Search Sets, Viewpoints, Etc.)
  - (1) Final copy of the Navisworks Model in .NWD format with all design files (.NWC) linked and published

SPECIFICATIONS, O&M MANUALS, WARRANTY INFORMATION

PRINT:

- (3) complete sets of each, printed and bound on 8.5"x11" paper
    - (2) sets should be labeled "VCU Plan Room Copy" on the cover page

ELECTRONIC:

- (1) Complete set of each in PDF format
- Each set of O&M's & Warranties should be organized by reference division used in specifications

POWERPOINT PRESENTATIONS

ELECTRONIC:

- (1) Complete set of each presentation in Microsoft PowerPoint (PPT,PPTX) format
- All graphics used in presentation must be included in TIFF Format, minimum 300 dpi

STUDIES AND MASTER PLANS

PRINT:

- (1) Complete set in PDF format
- All graphics used in the study or Master Plan must be included in RIFF format, minimum 300dpi resolution

PROPERTY AND SITE SURVEYS (Must be on State Plan Coordinate System)

PRINT:

- (1) Complete set labeled "VCU Plan Room Copy" on the cover page

ELECTRONIC:

- Final copy of DWG surveys and plans to meet DWG guidelines of RECORD DRAWINGS

NAMING CONVENTIONS:

- MODEL NAMING EXAMPLE
    - (Firm Proj #)-(Firm Acronym)- (VCU Bldg #)-(Project Acronym)- (Discipline)-(Subset).file type
        - 34567-BCWH-279-ALC-ARCH.rvt
        - 5678-KSS-279-ALC-ARCH-Interiors.rvt
        - 9876-HCYu-279-ALC-MEP-Electrical.rvt
        - **34567-BCWH-279-ALC-RECORD.rvt**
        - **9080-HOURIGAN-279-ALC-ASBUILT.nwd**

- DWG EXPORT NAMING EXAMPLE
    - (VCU Bldg #)-(Project Acronym)-(Discipline)-(PlanType)-(Level#)
        - **279-ALC-ARCH-FloorPlan-Level2.dwg**

- DWG DESIGN NAMING EXAMPLE
    - Project # - Project Code - Sheet #
        - 236-17896-E202
        - 279-17896-A001

Appendix D – AIA E202-2008 SAMPLE

No.	Date	Description	Changes Made
1	07-28-2013	Draft release for VCU Review by FMD BIM team.	
2	9/20/2013	Adjustments to the document outline and additions to the document provided by Mary Cox.	Adjustments were made for minor inclusions to the scope. Primary adjustments were to the layout of the structure and addition numerical outline format for referencing the documents. Adding the new Appendix D, AIA E202 document.
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Do Not Include in Proposal

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