National BIM Standard - United States®
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# National BIM Standard - United States® Version 3

## 5 Practice Documents

### 5.5 Mechanical, Electrical, Plumbing, And Fire Protection Systems (MEP) Spatial Coordination Requirements for Construction Installation Models and Deliverables – Revised May 2012

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### 5.5.1 Scope

The recent widespread adoption of Building Information Modeling (BIM) and 3D modeling in the construction industry has necessitated the development of a well-defined, organized, consistent, and repeatable framework for installation level spatial coordination of mechanical, electrical, plumbing, and fire protection systems (MEP).

This document, *Mechanical, Electrical, Plumbing, and Fire Protection Systems Spatial Coordination Requirements for Construction Installation Models and Deliverables*, will provide guidance to construction companies and individuals involved in 3D MEP spatial coordination of systems and components for fabrication and installation. It does not delve into design coordination or interfaces between designers and installing contractors. It is not a replacement for the ConsesusDOCS 301: BIM Addendum, a BIM implementation plan, or any other more project specific scope of work or contract. No single document can convey every aspect required to complete a BIM; therefore, the primary focus of this document is to outline the MEP spatial coordination process using 3D and BIM technology for the installing contractors and trades people. When used as intended, this document will provide assistance with team structure, definition of roles and responsibilities, recommendations for technical and IT considerations, social structure, and accountability.

While focused on traditional design-bid-build delivery methods, this document (with minor additions) should work equally well on design-assist, and design-build projects. Projects using an "integrated form of agreement" or other less traditional contracting method may find the document useful, but lacking in detail for interfaces between contractors and designers.

MEP trades have been spatially coordinating work between themselves for purposes of constructability, fabrication, and installation for over 20 years. Working relationships and team structures that work both contractually and legally have evolved over time. Those traditional methods of spatial coordination for the creation of fabrication and installation documents are the guideline for this document. Clarification of roles and responsibilities for stakeholders reflect the use of newer technologies (i.e., digital overlay and simulation software in place of light tables). Maintaining current 2D deliverable roles and team framework while adding the 3D technical aspects are the objective. If a question of “who should do what” arises, the team member with the highest risk and most to gain should perform the task. In most cases, the contractor responsible for installing the work (i.e., mechanical, electrical, plumbing, fire protection, or framing) should also be responsible for accurately depicting it in the 3D model.

***Commentary***

*SMACNA, NECA, and MCAA, representing the sheet metal, electrical, plumbing and mechanical, have issued a definition of the traditional MEP coordination delivery process referenced in the standard.*

*a. Standard and acceptable industry practice for spatial coordination performed under the contract documents is a collaborative process executed between the primary installation contractors and overseen by the general contractor or construction manager. This practice for spatial coordination seeks to integrate objects, systems, and components into spaces allocated in the contract documents. Standard and acceptable industry practice for coordination does not include adding pipe, ductwork, fittings, conduits, cable tray, junction boxes, or other appurtenances to remedy spatial constraints. Such work falls beyond the scope of what is considered standard and acceptable industry practice for coordination and will be performed as expressly directed pursuant to the terms of the contract. Achievement of spatial coordination under the contract documents that represents standard and acceptable practice in the industry assumes:*

- *The contract drawings have been fully designed and coordinated by the owner and/or its design professionals such that, if installed as shown on the contract drawings,*

*the finished product will result in systems operating as designed by the owner and/or its design professionals.*

- *Systems fit within the spaces allocated on the contract drawings as qualified below.*

*b. Spatial coordination that is standard and acceptable practice in the construction industry does not include relocating systems from their allotted spaces as shown on the contract drawings when such relocations require added materials, shop or field labor, or coordination time. Any such relocations or alterations of components and/or systems may compromise the integrity and/or the planned performance of the system(s) as designed by the owner and/or its design professionals. Responsibility for the integrity and/or planned performance of the relocated systems will remain the sole responsibility of the owner and/or its design professionals.*

*c. Depending on the complexity of the project, from one to three iterations each of clash identification and attempts at clash resolution are considered standard and acceptable industry practice for coordination. Further iterations fall beyond the scope of what is considered standard and acceptable industry practice for coordination.*

*d. The physical spaces for electrical, mechanical, sheet metal and plumbing equipment rooms must be adequate to allow for the installation of equipment as shown on the contract drawings. All designed spaces must include clearances in and around equipment as required by the contract documents, applicable codes and the equipment manufacturer's specifications. Adequate spaces must be included in the design to accommodate incoming and outgoing services to and from the equipment and for maintenance as required by the contract documents.*

*Spatial coordination is a cooperative and collaborative effort between the design professional, owner, general contractor or construction manager, and the trade contractors. Normal and expected spatial coordination performed by the trade contractors after the execution of a contract is not design. Rather, it is the reflection of the design in a three dimensional model. Trade contractors rely on complete and accurate designs when bidding projects in order to provide accurate bid pricing. In return, trade contractors, such as those represented by the MCAA, SMACNA, and NECA, using that design, are able to produce reliable models by which the project can be constructed in a more efficient, timely and cost effective manner.*

When adopting this methodology the focus should be on maintaining as many of the traditional spatial coordination social relationships as possible. Doing so will reduce learning curve and avoid disruption in established, well-functioning stakeholder relationships.

### 5.5.2 Normative references

None

### 5.5.3 Terms, definitions, symbols, units and abbreviated terms

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

**5.5.3.1**
**3D**
**three dimensional**

### 5.5.4 Mechanical, Electrical, Plumbing, and Fire Protection Systems Spatial Coordination Requirements for Construction Installation Models and Deliverables, November 2009

This Mechanical, Electrical, Plumbing, and Fire Protection Systems (MEP) Spatial Coordination Requirements for Construction Installation Models and Deliverables is a derivative work of a best practice guideline written by David Morris in 2003 and modified for the AGC BIMForum in 2009. It is the result of capturing ten years of practical methods on real world construction projects and reflects continual feedback and improvement gained from that process. Many individuals have provided critical input and their observations incorporated in the document. David Morris is the Director of Virtual Construction for EMCOR Construction Services and the current Chair of the National BIM Standard-United States®.

#### 5.5.4.1 Minimum qualifications – MEP spatial coordination team

Participating companies should have adequate infrastructure and qualified competent personnel before onset of coordination.

Individual participants (persons not companies) in the MEP Spatial Coordination Team should have verifiable experience in at least two fully coordinated 3D projects where the MEP team spatially coordinated a 3D construction model.

#### 5.5.4.2 Project coordination manager – general contractor's representative

The Project Coordination Manager (PCM) will administrate the MEP Spatial Coordination Team and ensure subcontractor participation and performance in all coordination efforts. The PCM will also create the mutually agreed upon construction and BIM coordination schedules and ensure the two are kept up to date and reconciled with each other. The PCM will maintain meeting minutes, monitor Subcontractor performance against the spatial coordination and construction schedules, and resolve issues of noncompliance.

The PCM will obtain and convey to the MEP Spatial Coordinator (see following section for definition of role) all structural and architectural features[1] that are required to complete the MEP spatial coordination. Specifically, the PCM will manage the timely distribution of architectural, structural, and MEP electronic data and hard copy drawings between the Design Team (Project Architect, Mechanical Engineer, Plumbing Engineer, Electrical Engineer, etc.) and the MEP Spatial Coordination Team and maintain current logs[2].

The PCM will act as liaison between the MEP Spatial Coordination Team, the owner, and designers to ensure that all parties are aware of design changes or spatial issues requiring design input for resolution.

Design changes that affect the MEP systems or spatial issues requiring resolution by the Design Team but not conveyed to the MEP Spatial Coordination Team in a timely fashion may adversely affect the coordination and construction schedules and impact cost.

In the event a spatial coordination issue cannot be resolved between the MEP Spatial Coordinator and MEP subcontractors, the PCM will act as final arbitrator.

#### 5.5.4.3 MEP spatial coordinator – MEP lead subcontractor

The MEP Spatial Coordinator (MSC) will lead the MEP Spatial Coordination Team under the administration of the PCM and in partnership with the Mechanical, Electrical, Plumbing, Fire Protection, and all other MEP coordination participants. The MSC will be responsible for the daily MEP spatial coordination, including but not limited to, conducting the spatial coordination meetings, facilitating the

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1 Annex A, Note 5.

2 Annex A, Note 4.

federated model updates, maintaining the collaborative workspace, and facilitating meeting participation for local and remote participants.

#### 5.5.4.4 Project coordination schedule

The General Contractor will prepare and maintain a mutually agreed upon spatial coordination schedule with coordination drawing submittal milestones that meet the overall project construction schedule. A realistic and mutually agreed upon preconstruction coordination schedule created by the General Contractor with input from all subcontractors participating in the coordination is imperative to success. Coordination drawing development, coordination submittal drawing submission and review by the Engineer of Record, fabrication duration, and delivery lead times will be included to support the project construction schedule.

#### 5.5.4.5 Coordination set-up and participation

The Design Team will provide electronic Models and applicable existing CAD files of the current contract drawings to the MEP Spatial Coordination Team at no cost, in the format specified in Annex A. The MSC will use the electronic files provided by the Design Team to create backgrounds, a key plan, title block files with defined views in a scale that coincides with the architectural sheet set, and other support files necessary to complete project coordination. All MEP trades must fully participate in the coordination process. Success requires that the MSC, PCM, and all of the MEP subcontractors are fully committed throughout the entire process. Any contractor who fails to comply with the agreed upon coordination schedule will bear the costs incurred by others. (This clause should be added to the contract in the division 1 requirements, in the absence thereof; a contract addendum including this entire document is acceptable).

#### 5.5.4.6 Human resource requirement

Each participating company must adequately staff their coordination department with qualified trade knowledgeable personnel. Participants must have **proficiency and authority** for spatial coordination of their work. The ability to collaborate in a team environment is imperative.

#### 5.5.4.7 File transfer and collaboration workspace

The MSC will establish and host a web-based electronic workspace or File Transfer Protocol (FTP) for the purpose of efficient and timely transfer of coordination files. The workspace will provide a collaborative location where the current contract CAD drawings, coordination CAD Models, and fully coordinated submittal drawing files will reside. Each BIM coordination team member obtains data from this location. MEP Spatial Coordination Team members are to upload updated copies of their coordination files, provide notification, and make collaboration comments/annotations as often as necessary to maintain the coordination schedule. The Construction Manager or General Contractor may use the MEP spatial collaboration workspace as an interface for collaboration between the Owner, Design Team, and other trades not actively involved in the MEP spatial coordination process.

#### 5.5.4.8 File format, compatibility, and completeness

All team members must produce coordination drawings in the format specified in Annex A 3.4 to ensure compatibility with the other coordination team members. Each MEP Coordination Team member is to model ***all*** of the ***major components***[3] of their work to scale, at elevation, and free from interference with the structure, their own components, and other MEP trades' work. Supports, hangers, seismic restraints,

[3] Annex A, Note 1.

insulation, structural zones of influence, serviceability access, and maintenance clearances shall be included.

*After all coordinated components are in place, installation of items not included in the coordinated installation drawing may begin. Any items not in the coordinated model will be installed after* coordinated items are in place. Accessibility to install non-coordinated work is not an exclusion or exception to this requirement. Each participant is required to consider sequence of work when determining the degree of detail required.

#### 5.5.4.9 Coordination meetings

The MSC will host regular weekly (or more frequent) coordination meetings, administrated by the PCM. Attendance is mandatory by all MEP Spatial Coordination Team members to maintain the coordination and construction schedules.

#### 5.5.4.10 MEP spatial coordination

Before the onset of 3D modeling, the MSC will host a spatial planning meeting for conceptual routing of MEP components within the architectural space. The primary goal is to properly pre-plan the initial routing of major systems to increase efficiency of the MEP coordination process by reducing the number of "first pass" spatial interferences.

Electronic MEP spatial interference reconciliation by the MSC occurs during mandatory coordination meetings. Using collaboration software[4], the MSC provides "real time" rendered views of the structure and MEP components, documentation of spatial interferences, and identification of the party responsible for making changes. After every spatial coordination meeting a report of required changes is distributed to the MEP Spatial Coordination Team members by the MSC. The Design Team shall participate in the coordination meetings as necessary to resolve spatial issues that may require design consideration. The Design Team must document and transfer to the PCM for distribution to the MEP Spatial Coordination team any design changes that occur during the MEP spatial coordination process.

#### 5.5.4.11 Submittal and coordination sign-off drawings

When all spatial interferences and coordination issues have been resolved, each MEP coordination team member will produce complete and fully annotated installation drawings5 of their respective systems, including title blocks appropriate for installation by their field team. One hard copy and one PDF data file are required for submission to the Design Team for review of compliance with design intent. Upon approval by the Design Team, a copy of the fully coordinated coordination submittal drawings, signed by each participant, will become the official "Coordination Sign-off Drawings." The "Coordination Sign-off Drawings" (stored by the General Contractor on the project site) form the basis for resolution of any field installation conflicts or disagreements.

Persons installing components not shown on, or not installed in accordance with, the "Coordination Sign-off Drawings" will relocate those components at their expense.

Non-compliant parties bear all cost for rework, re-coordination, or schedule impact required to accommodate components not shown on, or not installed in accordance with, the "Coordination Sign-off Drawings," including impacts to other parties affected by their lack of compliance.

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4 Annex A, Note 3.6.

5 Annex A, Note 6.

#### 5.5.4.12 Record and as-built deliverables

At project completion, each MEP participant shall:

- Incorporate “As-Built” conditions affecting their work into the electronic CAD files and provide a record set of drawings in PDF format.
- Provide printed copies of the PDF files in quantities required by project specification.
- Export electronic CAD files in 3D to IFC format and transfer via electronic media (CD, DVD, FTP site) and other means as required by project specification.
- Provide rendered models for inclusion in a comprehensive “Project Master Model” assembled by the PCM or other designated party.

#### 5.5.4.13 Hardware and software requirements

All MEP Spatial Coordination Team members are responsible to have, or obtain at their cost, the hardware and software required to participate efficiently in this critical phase of the project. See Annex A for minimum hardware and software recommendations6. Personnel participating in the coordination efforts of this project must be proficient in the use of this technology.

### 5.5.5 Bibliography

None

[6] Annex A, Note 3.

## Annex A

### 1. Major Components

1.1. HVAC Duct

1.1.1. All ductwork, grilles, registers, diffusers, dampers, access panels, air moving equipment, maintenance clearances, and any item that may impact coordination with other disciplines.

1.2. HVAC Piping

1.2.1. All overhead piping, vertical piping in shafts, connections to equipment, scheduled equipment, maintenance clearances, hangers, supports, and any item that may affect coordination with other disciplines.

1.3. Plumbing

1.3.1. All overhead piping, vertical piping between floors, connections to equipment and fixtures, maintenance clearances, hangers, supports, and any item that may affect coordination with other disciplines.

1.4. Fire Protection Piping

1.4.1. All overhead piping, branch connections, drops and heads, access panels, maintenance clearances, hangers, supports, and any item that may impact coordination with other disciplines.

1.5. Electrical

1.5.1. All conduits 2" and larger, any rack of two or more conduits regardless of size, lights and fixtures, electrical pull and circuit boxes, access clearances, all cable trays, hangers, supports, raceways, and any item that may impact coordination with other disciplines.

1.6. Framing

1.6.1. All king studs, headers, and any item that may affect coordination with other disciplines.

**2. Minimum Hardware Requirements (**update on every project**)**

2.1. Computer:

**3. Minimum Software Requirements (Modify and update specifically for each project)**[7]

**4. Logs**

4.1. RFI

4.2. Submittal

4.3. Contract Drawings

4.4. ASI

[7] Hardware and software requirements are meant as a general guideline and should be reviewed and modified as project requirements dictate.

4.5. Change Proposals

4.6. Specifications

## 5. Structural/Architectural Features Required for MEP Coordination

5.1. Spatially accurate and dimensionally scalable building elements including but not limited to soffits, fixture locations, ceiling/floor tile locations, ADA clearances, interior wall framing, moment frame side plates, cross bracing, gusset plates, beam stiffeners, miscellaneous steel framing, and other similar entities within the modeling space requiring coordination with the MEP trades.

## 6. Fully Annotated Installation Drawings

6.1. Fully annotated installation drawings shall include all text, dimensions, and annotations required for physical location of all elements shown on the drawings in the physical space at the time of installation.