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ATTACHMENT “M” Virtual Design & Construction Guidelines

Introduction

Harbison-Mahony-Higgins Builders, Inc. (HMH) is implementing Building Information Modeling (BIM), a digital, three-dimensional model linked to a data base of project information, which will provide a platform for collaboration throughout the project’s design and construction.

Because BIM combines, among other things, design, fabrication information, erection instructions, and other project management logistics, HMH and its subcontractors will have the ability to analyze different design solutions for construction, costing and scheduling impacts.

Through some basic guidelines, we feel a solid foundation will be in place to achieve our goals. In addition, we believe these guidelines will improve the process of exchanging electronic information, making it easier and more reliable for all entities involved.

Required Participants

For this project, HMH will require participation in a formal BIM process, including detailed fabricated 3D CAD drawings, by the following trades:

- Metal Stud Framing Systems
- Acoustical Ceiling
- Mechanical Systems
- Plumbing Systems
- Fire Sprinkler Systems
- Pneumatic Tube
- Electrical & Associated Line and Low Voltage Systems
- Cast in Place Concrete
- Structural Steel
- Miscellaneous Steel Supports

The above participants will be part of a team that will meet on a regular basis to model the building and its systems, coordinate the work, build the project virtually, with an end goal of eliminating as many conflicts and clashes as possible. HMH will administer and oversee the process, bring the individual models together in Navisworks 2010, run clash detection reports, and generally coordinate the efforts. The individual participants will be partners in this process, model their work, coordinate this with other trades and building components, obtain approvals from the architect and engineers of record, and relocate/modify their systems as necessary when conflicts arise.

Unless otherwise noted, trades other than those listed above will NOT be required to furnish 3D models for project coordination on this project, but are encouraged to participate.

The Team will adhere to the following guidelines in the preparation of building system models for their own work. The cost of all software, modeling, drafting, transmission, submittal, meetings, etc. for this process shall be the responsibility of the subcontractor and are included in this subcontract. The subcontractor shall list the cost for this work in his Schedule of Values as a discrete item.

Interoperability

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The Architect, Structural Engineer, Mechanical/Plumbing Engineer and Electrical Engineer drawings will be provided in 3D CAD format for this modeling effort. It is the intent of this coordination effort is to utilize the Architectural, Structural, Mechanical/Plumbing Engineer and Electrical Engineer modeled drawings. HMH is not requiring Subcontractors to use the following formats, but is the intent to reduce “redraw” and “remodel” work. Also it is the intent to utilize IFC translation for importing and exporting to each BIM platform.

The format type of modeled drawings will be provided in the following formats:

- Architectural and Structural BIM Model – AutoDESK Revit 2010
- Mechanical/Plumbing/Fire Sprinkler 3D Model – CAD Mech and CAD Pipe 2009
- Electrical 3D model – AutoCAD MEP 2009

Modeling Schedule

HMH will develop a modeling/coordination schedule that will align with the overall construction schedule (see Attachment F). Participants will be required to maintain this schedule so that the modeling/coordination schedule and the overall construction schedule are maintained.

The subcontractor shall develop accurate models for their work significantly in advance of the scheduled dates for fabrication and installation to allow for simultaneous coordination and analysis of the building systems. So that coordination efforts can commence in a timely manner, subcontractors must submit their model data appropriate to the project schedule. In most cases, the project schedule will require that all models be submitted such that there will be sufficient time for coordination, review, revisions, re-submittals, procurement, and fabrication for the trade with the longest lead time and earliest install date.

Please note that the design, architectural and/or engineering team(s) shall be provided fifteen (15) workdays for each of their review and comment processes. Further, due to the complexity of certain projects, multiple re-reviews including correction of the model with re-submittal may be required to achieve approval from the design, architectural and/or engineering team(s). Therefore, some trades will be required to submit a model much earlier than their own lead times or install dates might dictate. It is the subcontractor’s responsibility to include man hours for extra modeling efforts. This applies to trades that may have a deferred submittal process, e.g. fire protection.

On some projects, BIM coordination will take place in phases by area, level, or other zone. To this end, the subcontractor must develop and submit models to match the schedule logic of the project. Please refer to the project schedule for further information.

HMH may utilize the 3D model for scheduling purposes, and therefore will convert the 3D model into a 4D model incorporating time. Participants will be required to assist HMH in the scheduling work as it relates to their work and their modeling efforts.

Modeling Coordination Meetings

Each participant will be required to complete and coordinate the modeling prior to fabrication or deck inserting. Provide modeling manpower as required maintaining the coordination schedule throughout this effort. Modelers will be required to attend weekly jobsite coordination meetings as scheduled by HMH. The intent of these meetings is to identify and resolve conflicts between systems, through the realignment of the work, to avoid conflicts during installation. In general, the routing of major systems shall not greatly deviate from that shown on the design documents unless rerouting is agreed to by HMH and the design team. If all trades cannot agree upon a solution to a conflict, HMH will determine that solution for

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the team in order to maintain forward progress. HMH requires subcontractors to exchange drawing files and coordinate as necessary between meetings via whatever methods are agreeable to the subcontractors. Subcontractors must keep HMH informed of progress.

Coordination System Priorities

The modeling effort will identify space constraints and system conflicts. These will require each participant to relocate its systems to coordinate with the design, engineering, or work by other participants. It is anticipated that each participant will have to relocate at least some of its systems. Plan for this in your modeling efforts, the following construction efforts, and your Base Bid. If agreement can not be reached between participants, the following guideline will be used to resolve conflicts between trades. The items below are listed in descending order of priority:

1. Items shown on the architectural and structural plans
2. Equipment shown on the mechanical or electrical plans which cannot be relocated
3. Equipment or devices requiring access for maintenance
4. Fire sprinkler mains, existing
5. Plumbing and HVAC gravity lines
6. Ductwork, rigid
7. Plumbing and HVAC piping 4" or larger
8. Fire sprinkler mains, new
9. Electrical conduit 2-1/2" or larger
10. Plumbing and HVAC piping 3-1/2" and smaller
11. Fire sprinkler piping other than mains
12. Electrical conduit 2" or smaller
13. Ductwork, flex
14. Low Voltage Systems, i.e. Telecomm, Nurse Call, Fire Alarm, etc.

Scope Specific Information

Model Level of Detail (LOD)

ALL Required Participants:

Subcontractors shall develop 3D fabrication models for coordination with sufficient level of detail for accurate coordination of ALL building systems and components. Accurately depicts ALL elements required in assemblies, even components not required for coordination. Each model shall show (regardless of size) all systems and building components as applicable. Subcontractors will also be responsible for modeling, "no fly zones," accessibility areas, code clearance zones, OSHPD requirements, etc. (e.g. concrete anchor zone clearance, pipe clearance, etc.) These zone/areas shall be a 3D model object with specific identification that will be utilized in the NavisWorks Clash Detection.

List of minimum modeling objects required, but not limited to:

HVAC:

Return Air Ducts
Supply Air Ducts
Exhaust Air Ducts
CAV's
Fire Smoke Dampers

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Ceiling/Wall Registers
Flex Duct
Hanger Supports
E.Q. Bracing
Air Handling Units

Plumbing Systems:

Domestic Hot and Cold Pipe
Chilled Water Pipe
Heating Hot Water Pipe
Med Gas Pipe
Steam Pipe
Rain Water Leaders and Overflow Pipe
Waste and Vent Pipe
Pipe Insulation
Hanger Supports
E.Q. Bracing
Equipment and Pumps
Equipment Valves

Electrical:

Conduit Runs 1.5” and Larger
Conduit Racks
Cable Trays and or J hooks system
Panels/Switch Gear
Ceiling/Wall Light Fixtures
J Boxes
Hanger Supports
E.Q. Bracing

Fire Sprinkler:

Fire Sprinkler Mains
Fire Sprinkler Branchlines
Fire Sprinkler Drops
Ceiling Sprinklers
Upright Sprinklers
Valves
Riser Assemblies
Pump Assemblies
Pump and Jockey Pump Controllers
Pre-Action Panels
Hanger Supports
E.Q. Bracing

Pneumatic Tube:

Pipe Tube
Diverters
P-Tube Stations
Hanger Supports
E.Q. Bracing

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Metal Stud Framing Systems:

Metal Stud Contractor will be responsible for modeling 3D Interior Metal Stud Framing Systems. It is the intent of this coordination effort to synchronize modeling components with the Architectural Revit model that will be provided.

Top and Bottom Track/Slip Track
“HOW” Head of wall conditions (Z clips and Slip Track)
Door & Window King Studs
Metal Studs (Wall Corner Studs will suffice)
Door and Window Headers/Frames
MEP Wall Block Outs
Soffit and Wall Kickers
Ceiling and Soffit Framing

Acoustical Ceiling Systems:

Acoustical Ceiling systems
Compressions Post and Wires

Cast in Place Concrete:

It is the intent of the Concrete subcontractor to provide a detailed 100% Tekla Structure 3D model (or equal) that utilizes the total station for accurate field layout. It is the intent of this model to be coordinated with the Structural Steel model.

Structural Steel:

It is the intent of the Structural Steel subcontractor to provide a detailed 100% Tekla Structure 3D fabrication model or equal. It is the intent of this model to be coordinated with the Concrete model.

Miscellaneous Steel Supports:

It is the intent of this subcontractor to provide a detailed 3D fabrication model for all miscellaneous steel supports, i.e. Medical Equipment supports.

Wall and Shaft Coordination

Prior to layout of walls by others, subcontractors shall coordinate their in-wall rough-in and support requirements with the wall types specified, and shall advise HMH in writing of any dimensional or structural support discrepancies; otherwise the subcontractor(s) shall be responsible for costs to revise the work, including reframing, etc.

Prior to modeling any floor plans the mechanical and electrical subcontractors shall coordinate the vertical pipe and duct shafts and openings in the decks. Deck openings shall be minimized to allow at least six inches of clear deck inside the shaft walls. The clear deck areas are needed to support and anchor the ends of the duct and pipe supports. Include all seismic and vibration isolation requirements.

If shaft bottoms exist these shall be fully coordinated and modeled, and may need to be reviewed and approved by the architect and engineers of record.

VD&C Field layout and Model Verification

Steel Decking:

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As a convenience, HMH will promptly identify the floor metal deck flute locations at the time of install. It is the intent of this effort to take this field layout and input this back into the BIM Model. It will be the subcontractor's responsibility at this expedited time to verify all insert locations (hangers, bracing etc.) in conjunction with the as-installed deck flute locations. If there is a discrepancy it is the subcontractor's responsibility to adjust their 3D model per manufacturer insert specifications and to include labor hours in for redraw and coordination efforts. The sign off coordination model will not be finalized until this effort is completed.

Field Layout:

It is the ongoing responsibility of the subcontractor to report all field layout conditions that conflict with the sign off coordination model. All deviations i.e., hanger inserts, pipe sleeves, deck penetrations, system layout, etc., will be required to be reported back into the 3D model and notify HMH immediately to update the clash detection reports. It is the subcontractor's responsibility to include labor hours in for modeling the field layout conditions.

Total Station:

It is the subcontractor's responsibility to furnish all equipment and labor to perform field verifications using the Total Station. The intent of the effort is to insure modeling efforts will be accurate per field layout conditions. The Total Station will be required for but not limited to, all hanger and bracing inserts, wall and slab penetrations and pipe sleeve locations. It is the subcontractor's responsibility to insure accuracy of Total Station CAD data point placement.

Background/Template Drawings

As a convenience, the project architect will commonly furnish to HMH CAD files for use in developing 3D coordination drawings. To receive these files, subcontractors will be required to sign an Electronic Media Disclaimer stating that all such electronic files are to be used at the subcontractors' own risk, and confirming that the subcontractor will indemnify and hold harmless HMH and the architect, engineers, or their consultant(s) for any losses that result from discrepancies in the model.

HMH will manage the Architectural, Structural and Consulting Engineer's AutoCAD Background files and place them on a secure FTP Site, to be downloaded. HMH makes no promise that the file format shall be compatible with the subcontractor's software. The standard file format will be AutoCAD 2007.

Regardless of any background or template drawings provided, it shall remain the responsibility of the subcontractor to ensure that their model is accurate.

In cases where these reference drawings are not made available to subcontractors, for any reason, the subcontractor shall still be responsible for producing an accurate 3D model of his work with no reimbursement by HMH.

Model Quality and Fitness for Purpose

The subcontractor is required to understand and coordinate with the work of all other trades in the development of the 3D model. The subcontractor shall check and provide quality control over the work of draftsmen so that the 3D model accurately represents the design intent as it will be installed in the field to function properly in a fully-integrated system that meets all building codes and the requirements of other agencies/entities having jurisdiction over this project (e.g., OSHPD, Fire Marshall, ADA, etc.)

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If the subcontractor lacks the in-house experience, hardware, or software to accurately create the 3D model, he or she may elect to outsource this process to a 3rd party. In this case, the subcontractor shall be responsible for all costs resulting from the model building AND be responsible for accuracy of the model.

HMH reserves the right to reject any model that is inaccurate, improperly formatted, or otherwise deemed unfit for its purpose. The subcontractor shall bear all costs resulting from the subcontractor's model correction & resubmittal, including expediting premiums.

If the subcontractor fails to provide an accurate model per the project schedule requirements, HMH reserves the right to prepare a suitable model on the subcontractor's behalf through its own resources or agents, at the subcontractor's expense.

Coordination Requirements

All subcontractors shall distribute their 3D models in an electronic file to HMH "gatekeeper", which will perform clash detections among all subcontractors, and develop discrepancy reports. HMH requires that all 3D CAD formats to be distributed in a minimum of AutoCAD 2007 format.

The subcontractor shall participate in regular coordination meetings (with HMH and the other trades) to review conflicts and the discrepancy report, and to jointly develop conflict solutions. These meetings will be held weekly, or as needed, at the discretion of HMH. For these meetings, subcontractor shall provide personnel capable of addressing and resolving conflicts, and the cost/schedule implications they may have.

HMH may also provide a GoTo Meeting (internet based meeting) for those who cannot attend the Job Site Meeting. This will require a moderate internet connection and a phone line that is the responsibility by the subcontractor to furnish.

The subcontractor shall implement the solutions in a revised model and re-submit to HMH. HMH shall make the final determination as to whether a conflict or discrepancy has been sufficiently resolved and will update the clash report to reflect this. All updated 3D Modeled drawings shall be uploaded not later than 4 Hours prior to Coordination Meeting.

Subcontractor shall familiarize themselves with requirements of other subcontractors and coordinate their own work with others to provide the best possible combined installation.

Identify within your model any element such as anchors, embedment's, miscellaneous iron, supports, bracing, cast-in-place curbs, block-outs, etc., which are required for subcontractor's own work (even when others provide and install these elements.)

The model shall allow for printable shop drawings, including dimensions, elevations and location of specific trade elements, based off of the buildings grid and/or coordinates. The printed material shall comply with submittal requirements noted elsewhere in the subcontract.

Identify on shop drawings any elements of work, which will have to be left out until the final pieces of their work are installed or shall break down and reassemble their work as required or make other arrangements at their cost.

Submit final shop drawings reflecting the results of space coordination with other Subcontractors. Provide offsets as required to maintain required clearance, coordinate with the work of others and "make it work."

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Coordinate work with other trades to allow installation of all exposed work in coordinated symmetrical patterns, or to comply with Architectural reflected ceiling plans.

Software and Drawing Types

Due to BIM's evolution and its associated technology, HMH shall utilize interconnected models developed by each subcontractor, sub-tier subcontractor or specialty trade (subcontractor) whereby subcontractors shall utilize software compatible with Autodesk NavisWorks Manage 2010.

All subcontractors shall develop, modify and maintain their own models, which shall include, but not be limited to, plans, elevations, details, shop drawings or other related documents, incorporating any revisions, addendums, bulletins or other project modifications along with any other project related information, in real world coordinates and with true dimensions.

If HMH's official software version is older than the release currently available, subcontractors may convert to the newer released version, provided it maintains compatibility with HMH's chosen version. It shall be the responsibility of the subcontractor to maintain this compatibility. HMH is current with AutoDESK AutoCAD and Revit 2010 and ArchiCAD 12.

All models submitted to HMH shall conform and adhere to these standards throughout the duration of the project.

General Guidelines

The Basics

Since this guideline is not intended to be an instruction manual for developing models, or to be a complete guideline for the preparation of construction documents, it will assume that the subcontractor has a working knowledge of both. It is the subcontractor's responsibility to prepare their model(s) in a professional manner that meets the basic requirements typical of the architectural and construction professions including:

- Providing all the information, this is necessary to complete their project assignment.
- Using appropriate and distinct line weights so drawings are easier to read.
- Insuring that no duplicated entities such as blocks and/or lines overlap each other.
- Maintaining accuracy and precision throughout their models.

Drawing Submittals

Paper documents will serve as the primary vehicle for code, regulatory review and architectural review. In the event of a conflict, 2 dimensional drawings, and other printable documents shall prevail over the modeling information, and the model shall be corrected to meet the primary documentation.

Proper transmittal notice of modification to the modeling tracking and control of information shall be required, including file name, file size and time date stamp for each file submitted. Models shall be transmitted via the "Electronic File Transfer Transmittal", see attached.

Model Preservation

The subcontractor shall be responsible to preserve (save) their model per the defined milestones listed in the project schedule. Model preservation shall include "snapshots" of the model for legal and historical

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values (bid, negotiations, contract and others) and shall be transmitted via the “Electronic File Transfer Transmittal”, see attached. Model preservation shall be backed-up and maintained with off-site storage for critical models.

Insurance

Subcontractors shall provide and maintain insurance, which shall cover economic losses for all parties due to loss or damage to the model. Refer to Attachment “A” for Insurance coverage’s.

Model Ownership

The model ownership shall become the property of HMH and transmitted along with the “as-built” drawings upon completion of the project.

Protection of Intellectual Property or Proprietary Information

Subcontractors who provide intellectual property and/or proprietary information which is incorporated into their models shall provide notification of the confidentiality of the information.

Consequential Damages

Subcontractors will be required to sign an agreement appropriately limiting or waiving consequential damages due to errors in their model. This is a precondition to model access.

Gatekeeper

HMH shall be the responsible party for administrating the integrated model, providing technical resources which may be required to enable connectivity, host files, manage access, and assure security. HMH shall NOT maintain insurance for loss or damage to the model. HMH will facilitate a FTP Site “ShareFile” where all electronic files will be managed and shared. See attached ShareFile expository.

HMH’s Virtual Design & Construction Engineer or Coordinator shall be the “Gatekeeper” who controls and incorporates what information is permitted into the project model. Integration shall be purely technical.

The Project Superintendent shall determine how conflicting information shall be reconciled. Trade coordination and model modification shall remain the responsibility of each subcontractor or other design professional.

Partial Model Approval

Due to varying project conditions, partial model approval may be required. The HMH project team, along with the individual subcontractor shall mutually agree to approve elements, or partial models within the greater model to allow other trades to continue with development of their models. In the event a partial model is approved, modifications shall be tracked and submitted to the gatekeeper prior to incorporation into the updated model.

Drawing Orientation and Location Break Down Schedule

The drawing orientation will be established in the intersection of the lower left corner of the column grids will be at world coordinate (0,0,0) at intersection (A and 6). HMH will be facilitating multiple LBS for

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Coordination. Each LBS shall be under a separate CAD Drawing utilizing the same (0,0,0). LBS TBD. Please note that there can be multiple LBS for each floor. See project schedule.

Dimensions

All models shall maintain “live dimensions.” Any forms of exploded or overridden dimensions are not acceptable unless specifically dictated by construction document style such as “5 EQ. SPACES @ 24” O.C.”.

Layers

HMH leaves the CAD Layering identifications up to the subcontractor. It is the subcontractors’ responsibility to maintain consistent layers. HMH is not responsible if 3D Objects are on the wrong layers and was missed in the NavisWorks Clash Detection. All subcontractors’ layer conventions must be submitted to HMH prior to modeling.

Drawing Title Blocks

For all drawings, consultants shall use appropriate standard title block. Subcontractors shall include their company name and may include their logo within the drawing sheet title block in the space provided. Sheet title blocks shall not contain fonts other than those indicated above.

Record Drawing Set and Project Closeout Procedures

In addition to 2D traditional record set drawings, the subcontractor is required to provide record set drawings in a 3D model format. At HMH Builder’s discretion, this requirement may be waived and record set submittal limited to 2D drawings only.

The following section describes in more detail the closeout procedure for a project as it relates to these CAD documents and their use as record documents for the completed project.

What the Record Set Is

The record set is defined as the final working drawings and documents reflecting the finished project as constructed and/or renovated. These documents include all updated plans, elevations, details, shop drawings, revisions, addendums, bulletins and schedules from all subcontractors.

All conditions depicted in revisions, addendums and bulletins, including manually drafted drawings, shall be incorporated electronically into the final model so that each model accurately depicts all corresponding project conditions at the time of completion.

The record set includes a reproducible hard copy of the model renderings, drawings and documents mentioned above, and their corresponding electronic files. In addition, any number of blueprint copies may be required.

When the Record Set is Submitted to HMH

The record set shall be submitted to HMH within thirty (30) days after the project completion. Project completion will be defined and determined per project by the Project Manager.

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Multiple phase projects will generally require a record set for each completed phase and a cumulative record set of the entire project with all phases completed. Specific details concerning multiple phase projects will be determined per project by the Project Manager.

To Whom the Record Set will be Sent

The record set (hard copies and electronic files) should be sent directly to HMH's Project Manager.

What Transfer Media is Acceptable

See "File Transfer" below for acceptable transfer media.

Please Note the Following Information about the Submittal and Approval of Record Sets

Documents must reflect all changes due to change orders, design revisions, scope, field conditions, etc. These changes must be reflected electronically on the final record set. NO manual drafting is accepted.

HMH may require the record set to be resubmitted if it does not accurately reflect project conditions at the time of completion.

The record set should maintain all parameters and requirements set forth by the HMH Guidelines. If the model is not in compliance, the subcontractor may be required to correct the files and resubmit the model.

File Transfer

Models shall be transmitted via a "Electronic File Transfer Transmittal," see attached.

Drawing Preparation

Before uploading electronic files to HMH FTP Site, subcontractors are required to perform the following tasks.

Purge all unused blocks

Purge all unused layers

Include the Xref files if used (do NOT bind the drawings)(SUBMITTAL DRAWINGS ONLY)

Zoom out to the drawing extents

DO NOT INCLUDE XREFS IN 3D MODELING. NO XREFS SHALL BE USED.

Use the "HMH Electronic Files Transmittal and Check list" provided with this standard and include it in the package or fax it to the Project Manager.

Media Disks

If the modeling files must be sent by disk, acceptable formats are as follows (provide adequate protection to avoid any damage during shipping. CD-ROM

Electronic Transfer

The drawing files can be transferred on HMH FTP Site "ShareFile". Please see attached ShareFile expository.

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Drawing Setup

File Naming Convention for Models are:

JOB_Company_Discipline_Floor_Area_date

Example: Dameron_HMH_S_3F_A_100211.dwg

Dameron Hospital_Harbison Mahony Higgins_Structural_3rd Floor_Area A_2010, February 11th

(Note that in NavisWorks, the date _090306 would be stripped off to ensure consistency of the NavisWorks collision log) (a 3D solid object date stamp shall be placed at the 0,0,0 reference point) Any same file that is uploaded in the same day, please add “R1” at the end of file. R represents revisions 1, 2 etc.

Name Prefix and Suffix

All subcontractors shall follow the file-naming prefix (discipline code) per their disciplines:

Building	A -Architectural / W-Walls / C-Ceilings / SF-Soffit Framing
Structural Steel	S
Electrical	E
Low Voltage	LV
Mech. HVAC	M
Waste and Vent	WV
Domestic Water	DW
Rain Water Leader and Overflow	RW
Med Gas	MG
Chilled Water	CW
Mech. Pipe (hydronics)	HHW
Fire Protection	FP
Structural Concrete	SC
Pneumatic Tube	PT
Miscellaneous Steel Supports	MS

Drawing Layer Descriptions

Each subcontractor shall be responsible for creating 3D systems and objects with smart layering capabilities. Each system and object shall be easily identified by the layer name. HMH understands that most 3D software programs already have unique layering systems that can or can not be manipulated. Each Subcontractor shall submit a layering spreadsheet to HMH for reference.

System Color Identification

Each subcontractor will be required to have a unique color for each system type, and be submitted to the Coordination Team for reference.