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**FACILITIES CONSTRUCTION, ENGINEERING AND TECHNICAL SERVICES
(FaCETS)**

ATTACHMENT NO. 4

FMD CADD MANUAL

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2010

FMD CADD Manual 2010 Edition

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Chapter 1: Introduction

Acronyms

FaCETS - Facilities Construction Engineering and Technical Services
FMD – Facilities Management Division
GSFC – Goddard Space Flight Center
SRD – Standard Reference Document
SDSFIE – Spatial Data Standards for Facilities Infrastructure and Environment

Purpose

For this update of the GSFC FMD CADD manual FMD will follow the A/E/C CADD Standard 4.0 as published by the U.S. Army Engineer Research and Development Center, and Autodesk 2010 products (AutoCAD MEP and AutoCAD Architecture). These standards are based on the AIA layering guidelines with Autodesk embedding AIA Version 3 in its products.

Scope of Manual

The Computer-Aided Drafting and Design (CADD) Manual provides instructions covering CADD requirements for the Goddard Space Flight Center/Facilities Management Division's (GSFC/FMD) CADD system. All drawings produced for FMD shall follow the specifications in this manual. This document is revised on an as needed basis. This version of the CADD manual supersedes the version dated February, 2007.

The CADD manual is a component of the Standard Reference Document (SRD) and the Facilities Construction Engineering and Technical Services (FaCETS) contract. The manual is maintained by the FaCETS CADD Resource Group (in conjunction with the Government Technical Policy Group). The CADD manual provides specific guidance for all designers and engineers preparing CADD drawings. All users are encouraged to provide feedback and suggestions concerning these specifications to the CADD Resource Group.

The GSFC FMD CADD manual provides instructions covering CADD requirements for the GSFC/FMD's CADD system. The GSFC FMD CADD Standards manual is intended to augment the A/E/C CADD Standard 4.0 for FMD Specific requirements.

Background

NASA GSFC FMD has previously maintained detailed standards specific to FMD's needs and requirements. With the large volume of interaction required to communicate through CADD systems it was deemed more appropriate to adhere to an established standard. The A/E/C CADD Standard 4.0 was chosen because of its unlimited distribution, development specific to federal facilities, and it is based on well defined and accepted standards.

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Structure of the Manual

The main body of the CADD manual consists of specifications that apply regardless of where drawings are developed. In addition to the main body of the CADD manual, there are four Appendices. Appendix A applies only to drawings produced OFFSITE, and Appendices B, C, and D apply to those drawings produced ONSITE.

- Chapter 1 Provides an introduction to the CADD manual.
- Chapter 2 Specifies the software required to develop and transmit drawings.
- Chapters 3-7 Specifies the general requirements to develop and as-build project drawings.
- Appendix A Addresses topics that pertain specifically to OFFSITE A-E's.
- Appendix B Addresses topics that pertain specifically to ONSITE A-E's.
- Appendix C Addresses topics that pertain to the CADD Resource Group As-building responsibilities for models and controlled schematics.
- Appendix D Provides recommendations for efficient use of AutoCAD.

OFFSITE Architects-Engineers (A-E's) are provided a version of the manual that includes all chapters up through and including Appendix A.

ONSITE A-E's have access to all chapters and Appendices.

Units of Measure

All work shall be in the United States Customary System (USCS–Imperial) with building models completed in units inches, and Site work completed in units feet.

As-Built Models and Schematics

All building model drawings are in inches; all site model drawings are in feet. Any residual Metric information is for reference only, and will be replaced with Imperial information as need requires. The exception is UCS control sequences. UCS control sequences are depicted using dual units (i.e., SI first, followed by Imperial in parenthesis) in order to simplify future conversion efforts. These drawings are only in the Control series (86000-88999).

New Project Drawings

All work shall be in the United States Customary System (USCS–Imperial) with the exception of UCS control sequences. UCS control sequences are depicted using dual units (i.e., SI first, followed by Imperial in parenthesis) in order to simplify future conversion efforts.

Old Project Drawings

Old projects exist as a mixture of SI and Imperial (mostly Imperial).

Future Technologies

NASA GSFC FMD concurs with the direction established within the AEC CADD Standard.

Chapter 2: Software Specifications

Project drawings shall be completed using the following applications unless directed otherwise by the PM

- AutoCAD Architecture 2010
- AutoCAD MEP 2010
- AutoCAD Civil 3D 2010
- AutoCAD Revit Architecture 2010 (Only with PM prior approval)
- AutoCAD Revit MEP 2010 (Only with PM prior approval)
- AutoCAD Revit Structure 2010 (Only with PM prior approval)
- Industry Foundation Class (IFC) compliant database
- AutoCAD 2010 can be accepted at the discretion of the PM.
- ESRI Spatial Data Standards for Facilities Infrastructure and Environment (SDSFIE) Compliant Personal Geodatabase.

Electronic construction and As-built document submissions are to be created using AutoCAD Architecture 2010 or AutoCAD MEP 2010. All symbols and blocks must come from AutoCAD Architecture 2010 or AutoCAD MEP 2010, or from the provided Legend sheets, unless otherwise noted. All symbols and blocks are to match FMD standards.

Chapter 3: DATA Transmittal Methods

Transmittals shall be created using Autodesk's eTransmit command. When created as a project the entire project should be part of the eTransmit. All associated plot style tables, plotter configuration files, and External References shall be included in the transmittal. Project data is to be transferred in a secure fashion using one of the following methods as determined by the PM. All Building Utility data and Site Utility data is to be considered Sensitive But Unclassified (SBU) and should be handled in accordance with NPR 1600.1

- Secure FTP data transfer
- CD/DVD Media

Chapter 4: Presentation Graphics

The presentation graphics defined in the AEC CADD Standard will be used in its entirety. The Line attributes have been included in the AIA Standard.ctb file provided by Autodesk.

Line Widths

FMD will utilize these as integrated into the AutoCAD MEP and AutoCAD Architectural applications.

Line types/styles

FMD will utilize the line types/styles integrated into the AutoCAD MEP and AutoCAD Architectural applications.

Line color

FMD will utilize the line color integrated into the AutoCAD MEP and AutoCAD Architectural applications.

Screening

The Screening attributes have been included in the AIA Standard.ctb file provided by Autodesk.

Plotting

Plotting will be completed using the AIA Standard.ctb file supplied by Autodesk.

Chapter 5: Project Drawing Development

Project Categories and Numbers

Projects fall primarily into two categories, a Headquarters (HQ/JX) funded Construction of Facilities (CoF) program, and a non-HQ funded Center Program (WR). Projects must have a project number assigned prior to the generation of any electronic CADD files. The designer must know the project number when developing a project because the project number is used in the naming of models and printable drawing files.

Project Category	Project Number	Example
WR	Work Request	A2498, 9683
CoF	Project Code	91GCAZ, 03GTBZ

Figure 1 Project Categories, Project Numbers, and Examples

Chapter 6: Utilizing the AutoCAD MEP Project Setup

All Design packages are to be created using Autodesk's Project Browser to create a new Project. FMD Utilizes a Prototype Project that can be made available to external AEs.

Create the Project Folder

All projects shall reside at Q:\CADD_ACTIVE\WR\... If your project directory has not already been defined, create a directory in Q:\CADD_ACTIVE\WR\...

Use your window navigator tool to create the directory.

Start the Project Browser

The **Project Browser...** is accessed from the **Quick Access Ribbon** toolbar.



Figure 2 Navigation Bar

Select the **Project Browser...** icon.



Figure 3 Project Browser Icon

Create the Project

In the **Project Browser...** navigate to **Q:\CADD\ACTIVE\WR\A#####** (A##### is your work request number)

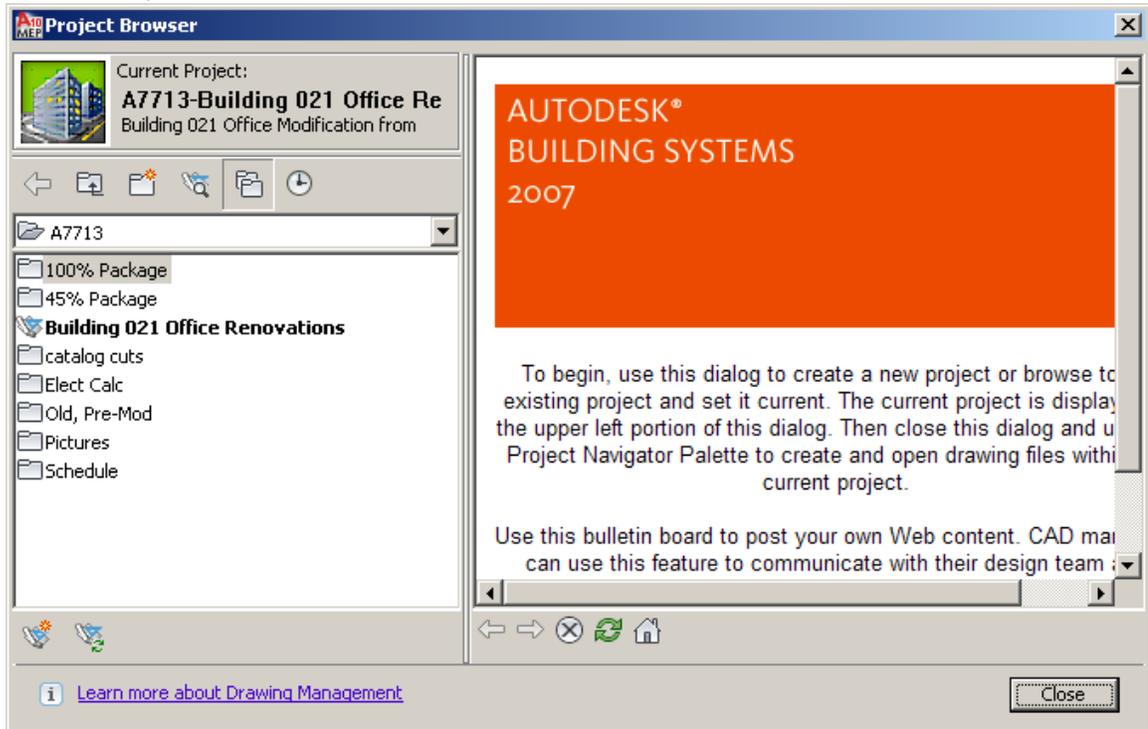


Figure 4 Project Browser

Select the **New Project** icon.



Figure 5 New Project Icon

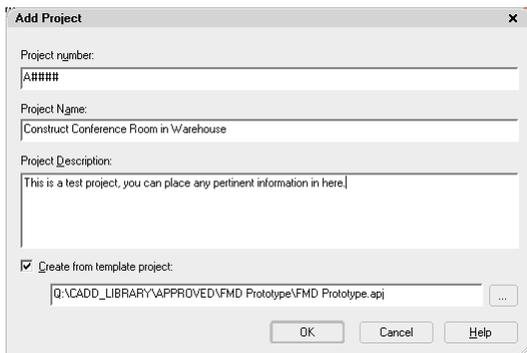


Figure 6 Add Project Dialog box

Enter your Project number, Project Name (This will be inserted into ALL title blocks), and a Project Description (This can be a cut and paste from the Work Request System)

Be sure to check the **Create from template** checkbox and define **Q:\CADD_LIBRARY\APPROVED\FMD Prototype\FMD Prototype.apj** as the template project.

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Once this is done, it will remain the template for future projects unless the application is reinstalled.

Select **OK**.

Once the project has completed setup, the **Project Browser** screen is displayed again. The current project is shown **Bold**.

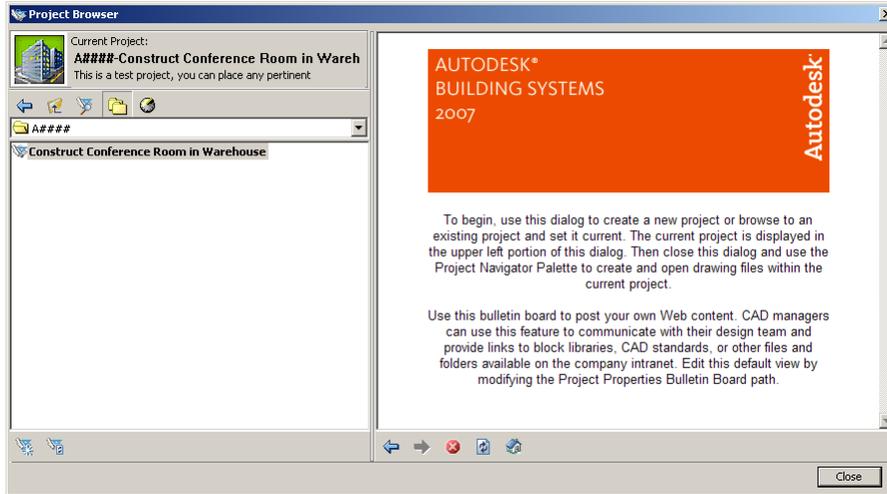


Figure 7 Project Browser

Select **Close**.

Add / Modify Project Data

One way to access and modify project data Project Data is by selecting the Sheets tab and selecting Properties in the Project Navigator. The **Sheet Set Properties** window will open.

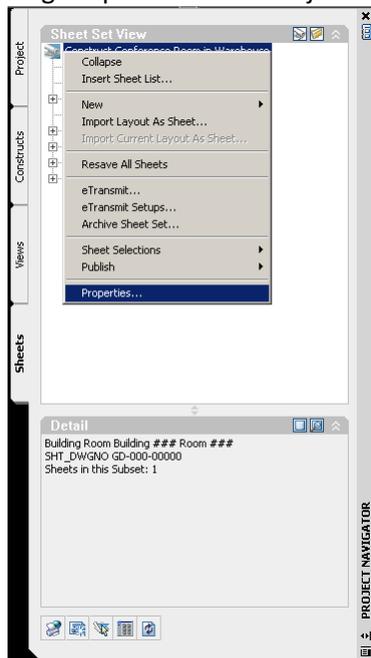


Figure 8 Project Navigator

Sheet Set Properties

You will enter data pertinent to ALL sheets in the project here.

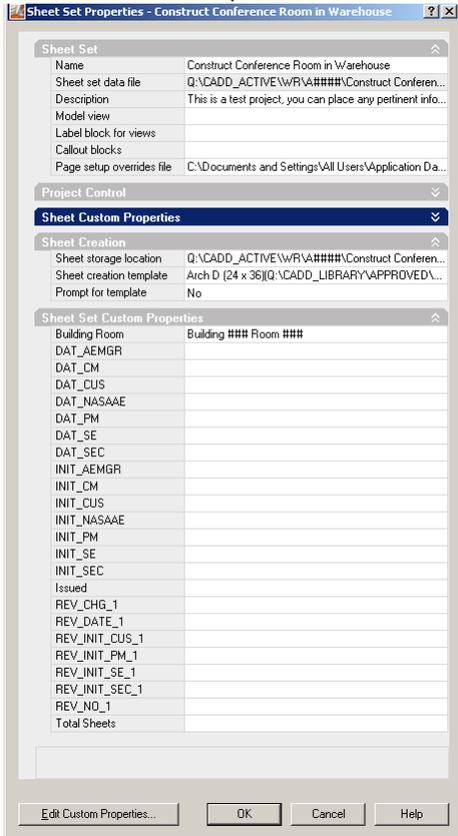


Figure 9 Sheet Set Properties dialog box

Creating Constructs

Constructs shall be named in accordance with the A/E/C CADD Standard 4.0 section 2, Electronic Drawing File Naming conventions, Model file Naming convention.

Every building project must have an Architectural construct, whether there is Architectural work involved or not. The Architectural model is externally referenced into all other discipline base building models.

Every site project must have a civil construct. The Civil construct is externally referenced into all other discipline base site models, if they exist (it is recommended that all site work be shown in the Civil construct, regardless of discipline).

All constructs must be externally referenced (XREF) at 0,0,0 to maintain orientation with the As-built database. This is accomplished via drag and drop of the constructs. All model drawings must be externally referenced in Tilemode 1, model space.

The Mechanical Engineer externally references (XREFs) the architectural construct into the mechanical construct. The Electrical Engineer XREFs the architectural construct

into the electrical construct. The Civil construct is externally referenced into all other discipline specific site base constructs.

Items located in model space in the model should include:

- Annotation related to sizes of devices, wiring, piping, duct work and other similar information
- Externally referenced (XREF'ed) design constructs pertinent to the project
- Information needed for construction and call-outs that point to specific items on construct drawings that must not be affected by moving the viewport
- Note tags (i.e., callouts)
- Point of connect/disconnect symbols

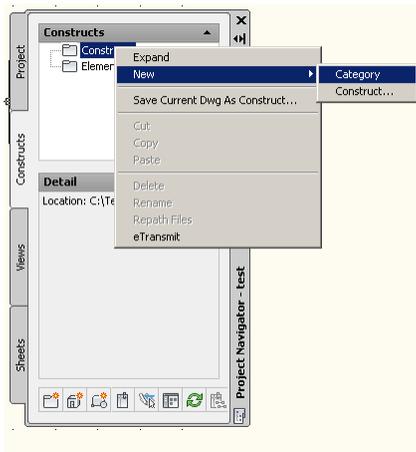


Figure 10 New Construct dialog box

Creating Sheets

Sheets shall be named in accordance with the A/E/C CADD Standard 4.0 section 2, Electronic Drawing File Naming conventions, Sheet file naming convention.

All Sheets shall be created within the Project manager. The default sheets size is D-size (24x36). All details, schedules, notes, and information pertaining to project specific construction should be located in the “Sheets” drawings. Do not place any of the specific construction instructions in the model. This list is not all-inclusive, it is meant to be more of a general placement guide for information (i.e., either paper space or model space).

Items located in layout tabs should include:

- Abbreviation list
- General annotation (i.e., notes)
- Information needed for construction that is not affected by moving the viewport
- Schedules
- Symbol—Material list
- Titles

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 SEAL AREA										
	REV	DATE	DESCRIPTION	S&E BR.	CUSTOMER	PM	SECT.HEAD			
	DRAWN	INITIALS	DATE	FMD PROTOTYPE COVER SHEET			G001			
	A-E			BUILDING ### ROOM ###						
	CHECKED BY			NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MARYLAND FACILITIES MANAGEMENT DIVISION						
	A-E MANAGER									
	NASA A-E									
	S&E BRANCH									
	CM									
	PM									
CUSTOMER										
SECTION HEAD										
GENERAL			DATE ISSUED	CoF CODE or WR#	SHEET	DRAWING NO.				
			↓	A0000	--- OF ---	GD-000-00000				

FORM D 10-11-07

Figure 11 Title Block

Signatures and Stamp

For ONSITE A-E, refer to the FaCETS contract for Seal requirements.
 For OFFSITE A-E, final drawings shall always be stamped.

Printable Drawing Sheet Numbering

The PM is responsible for reserving all sequential numbers necessary for all project drawings prior to the 90 percent submission printing.
 For OFFSITE A-E's, the sequential numbers shall be provided by the NASA PM prior to the 90 percent submission.

As-Built Project Drawing Development: as-Building

Upon construction completion, after construction contractor redlines have been received and approved as complete and correct, the project drawings are updated by the A-E with this information. The As-built project drawings are updated using layers as previously described in Chapter 7 (generally using the -N and -D layers. The -C layer is used only to correct the background information discovered to be incorrect either during the design or the construction).

OFFSITE A-E's shall return the contractor redlines and the final As-Built to the PM.
 ONSITE A-E's shall follow the requirements in Appendix B.

After the project drawings are updated and approved, the PM posts the drawings in the appropriate directory, and notifies the CADD Resource Group that the As-built drawings are ready for incorporation into the FMD As-built directories.

Sheet Properties

To access and modify sheet data select the **Sheets** tab and select the sheet that you wish to modify with the right mouse button, and then select **Properties**.

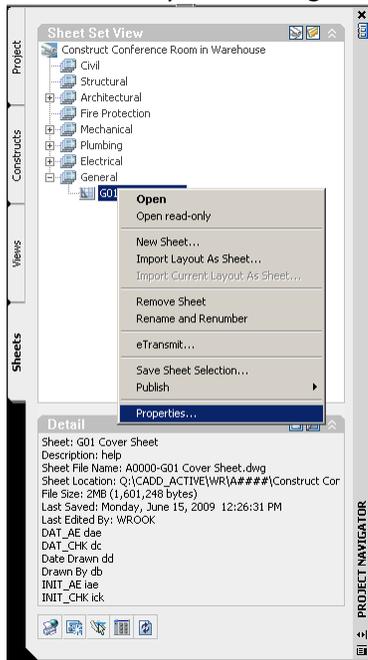


Figure 12 Sheet Properties dialog box

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The **Sheet Properties** window will open.

You will enter data pertinent to INDIVIDUAL sheets here.

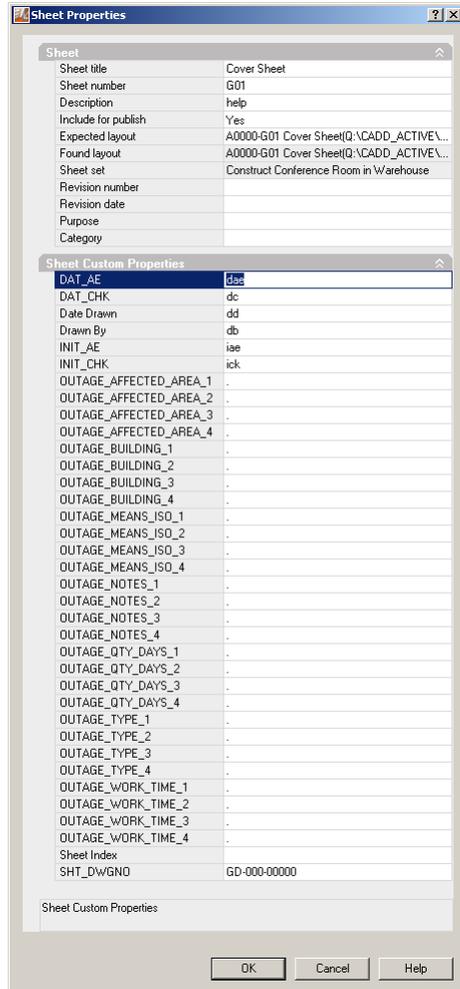


Figure 13 Sheet Properties dialog box

Chapter 7: Layering Conventions

FMD Layering Conventions

The layers that are in active use at GSFC integrated into the applications. FMD utilizes several layering standards, as shown below:

- For Buildings, FMD uses AEC CADD Standard version 3 that is imbedded in AutoCAD MAP and AutoCAD Architecture.

- For Site, FMD complies with the SDSFI Standards.

If there is a need for a layer that is not in the AEC CADD Standard version 3:

- For Buildings use the AEC CADD Standard version 3 AIA layering conventions to determine the necessary layer specifications. Follow the AEC CADD Standard version 3 AIA layering standards to create the correct modification of the new layer's name.

- For Site, consult with the FaCETS Site Team Lead, in conjunction with the Government Technical Policy Group. All new layers created must be routed through the NASA FMD Information Resources Manager. The CADD Resource Group will review the layer with the Government Technical Policy Group.

Suffixes for Layering Conventions

The use of the suffixes in layer names allows the FMD CADD Resource Group to extract only modified information from project drawings for incorporation into As-built models. Suffixes allow changes indicated by designers to be accurately identified and reincorporated in the As-built and As-designed drawings.

Existing

Existing conditions that are not Corrections, Demolition, or New Work. Existing conditions utilize the root layer with no suffix.

Demolition

Demolition utilizes the appropriate root layer with a “-D” suffix. A-E’s will specify this as DEMO (cut from EXISTING).

New Work

New Work utilizes the appropriate root layer with a “-N” suffix. A-E’s will specify this as NEW work (added to EXISTING).

Corrections

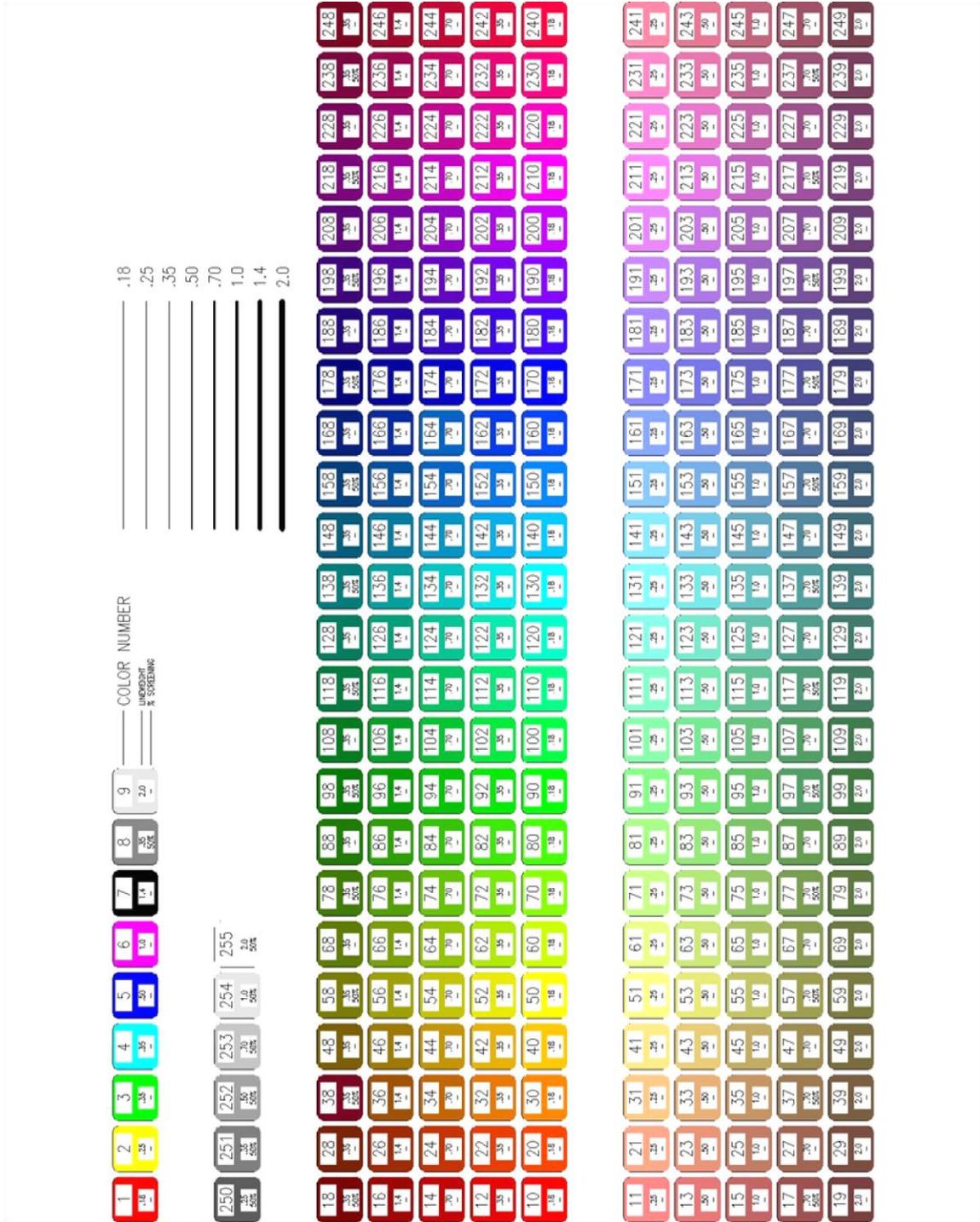
Corrections utilizes the appropriate root layer with a “-C” suffix.

This will be corrected information per A-E field verification.

Color and Pen Weight

FMD Utilizes the AIA Standard.ctb as provided by Autodesk. Any color choices that need to be made concerning

Graphic Representation of Pen Assignments



Plot Configuration

Pen width

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Pen Color	Line Width	Typical Use
Fine	.18 mm	Patterning
Thin	.25 mm	Dimension Lines, dimension leader/witness lines, note leader lines, long break lines, schedule grid lines, and objects at a distance
Medium	.35 mm	Minor object lines
Wide	.50 mm	Major Object lines, cut lines, section cutting plane lines, and titles.
Extra Wide	.70 mm	Minor title underlining, match lines, schedule outlines, large titles, and object lines requiring special emphasis
XX Wide	1.00 mm	Major title underlining and separating portions of the drawing.
XXX Wide	1.40 mm	Border sheet outlines and cover sheet line work
XXX Wide	2.00 mm	Border sheet outlines and cover sheet line work

Figure 14 Pen Weight assignments

Indicating Space (Room) Numbers

The CADD Resource Group works with other members of the IRM team, who enter data in a temporary holding file for use in updating the LISTS/BRS database when the space numbers actually appear during the As-built entry stage.

FMD Standard drawing Sheet Layout

All standard project drawings are required to contain elements that are located in specific places on the drawing. When creating a new drawing, follow the example in the succeeding figure.

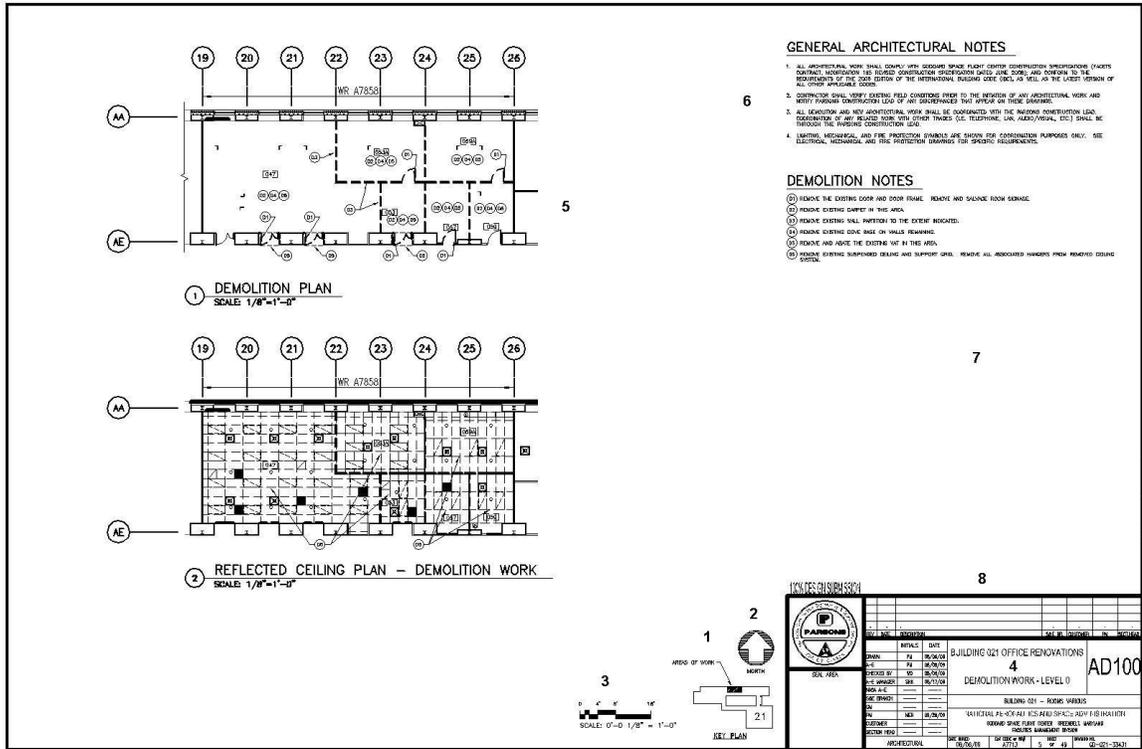


Figure 15 Standard Drawing Sheet Layout

1. Key Plan - The Project Architect for each project is generally responsible for the key plan and indication of the work area using the AutoCAD BHATCH command. If the project does not call for architectural work, the project Lead is responsible for the key plan and crosshatching the work area. The key plan is an AutoCAD WBLOCK that is copied into the project as a construct. Name the construct KEYPLAN. All drawings must include the key plan. This adds consistency to the project. It is the project Architect/Lead's responsibility to construct new/updated key plans as designs are implemented. The new/updated files are to be provided to the CADD Resource Group for updating.
2. North Arrow - The key plan includes a standard north arrow, as depicted in the succeeding figure. The north arrow is assumed PLAN north unless otherwise specified. The PLAN north should always be shown either pointing up or pointing to the left in the drawing. A true north arrow can also be included in the drawing if it is needed. Use the same style arrow that is used to indicate the PLAN north with TRUE NORTH annotated below the arrow.

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3. Graphic Scales - All drawings are to include a graphic scale (Bar scale) to indicate the scale used in the drawing.
4. Drawing Titles - Insert drawing titles in Paper Space. Left justify titles under the plan, detail, etc., that they are describing. The standard title layout will utilize AutoCAD MEP's Title Mark. The Autodesk program controls all of the fonts, heights, and widths.
5. Viewport - All model work is done in the constructs and referenced into the drawing through a viewport.
6. Drawing Notes - Use the same text, font style and underline for the note title as is used for the drawing titles, with the exception of the bubble. Notes should be plotted at pen weight 2, and titles should be at pen weight 1. A drawing with more than one discipline should arrange the notes by discipline, with separate titles for each group.
7. Schedules - Use the same text, font style and underline for the schedule as used for the drawing notes. The schedule is located below the notes.
8. Scope of Work - Use the same text, font style and underline for the Scope of Work as used for the drawing notes. The Scope of Work is located above the title block.

Drawing Titles

Insert drawing titles in Paper Space. Left justify titles under the plan, detail, etc., that they are describing. All titles are plotted at pen weight 2. The standard title layout will utilize Autodesk's AEC, ANNOTATION, TITLE MARKS command. The Autodesk program controls all of the fonts, heights, and widths.

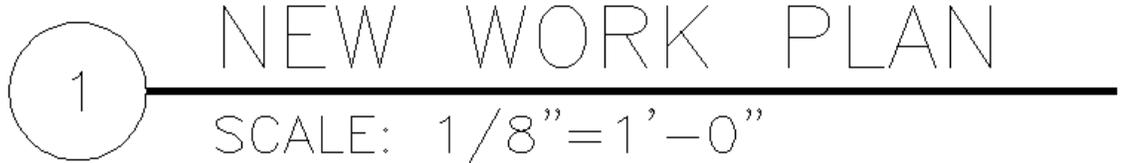


Figure 16 Typical Drawing Title with Bubble

Drawing Notes

Use the same text, font style and underline for the note title as is used for the drawing titles, with the exception of the bubble. Notes should be plotted at pen weight 2, and titles should be at pen weight 1.

A drawing with more than one discipline should arrange the notes by discipline, with separate titles for each group.

CONSTRUCTION NOTES

- 1A) PROVIDE NEW WALL PARTITION. NEW WALL PARTITION SHALL EXTEND FROM THE TOP OF THE FINISHED FLOOR ELEVATION TO A HEIGHT OF 9'-4".
- 1B) PROVIDE NEW WALL PARTITION. NEW WALL PARTITION SHALL EXTEND FROM THE TOP OF THE FINISHED FLOOR ELEVATION TO THE UNDERSIDE OF THE NEW SUSPENDED CEILING, A HEIGHT OF 8'-8".
- 2) PROVIDE A NEW DOOR AND DOOR FRAME IN THIS LOCATION. PREPARE AND PAINT NEW DOOR AND DOOR FRAME. INSTALL SALVAGED ROOM IDENTIFICATION SIGNAGE AT THIS DOOR LOCATION. SIGNAGE FRAME SHALL BE MOUNTED 2" FROM THE DOOR FRAME, ON THE STRIKE SIDE, AT 66" TO THE TOP OF THE SIGN FRAME. REUSE SALVAGED ROOM NUMBER INSERT WHERE APPLICABLE OR PROVIDE NEW ROOM NUMBER INSERT IF ROOM NUMBER DID NOT PREVIOUSLY EXIST.
- 3) PREPARE AND PAINT THIS DOOR AND DOOR FRAME. PROVIDE NEW ROOM NUMBER SIGNAGE INSERT WHERE APPLICABLE IF ROOM NUMBER DID NOT PREVIOUSLY EXIST. REMOVE ALL OTHER OUTDATED SIGNAGE INSERTS IN FRAME.
- 4) PATCH AND REPAIR ALL OPEN WALL PENETRATIONS LEFT FROM REMOVED ITEMS. PREPARE AND PAINT ALL WALLS IN THIS AREA. PROVIDE NEW FLOOR COVERING PER THE FINISH SCHEDULE AND 4" VINYL COVE BASE IN THE AREA.
- 5) PROVIDE NEW SUSPENDED CEILING AND SUPPORT GRID. NEW SUSPENDED CEILING SHALL BE INSTALLED AT A HEIGHT OF 8'-8" ABOVE THE FINISH FLOOR ELEVATION.

Schedules (or other detailed information, if applicable)

Use AutoCAD's Schedules for room finish schedules.

The figure displays three detailed Room Finish Schedules for Level 0, Level 1, and Level 2. Each schedule is a large table with columns for Room No., Room Name, Area, and various finish specifications. The Level 2 schedule includes a title block at the bottom right with the following information:

		BUILDING OFFICE RENOVATIONS FINISH SCHEDULES A602
PROJECT NO. SHEET NO.	DATE DRAWN BY CHECKED BY APPROVED BY	BUILDING OFFICE RENOVATIONS FINISH SCHEDULES A602

Figure 17 Schedules

Scope of Work (if applicable)

Use the same text, font style and underline for the Scope of Work as used for the drawing notes. The Scope of Work is located above the title block.

SCOPE OF WORK

PROVIDE 6" EXHAUST DUCT CONNECTION BETWEEN CUSTOMER-SUPPLIED ELECTRO-POLISHING SYSTEM AND EXISTING 10" EXHAUST DUCT.

Figure 18 Scope of Work

Dimensioning

All dimensioning is done through the active model space viewport from paper space, TILEMODE (0). Click the Scale to Paper Space checkbox from the Geometry dialog box as accessed from the Dimension Style dialog box under the Format pull-down (Autodesk). This will enable Paper Space dimensioning which takes into account the viewport scale. Text height and font specifications are based on FMD standards as previously mentioned. Architectural Tick is the required dimension arrowhead, as depicted in the succeeding figure.

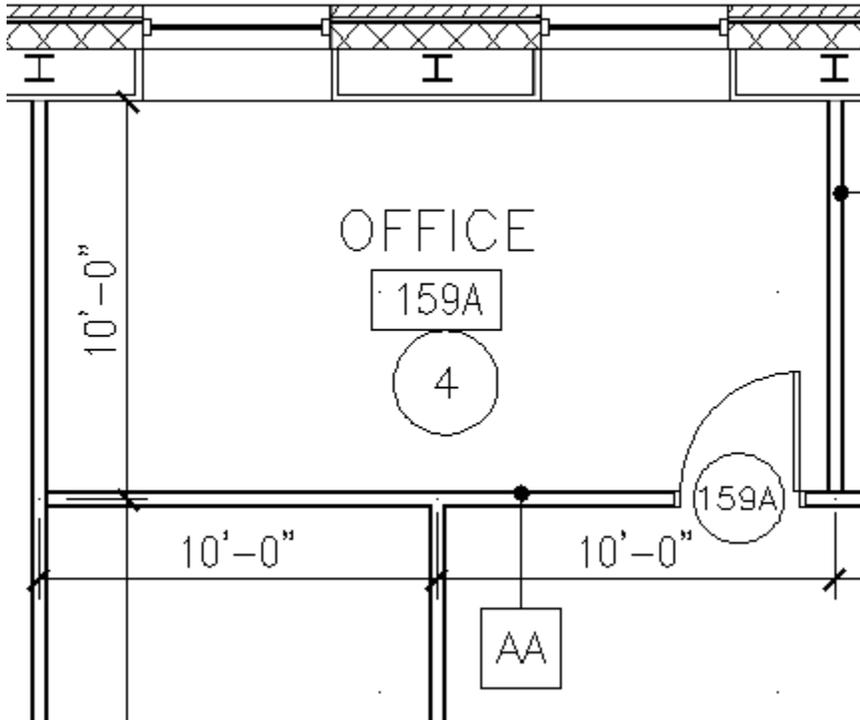


Figure 19 Typical Dimensioning representation

Leaders

Most of the leaders use arrows. Use loop leaders when designating pipe and wire sizes. Insert leaders in Model Space. See the examples in the succeeding figure.

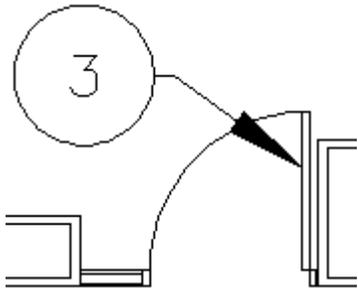


Figure 20 Typical Leader Representation

Symbols

Several basic identification symbols are used, as shown in the succeeding figure. Place all of these call-out symbols in model space.

General



Revisions



Notes

115

Room Numbers

Figure 21 Typical Callout Symbols

Discipline Specific Requirements

Abbreviation and Legend Sheets

The standard FMD Abbreviation and Legend sheets are template drawings utilizing Autodesk symbology and other non-Autodesk symbols, as indicated in the legend. All FMD standard symbols and attributes are to be adhered to. Use Autodesk symbology as designated on the Legend sheets. When non-Autodesk symbology is indicated on a Legend sheet, it will be necessary to copy the symbology for use within the project.

Standard Discipline Details

The individual engineering disciplines have developed certain standard details that meet the standards of FMD. Approved details are stored in an APPROVED folder. Review only the approved details to determine which may be appropriate for the project. When a detail exists, and it meets the requirements of the project, the standard detail should be utilized to the greatest extent possible. However, project requirements shall always govern. Adjust standard details to the project as necessary. The following is a list of available folders:

- ARCHITECTURAL
- Bar Scales—contains bar scales only, no discipline details
- CIVIL
- ELECTRICAL
- ENVIRONMENTAL AND HAZARDOUS—The environmental details were obtained from the Maryland Standards and Specifications for Soil Erosion and Sediment Control. The file name in the folder indicates the page number of the drawing in the Maryland book.
- FIRE PROTECTION
- KEYS—contains plan keys only, no discipline details
- LANDSCAPING

- MECHANICAL
- PLUMBING
- STRUCTURAL

Goddard Operation, Maintenance, and Repairs system (GOMARS)

The Goddard Operation Maintenance And Repair System (GOMARS) is used by the FMD to identify equipment and to track maintenance and repairs. The GOMARS numbers are used mainly on drawings (generally in plans and schedules) to identify equipment. The *gomars.xls* file provides designers with a guide indicating the type of equipment requiring GOMARS numbers, their various naming formats, and specific GOMARS processes to be followed. Unique equipment numbers (actual numbers to be placed on drawings) must be obtained from the Government’s Construction, Operations, and Maintenance Branch (COMB) during the design process.

Room Tags



Door Tags

Door tags contain attribute information – Door Identification, Size, Material, and Fire Rated (y/n). Layer – A-DOOR-IDEN. Requirements are as shown in the Architectural Legend:

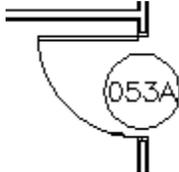


Figure 22 Door Tag Symbolology

Wall Tags

Interior wall tags contain attribute information – Material/Type, and Fire Rated (F). Layer – A-WALL-IDEN.

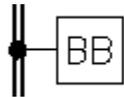


Figure 23 Wall Tag

Window Tags

Window tags display window and sill height. Layer – A-GLAZ-IDEN. Requirements are as shown in the Architectural Legend:

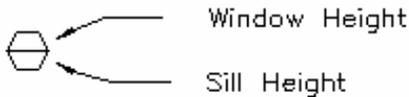


Figure 24 Window Tag

This symbol is not from the Autodesk Symbol Manager. It is a block with attributes that must be inserted into the drawing. This symbol (*winsymbol.dwg*) is located in the Architectural Legend.

Coordination with Site GIS As-Built Database

Designers must be acutely aware that upon completion of site projects (or projects with site work), that the project drawings are incorporated not only into CADD As-built databases, but also into a distinctly separate GIS database. Therefore it is critical to take into consideration what information is to be included in the design drawings along with inherent properties of the linework being created. The following guidelines are provided to facilitate the transition.

Attribute Data

The structure of the GIS database has vastly greater capabilities to record attribute data about system elements (i.e., pipes, valves, manholes, etc.) than does CADD capabilities. However, the format whereby GIS records information is a very precise set of attribute tables that have been defined in exact terms as to how and what information FMD wants to store for the various elements.

For information to be extracted from CADD project drawings to the GIS database involves intensive manual efforts broken down into two components: copy/paste efforts, and find/retype efforts. The copy/paste work generally is the transferring of spatial elements (points, lines, polygons) that represent valves, pipes, roads, etc. The find/retype work generally is the transferring of attribute data (invert elevations, top of pipe elevations, GOMARS numbers, valve type, size, etc) that are associated with the spatial data. It is the find/retype work that is most prone to being impeded during this process by CADD project drawings that are 1) incomplete, 2) difficult to interpret or extract information from, and 3) use of attribute data that is contrary to the GIS requirements. Each of these contrary practices is discussed below. Attribute tables vary in size according to the type of spatial element under consideration. For discussion purposes, a sample system element has been arbitrarily chosen to illustrate the intended points.

Sample: The Chilled Water System, Well element, has 12 engineering specific attribute data fields capable of recording the following data:

- Pump inlet elevation, m
- Pump top elevation, m
- Pump GOMARS
- Screening top elevation, m
- Screening bottom elevation, m
- Cover/casing outer diameter, mm
- Casing top elevation, m
- Top of water elevation in well, m
- Depth of well, m
- Size, mm
- Type (for this particular element, only one Type—"non-potable" has been defined by FMD) · GOMARS

Spatial Data

All utility linework shall be contiguous lines or polylines with all ends or changes in directions placed at the correct coordinates and elevations using the system specific definition (ex: Top of pipe, Bottom of pipe, etc) as defined in the GIS Data Dictionary. All linework endpoints shall have the correct coordinates and elevations along with the specific data associated with each endpoint.

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Utility lines can consist of lines and arcs as segments or polylines. Continuous runs shall be indicated with a single line or polyline segment. Changes in elevation or direction are acceptable endpoints for line segments with the correct coordinates and elevations.

There shall be no gaps between line segments for an individual utility run. The coordinates for the endpoint of a line segment shall be the exact coordinates for the starting point of the subsequent line segment.

Assembling the Printable Drawing Construction Package

Drawing Set Organization

The FMD generally follows the Construction Specification Institute (CSI) and the Uniform Drawing System (UDS) drawing set organization standards with the exception of the ones not used by FMD as indicated in the succeeding figure. CSI-UDS standards cited here are for reference. Organize drawing sets accordingly.

Subsets

FMD does not follow CSI-UDS using the Level 2 designators for sheet content as described in their standards. Discipline subsets are packaged in the order shown in the succeeding figure:

CSI-UDS Level 1 Designator	Column1	FMD Comment
G	General	Cover and Abbreviation sheets
H	Hazardous Materials	Also includes Environmental sheets
V	Survey/Mapping	Not Used by FMD
B	Geotechnical	Not Used by FMD
C	Civil	Should include all discipline Site utilities
L	Landscaping	
S	Structural	
A	Architectural	
I	Interior	Not Used by FMD
Q	Equipment	
F	Fire Protection	
P	Plumbing	
D	Process	Not Used by FMD
M	Mechanical	
E	Electrical	
T	Telecommunications	Not Used by FMD
R	Resource	Not Used by FMD
X	Other Disciplines	Not Used by FMD
Z	Contractor Shop Drawings	Not Used by FMD
O	Operations	Not Used by FMD

Figure 25 UDS Organizational Categories

Content

Content order within each subset will be as shown in the succeeding figure:

Column1	CSI-UJS Requirement	FMD Comment
0	General	Legend sheet
1	Plans	For all disciplines excluding Mechanical, the generic CSI-UJS order is to be followed. The FMD Mechanical discipline has determined the order of content to a much greater level of detail for the subsets of Fire Protection, Plumbing, and Mechanical. That greater detail
2	Elevations	
3	Sections	
4	Large Scale Views	
5	Details	
6	Schedules and Diagrams	
7	User Defined	
8	User Defined	
9	3d Representations	

Figure 26 Subset content Order

Additional requirements for all disciplines include the following:

- Discipline Legend sheet should be the first drawing within the individual discipline subsets
- Demolition drawings should precede new work
- When architectural plan areas are segmented within levels (in order to fit on the printable drawing), all subsequent work units (as well as all other disciplines) should follow the same segmentation

Greater Fire Protection Detail

For large projects, Fire Protection drawings should include separate subdiscipline drawings for Fire Suppression Systems (i.e., sprinklers, standpipes) and for Fire Alarm/Detection Systems. On smaller projects, they can be combined on a single plan if appropriate. Demolition drawings for both subdisciplines should be grouped, followed by New Work drawings for both. Under both demolition and new work, the plans will be followed by other drawing types as applicable, in the order shown:

- Fire Protection Legend
- Demolition
 - Plans
 - Fire Suppression
 - Fire Detection and Alarm
 - Large Scale or Partial Plans (order of subdisciplines same as for plans)
 - Elevations (order of subdisciplines same as for plans)
 - Sections (order of subdisciplines same as for plans)
 - Details (order of subdisciplines same as for plans)
- New Work
 - Plans
 - Fire Suppression
 - Fire Detection and Alarm

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- Large Scale or Partial Plans (order of subdisciplines same as for plans)
- Elevations (order of subdisciplines same as for plans)
- Sections (order of subdisciplines same as for plans)
- Details (order of subdisciplines same as for plans)
- Schematics (order of subdisciplines same as for plans)

Greater Plumbing Detail

Greater Mechanical Detail

Cover Sheet

Title Block

Field Legend

Signatures and Stamp

Printable Drawing Sheet Numbering

Greater Plumbing Detail

Demolition drawings should be grouped, followed by New Work drawings. Under both demolition and new work, the plans will be followed by other drawing types as applicable, in the order shown:

- Plumbing Legend
- Demolition
 - Plans
 - Large Scale or Partial Plans
 - Elevations
 - Sections
 - Details
 - Schedules
 - Schematics
- New Work
 - Plans
 - Large Scale or Partial Plans
 - Elevations
 - Sections
 - Details
 - Schedules
 - Schematics

Greater Mechanical Detail

For larger projects, Mechanical drawings should include separate sub-discipline drawing for: HVAC Ductwork (generally including all items on M-HVAC* CADD layers), HVAC Piping (generally including items on M-PIPE-CHW*, M-PIPE-DHW*, M-PIPE-CND*, M-PIPE-STM*, M-PIPE-REF* CADD layers, Service Piping (generally including items on M-PIPE-SPC*, M-PIPE-CFO*, M-PIPE-VAC*, M-PIPE-CMP*, M-PIPE-PRC* CADD layers), and HVAC Controls. On smaller projects they can be combined on a single plan if appropriate. Demolition drawings for all sub-disciplines should be grouped followed by New Work drawings for all. Under both demolition and new work, the plans will be followed by other drawing types as applicable, in the order shown:

- Mechanical Legend
- Demolition
 - Plans

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- HVAC Ductwork
 - HVAC Piping
 - Service Piping
 - Large Scale or Partial Plans (order of subdisciplines same as for plans)
 - Elevations (order of subdisciplines same as for plans)
 - Sections (order of subdisciplines same as for plans)
 - Details (order of subdisciplines same as for plans)
- New Work
 - Plans
 - HVAC Ductwork
 - HVAC Piping
 - Service Piping
 - Large Scale or Partial Plans (order of subdisciplines same as for plans)
 - Elevations (order of subdisciplines same as for plans)
 - Sections (order of subdisciplines same as for plans)
 - Details (order of subdisciplines same as for plans)
 - Schedules (order of subdisciplines same as for plans)
 - Schematics (order of subdisciplines same as for plans)
- HVAC Controls
 - HVAC Controls Legend
 - Network Plans or Connection Diagrams
 - Controls for Each System (including Schematic, Sequence of Operation, and Point Schedules)

Cover Sheet

CoF projects always include a cover sheet, while WR projects may or may not include a cover sheet. A project specific cover sheet is created when using the FMD Prototype Project. The cover sheet is available for standard drawing packages in D size.

The standard cover sheet contains general information, editable attributes, and areas for insertion of project specific instructions.

Project Cover Information includes:

- NASA Address, Logo, and Project Title
- Vicinity Map
- Location Map
- General Notes
- Drawing Index
- Title Block

Appendix A: Offsite A-E Processes

Requesting As-builts to Start

A Data Request form (DataRequest.doc) will be submitted to obtain electronic copies of drawings. This form is part of the CADD Resource Group information provided by the PM. Complete the request form and return it to the PM. Drawings are available to OFFSITE A-E's at the PM's discretion. Most content will be considered Sensitive But Unclassified (SBU). If this is the case

Standards for CADD Work

The A-E must verify that they have the requisite standards with which to begin

- FMD Master Layer List (*Autodesk's AIA Standard V3*)
- GIS Data Dictionary (*SDSFIE*)
- GOMARS Conventions (*gomars.xls*)

Template Files

The A-E must verify that they have the requisite electronic template files with which to begin as shown below:

- As-builts of Existing Conditions
- AutoCAD MEP NASA FMD Prototype Project file

Project Drawing Development

During the design phase, the A-E shall be providing milestone submissions in both print (for Engineering Branch review), and electronic AutoCAD based files (for CADD Resource Group review) formats. The CADD Resource Group review comments shall be returned to the A-E via the Government PM, accompanied by the Engineering Branch comments. It is crucial to the integrity of the FMD As-builts that the A-E follows the requirements outlined. Failure to do so will result in more work by the A-E to correct the drawings prior to the final submission.

Interim Milestone Submissions

All electronic CADD file submissions are to be accompanied by an Excel file that indicates the CADD filename, GSFC drawing numbers (after sequential numbers have been assigned by the GSFC documentation clerk), drawing title, description of drawing contents, and GSFC Project Number. The A-E will test the files as compressed on the disk to ensure that the information is satisfactory before submission to NASA.

Final Submission

In addition to the electronic plottable drawing files for each project, a composite electronic drawing of all layers for each floor of the project is to be provided. This composite drawing will include comprehensive discipline specific information for each

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floor, and will not be dependent upon any external references. Plot final hardcopy drawings on film (0.0762 mm minimum thickness) with matte finish on top.

Appendix B: Onsite A-E Processes

Directory Structure

The CADD Building and Site model drawings directory is located on the <\\GSFC-FileSRVC\220CAD\Goddard\Greenbelt> server (Q:).

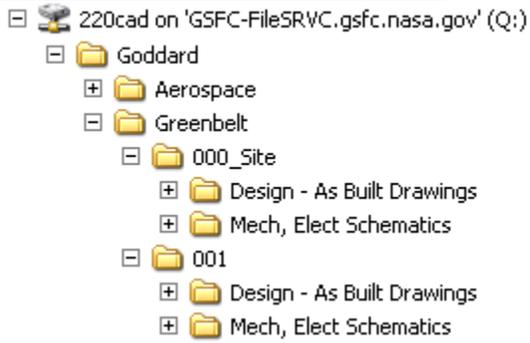


Figure 27 Directory Structure

File Locations

The As-built building models and schematics are available via the network as indicated above. The Greenbelt site path is **Q:\Goddard\Greenbelt**. This is a read-only directory, meaning that the directory is accessible, but work cannot be saved in it. The CADD Resource Group maintains the directory. For the building models, each building is in its own directory and each level is a separate file. For the schematics, each building and each system is a separate file, but there may be multiple files to complete a system. All data is in an “As-Built” status.

Site As-Built Models

The As-built site AutoCAD model is available via the network as indicated above. It is located at **Q:\Goddard\Greenbelt\000_Site\AutoCAD_Site_GIS_export.DWG** . This is a read-only file, meaning that the file is accessible, but work cannot be saved in it. The CADD Resource Group maintains the directory. The Site model is maintained in an “As-built” status.

GIS Models

Access Form

All User access requests are available through IdMAX. The user must have an approved IdMAX request prior to installation.

The user needs to be a member of the GS-GG-OD-FMD_22xUSERS global group. (All existing FMD Users should already be in this group)

The GIS administrator will assign a User Name and Password. The person performing the install will need this information available for testing and to deliver to the user when installation is complete.

Starting FMD_GIS application

To open the application, double click on the shortcut that has been installed on your desktop.



Figure 28 FMD-GIS icon

Enter your User Name and Password in the spaces provided.

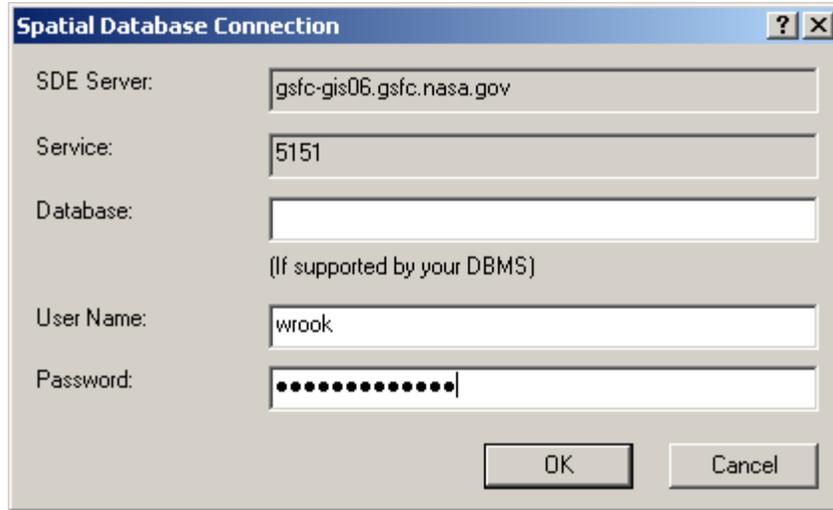


Figure 29 Spatial database connection

The application will take approximately 3 minutes to open. Please be patient. This application is providing access to a very large database with significant content.

Select Close on the following message.

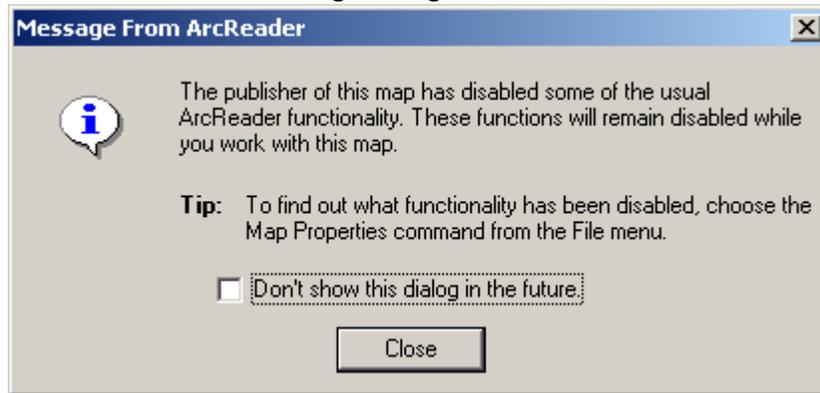


Figure 30 ArcReader message

User Interface

The user interface includes the **File Toolbar**, **Data Toolbar**, and the **Table of Contents**. These are the major components that will be reviewed in this training session. Thorough explanations on all application features are available from the **Help > ArcReader Help** pulldown.

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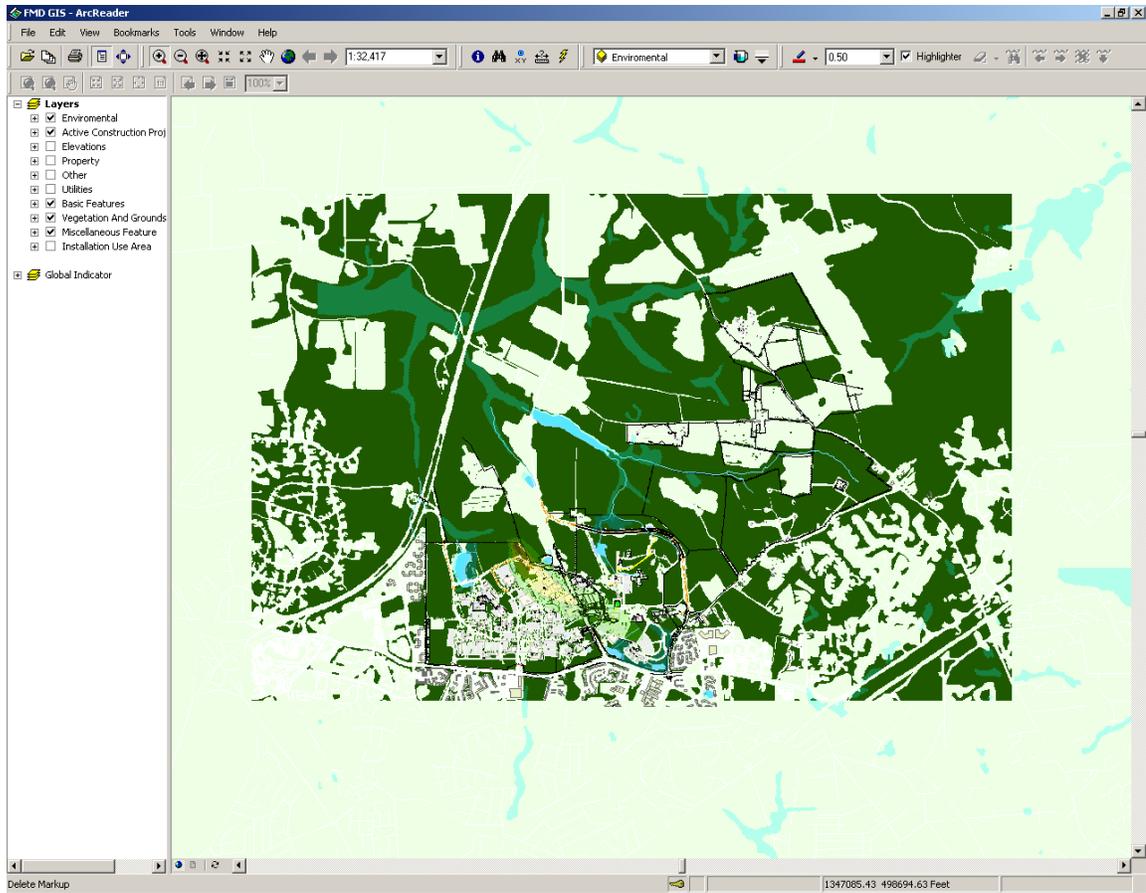


Figure 31 ArcReader interface

Bookmarks

For your convenience bookmarks for various buildings and complexes have been created. These are accessed from the Bookmarks pulldown.

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Figure 32 FMD-GIS bookmarks

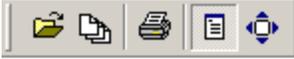


Figure 33 File toolbar

You will not need to use this at this point with the exception of printing. The application is configured during installation to open the FMD GIS database.

Data Toolbar

The Data Toolbar provides access to the attribute data within the database. Two components we will review are the **Hyperlinks** and **Identify**



Figure 34 Data Toolbar

Hyperlinks are highlighted when the following icon is selected.



Figure 35 Hyperlink icon

Once highlighted, you can place your cursor over the highlighted items and the hyperlink(s) will be displayed as a tooltip. Select the object and the hyperlink will open in its native application.

To Identify an object select the Identify icon shown below, then select the object that you wish to view the attribute information for.



Figure 36 Identify icon

After selection, the data for the selected object(s) will be displayed in the Identify window.

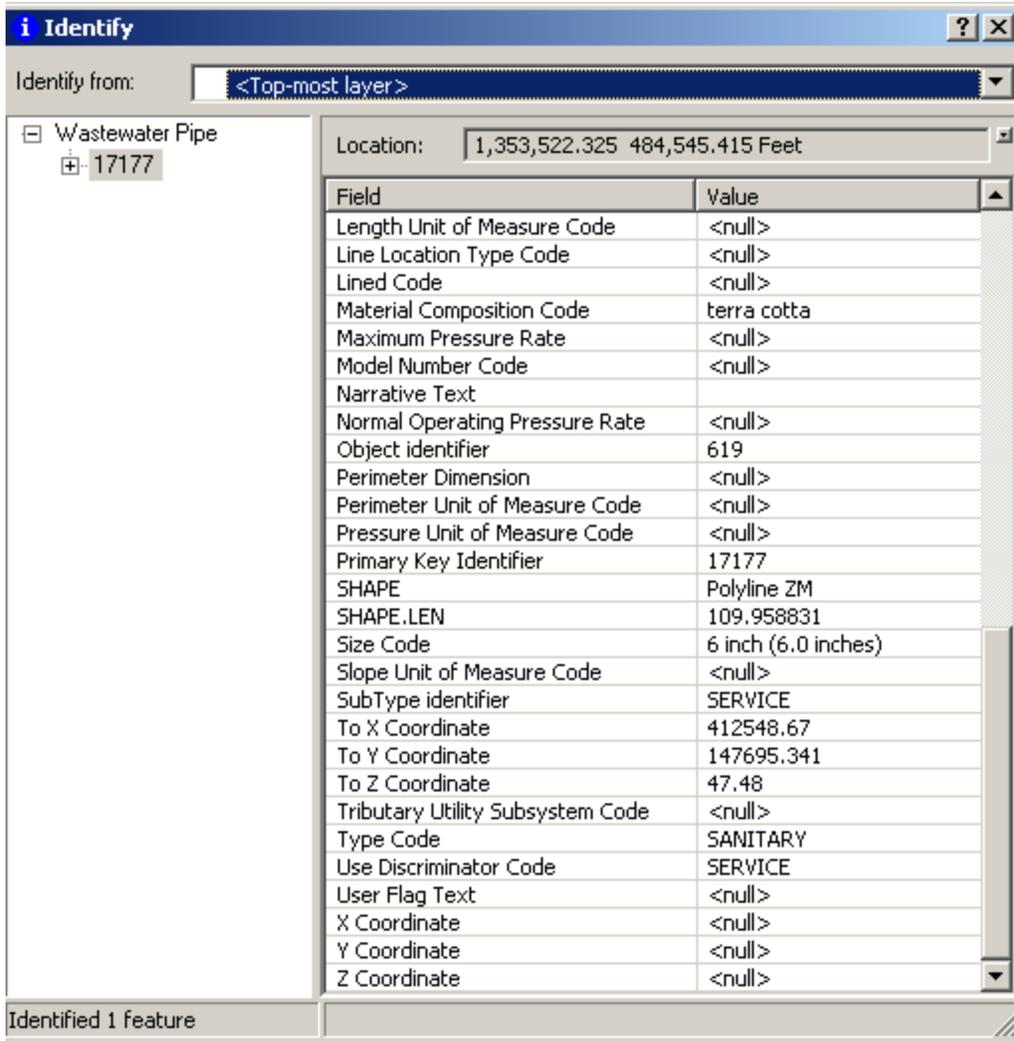


Figure 37 Identify dialog box

Markup

The Markup toolbar allows the reviewer to provide comments on the data and forward the comments to the GIS team for review and incorporation into the GIS database. You can use multiple colors and lineweights to highlight the needed adjustments. There are no provisions for entering text in the markup toolbox. Provide any required textual information in the body of an email message sent to the GIS administrator.



Figure 38 Markup toolbar

Once you have completed marking the area of concern, select the Export Markup button shown below.



Figure 39 Export Markup icon

An Export markup window will open.

Select the file button and direct the file to be saved to your “My Documents” folder.



Type a name for the file. DO NOT use the default name, provide a descriptive filename and retain the .pmfinkx extension.

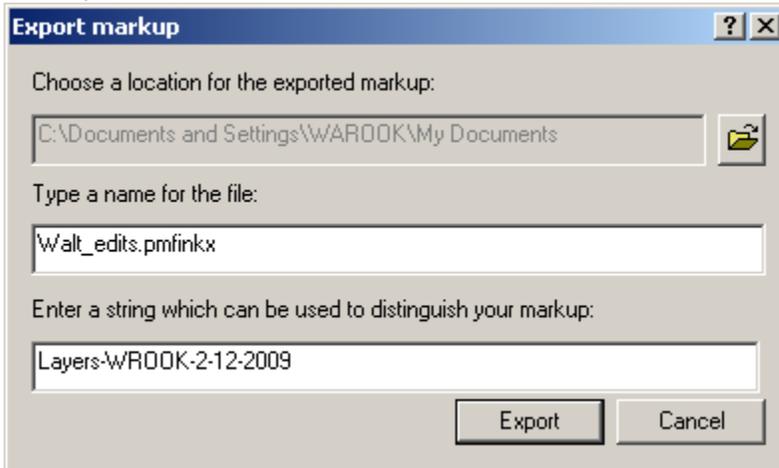


Figure 40 Export Markup dialog box

Email the file as an attachment to Michael.P.Westbrook@nasa.gov

Printing

Use the print button shown below to print the currently viewed map at a scale to fit on your default printer.



Figure 41 Printer icon

The GIS site models are available using the FMD_GIS project via ArcReader. A user must request access to this through IDMAX and it will be installed by a member of the CADD / GIS Team. This is a reference only application.

The update process for GIS models is straightforward. Once the information is received by the CADD Resource Group manager, the quality of the As-built is inspected. If it is acceptable, the following basic operations are performed:

- necessary linework and symbols are transferred to the appropriate layers
- demolition linework and symbology within the existing drawing is removed
- Symbol designations are inserted onto appropriate layers
- Sizes are transferred to appropriate layers
- Imported into GIS model
- Attribute data populated

If the information is incomplete, it is returned (with comments) to the PM via the CADD manager. The GIS models are maintained in an “As-Built” status.

Project Drawings

Drawings for projects are available via the network as indicated above. They are located in **Q:\CADD_ACTIVE\WR** or **Q:\CADD_ACTIVE\CoF**. These directories are used both to develop project drawings for design and to record the project's As-built changes after construction. If the files in either directory are not used within a thirty-day period, they are automatically archived by the CADD Resource Group to one of the following inactive directories: **Q:\CADD_INACTIVE\WR** or **Q:\CADD_INACTIVE\CoF**. The **CADD_INACTIVE** directory is write-protected; therefore the necessary drawing files must be copied back into the appropriate **CADD_ACTIVE** directory for use.

Creating a Project Directory Folder

Each project must have a unique project folder directory created on the network in the appropriate **Q:\CADD_ACTIVE** directory. The unique number used is the project number. The PM is responsible for having the appropriate subdirectory created for the project. Examples: WR project A2854 is named: **Q:\CADD_ACTIVE\WR\A2854** CoF project 00GMAZ is named: **Q:\CADD_ACTIVE\CoF\00GMAZ** If a CoF project also has a WR number, it is always stored in the CoF folder using the CoF project code.

Abbreviations and Legend Sheets

The Abbreviation and Legend sheets are available in the **Q:\CADD_LIBRARY\APPROVED\STANDARDS\Legends** directory. Hazardous & Environmental and Landscaping legends are currently placeholders only. No symbology is contained on these sheets.

Standard Details

Standard CADD details are organized and indexed in a manner suitable to each discipline. Approved details are found in **Q:\CADD_LIBRARY\APPROVED\DETAILS\{discipline}\{filename}**. If the folder is empty, it is currently being used as a placeholder for details in the process of being developed. Unapproved details are found in **Q:\CADD_LIBRARY\UN-APPROVED\DETAILS\{discipline}\{filename}**. Several groups are responsible for developing, promoting, and maintaining StandardDetails as shown below:

- CADD Resource Group—The CADD Resource Group is responsible for posting approved standard details.
- Discipline Committees—The Discipline Committees are responsible for developing the CADD Standard Details for their discipline. Anyone may initiate a proposed Standard Detail.
- Government Technical Policy Discipline Lead— The Government Technical Policy Discipline Lead is responsible for promoting development of Standard Details to the Discipline Committees. Additionally, the Government Technical Policy Discipline Lead is responsible for detail approval (in conjunction with the discipline committee), as well as to inform and provide approved details to the CADD Resource Group.

Formatting Drawing Numbers for Printable Drawings

Use the format in the succeeding figure to develop both the information needed in the drawing title blocks, and proper numbering for all project drawings. **{G}{Sheet size}–{Building number & letter (or Site)}–{Sequential number}** Example: Project in Building 16W, using sheet size A1, and the next available sequential number from the *DrwgNumb.xls* log of 12345: GA1–016W–12345 Example: Project in Site, using sheet size B1, and the next available sequential number from the *DrwgNumb.xls* log of 23456: GB1–SITE–23456 **WR/CoF** project file drawings are in the sequential series 00001-59999

Reserving Numbers for Printable Drawings

Drawing numbers are obtained and documented using the *DrwgNumb.xls* file located in the **P:\drawing numbers** folder. Instructions are included in this file.

Incorporating Redlines into As-Builts

Redlines will be incorporated into the AutoCAD drawing files, and the revision block will be marked to indicate that the update has been completed per As-built conditions. Record of the completion of this action must be submitted to the government via a “Material Approval Submittal Transmittal” form for the proper customer review cycle. Upon completion of these actions, and receipt by the CADD Resource Group, the completed work will be integrated into the composite building models, or site plan, as appropriate.

Appendix C: CADD Resource Group As-Building

As-Built Models and Schematics

Upon posting of the project drawings to the appropriate **Q:\CADD_ACTIVE** directory, and notification of the CADD Resource Group that As-builts are ready to be incorporated, the As-builts shall be incorporated into the models (and schematics). For further information on the Mechanical Schematic updating process, see SRD Section 9.1.11. For further information on the Electrical Single-Line Diagram updating process, see SRD section (TBD). The CADD Resource Group updates the As-built models and schematics within the following schedule;

- <\$100,000 30 days
- \$100,000-\$500,000 45 days
- >\$500,000 60 days.

After the project drawings are updated and approved, the PM will post the drawings to the appropriate **Q:\CADD_ACTIVE** directory and notifies the CADD Resource Group that the As-built drawings are ready for incorporation into the FMD As-built directories.

As-Built GIS

Upon completion of the updates to the Site As-built model only, spatial information is then transferred into the Site GIS model. Once this information has been transferred, attribute data is populated into attribute tables, as is available from the project As-builts.

Building Model File Naming

File names for composite As-built building models are created and maintained by the CADD Resource Group using the format **{Building number & letter}–{Level number}_{Sublevel number}.dwg** Example: Building 1A, 1st floor, sub-level 1: 001a-1_1.dwg Example: Building 6, 2nd Floor: 006-2.dwg

Schematic Drawing File Naming

File names for controlled As-built schematics are created and maintained by the CADD Resource Group using the format in the succeeding figure: **{sch}{Building number & letter}–{Sheet designation}{Sequentialnumber}.dwg** Example: Building 16W, Mechanical Supply/Return Ductwork Schematic, 3rd schematic in the series: sch016W–mhv03.dwg Schematics are controlled documents maintained outside of the normal project structure. Figure 44 contains guidance on drawing number assignment. Pay particular attention to the Series column, as this column defines specific drawing number ranges corresponding to the type of system represented. The table also contains information on Drawing Types, Subsystems, and Sheet Designations. Refer to the example in Figure 36 for a practical application of this concept. Although schematics may be created as part of a WR or CoF project, they must be reviewed and defined as a controlled drawing by the PM before being assigned a controlled drawing

number. The drawing will utilize the conventional drawing number scheme for a project drawing file for the duration of the project.

Schematic Drawing Numbering

Numbering for controlled schematics are created and maintained by the CADD Resource Group using the format in the succeeding figure: **{G}{Sheet size}–{Building number}–{Sequential series number}.dwg**

Example: Building 16W, Mechanical Plumbing Schematic, using A1 size sheet, with the next available sequential series number of 83241: GA1–016W–83241.dwg **Figure 40 – Controlled Schematic Drawing Numbering Format** The sequential series number is again, as its name implies, the next available number that is drawn from a block of numbers that becomes part of the overall Controlled Schematic drawing number, as shown in the preceding figure. Refer to the table in the succeeding figure for information on the Series numbers, Types, and Subsystems available. Schematic drawing numbers are also not necessarily in order. They are not concurrent by building number, or within a building. For example, Building 013 has a lower series numbers (8xxxx) than Building 007 because the schematic work was done at an earlier time. If Building 013 is modified in the future, it is possible that additional schematics will be needed. The additional drawing numbers would not be sequential to the previously created schematic drawings. They would take the next open number in the discipline appropriate schematic series.

Sheet Designations for Schematics

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SERIES	TYPE	SUBSYSTEMS INCLUDED WITHIN SERIES TYPE	SHEET DESIGNATION
00001 -	Construction Documents		
59999			
60000 – 69999	RESERVED		
70000 – 79999	RESERVED		
80000 – 80999	Mechanical Ductwork AS-BUILT SCHEMATICS	Supply/Return Ductwork Exhaust Ductwork	MHV MEX
81000 – 81999	Mechanical Piping AS-BUILT SCHEMATICS	Steam/Condensate Piping Chilled Water Piping Secondary Water Piping Hot Water Piping Refrigerant Piping Compressed Air Piping <i>Condenser Water Piping</i> <i>Fuel Piping</i> <i>Vacuum Piping</i> <i>Lab Fluids Piping</i> <i>Process Piping</i>	MST MCW MSW MHW MRE MCA <i>MCO</i> <i>MFU</i> <i>MVA</i> <i>MLF</i> <i>MPR</i>
83000 – 84999	Plumbing AS-BUILT SCHEMATICS	Domestic Water De-ionized Water Sanitary Drain Storm <i>Lab Supply Water</i> <i>Lab/Acid/Other Drain</i>	PDW PDI PSD PST <i>PLA</i> <i>PLD</i>
85000 – 85999	Fire Protection AS-BUILT SCHEMATICS	Sprinkler Standpipe	FSP FST
86000 – 88999	<i>Controls</i>	<i>Metasys Controls</i> <i>Non-Metasys Controls</i>	<i>TBD</i> <i>TBD</i>
89000 – 89999	RESERVED		
90000 – 90999	Electrical One Line AS-BUILT SCHEMATICS		EOL
91000 – 99999	RESERVED		

Figure 42 Sheet Designation table

Space (Room) Numbers

The CADD Resource Group works with other members of the IRM team, who enter data in a temporary holding file for use in updating the LISTS/BRS database when the space numbers actually appear during the As-Built entry stage.

Appendix D: AutoCAD Recommendations and Guidelines

Enabling the Automatic save Feature

Follow the steps below to set the automatic save feature in Autodesk. This will ensure that you do not lose your work. Type CONFIG at the command line and press Enter. The Preferences dialog box will appear.

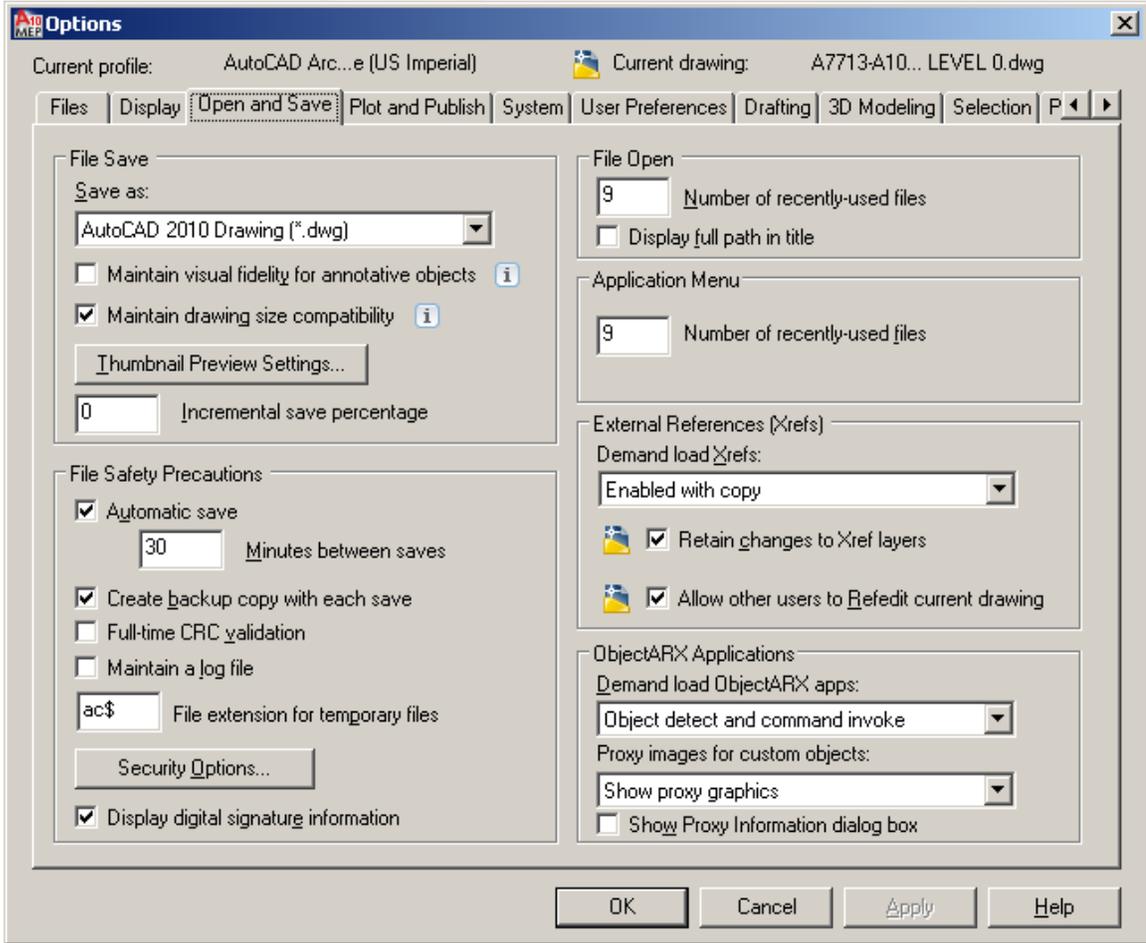


Figure 43 Automatic Save dialog box

Click the General tab and set the preferences as shown in the preceding figure. You can opt to set the Minutes between saves: field to your preference. Click first the Apply, then the OK button.

Display Configuration

Be sensitive to which information you are trying to display in each viewport. By selecting Ceiling, as opposed to Floor, items such as door swings could be turned off.

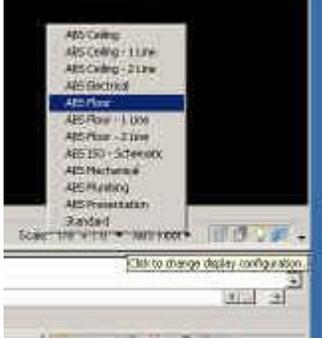


Figure 44 Display Configuration