ERDC/ITL TR-06-X

The CADD/GIS Technology Center

for facilities, infrastructure, and environment

A/E/C CADD Standard

Release 3.0

September 2006

The A/E/C CADD Standard is compliant with Version 3.1 of the U.S. National CAD Standard

The A/E/C CADD Standard contains supplemental materials and DoD specific requirements not addressed in the U.S. National CAD Standard.

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Prepared for U.S. Army Engineer Research and Development Center
Vicksburg, MS 39180-6199

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Introduction

The A/E/C CADD Standard Manual has been developed by the CADD/GIS Technology Center (CGTC) for Facilities, Infrastructure, and Environment to eliminate redundant Computer-Aided Design and Drafting (CADD) standardization efforts within the Department of Defense (DoD) and the Federal Government. The manual is part of an initiative to develop a nonproprietary CADD standard that incorporates existing industry, national, and international standards and to develop data standards that address the entire life cycle of facilities within the DoD. The A/E/C CADD Standard Manual is part of a set of standards being developed by the CGTC. Additional manuals include the following:

a. Contract Language Guidelines for Acquiring Geospatial Data (CADD, GIS, CAFM) System Deliverables from Architect-Engineer (A-E) Consulting Firms, *https://tsc.wes.army.mil/products/standards/aeguide/index.asp*

b. Spatial Data Standard for Facilities, Infrastructure, and Environment (for more information, please contact Nancy Blyler at *Nancy.J.Blyler@hq02.usace.army.mil)*

Information on these standards, unless otherwise noted, can be obtained from the CGTC's Web page at *https://tsc.wes.army.mil*.

Mr. James T. Wilson is the Acting Chief of the CGTC, which is located in the Information Technology Laboratory (ITL), U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS. The Director of ITL is Dr. Jeffery P. Holland, and the Assistant Director is Dr. Deborah F. Dent. At the time of publication of this report, the Director of ERDC was Dr. James R. Houston. Commander of ERDC was COL Richard B. Jenkins.

United States National CAD Standard

In 1995, the combined resources of the CGTC, the American Institute of Architects (AIA), the Construction Specifications Institute (CSI), the United States Coast Guard, the Sheet Metal and Air Conditioning Contractors National Association (SMACNA), the General Services Administration (GSA), and the National Institute of Building Sciences' (NIBS) Facility Information Council began an effort to develop a single CADD standard for the United States. Working together, these organizations agreed to develop an integrated set of documents that collectively would represent the U.S. National CAD Standard (NCS).

A Memorandum of Understanding (MOU) was signed on August 8, 1997. In accordance with that MOU, Release 3.0 of the A/E/C CADD Standard follows, utilizes, or references the work developed by each of the signatories. The two main documents referenced within Release 3.0 of the A/E/C CADD Standard are:

- "Uniform Drawing System"
  The Construction Specifications Institute
  99 Canal Center Plaza, Suite 300
  Alexandria, VA 22314-1588
  http://www.csinet.org

- "AIA CAD Layer Guidelines"
  The American Institute of Architects
  1735 New York Avenue, NW
  Washington, DC 20006-5292
  http://www.aia.org

Each of these documents is available as part of the U.S. National CAD Standard. Additional information on the U.S. National CAD Standard can be obtained from

NIBS Facility Information Council
National Institute of Building Sciences
1090 Vermont Avenue NW, Suite 700
Washington, DC 20005-4905
http://www.nationalcadstandard.org

1 Introduction

Acronyms

First, a few useful acronyms:

- A-E – Architect-Engineer
- A/E/C – Architectural, Engineering, and Construction
- AIA – American Institute of Architects
- ANSI – American National Standards Institute
- ASTM – American Society for Testing and Materials
- BIM – Building Information Modeling
- CAD – Computer-Aided Design
- CADD – Computer-Aided Design and Drafting
- CGTC – The CADD/GIS Technology Center
- CSI – Construction Specifications Institute
- DoD – Department of Defense
- FM – Facility Management
- GIS – Geographic Information System
- IAI – International Alliance for Interoperability
- IFC – Industry Foundation Class
- ISO – International Organization for Standardization
- NCS – National CAD Standard

- NIBS – National Institute of Building Sciences
- SI – International System of Units (Le Système International d'Unités)
- UDS – Uniform Drawing System

Scope

This manual provides guidance and procedures for preparing Computer-Aided Design and Drafting (CADD) products within the Department of Defense (DoD).

Chapters 1-5 of this manual address topics such as presentation graphics, level/layer assignments, electronic file naming, and standard symbology. Appendices A-D contain tables on model and sheet file level/layer names, color comparisons, as well as Architectural, Engineering, and Construction (A/E/C) CADD symbology.

Purpose

The purpose of this manual is to set a basic CADD standard to ensure consistent electronic deliverables (products) within the DoD. These consistent deliverables are part of a comprehensive installation life-cycle management strategy. This manual sets a CADD standard specifically for the A/E/C disciplines of facilities development and civil works projects. As this manual evolves, it will be integrated with other standards initiatives by the CADD/GIS Technology Center (CGTC) for Facilities, Infrastructure, and Environment such as Contract Language Guidelines and Building Information Modeling (BIM).

Background

The immediate benefits of CADD standards are many: consistent CADD products for customers; uniform requirements for A-E deliverables; sharing of products and expertise; and collection, manipulation, and exchange of database information. Recognizing such potential benefits, each of the DoD agencies independently initiated efforts to establish CADD standards in the late 1980's. The Air Force Logistics Command (1989) released the "Architectural and Engineering Services for CADD Implementation Within Air Force Logistics Command." Headquarters, U.S. Army Corps of Engineers (1990), published Engineer Manual 1110-1-1807, "Standards Manual for U.S. Army Corps of Engineers Computer-Aided Design and Drafting (CADD) Systems." In 1993, the

Naval Facilities Engineering Command distributed its "Policy and Procedures for Electronic Deliverables of Facilities Computer-Aided Design and Drafting (CADD) Systems."

To consolidate these efforts into a single standard, the CGTC was tasked to develop standards for the A/E/C disciplines. This manual presents the CGTC's effort at standardizing CADD requirements for A/E/C design and construction documents.

International System of Units (SI) Considerations

For this standard manual, the impact of the SI, more commonly referred to as the metric system, on such items as drawing scales, sheet sizes, and dimensioning is addressed. The SI was established by the General Conference of Weights and Measures of 1960, as interpreted or modified from time to time for the United States by the Secretary of Commerce under the authority of Public Law 94-168, the Metric Conversion Act of 1975, and the Metric Education Act of 1978. As of January 1, 1992, in accordance with Public Laws 94-168 and 100-418, the Omnibus Trade and Competitiveness Act of 1988, and Executive Order 12770, "Metric Usage in Federal Government Programs," July 25, 1991, all new and revised construction standards and criteria must be developed using the SI.

Future Technologies

There are several ongoing initiatives to create a universal language for collaborative work in the area of building and construction software. This work stems from the need to automate current building and construction tasks to become more efficient and cost effective. One of these initiatives is by the International Alliance for Interoperability (IAI), a nonprofit building industry alliance comprising architects, engineers, contractors, software vendors, government agencies, research laboratories, and universities. The goal of the IAI is to unite the A/E/C and Facility Management (FM) businesses by specifying Industry Foundation Classes (IFCs) as a universal language. The concept behind the IFCs is to create a series of standard intelligent software objects for the building industry that allow all process disciplines (i.e., architects, designers, engineers, builders, facilities managers) to exchange information. The IAI is developing IFCs that allow current software packages such as AutoCAD and MicroStation to share building and construction data. IFCs would improve the quality of the life cycle of a building from construction through maintenance and ultimately to demolition through reduced expense and delivery time, enhanced communications, and increased discipline proficiency.

Target Systems

This manual does not target any specific CADD system or software. However, to ensure successful translations among CADD applications, certain system-specific characteristics were considered and the standard adjusted accordingly. During the preparation of the standard, several baseline decisions were made:

- The standard must be applicable to the latest release of commercially available CADD packages. AutoCAD and MicroStation were chosen based on their prevalence in the DoD.
- The standard is based on CADD applications that utilize layer/level names and reference files.
- The standard requires every final plotted drawing sheet to have its own separate electronic drawing file.

Since there have been considerable improvements and updates to CADD software, including changes to the file formats, it becomes more important to have a standard version of each appropriate CADD platform. Based on this, the following versions of the primary software products are considered the standard versions for use:

- MicroStation Version 2004 (ver. 8.5)
- AutoCAD 2004

Design Applications and Other Applications

Numerous design applications have been developed to run on top of basic CADD engines. These applications can be used by designers to generate graphics inside CADD files. Most notable are design software packages for civil/site and Building Information Modeling (BIM).

Document management systems that contain attributes for individual files and have such features as title block integration are becoming standard tools for management of electronic files. Use of these systems to store searchable attribute information on files is encouraged.

Coordination with Design Agent

With all the complexity and options currently available in the world of CADD, it becomes important to coordinate fundamental aspects of design work. The previously mentioned issues of basic platform, design

applications, and document management are only three of the issues that can affect the success of a project and the future usefulness of the final documents. As such, each project should have at its initiation discussions and agreements on such issues as this. Each software package being used should be approved and a determination made on how much of the supporting electronic files should be provided to the customer as a part of the end product.

Additions/Revisions

This standard is intended to be neither static nor all-inclusive and thus will be updated and enhanced as appropriate. Suggestions for improvements are strongly encouraged so that subsequent updates will reflect the input and needs of CADD users.

Recommendations or suggested additions should be sent to:

The CADD/GIS Technology Center
U.S. Army Engineer Research and Development Center
ATTN: CEERD-ID/Spangler
3909 Halls Ferry Road
Vicksburg, MS 39180-6199
or by e-mail at: *Steve.C.Spangler@erdc.usace.army.mil*

2 Drawing File Organization

Design Area

Available drawing area

The two most extensively used CADD applications within the DoD, AutoCAD and MicroStation, both provide for a drawing area with infinite range in each positive and negative axis (x,y,z).

File accuracy (units)

CADD systems allow the designer to work in "real-world" units. The most common units are feet:inches, feet:tenths of feet, and meters:millimeters.

MicroStation's approach to file accuracy allows the user to set the working units (i.e., real-world units) as the following:

- Master Units = The largest unit that may be referred to when working in the design file (e.g., feet, meters)
- Sub Units = Subdivisions of Master Units (e.g., inches, millimeters)

Note: *For MicroStation V8, changing the Master Units in a drawing no longer changes the size of design file elements. For instance, if a design file was created in feet and a 1-ft line is drawn, changing the Master Units to inches results in the line measuring 12 in.*

For MicroStation V8, Positional Units have been eliminated (since these previously determined the size of the design cube and the ultimate accuracy of the file). Positional Units can still be set using the Settings – Design File – Working Units – Advanced button, but this is not recommended (unless the design file is going to be saved back to a MicroStation V7 file).

In AutoCAD, the basic drawing unit for any file is the distance between two fixed Cartesian coordinates. For example, the distance between coordinates (1,1,1) and (1,1,2) is one drawing unit. A drawing unit can correspond to any measurement (e.g., foot, inch, meter, mile, fathom). AutoCAD users may enter the **Units** display option to set the desired drawing units.

The **Units** command of AutoCAD does not have a direct metric system setup. For metric designs, the recommended procedure is to choose the **Decimal** option in the **Drawing Units** dialogue box. This will allow each drawing unit to represent decimal meters, millimeters, etc., at the discretion of the user.

International Feet versus Survey Feet (V8)

Many sites have to deal with the initial question as to whether a particular project is designed using International Feet or Survey Feet. In some states, it is specified by statute that units of measure for grid coordinates have to be either International Feet or Survey Feet. The two units are defined as follows:

- International Feet: 1 foot = 0.3048000 m
- U.S. Survey Feet: 1 foot = 0.3048006 m

Looking at this comparison, the difference between the two (0.0000006 m) may seem insignificant; however, ultimately this difference may cause coordinate values to be off by several feet, resulting in inaccurate design files. In MicroStation V8, the **units.def** file does contain a definition for Survey Feet (usually stored in **Program Files\Bentley\Workspace\System\data**), but it is disabled by default. To enable, scroll down the **units.def** file to the section **English units (based on U.S. Survey Foot**) and delete the **#** in front of **#sf,ft,** which will allow for the selection of Survey Feet from the Working Units box the next time MicroStation is started.

Note: *If a drawing has already been created using International Feet, changing the Master Units to Survey Feet will not automatically scale all elements in the drawing to Survey Feet. To address this problem, several Districts and A-E firms have developed macros to correctly scale existing elements, some of which also help bring V7 drawings into V8 while maintaining survey foot measurements.*

Origin (global origin)

Positioned within every electronic drawing file is an origin ("global origin" in MicroStation and "origin" in AutoCAD). The origin of a drawing file is important because it serves as the point of reference from which all other elements are located. Origins are typically defined in a drawing file by the Cartesian coordinate system of x, y, and z.

The benefit of standardizing the location of the origin of a drawing is most notable in the use of reference files (see section "Reference Files (XREFs)" in Chapter 4). A standardized origin is also helpful when translating files between CADD applications. The recommended global origin for 2D files in both AutoCAD and MicroStation drawings is x = 0 and y = 0. When 3D files are used, the z-origin should be set to allow for elevations below 0.

Model Files and Sheet Files

Two distinct types of CADD files are addressed in this standard: model files and sheet files.

A model file contains the physical components of a building (e.g., columns, walls, windows, ductwork, piping, etc.). Model files are drawn at full scale and typically represent plans, elevations, sections, etc. Model files can be generated either by placing graphics or from BIM model extractions.

A sheet file is synonymous with a plotted CADD drawing file. A sheet file is a selected view or portion of referenced model file(s) within a border sheet. The addition of sheet-specific information (e.g., text, dimensions, and symbols) completes the construction of the document. In other words, a sheet file is a "ready-to-plot" CADD file.

Figure 2-1 illustrates how different model files are referenced to a sheet file (notice that even the border sheet is a referenced model file). Again, a sheet file is the combination of referenced model files with sheet-specific text/symbols to create a final ready-to-plot CADD file. A useful rule of thumb was stated in the 2nd edition of the American Institute of Architects' (AIA) *CAD Layer Guidelines* (AIA 2005): "Model files are always referenced by other files, while sheet files are never referenced by other files."

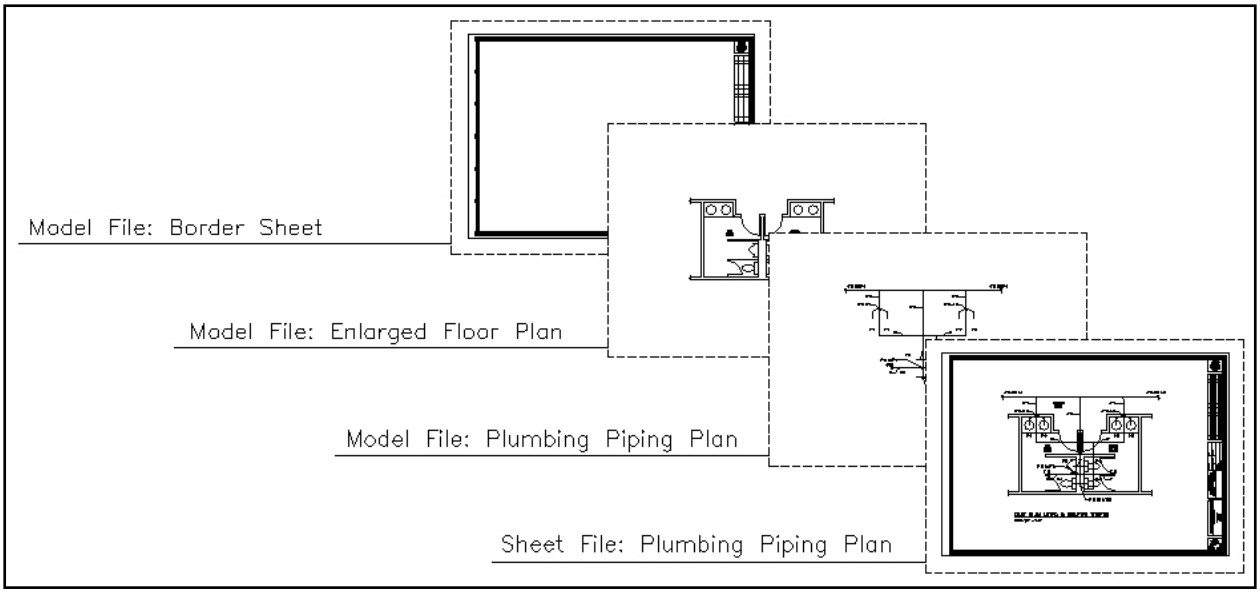


Figure 2-1. Sheet file composition

Design Models and Sheet Models

Inside each CADD file can exist Design Models (or Model Space for AutoCAD users) and Sheet Models (or Paper Space for AutoCAD users). Design Models are where model files are developed or possibly where model files are assembled together prior to creation of the Sheet Model (see the following section “Drawing Sheet Assembly”). Design Models contain graphic information in a model file format. For example, it may contain the entire Architectural Floor Plan model file for a building. It is this model file that is used as a reference for creating individual sheet files.

By contrast, a Sheet Model shows the presentation of model file graphics as they would appear on an individual drawing sheet. This assembly area would contain referenced individual model files, one of which would be a border sheet.

Drawing Sheet Assembly

Two main options for drawing sheet assembly may be used. Each involves assembling individual model files and a border sheet model file to create final plotted sheets. There are some differences that are explained in the following paragraphs. One similarity in both assembly processes is that nested referenced border sheet model files are not allowed. The method used should be defined at the start of a project, and all files should be built in the same manner.

Option 1 – Use of Design Model and Sheet Model

This option is the preferred method of drawing assembly (new to MicroStation users, but common to AutoCAD users, who are used to Paper Space). It consists of using a sheet file that contains a Design Model and a Sheet Model. The Design Model is used to assemble all the individual reference files necessary to display the graphics. This may include references to individual views of Design Models in other files, or even coincident references. The Design Model should also contain real-world graphics such as northing and easting coordinate values of points. The Sheet Model contains a reference to the project border sheet model file (at 1:1), plus a reference to the Design Model in the active sheet file, scaled to fit into the Sheet Model (Figure 2-2).

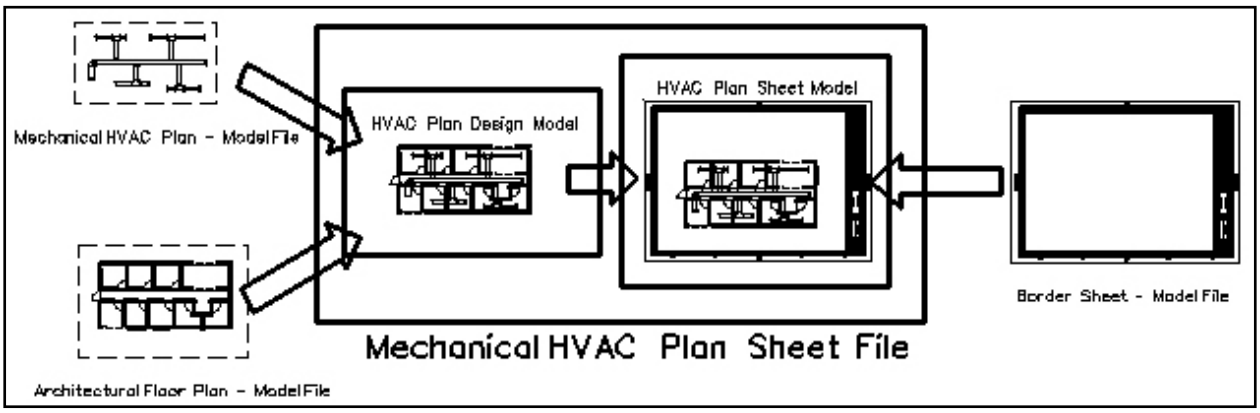


Figure 2-2. Sheet file composition using Design Model and Sheet Model

Option 2 – Use of Design Model Only

This option consists of using the Design Model only (the Sheet Model (or Paper Space) is not used). This Design Model would have all model files referenced to it, including the border sheet model file. Since all work would be done in the Design Model, a determination should be made at the start of any project using this option on whether to scale up the border sheet model file to fit around the 1:1 model files, or scale down the model files to fit inside the 1:1 border sheet model file (Figure 2-3). Whichever method is chosen, it should be consistent throughout the project.

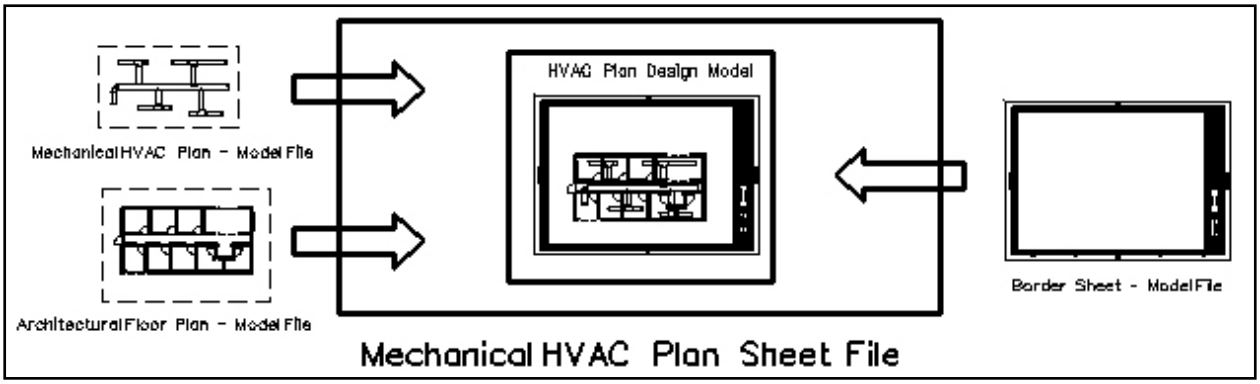


Figure 2-3. Sheet file composition using only the Design Model

Electronic Drawing File Naming Conventions

Naming conventions for electronic drawing files (both model files and sheet files) allow CADD users to determine the contents of a drawing without actually displaying the file. They also provide a convenient and clear structure for organizing drawing files within project directories.

Project Code

The Model File naming convention and the Sheet File naming convention both allow for a 0- to 20-character Project Code at the beginning of the file name. Use of a Project Code is recommended and should be identified at the start of each project to ensure consistent file names within that project. Some examples of Project Codes are:

- The official agency project number
- The project number defined by the agency system manager for their record system

The use of Project Codes in file names is highly recommended, because it prevents the same file name from existing in different directories. When this field is used, standard naming should consider use of a special character such as an underscore "_" for all model files so that folder sorting routines group like files together.

When a project includes multiple sites or buildings, it is important to identify each file with the appropriate feature. This should be done as a part of the Project Code. For example, a model file for project P123, building 2, could possibly use a Project Code of "_P123-Bldg2".

Model file naming convention

The model file naming convention (Figure 2-4) has one optional field, followed by three mandatory fields. While the first field is optional and may be omitted, the remaining fields must be used and in the correct sequence.

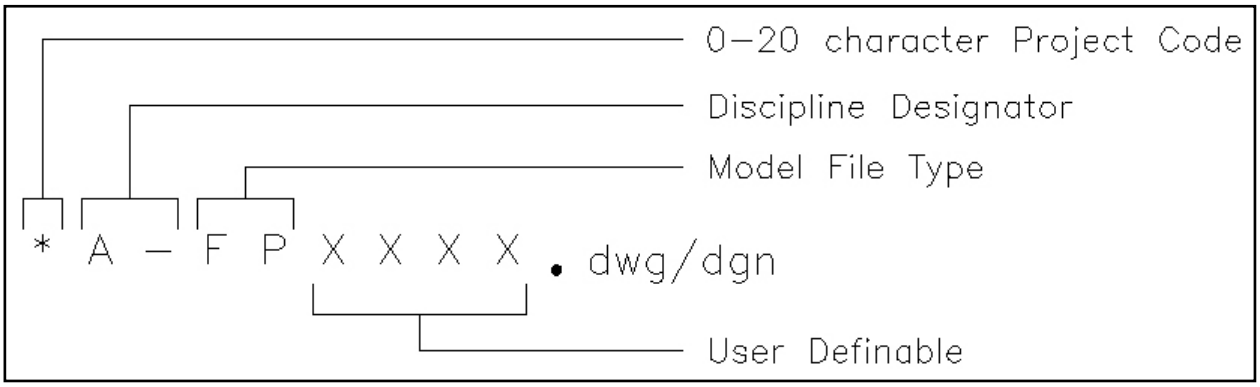


Figure 2-4. Model file naming convention

Following the optional Project Code field, the first two-character field represents the Discipline Designator. The allowable characters for the first character in the Discipline Designator are listed in Table 2-1. The second character of the Discipline Designator field is always a hyphen "-". The next two-character field represents the Model File Type (Table 2-2). The final four-character field is User Definable.

Note: *Several CADD Standards implementation packages use the file name conventions to determine the type of file being created, so certain character fields need to be located in the same position in every file name. If not all of the User Definable characters are needed, placeholders must be used for these implementation tools to function properly*.

Example. The model file name for a project at the U.S. Army Engineer Research and Development Center (ERDC), Building 8000, 1st floor, Architectural Floor Plan could be:

ERDC8000A-FPF1XX.dgn/dwg

where ERDC8000 is the Project Code, A- is the Discipline Designator, FP is the Model File Type (Floor Plan), and F1 is a user-definable set of characters for Floor 1. Since not all of the user-definable characters were used, the characters XX were used as placeholders.

Table 2-1
Discipline Designators

Discipline	Designator
General	G
Hazardous Materials	H
Survey/Mapping	V
Geotechnical	B
Civil	C
Landscape	L
Structural	S
Architectural	A
Interiors	I
Equipment	Q
Fire Protection	F
Plumbing	P
Process	D
Mechanical	M
Electrical	E
Telecommunications	T
Resource	R
Other Disciplines	X
Contractor/Shop Drawings	Z
Operations	O

Table 2-2
Model File Types

Discipline	Code	Definition
General	BS	Border Sheet
	CS	Cover Sheet
	KP	Key Plan
Hazardous Materials	DT	Detail
	EL*	Elevation
	LG	Legend
	PP	Pollution Prevention Plan
	QP*	Equipment Plan
	SC	Section
	XD*	Existing/Demolition Plan
Survey/Mapping	AL	Existing Airfield Lighting Plan
	CP	Existing Communication System Plan
	EU	Existing Electrical Utilities Plan
	HP	Existing Hydrographic Survey and Mapping Plan
	HT	Existing HTCW Utilities Plan
	LG	Legend
	PB	Property Boundary
	PR	Existing Profile
	SC	Existing Section

* = No Model File Table available in Appendix A *(Continued)*

Table 2-2 (Continued)

Discipline	Code	Definition
Survey/Mapping	SP	Survey and Mapping Plan
	UP	Existing Utilities Plan
Geotechnical	DT	Detail
	JP	Joint Layout Plan
	LB	Boring Log
	LG	Legend
	PV	Pavement Site Plan
	SC	Section
	SH*	Schedule
	SI	Subsurface Investigation Plan
Civil	AF	Airfield Plan
	BR	Beach Renourishment Plan
	DT	Detail
	EL	Elevation
	ER	Eco-Restoration Plan
	FC	Flood Control Plan
	GP	Grading Plan
	IP*	Installation Plan/Base Map
	JP	Joint Layout Plan
	KP*	Staking Plan
	LG	Legend
	NG	Navigation/Dredging Plan
	PL*	Project Location Map
	PR	Profile
	SC	Section
	SH*	Schedule
	SP	Site Plan
	TS	Transportation Site Plan
	UP	Utilities Plan
	XD*	Existing/Demolition Plan
Landscape	DT	Detail
	EL*	Elevation
	IP	Irrigation Plan
	LG	Legend
	LP	Landscape Plan
	SC*	Section
	SH*	Schedule
	XD*	Existing/Demolition Plan
Structural	3D	Isometric/3D
	BP	Bridge Plan
	CP	Column Plan
	CW	Misc. Small Civil Works Structures
	DT	Detail
	EL	Elevation
	EP	Enlarged Plan
	FC	Flood Control Structures

* = No Model File Table available in Appendix A *(Continued)*

Table 2-2 (Continued)

Discipline	Code	Definition
Structural	FP	Framing Plan
	LD	Locks and Dams
	LG	Legend
	NP	Foundation Plan
	SC	Section
	SH	Schedule
	XD*	Existing/Demolition Plan
Architectural	3D*	Isometric/3D
	AC	Area Calculations/Occupancy Plan
	CP	Reflected Ceiling Plan
	DT	Detail
	EL	Elevation
	EP*	Enlarged Plan
	FP	Floor Plan
	LG	Legend
	QP	Equipment Plan
	RP	Roof Plan
	SC	Section
	SH*	Schedule
	XD*	Existing/Demolition Plan
Interiors	3D*	Isometric/3D
	DT	Detail
	EL	Elevation
	EP*	Enlarged Plan
	FL	Floor Patterns
	LG	Legend
	QP*	Equipment Plan
	RP	Furniture Plan
	SC*	Section
	SH*	Schedule
	SP	Signage Placement Plan
	WP	System Furniture Plan
	XD*	Existing/Demolition Plan
Fire Protection	3D*	Isometric/3D
	DG*	Diagram
	DT	Detail
	FA	Fire Alarm/Detection Plan
	FP	Fire Suppression Plan
	LG	Legend
	LP	Life Safety Plan
	SH*	Schedule
	XD*	Existing/Demolition Plan
Plumbing	3D*	Isometric/3D
	DG	Diagram
	DT	Detail

* = No Model File Table available in Appendix A *(Continued)*

Table 2-2 (Concluded)

Discipline	Code	Definition
Plumbing	EL*	Elevation
	EP*	Enlarged Plan
	LG	Legend
	PP	Piping Plan
	SH*	Schedule
	XD*	Existing/Demolition Plan
Mechanical	3D*	Isometric/3D
	DG	Diagram
	DT	Detail
	EL	Elevation
	EP*	Enlarged Plan
	HP	HVAC Plan
	HS	Hydraulic Systems
	HT	HTCW Utilities Plan
	LG	Legend
	MD	Machine Design Plan
	MH	Material Handling Plan
	QP*	Equipment Plan
	SC	Section
	SH*	Schedule
	SP	Specialty Piping and Equipment Plan
	XD*	Existing/Demolition Plan
Electrical	AL	Airfield Lighting Plan
	AP*	Auxiliary Power Plan
	CP	Exterior Communication Systems Plan
	DG	Diagram
	DT	Detail
	EU	Electrical Utilities Plan
	GP	Grounding System Plan
	LG	Legend
	LP	Lighting Plan
	PP	Power Plan
	SH*	Schedule
	SS	Special Systems Plan
	XD*	Existing/Demolition Plan
Telecommunications	DG	Diagram
	DT	Detail
	LG	Legend
	SH*	Schedule
	TP	Telephone/Data Plan
	XD*	Existing/Demolition Plan

* = No Model File Table available in Appendix A

Existing/Demolition model file naming. There are instances when a facility is being renovated and the as-built designs need to be revised to show demolition and new items. These revisions would not be made on existing as-built model files, but on copies to ensure the original as-builts are not modified.

A model file type, Existing/Demolition (XD), has been added to the standard to allow users to make revisions to as-built files. This model file type is used to aid users in separating existing-to-remain items from items that will be demolished.

Example. An architect has an existing as-built floor plan model file for Building 1000, 2nd floor. For the current project, walls will be demolished and new walls constructed on the 2nd floor. First, a copy would be made of the original as-built file (B1000A-FPF2XX.dgn/dwg) , and the copy would be named B1000RENA-XDF2XX.dgn/dwg (B1000REN is the Project Code, A- is the Discipline Designator, XD is the Model File Type (Existing/Demolition Plan), and F2XX are user-definable characters (F2=Floor 2)). The architect would open this file and move all demolition items to demolition levels/layers (see Chapter 4, "Status (phase) levels/layers"). When the new items in the Floor Plan are drawn, the architect would open a new model file called something like B1000RENA-FPF2XX.dgn/dwg (B1000REN is the Project Code, A- is the Discipline Designator, FP is the Model File Type (Floor Plan), and F2XX are user-definable characters (F2=Floor 2)). The file

B1000RENA-XDF2XX.dgn/dwg

would be referenced in with the demolition levels/layers turned off. The architect would then use the Floor Plan active levels/layers to construct the new items for that project.

Sheet file naming convention

The sheet file naming convention (Figure 2-5) has one optional field for the Project Code, followed by four mandatory fields. Similar to the format for model file naming, all mandatory fields must be used and in the correct sequence.

The first field is entirely optional and can be used for a 0- to 20-character Project Code (see "Model file naming convention"). The next two characters are the Discipline Designator with Level 2 Designator (Table 2-3). The next character is the Sheet Type Designator (Table 2-4) followed by a two-character Sheet Sequence Number (01-99).

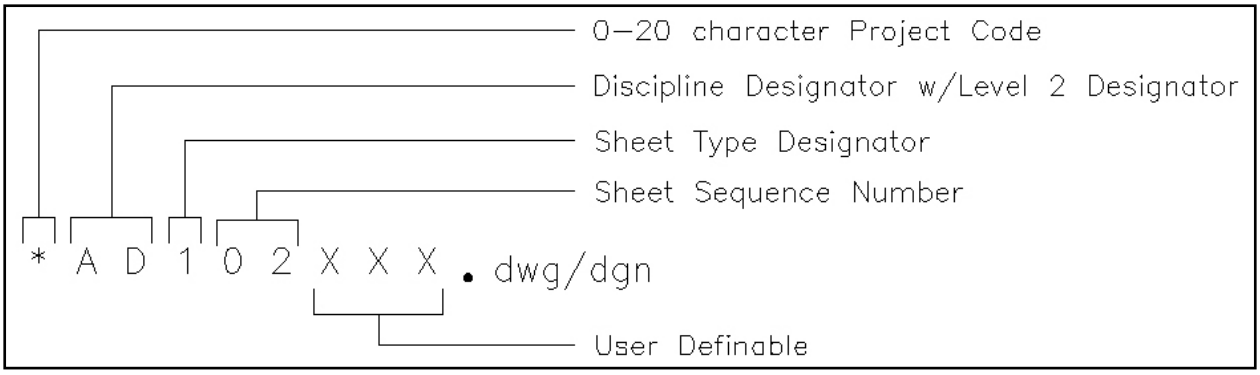


Figure 2-5. Sheet file naming convention

The remaining three characters are user definable.

Note: *If the sheet sequence number goes above 99 sheets for a particular discipline, the first character in the User Definable field could be used to expand the limit of sheets per discipline to 999. However, if more than 99 sheets are required for one discipline's drawings, the user might want to consider using the Level 2 Designator in the Discipline Designator to further subdivide the discipline (Table 2-3).*

Note: *Occasionally, more than one Sheet Type (e.g., plan, elevation, detail) will be represented in one sheet file. If this is the case, the dominant Sheet Type determines the Sheet Type Designator.*

For example, the sheet file name for a project at ERDC, Building 8000, 1st floor, Quadrant B, Architectural Floor Plan, sheet sequence 02 could be:

ERDC8000A-102F1B.dgn/dwg

where ERDC8000 is the Project Code, A- is the Discipline Designator, 1 is the Sheet Type Designator (Plan), 02 is the Sheet Sequence Number, and F1B is a user-definable set of characters for Floor 1, Quadrant B.

Table 2-3
Discipline Designators with Level 2 Designators

Discipline	Designator	Description	Content
General	G-	All General	All or any portion of subjects in the following Level 2 Designators
	GI	General Informational	Drawing index, code summary, symbol legend, orientation maps
	GC	General Contractual	Phasing, schedules, contractor staging areas, fencing, haul routes, erosion control, temporary and special requirements
	GR	General Resource	Photographs, soil borings
Hazardous Materials	H-	All Hazardous Materials	All or any portion of subjects in the following Level 2 Designators
	HA	Asbestos	Asbestos abatement, identification, or containment
	HC	Chemicals	Toxic chemicals handling, removal or storage
	HL	Lead	Lead piping or paint removal
	HP	PCB	PCB containment and removal
	HR	Refrigerants	Ozone depleting refrigerants
Survey/Mapping	V-	All Survey/Mapping	All or any portion of subjects in the following Level 2 Designators
	VA	Aerial Survey	
	VF	Field Survey	
	VH*	Hydrographic Survey	
	VI	Digital Survey	
	VU	Combined Utilities	
Geotechnical	B-	All Geotechnical	All or any portion of subjects in the following Level 2 Designators
Civil	C-	All Civil	All or any portion of subjects in the following Level 2 Designators
	CB*	Civil Beach Renourishment	Beach Disposal and Renourishment
	CD	Civil Demolition	Structure removal and site clearing
	CE*	Civil Ecosystem Restoration	Environmental restoration
	CF*	Civil Flood Control	Levees, spillways, pump stations
	CG	Civil Grading	Excavation, grading, drainage, erosion control, retention ponds
	CI	Civil Improvements	Pavers, flagstone, exterior tile, furnishings, retaining walls, and water features
	CN*	Civil Navigation	Navigation, harbors, dredging
	CO*	Civil Operation and Maintenance	Repair and upgrade to O&M structures
	CP	Civil Paving	Roads, driveways, parking lots
	CH*	Civil Shore Protection	Erosion protection structures on shoreline
	CR*	Civil Recreation	Recreation facilities
	CS	Civil Site	Plats, topographic, dimension control
	CX*	Civil Security	Security-related work
	CT	Civil Transportation	Waterways, wharves, docks, trams, railways, airfields, and people movers
	CU	Civil Utilities	Water, sanitary sewer, storm sewer, power, communications, natural gas, and steam systems

** = Not in NCS 3.1* *(Continued)*

Table 2-3 (Continued)

Discipline	Designator	Description	Content
Landscape	L-	All Landscape	All or any portion of subjects in the following Level 2 Designators
	LD	Landscape Demolition	Protection and removal of existing landscape
	LI	Landscape Irrigation	
	LP	Landscape Planting	
Structural	S-	All Structural	All or any portion of subjects in the following Level 2 Designators
	SD	Structural Demolition	Protection and removal
	SS	Structural Site	
	SB	Structural Substructure	Foundations, piers, slabs, and retaining walls
	SF	Structural Framing	Floors and roofs
Architectural	A-	All Architectural	All or any portion of subjects in the following Level 2 Designators
	AS	Architectural Site	
	AD	Architectural Demolition	Protection and removal
	AE	Architectural Elements	General architectural
	AI	Architectural Interiors	
	AF	Architectural Finishes	
	AG	Architectural Graphics	
Interiors	I-	All Interiors	All or any portion of subjects in the following Level 2 Designators
	ID	Interior Demolition	
	IN	Interior Design	
	IF	Interior Furnishings	
	IG	Interior Graphics	Murals and visuals
Equipment	Q-	All Equipment	All or any portion of subjects in the following Level 2 Designators
	QA	Athletic Equipment	Gymnasium, exercise, aquatic, and recreational
	QB	Bank Equipment	Vaults, teller units, ATMs, drive-through
	QC	Dry Cleaning Equipment	Washers, dryers, ironing, and dry cleaning
	QD	Detention Equipment	Prisons and jails
	QE	Educational Equipment	Chalkboards, library
	QF	Food Service Equipment	Kitchen, bar, service, storage, and processing
	QH	Hospital Equipment	Medical, exam, and treatment
	QL	Laboratory Equipment	Science labs, planetariums, observatories
	QM	Maintenance Equipment	Housekeeping, window washing, and vehicle servicing
	QP	Parking Lot Equipment	Gates, ticket, and card access
	QR	Retail Equipment	Display, vending, and cash register
	QS	Site Equipment	Bicycle racks, benches, playgrounds
	QT	Theatrical Equipment	Stage, movie, rigging systems
	QV	Video/Photographic Equipment	Television, darkroom, and studio
	QY	Security Equipment	Access control and monitoring, surveillance
Fire Protection	F-	All Fire Protection	All or any portion of subjects in the following Level 2 Designators
	FA	Fire Detection and Alarm	
	FX	Fire Suppression	Fire extinguishing systems and equipment

** = Not in NCS 3.1* *(Continued)*

Table 2-3 (Continued)

Discipline	Designator	Description	Content
Plumbing	P-	All Plumbing	All or any portion of subjects in the following Level 2 Designators
	PS	Plumbing Site	Extensions and connections to Civil Utilities
	PD	Plumbing Demolition	Protection, termination, and removal
	PP	Plumbing Piping	Piping, valves, and insulation
	PQ	Plumbing Equipment	Pumps and tanks
	PL	Plumbing	Domestic water, sanitary and storm drainage, fixtures
Process	D-	All Process	All or any portion of subjects in the following Level 2 Designators
	DS	Process Site	Extension and connection to civil utilities
	DD	Process Demolition	Protection, termination, and removal
	DL	Process Liquids	Liquid process systems
	DG	Process Gases	Gaseous process systems
	DP	Process Piping	Piping, valves, insulation, tanks, pumps, etc.
	DQ	Process Equipment	Systems and equipment for thermal, electrical, materials handling, assembly and manufacturing, nuclear, power generation, chemical, refrigeration, and industrial processes
	DE	Process Electrical	Electrical exclusively associated with a process and not the facility
	DI	Process Instrumentation	Instrumentation, measurement, recorders, devices and controllers (electrical and mechanical)
Mechanical	M-	All Mechanical	All or any portion of subjects in the following Level 2 Designators
	MS	Mechanical Site	Utility tunnels and piping between facilities
	MD	Mechanical Demolition	Protection, termination, and removal
	MH	Mechanical HVAC	Ductwork, air devices, and equipment
	MP	Mechanical Piping	Chilled and heating water, steam
	MI	Mechanical Instrumentation	Instrumentation and controls
	MY*	Mechanical Hydraulic Systems	Pump stations, spillways, slide gates
Electrical	E-	All Electrical	All or any portion of subjects in the following Level 2 Designators
	EA*	Electrical Airfield Lighting and Navaids	Visual air navigation systems
	ES	Electrical Site	Exterior electrical systems (power, lighting, auxiliary)
	EC*	Electrical Cathodic Protection	Cathodic protection systems
	EG*	Electrical Grounding	Grounding, lightning protection devices
	ED	Electrical Demolition	Protection, termination, and removal
	EP	Electrical Interior Power	Interior power
	EL	Electrical Interior Lighting	Interior lighting
	EI	Electrical Instrumentation	Controls, relays, instrumentation, and measurement devices
	EY	Electrical Interior Auxiliary Systems	Alarms, nurse call, security, CCTV, PA, music, clock, and program

** = Not in NCS 3.1* *(Continued)*

Table 2-3 (Concluded)

Discipline	Designator	Description	Content
Telecommunications	T-	All Telecommunications	All or any portion of subjects in the following Level 2 Designators
	TD*	Telecommunications Demolition	Protection, termination, and removal
	TA	Audio Visual	Cable, music, and CCTV systems
	TC	Clock and Program	Time generators and bell program systems
	TI	Intercom	Intercom and public address systems
	TM	Monitoring	Monitoring and alarm systems
	TN	Data Networks	Network cabling and equipment
	TS*	SCADA	Supervisory Control and Data Acquisition (SCADA) systems and equipment
	TT	Telephone	Telephone systems, wiring, and equipment
	TY	Security	Access control and alarm systems
Resource	R-	All Resource	All or any portion of subjects in the following Level 2 Designators
	RC	Resource Civil	Surveyor's information and existing civil drawings
	RS	Resource Structural	Existing facility structural drawings
	RA	Resource Architectural	Existing facility architectural drawings
	RM	Resource Mechanical	Existing facility mechanical drawings
	RE	Resource Electrical	Existing facility electrical drawings
Other Disciplines	X		
Contractor/Shop Drawings	Z		
Operations	O		

* = Not in NCS 3.1

Table 2-4
Sheet Type Designators

Sheet Type	Designator
General (symbols legend, notes, etc.)	0
Plans (horizontal views)	1
Elevations (vertical views)	2
Sections (sectional views)	3
Large-Scale Views (plans, elevations, or sections that are not details)	4
Details	5
Schedules and Diagrams	6
User Defined	7
User Defined	8
3D Representations (isometrics, perspectives, photographs)	9

Coordination Between Sheet File Name and Sheet Identifier

In assigning a sheet identifier (for use in the sheet identification block, reference bubbles, etc.), the user should coordinate with the name assigned to the electronic sheet file. The sheet identifier should consist of the discipline designator, sheet type designator, and the sheet sequence number (Figure 2-6).

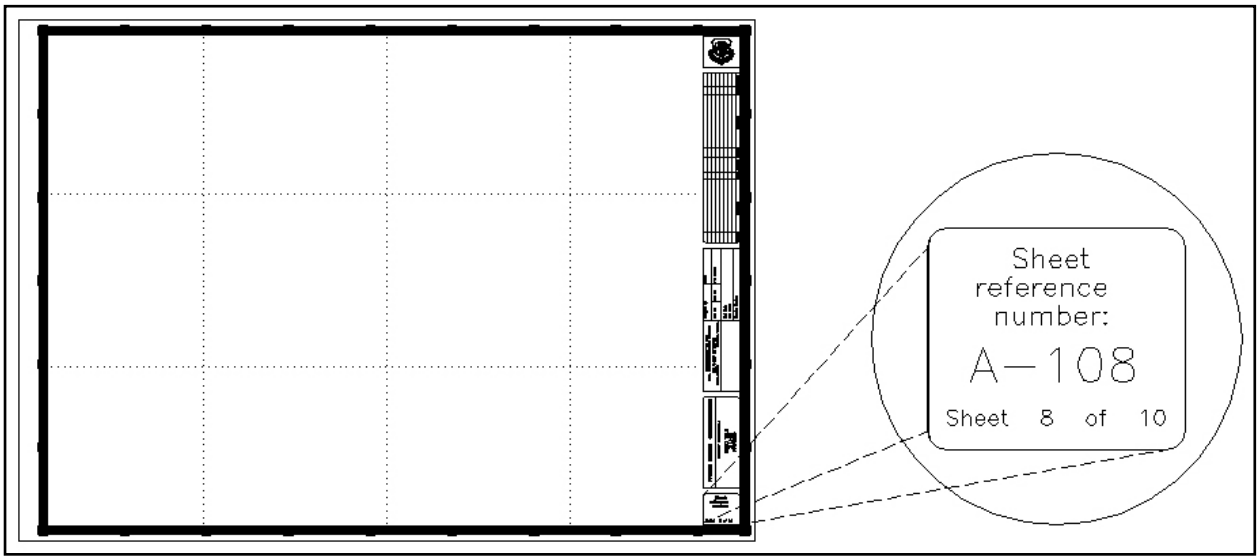


Figure 2-6. Typical border sheet title block with sheet identification block

As far as the sequence of the discipline designators in a drawing set, the National CAD Standard mandates that the disciplines follow the order as shown in Table 2-1.

3 Graphic Concepts

Presentation Graphics

The first step in establishing an effective CADD standard is the development of a uniform approach to presentation graphics. Presentation graphics typically consist of drawing elements such as lines, arcs, shapes, text, and their attributes (line color, line width, and line style). This chapter presents brief overviews of the characteristics of presentation graphics and the philosophy used to standardize them.

Line widths

Although "monotone" line work is not contractually improper, varied line widths substantially improve readability. Most commercial CADD systems provide an extensive variety of line widths. However, for the majority of A/E/C drawings, the eight line widths defined in Table 3-1 are considered sufficient and should not be expanded unless an appreciable improvement in drawing clarity or contrast can be realized. Table 3-1 shows information about the various allowed line widths.

Table 3-1
Comparison of Line Widths

Line Thickness	mm	in.	MicroStation Line Weight	Typical Use
Fine	0.18	0.007	wt = 0	Patterning
Thin	0.25	0.010	wt = 1	Dimension lines, dimension leader/witness lines, note leader lines, long break lines, schedule grid lines, and objects seen at a distance
Medium	0.35	0.014	wt = 2	Minor object lines
Wide	0.50	0.020	wt = 3	Major object lines, cut lines, section cutting plane lines, and titles
Extra Wide	0.70	0.028	wt = 5	Minor title underlining, match lines, schedule outlines, large titles, and object lines requiring special emphasis
XX Wide	1.00	0.040	wt = 7	Major title underlining and separating portions of drawings
XXX Wide	1.40	0.055	wt = 10	Border sheet outlines and cover sheet line work
XXXX Wide	2.00	0.079	wt = 15	Border sheet outlines and cover sheet line work

- Fine (0.18 mm). Fine lines should be used sparingly, mostly for hatching/patterning (this line thickness typically does not reproduce well in blue-line format and/or in photocopies).

- Thin (0.25 mm). Thin lines should be used for depicting dimension lines, dimension leader/witness lines, note leader lines, line terminators (arrowheads, dots, slashes), phantom lines, hidden lines, center lines, long break lines, schedule grid lines, and object lines seen at a distance.

- Medium (0.35 mm). Medium lines should be used for depicting most object lines, text (dimensions, notes/callouts, and schedule), and schedule grid accent lines.

- Wide (0.50 mm). Wide lines should be used for major object lines, cut lines, section cutting plane lines, and titles.

- Extra wide (0.70 mm). Extra-wide lines should be used for minor title underlining, schedule outlines, large titles, and object lines requiring special emphasis. For very large scale details drawn at 3 in. = 1 ft-0 in. or larger, the extra-wide width should be used for the object lines. Extra-wide widths are also appropriate for use as an elevation grade line, building footprint, or top of grade lines on section/foundation details.

- XX Wide (1.00 mm). This line weight should be used for major title underlining and separating portions of drawings.

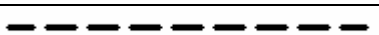
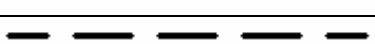
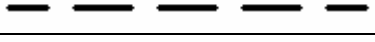
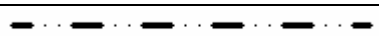
- XXX Wide (1.40 mm). This line weight should be used for border sheet outlines and cover sheet line work.

- XXXX Wide (2.00 mm). This line weight should be used for border sheet outlines and cover sheet line work.

Line types/styles

The predominant line types/styles used in this standard are listed in Table 3-2. The CGTC has created line style files for MicroStation and AutoCAD (called tsaec.rsc and tsaec.lin, respectively), which include the line styles in Table 3-2, as well as additional discipline custom line styles (see Appendix D). These files are available on the CGTC's Internet site at *https://tsc.wes.army.mil*.

Table 3-2
Standard Line Types/Styles

ID	Description	MicroStation Designator	AutoCAD Designator	Example
0	Continuous	0	Continuous	
1	Dotted	1	Dot	
2	Dashed	2	Hidden	
3	Dashed spaced	3	Dashed	
4	Dashed dotted	4	Dashdot	
6	Dashed double-dotted	6	Divide2	
7	Chain	7	Center	

Line color

The primary reason to use color in CADD drawings is to improve the clarity of the drawing on a computer monitor. The variety of colors available in a CADD application depends on the capabilities of the computer monitor and its video card. Today, most systems are capable of displaying up to 16.8 million colors. For consistency, this manual recommends that all A/E/C drawings be created using the basic colors presented in Table 3-3 whenever possible.

Note: *The recommended colors are best viewed on a monitor with a black background.*

Appendix C contains a 256-color map for the AutoCAD and MicroStation color palettes. The table maps AutoCAD's default color palette to MicroStation's default color palette. The color table is provided for those users who require more colors than the eight shown in Table 3-3.

Table 3-3
Screen Color Comparison

Color	Color Number		Ratios of RGB		
	AutoCAD	MicroStation	Red	Green	Blue
Blue	5	1	0	0	255
Gray	8	9	128	128	128
Green	3	2	0	255	0
Red	1	3	255	0	0
Yellow	2	4	255	255	0
Magenta	6	5	255	0	255
Cyan	4	7	0	255	255
White	7	0	255	255	255

Note: Color numbers for AutoCAD and MicroStation were taken from default color tables.

Screening

Screened images are created through a process in which the density and pattern of black and white dots are varied to simulate different shades of gray. Varying the intensity of gray scales allows users to distinguish different aspects of a drawing when it is plotted. For example, an area on a site designated for demolition can be assigned a color that has been assigned a screening percentage. When plotted, the area will be shown at a lighter shade compared with other elements in the drawing. This will allow the contractor to immediately identify the demolition area on the drawing.

Table 3-4 lists colors recommended to be used for screening along with a recommended screening percentage. Optionally, when variations in screening are not important, a single screening can be applied to all screened graphics.

Table 3-4
Screened Colors

AutoCAD		MicroStation		Gray Scale Ratios (RGB)		
Color No.	Screen percent	Color No.	Screen percent	Red	Green	Blue
250	60	8	60	102	102	102
251	50	200	50	128	128	128
252	40	168	40	153	153	153
253	30	120	30	179	179	179
254	20	56	20	204	204	204

Text styles/fonts

Each of the two major CADD platforms contains sets of fonts that have been designed for use in CADD drawing presentation. MicroStation has various fonts stored in font resource files, with each resource file capable of containing multiple fonts. AutoCAD has individual fonts as shape files. In addition, each platform has the ability to support True Type fonts that are installed on the individual computer. Although True Type fonts present a very useful alternative for fonts, there are drawbacks with their use. The most notable drawback is the longer time for rendering the drawing on the screen, and the longer time required for actual plotting. Each application also has the ability to create additional fonts for its use. Since projects designed in CADD are planned for use many years into the future and files will be used by many different individuals, use of any nonstandard font is not recommended. This includes fonts for symbology, logos, business titles, etc.

There is not a direct relationship between MicroStation resource files and AutoCAD shape files. Therefore it is important that font use be reviewed at the start of a project and decisions made on fonts that are then used consistently throughout the project by all disciplines. If a project is to be exchanged between CADD platforms either because individual offices require different CADD applications, or because the end user requires a specific software format, a general guideline would be to use True Type fonts. This would allow direct translations between the applications. If a project is to be designed in a single CADD application and there is no likelihood that there will be a need to translate it to a different CADD platform, then the native CADD application fonts should be used.

Contrasting text styles (or fonts) are used within a drawing to delineate types of information. In most A/E/C drawings, the fonts shown in Table 3-5 should be sufficient.

- Monotext font. This font creates text characters that are evenly spaced. Monotext font should be used where text fields need to be aligned such as in schedules or, in some cases, title blocks.

- Proportional font. This font creates text where the characters are proportionally spaced. It is appropriate for general notes, labels, or title blocks.

- Slanted font. A slanted font is used where text needs to be easily distinguished from other text.

- Filled font. Filled fonts are used primarily for titles and on cover sheets.

- Outline font. When a pen plotter is used for final output, the outline font is used as a substitute for filled fonts for major titles such as cover sheet information to save plotting time.

- Symbology font. This font should be used in cases where Greek symbols are representations for technical information.

Table 3-5
Comparison of Font Types

Font Type	MicroStation	AutoCAD	True Type
Monotext	Font #3 ABCDEFGHIJKLMNOPQRST UVWXYZ abcdefghijklmnopqrst uvwxyz	monotxt ABCDEFGHIJKLMNOPQRST UVWXYZ abcdefghijklmnopqrst uvwxyz	Monospace 821 BT ABCDEFGHIJKLMNOPQRST UVWXYZ abcdefghijklmnopqrst uvwxyz
Proportional	Font #1 ABCDEFGHIJKLMNOPQRST UVWXYZ abcdefghijklmnopqrst uvwxyz	romans ABCDEFGHIJKLMNOPQRST UVWXYZ abcdefghijklmnopqrst uvwxyz	Arial ABCDEFGHIJKLMNOPQRST UVWXYZ abcdefghijklmnopqrst uvwxyz
Slanted	Font #23 *ABCDEFGHIJKLMNOPQRST* *UVWXYZ* *abcdefghijklmnopqrst* *uvwxyz*	romans (obliquing angle = 21.8) *ABCDEFGHIJKLMNOPQRST* *UVWXYZ* *abcdefghijklmnopqrst* *uvwxyz*	Arial (slanted by 21.8 degrees) ***ABCDEFGHIJKLMNOPQRST*** ***UVWXYZ*** ***abcdefghijklmnopqrst*** ***uvwxyz***
Filled	Font #43 **ABCDEFGHIJKLMNOPQRST** **UVWXYZ** **abcdefghijklmnopqrst** **uvwxyz**	Swiss 721 BT **ABCDEFGHIJKLMNOPQRST** **UVWXYZ** **abcdefghijklmnopqrst** **uvwxyz**	Swiss 721 BT **ABCDEFGHIJKLMNOPQRST** **UVWXYZ** **abcdefghijklmnopqrst** **uvwxyz**
Outline	Font #42 ABCDEFGHIJKLMNOPQRST UVWXYZ abcdefghijklmnopqrst uvwxyz	Swiss 721 Black Outline BT ABCDEFGHIJKLMNOPQRST UVWXYZ abcdefghijklmnopqrst uvwxyz	Swiss 721 Black Outline BT ABCDEFGHIJKLMNOPQRST UVWXYZ abcdefghijklmnopqrst uvwxyz
Symbology	Font #26 ΑΒΧΔΕΦΓΗΙΦΚΛΜΝΟΠΞΡΣΤ ΥΦΩΧΨΖ αβχδεφγηιφκλμνοπξρστ υφωχψζ	greekc ΑΒΧΔΕΦΓΗΙ?ΚΛΜΝΟΠΘΡΣΤ ΥΩΞΨΖ αβχδεφγηι?κλμνοπθρστ υεωξψζ	Symbol ΑΒΧΔΕΦΓΗΙϑΚΛΜΝΟΠΘΡΣΤ ΥςΩΞΨΖ αβχδεφγηιφκλμνοπθρστ υϖωξψζ

Abbreviations

Abbreviations for words or phrases frequently used in plans, sections, elevations, or details should follow the abbreviations as established in the NCS (UDS Module 5 – Terms and Abbreviations). When possible, the use of abbreviations should be kept to a minimum. Other abbreviations, particularly discipline-unique abbreviations, may be used but must not conflict with those established in the NCS. The NCS Standard is available for purchase from the National Institute of Building Sciences at *http://www.nibs.org/ncsorderform.html*.

Plotting

Printers and plotters are controlled by files called pen tables or feature tables. These files (tables) convert thicknesses and/or color in an electronic file to line thicknesses on a paper drawing.

This manual standardizes presentation graphics as they relate to electronic drawing files (screen display) and not the final printed or plotted paper drawing. By employing pen tables, each agency can ensure that consistent drawings are produced from an electronic file regardless of the type of printer or plotter used. It is the responsibility of each field activity to develop pen tables based on the printer/plotter used at that activity.

Border Sheets

Sheet sizes

Typical A/E/C projects (contract documents) will be prepared on American National Standards Institute (ANSI) D sheets (ANSI E may be used for large maps (i.e., installation master plans and drawings for civil works projects)). For international projects, International Organization for Standardization (ISO) A1 sheets are to be used (ISO A0 may be used for large maps). Other industry standard sizes may be used depending on specific customer requirements. Table 3-6 lists the standard sizes of all sheets.

Table 3-6
ISO, ANSI, and Architectural Sheet Size Comparison

ISO Designation	Width		Length		ANSI Equivalent		Architectural Equivalent	
	mm	in.	mm	in.	Letter	in.	Letter	in.
NA	NA	NA	NA	NA	F	28.0 x 40.0	F	30.0 x 42.0
A0	841	33.11	1189	46.81	E	34.0 x 44.0	E	36.0 x 48.0
A1	594	23.39	841	33.11	D	22.0 x 34.0	D	24.0 x 36.0
A2	420	16.54	594	23.39	C	17.0 x 22.0	C	18.0 x 24.0
A3	297	11.69	420	16.54	B	11.0 x 17.0	B	12.0 x 18.0
A4	210	8.27	297	11.69	A	8.5 x 11.0	A	9.0 x 12.0

To develop the graphics for the sheet border, the following guidelines are to be used:

- Top and bottom margin: 3/4 inch (20 mm)
- Left margin: 1-1/2 inch (40 mm)
- Right margin: 3/4 inch (20 mm)

Note: *Users plotting A1 size drawings on ANSI D-size paper should reduce the width of the A1 border from 594 mm (23.39 in.) to 559 mm (22.0 in.). The length can remain the same. This revised border will fit on an ANSI D-size sheet (22 by 34 in.) and can be reproduced on standard office photocopiers.*

Title block

The CGTC recommends the use of a vertical title block placed in the right-hand margin of the border sheet as shown in Figure 3-1. Use of the vertical title block provides the most usable drawing space on a sheet. The vertical title block also ensures that the most prevalent and pertinent information remains at the bottom right of the sheet. In compliance with the *Uniform Drawing System* (Construction Specifications Institute (CSI) 2004), title block data will include the following:

- Designer identification block
- Issue block
- Management block
- Project identification block/sheet title block
- Sheet identification block

Note: *Local standards may modify the content of the title block but should not alter its size or configuration if possible. See the Uniform Drawing System for additional recommendations.*

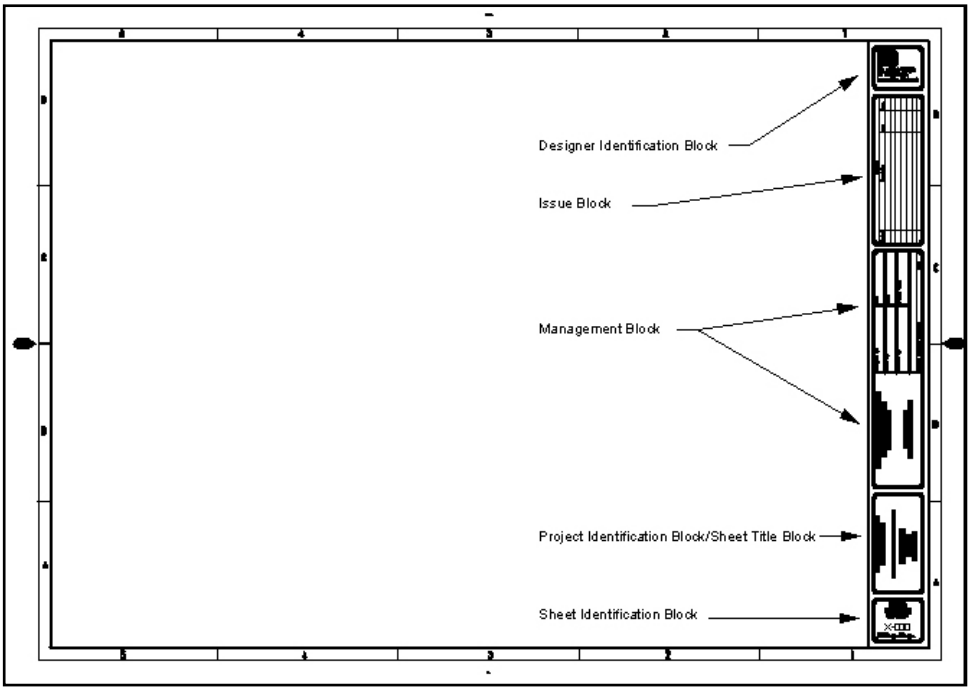


Figure 3-1. Vertical title block

Designer identification block. The designer identification block (Figure 3-2) contains the logo or name of the agency that designed the sheet. This space could also be expanded by reducing the size of the issue block to accommodate professional seals when required.

Issue block. The issue block (Figure 3-3) contains a history of revisions, addenda, and/or clarifications to the sheet. The first entry should be placed on the lower left-hand line of the issue block and subsequent entries should be made above it.

Management block. The management block (Figure 3-4) contains information about the designer, reviewer, and submitter. This block can also be used to maintain filing information about the drawing, such as the file name, plot scale, and drawing code (this information is sometimes plotted outside the drawing sheet cut line). If an A-E has developed the drawings, there is room for information about the firm in the lower left portion of the block.

The management block can also contain authorization block information. This is typically where the principals of the design agent would sign drawings, either for a whole project or by individual disciplines. Also, sometimes a disclaimer is included stating whether the project was designed by a Government agency or through a contract with a Government agency.

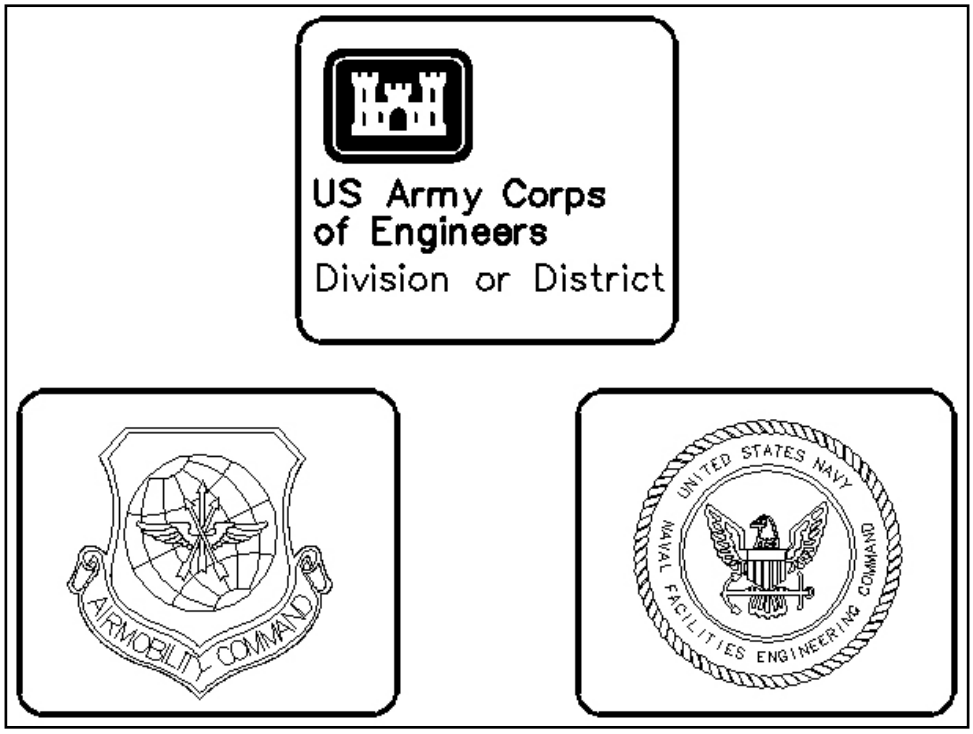


Figure 3-2. Designer identification block

Revisions			
Symbol	Description	Date	Appr.

Figure 3-3. Issue block

U. S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS DISTRICT, STATE AE DESIGN FIRM COMPANY INFORMATION	Designed by:	Date
	Drawn by:	Scale:
	Checked by:	Drawing code:
	Project Engineer/Architect:	Date:

Figure 3-4. Management block

Project identification block/sheet title block. The project identification block/sheet title block (Figure 3-5) contains two sets of information. First, the project name is identified, possibly with the location or phase of the project identified. If small enough, a project logo can be presented in this block. The second set of information contains a description of the

content of the sheet (e.g., Architectural Floor Plan). If more than one type of information is presented on the sheet (i.e., plans, schedules, details), the most important information is identified.

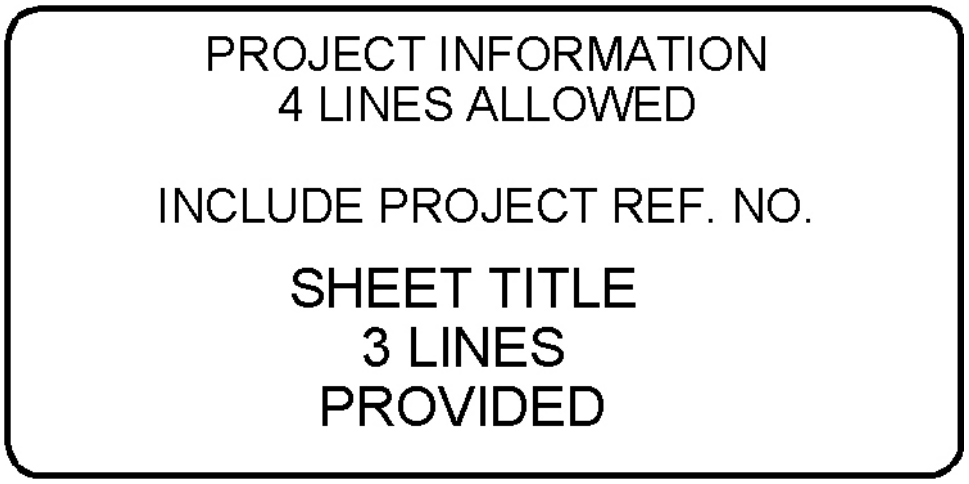


Figure 3-5. Project identification block/sheet title block

Sheet identification block. The sheet identification block (Figure 3-6) contains the sheet identifier. This sheet identifier is composed of the discipline designator, the sheet type designator, and the sheet sequence number described in the section, "Electronic Drawing File Naming Conventions" (Chapter 2). The "number of sheets" listing is optional and can contain either the total number of sheets for the entire project drawing set or the number of sheets for that particular discipline designator.

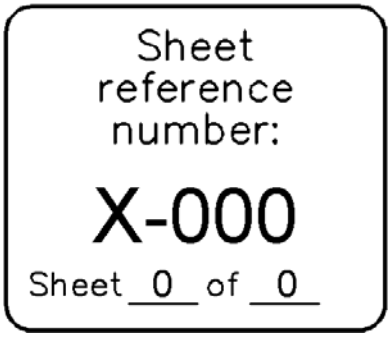


Figure 3-6. Sheet identification block

Drawing Scales

Typical drawing scales for both SI and inch-pound measurements are indicated in Table 3-7.

The National CAD Standard (National Institute of Building Sciences (NIBS) 2005) recommends that the minimum text height for plotted CADD files is 3/32" (2.4 mm). However, to maintain legibility in half-size

drawings, most sites go no lower than 1/8” (3 mm) in text height. Table 3-8 lists recommended text sizes for common inch-pound scales, as well as line type scale factors for those scales. Table 3-9 lists recommended text sizes for common metric scales. (Note: The scales shown are not all-inclusive. Scales used should be limited to those commonly found on hand-held architectural, mechanical, and engineering scales.)

Table 3-7
Typical Drawing Scales

Drawing Type	Metric	Inch-Pound
Site Plans	1:200	1" = 20'
	1:400	1" = 30'
	1:500	1" = 40'
	1:600	1" = 50'
	1:700	1" = 60'
	1:1000	1" = 100'
	1:2000	1" = 200'
	1:5000	1" = 400'
	1:6000	1" = 500'
	1:10000	1" = 1000'
	1:20000	1" = 2000'
Floor Plan	1:50	1/4" = 1' - 0"
	1:100	1/8" = 1' - 0"
	1:200	1/16" = 1' - 0"
Roof Plan	1:200	1/16" = 1' - 0"
Exterior elevations	1:100	1/8" = 1' - 0"
	1:200	1/16" = 1' - 0"
Interior Elevations	1:50	1/4" = 1' - 0"
	1:100	1/8" = 1' - 0"
Cross sections	1:50	1/4" = 1' - 0"
	1:100	1/8" = 1' - 0"
	1:200	1/16" = 1' - 0"
Wall sections	1:20	1/2" or 3/4" = 1' - 0"
Stair details	1:10	1" or 1-1/2" = 1' - 0"
Details	1:5	3" = 1' - 0"
	1:10	1" or 1-1/2" = 1' - 0"

Table 3-8
Inch-pound Text Sizes and Line Type Scales

Scale	Text Size	Line Type Scale
12" = 1' - 0" or Full Size	0.125"	1
6” = 1’-0”	0.25”	2
3" = 1' - 0"	0.50"	4
1-1/2" = 1' - 0"	1"	8
1" = 1' - 0"	1.5"	12
3/4" = 1' - 0"	2"	16
1/2" = 1' - 0"	3"	24
3/8" = 1' - 0"	4"	32
1/4" = 1' - 0"	6"	48
3/16" = 1' - 0"	8"	64
1/8" = 1' - 0"	12"	96
3/32" = 1' - 0"	16"	128
1/16" = 1' - 0"	24"	192
1/32" = 1' - 0"	48"	384
1" = 5'	7.5"	60
1" = 10'	1.25’	120
1" = 20'	2.5’	240
1" = 30'	3.75’	360
1" = 40'	5’	480
1" = 50'	6.25’	600
1" = 60'	7.5’	720
1" = 100'	12.5’	1200
1" = 200'	25’	2400
1" = 400'	50’	4800
1" = 500'	62.5’	6000
1" = 1000'	125’	12000
1" = 2000'	250’	24000

Table 3-9
Metric Text Sizes and Line Type Scales

Scale	Text Size	Line Type Scale
1:1 or Full Size	3 mm	1
1:2.5	7.5 mm	2.5
1:5	15 mm	5
1:10	30 mm	10
1:20	60 mm	20
1:30	90 mm	30
1:40	120 mm	40
1:50	150 mm	50
1:60	180 mm	60
1:100	300 mm	100
1:200	600 mm	200
1:400	1.2 m	400
1:500	1.5 m	500
1:600	1.8 m	600
1:700	2.1 m	700
1:1000	3.0 m	1000
1:2000	6.0 m	2000
1:5000	15 m	5000
1:6000	18 m	6000
1:10000	30 m	10000
1:20000	60 m	20000

Dimensioning

As far as the appearance of dimensions, the NCS is very specific. Dimension text heights should match the size of the text in the rest of the drawing (i.e., notes and callouts) and the location of the dimension text should be at the midpoint and top of the dimension line (where possible). Dimension lines should be offset a minimum of 9/16” (14.5 mm) and extension lines should be offset a minimum of 1/16” (1.5 mm) from the element being dimensioned. Slashes are recommended by the NCS for dimension terminators; however, filled arrowheads are allowed in the A/E/C CADD Standard, as long as the arrowhead width is 1.5 * TH (TH = dimension text height) and the height is 0.5 * TH. This achieves the NCS requirement of 3:1 filled arrowheads. Dimension terminator selection should be consistent across the entire set of drawings.

Dimensioning in Metric (SI)

Methodologies for dimensioning metric (SI) drawings are based upon the recommendations of the Construction Metrication Council of NIBS, Washington, DC. These recommendations comply with the American Society for Testing and Materials (ASTM) E 621-94 (ASTM 1999).

Millimeters

The preferred unit of measure for most A/E/C work is millimeters. Unit notations are unnecessary and should not be used. The dimension is provided as a whole number as shown in Figure 3-7. Also, a note should be added to the drawing stating, "All dimensions and/or dimensions shown in callouts/notes are in millimeters unless otherwise noted."

When meter measurements are included on the same sheet, the meter dimension is provided as a real number taken to three places past the decimal point (Figure 3-8). Again, unit notations are unnecessary.

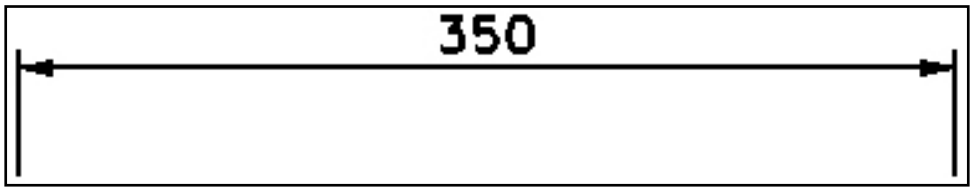


Figure 3-7. Dimension in millimeters. Always shown as a whole number

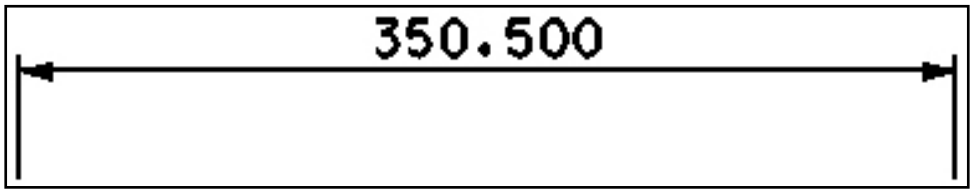


Figure 3-8. Dimension in meters. Always shown as a real number (with decimal)

Note: *In circumstances where very small dimensions are used (e.g., machine details), it is permissible to use real numbers for millimeter dimensions. A note should be placed on the detail regarding this fact.*

Meters

For site plans or other drawings drawn to scales over 1:200, the unit of measure is typically meters. Where greater accuracy is required, show dimensions to three decimal places (Figure 3-8). A note should be added to the drawing stating, "All dimensions and/or dimensions shown in callouts/notes are in meters unless otherwise noted."

Large units of measure

Commas shall not be used when providing large units of measure; instead, a space replaces the traditional comma in numbers containing five or more digits (e.g., the number 45,000 is displayed as 45 000). In numbers containing four digits, no space is necessary (e.g., 5000). These methods are shown in Figures 3-9 and 3-10.

Note: *The automatic dimensioning features of AutoCAD do not allow users to replace commas with spaces in dimension text. The dimension text will presently have to be edited to provide the spacing required by ASTM E 621-94 (ASTM 1999).*

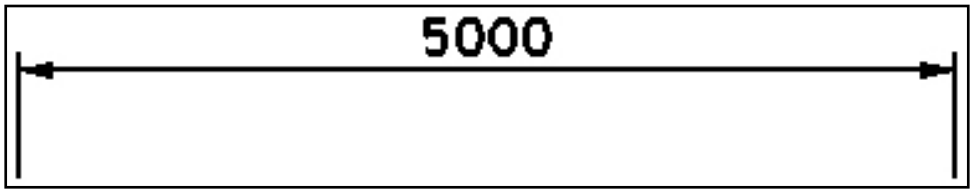


Figure 3-9. Proper dimension presentations for metric measurements with four or fewer digits

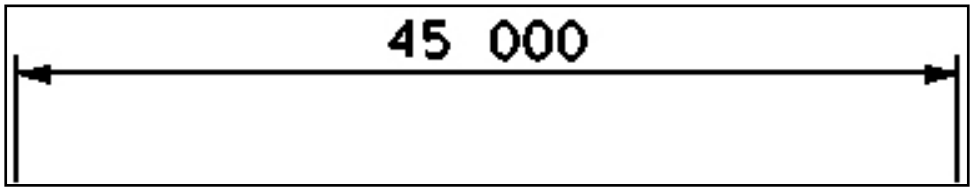


Figure 3-10. Proper dimension presentations for metric measurements with five or more digits

Dual units

To avoid confusion, dual units (both inch-pound and metric) should not be used. As stated in Construction Metrication Council (1998), the use of dual units "increases dimensioning time, doubles the chance for errors, makes drawings more confusing, and only postpones the (metric) learning process."

Exceptions to this include certain "standard building designs" where dual dimensions ensure that the design can be used in either SI or inch-pound projects and in situations where products/components used in an SI project are available only as inch-pound products.

4 Level/Layer Assignments

Levels/Layers

CADD levels or layers are analogous to overlays in manual drafting systems and serve to separate graphic elements (lines, shapes, and text) according to the design discipline they represent (Figure 4-1).

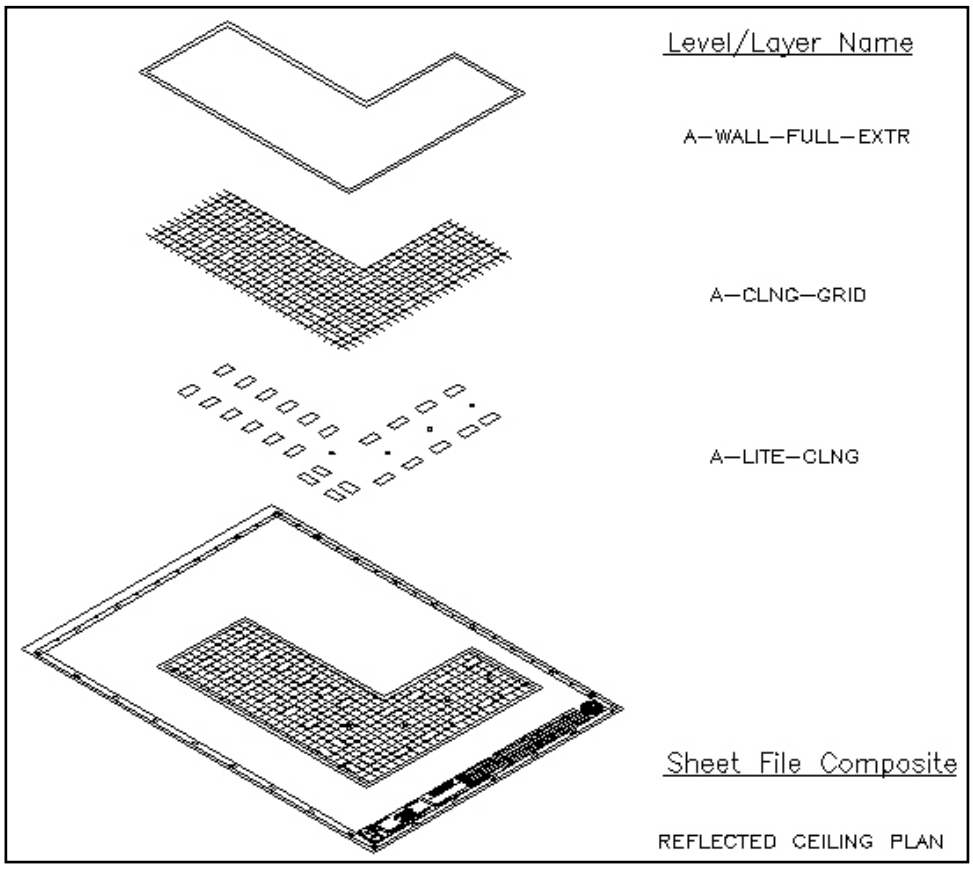


Figure 4-1. Typical levels/layers contained in a sheet file

The types of information represented by individual levels/layers can be grouped into two primary types: model-file-specific information and sheet-file-specific information (Figure 4-2). Sheet-file-specific

information can then be broken down into two secondary types: design-model-specific and sheet-model-specific.

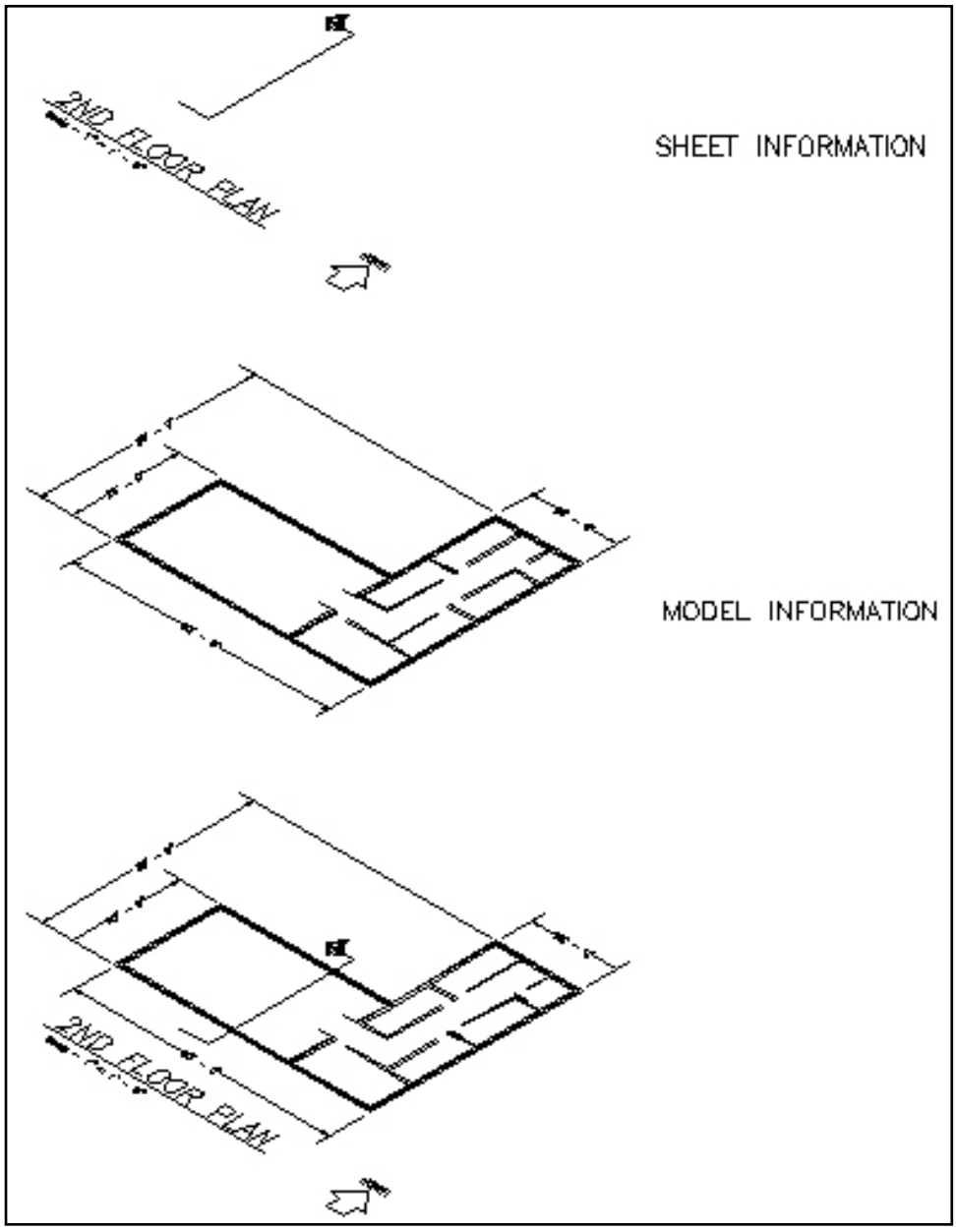


Figure 4-2. Sheet- and model-specific information

- Model-file-specific information represents the physical form of a site, a building, or objects composing a building. This information is often shared between CADD files (both model file and sheet file) through the use of reference files. Examples include walls, doors, light fixtures, and room numbers. Model-file-specific information may be either literal (e.g., walls) or symbolic (e.g., electrical outlets).

- Sheet-file-specific information may include notes, annotative symbols, and titles. This type of information is usually not shared between CADD files or drawings. Design models inside a sheet file contain graphic information that would relate to real-world information (e.g., point coordinates), or information that would be sectioned off into multiple sheets (e.g., a floor plan that may take three sheets to present because of its size). Sheet-model-specific information would include items specific for the presentation of that sheet. This is one reason that sheet models should never be used as a reference file to other files.

A third type of information exists for BIM. The files created in BIM are different from model files and sheet files because they are not directly referenced as graphics in the generation of drawings. Information from BIM is extracted and used to create the traditional models used in CADD generation of drawings.

To use and manipulate model-file- and sheet-file-specific information effectively, every level/layer must be defined (standardized) by its name and its use.

Level/layer naming convention

The reuse, not duplication, of graphic information reduces drawing time and improves project coordination. The level/layer is the basic tool used in CADD for managing graphic information (Figure 4-3). The levels/layers defined within this standard are based on the recommendations set forth in "AIA CAD Layer Guidelines" (AIA 2005).

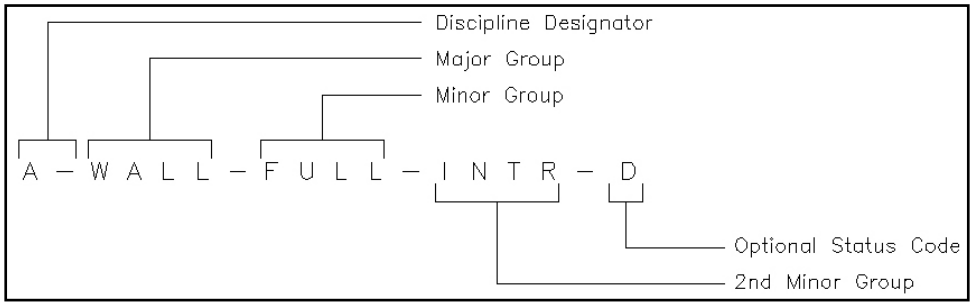


Figure 4-3. Level/layer naming format

A basic level/layer name consists of a two-character Discipline Designator (e.g., "A-" for Architectural, "M-" for Mechanical), a four-character Major Group (e.g., "DOOR" for Doors, "LITE" for Lighting Fixtures), and a four-character Minor Group (e.g., A-WALL-CNTR for wall center lines, M-HVAC-CDFF for HVAC ceiling diffusers). For further differentiation, another four-character Minor Group may be used (e.g.,

A-WALL-FULL-EXTR for exterior full-height walls versus A-WALL-FULL-INTR for interior full-height walls). An optional item to indicate Status or Phase can also be added to every level/layer name (See “Status (Phase) levels/layers” later in this chapter).

ISO format

ISO 13567-2 (1SO 1998) presents an international method for level/layer naming (Figure 4-4). This method consists of 10 mandatory alphanumeric characters, followed by 10 optional alphanumeric characters. The first two-character field, Agent Responsible, correlates to the AIA’s Discipline Designator. The following six-character field, Element, can map to a shortened version of the AIA’s Major and Minor Groups (e.g., DOOR-FULL becomes DOORFU, DOOR-PRHT becomes DOORPR). The final two-character field in the mandatory level/layer name, Presentation, designates whether the level/layer information is Model information (i.e., model-specific information) or Page/Paper information (i.e., sheet-specific information). Appendix A gives a corresponding ISO Format level/layer name for each AIA Format level/layer name.

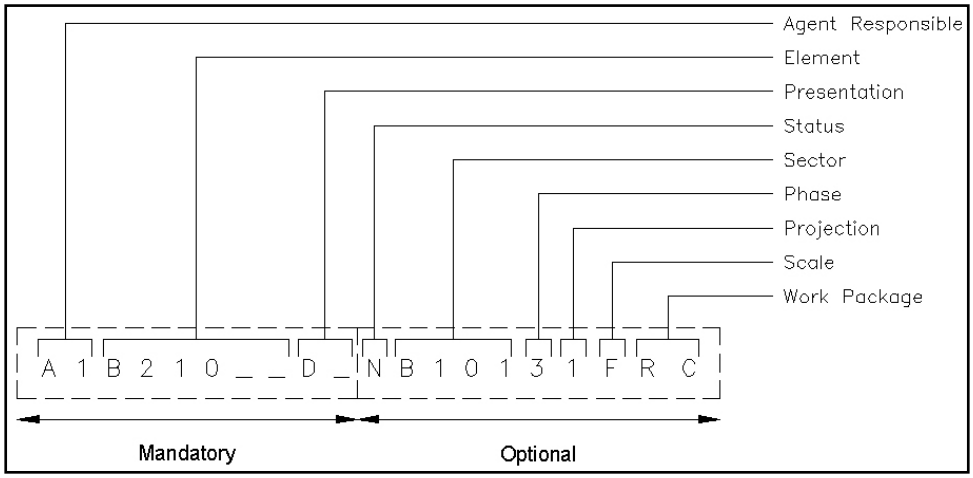


Figure 4-4. ISO 13567-2 level/layer naming method

Model Files

As mentioned in Chapter 2, model files represent full-size drawings of building elements, systems, or information (e.g., the mechanical HVAC system, the architectural floor plan, details, or sections), and sheet files represent final plotted sheets. Model files are used as components in creating plotted sheet files. The information contained within a model file for a discipline may be referenced by other disciplines to create the particular model files or sheet files for that discipline.

A model file can be considered a work in progress. For instance, a mechanical engineer may reference the architect's floor plan model file to begin development of the HVAC ductwork layout model file. Meanwhile, the architect can continue developing the floor plan to meet new requirements. Any changes to the floor plan would be immediately accessible to the mechanical engineer. The viewing of real-time updates eliminates a great deal of frustration for other disciplines because it allows for on-the-spot rather than after-the-fact modifications.

Level/layer assignment tables

The level/layer assignment tables in Appendix A present the following (Figure 4-5 presents an excerpt):

- The levels/layers assigned to each model file.
- An AIA and corresponding ISO format level/layer name for each level/layer.
- A detailed description for each level/layer.
- The recommended presentation graphics associated with each level/layer. This includes the line style, line width, and color. (Note: The recommended presentation graphics may be changed to aid in drawing clarity (e.g., to show hidden objects). However, the recommended presentation graphics should be adhered to as much as possible to maintain drawing consistency.)
- The various model files that levels/layers can be created in.

Annotation levels/layers. The function of annotation levels/layers is to contain model-specific information that might not be required by other disciplines. These levels/layers are as follows with ** representing a Discipline Designator (e.g., A-, C-):

**ANNO-DIMS
Witness/extension lines, dimension terminators, and dimension text.

**ANNO-KEYN
Reference keynotes with associated leaders.

**ANNO-NOTE
General notes and remarks.

**ANNO-NPLT
Non-plotting graphic information.

**ANNO-PATT
Patterning, poche, shading, and hatching.

**ANNO-SYMB
Miscellaneous symbols.

**ANNO-TEXT
Miscellaneous text and callouts with associated leaders.

**ANNO-RDME
Read-me information.

**ANNO-REFR
An AutoCAD user-specific layer for use in attachment of external references (i.e., reference files).

Discipline: Architectural
Model File Layers/Levels

Level/Layer Naming			Graphic Defaults				Model File Types							
AIA Format	ISO Format	Level/Layer Description	Line Style	Line Width (mm)	AutoCAD Color #	MicroStation Color #	Floor Plan	Reflected Ceiling Plan	Roof Plan	Equipment Plan	Area Calculations/Occupancy Plan	Elevations	Sections	Details
General Information														
A-ANNO-DIMS	A-----DIP-	Witness/extension lines, dimension terminators, dimension text	0	V	V	V	X	X	X	X	X	X	X	X
A-ANNO-KEYN	A-----KEP-	Reference keynotes with associated leaders	0	V	V	V	X	X	X	X	X	X	X	X
A-ANNO-NOTE	A-----NOP-	General notes and general remarks	0	0.35	2	4	X	X	X	X	X	X	X	X
A-ANNO-NPLT	A-----NPP-	Non-plotting graphic information	0	0.18	5	1	X	X	X	X	X	X	X	X
A-ANNO-PATT	A-----PAP-	Patterning, poche, shading, and hatching	V	0.18	8	9	X	X	X	X	X	X	X	X
A-ANNO-RDME	A-----RDP-	Read-me information	0	0.18	5	1	X	X	X	X	X	X	X	X
A-ANNO-REFR	A-----RFP-	Reference files (AutoCAD users only)	NA	NA	NA	NA	X	X	X	X	X	X	X	X
A-ANNO-SYMB	A-----SYP-	Miscellaneous symbols	V	V	6	5	X	X	X	X	X	X	X	X
A-ANNO-TEXT	A-----TEP-	Miscellaneous text and callouts with associated leaders	0	V	V	V	X	X	X	X	X	X	X	X
Area Information														
A-AREA-IDEN	A-AREAIDM-	Room numbers, tenant identifications, area calculations	0	0.35	2	4					X			
A-AREA-LINE	A-AREALIM-	Architectural area calculation boundary lines	0	0.50	4	7					X			
A-AREA-OCCP	A-AREAOCM-	Occupant or employee names	0	0.35	2	4					X			
A-AREA-PATT	A-AREAPAM-	Area cross hatching	0	0.18	8	9					X			

Figure 4-5. Model file level/layer assignment table

Status (Phase) levels/layers. In some cases, levels/layers may be modified to show the status of a particular item in the drawing (e.g., to be demolished, to be moved, future work, etc.). In these cases, levels/layers may have a Status Field appended to them as shown in Figure 4-3. See Table 4-1 for the Status (Phase) codes.

Table 4-1
Status (Phase) Codes

Code	Description
N	New work
E	Existing to remain
D	Existing to demolish
F	Future work
T	Temporary work
M	Items to be moved
X	Not in contract
1-9	Phase numbers

The use of the Status (Phase) code should be limited, since it can significantly increase the number of levels/layers in a model file. Most items can be shown through referenced model files or changing the line style of items. For instance, New Work can be shown in the current model file; Existing to Remain items can be shown through a screened reference file. Not in Contract items and Future Items could be shown with a dashed line style. Therefore, it is up to the user to determine whether the use of the Status (Phase) code in level/layer names increases the readability of the model file.

Border sheet model files

As mentioned before, a model file contains information that can be referenced by other disciplines to create other model files or final sheet files. Border sheets are referenced by all disciplines to create sheet files; therefore border sheets are model files. A border sheet model file contains border sheet linework, the title block, and project-specific symbols and text. Typically, each discipline will use the same border sheet and fill in sheet-specific information within the title block or revision block prior to printing the final sheet file (e.g., sheet number, designer names).

Reference files (XREFs)

Reference files (external references or XREFs) enable designers to share drawing information electronically, eliminating the need to exchange hard copy drawings between the design disciplines. With the use of reference files, the structural engineer need not wait for the architect to complete the architectural floor plans before beginning the structural framing plan model file.

Referencing electronic drawing information makes any changes later made by the architect apparent to the structural designer. This real-time

access to the work of others ensures accuracy and consistency within a set of drawings and helps promote concurrent design efforts. No longer does one discipline have to wait until another discipline is nearly finished before they begin their drawings.

However, the use of level/layer assignments is a key component in the successful use of reference files. Proper use of levels/layers allows others to use the information in various model files efficiently by allowing levels/layers to be turned on only for the desired graphics.

Sheet Files

Sheet files are the final project sheets that are ready to be plotted. A sheet file contains sheet-specific information (e.g., north arrows, scales, section cuts, title block information) in a sheet model (i.e., Paper Space for AutoCAD users). A design model inside the sheet files contains the model information assembled as it would be displayed on a sheet. This model would have real-world spatial alignment and would be used as the primary model for graphical information to be displayed and presented in the sheet model. (See Chapter 2 for more on drawing assembly.)

Level/layer assignment tables

The level/layer assignment tables in Appendix B present the following (Figure 4-6):

- The levels/layers assigned to each sheet file.
- An AIA and corresponding ISO format level/layer name for each level/layer.
- A detailed definition for each level/layer.
- The recommended presentation graphics associated with each level/layer. This includes the line style, line width, and color.

Users should note that the first 13 level/layers of the sheet file type for every discipline are the same, with the exception that the Discipline Designator changes depending on the discipline for that sheet file type. The unique function of these Annotation levels/layers is to contain sheet-specific information. These levels/layers are as follows with ** representing a Discipline Designator (e.g., A-, C-):

**ANNO-DIMS
Sheet-specific witness/extension lines, dimension terminators, and dimension text.

Discipline: Architectural

Level/Layer Naming			Graphic Defaults			
AIA Format	ISO Format	Level/Layer Description	Line Style	Line Width (mm)	AutoCAD Color #	MicroStation Color #
General Information						
A-ANNO-DIMS	A-----DIP-	Sheet-specific dimensions (includes witness/extension lines, dimension terminators, dimension	0	V	V	V
A-ANNO-KEYN	A-----KEP-	Sheet-specific reference keynotes with associated leaders	0	V	V	V
A-ANNO-LEGN	A-----LEP-	Legends and symbol keys	0	V	V	V
A-ANNO-NOTE	A-----NOP-	Sheet-specific notes and general remarks	0	0.35	2	4
A-ANNO-NPLT	A-----NPP-	Non-plotting graphic information	0	0.18	5	1
A-ANNO-PATT	A-----PAP-	Sheet-specific patterning and hatching (e.g., keyplan patterning)	0	0.18	8	9
A-ANNO-RDME	A-----RDP-	Read-me information	0	0.18	5	1
A-ANNO-REDL	A-----REP-	Redlines	0	0.25	1	3
A-ANNO-REFR	A-----RFP-	Reference files (AutoCAD users only)	NA	NA	NA	NA
A-ANNO-REVS	A-----RVP-	Revisions	0	0.50	4	7
A-ANNO-SCHD	A-----SCP-	Schedules	0	V	V	V
A-ANNO-SYMB	A-----SYP-	Sheet-specific symbols (e.g., scales, north arrow, section cuts, detail bubbles, etc.)	V	0.35	6	5
A-ANNO-TEXT	A-----TEP-	Sheet-specific text and callouts with associated leaders (e.g., title block text, legend and schedule	0	V	V	V

Figure 4-6. Sheet file level/layer assignment table

**ANNO-KEYN
Sheet-specific keynotes with associated leaders.

**ANNO-LEGN
Legends and symbol keys.

**ANNO-NOTE
Sheet-specific notes and general remarks.

**ANNO-NPLT
Non-plotting graphic information.

**ANNO-PATT
Sheet-specific patterning and hatching (e.g., keyplan patterning).

**ANNO-RDME
Read-me information.

**ANNO-REDL
Redlines.

**ANNO-REVS
Revisions, amendments, addenda, and modifications.

**ANNO-SCHD
Schedules.

**ANNO-SYMB
Sheet-specific symbols (e.g., north arrow, scales).

**ANNO-TEXT
Sheet-specific text and callouts with associated leaders.

**ANNO-REFR
An AutoCAD user-specific layer for use in attachment of external references (i.e., reference files).

Development of sheet files

As mentioned previously, referenced model files are used in the construction of sheet files. The user opens the sheet file type from Appendix B that is appropriate to his/her discipline, then references existing model files into a design model. This design model is used to generate the sheet model for that file. At this point, information can be placed on the annotation layers for the model that has been assembled.

For example, after the designer assembles the model files and creates the sheet model as described previously in Chapter 2, the designer would have to "turn off" levels/layers within each referenced model file to achieve the desired sheet file. Which method of drawing assembly is to be used determines how additional annotations are placed. In the design model/sheet model option, design-model-specific annotations can be placed in the design model. When a border sheet and the design model are referenced together to form the sheet model, the designer could then place sheet-specific annotations in the sheet model. When the single model approach is taken, the border sheet is referenced along with the design model (separate design file) into a sheet model and annotations are then placed in the sheet model. The sheet file levels/ layers such as P-ANNO-TEXT would be used to fill in sheet-specific information (e.g., sheet number, designer name). Once the final sheet file is achieved, the resulting file is saved (with all reference files attached).

5 Standard Symbology

Introduction

A “cell” in MicroStation and a “block” in AutoCAD are groups of graphical elements that can be manipulated as a single entity. Examples of typical cells/blocks are windows, doors, graphic scale keys, furniture, etc. The use of such symbology enhances CADD productivity and provides an excellent opportunity for CADD standardization.

Electronic Version of the Symbology/Elements

Deliverables

Within the electronic deliverables available as part of the A/E/C CADD Standard, the following symbology is provided:

- MicroStation cells contained in cell libraries (.cel) and custom line styles contained in resource files (.rsc).

Note: *Even though the symbols are provided in cell libraries, for MicroStation V8 each symbol is an individual .dgn file. The .cel files are groupings of those .dgn files.*

- AutoCAD blocks, each in an individual drawing (.dwg) file, patterns in a pattern library file (.pat), multilines in a multiline library file (.mln), and custom line styles in a line type library file (.lin).

Line styles

Line style definitions determine the particular dash-dot sequence and relative length of dashes, blank spaces, and the characteristics of any included text or shapes. Working with line styles provides a means of distinguishing the purpose of one line from another.

AutoCAD and MicroStation both provide a set of standard line styles, as well as allowing the user to define custom line styles. In AutoCAD these custom line styles are defined in a line type library file (.lin) and a multiline library file (.mln). In MicroStation, custom line styles are contained in resource files (.rsc) (see Chapter 3, “Line types/styles” for more information.

Note: *Custom line styles do not readily translate between systems; therefore users should anticipate that translated custom line styles may revert into their primitive graphics.*

Tabulated Version of the Symbology/Elements

Graphical presentations of the entire symbology library are shown in Appendix D, “A/E/C CADD Standard Symbology.”

The symbology library contains four types of elements: Lines, Patterns, Symbols, and Objects. Lines are defined as a graphical representation of linear drawing features (e.g., utility lines, fence lines, contours). Patterns are defined as repeated drawing elements (e.g., lines, dots, circles) within a defined area. Symbols are defined as MicroStation cells or AutoCAD blocks that are representative of objects (e.g., electrical outlets, smoke detectors). Objects are defined as MicroStation cells or AutoCAD blocks that retain their actual size no matter the scale of the drawing (e.g., 30- by 50-in. desk, 3’-0” door).

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