

## 2 CADD Data Deliverables

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### Introduction

A general checklist and discussion of the basic items to consider when specifying A-E CADD deliverables criteria are included in this chapter. More detailed information concerning each item can be obtained from the “Tri-Service Architectural, Engineering, and Construction (A/E/C) Computer-Aided Design and Drafting (CADD) Standards” (Tri-Service Center, in preparation) (hereafter referred to as the “Standards Manual”). The items discussed are considered generic to all DoD Tri-Service installations. Project- or installation-specific requirements may necessitate additional requirements which are not addressed in this release.

### Ownership

The Government's rights to ownership of the digital data and other deliverables developed by the A-E under the contract must be clearly defined in the technical contract provisions. The Government has a legal right to demand unrestricted ownership to all data, designs, and materials for which the Government has paid 100 percent of the development cost. If the Contractor has to develop data, designs, or materials above and beyond what the Government specifies and pays for 100 percent, then the Contractor owns the rights to that percentage.

A statement similar to the following should be included in each A-E contract:

*The Government, for itself and such others as it deems appropriate, will have unlimited rights under this contract to all information and materials developed under this contract and furnished to the Government and documentation thereof, reports and listings, and all other items pertaining to the work and services pursuant to this agreement including any copyright. Unlimited rights under this contract are rights to use, duplicate, or disclose data, and information, in whole or in part in any manner and for any purpose whatsoever without compensation to or approval from the Contractor. The Government will at all reasonable times have the right to inspect the work and will have access to and the right to make copies of the above-mentioned items. All digital files and data, and other products generated under this contract, shall become the property of the Government. By reference, the following DFAR clauses are included in this contract as a part of the requirements herein:*

- a. *DFAR 252.227-7013, “Rights in Technical Data and Computer Software.”*
- b. *DFAR 252.227-7018, “Restrictive Markings on Technical Data.”*
- c. *DFAR 252.227-7019, “Identification of Restricted Rights Computer Software.”*
- d. *DFAR 252.227-7028, “Requirement for Technical Data Representation.”*

- e. DFAR 252.227-7037, “Validation of Restrictive Markings on Technical Data.”

## Target CADD System Considerations

### CADD platforms and software packages

The two predominant basic CADD software packages currently used by Tri-Service installations consist of MicroStation and AutoCAD. The predominant target platforms currently used by Tri-Service installations consist of workstations with a Windows NT operating system, or PC's with a Windows NT or 95 operating system.

The target platform (i.e., hardware with type and version of operating system software) used by the installation on which the CADD deliverables developed by the A-E will be processed should be specified in the technical contract documents. The A-E firm should not be required to use the same hardware as the installation. However, it is recommended that the same type and version of operating system software be used in development of the CADD-generated drawings.

The type and version of the basic CADD software package used by the installation must be specified in both the *CBD* announcement and the technical contract documents. In addition, the type(s) and version(s) of the CADD application software package(s) (e.g., Intergraph INROADS or Softdesk Advanced Civil Design) used by the installation must be specified in the technical contract documents. Different types of software packages used by A-E's may not be compatible with those used by the installation. Therefore, it is very important to ensure that A-E's either prepare their designs and drawings using the same basic and application CADD software package as used by the installation, or provide electronic CADD deliverables which can be read and used directly by the installation's CADD software and platforms (*without conversion, preprocessing, or postprocessing*). The term “compatible” means that data can be accessed directly by the target

basic and advanced CADD software packages and platform without translation, preprocessing, or postprocessing of the data files.

If this is not done, the digital information obtained may only contain the simple graphics. The Government may not be able to execute or recover the analysis features and supporting data used by the advanced CADD application package(s).

### File names

The characteristics of the UNIX and existing MS-DOS/Windows operating systems mandate that file-naming conventions address the limitations of MS-DOS. MS-DOS will accept file names with a maximum length of eight characters plus the three-character extension. A standard system for establishing file names should be established by each installation. Recommended file-naming conventions are discussed in the “Standards Manual.” It is also recommended that an electronic database management system for organizing and maintaining records of file names and pertinent project information be established and maintained for each installation.

A-E's should use the same standard file-naming convention as used by the installation for which the work will be accomplished. The appropriate standard (installation, Tri-Service, etc.) should be referenced in the CADD deliverable requirements, and should be furnished to the A-E along with the Government-furnished materials (GFM).

## Graphic Concepts

Graphics files can contain both vector and nonvector raster graphics.

## Vector graphics

Vector elements are graphical objects which have a precise direction, length, and shape. The vector graphical objects can be points, lines, polygons, arcs, rectangles, circles, splines, text, ellipses, elliptical arcs, arc wedges, elliptical arc wedges, and symbols.

Grouped vector objects are either in the form of graphic groups or complex elements such as cells or blocks. Vector graphics are particularly well-suited for processes where drawing development and modification are heavy and true two- and three-dimensional accuracy is required. Vector graphic images can exist in two- or three-dimensional design environments and are created using CADD basic and advanced software packages. In addition, the ability to deal with geometric elements as unique entities provides a powerful linkage for images to be grouped with nongraphical data attributes. Output from CADD software packages creates a proprietary binary data file that has limited portability across various platforms and vendor packages, unless it is converted into IGES or other neutral data format.

In addition to the vector entities, digital drawings may also contain symbols and details (cells/blocks), reference drawings, and reference database files. All of these must be a part of the deliverables, or transfer from one digital format to another.

Two-dimensional vector entities are represented by x- and y-coordinate points, taking the form of a single point, string of points (e.g., lines, arcs, and splines), and closed lines (e.g., polygons, rectangles, circles, and ellipses).

Three-dimensional vector entities are represented by x-, y-, and z-coordinate points.

## Raster graphics

Raster graphics, or bit-mapped graphics, are digital images stored as arrays of pixels for display and modification. In raster data there are no lines, circles, or polygons, only pixels that are

grouped to give the appearance of these elements. In order to possess properties that can be used by a CADD system to perform analyses, raster graphics have to be converted to vector graphics.

In a monochrome (black and white) graphic system each pixel corresponds to one binary digit (bit) on the display screen. A bit is the smallest unit of information that a computer can handle. Color graphic systems require more bits per pixel to create colors. The need for more memory and memory management increases as both color and screen resolution increase.

Raster graphics are commonly created in one of two ways:

- a. Use of “paint” type computer graphics programs (e.g., desktop publishing, image editing, and paint) to draw and edit images.
- b. Quick capture by optically scanning the image of existing hard copy drawings and converting it to a digital format (bit-mapped). Once captured digitally, the drawings can be archived, distributed, or converted to a vector format. The scanning can be accomplished by either electronic scanning equipment or digital cameras.

Some of the more common raster (bit-mapped) file formats in use include:

- a. Microsoft Windows Paintbrush (PCX).
- b. Tag Image File Format (TIFF).
- c. Graphics Interchange Format (GIF).
- d. Bit-Mapped Picture (BMP).

The type(s) and version(s) of raster graphics software packages used by the installation should be addressed in the contract technical provisions.

## Nongraphic Criteria

Each platform on which CADD software operates supports different database software packages. There are linkages within the graphic elements to connect the graphics file to records in the database. While the different platforms will directly exchange graphics files without translation, they do not all support the same database software packages. Even though different databases behave similarly, they are not normally compatible with one another unless translated.

The type and version of database software package (e.g., dBase IV, Informix, Oracle, or Microsoft's Open Database Connectivity (ODBC)) used by the installation should be addressed in the technical contract documents.

Using an intermediate database interface software (e.g., Intergraph's Relational Interface System (RIS)) will allow the A-E to use one specific database and provide a portable product in the format of multiple databases.

For contracts requiring database deliverables, the A-E must provide data which can be directly imported to, displayed and edited within, and output from the database software specified by the Government. Additionally, all linkages of nongraphic data with graphic elements, relationships between database tables, and report formats shall be maintained, or automatically reconstructed, when transferred to the CADD software specified by the Government. Not doing so will require the Government to recreate the linkages, a time-consuming and expensive proposition. Data files and tables can be transferred in various ways in order to prevent data reentry and its associated costs.

The database structure and naming conventions should conform to those provided in the "Tri-Service Standards, Part 3, Spatial Data Standards."

## Basic Graphic Standards

### Graphic files

Each graphic file should contain the contents of only one drawing. A drawing size conforming to installation requirements should also be specified. The two most predominant (English unit) drawing sizes (according to the American National Standards Institute (ANSI) Y14.1) and currently used by Tri-Service installations, are (a) a D-size drawing, 22 in. vertical by 34 in. horizontal (as measured between the cut lines), and (b) an F-size drawing, 28 in. vertical by 40 in. horizontal (as measured between the cut lines) (ANSI 1980). According to ANSI Y14.1, the International (SI unit) counterpart for the D-size drawing is A1 (841 mm horizontal by 594 mm vertical). An International counterpart for the F-size drawing is not provided in ANSI Y14.1.

### Units

The resolution and scaling of the graphics file affect the accuracy and limits of the drawing (design plane). The units, or number of positional units used to define the subunits and master units, will determine the accuracy and expanse of the graphics file.

Units should conform to the "Standards Manual (Tri-Service Center, in preparation)." The requirement to use English or SI units should be specified in the technical contract provisions. DoD policy requires agencies to begin using SI units as the standard unit of measure.

### Cells/blocks

All cells/blocks (symbol/detail) libraries should be prepared in accordance with the "Standards Manual." Cell/block libraries typically contain symbols and details which are

used on a repetitive basis in preparing CADD drawings, and are typically not altered with each application. It is recommended that the standard cell/block libraries used by the installation, or provided with the “Standards Manual” (Tri-Service Center, in preparation), be furnished to A-E's as a part of the Government Furnished Material (GFM). All cells/blocks not available in standard symbol/detail libraries should be created in accordance with the “Standards Manual.” All cells/blocks not provided as GFM must be provided to the Government as a part of the electronic digital deliverables.

## **Origin**

The location of the origin for each drawing should conform to the requirements of the “Standards Manual,” or specific installation requirements. The same origin or reference points shall be used on all drawings for a project, and the A-E must coordinate origins across files.

## **Scales**

All CADD graphic file scales should be created according to the installation requirements. It is recommended that they be created in actual (real world) size.

## **Text**

Text size, format, and placement should conform to each service's current drafting standards. This includes nodal/attribute text and dimension text (while part of those entities).

## **Font libraries**

Font libraries should conform to the fonts selected for the “Standards Manual.” Standard font libraries should be furnished to A-E's as part of the GFM. Any custom fonts developed by the A-E must be provided to the Government along with the electronic digital deliverables. It is recommended that only the Government's standard

font libraries be used.

## **Line weights/thicknesses**

Line weight/thickness should conform to the “Standards Manual.”

## **Line styles/types**

Line styles/types should conform to the “Standards Manual.” The most commonly used line styles/types are solid, dotted, hidden, viewing plane, dash-dot, stitch, dash-dot-dot, centerline, and phantom. Any custom line styles/types developed by the A-E must be provided to the Government with the electronic digital deliverables. It is recommended that only the Government's standard line styles/types libraries be used.

## **Levels/layers**

Level/layer assignments should conform to those established in the “Standards Manual.” The characteristics of AutoCAD and MicroStation mandate that level/layer organization address the limitations of MicroStation. MicroStation accepts up to 63 layers per drawing file. Additional layers may be attained through the use of reference files. AutoCAD accepts an unlimited number of layers. Levels/layers are analogous to the overlays used in hand drafting.

## **Colors**

Color tables should conform to the “Standards Manual.” The same colors should be used for both display and plotting.

## **Reference Files**

Reference files are graphics files used as overlays to the current graphic file. This

capability is very productive because when the reference file is changed, the system automatically updates all files with that reference file attached without the need to update each file. Reference files should be prepared in accordance with the same standards and format as graphics files. Examples of reference files might include standard border sheets, standard title blocks (may also be a cell/block), floor plans, topographic maps, and contour drawings.

Standard reference files containing border sheets, title blocks, etc., should be furnished to A-E's as a part of the GFM.

## Seed/Prototype Files

Whenever a new graphics file is created, a seed/prototype file should first be identified as a template for the new file. Seed/prototype files contain preset settings (e.g., units, color tables, line weights/thicknesses, level/layer structure, line styles/types, origin, text, etc.) and view configurations, but no elements. A seed/prototype file should be established for each type of graphics file that will be used (e.g., civil design, architecture, mapping, mechanical engineering, etc.).

Standard seed/prototype files should be developed by each installation in accordance with the "Standards Manual" and furnished to A-E's as a part of the GFM.

## Presentation Graphics

### Plotting

A plot file should be prepared for each furnished project drawing, and should be identical to the finished project drawing. Plot files should have the same file name as the design file with an appropriate file extension (normally ".plt" or ".i" file extension). Information such as levels/layers, plot scale, reference file displays, pen tables (line weights/thicknesses), color tables, plotter configuration, and views/viewing angles (needed

to recover isometrics and perspective type drawings) are necessary to create a plot.

It is recommended that the technical contract document the plotter configuration in which the plot files should be delivered to the Government. The plotter configuration should be the one used by the installation to plot the finished drawings.

The A-E should be required to provide documentation concerning the plotter configuration and settings for each plot file.

### Details

Details and typical sections are a combination of drawing elements, symbols (cells/blocks), and text. The size of a detail depends on the size of the sheet border and the number of quadrants marked on the border edges. The ideal size of a section or detail is one that is wholly contained in a quadrant or number of quadrants with no other details encroaching on the quadrants of the detail.

Details and typical sections may be developed as cells/blocks or reference files, depending on size and frequency of use. The installation's standard details and typical sections should be provided to the A-E along with the GFM. All details and typical sections developed by the A-E must be provided to the Government along with the electronic digital deliverables.

### Tables and schedules

Tables and schedules should be used to denote equipment and item (e.g., doors and windows) features in lieu of lengthy callouts placed next to symbols on plans, lengthy descriptions in symbol legends, and notes.

The format for preparation of tables and schedules should be provided to the A-E along with the GFM. All tables and schedules developed by the A-E must be provided to the Government along with the electronic digital deliverables. It is recommended that all tables and schedules be provided on the drawings.

“Standards Manual.” Title blocks should contain the installation's standard information and format.

### **Titles or border sheets**

Titles or border sheets should conform to the standard sizes and formats addressed in the