ERDC/ITL SR-23-1

US Army Corps
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The CAD/BIM Technology Center
for Facilities, Infrastructure, and Environment

A/E/C Graphics Standard

Release 2.2

Stephen C. Spangler, Roger Fujan, Gerald Piotrowski, and
Brian Baker

August 2023

Information Technology Laboratory

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Facilities, Infrastructure, and Environment

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Abstract

The *A/E/C Graphics Standard Release 2.2* has been developed by the Computer-Aided Design/Building Information Modeling Technology Center to document how proper hand-drafting practices can be achieved in advanced modeling. It is through the collection and documentation of these practices that consistent models and drawings shall be achieved throughout the US Army Corps of Engineers (USACE), as well as other federal agencies. In the collection of these practices, various historical USACE District drafting manuals were consulted and compared against practices contained in industry and national standards, with consideration toward whether software can achieve those practices. The documentation of these practices will help to achieve both clear and aesthetically pleasing construction documents.

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Preface

This study was conducted for Headquarters, US Army Corps of Engineers (HQUSACE). The technical monitor was Mr. Jason Fairchild, HQUSACE.

The work was led by Mr. Stephen C. Spangler of the Computer-Aided Design / Building Information Modeling Technology Center of the Software Engineering and Informatics Division, US Army Engineer Research and Development Center, Information Technology Laboratory. At the time of publication, Ms. Mariangelica Carrasquillo Mangual was branch chief; Mr. Quincy Alexander was division chief; and Dr. Robert M. Wallace and Mr. Ken Pathak were technical directors. The deputy director was Dr. Jackie S. Pettway, and the director was Dr. David A. Horner.

COL Christian Patterson was commander of ERDC, and Dr. David W. Pittman was director.

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1 Introduction

The *A/E/C Graphics Standard* Release *2.2* has been developed by the Computer-Aided Design/Building Information Modeling (CAD/BIM) Technology Center (hereafter referred to as the Center) for Facilities, Infrastructure, and Environment at the Information Technology Laboratory (ITL), US Army Engineer Research and Development Center (ERDC), Vicksburg, MS. Its purpose is to address a need for standard CAD, BIM, and Civil Information Modeling (CIM) drafting practices that were once covered by documents related to hand drafting techniques. This report supersedes *A/E/C Graphics Standard Release 2.1* (ERDC/ITL TR-19-6).

1.1 Background

The *A/E/C CAD Standard* (CAD/BIM Technology Center 2019), first published in May 1994, has been the go-to manual for developing CAD documents for tri-service (Army, Air Force, and Navy) A/E/C (architecture/engineering/construction) disciplines. The Standard defines symbology, graphic representations, and layer breakouts within the different types of CAD files the A/E/C disciplines typically create.

However, what it does not cover are the good practices behind CAD drafting. These practices were required learning for all new architects, engineers, and draftsmen when hand drafting was the only way of creating construction documents. With the incorporation of CAD into design, these practices were lost along the way. The US Army Corps of Engineers (USACE) CAD/BIM Community of Practice (CoP) recognized this fact and tasked the Center to develop a manual reintroducing these practices, updating them to fit into the CAD/BIM/CIM workflow.

In the development of this manual, the Center collected many District drafting standards, compared them, and compiled similarities. Where applicable, the practices pulled from these drafting standards were compared with those of industry and national standards since those documents address drafting to a certain extent. In situations where industry and national standards did not make a strong statement as to a drafting methodology, the USACE drafting standards were considered to be the expert opinion and took priority in decisions.

1.2 United States National Computer-Aided Design (CAD) Standard

In 1995, the combined resources of the Center, 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 CAD standard for the United States. Working together, these organizations agreed to develop an integrated set of documents that collectively would represent the United States National CAD Standard (NCS).

The primary NCS document referenced within the *A/E/C Graphics Standard* is the following:

"Uniform Drawing System"
The Construction Specifications Institute
123 North Pitt Street, Suite 450
Alexandria, VA 22314

This document is available as part of the NCS to all USACE personnel through an enterprise license with NIBS. Additional information on the NCS can be obtained from the following:

National Institute of Building Sciences
1090 Vermont Avenue NW, Suite 700
Washington, DC 20005-4905
https://www.nibs.org/

https://www.nationalcadstandard.org/

1.3 Objectives

The objective of the A/E/C Standards is to ensure design intent is consistently, efficiently, and effectively transmitted through the construction phase to operations and maintenance (O&M) and back to design for future work.

1.4 Approach

The approach chosen to respond to A/E/C community comments and feedback entailed reviewing the concern and/or recommendation. If the

comment was from a purely personal preference standpoint, it was disregarded. If the comment proposed an objective opportunity for improvement, a workaround was determined to best resolve the issue while still maintaining the intent of industry standards. A Frequently Asked Questions (FAQ) page was established to document the interim solutions. This document updates the A/E/C Standards to incorporate those solutions.

The intent of this document is to embrace the National CAD Standard while providing more guidance and clarifying areas of misunderstanding.

This document will not cover every circumstance encountered in drawing production. There may be specialized instances where it will be up to the site to develop internal best practices.

1.5 Scope

This manual provides guidance for preparing the presentation of A/E/C designs within the Department of Defense (DoD).

1.6 Essentials of Good Drafting

Why bother with developing a manual that addresses drafting practices? The A/E/C CAD Standard already implements practices in the formation and presentation of final CAD files; isn't that enough? The US Army Engineer District, Jacksonville, *Drafting Standards* manual (US Army Engineer District, Jacksonville 1976) states the reason best in the "Essentials of Good Drafting" section:

> A well-prepared drawing, complete so that it conveys the intended meaning yet contains a minimum of unnecessary detail, is the type of drawing which is required. Such a drawing, when [correctly] prepared, reflects credit to the [engineer, architect], or draftsman who was responsible for it. While the principal object in working up drawings is to produce a neat, accurate set of plans in the shortest possible time, it is not the intention to sacrifice neatness and accuracy for speed or vice versa. When making alterations or additions to existing drawings, special care shall be exercised to follow the same style and

size of lettering and all other conventions on the drawings for uniformity.

In addition to this reason, agencies should constantly strive for a sense of consistency. This results in a more unified workplace as all architects, engineers, drafters, and partners are following a consistent set of rules and guidelines.

1.7 Additions/Revisions

This Standard is intended to be neither static nor all inclusive. Suggestions for improvements are strongly encouraged so that subsequent updates will reflect the input and needs of the users.

Recommendations or suggested additions should be sent by email to CADBIM@usace.army.mil.

2 Border and Cover Sheets

Note: *In an effort to make sheets more consistent across all agencies, the only border and cover sheets that shall be used are those defined in this section. This supersedes all previous border definitions from all other various locations. The border and cover sheet files can be found in the latest workspace and templates on the Center's website*: https://cadbimcenter.erdc.dren.mil/.

2.1 Border Sheets

2.1.1 Sheet Sizes

A/E/C projects (contract documents) shall be prepared on American National Standards Institute (ANSI) D sheets (ANSI E or F may be used for oversized drawings [e.g., 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 oversized drawings). Table 2-1 lists the standard sizes of ANSI and ISO sheets.

Table 2-1. ANSI and ISO sheet size comparison.

ANSI		ISO	
Mark	Size in inches	Mark	Size in inches (mm)
F	28.0 × 40.0	NA	NA
E	34.0 × 44.0	A0	33.1 × 46.8 (841 × 1,189 mm)
D	22.0 × 34.0	A1	23.4 × 33.1 (594 × 841 mm)
C	17.0 × 22.0	A2	16.5 × 23.4 (420 × 594 mm)
B	11.0 × 17.0	A3	11.7 × 16.5 (297 × 420 mm)
A	8.5 × 11.0	A4	8.3 × 11.7 (210 × 297 mm)

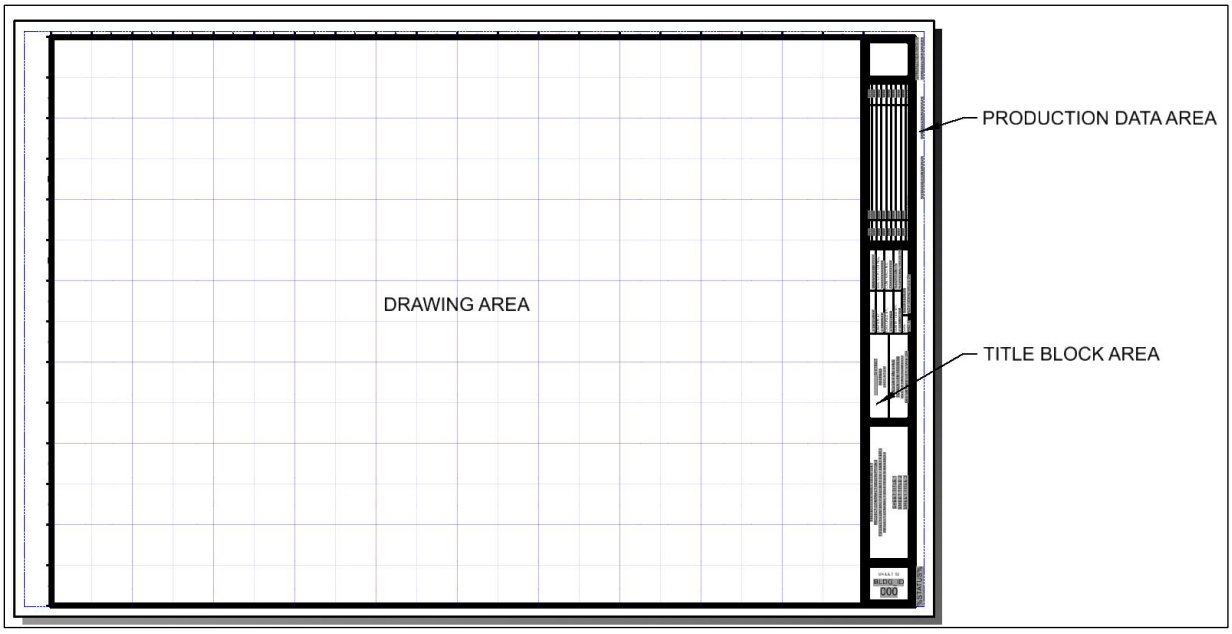
2.1.2 Sheet Margins

The minimum distance from the paper's edge to any item in a design is 3/16 inch (in.). Borders and related data (grid callouts and production data) shall be centered vertically in the space and shifted to the right as far as practical to maintain a binding edge on the left. The borders provided by the Center shall be used for all printed contract and O&M designs (not including shop drawings). This includes both electronic (PDF) and hard copies.

2.1.3 Border Sheet Areas

The border sheet is broken out into three main areas. These areas are the Production Data Area, the Drawing Area, and the Title Block Area (Figure 2-1). Of these three areas, only the Production Data Area is optional.

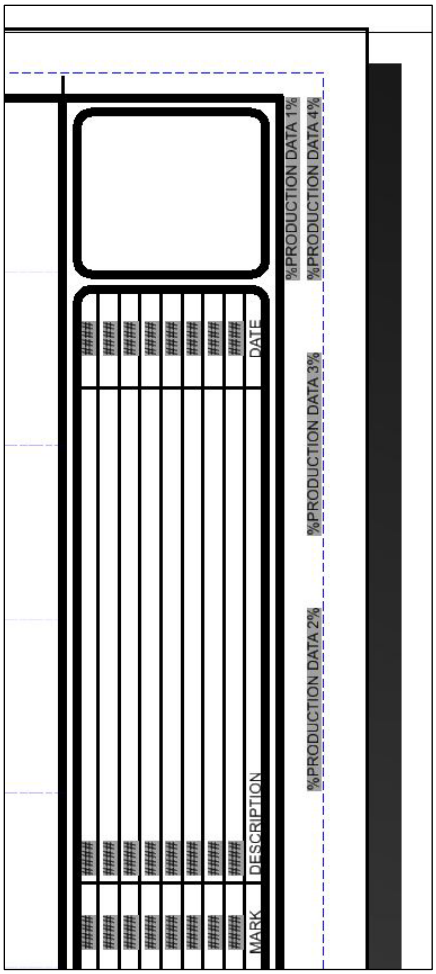
Figure 2-1. Three main areas of the border sheet.



2.1.4 Production Data Area

The Production Data Area contains detailed production information about the sheet. The information is located outside of the Drawing Area border in the upper right corner of the sheet (Figure 2-2).

Figure 2-2. Production data area.



As mentioned, use of this area is optional. Examples of information that could be provided in the Production Data Area include

- full path and file name;
- date/time the sheet was plotted;
- name of the user who plotted the sheet;
- plot driver and design script used to plot the sheets; and
- plot scale of the sheet.

Note: *The default text is commented with percent signs (%) to allow for text substitution via design scripts, pen tables, or attributes/tags.*

2.1.5 Drawing Area

The Drawing Area is where graphic/textual items (e.g., plans, sections, elevations, schedules, details, notes) used to convey the project design

intent are placed. The Drawing Area is broken up into modules for the placement of these items. To identify module locations within the Drawing Area, a grid is labeled with characters going in alphabetical order (A, B, C, D, etc.) from lower left to top left and characters going in numerical order (1, 2, 3, 4, etc.) from upper left to upper right. To avoid confusion, the alphabetic characters I and O are not used.

The Border Sheet provided by the Center uses modules measuring 1-1/2 in. × 1-1/2 in. Multiple modules can be combined to create a drawing block (Figure 2-3). When using a drawing block, the lower left corner is referenced to a grid intersection (See Section 4.2.3.1 for information on how to reference the grid). Graphic items are required to fit exactly within the drawing block; they are allowed to take up more than one module in the vertical and/or horizontal direction (Figure 2-4). However, if a graphic item does not fill up a complete drawing block, other items are not allowed to take up the remainder of the block's space. Instead, that item shall be placed in the next available drawing block (Figure 2-5).

Figure 2-3. Module and drawing block.

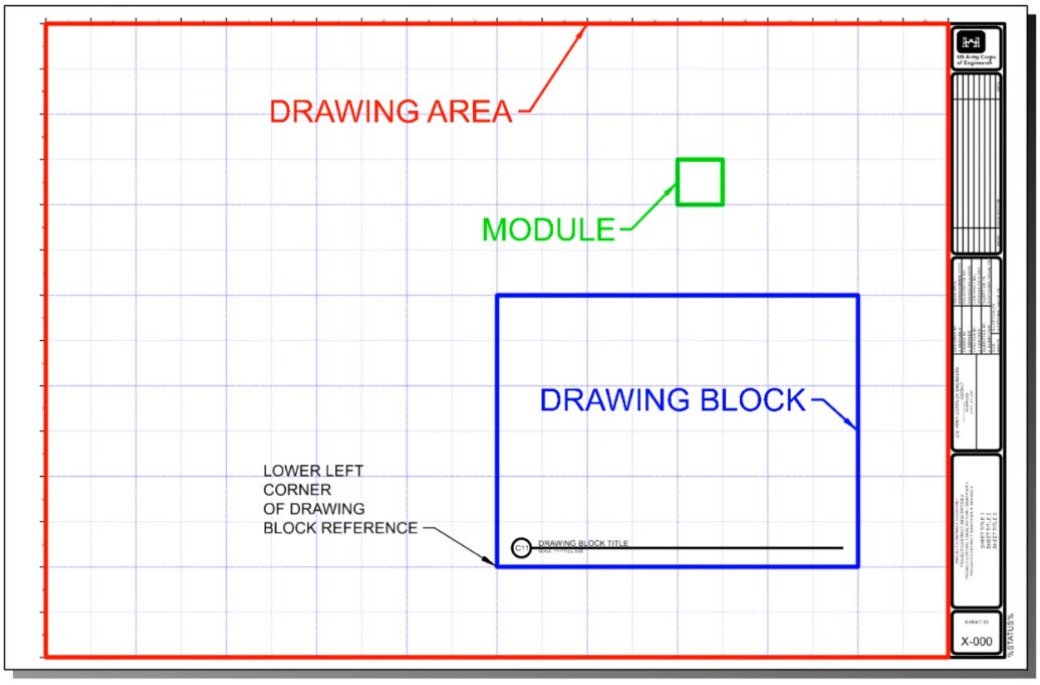


Figure 2-4. Examples of correctly and incorrectly sized drawing blocks.

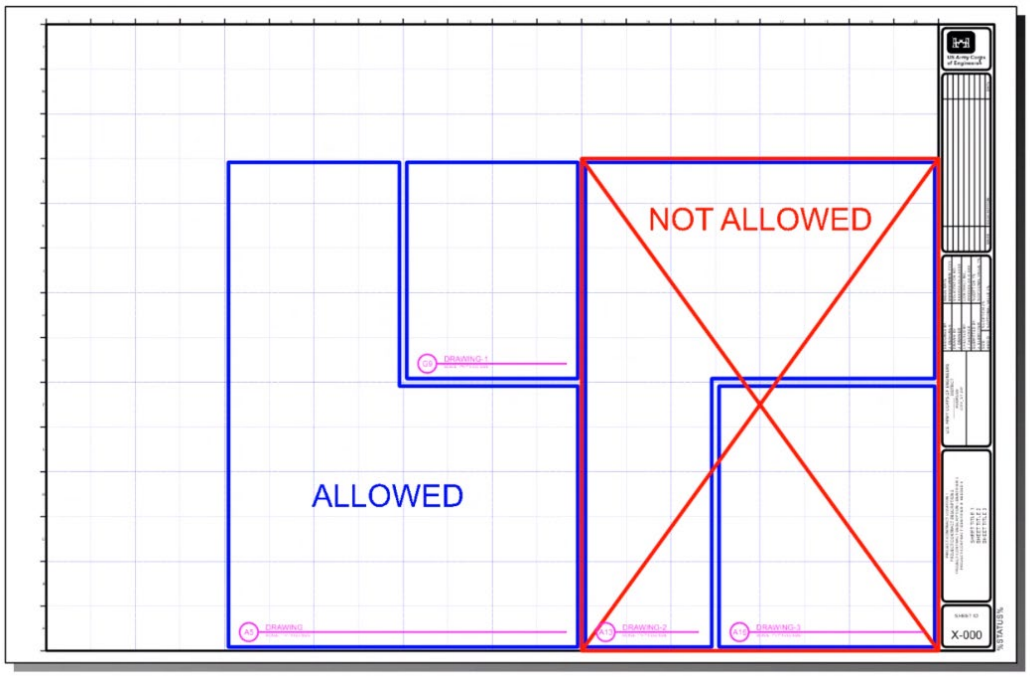
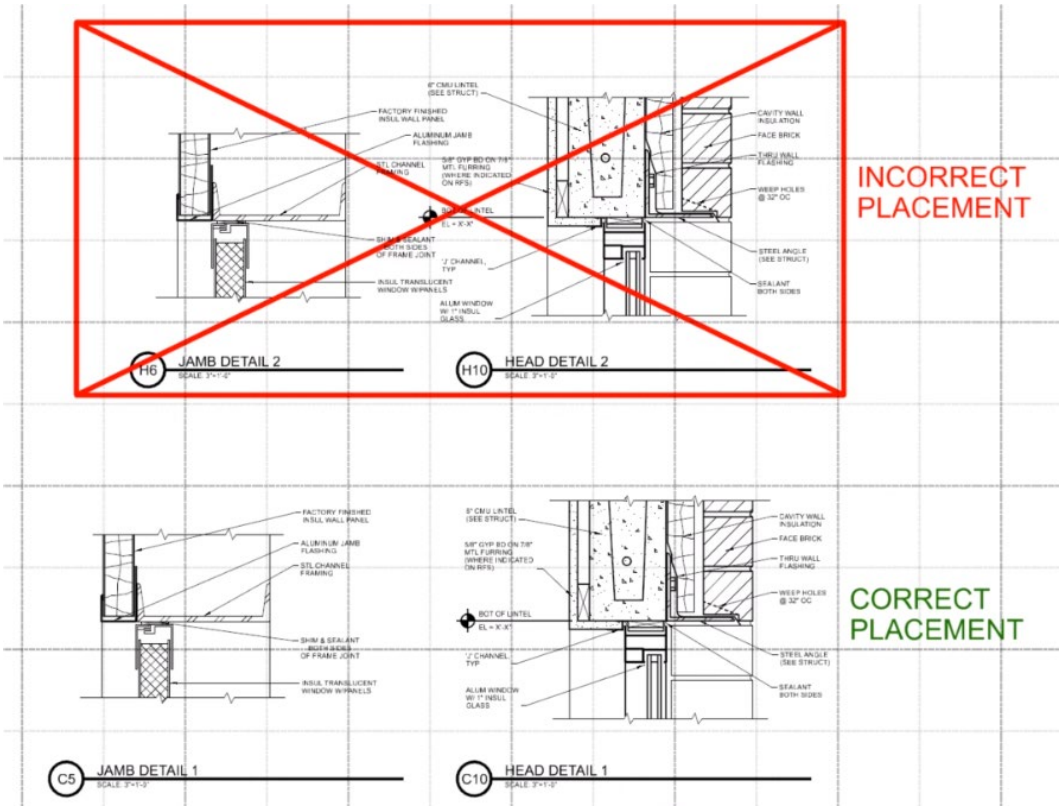


Figure 2-5. Incorrect and correct drawing block adjacencies.



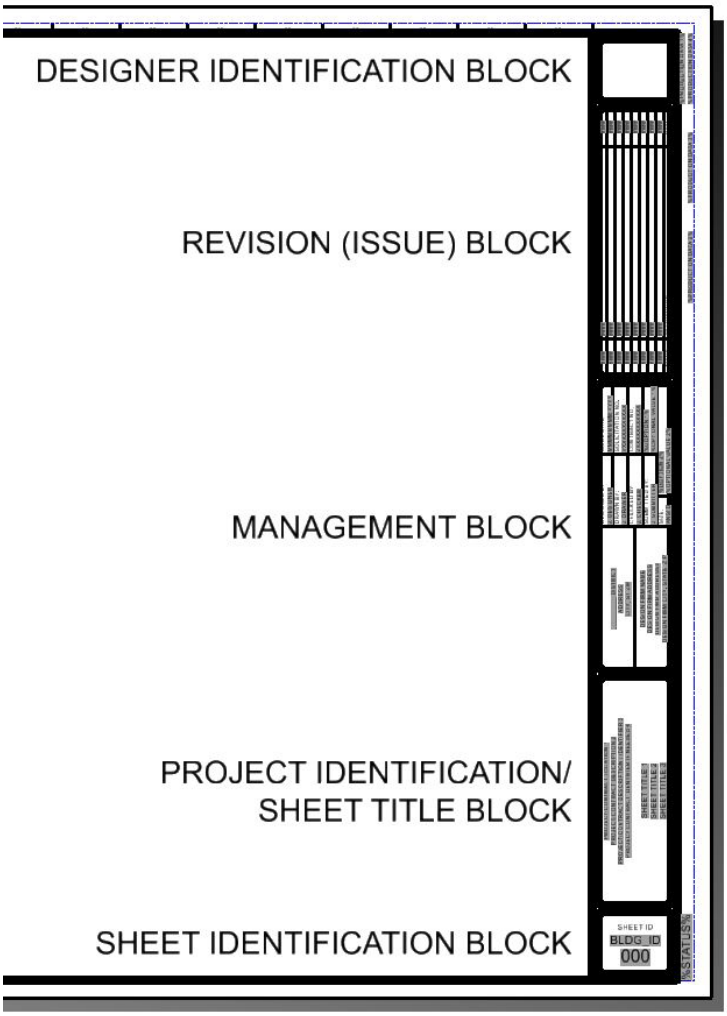
If general notes, keynotes, legends, or key plans are included on a sheet, they shall be located in the rightmost modules. The key plan shall always be located within the lowest module of this area.

2.1.6 Title Block Area

The *A/E/C Graphics Standard* requires the use of a vertical title block placed in the right-hand margin of the border sheet as shown in Figure 2-6. Use of a vertical title block allows for the most usable drawing area on a sheet. The vertical title block also ensures the most prevalent and pertinent information remains at the bottom right of the sheet. The title block area shall include the following:

- Designer Identification block
- Revision (Issue) block
- Management block
- Project Identification/Sheet Title block
- Sheet Identification block

Figure 2-6. Vertical title block.



Note: *The blocks contained in the Title Block Area shall not be resized or modified.*

2.1.7 Designer Identification Block

The Designer Identification Block (Figure 2-7) contains the logo and/or name of the agency that is the owner of the sheet. The Owner Communication Mark is inserted into the border to represent the owner of the information (typically the Issuing Agency responsible for the project). No modification of either the symbology or text within the Communication Mark shall be allowed. Designers shall refrain from reducing the size of the Communication Mark to add text identifying a specific organization/site within the Designer Identification Block. Instead, that information shall be added to the Management Block.

Figure 2-7. Designer identification block with example Owner Communication Marks.

Example: *Using the US Army Corps of Engineers Communication Mark only in the Designer Identification Block provides for consistency within USACE and eliminates duplicating information contained elsewhere on the Border Sheet (see Section 4.1).*

2.1.8 Revision (Issue) Block

See Section 7.3 Revision (Issue) Block.

2.1.9 Management Block

The Management block (Figure 2-8) contains information about the owner, the design firm, sheet data, and project management data. All text placed within this block shall be 3/32 in. high.

Figure 2-8. Management block.

U.S. ARMY CORPS OF ENGINEERS _____ DISTRICT STREET ADDRESS CITY, STATE ZIP	DESIGNED BY: J. DESIGNER	ISSUE DATE: MMMMMMMMM YYYY
	DRAWN BY: J. DRAWER	SOLICITATION NO.: XXXXXX XX X XXXX
DESIGN FIRM STREET ADDRESS CITY, STATE ZIP ADDRESS 4	CHECKED BY: J. CHECKER	CONTRACT NO.: XXXXXX XX X XXXX
	SUBMITTED BY: J. SUBMITTER	OPTIONAL FIELD 1
	SIZE: ANSI X	OPTIONAL FIELD 2

OWNER: The top-left portion of the Management block is dedicated to the owner of the information (i.e., issuing agency overseeing the project). Four lines are provided for this information. The top line shall always be the Issuing Agency (e.g., US Army Corps of Engineers, US Air Force, etc.). The second line shall identify the specific Office (e.g., Vicksburg District, Tyndall AFB, etc.). The third line shall identify the street address (e.g., 4155 Clay Street). The fourth line shall identify the city, state, and ZIP code (e.g., Vicksburg, MS 39183).

DESIGN FIRM: The bottom left portion of the Management block shall capture information about the design firm (A–E firm, District, or Base) that did the design on that particular sheet. Four lines are provided to provide the name and address of that design firm, similar to the Owner portion above. If desired, an A–E firm may substitute a logo for this information.

Note: *Districts performing design work internally may leave the Design Firm area blank.*

DESIGNED BY: The name of the lead architect or engineer who did the design shall provide their information here. The format of the name provided shall be first initial, followed by a period, then full last name (e.g., J. Designer).

DRAWN BY: The name of the person who created the sheet shall provide their information here. The format of the name provided shall be first initial, followed by a period, then full last name (e.g., J. Drawer).

CHECKED BY: The name of the person who verified the data on the sheet is consistent with the design intent shall provide their information here. The format of the name provided shall be first initial, followed by a period, then full last name (e.g., J. Checker).

SUBMITTED BY: The name of the Project Architect or Project Engineer shall provide their information here. The format of the name provided shall be first initial, followed by a period, then full last name (e.g., J. Submitter).

SIZE: The nominal size of the sheet (e.g., ANSI D, ANSI F, ISO A1).

ISSUE DATE: This date shall be the month and year the project is going to advertisement. The format of the date shall be MONTH YEAR (e.g., OCTOBER 2014).

SOLICITATION NO.: This section shall be filled with the solicitation for advertisement number.

CONTRACT NO.: This section shall be filled with the actual construction contract award number.

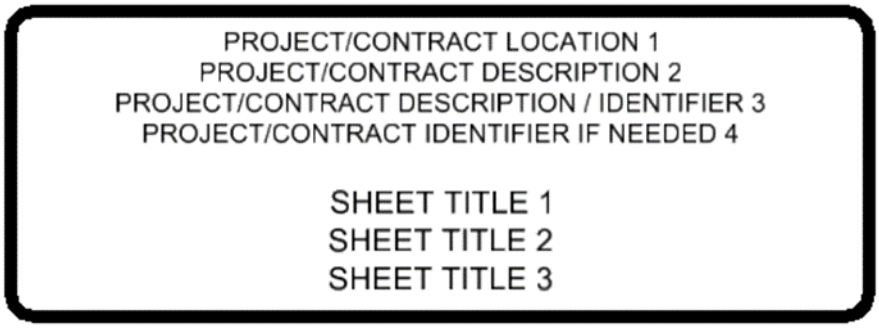
Note: *SOLICITATION NO. and CONTRACT NO. may vary on multiple factors (e.g., the project is design-build, design-bid-build, or other contractual requirements).*

Note: *Two optional sections are available in the lower right of the Management block. These sections could potentially be used to record the total number of sheets in the construction document set, to record the number of the sheet in the set, or to capture information such as the file name, facility code, or drawing code. This data shall be defined by the Issuing Agency.*

2.1.10 Project Identification / Sheet Title Block

The Project Identification/Sheet Title block (Figure 2-9) is composed of two sets of information: project identification and sheet information. The organization of data in each half of the block reflects a philosophy of moving from general information to specific.

Figure 2-9. Project Identification / Sheet Title block.



PROJECT IDENTIFICATION: The top half of this block contains information about the project. All text within this part of the block shall be 3/32 in. high. The first line shall provide information about the project location (e.g., FORT LEONARD WOOD, MISSOURI). The second line shall provide a description of the project (e.g., DINING FACILITY). The third line shall provide a project identifier (e.g., P2#, PN#, FY). If more space is required for the description of the project, this description information shall continue into the third line, and the project identifier information shall be provided in the fourth line.

SHEET TITLE: The bottom half of this block contains a description of the content of the sheet. All text within this part of the block shall be 1/8 in. high. The first line shall provide a description of what is presented on

the sheet (e.g., REFLECTED CEILING PLAN, FLOOR PLAN). If more than one type of information is presented on the sheet (e.g., plans, schedules, details), the most important information is identified. The second line shall provide what floor the information on the sheet is located (e.g., FLOOR 2, BASEMENT). The third line shall provide specific quadrant location information if required (e.g., ZONE 3, AREA B).

2.1.11 Sheet Identification Block

The Sheet Identification block (Figure 2-10) contains, at a minimum, the "SHEET ID" title and the sheet identifier. The sheet identifier is composed of the discipline designator, the sheet type designator, and the sheet sequence number (e.g., A-101). The "SHEET ID" title shall be 1/8 in. high. The height of the sheet identifier shall be 9/32 in. high.

Figure 2-10. Sheet Identification block.

Note: *An optional BLDG ID field is available for those construction projects where the sheet set contains more than one structure, feature, volume, or option. If this field is used, identification for that particular structure, feature, volume, or option is placed in this field. The height of the BLDG ID field shall be 3/16 in. high. If this field is not used, leave this space blank.*

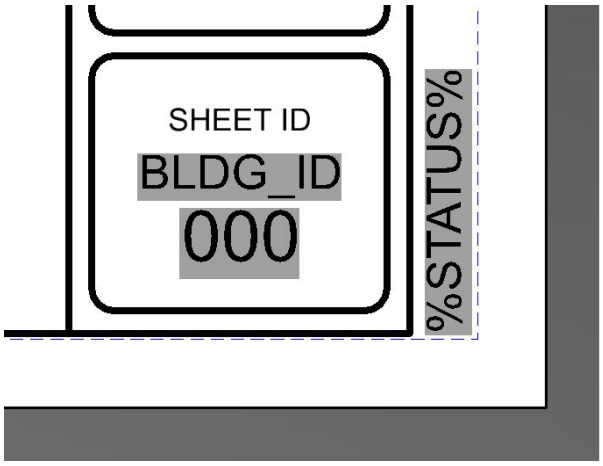
Note: *"Sheet X of Y" has been removed from the Sheet Identification block because the Index contains the sheet order information. Trying to keep "Sheet X of Y" constantly updated becomes a huge burden on the design team during project close out. When pages are added or removed, the entire drawing set must be renumbered to modify the page count and sheet numbers. Even on small projects (fewer than 100 sheets), the renumbering process can take several hours to make the necessary changes. Reprinting, reviewing, correcting, and potential reprinting of all the sheets increases the burden of time and labor on the design team. On*

larger projects, this renumbering process potentially could take several days.

2.1.12 Status

An additional field (Figure 2-11) is available on the Border Sheet for specifying the current status of the project (e.g., 30%, 60%, 90%, PRELIMINARY SUBMITTAL, FINAL SUBMITTAL, READY FOR ADVERTISEMENT, AS AWARDED, AS-BUILT, RECORD DRAWING, etc.). This information shall be located at the bottom-right corner of the Border Sheet and shall be 3/16 in. high.

Figure 2-11. Status field.

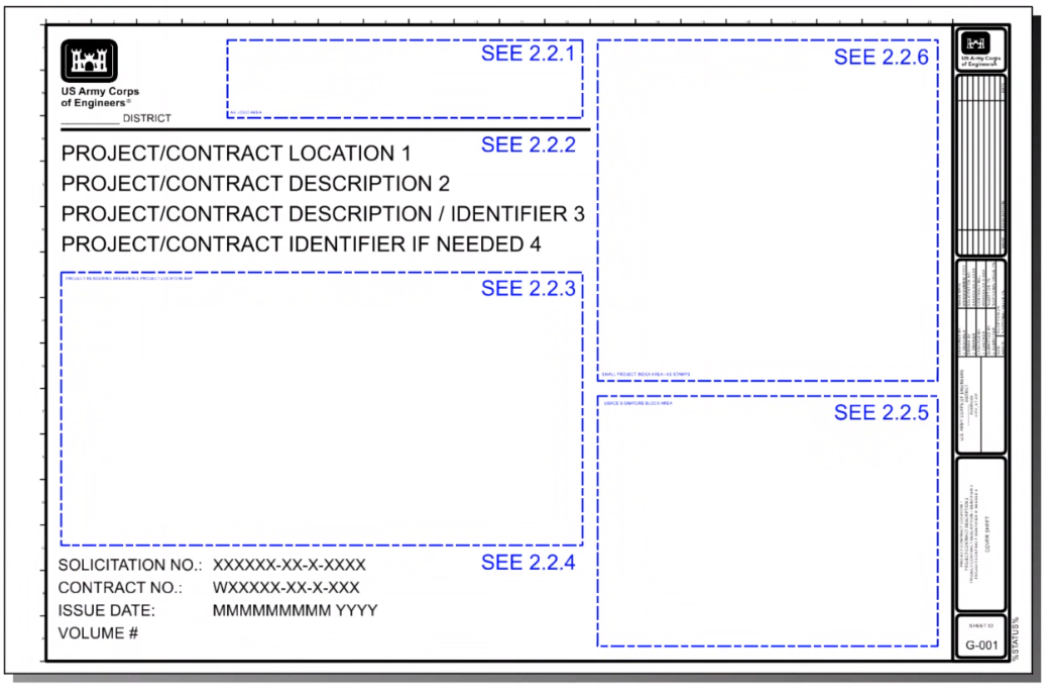


Note: *Status data are specific to each project or design organization. Contact the organization for details on how this information is to be presented.*

2.2 Cover Sheet

Similar to the cover of a book, a Cover Sheet contains information provided for both informational and promotional purposes. Like the rest of the project set, the Cover Sheet information is contained within a Border Sheet and is always given the Sheet Identifier of G-001. Information captured on a Cover Sheet comprises mandatory textual information and areas available for promotional/approval/contractual items (Figure 2-12).

Figure 2-12. Cover sheet.

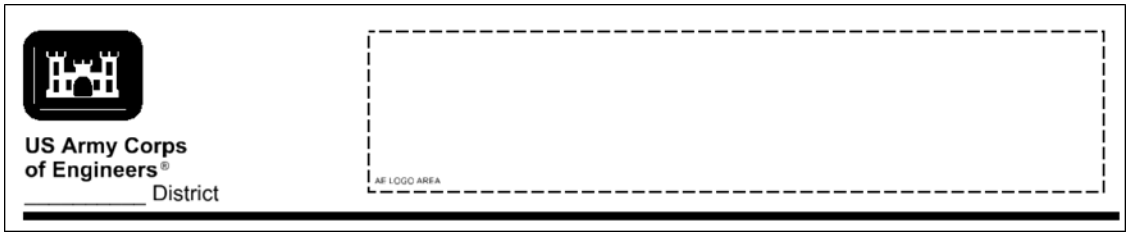


Note: *Areas shown inside the dashed lines are intended for visual reference in this section. The blue dashed lines and text are* not *intended to be plotted.*

2.2.1 Owner/Designer Information

Starting at the top left of the Cover Sheet and proceeding counterclockwise, the first information that is captured on the Cover Sheet is information about the owner and designer(s) (Figure 2-13). The Owner Communication Mark shall be presented to the far left of this section. For USACE Districts, this logo shall be the USACE Communication Mark with 1/4 in. high text directly beneath, identifying the specific District. To the right of the Owner logo, there is an area provided for designer logos. These logos could be another District's logo (using the same USACE Communication Mark, with identifying District text) or an A-E's logo. However, the Owner's logo shall always be the largest of the logos provided in this section of the Cover Sheet.

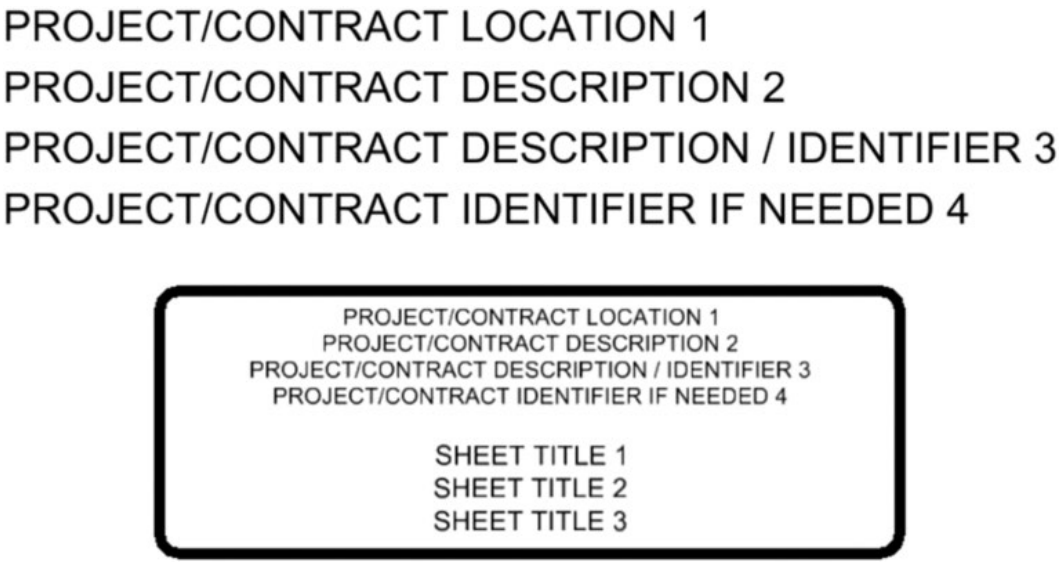
Figure 2-13. Owner/Designer information.



2.2.2 Project/Contract Information (Part 1)

Directly below the Owner/Designer information section, there are four lines of textual information identifying the project/contract (Figure 2-14). The information captured in this section shall be the same information that is shown in the top half of the Border Sheet's Project Identification / Sheet Title block. All text in this section shall be 1/2 in. high.

Figure 2-14. Link between Project/Contract information on Cover Sheet and Border Sheet.



2.2.3 Project Rendering / Small Location Map Area

Below the Project/Contract Information is a large area (Figure 2-15). This space is available for providing a rendering of the project, showcasing the intended final look. Another possible use for this space is for providing a small vicinity map.

Figure 2-15. Project rendering / small location map area (example rendering shown).

2.2.4 Project/Contract Information (Part 2)

The next section of the Cover Sheet is devoted to information about the construction contract (Figure 2-16). Three of these text items shall be the same as information already contained in the Border Sheet's Management block while the fourth is an optional field. All text in this section shall be 3/8 in. high.

Figure 2-16. Project/contract information (Part 2) area.

SOLICITATION NO.: XXXXXX XX X XXXX
CONTRACT NO.: XXXXXX XX X XXXX
ISSUE DATE: MMMMMMMMM YYYY
VOLUME X

SOLICITATION NO.: This field shall be filled with the solicitation for advertisement number.

CONTRACT NO.: This field shall be filled with the actual **construction** contract award number.

Note: *SOLICITATION NO. and CONTRACT NO. may vary on several factors such as the project is design-build, design-bid-build, or other contractual requirements.*

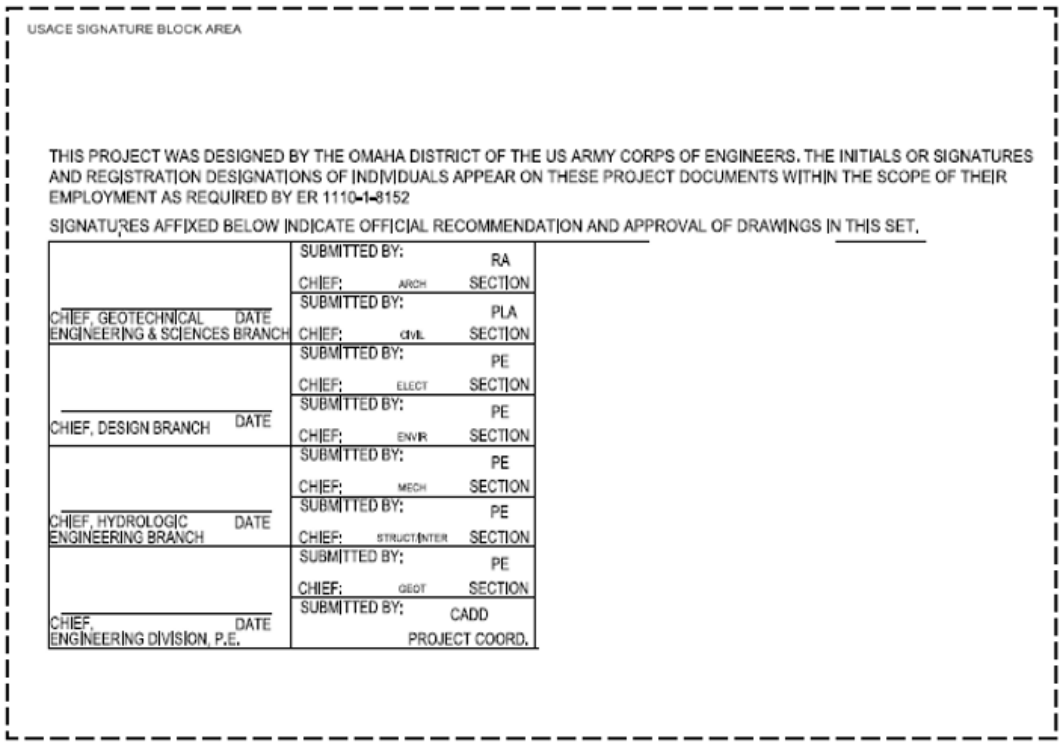
ISSUE DATE: This field is for the month and year that the project is going to advertisement. The format of the date shall be MONTH YEAR (e.g., OCTOBER 2014).

VOLUME: This field is optional and is available for those projects where more than one volume of contract drawings is required.

2.2.5 Signature Block Area

The bottom right portion of the Cover Sheet is dedicated to any required agency signature blocks (Figure 2-17). These could be signature blocks that cover the entire drawing set, either showing approval and/or review of the set by a District's Chief of Engineering. Signature blocks and the information contained within are defined by the host agency and vary depending on project needs.

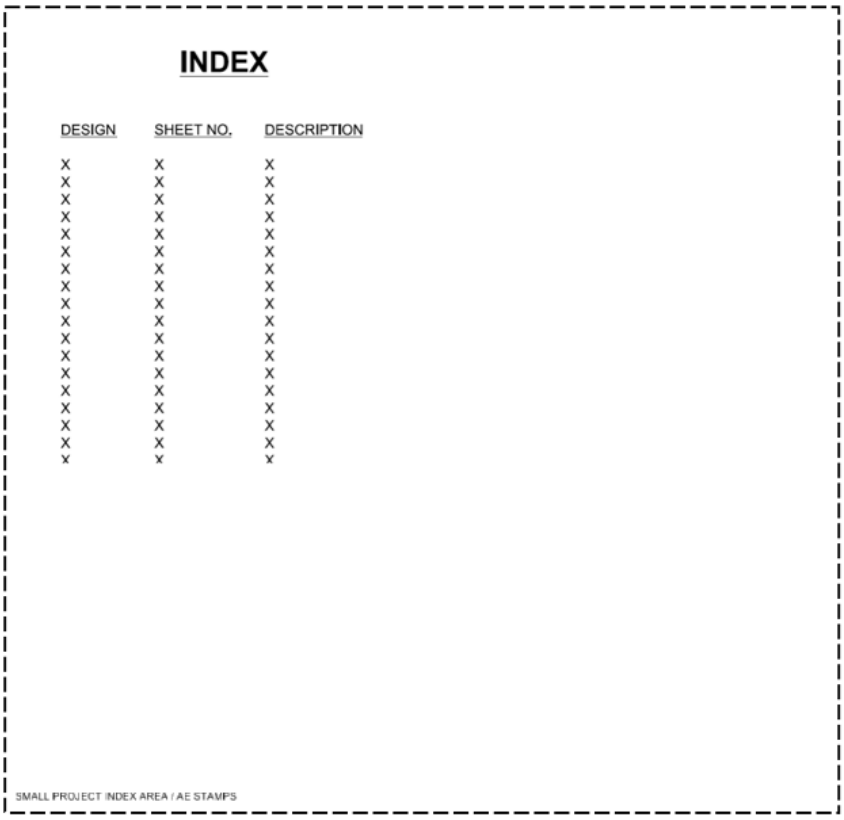
Figure 2-17. Signature block area (example signature block shown).



2.2.6 Small Project Index / A-E Stamps Area

The last area of the Cover Sheet, contained in the upper-right quadrant, is available for either a small project's index of drawings or A-E professional stamps (Figure 2-18). The index is defined by the host agency and varies depending on project needs.

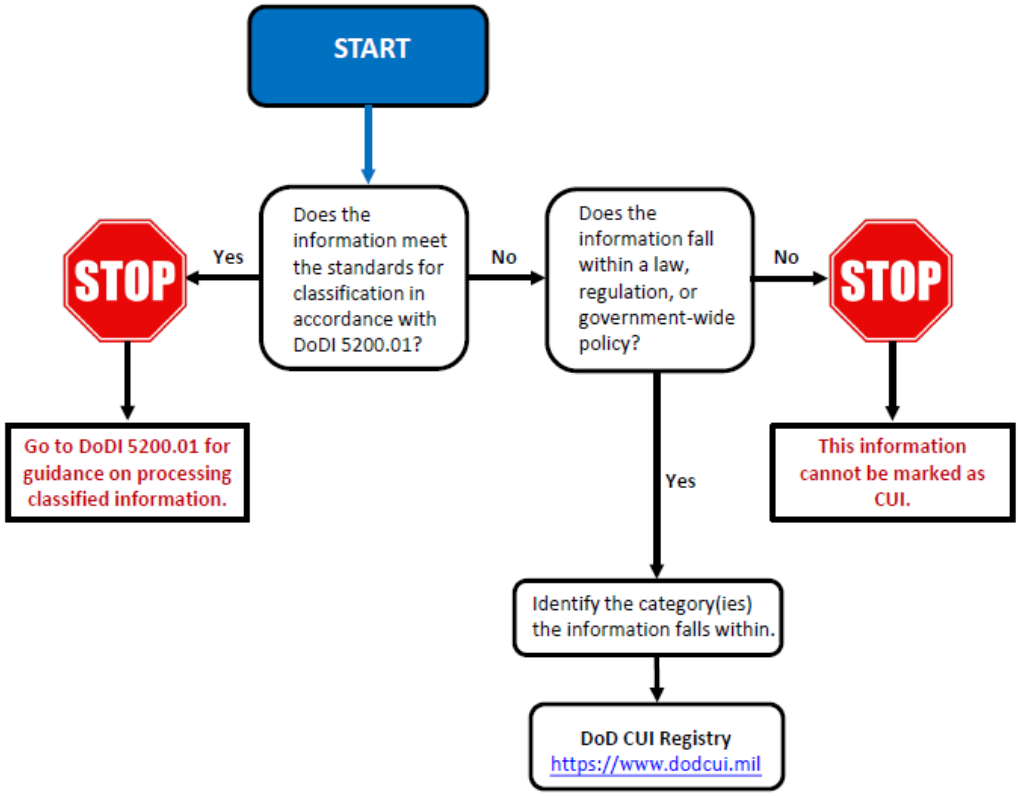
Figure 2-18. Small project index / A-E stamps area (example index shown).



2.3 Marking Controlled Unclassified Information (CUI) Construction Drawings

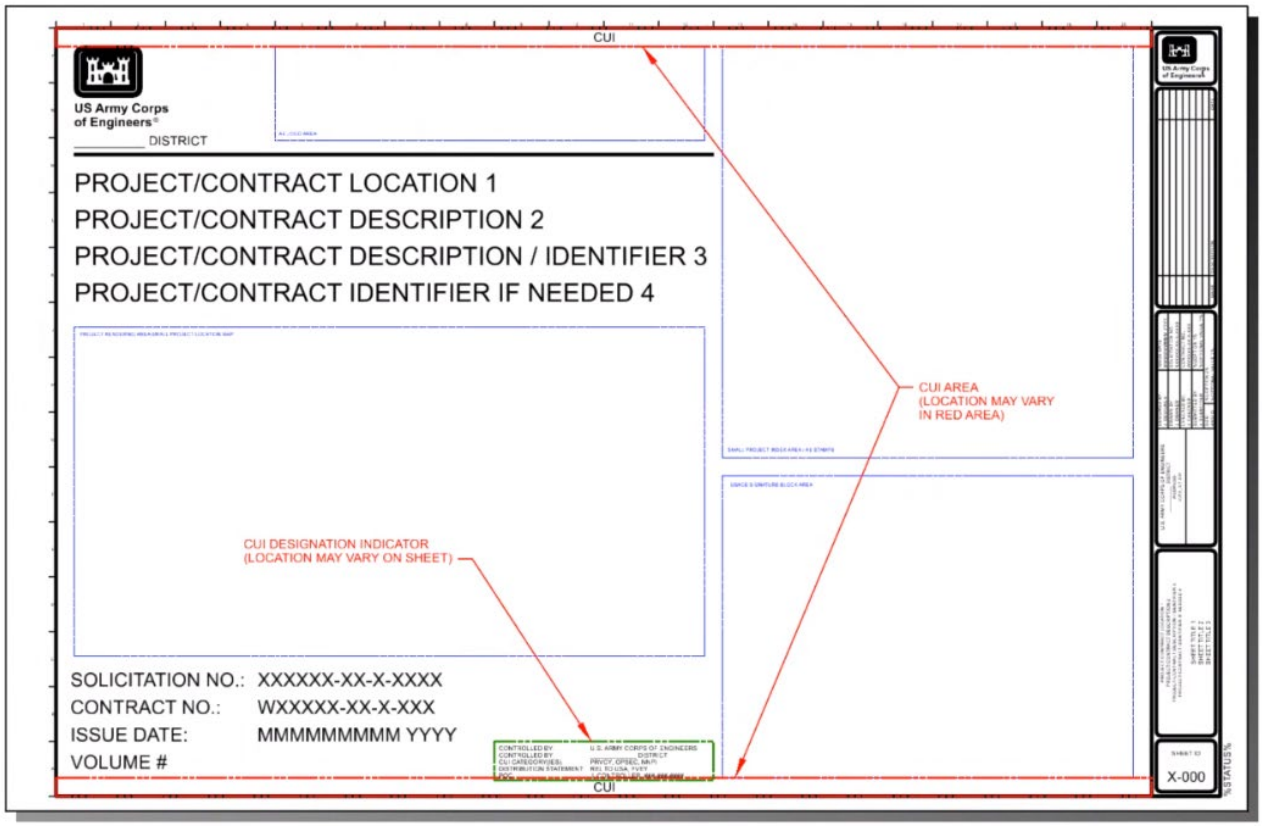
Some Department of Defense projects may require the marking of construction drawings as containing Controlled Unclassified Information (CUI). This determination shall be the result of the Project Delivery Team (PDT) going through the CUI process flowchart to decide if the project meets the criteria (Figure 2-19).

Figure 2-19. Process flowchart for CUI determination.



If the information is determined to fit the criteria from the flowchart, then "CUI" shall be included at the top and bottom of each page in the construction set of drawings. This text shall be Arial font at a height of 1/4" (6 mm). On the Cover Sheet only, a CUI Designation Indicator shall also be included (Figure 2-20).

Figure 2-20. Cover sheet with CUI markings (locations may vary).



All text within the CUI Designation Indicator section shall be Arial and 1/8" high. Each line in it shall contain the following information:

CONTROLLED BY: Name of the DoD Component

CONTROLLED BY: Name of the office creating the document

CUI CATEGORY(IES): List category or categories of CUI contained in the document

DISTRIBUTION STATEMENT: Applicable distribution statement or limited dissemination control

POC: Name and phone number / email of point of contact (POC)

3 Orientation

3.1 Common

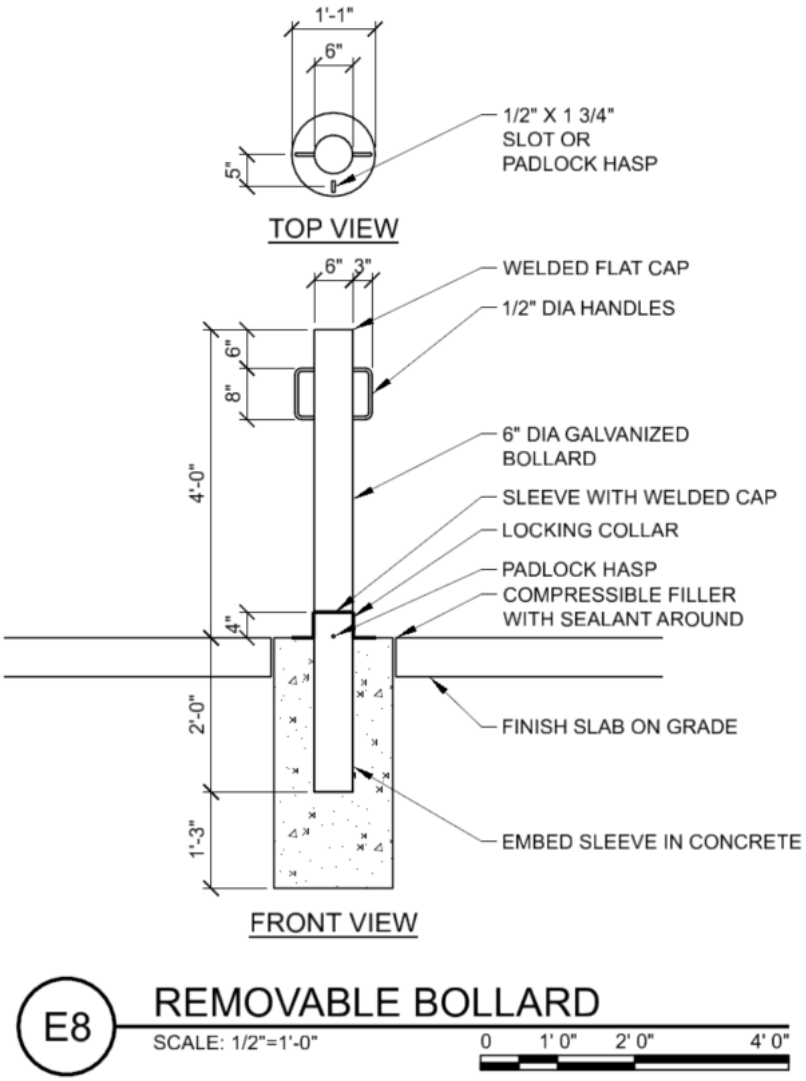
3.1.1 Project Orientation Hierarchy

The project orientation shall be governed by the main feature of the project. For instance, a levee repair with a roadway shall be oriented so that the sheets follow the levee orientation (see Section 3.2.4). A roadway repair on a levee shall be oriented so that the sheets follow roadway orientation (see Section 3.2.5).

3.1.2 Views

Views shall be oriented on the sheet so that elevations and features are aligned whenever possible. When detailing is being added, details shall appear on the sheet based on their orientation on the feature. For instance, the top view of a detail shall be oriented above the front view of the same detail (Figure 3-1). If a detail is taken from a large-scale plan or elevation, the orientation shall remain the same as the view from which the cut was taken. If this is not possible, a note stating that the orientation was changed shall be added (e.g., VIEW ROTATED 90 DEGREES). When two or more plans are put on the same drawing, the orientation of all must conform to one another and to their relative positions on the ground.

Figure 3-1. Proper orientation of detail views.



3.1.3 Vicinity Maps

Vicinity maps shall be oriented with true north toward the top of the sheet.

3.1.4 Plan Views

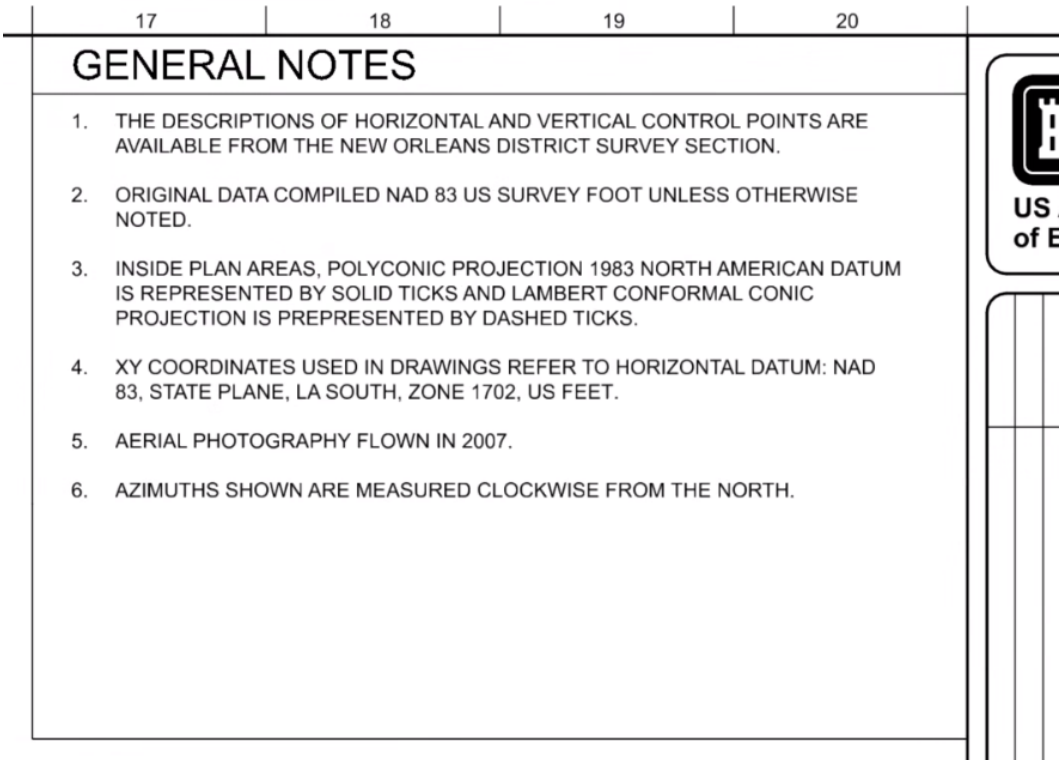
Plan views shall be oriented so that plan north is toward the top of the sheet when practicable or toward the left when impracticable.

3.2 Horizontal

3.2.1 Project Coordinate System

The specified coordinate system/datum (usually State Plane) used for the project shall be denoted at least once on civil plans. Coordinates shall be identified using tick marks, which are oriented to show north, south, east, and west. The grid system used shall be described in the general notes (Figure 3-2).

Figure 3-2. Grid system described in general notes (example shown).



3.2.2 Channels and Waterways

Included under this heading are new channels and channel improvements such as channel clearing and snagging, dredging, cleanout, enlargement, and realignment (cutoffs). Detailed plans shall be oriented with the alignment from top to bottom or from left to right, if practicable. The direction of water flow for all waterways shall be indicated by arrowheads

at the upper and lower limits of the sheet, pointing in the direction the water flows (Figure 3-3).

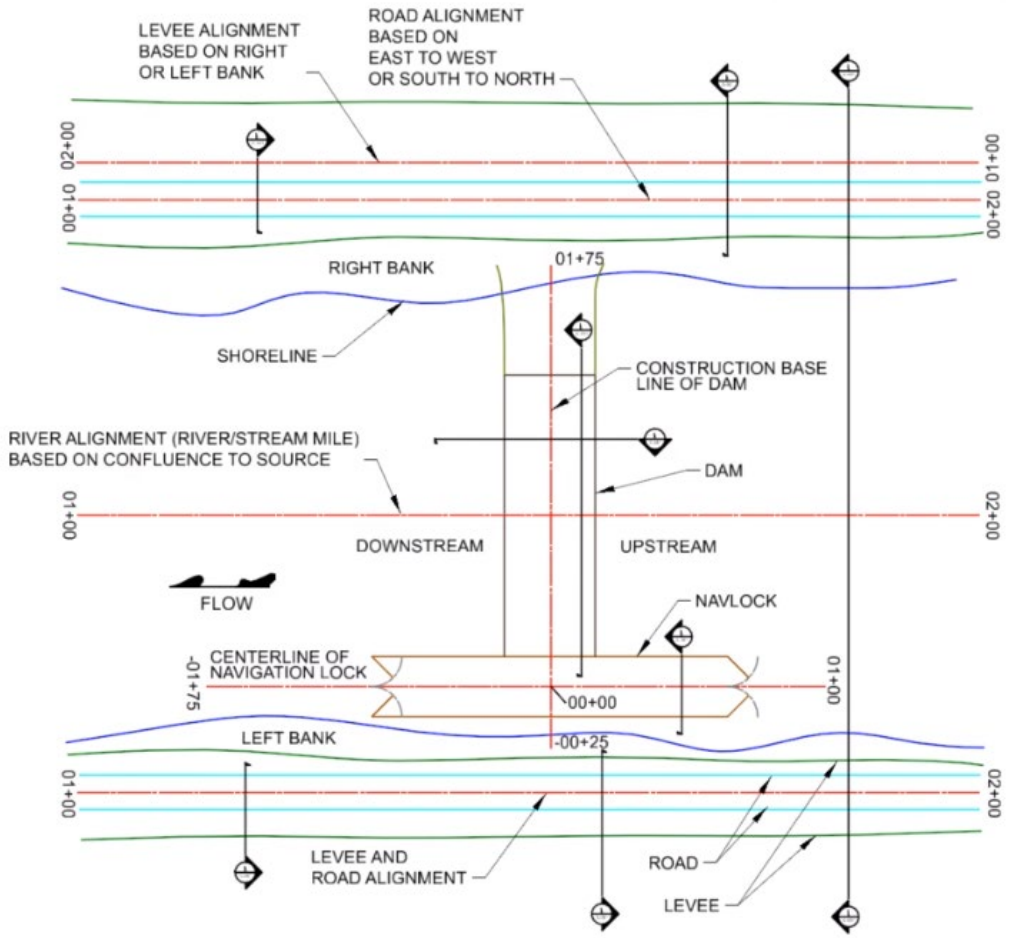
Note: *For coastal projects with tidal flows rather than river flows, all channel sections are oriented looking inshore, which is usually also looking toward increasing stations. Typically, labeling for port entry channels begins offshore with negative stations and increases inshore with station 0+00 at the crossing of the shoreline into a landlocked channel. Stations continue to increase inshore/upstream. However, it is recommended that users research specific District requirements to follow proper District procedure.*

Channel cross sections shall be shown as if the observer were looking downstream. The words LEFT BANK and RIGHT BANK shall be shown in their proper places at the top of the sections.

Note: *River banks are always determined as being right bank or left bank by facing in direction of water flow*).

Where cross sections are plotted on a common centerline, the words LEFT BANK and RIGHT BANK need to be shown once on the top section.

Figure 3-3. Typical orientation of cross sections.



Some construction drawings of flood control projects will require the section to be shown looking upstream. For instance, some downstream elevations will be unique and will need to be drawn in various projections.

3.2.3 Locks and Dams

General plans, elevations, and longitudinal sections of locks, dams, and similar structures shall be oriented with the direction of water flow from bottom to top or from left to right, if practicable. Plans and profiles of floodgates shall be oriented with the observer looking downstream. Cross sections of locks shall be shown as if the observer were looking downstream, except in special cases where an upstream view would better clarify a complex positioning of adjoining elements. Typical dam sections shall be shown with the upstream side on the left and the downstream side on the right. The words UPSTREAM and DOWNSTREAM shall be shown in their proper places at the top of the sections (see Figure 3-3).

3.2.4 Levees

Detailed plans of levees, dikes, berms, and slide repairs shall be oriented with the stream side (unprotected side) at the top of the sheet, irrespective of stream flow. All levee cross sections shall be plotted looking in the direction in which the stations increase. The words LANDSIDE and WATERSIDE shall be shown in their proper places at the top of all plotted sections. Where cross sections are plotted on a common Centerline, the words LANDSIDE and WATERSIDE must be shown once on the top section (see Figure 3-3).

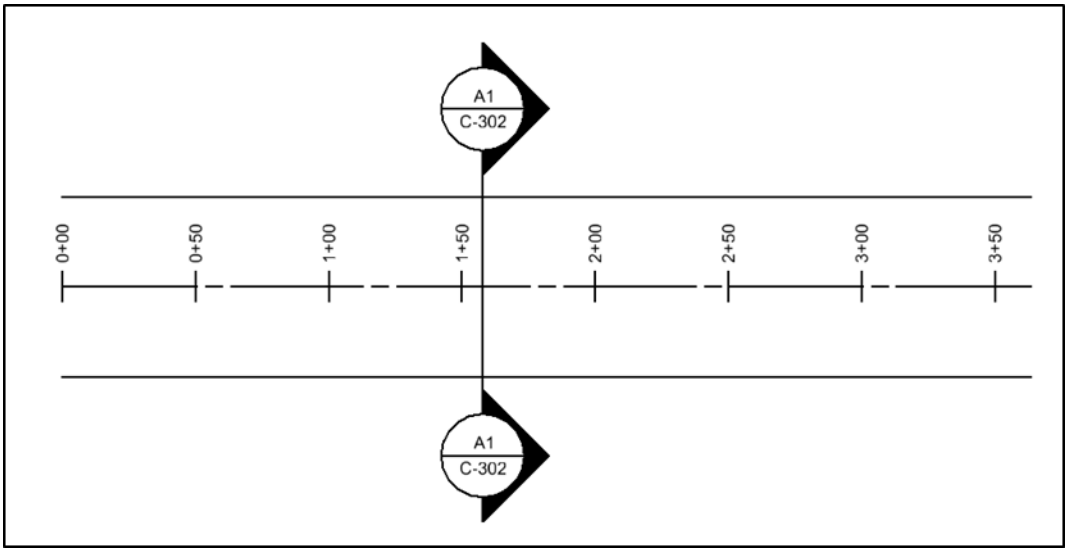
Note: *Because of channel orientation and irregular shapes of levee dredge material placement areas, plans are sometimes oriented*

1. *to match channel orientation (stationing increasing right to left), allowing the channel to be shown either above or below the placement area*
2. *to fit the irregular shape to the plan sheet trying to best maintain the north up/left orientation.*

3.2.5 Roadways

Roadways shall be oriented so that stationing runs either left to right or bottom to top of the drawing. For short roads and entrances (i.e., driveway to parking lot), start stationing at the Centerline of the most major road (always confirm with state publications/requirements). Cross sections shall be shown as if the observer were looking up station (Figure 3-4).

Figure 3-4. Orientation of roadways.



3.3 Vertical

3.3.1 Column Grid System

A grid system is used to indicate structural columns, load-bearing walls, shear walls, and other structural elements on the drawings. It is used primarily for reference in schedules of structural data. A grid system is also used if the design of a building is based on a module system, regardless of the structural system. Grid lines are used as a basis for dimensioning. Proper planning and layout of a drawing on the selected sheet size requires the accommodation of alphanumeric grid designations within column indicators. Vertical grid lines shall have designators at the top of the grid numbered from left to right. Horizontal grid lines shall have designators at the right side of the grid alphabetized from bottom to top. To eliminate confusion with the numerals 0 (zero) and 1 (one), do not use letters O or I (UDS Module 4—Drafting Conventions [CSI 2014]).

Where additional intermediate structural support elements occur between grid lines, a [decimal] designation is used. For example, a column occurring at the midpoint between grid lines 2 and 3 would be designated 2.5. In a similar manner, columns occurring between grid lines A and B would be represented as A.1, A.2, A.3, and A.4 (Uniform Drawing System Module 4—Drafting Conventions [CSI 2014]).

3.3.2 Numbering of Floors

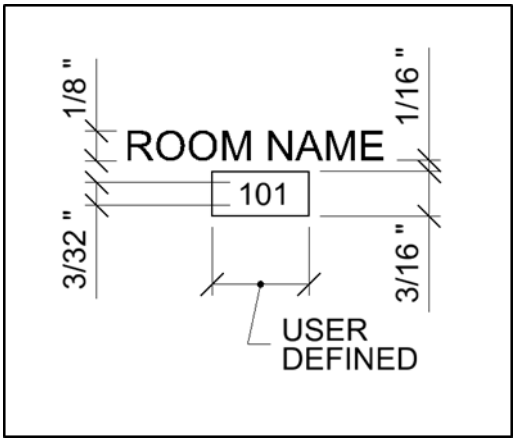
The ground floor shall be designated as the first floor (e.g., FLOOR 1, FIRST FLOOR, F1, etc.). All occupied floors above the first floor are to be numbered sequentially upward. The floor below the first floor is considered to be the first basement (e.g., BASEMENT 1, B1, etc.). Subsequent floors below the first basement are numbered sequentially. The topmost floor of the building that does not contain office or habitable space is designated as the attic (typically this area contains structural framing and HVAC equipment/ducts). The area above the topmost floor is designated as the roof (ROOF, or ROOF1 [R1], ROOF2 [R2], etc. if you have roofs at different elevations).

3.3.3 Numbering of Rooms

All floor plans (except structural) shall show room identifiers (Figure 3-5). The first part of a room identifier shall match the floor number. Typically, room numbering starts at the most prominent means of access (e.g., main

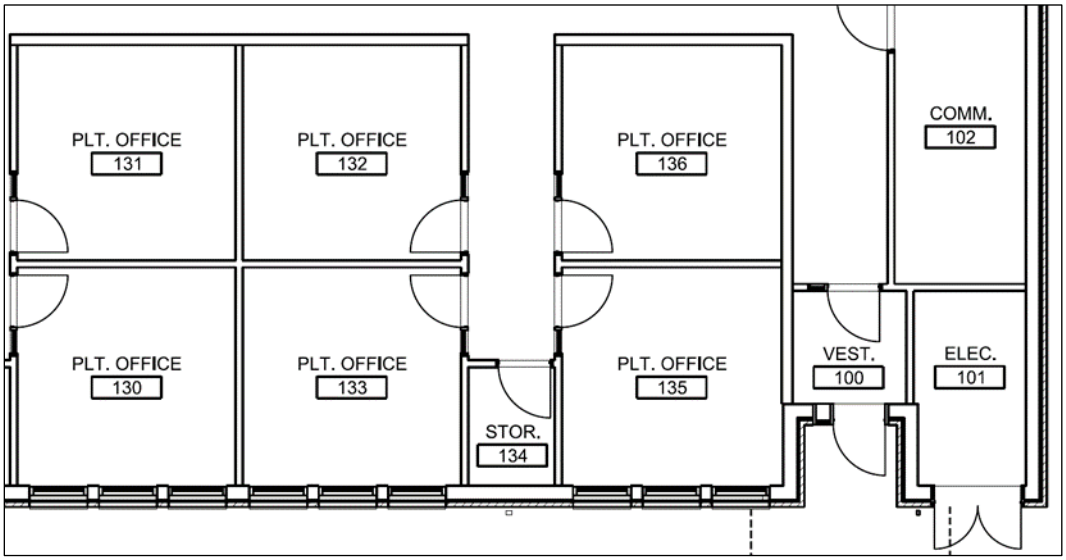
entrance, elevator, or stair) to the floor and proceeds sequentially. For instance, if the building is a single-story structure, then the first room to the right of the main entrance would be 101. If the main entrance opens into a lobby or vestibule, then the lobby would be numbered 100, and numbering would continue sequentially with the first room to the right (Figure 3-6).

Figure 3-5. Room identifier symbol.



Note: *Room numbers on construction documents are typically for construction references and do not necessarily reflect the final room numbers. See the Signage schedule for final room number/names. It is recommended that the architect consult the building owner before beginning room numbering.*

Figure 3-6. Room numbering example.



3.3.4 Numbering of Doors

Each door opening in a building shall have a door mark symbol composed of a 3/32 in. (2.4 mm) text unique identifier inside of an elongated circle 3/8 in. (10 mm) wide × 3/16 in. (5 mm) high (Figure 3-7). For rooms that have one door opening, the door opening number shall be the same as the secure side room number. If more than one door opening in a room exists, door openings within that room shall be identified by the room number followed by an alphabetical character starting clockwise from the corridor access door opening. For example, for Room 126 (Figure 3-8), the corridor access door opening would be numbered 126A, and the second door opening within Room 126 would be numbered 126B. The door identifier shall also be placed in the Mark column of Door Schedules that are developed.

Figure 3-7. Door mark symbol.

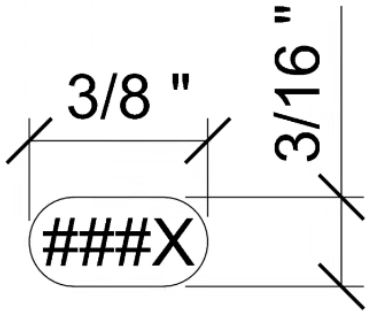
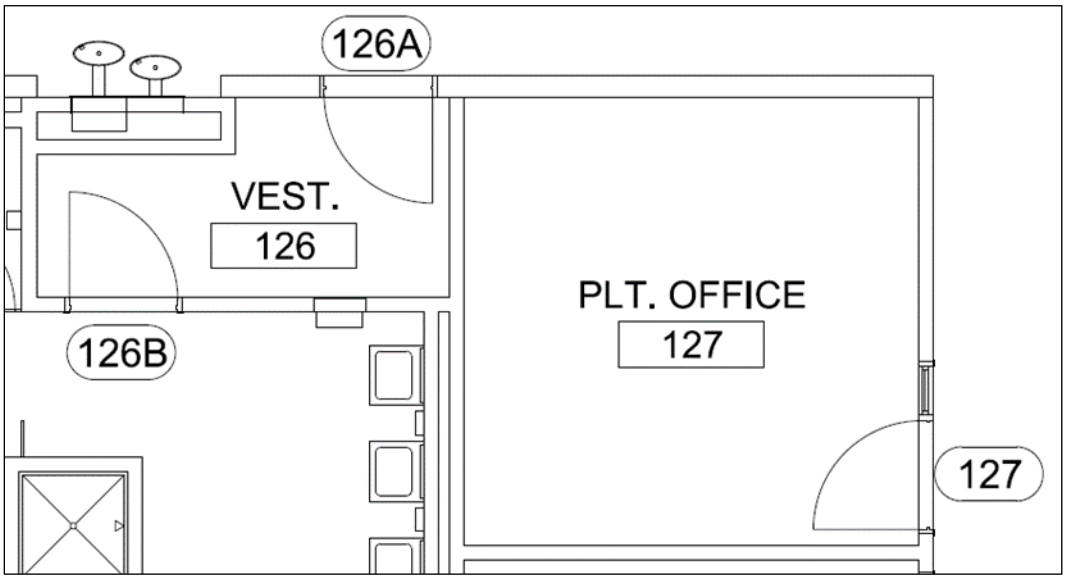


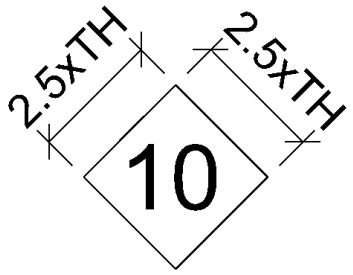
Figure 3-8. Numbering of doors.



3.3.5 Identification of Windows

Each window in a building shall have a window identifier symbol composed of a 3/32 in. (2.4 mm) text unique identifier inside of a diamond (Figure 3-9). The window identifier number and letter shall also be placed in the Mark column of Window Schedules that are developed.

Figure 3-9. Window identifier symbol.



3.3.6 Numbering of Stairs

The most prominent stair with the largest egress capacity shall be identified with 3/32 in. (2.4 mm) high text as STAIR 1. On the first floor, number the stairs sequentially, moving clockwise from the first stair. The stair number remains the same for its entire height. Stairs above or below the first floor that do not connect with the first floor are numbered following those that do. If several prominent stairs with large egress capacity exist, the stairs may be numbered in order of their importance to the main egress point in the building. Additional stairs may be numbered as described.

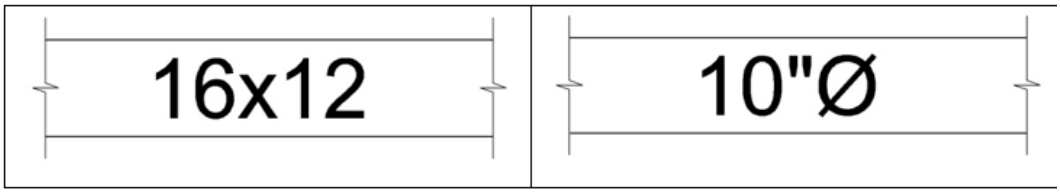
3.3.7 Numbering of Elevators

The elevator nearest to the building entrance with the largest access and egress capacity shall be identified with 3/32 in. (2.4 mm) high text as ELEVATOR 1. Number additional elevators moving clockwise within elevator banks. Use the same sequence and arrangement of numbers on additional banks of elevators if present.

3.3.8 Labeling of Duct

The SMACNA labels rectangular duct as shown in Figure 3-10*a* (SMACNA 2001). The first value represents the side of the duct shown (width), and the second value represents the side of the duct not shown (depth). Round duct is shown as the diameter of the duct, followed by a diameter symbol (Figure 3-10*b*).

Figure 3-10. Duct labeling.



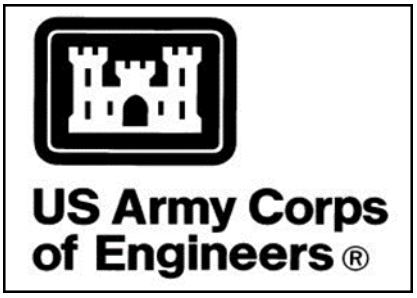
a. Rectangular duct. b. Round duct.

4 Drawing Symbology

4.1 Corps Castle

The appearance of the USACE Communication Mark (commonly known as the Corps Castle) has very specific requirements (Figure 4-1). Customized versions of the Communication Mark for individual USACE organizations are prohibited unless the purpose is for "employee morale welfare activities." The Communication Mark is trademarked, and the ® symbol is to be included "when reproducing printed promotional material that is intended for public usage."

Figure 4-1. US Army Corps of Engineers Communication Mark (commonly known as the Corps Castle).



The "US Army Corps of Engineers®" text located underneath the Communication Mark shall be aligned with its left edge. If a Field Operating Activity (FOA) signature is added to the Communication Mark (Figure 4-2), the text shall always be placed below the "US Army Corps of Engineers®" text. For more information on the USACE Communication Mark, go to http://www.publications.usace.army.mil/Portals/76/Publications/EngineerPamphlets/EP_310-1-6.pdf.

Figure 4-2. Placement of Field Operating Activity (FOA) signature in USACE Communication Mark.

4.2 Symbols

4.2.1 Symbol Descriptions

Symbol descriptions, located anywhere in a drawing set, shall adhere to the following basic guidelines to allow their repetition from job to job, preclude conflicts within the drawings, and maximize suitability for CAD interface:

- Symbol descriptions in legends shall be concise and worded in a comma-separated structure that flows from the general to the specific. For example, in lieu of wording the description of a convenience receptacle as WALL-MOUNTED, DUPLEX RECEPTACLE, structure the wording as RECEPTACLE, DUPLEX, WALL-MOUNTED.
- The symbol description shall not contain specific information that would normally be contained in equipment schedules or on the plans.
- Where equipment or devices within a room are all identical, one symbol shall be identified with the full type identifier, and other information and a callout shall be referenced to this symbol with the following words: TYPICAL FOR THIS ROOM. TYPICAL (abbreviated "TYP"), when used by itself, applies to everywhere a symbol is used in a drawing set unless otherwise noted.

4.2.2 Symbol Identifiers

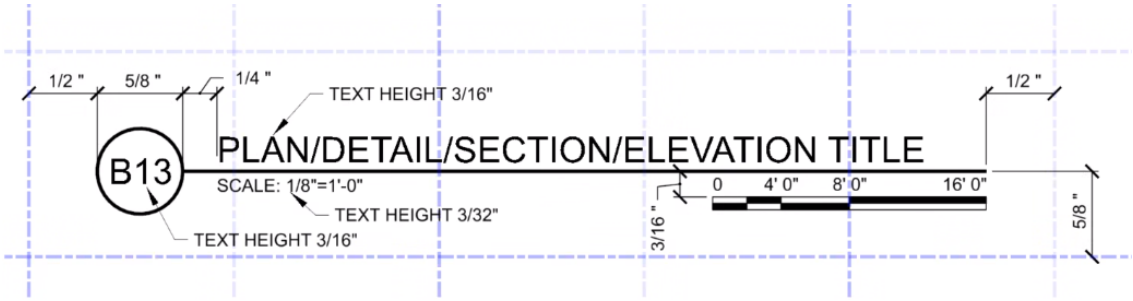
Identifying letters within and around symbols must be legible at half normal size. Therefore, letter sizes for symbols shall be a minimum of 3/32 in. (2.4 mm) for that symbol.

4.2.3 Drawing Block Title

4.2.3.1 Drawing Block Title Identification and Placement

The Drawing block title is composed of multiple pieces. The identification is a bubble with a combination row letter then column number identification (Figure 4-3). The alphabetic/numeric identification is based on where the drawing block is placed on the sheet grid in the drawing area (see Section 2.1.5). For instance, if the lower left corner of a drawing block is located at the intersection of sheet grid row B and sheet grid column 3, then the identification becomes B3. That identification is also used in the top-half of the detail/section/elevation indicator symbols.

Figure 4-3. Drawing block title identification symbol.



The decision on where to place the drawing block title within the drawing area of the sheet shall be based on priority and convenience:

> [When placing details, sections, or elevations,] locate the most frequently used referenced drawing block at the lowest drawing module adjacent to the title or notation block [bottom right portion of the drawing area]. Add additional drawings in order of priority, from bottom to top and from right to left. Starting the drawings from the right to the left makes it easier to use partially filled sheets. This eliminates the need to open a heavy set of drawings all the way to the binding to refer to a few details drawn on the left-hand side of the sheets. (UDS Module 4—Drafting Conventions [CSI 2014]).

Note: *When only one subject appears on a drawing, and its title already appears in the title block, a drawing block title shall also be placed under the entire area of the subject.*

Note: *For consistency and uniformity, multiple details with differing subject matters and subtitles are no longer allowed in the same drawing area. Details are to be a single subject matter. Additional information can be added as a note.*

4.2.3.2 Drawing Block Title Text

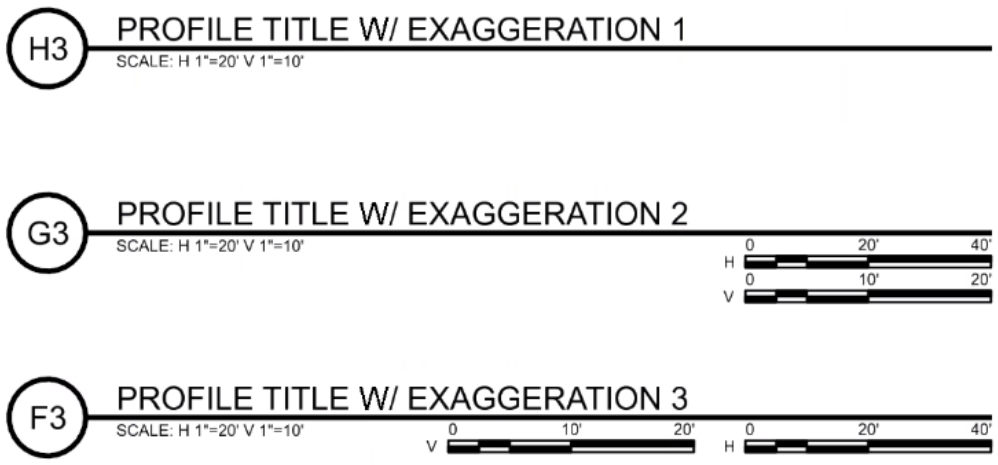
All text placed in the drawing block title shall be Arial. The height of the text within the bubble and on the drawing area title line shall be 3/16 in. The scale text underneath the drawing block title line shall be 3/32 in.

4.2.3.3 Scales

Drawing block titles shall have the text scale placed below the left side of the drawing block title line. To ensure that reduced or enlarged prints are plotted to scale, at least one graphic scale shall be placed in the drawing for each different scale used on the sheet. The graphic scale is placed in the lower right corner of the drawing block below the drawing block title line of the respectively scaled item (see Figure 4-3).

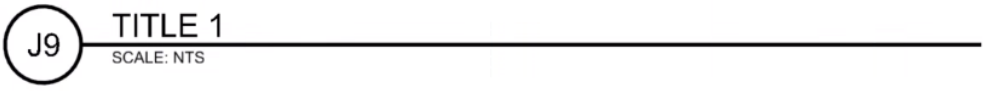
When there is an exaggeration in scales associated with a view (e.g., profiles and cross sections), then all scales shall be provided below the drawing block title line (Figure 4-4). For instance, in Figure 4-4's first example, no graphic scale is required when a profile or cross section has a scaled grid, otherwise a graphic scale shall be placed similarly to the requirements stated above.

Figure 4-4. Exaggerated scale examples.



When a drawing is not drawn to any particular scale, the words "SCALE: NTS" shall be so stated, where NTS indicates Not to Scale (Figure 4-5).

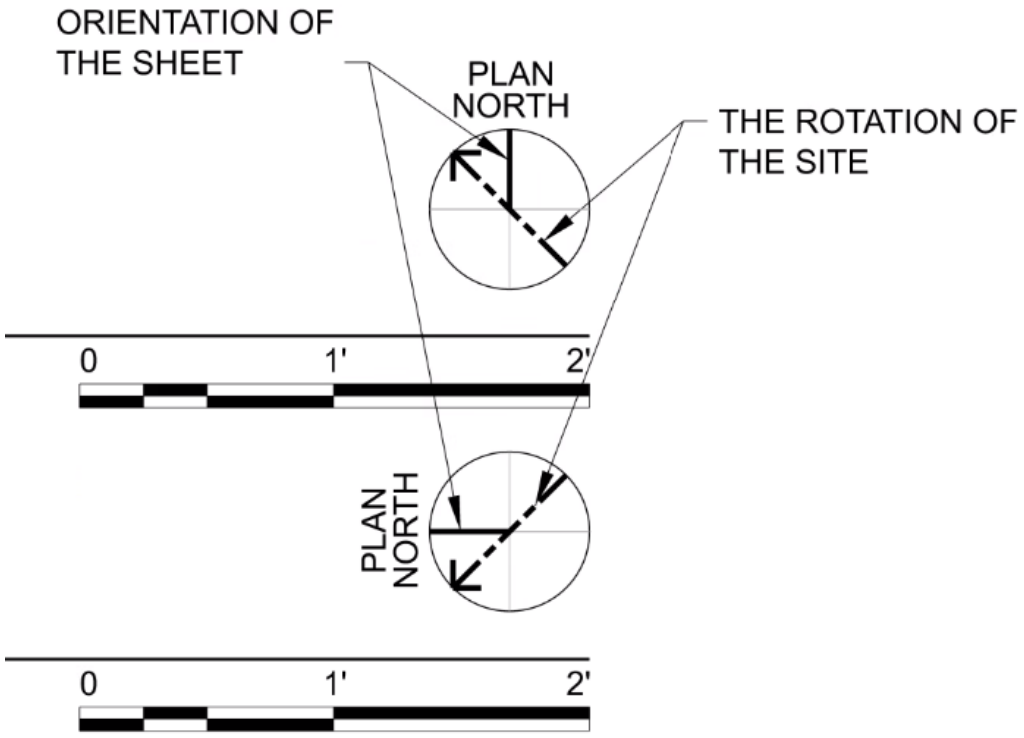
Figure 4-5. Not to scale example.



4.2.3.4 North Arrow

The plan north arrow defines the orientation of the sheet and shall be oriented so that it points to the top or the left of the drawing block. The true north arrow (shown dashed in the symbol), as defined by the project (e.g., grid north, magnetic north, etc.), is adjusted to show the rotation of the site in relation to the drawing block. The north arrow (Figure 4-6) shall be placed in the lower right-hand corner of the drawing block above the drawing block title. If possible, the orientation of the true north arrow shall be maintained throughout an entire drawing set.

Figure 4-6. North arrow.

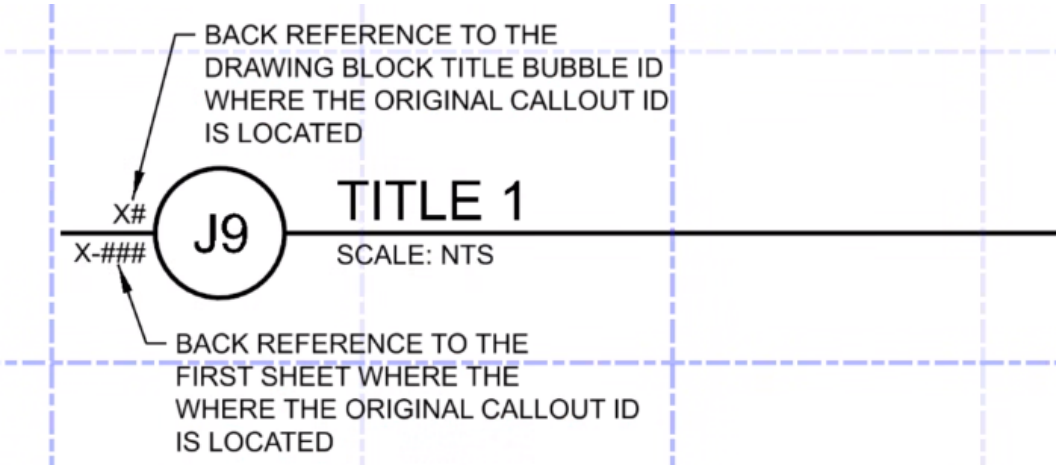


4.2.3.5 Back-referencing

Back-referencing occurs when the drawing block title references back to the original sheet and location where a detail/section/elevation is called out. The practice of back-referencing is not addressed by the NCS. While not against the A/E/C Standards, back-referencing requires an inordinate amount of coordination to make sure all information is kept up-to-date and thus is *not* required.

To provide a standard means to accomplish back-referencing that does not conflict with the NCS convention (Figure 4-7), a simple method was developed. The method places the back-reference to the left of the drawing block title bubble and has two parts. The upper half shows the grid location of the original drawing block identification. The lower half shows the first sheet number that the indicator symbol shows up on.

Figure 4-7. Back-referencing method using the drawing block title.



4.2.4 Elevations, Sections, and Details

4.2.4.1 Elevation/Section/Detail Indicator Symbol

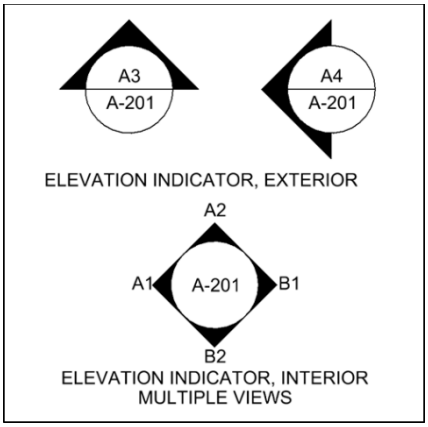
The symbology for elevation, section, and detail callouts may be different, but the procedure for identifying and naming them is the same. The elevation, section, or detail is called out in a drawing with a two-part symbol that identifies the following:

- The elevation/section/detail identification
- The sheet on which the elevation/section/detail is located

4.2.4.2 Elevation Indicator Symbol

The elevation indicator symbol (or callout) is a symbol that indicates an area of the drawing that is shown as an elevation on the elevations sheet (Figure 4-8). As mentioned previously, the top part of the circle is filled in with the elevation identification, and the bottom part is filled in with the sheet number on which the elevation occurs. The sheet number shall always be an XX2NN designation where XX is the Discipline Designator, 2 indicates it is an Elevations sheet, and NN is the Sheet Sequence Number (01–99).

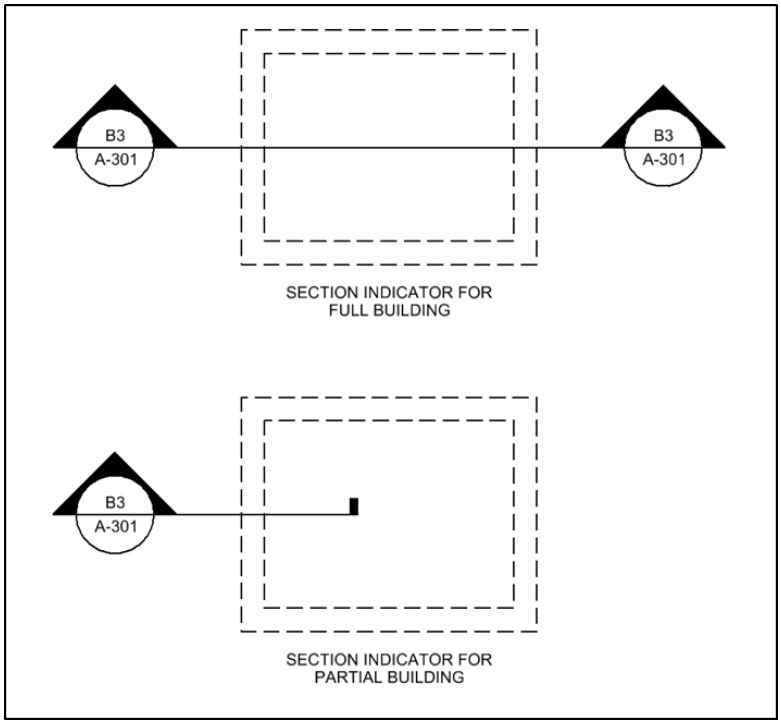
Figure 4-8. Elevation indicator symbol.



4.2.4.3 Section Indicator Symbol

The section indicator symbol (or callout) is a symbol that cuts through an area of the drawing that is shown as a section cut on the sections sheet (Figure 4-9). As mentioned previously, the top part of the circle is filled in with the section identification, and the bottom part is filled in with the sheet number on which the section occurs. The sheet number shall always be an XX3NN designation, where XX is the Discipline Designator, 3 indicates it is a Sections sheet, and NN is the Sheet Sequence Number (01–99).

Figure 4-9. Section indicator symbol.

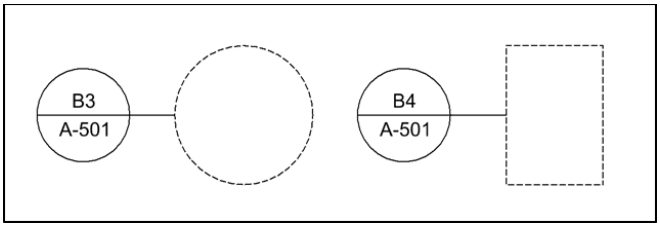


4.2.4.4 Detail Indicator Symbol

The detail indicator symbol (or callout) is a circle that points to an area of the drawing that is shown as a detail on the details sheet (Figure 4-10). As described previously, the top part of the circle is filled in with the detail identification, and the bottom part is filled in with the sheet number on which the detail occurs. The sheet number shall always be an XX5NN designation where XX is the Discipline Designator, 5 indicates that it is a Details sheet, and NN is the Sheet Sequence Number (01–99).

Note: *For enlarged areas, the detail indicator symbol is used in a similar fashion as described above. The difference is that the sheet number shall always be an XX4NN designation where XX is the Discipline Designator, 4 indicates that it is an Enlarged Area sheet, and NN is the Sheet Sequence Number.*

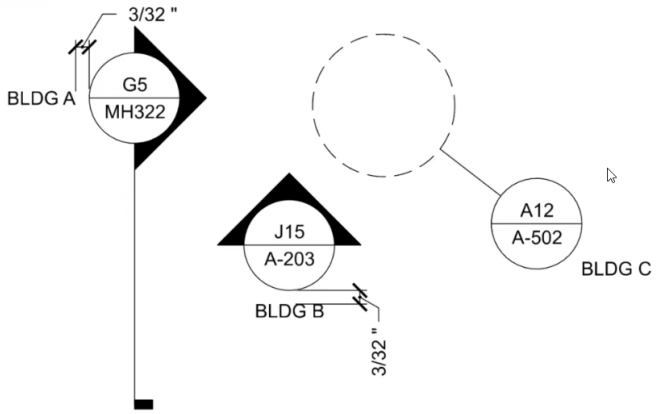
Figure 4-10. Detail indicator symbol.



4.2.4.5 Callouts Using Building IDs

Sometimes a project has multiple buildings within the same plan set. When calling out an elevation/section/detail, place the building ID opposite the arrow or leader (Figure 4-11).

Figure 4-11. Building ID placement.



4.2.5 Welding Symbols

When typical weld symbols are developed, the following drafting convention shall be followed (Figures 4-12 and 4-13, Table 4-1).

The numbers in Figure 4-12 are keyed to the following list:

1. Finishing symbol
2. Contour symbol
3. Groove angle: includes angle of countersink for plug welds
4. Root opening: depth of filling for plug and slot welds
5. Groove weld size
6. Depth of bevel: size or strength for certain welds
7. Specification, process, or other references
8. Tail (may be omitted when reference not used)
9. Length of weld segment
10. Pitch (center-to-center spacing) of weld segments
11. Field weld symbol (flag always points to tail of weld symbol)
12. Arrow connecting reference line to arrow side member of joint or arrow side of joint
13. Reference line
14. Basic weld symbol or detail reference
15. Number of spot, seam, stud, plug, slot, or projection welds
16. Weld-all-around symbol

Figure 4-12. Typical welding symbols.

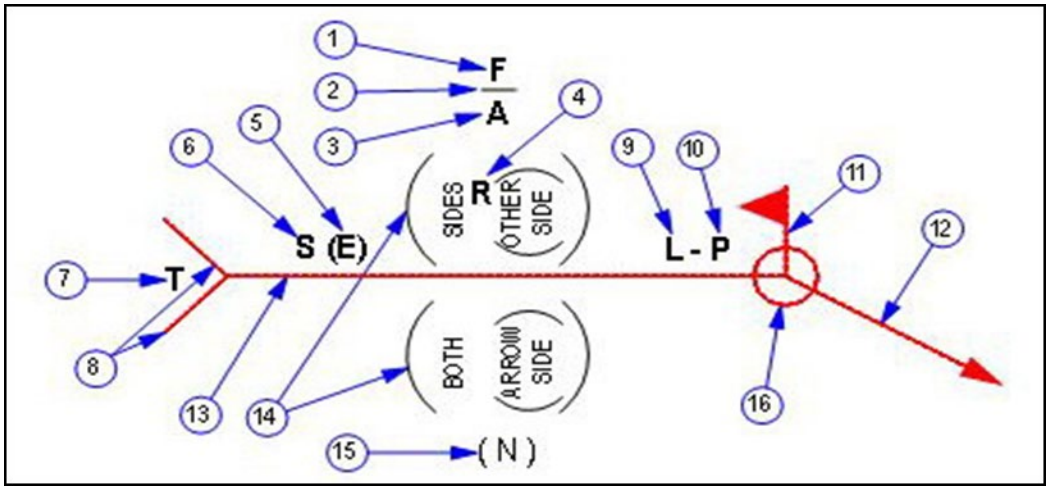


Figure 4-13. Weld symbols.

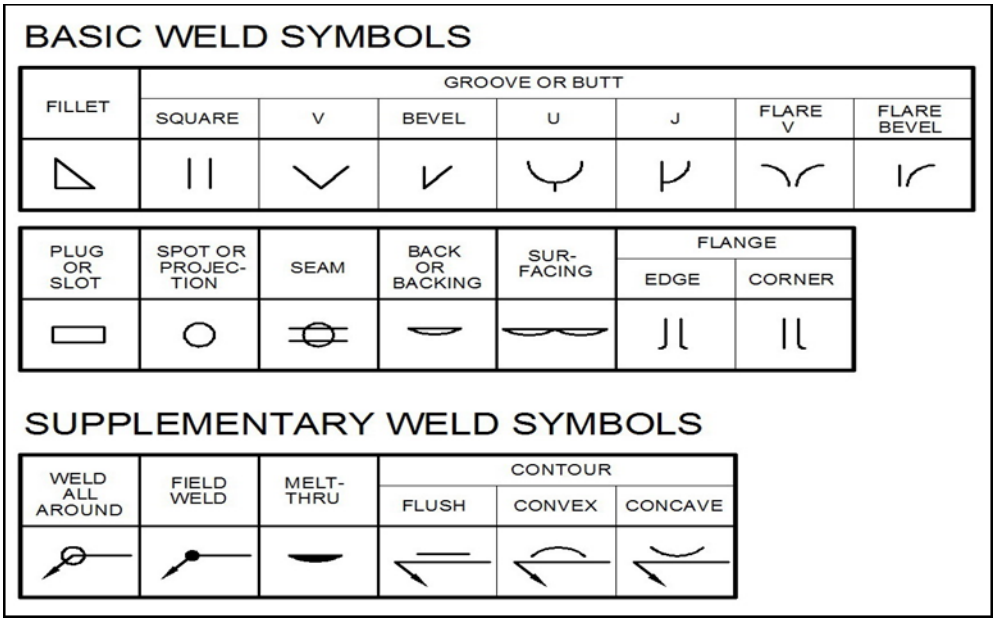


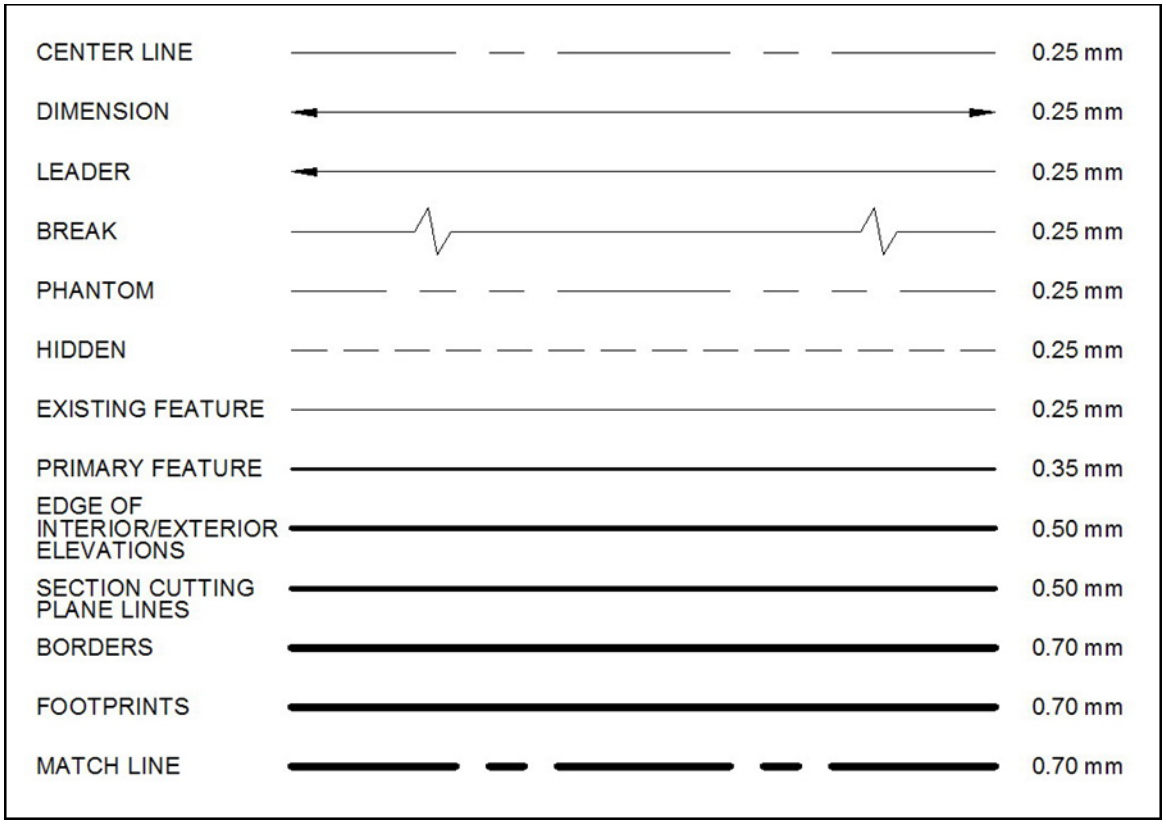
Table 4-1. Common welding processes.

Process	Abbreviation
Electrogas arc welding	EGW
Flux cored arc welding	FCAW
Gas metal arc welding	GMAW
Gas tungsten arc welding	GTAW
Plasma arc welding	PAW
Submerged arc welding	SAW
Shielded metal arc welding	SMAW
Flash welding	FW
Resistance welding	RW
Oxyfuel gas welding	OFW
Diffusion welding (solid state)	DFW
Friction welding (solid state)	FRW
Dip brazing	DB
Diffusion brazing	DFB
Furnace brazing	FB
Induction brazing	IB
Infrared brazing	IRB
Resistance brazing	RB
Torch brazing	TB
Electron beam welding	EBW
Electroslag welding	ESW
Laser beam welding	LBW

4.3 Linework

Various types of lines require specific line weights. Some of those line types and associated line weights are shown in Figure 4-14 (see the Symbol Guide for additional line types).

Figure 4-14. Types of lines and associated line weights.



Centerlines: Centerlines ("014200-914 Centerline" in the *A/E/C CAD Standard*) are used to indicate the travel of a center. Centerlines shall cross without voids. Short centerlines may be unbroken if there is no confusion with other lines.

Dimension Lines: Dimension lines are used to show a linear measurement indicated on a drawing. Dimensions show the extent and significance of the object.

Leaders: Leaders are used to indicate a part or portion to which a number, note, or other reference applies.

Break Lines: Break lines are used to indicate that only a portion of a drawing or a partial view is being shown.

Phantom Lines: Phantom lines ("014200-915 Phantom Line" in the *A/E/C CAD Standard*) are used to indicate the alternate position of parts, repeated detail, or the relative position of an absent part.

Hidden Lines: Hidden lines ("014200-913 Hidden Line" in the *A/E/C CAD Standard*) are used to show the hidden features of a part or object. Relevance for clarity must be considered. Crossing and stacked hidden lines shall be avoided.

Existing Features: Existing feature lines are used for all lines on the drawing representing objects or structures that already exist and will impact the design. Existing feature lines are typically shown screened.

Primary Features: Primary features represent all new work in the design documents.

Edge of Interior/Exterior Elevations: The edges of interior/exterior elevations are the outlines around the perimeter of an elevation.

Section Cutting Plane Lines: Cutting plane lines are used to indicate a plane or planes in which a section is taken.

Borders: Border lines are used to create a margin on the drawing sheet.

Footprints: Footprints show the outline of a building or other object within the drawing.

Match Lines: Match lines (use "014200-914 Centerline" in the *A/E/C CAD Standard*) are used to show where part of a drawing that is too large to be contained on one sheet matches the continuation of that drawing on another sheet.

4.3.1 Showing New Work vs. Demolition Work

For clarity in as-built drawings, plan views of demolition work shall not be combined with those for new work. Demolition plans shall show features to be removed that have contractual significance to the work in the construction contract. Notes shall state which items shown on the demolition plans will be removed unless noted or specified. Notes, key notes, symbol modifiers, patterns, line styles, or callouts shall be used to delineate items to be removed or relocated.

4.3.2 Showing New Work vs. Existing Conditions

New work shall be easily distinguishable from other information shown on the drawings. Show new work at 100% (unscreened), and show existing conditions, including text, screened at a percentage between 20% and 60%. This screening is performed so that the new work will stand out from the existing conditions.

Survey drawings shall be shown at 100% (unscreened) to be screened later if incorporated into design drawings.

5 Drawing Annotation

5.1 Text

5.1.1 Font

Contrasting text fonts are used within a drawing to delineate types of information. In most A/E/C drawings, the fonts shown in Table 5-1 and described below should be sufficient.

- Regular font: This font is appropriate for most general notes, labels, dimensions, or title blocks.
- Italic font: An italic 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.
- Symbol font: This font shall be used in cases where Greek symbols are representations for technical information.

Table 5-1. Comparison of font types.

Font Type	True Type
Regular	Arial ABCDEFGHIJKLMNOPQRST UVWXYZ
Italic	Arial (Italic) *ABCDEFGHIJKLMNOPQRST* *UVWXYZ*
Filled	Arial (Bold) **ABCDEFGHIJKLMNOPQRST** **UVWXYZ**
Symbol	Arial (Symbols) ΑΒΧΔΕΦΓΗΙϑΚΛΜΝΟΠΘΡΣΤ ΥςΩΞΨΖ αβχδεφγηιφκλμνοπθρστ υϖωξψζ

5.1.2 Text Height

The minimum text height for dimensions, notes, callouts, table/schedule text, and general text in plotted files is 3/32 in. (2.4 mm). Title and subtitles shall be plotted equivalent to 3/16 in. (5 mm) and 1/8 in. (3 mm) lettering size, respectively. The text height and text width shall be assigned equal number values. Line spacing shall be equal to one-half of the text height.

To avoid confusion of the word *minimum*, Table 5-2 shows the allowable text height variations from paragraph above for all architectural or vertical disciplines (Hazardous Materials, Structural, Architectural, Interiors, Fire Protection, Plumbing, Mechanical, Electrical, Telecommunications, Resource, Other Disciplines, and Operations). Table 5-3 shows the allowable text height variations for civil or horizontal disciplines (General, Survey/Mapping, Civil, Geotechnical, and Landscape). Text heights for symbols, line styles, and text within the border shall follow the heights listed in Table 5-3, regardless of the discipline.

Table 5-2. Vertical discipline: allowable text heights.

Units	Actual	International Feet (Architectural)	Survey Feet (Architectural)	Actual (metric)	Architectural (metric)
Normal text height	0.09375"	3/32"	N/A	2.38125 mm	2.4 mm
Subtitle height	0.125"	1/8"	N/A	3.175 mm	3 mm
Title text height	0.1875"	3/16"	N/A	4.7625 mm	5 mm

Table 5-3. Horizontal discipline: allowable text heights.

Units	Actual	International Feet (Civil)	Survey Feet (Civil)	Actual (metric)	Civil (metric)
Normal text height	0.125"	0.125"	0.125 si	3.175 mm	3 mm
Subtitle height	0.125"	0.125"	0.125 si	3.175 mm	3 mm
Title text height	0.1875"	0.1875"	0.1875 si	4.7625 mm	5 mm

Table 5-4 lists recommended text heights for common inch-pound scales, as well as line-type scale factors for those scales. Table 5-5 lists recommended text heights for common metric scales.

Note: *The scales shown are not all inclusive. Scales used shall be limited to those commonly found on hand-held architectural, mechanical, and*

engineering scales. Common scale factors are provided in the A/E/C Workspace through annotation scale. Tables 5-4 and 5-5 are provided as a reference for AutoCAD and legacy drawings.

Table 5-4. Inch-pound text heights and line type scales.

Scale	Text Height	Line Type Scale
12" = 1'0" or full size	3/32"	1
6" = 1’0"	3/16"	2
3" = 1'0"	3/8"	4
1-1/2" = 1'0"	3/4"	8
1" = 1'0"	1.125"	12
3/4" = 1'0"	1.5"	16
1/2" = 1'0"	2.25"	24
3/8" = 1'0"	3"	32
1/4" = 1'0"	4.5"	48
3/16" = 1'0"	6"	64
1/8" = 1'0"	9"	96
3/32" = 1'0"	12"	128
1/16" = 1'0"	18"	192
1/32" = 1'0"	36"	384
1" = 5'	5.625"	60
1" = 10'	11.25"	120
1" = 20'	1.875'	240
1" = 30'	2.8125'	360
1" = 40'	3.75'	480
1" = 50'	4.6875'	600
1" = 60'	5.625'	720
1" = 100'	9.375'	1,200
1" = 200'	18.75'	2,400
1" = 400'	37.5'	4,800
1" = 500'	46.875’	6,000
1" = 1,000'	93.75'	12,000
1" = 2,000'	187.5'	24,000

Table 5-5. Metric text heights and line type scales.

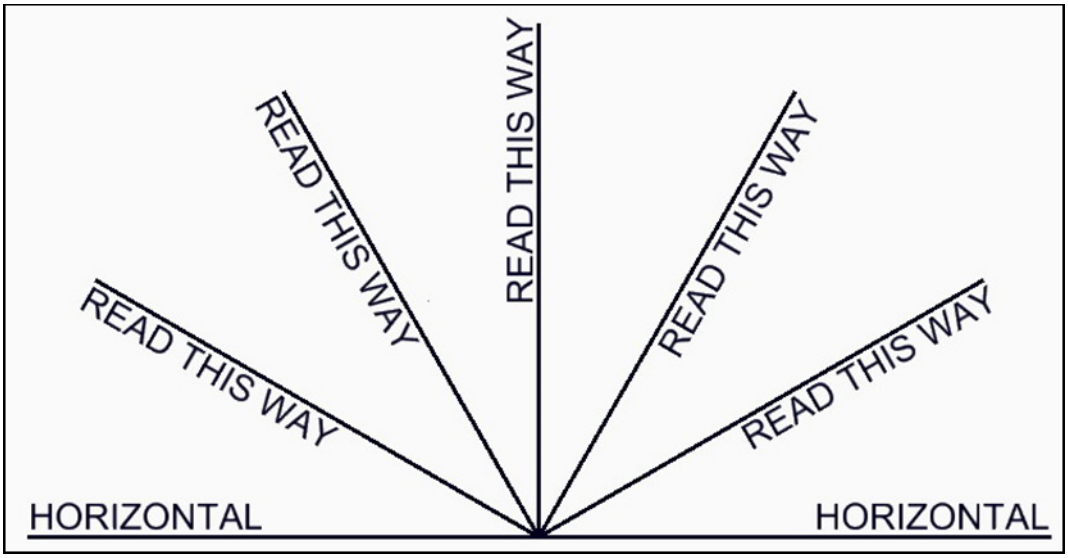
Scale	Text Height	Line Type Scale
1:1 or full size	2.4 mm	1
1:2.5	6 mm	2.5
1:5	12 mm	5
1:10	24 mm	10
1:20	48 mm	20
1:30	72 mm	30
1:40	96 mm	40
1:50	120 mm	50
1:60	144 mm	60
1:100	240 mm	100
1:200	480 mm	200
1:400	960 mm	400
1:500	1.2 m	500
1:600	1.44 m	600
1:700	1.68 m	700
1:1000	2.4 m	1,000
1:2000	4.8 m	2,000
1:5000	12 m	5,000
1:6000	14.4 m	6,000
1:10000	24 m	10,000
1:20000	48 m	20,000

5.1.3 Orientation and Placement

Text shall be set parallel to the primary base of the drawing. If necessary, text can be rotated at 30-degree angles up to 180 degrees as long as the orientation is as shown in Figure 5-1. However, rotating the text is discouraged to prevent having to turn the drawing sheet to read notations.

Note: *An exception to maintaining this text orientation would be on waterways projects because of the various directions in which channels are located. Often text that has a definite bearing on the contract is kept at proper orientation while map features incidental to the contract are allowed to follow the orientation when created in a north-up base map, which may result in upside-down text on rotated plan sheets.*

Figure 5-1. Orientation of text.



Text shall never be placed over other text. Text shall not be placed over feature lines, hatching, or patterning. If text is required in a hatched or patterned area, the hatching/patterning shall be clipped (masked) so the text can be clearly read. The same criteria apply to background imagery.

Text justification depends upon the type of text being placed. For example, general numbered notes shall have upper-left justification, elevation labels appearing to the left of a feature shall have bottom-right justification, and elevation labels appearing to the right of a feature shall have bottom-left justification.

Note: *Use proper planning for text justification so future editing does not require the text to be moved. Use multiline text (node) versus single-line text wherever multiple lines of text are placed.*

5.1.4 Capitalization

Capital letters shall be used in text (Figure 5-2). Capital letters retain improved readability when reproduced at half-size.

Figure 5-2. Capitalization in text.

5.1.5 Leader Terminators

Arrowheads, dots, and tildes are examples of typical terminators used with text leaders (Figure 5-3). See Table 5-6 for terminator sizing.

Figure 5-3. Terminator examples.

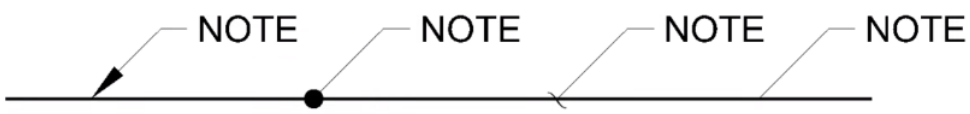


Table 5-6. Terminator sizing.

Terminator	Size
Arrowhead	W = 1.5 × Text height (TH)
Dot	Dia = 0.75 × TH
Tilde	TH

5.2 Note Block

Per the NCS:

> The note block is the module or modules within the drawing area where keynotes, general notes, and key plans are located. Not all sheets will have a note block. The note block is located in the far-right column(s) of the drawing area. (Figure 5-4)

When note blocks expand beyond a single column, additional columns shall be added directly to the left of the far right note block column, and the hierarchy shall be maintained from top to bottom and left to right (Figures 5-5 and 5-6).

Figure 5-4. Location of note block area.

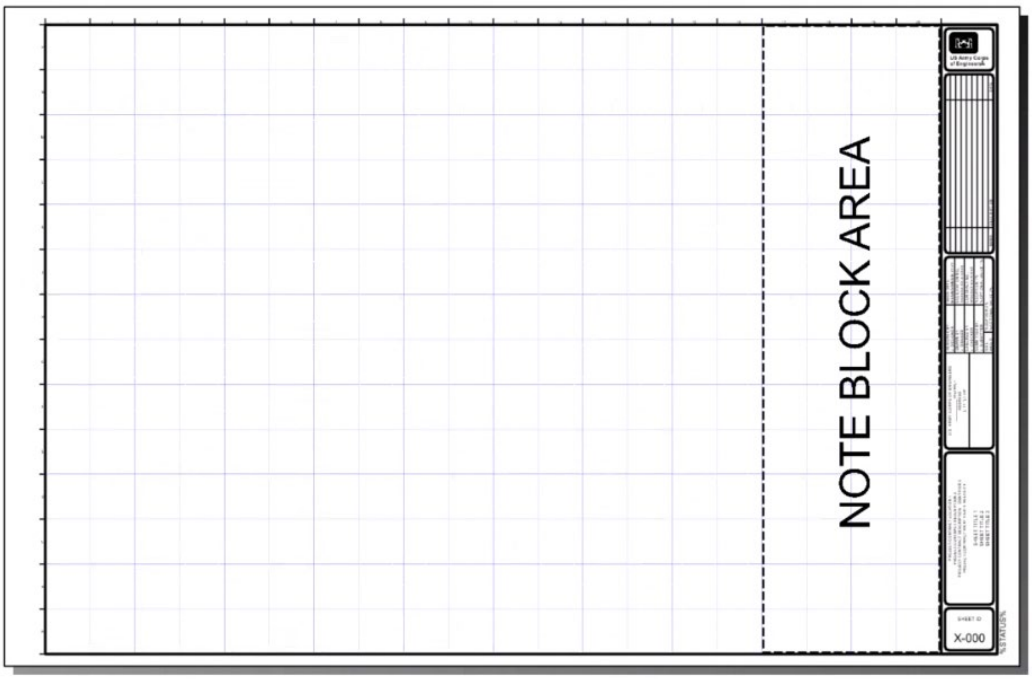


Figure 5-5. Full sheet of notes examples.

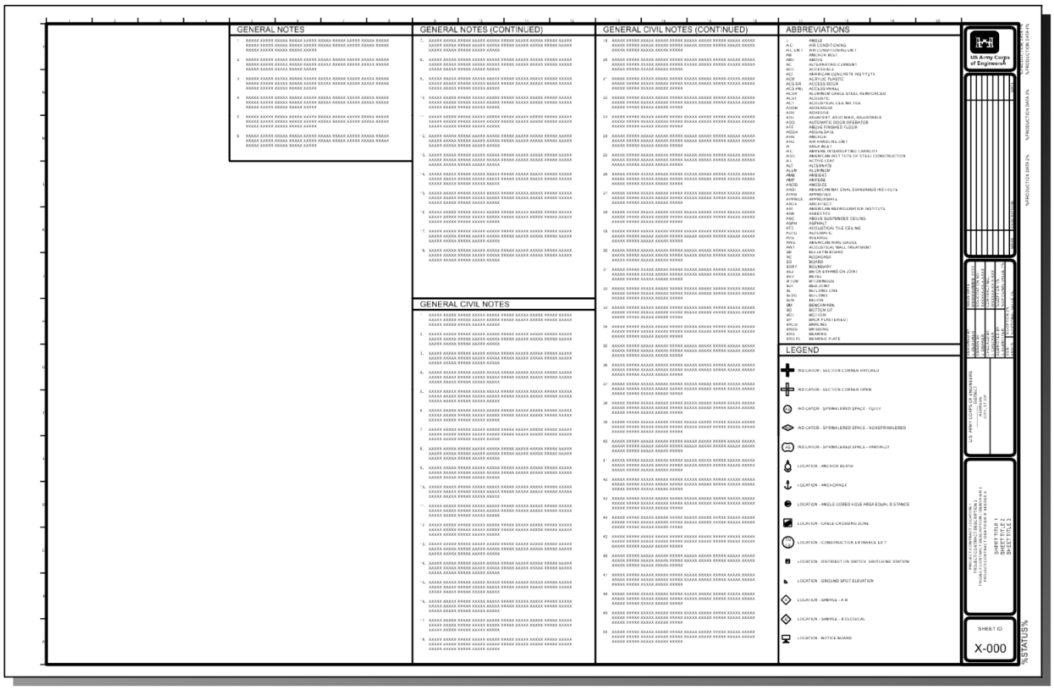
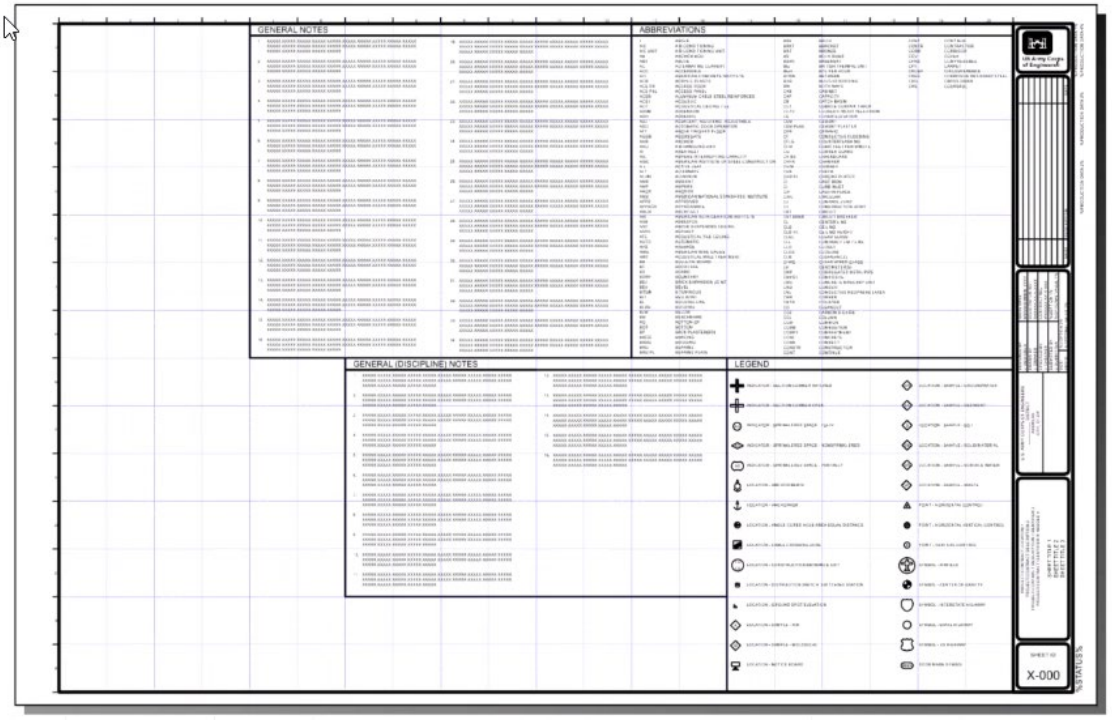


Figure 5-6. Full sheet of notes examples.



The hierarchy of categories within the note block shall be General Notes, General Discipline Notes, General Sheet Notes, Sheet Keynotes, Abbreviations, Legend, and Key Plan. The hierarchy of categories and numbered notes shall be maintained from left to right (see Figures 5-7 and 5-8). All categories may not be used. The note block area shall be a minimum of 4 modules wide by 1 module high. All notes located within the note block area shall be clear and concise.

Figure 5-7. Hierarchy of categories.

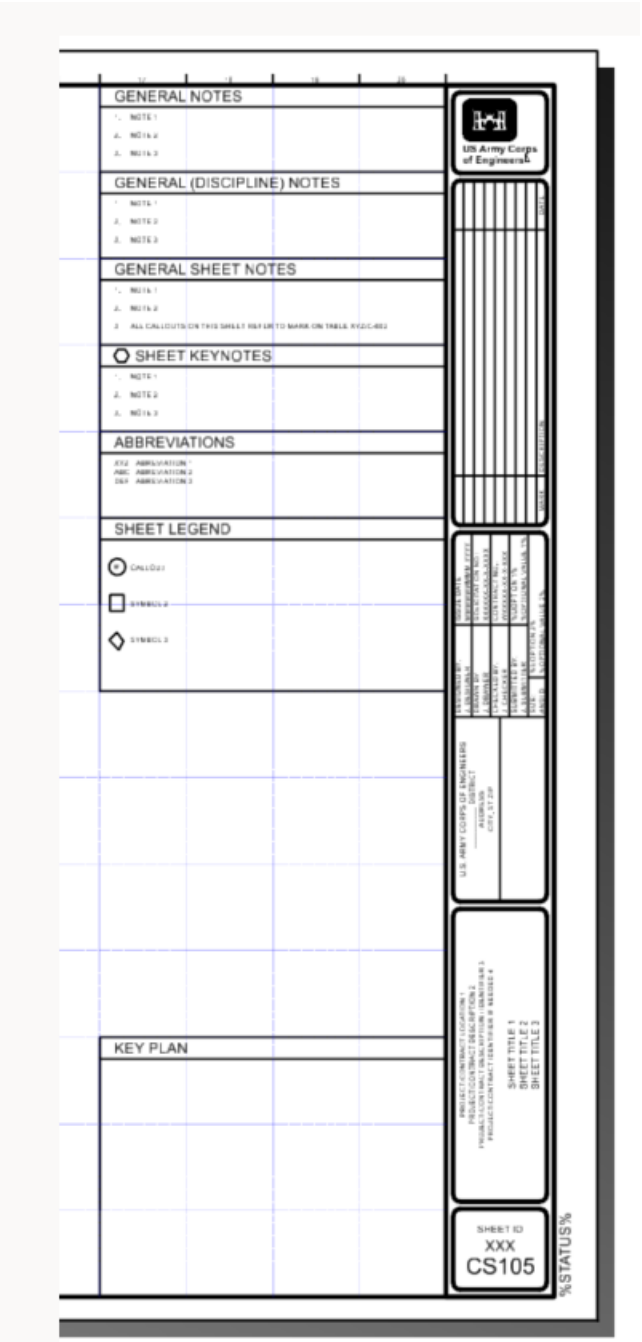
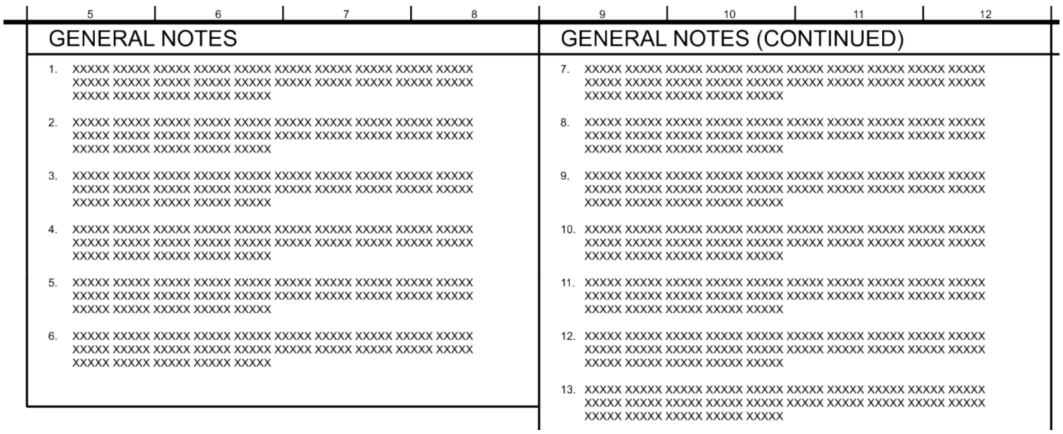


Figure 5-8. Hierarchy of numbered notes.



5.2.1 General Notes

General notes shall have the note block category titled GENERAL NOTES. General notes are notes with universal application to contract work on all drawings. General notes shall be worded such that they are independent of the drawing(s), without cross-referencing or pointing with leaders to plans, details, and so on. General notes shall be capable of being removed from the drawings and placed in the specifications.

All notes under the GENERAL NOTES heading shall be numbered sequentially starting with 1. General notes shall not include contractual requirements, such as statements of costs, time and place of delivery, methods of payment, and requirements for submission, approval, or distribution of data or reports.

5.2.2 General Discipline Notes

General notes applicable to a particular discipline (e.g., architectural, electrical, mechanical) shall be located on the first sheet for that discipline and the note block category shall be titled GENERAL (Insert Discipline) NOTES (Figure 5-9). If using Level 2 Discipline Designators (e.g., MH for Mechanical HVAC, MP for Mechanical Piping, etc.), each type of designator could potentially have its own general discipline notes (typically found on the first sheet of that designator) (Figure 5-10).

Figure 5-9. General discipline notes.

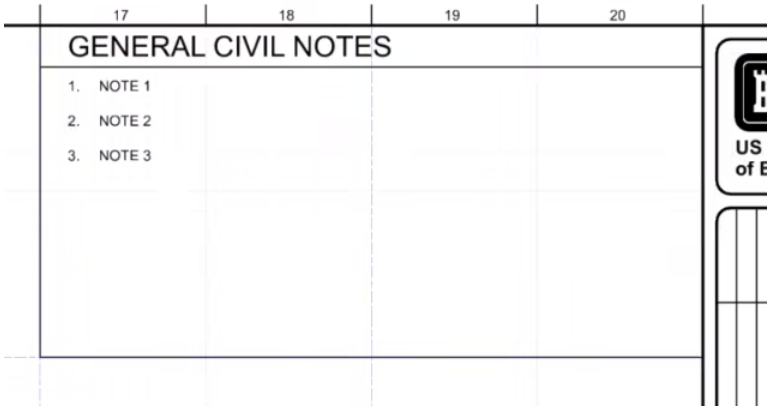
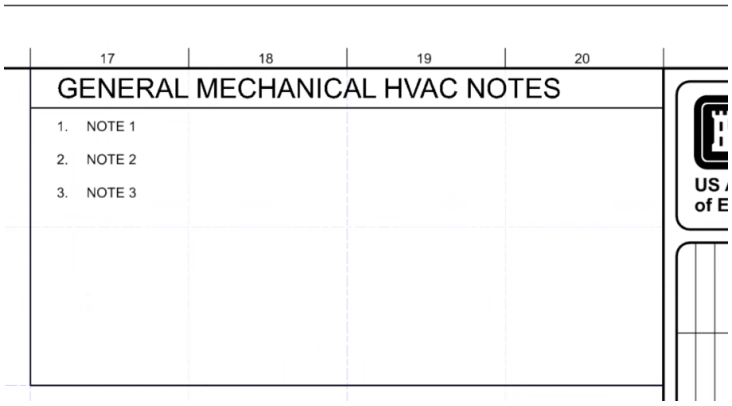


Figure 5-10. General discipline notes (if using Level 2 discipline designators).



5.2.3 General Sheet Notes

General notes applicable to an individual sheet or a range of sheets shall have the note block category titled GENERAL SHEET NOTES or GENERAL SHEET NOTES: _____ THRU _____ (Figures 5-11 and 5-12).

Figure 5-11. General sheet notes (individual sheet).

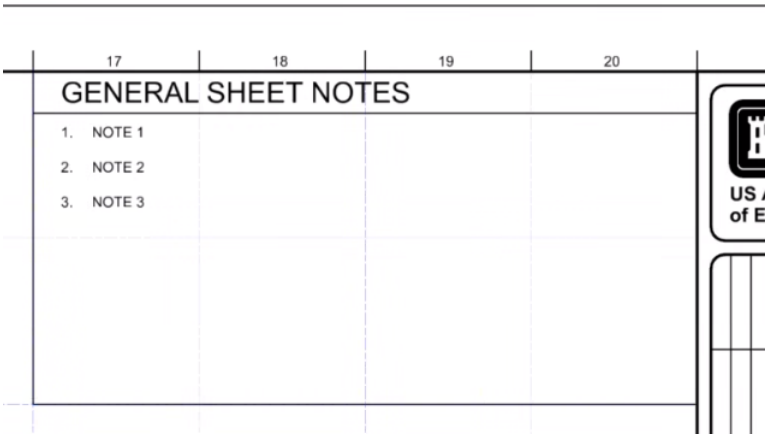
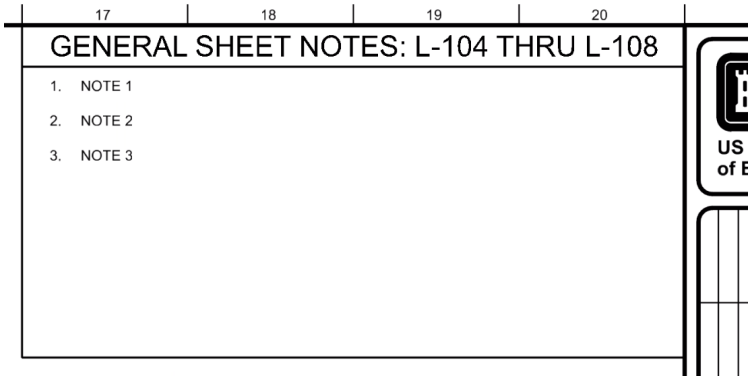


Figure 5-12. General sheet notes (range of sheets).



5.2.4 Sheet Keynotes

Keynotes used in the drawing set shall be defined in a note block category titled SHEET KEYNOTES. Keynotes are useful when there is a lot of text to be placed that may clutter or confuse the intent of the drawing. Per the NCS:

> (Keynotes) Identify, inform, and instruct without reference to the specifications. They are drawn with a hexagonal symbol containing a numeral with (or without a) leader(s) from the hexagon to the identified item (see Figure 5-13). … The numeral for each symbol that appears on the sheet is listed in the sheet's note block along with a text note that describes the graphic. A unique numeral must be assigned for

each identified item, and the keynotes tabulated sequentially within the note block (see Figure 5-14).

Figure 5-13. Keynote symbol (with and without leader).

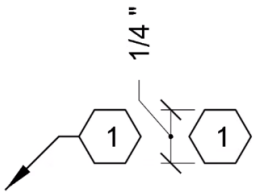
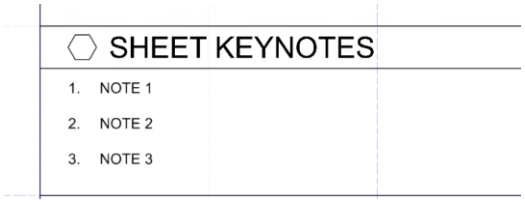


Figure 5-14. Sheet keynotes (note block).



5.2.5 Abbreviations

Abbreviations used in the drawing set shall be defined in a note block category titled ABBREVIATIONS (see Figure 5-7). There could be an abbreviations sheet covering the entire project set (located within the General discipline set of sheets) and/or an abbreviation category specific to disciplines (located at the beginning of a discipline's set of sheets).

Abbreviations for words or phrases frequently used in plans, sections, elevations, or details shall follow the abbreviations as established in the NCS UDS Module 5—Terms and Abbreviations. In addition to this requirement, the following rules regarding abbreviations shall be followed:

- The use of abbreviations shall be kept to a minimum and only when their meanings are unquestionably clear. When in doubt, spell it out.
- Once an abbreviation has been used, the same abbreviation must be continued throughout the project document. Only one abbreviation is allowed for each nomenclature.
- Other abbreviations, particularly discipline-unique abbreviations, may be used but must not conflict with those established in the NCS.
- Any abbreviation used shall be identified in the abbreviations list of the drawing set.
- The rules of grammar concerning capitalization shall be followed. Upper case letters shall be used in all abbreviations except where the

use of lower case has been established by the NCS or by long practice (e.g., Hz for Hertz).
- Periods shall be omitted (e.g, “TYP” instead of “TYP.”)
- Spell out all titles and subtitles.
- The ampersand (&) may be used in firm names (e.g., Jones & Co., Mobile & Ohio R.R.) or in abbreviations of commonly joined words (e.g., T&G for *tongue and groove*, C&G for *curb and gutter*) but never to take the place of *and* in sentences, notations, or titles.

5.2.6 Legend

Symbols used in the drawing set shall be defined in a note block category titled PROJECT LEGEND, (DISCIPLINE) LEGEND, or SHEET LEGEND (see Figure 5-7). There could be a legend sheet covering the entire project set (typically located within the General discipline) and/or a legend category specific to disciplines (located at the beginning of a discipline), and/or a legend category specific to a sheet (located on that sheet).

Note: *The project needs dictate how legends are formatted for the project set and shall be consistent across all disciplines.*

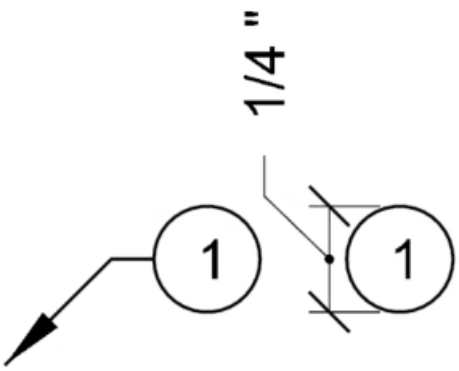
5.2.7 Key Plan

The key plan when used in the discipline drawing set shall be defined as a note block category titled KEY PLAN. When a key plan is shown, the location shall always be in the lower right of the drawing area, and the minimum size shall be 4 drawing modules wide and 3 drawing modules high (see Figure 5-7).

5.3 Callouts

Callouts are similar to keynotes, but they refer to a feature or schedule instead of a note. Callouts are useful when there is a lot of text to be placed that may clutter or confuse the intent of the drawing. Callouts shall use a 1/4" minimum diameter circle with a minimum 3/32" high numerical or alphabetical character inside (Figure 5-15).

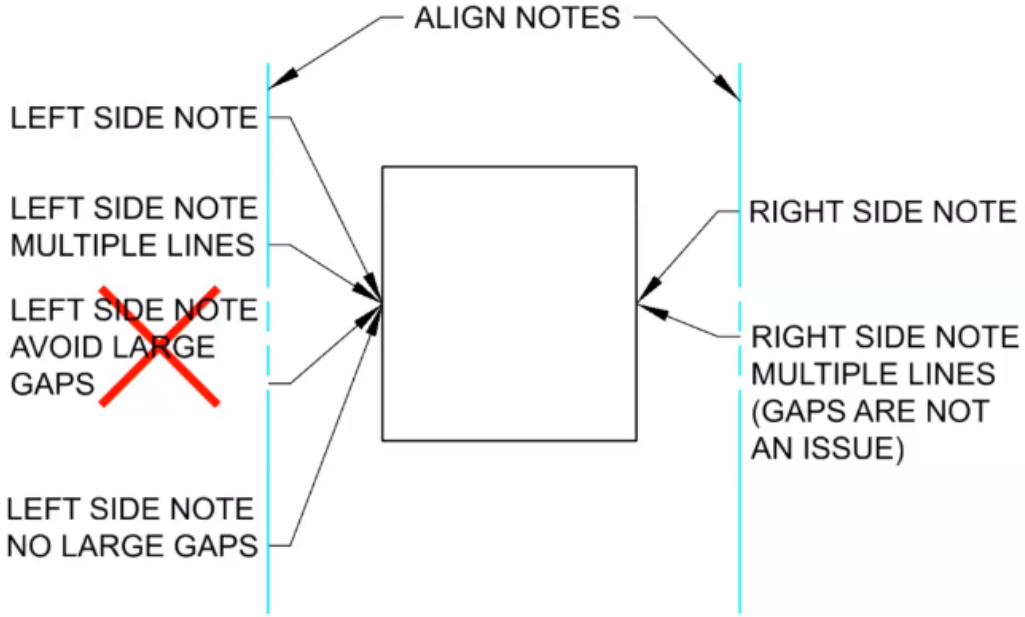
Figure 5-15. Callout symbol (with and without leader).



5.4 Notes with Leader(s)

When placing notes with a leader, if the note is placed on the left side of the object, the leader line shall start from the lowest line of text. If the note is placed on the right side of the object, the leader line shall start from the highest line of text. Regardless of which side the note is on, all text shall be left justified. Leader landings of notes shall be aligned (Figure 5-16).

Figure 5-16. Location and alignment of note leaders.

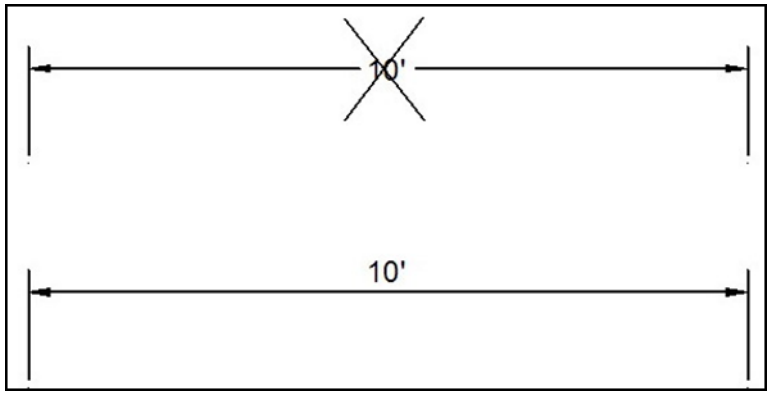


5.5 Dimensions

5.5.1 Dimension Placement

Dimension values shall always be placed above the dimension line, preferably midway between the dimension terminators (Figure 5-17). The dimension line shall never be broken to insert the dimension, apart from angular dimensioning. It is preferred that dimensions always be placed outside the view, located at the top and/or the right side of the plans. Dimensions shall apply to one view only (i.e., no shared dimensions between views). The dimension shall be placed on the view that shows its true length. Exploded dimensions or dimensions where the dimension text has been edited are strongly discouraged except for the following: where software limitations prevent users from providing the appropriate dimensioning, where the dimension is intended to be an approximation and is notated as such, or where a dimension is displayed as a mathematical formula. An exploded dimension for the sole purpose of displaying a value different from the actual measured value is strictly prohibited.

Figure 5-17. Positioning of text in dimensions.



5.5.2 Graphic Settings

Dimensions shall be spaced a minimum of 4 × TH (where TH = dimension text height) from the outlines of the view (shown as dimension “A” in Figure 5-18). Dimension extension lines shall be offset a minimum of 0.5 × TH from the element being dimensioned (dimension “B” in Figure 5-18). Extension lines shall extend 0.5 × TH beyond the dimension line (dimension “C” in Figure 5-18). Parallel dimension lines shall be spaced at least 3 × TH between lines (Figure 5-19). Extension lines that cross other extension lines or dimension lines shall be masked considering that if a

dimension is dropped or exploded, the dimension will lose its association to the element. The numeral size in dimensions shall match the height of the text in the drawing.

Figure 5-18. Dimension settings.

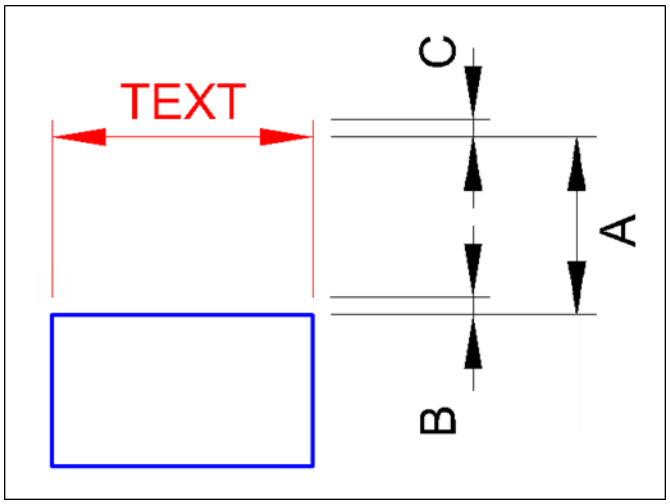
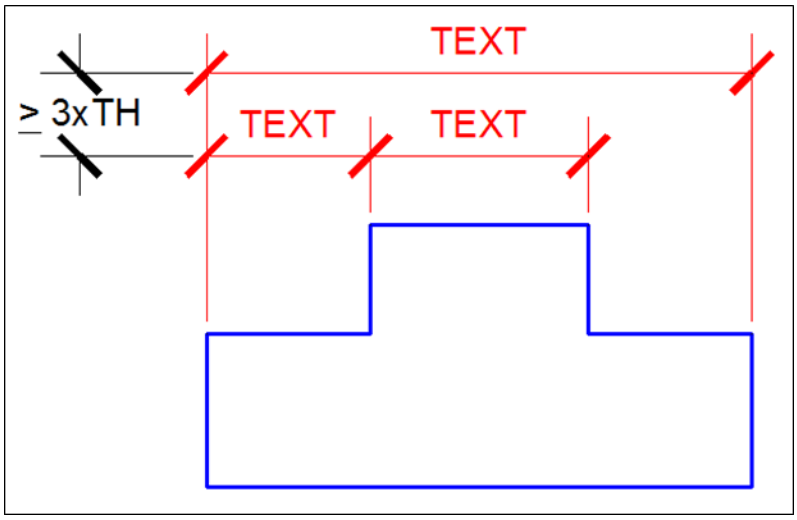


Figure 5-19. Parallel dimension line spacing.

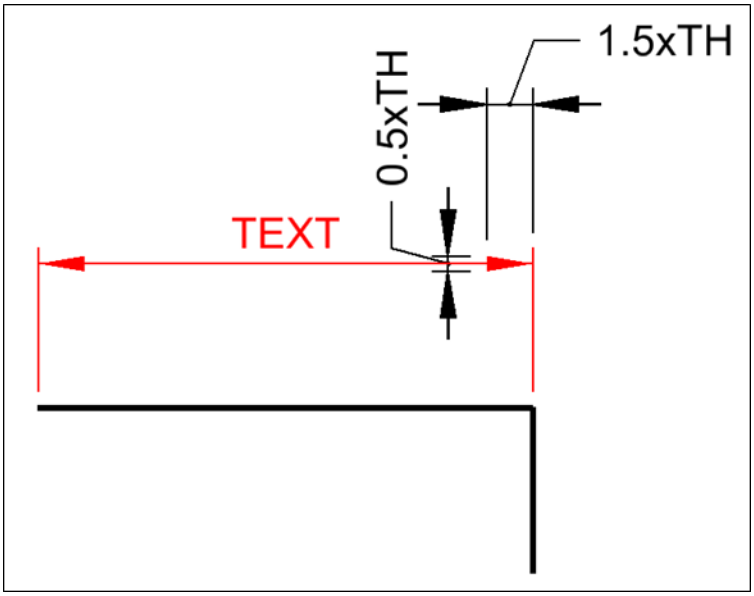


Continuous or staggered dimension lines may be used, depending on convenience and readability; however, continuous dimension lines are preferred.

5.5.3 Dimension Terminators

Slashes or filled arrowheads are allowed for dimension terminators. Filled arrowhead terminators shall have an arrowhead width of 1.5 × TH and a height of 0.5 × TH (Figure 5-20).

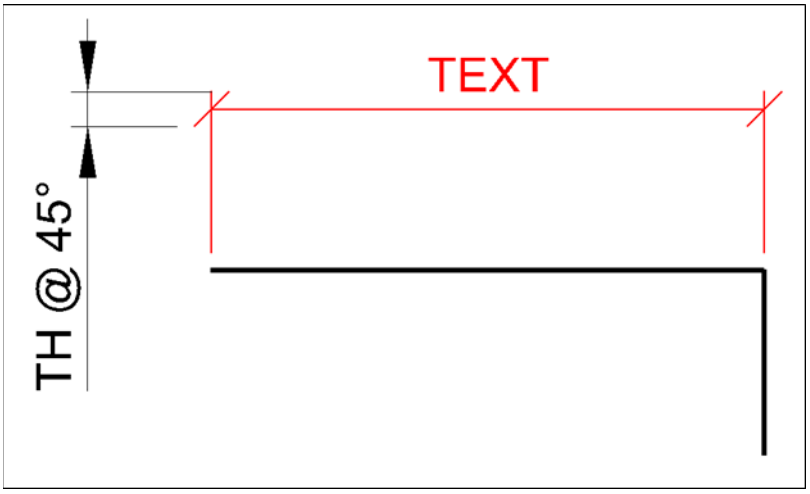
Figure 5-20. Filled arrowhead terminators.



For slash terminators, the slash shall be at an angle of 45 degrees with a height equal to the current text height (Figure 5-21).

Note: *Dimension terminator selection shall be consistent across the entire set of drawings.*

Figure 5-21. Slash terminators.

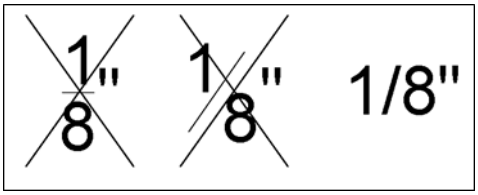


5.5.4 Fractions

All fractions on the drawing shall be inline (not stacked) (Figure 5-22). Fractions shall not be less than 1/16 in. (1.5 mm) because accuracy in the field rarely requires more precision. Decimal values shall always have a leading zero before the decimal point when values are less than 1.

Generally, architectural construction dimensions are shown in feet and inches (e.g., 50'6"). Civil construction dimensions are shown in feet and hundredths of feet (e.g., 50.50'). Decimals of a foot shall be used where dimensions are being set by surveying equipment, such as beam spacing, foundation locations, and structure widths. Details are typically architectural in nature.

Figure 5-22. Fraction format.



5.5.5 Graphic Settings

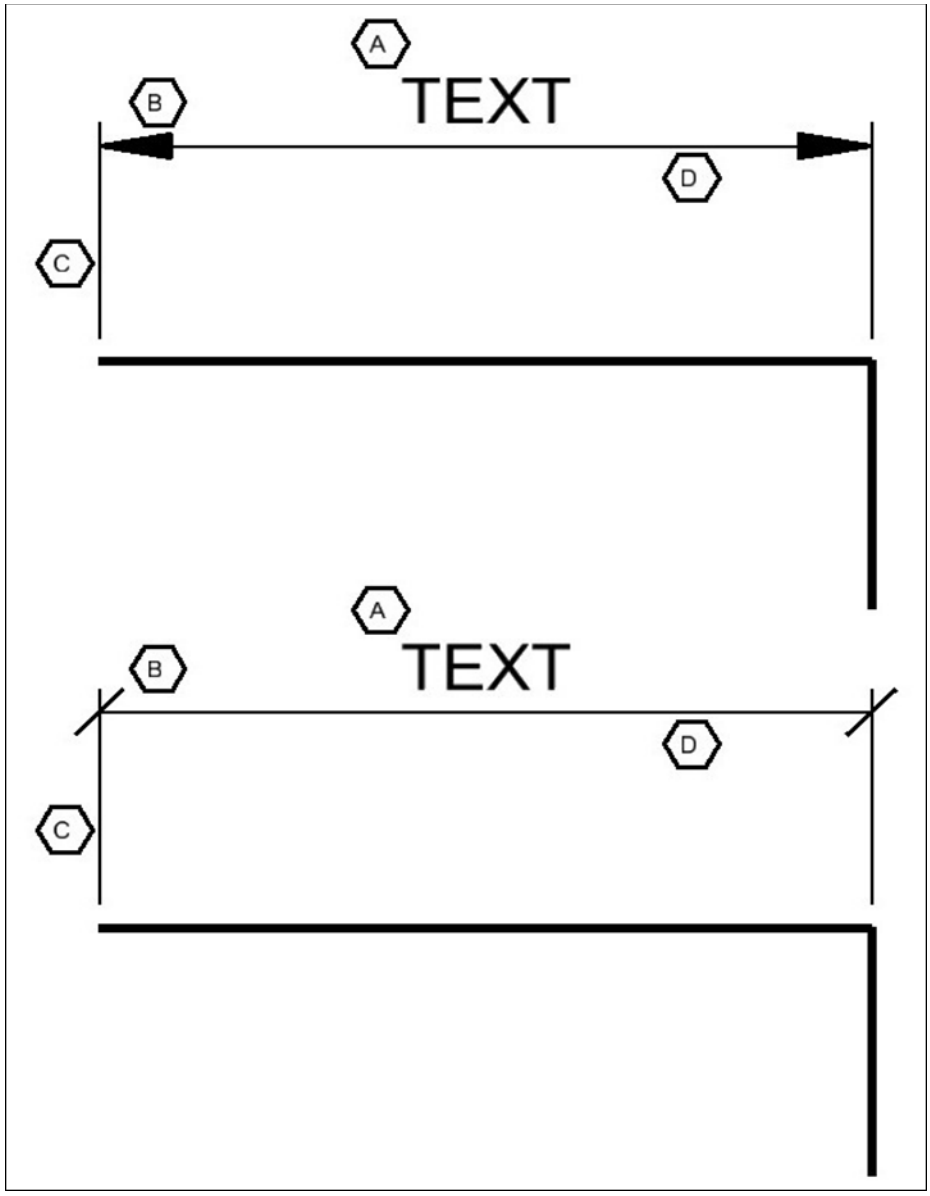
Line width settings for dimensions shall follow those shown in Table 5-7 and Figure 5-23.

Table 5-7. Dimension element settings.

Identifier	Dimension Element	Line Width (mm)
A	Dimension text	N/A*
B	Terminators	0.35
C	Extension lines	0.25
D	Dimension lines	0.25

* Not Applicable for TrueType fonts.

Figure 5-23. Dimension element settings.



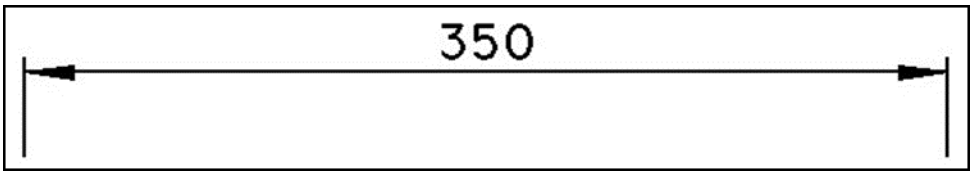
5.5.6 Dimensioning in Metric (SI)

Methodologies for dimensioning metric (SI) drawings are based upon the recommendations of the former Construction Metrication Council of NIBS, Washington, DC. These recommendations comply with the American Society for Testing and Materials (ASTM) E 621-94 (ASTM 1999—withdrawn 2008).

5.5.6.1 Millimeters

For metric vertical design, the unit of measure is typically millimeters. Unit notations are unnecessary and should not be used. The dimension is provided as a whole number as shown in Figure 5-24. Also, a note shall be added to the drawing stating, "All dimensions and/or dimensions shown in callouts/notes are in millimeters unless otherwise noted."

Figure 5-24. Dimension in millimeters, always shown as a whole number.



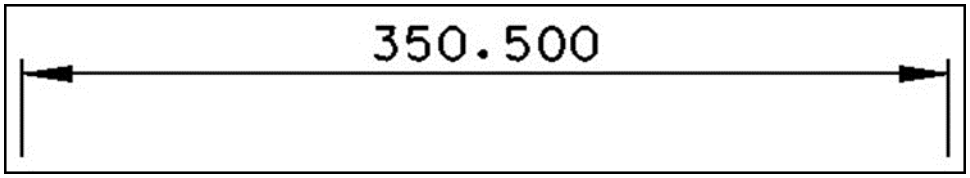
Note: *In circumstances where very small dimensions are used (e.g., machine details), it is permissible to use real numbers for millimeter dimensions. A note shall be placed on the detail regarding this fact.*

5.5.6.2 Meters

For metric horizontal design, the unit of measure is typically meters. Where greater accuracy is required, show dimensions to three decimal places (Figure 5-25). A note shall be added to the drawing stating, "All dimensions and/or dimensions shown in callouts/notes are in meters unless otherwise noted."

When meter measurements are included on the same sheet as millimeter measurements, the meter dimension is provided as a real number taken to three places past the decimal point (Figure 5-17). Again, unit notations are unnecessary.

Figure 5-25. Dimension in meters, always shown as a real number (with decimal).

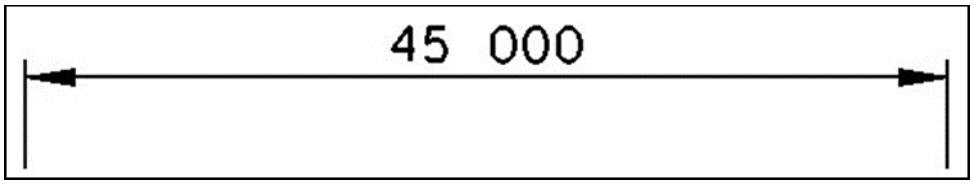


5.5.6.3 Large Units of Measure

Commas shall not be used when providing large units of measure; instead, a space replaces the traditional comma in numbers containing four or

more digits (e.g., the number 5,000 is displayed as 5 000, the number 45,000 is displayed as 45 000). This method is shown in Figure 5-26.

Figure 5-26. Proper dimension presentations for metric measurements with four or more digits.



Note: *The automatic dimensioning features of AutoCAD do not allow users to replace commas with spaces in dimension text, otherwise the associative properties of the dimension to the object being dimensioned would have to be overridden. Until AutoCAD includes a dimension setting to allow this, AutoCAD users are not mandated to follow this requirement.*

5.5.6.4 Dual Units

To avoid confusion, dual units (both inch-pound and metric) shall 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 (Construction Metrication Council 1998).

5.6 Elevations

Elevations shall be indicated with no more than two decimal places (e.g., EL 241.56 or EL 123.00).

5.7 Alignments

Alignment major stationing intervals shall be annotated with whole numbers and a "+" symbol between the hundreds and tens digit with no decimal places. Major station interval distance is 25 ft minimum or a

multiple of 25 ft (e.g., 0+00, 0+25, 0+50, 0+75, 1+00, etc.). Typically, minor stationing interval distance is set to one-fifth of the major stationing interval and is not annotated.

Note: *For metric, use whole meters, and the "+" symbol is placed between the decameter and hectometer digit (e.g., 150+00 for the 15 km station).*

Alignment geometry points are annotated similarly to major stationing intervals, except the distance begins with "STA" and may have up to two decimal places (e.g., STA 50+25.43).

Note: *For metric, use three decimal places, and the "+" symbol is placed between the decameter and hectometer digit (e.g., STA 150+00.125 for the 15.000125 km station).*

5.8 Match Lines

As mentioned in Section 4.3, match lines shall use a 0.70 mm line width and line style "014200-914 Centerline." The text for the match line shall be subtitle height (1/8 in.) per the NCS (Figure 5-27) and placed anywhere along the match line for plan legibility. However, since it is apparent from the text "MATCH LINE" that the reviewer will be required to go to another sheet to see the continuation, the word "SEE" required by the NCS is redundant and not required. At a minimum, use "XX/X-XXX" only when there are multiple drawing views on the referenced sheet and "X-XXX" when there is only one (see Figure 5-28 for information on these fields).

Figure 5-27. Match lines.

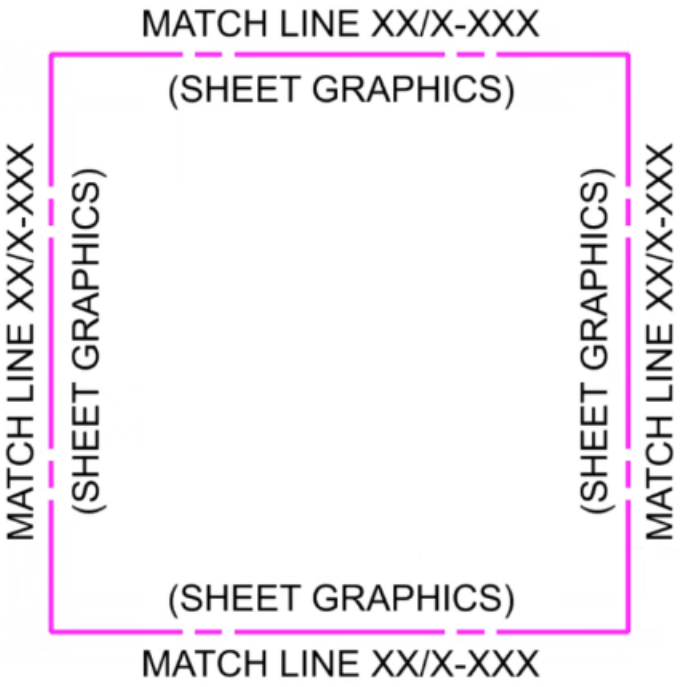


Figure 5-28. Format for match line fields.

6 Schedules

6.1 Features of a Schedule

The purpose of a schedule (or table) is to relay more detailed information about items shown in the drawing set. At a bare minimum, "a schedule consists of four parts—a subject title (Heading), a column identifying an item (Mark), a column for the description of an item (Item Description), and a column for indicating some notable characteristic (Distinguishing Feature)" (Figure 6-1) (UDS Module 3—Schedules CSI 2014). While a minimum of three columns is required in a schedule, additional columns are allowed (UDS Module 3—Schedules CSI 2014).

Figure 6-1. Schedule.

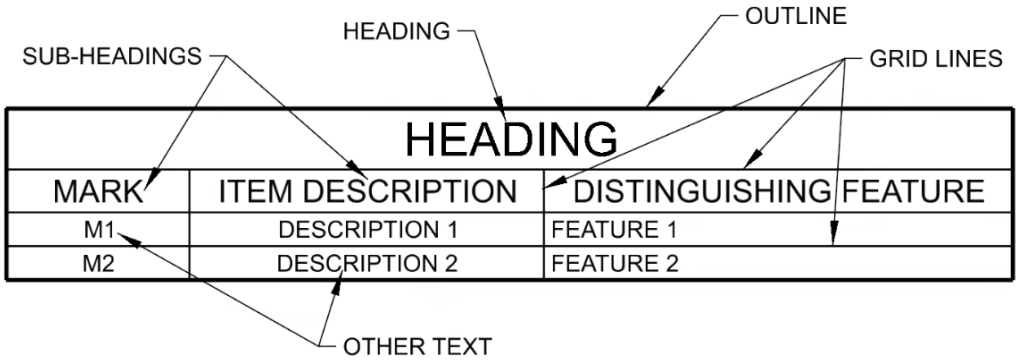
HEADING		
MARK	ITEM DESCRIPTION	DISTINGUISHING FEATURE
M1	DESCRIPTION 1	FEATURE 1
M2	DESCRIPTION 2	FEATURE 2

6.2 Graphic Settings

As far as graphic conventions for schedules, schedules shall have the following line widths and text heights (Figure 6-2):

- Schedule outlines: extra-wide line (0.70 mm)
- Schedule grid lines: medium line (0.35 mm)
- Schedule headings: 3/16 in. (5 mm)
- Schedule subheadings: 1/8 in. (3 mm)
- Schedule text: 3/32 in. (2.4 mm)

Figure 6-2. Schedule linework and text.



6.3 Excel Schedules

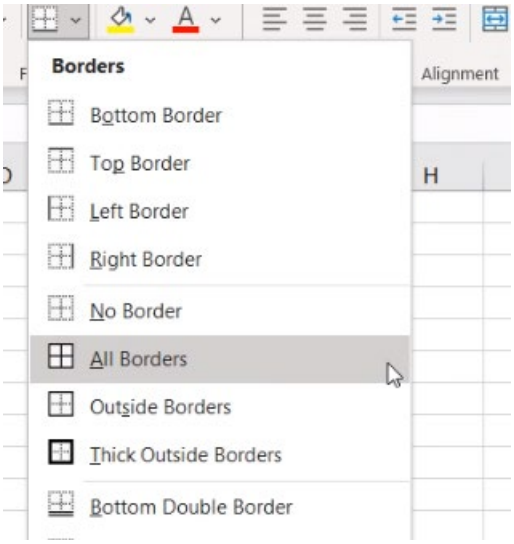
For Excel spreadsheets imported for use as schedules, the following settings shall be followed (Figure 6-3):

- Schedule headings: use Arial with a font size of 19.
- Schedule subheadings: use Arial with a font size of 12.
- Schedule text: use Arial with a font size of 10.
- Use linked/embedded schedules with a scale of 1.
- Horizontal grid lines shall be “All Borders” (Figure 6-4).
- Outlines around the exterior of the schedule shall be “Thick Outside Borders” (Figure 6-4).

Figure 6-3. Excel example.

HEADING		
MARK	ITEM DESCRIPTION	DISTINGUISHING FEATURE
M1	DESCRIPTION 1	FEATURE 1
M2	DESCRIPTION 2	FEATURE 2

Figure 6-4. Excel border settings.



7 Drawing Revisions

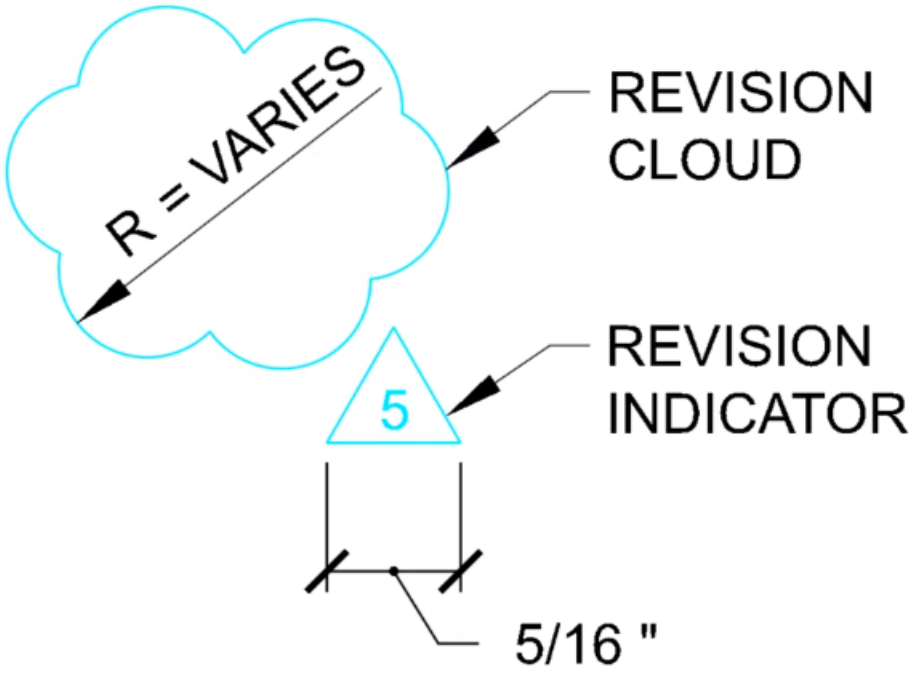
7.1 Revision Designations

During development of CAD contract drawings, revisions are inevitable. There are two different designations for these types of revisions: amendments and modifications. Amendments are revisions that occur during the contract advertisement period. Modifications are revisions that are made after the award of a construction contract. For more information on as-built revisions, see ERDC/ITL SR-21-6, *Record Package Guidance: Best Practices* (or most current version), available on the CAD/BIM Technology Center's website.

7.2 Revision Graphics

All revisions shall be flagged by a revision indicator (Figure 7-1). This indicator shall be an equilateral triangle.

Figure 7-1. Revision indicator with revision cloud.



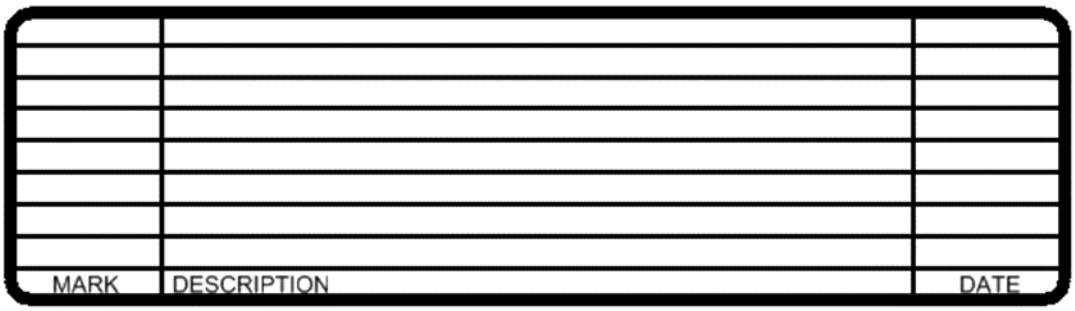
The revision shall be enclosed in a revision cloud drawn at medium thickness (0.35 mm). The revision indicator shall be positioned adjacent to the revision cloud. The revision indicator shall contain sequential numbers

for amendments (i.e., 1, 2, 3) or sequential capitalized alphabetical characters for modifications (i.e., A, B, C).

7.3 Revision (Issue) Block

The Revision (Issue) block (Figure 7-2) contains a history of revisions to the sheet. It is made up of three fields that contain information about each amendment or modification: MARK, DESCRIPTION, and DATE. All text placed within this block shall be 3/32 in. high.

Figure 7-2. Revision (Issue) block.



MARK: The MARK column shall contain either a numeric Amendment character (1, 2, 3, etc.) or an upper-case alphabetic Modification character (A, B, C, etc.). These characters shall relate to revision symbols (equilateral triangles) with the same corresponding characters found on the sheet. The first Amendment or Modification character shall be placed on the lowest line of the Revision (Issue) block, and subsequent entries shall be made above it.

DESCRIPTION: The DESCRIPTION column shall present brief information related to the Amendment or Modification that directs the reader to more detailed information found in a revision document (e.g., REVISED IN ACCORDANCE WITH AMDT 0004, GENERAL REVISIONS MOD 0006, REVISED TO SHOW AS-BUILT CONDITIONS). The DESCRIPTION column shall not be used to provide lengthy information about the revision. Although not required (or recommended), the initials of the designer who made the revision may be provided beside the Description (e.g., REVISED IN ACCORDANCE WITH AMDT 0001—WDG).

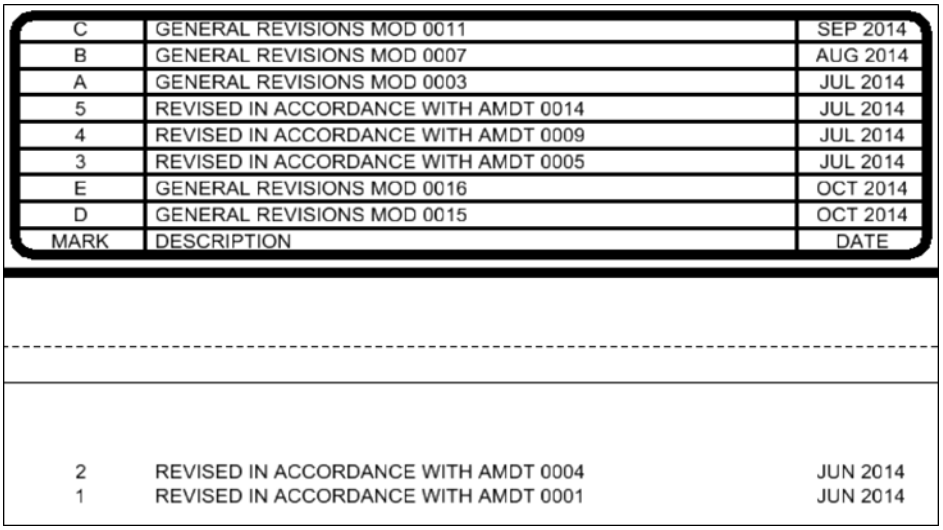
DATE: The DATE column contains the date (month and year) the revision was released in the change documentation. All dates shall be in the following format: MMM YYYY (e.g., OCT 2020, JUN 2022)

Note: *An APPR. column is not provided in the Revision (Issue) block due to lack of consistency in its use. Currently, there is no consistent legal/management direction on how to enforce this field. Initials are text placed in this field using CAD, so there is no method for legal tracking of the data. If showing who approved revisions becomes a requirement, a legal signature (physical or electronic) should be required, as well as direction for consistent usage.*

The Revision (Issue) block provided by the CAD/BIM Technology Center provides eight rows for identifying revisions. There are two possible options for dealing with situations where more than eight revisions are required:

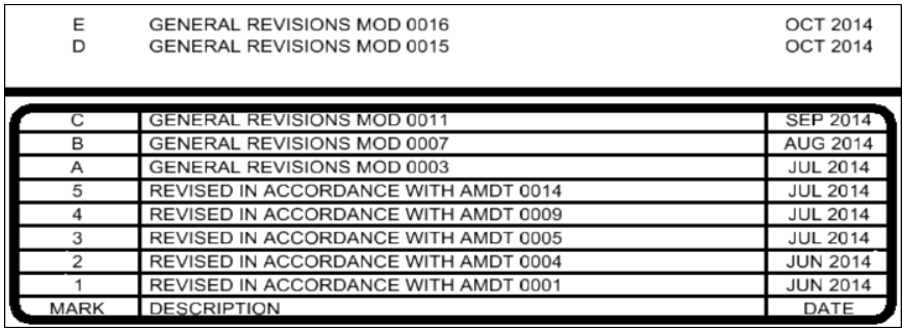
- **Option 1 (Preferred):** Replace the oldest revision in the Revision (Issue) block with the most current revision and continue replacing revisions as needed (Figure 7-3). If needed, older revisions can be copied outside the plotted area of the sheet for record purposes.

Figure 7-3. Option 1 for showing more than eight revisions.



- **Option 2:** Continue adding revisions directly above the eighth revision row so that they begin to spill out into the Drawing Area (Figure 7-4). This is not the preferred option, as it runs the risk of running into items that may be placed into this section of the Drawing Area.

Figure 7-4. Option 2 for showing more than eight revisions.



E	GENERAL REVISIONS MOD 0016	OCT 2014
D	GENERAL REVISIONS MOD 0015	OCT 2014
C	GENERAL REVISIONS MOD 0011	SEP 2014
B	GENERAL REVISIONS MOD 0007	AUG 2014
A	GENERAL REVISIONS MOD 0003	JUL 2014
5	REVISED IN ACCORDANCE WITH AMDT 0014	JUL 2014
4	REVISED IN ACCORDANCE WITH AMDT 0009	JUL 2014
3	REVISED IN ACCORDANCE WITH AMDT 0005	JUL 2014
2	REVISED IN ACCORDANCE WITH AMDT 0004	JUN 2014
1	REVISED IN ACCORDANCE WITH AMDT 0001	JUN 2014
MARK	DESCRIPTION	DATE

Note: *The option that is chosen shall remain consistent across the entire drawing set.*

8 Conclusion

Standards have been recognized as a vital tool in the development of drawings for DoD. Without standards, drawings would be hard to create, review, and interpret, resulting in excessive time and monetary costs for DoD. With these factors in mind, the *A/E/C Graphics Standard* has been an important document for DoD since 2012 by serving as the standard for the look and organization of drawings.

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Abbreviations

A/E/C	Architecture/engineering/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
CIM	Civil Information Modeling
CoP	Community of practice
CSI	Construction Specifications Institute
CUI	Controlled Unclassified Information
DoD	Department of Defense
ERDC	Engineer Research and Development Center
FAQ	Frequently asked questions
FOA	Field operating activity
ft	Foot/feet
GSA	General Services Administration
in.	Inch(es)
ITL	Information Technology Laboratory

m	Meter
mm	Millimeter
NCS	National CAD Standard
NIBS	National Institute of Building Sciences
O&M	Operations and maintenance
POC	Point of contact
SEID	Software Engineering and Informatics Division
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
TH	Text height
USACE	US Army Corps of Engineers

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14. ABSTRACT

The A/E/C Graphics Standard has been developed by the Computer-Aided Design/Building Information Modeling Technology Center to document how proper hand-drafting practices can be achieved in advanced modeling. It is through the collection and documentation of these practices that consistent models and drawings shall be achieved throughout the US Army Corps of Engineers (USACE), as well as other federal agencies. In the collection of these practices, various historical USACE District drafting manuals were consulted and compared against practices contained in industry and national standards, with consideration toward whether software can achieve those practices. The documentation of these practices will help to achieve both clear and aesthetically pleasing construction documents.

15. SUBJECT TERMS

Building information modeling; Computer-aided design; Computer graphics; Engineering design

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