



**US Army Corps
of Engineers®**
Engineer Research and
Development Center

CAD Drafting Standard

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CAD Drafting Standard

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Abstract

The CAD Drafting Standard has been developed by the CAD/BIM Technology Center (Center) to document how proper hand-drafting practices can be achieved in Computer-Aided Design (CAD). It is through the collection and documentation of these practices that consistent CAD drawings shall be achieved throughout the U.S. Army Corps of Engineers, 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 the U.S. National CAD Standard. The documentation of these practices will help to achieve both clear and aesthetically pleasing CAD drafting techniques in CAD construction documents.

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Contents

Abstract.....	ii
Figures and Tables.....	v
Preface.....	vii
1 Introduction.....	1
Acronyms	1
Background	1
Essentials of good drafting.....	2
Additions/revisions	2
2 Coordinate Systems.....	3
Drawing sheet coordinate system	3
Project coordinate system	3
Column grid system.....	3
3 Orientation	4
Plans, elevations, and details.....	4
Maps and drawings.....	4
Vicinity maps.....	4
Channels, locks, and dams.....	4
Waterways.....	5
Levees.....	6
Roadways and other structures.....	7
4 Linework in Drawings.....	8
5 Dimensions in Drawings.....	10
Dimension terminators	12
Fractions and commas/spacing in dimensions	13
Elevations	14
6 Text in Drawings	15
General notes	15
Abbreviations.....	15
Capitalization.....	16
Subject titles.....	16
Orientation	16
7 Drawing Symbology.....	18
Corps Castle	18
Scales	18
North arrows.....	19

Welding symbols.....	20
Symbol descriptions.....	23
Symbol identifiers.....	23
Details, sections, and elevations.....	23
<i>Detail/section/elevation identification symbol</i>	23
<i>Detail indicator symbol</i>	24
<i>Section indicator symbol</i>	25
<i>Elevation indicator symbol</i>	25
8 Schedules.....	27
9 Identifying spaces and objects.....	29
Numbering of floors.....	29
Numbering of rooms.....	29
Numbering of doors.....	30
Numbering of stairs.....	30
Numbering of elevators.....	32
Identification of windows.....	32
Labeling of duct.....	32
10 Showing Work Conditions within a Drawing.....	33
New work versus demolition work.....	33
New work versus existing conditions.....	33
11 Drawing Revisions.....	34
Revision strategies and symbology.....	34
Southwestern Division revision strategy.....	35
Amendments – Solicitation stage.....	35
General notes.....	35
Noting amendment drawing changes inside the drawing area.....	35
Referencing amendment drawing changes inside the border area.....	36
Noting amendment drawing changes in the border sheet issue block.....	37
Noting more than one amendment on a drawing.....	38
Narrative, write-in, or sketch Amendments.....	38
Adding or deleting drawing sheets and index sheet procedures.....	38
Amendments – Contract Award Stage.....	39
General notes.....	39
Modifications – Proposed or awarded.....	39
General notes.....	39
Noting proposed modification drawing changes inside the drawing area.....	39
Referencing proposed modification drawing changes inside the border area.....	40
Noting proposed modification drawing changes in the border sheet Issue Block.....	40
Noting awarded modification drawing changes in the border sheet Issue Block.....	41
Adding or deleting drawing sheets and index sheet procedures.....	41
Record drawing as-builts.....	41
Bibliography.....	43
Report Documentation Page	

Figures and Tables

Figures

Figure 1. Orientation of water flow in waterways.....	5
Figure 2. Orientation of water flow in plan and profile.....	6
Figure 3. Plan/cross section of a flood control project.....	7
Figure 4. Types of lines and line weights.	8
Figure 5. Placement of dimensions.....	10
Figure 6. Dimension settings for text height equal to 3/32 in. and 1/8 in.....	11
Figure 7. Parallel dimension line spacing.....	12
Figure 8. Filled arrowhead terminators.	12
Figure 9. Slash terminators.	13
Figure 10. Fraction format.	13
Figure 11. Format for dimensions.	13
Figure 12. Capitalization in text.	16
Figure 13. Orientation of text.	17
Figure 14. U.S. Army Corps of Engineers Communication Mark	18
Figure 15. Placement of FOA signature in Corps Communication Mark	19
Figure 16. Three acceptable NCS methods for showing scales.	19
Figure 17. Plan north arrow	20
Figure 18. Typical welding symbol.	21
Figure 19. Weld symbols.	21
Figure 20. Detail/section/elevation identification symbol.....	24
Figure 21. Detail indicator symbol.....	24
Figure 22. Section indicator symbol.....	26
Figure 23. Elevation indicator symbol.....	26
Figure 24. Schedule.....	27
Figure 25. Schedule linework.....	28
Figure 26. Room identifier symbol.	30
Figure 27. Room numbering example.	31
Figure 28. Numbering of doors.....	31
Figure 29. Window identifier symbol.....	32
Figure 30. Duct labeling.	32
Figure 31. Revision symbol.....	34
Figure 32. Southwestern Division strategy issue block.....	36
Figure 33. A/E/C CAD Standard issue block.....	36
Figure 34. Issue Block for amendment drawing changes.....	37

Figure 35. Numbering an added drawing 38

Figure 36. Issue Block for proposed modification drawing changes. 40

Tables

Table 1. Common welding processes..... 22

Preface

Introduction

The CAD Drafting Standard has been developed by the Tri-Service CAD/BIM Technology Center (Center) for Facilities, Infrastructure, and Environment at the Information Technology Laboratory (ITL), U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS. Its purpose is to address a need for standard CAD drafting practices that were once covered by documents related to hand drafting techniques.

The Center acknowledges the support of the Corps' Field Action CAD (FAC) committees, especially Jason Fairchild, Headquarters, U.S. Army Corps of Engineers. Special thanks go to Malida Vitaya-Udom, of the Center; Roger Fujan, U.S. Army Engineer District, Omaha (NWO); and Carl Broyles, U.S. Army Engineer District, Kansas City (NWK), for their assistance in the development of various figures and Toby Wilson, of the Center, for his assistance in the development of various sections. Finally, thanks go to the USACE CAD Managers community for taking the time to review this document, especially the following people: Roger Fujan and Lyle Craig, NWO; Hai Le, U.S. Army Engineer District, Mobile; Daniel Nelson, U.S. Army Engineer District, Philadelphia; Lynn Parsons, U.S. Army Engineer District, Walla Walla; Edward Dean and Thomas Reyes, U.S. Army Engineer District, Memphis; Carl Broyles, NWK; Sandy Wood, U.S. Army Engineering and Support Center, Huntsville, AL; Chuck Nemec, U.S. Army Engineer District, Baltimore; Eugene Hubbell, U.S. Army Engineer District, Alaska; Santiago Mor, U.S. Army Engineer District, Honolulu; Blake English, U.S. Army Engineer District, Tulsa; Joyce Rudy, U.S. Army Engineer District, Middle East; Michael Brennan, U.S. Army Engineer District, New Orleans; Ricardo Vera, U.S. Army Engineer District, Galveston; John Groboski, U.S. Army Engineer District, Chicago; Steve Hutsell, Van Woods, Justin Jameson, and Tim Grimm, U.S. Army Engineer District, Seattle; and Gerald Piotrowski, U.S. Army Engineer District, Afghanistan District - South. Special acknowledgement goes to U.S. Army Engineer Division, Southwestern, especially Steve Hutsell, formerly at U.S. Army Engineer District, Fort Worth, now at U.S. Army Engineer District, Seattle; and William Guldemon and Edward Murphy, U.S. Army Engineer District, Fort Worth, for their work in documenting the revision strategy presented in Chapter 11.

At the time of publication of this report, the Director of ITL was Dr. Reed L. Mosher, the Deputy Director was Dr. Deborah F. Dent, the Chief of the Software Engineering and Informatics Division was Ken Pathak, and the Acting Chief of the Tri-Service CAD/BIM Technology Center was Edward L. Huell. The Director of ERDC was Dr. Jeffery P. Holland, and the Commander of ERDC was COL Kevin J. Wilson.

United States National 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 CAD Drafting Standard is:

“Uniform Drawing System”
The Construction Specifications Institute
99 Canal Center Plaza
Alexandria, VA 22314-1588

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:

National Institute of Building Sciences
1090 Vermont Avenue NW, Suite 700
Washington, DC 20005-4905

<http://www.buildingsmartalliance.org/ncs/>

1 Introduction

Acronyms

First, a few useful acronyms:

- A/E/C – Architecture, Engineering, and Construction
- CAD – Computer-Aided Design
- CSI – Construction Specifications Institute
- FAC – Field Action CAD
- NCS – United States National CAD Standard
- NIBS – National Institute of Building Sciences
- UDS – Uniform Drawing System
- USACE – U.S. Army Corps of Engineers

Background

The A/E/C CAD Standard (CAD/BIM Technology Center 2009), first published in May 1994, has been the go-to manual for developing CAD documents for tri-service A/E/C 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 Corps' Field Action CAD (FAC) recognized this fact and tasked the Center to develop a manual "reintroducing" these practices, however updating them to fit into the CAD world.

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 the NCS, since this document addresses drafting to a certain extent. In situations where the drafting standards clearly conflicted with the NCS, the NCS took precedence. Where there was grey area because the NCS 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.

Essentials of good drafting

So 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; why isn’t that enough? The U.S. Army Engineer District, Jacksonville, Drafting Standards manual dated September 1976 probably states the reason best in a section called “Essentials of Good Drafting”:

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, USACE Districts and Divisions should constantly strive for a sense of consistency. This results in a feeling of a more unified USACE as all architects, engineers, and drafters are following a consistent set of rules and guidelines.

Additions/revisions

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

Recommendations or suggested additions should be sent to Stephen Spangler (Steve.C.Spangler@usace.army.mil).

2 Coordinate Systems

Drawing sheet coordinate system

Drawing sheets have an intrinsic coordinate system, arranged in columns and rows. Columns are identified with numerical characters starting with 1 and increasing to the right. Rows are identified with alphabetical characters beginning at the bottom with A and increasing toward the top of the sheet (UDS Module 2 – Sheet Organization (CSI 2011)). The drawing coordinate system is used to identify/talk about drawing objects.

Project coordinate system

The specified coordinate system/datum (usually State Plane) used for the project shall be denoted on maps (civil plans) whenever possible. The preferred location of denotation needs to be designated. Coordinates shall be identified using tick marks, which are oriented to show north, south, east, and west. Northings shall be labeled along one edge of the grid and eastings along the other. The grid system used shall be described in the general notes.

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 require the accommodation of alphanumeric grid designations within column indicators. Vertical grid lines should have designators at the top of the grid numbered from left to right. Horizontal grid lines should 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 2011)).

Where additional intermediate structural support elements occur between grid lines, a fractional designation is used. For example, a column at mid-point 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 (UDS Module 4 – Drafting Conventions (CSI 2011)).

3 Orientation

Plans, elevations, and details

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, a detail of the top of a wall shall be orientated above a detail of the bottom of the wall. 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 will be added (i.e., VIEW ROTATED 90 DEGREES). When two or more plans of the same structure or the plans of two or more different structures are put on the same drawing, the orientation of all must conform to one another and to their relative positions on the ground.

Maps and drawings

Civil works maps and drawings shall be oriented so that north is toward the top of the sheet when practicable or toward the left of the sheet if top orientation is impracticable.

Vicinity maps

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

Channels, locks, and dams

General plans, elevations, and longitudinal sections of channels, locks, dams, and similar structures shall be oriented with the direction of water flow from top to bottom of the sheet, if practicable, or from left to right. Detailed plans will be oriented with the direction of water flow from top to bottom. Plans and profiles of floodgates in levee construction will be oriented with the observer looking downstream. Cross sections of locks will 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 will be shown with the upstream side on the left and the downstream side on the right. The words “upstream” and “downstream” will be shown in their proper places at the top of the sections.

Waterways

Included under this heading are new channels and channel improvements such as channel clearing and snagging, cleanout, enlargement, and realignment (cut-offs). Detailed plans will be oriented with the direction of water flow from top to bottom of sheet, if practicable, or from left to right (Figures 1 and 2). The direction of water flow for all waterways will be indicated by arrowheads at the upper and lower limits of the sheet, pointing in the direction toward which the water flows.

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 will be shown as if the observer were looking downstream. The words, “left bank” and “right bank” will be shown in their proper places at the top of the sections (**Note:** River banks are always

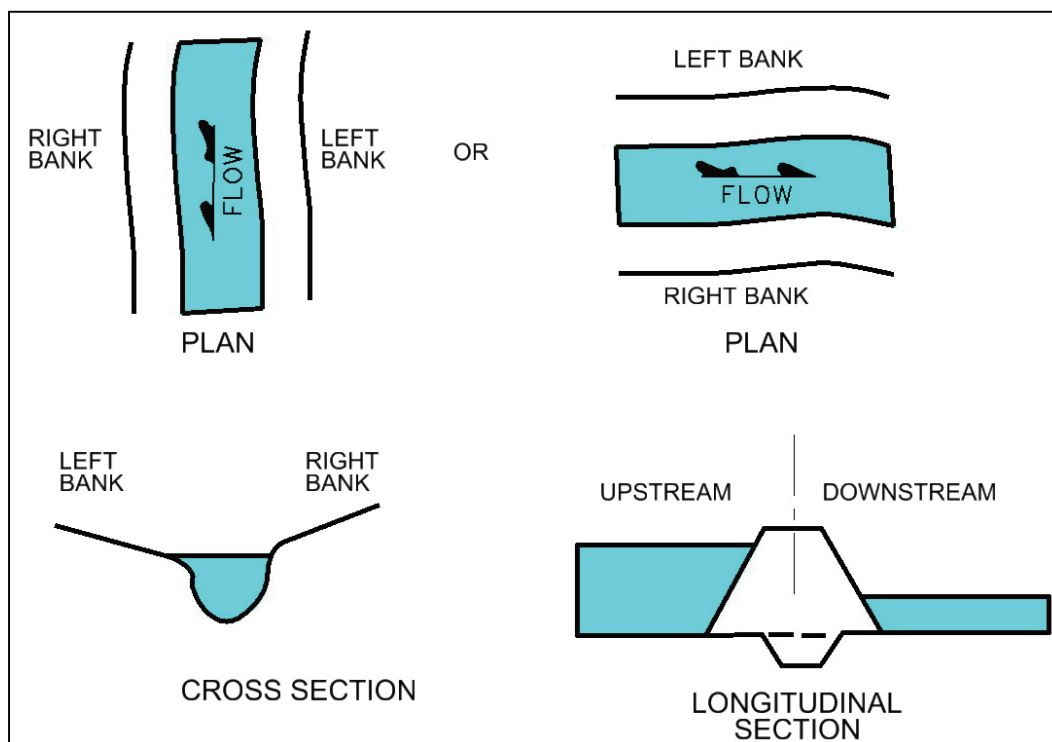


Figure 1. Orientation of water flow in waterways.

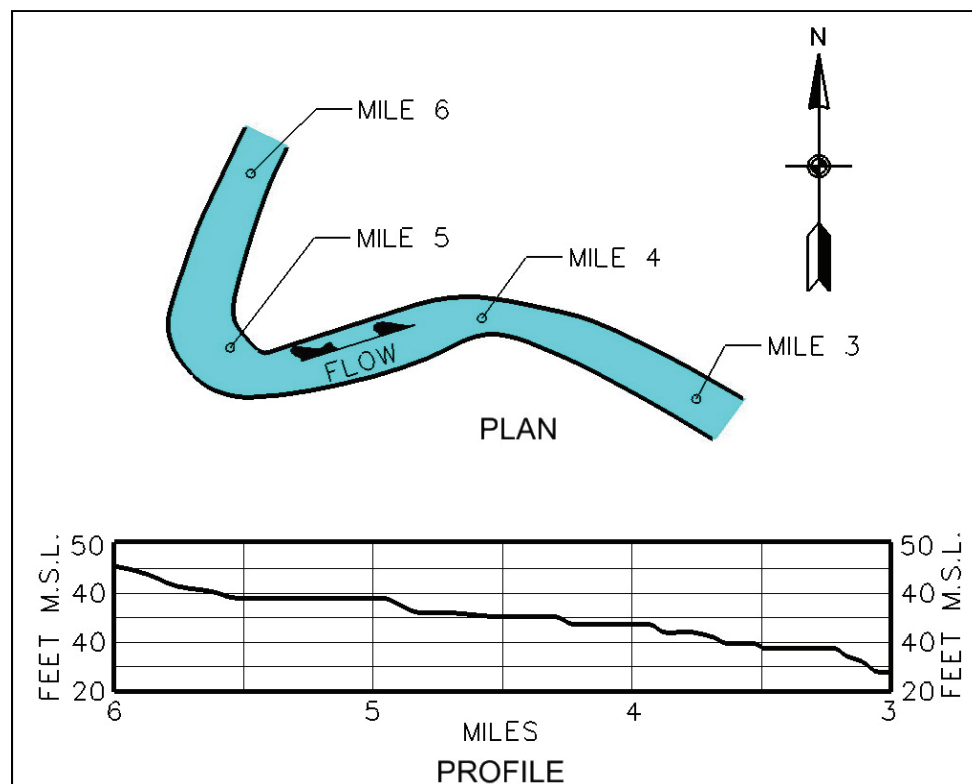


Figure 2. Orientation of water flow in plan and profile.

determined as being right bank or left bank by facing in direction of water flow). Where cross sections are plotted on a common center line, the words “left bank” and “right bank” need to be shown but once, on the top section only.

When two or more plans of the same structure or the plans of two different structures are put on the same drawing, the orientation of all must conform to one another and to their relative positions on the ground.

Some construction drawings of flood control projects will require the section to be shown looking upstream. For instance, downstream elevations will be unique for some projects and drawn in projection as shown in Figure 3.

Levees

Detailed plan maps of levees, dikes, berms, and slide repairs will be oriented with the stream side (unprotected side) at the top of the sheet, irrespective of stream flow. All levee cross sections will be plotted looking in the direction in which the stations increase. The words “landside” and

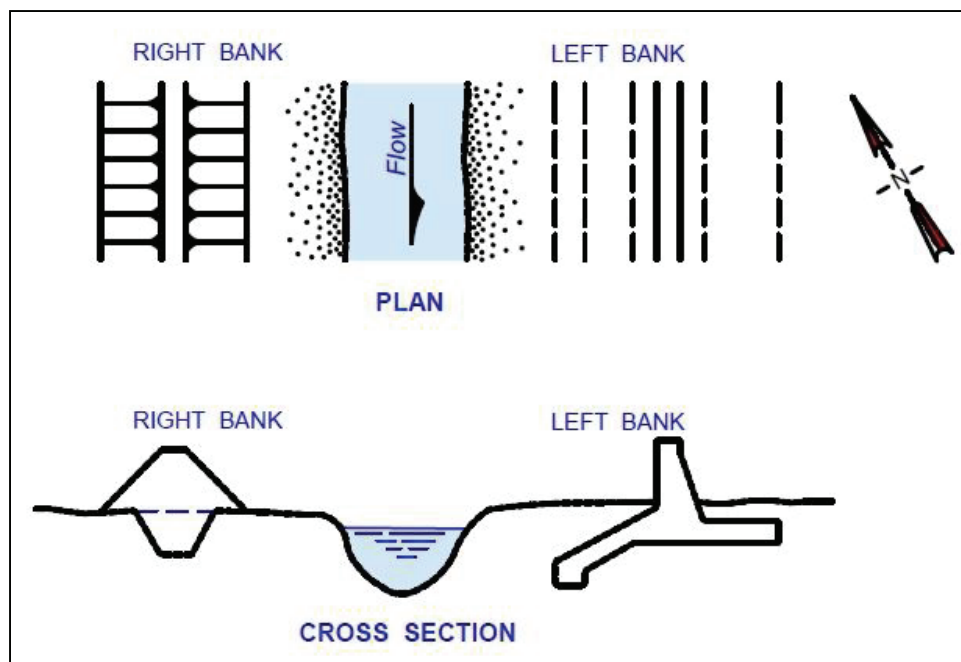


Figure 3. Plan/cross section of a flood control project

“riverside” will be shown in their proper places at the top of all plotted sections. Where cross sections are plotted on a common center line, the words “landside” and “riverside” need be shown but once, on the top section only.

Note: Because of channel orientation and irregular shapes of leveed dredged material placement areas (PA), 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 PA.
2. To best fit the irregular shape to the plan sheet trying to best maintain the north up/left orientation.

Roadways and other structures

General plans, elevations, and longitudinal sections of roadways and other structures will be oriented so that north will be toward the top of the sheet, or toward the right of the sheet if top orientation is impracticable. Stationing will be from west to east or south to north. Cross sections will be shown as if the observer were looking up station. Stationing shall read up station.

4 Linework in Drawings

To be compliant with the NCS, various types of lines require specific line weights. Some of those line types and associated line weights are shown in Figure 4.

CENTER LINE		0.25 mm
DIMENSION		0.25 mm
LEADER		0.25 mm
BREAK		0.25 mm
PHANTOM		0.25 mm
HIDDEN		0.25 mm
EXISTING FEATURE		0.25 mm
PRIMARY FEATURE		0.35 mm
EDGE OF INTERIOR/EXTERIOR ELEVATIONS		0.50 mm
SECTION CUTTING PLANE LINES		0.50 mm
BORDERS		0.70 mm
FOOTPRINTS		0.70 mm
MATCH LINE		0.70 mm

Figure 4. Types of lines and line weights.

Center Lines: Center lines are used to indicate the travel of a center. Center lines shall cross without voids. Short center lines 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 shall be 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 shall be used to indicate the alternate position of parts, repeated detail, or the relative position of an absent part.

Hidden Lines: Hidden lines are used to show the hidden features of a part or object.

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.

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 shall be 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 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.

5 Dimensions in Drawings

Dimension values should always be placed above the dimension line, preferably midway between the dimension terminators (Figure 5). The dimension line should never be broken to insert the dimension, with the exception of angular dimensioning. It is preferred that dimensions always be placed outside the view, preferably located at the top and/or the right side of the plans (UDS Module 4 – Drafting Conventions (CSI 2011)). With that in mind, dimensions should apply to one view only (i.e., no shared dimensions between views). The dimension should 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.

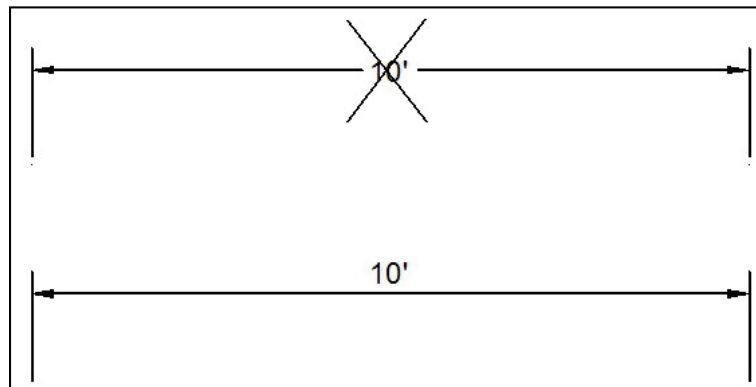


Figure 5. Placement of dimensions.

Dimensions shall be spaced a minimum of 9/16 in. (14.5 mm) from the outlines of the view. Dimension extension lines should be offset a minimum of 1/16 in. (1.5 mm) from the element being dimensioned. Parallel dimension lines should be spaced at least 3/8 in. (9.5 mm) between lines. Extension lines that cross other extension lines or dimension lines should be masked (Reason: if the dimension is dropped or exploded, the dimension will lose its association to the element). The numeral size in dimensions should match the height of the text in the drawing (i.e., if the height of text shown in drawings plots at 1/8 in. (3 mm), then the dimensions should also

plot at 1/8 in. (3 mm) in height). Figure 6 shows dimension settings for text height equal to 1/8 in. (3 mm) and 3/32 in. (2.5 mm). Figure 7 shows spacing for parallel dimension lines.

Continuous or staggered dimension lines may be used, depending on convenience and readability; however, continuous dimension lines are preferred. All dimension notes must read horizontally (from bottom of drawing).

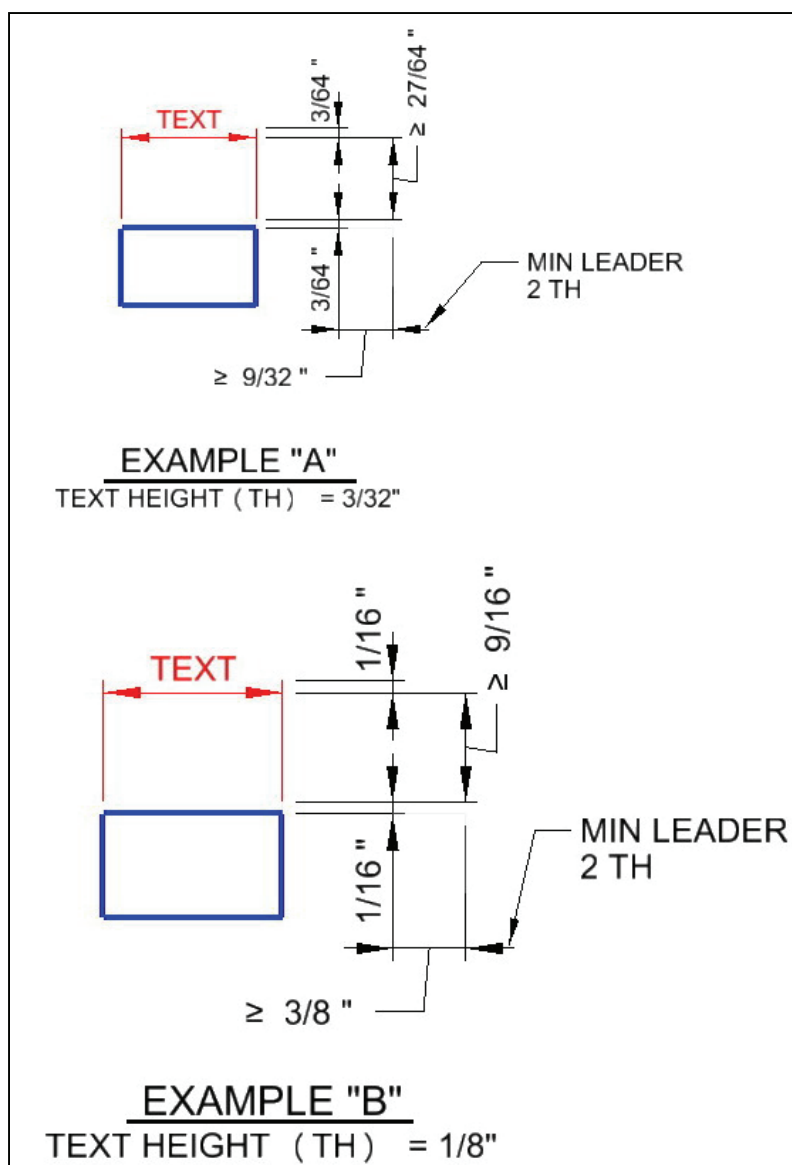


Figure 6. Dimension settings for text height equal to 3/32 in. and 1/8 in.

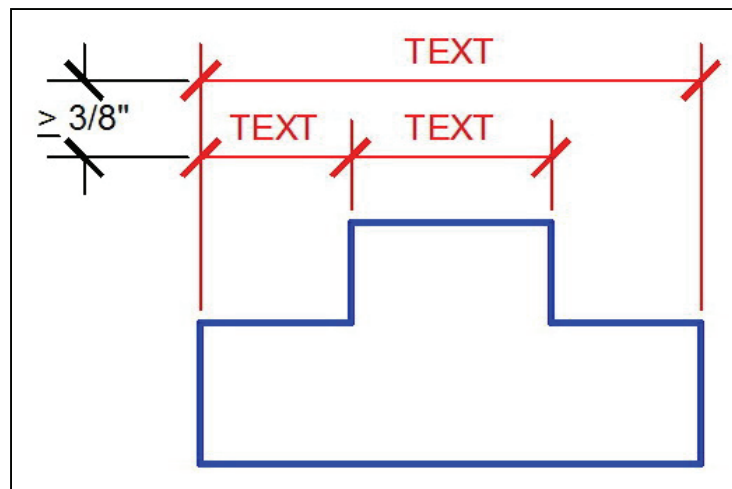


Figure 7. Parallel dimension line spacing.

Dimension terminators

As stated in the A/E/C CAD Standard, slashes or filled arrowheads are allowed for dimension terminators: “Filled arrowhead terminators should have an arrowhead width of $1.5 * TH$ (TH = dimension text height) and a height of $0.5 * TH$ ” (Figure 8).

For slash terminators, the slash should be at an angle of 45 deg with a height equal to the current text height (Figure 9).

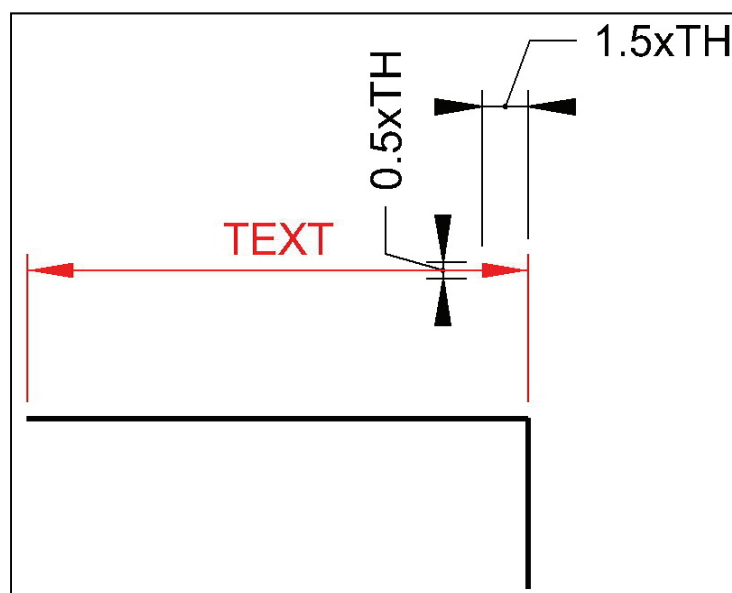


Figure 8. Filled arrowhead terminators.

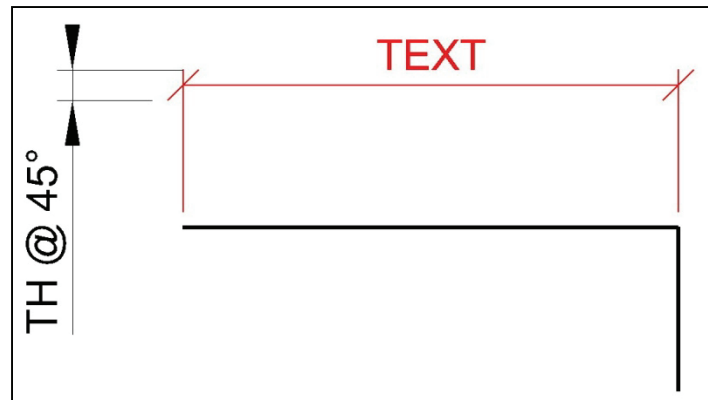


Figure 9. Slash terminators.

Fractions and commas/spacing in dimensions

For fractions, a diagonal bar shall always be used (Figure 10). Fractions should not be less than 1/16 in. (1.5 mm) because accuracy in the field rarely requires more precision (UDS Module 4 – Drafting Conventions (CSI 2011)). Decimal fractions shall always have a cipher (i.e., a zero) before the decimal point. Generally, architectural construction dimensions are shown in feet and inches. Decimals of a foot should be used where dimensions are being set by surveying equipment, such as beam spacing, foundation locations, and structure widths.

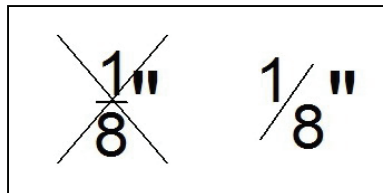


Figure 10. Fraction format.

For metric units (per the A/E/C CAD Standard) or inch-pound units, a space replaces the traditional comma in numbers containing five or more digits (Figure 11). In numbers containing four digits, no space is necessary.

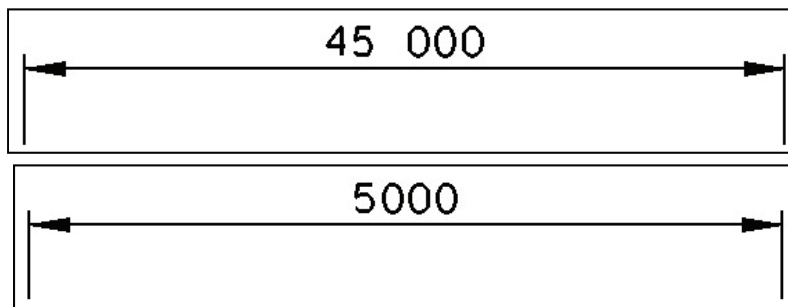


Figure 11. Format for dimensions.

Elevations

Elevations should be indicated with not more than two decimals (e.g., EL 241.56). Where an elevation is given to the even foot, only one decimal should be used (e.g., EL 241.0, EL 310.0).

6 Text in Drawings

General notes

Notes on drawings shall be clear and concise. General Notes are notes with universal application to contract work on all drawings or to all work on specific drawings. General Notes shall be worded such that they are independent of the drawing(s), without cross-referencing or pointing with leader arrows to plans, details, etc. General Notes shall be capable of being removed from the drawings and placed in the specifications. The title above a group of General Notes applicable to sheets for a particular discipline (e.g., Architectural, Electrical, Mechanical, etc.) shall be worded “GENERAL NOTES: APPLICABLE TO ALL (Insert Discipline) SHEETS.” General Notes applicable to specific sheets shall be worded “GENERAL NOTES: THIS SHEET ONLY” or “GENERAL NOTES: SHEETS _____ THRU _____.” 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.

All General Notes will be placed in the far right column of the drawing area of the Sheet File. Wherever general notes are used, they will be shown with a 1/4-in. (6-mm) title heading of “GENERAL NOTES”. All notes under the General Notes heading will be numbered sequentially starting with 1.

Abbreviations

As mentioned in the A/E/C CAD Standard (p. 31), “Abbreviations for words or phrases frequently used in plans, sections, elevations, or details should follow the abbreviations as established in the NCS (UDS Module 5 – Terms and Abbreviations).” In addition to this requirement, the following rules regarding abbreviations shall be followed:

- Abbreviations shall be used only when necessary and when their meanings are unquestionably clear. When in doubt, spell 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.
- Any abbreviation used shall be identified in the abbreviations list of the drawing set.

- The rules of grammar concerning capitalization will be followed. Upper case letters will be used in all abbreviations except where the use of lower case has been established by the NCS or by long practice.
- 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.

Capitalization

Use of capital letters is preferred in text, since capital letters retain readability when reproduced at one-half size (Figure 12).

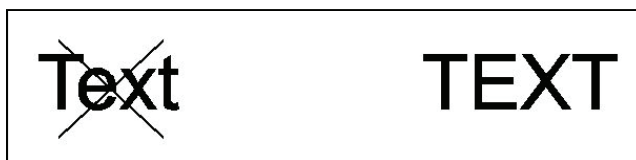


Figure 12. Capitalization in text.

Subject titles

When only one subject appears on a drawing, and its title appears in the title block, a subtitle should be shown under each view or detail on the drawing.

When more than one subject appears on a drawing, a title should be shown under each subject, and a subtitle shown below each view or detail in that group.

Orientation

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 13. 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.

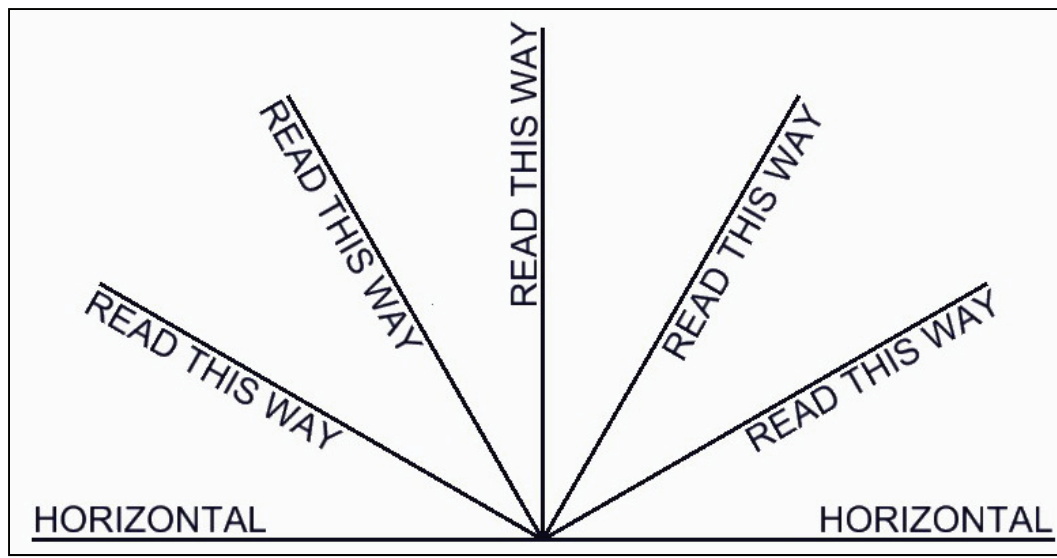


Figure 13. Orientation of text.

7 Drawing Symbolology

Corps Castle

The appearance of the U.S. Army Corps of Engineers Communication Mark (commonly known as the Corps Castle) has very specific requirements (Figure 14). 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.”

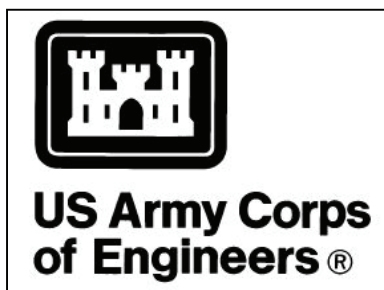


Figure 14. U.S. Army Corps of Engineers Communication Mark (commonly known as the Corps Castle)

The U.S. Army Corps of Engineers text should be set in the Helvetica Medium type face. The 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 15), the text should always be placed below the Corps names. The text for the FOA should be set in the Helvetica Regular type face. As mentioned previously, there are no other acceptable versions of the signature. For more information on the Corps Castle Communication Mark, as well as images available for downloading, go to <http://140.194.76.129/publications/graphics/>.

Scales

The scale or scales used for a drawing shall be stated in words and/or figures under the subtitle of each plan, elevation, section, part, or detail (Figure 16). If one or more scales are used on a sheet, a graphic scale or scales must appear on the sheet for each scale used on that sheet. This will



Figure 15. Placement of FOA signature in Corps Communication Mark

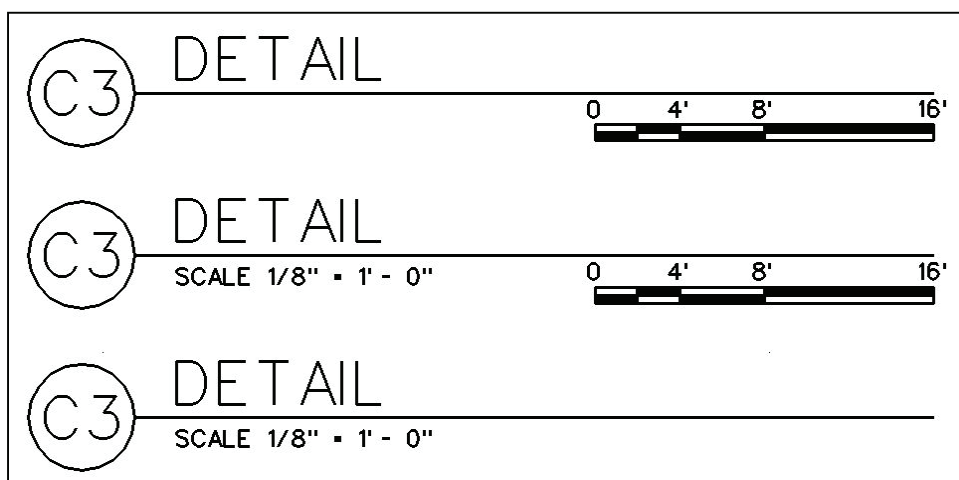


Figure 16. Three acceptable NCS methods for showing scales.

ensure that if a sheet is plotted, the sheet can be verified as plotted to the correct scale. The graphic scale or scales should be placed on the bottom right of the drawing sheet.

Graphic scales for maps shall be placed below the subtitle of each map.

When a drawing is not drawn to any particular scale, the words “SCALE: NTS” shall be so stated, where “NTS” indicates “Not To Scale.”

North arrows

A north arrow shall be provided on all Sheet Files where a plan or partial plan is being shown. A north arrow is not required on Sheet Files containing only nonplan items such as riser diagrams, schematic diagrams or one-line diagrams.

According to the NCS, the north arrow (or true north arrow) and the plan north arrow (Figure 17) should be placed in the lower right-hand corner of the drawing block title (UDS Module 4 – Drafting Conventions (CSI 2011)). While the A/E/C CAD Standard presents various north arrow symbols, the preferred symbol is the NCS north indicator symbol (NORNCS in the A/E/C CAD Standard “General” symbol library). Floor plans should be oriented so that the plan north arrow points to the top of the drawing block. The true north arrow (i.e., points to the North Pole) is adjusted so that the building grid and plan north arrow are parallel to the sheet orientation (UDS Module 4 – Drafting Conventions). If possible, the orientation of true north should be maintained throughout an entire set of drawings.

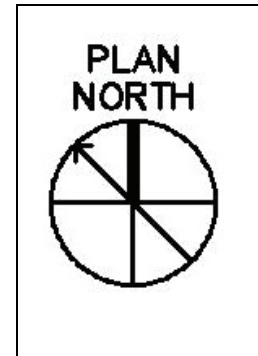


Figure 17. Plan north arrow

Welding symbols

When typical weld symbols are developed, the following drafting convention should be followed (Figures 18 and 19 and Table 1).

The numbers in Figure 18 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

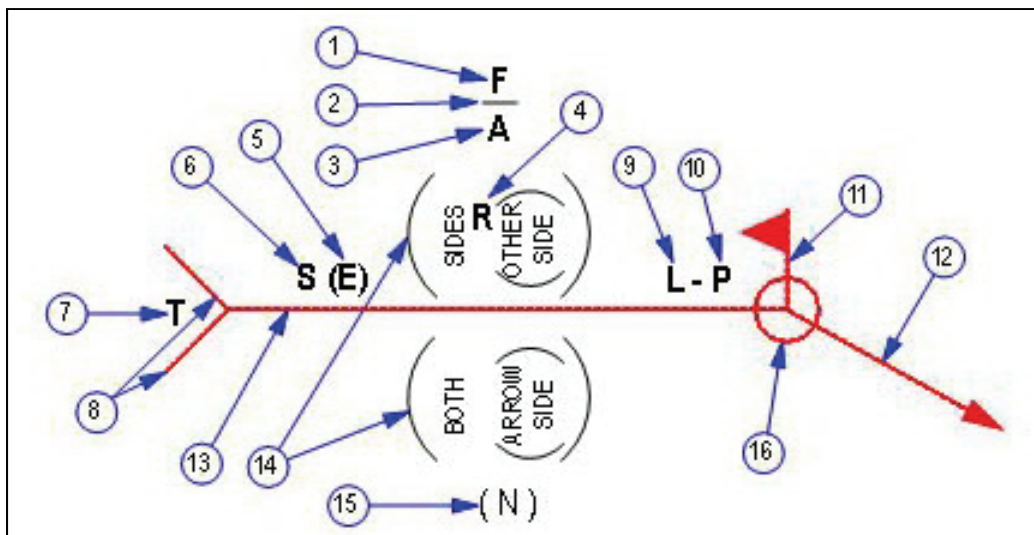


Figure 18. Typical welding symbol.

BASIC WELD SYMBOLS

FILLET	GROOVE OR BUTT						
	SQUARE	V	BEVEL	U	J	FLARE V	FLARE BEVEL

PLUG OR SLOT	SPOT OR PROJECTION	SEAM	BACK OR BACKING	SUR-FACING	FLANGE	
					EDGE	CORNER

SUPPLEMENTARY WELD SYMBOLS

WELD ALL AROUND	FIELD WELD	MELT-THRU	CONTOUR		
			FLUSH	CONVEX	CONCAVE

Figure 19. Weld symbols.

Table 1. Common welding processes.

Process	Abbreviation
Arc Welding	
Electrogas 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
Resistance Welding	
Flash welding	FW
Resistance welding	RW
Oxyfuel Gas Welding	
Oxyfuel gas welding	OFW
Solid-State Welding	
Diffusion welding	DFW
Friction welding	FRW
Brazing	
Dip	DB
Diffusion	DFB
Furnace	FB
Induction	IB
Infrared	IRB
Resistance	RB
Torch	TB
Other Welding	
Electron beam welding	EBW
Electroslag welding	ESW
Laser beam welding	LBW

Symbol descriptions

Symbol descriptions shall follow 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 should 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 can be identified with the full type identifier, and other information and a callout can be referenced to this symbol with the following words: “Typical for this room.” Do not use the word “typical” by itself without additional wording to show where the typicality applies.

Symbol identifiers

Identifying letters within and around symbols must be legible at one-half normal size. Therefore, letter sizes within and around symbols shall be a minimum of 1/8 in. (3 mm) in height (unless the NCS specifically calls out a text height of 3/32 in. (2.5 mm) for that symbol (e.g., Detail Indicator)).

Details, sections, and elevations

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

1. The detail/section/elevation identification
2. The sheet on which the detail/section/elevation is located

Detail/section/elevation identification symbol

The detail/section/elevation identification symbol (symbols TITLE1 or TITLE2 in the A/E/C CAD Standard) is basically a bubble with a combination alphabetic/numeric identification (Figure 20). The alphabetic/numeric identification is based on where the detail/section/elevation is

placed on the sheet grid. For instance, if the lower left corner of a detail is placed close to the intersection of sheet grid row B and sheet grid column 3, then the detail identification becomes B3. That identification is used in the top half of the callout symbols.

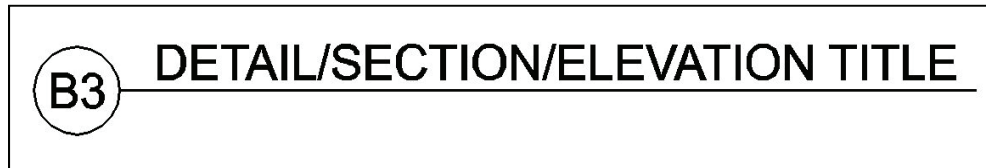


Figure 20. Detail/section/elevation identification symbol.

The NCS recommends that the decision on where to place details/sections/elevations within the drawing area of the sheet be based on priority and convenience: “Locate the most frequently used referenced drawing block [e.g., detail/section/elevation] 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 2011)).

Detail indicator symbol

The detail indicator symbol (or callout) is a two-part circle (symbol DTLIND in the A/E/C CAD Standard) that points to an area of the drawing that will be enhanced in a detail on the details sheet (Figure 21). As described in the previous paragraph, 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 should always be an XX5NN designation where XX is the Discipline Designator (Level 1 or Level 2), 5 indicates that it is a Details sheet, and NN is the Sheet Sequence Number (01-99).

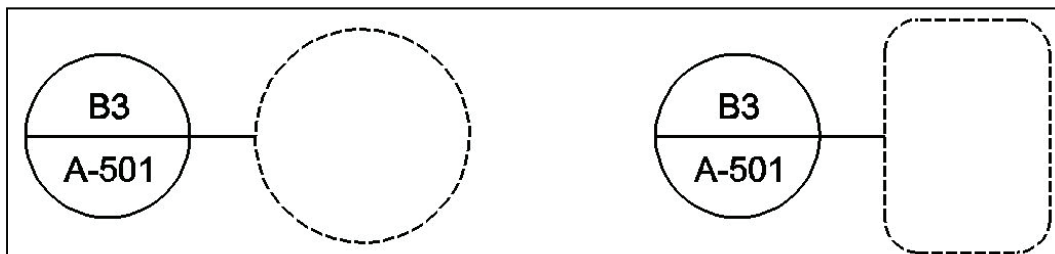


Figure 21. Detail indicator symbol.

Section indicator symbol

The section indicator symbol (or callout) is a two-part symbol (symbols SECIN1 and SECIN2 in the A/E/C CAD Standard) that cuts through an area of the drawing that will be shown in a section cut on the sections sheet (Figure 22). 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 should always be an XX3NN designation where XX is the Discipline Designator (Level 1 or Level 2), 3 indicates it is a Sections sheet, and NN is the Sheet Sequence Number (01-99).

Elevation indicator symbol

The elevation indicator symbol (or callout) is a two-part symbol (symbols SECIN1, SECIN2, and SECIN3 in the A/E/C CAD Standard) that indicates an area of the drawing that will be shown in an elevation on the elevations sheet (Figure 23). 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 should always be an XX2NN designation where XX is the Discipline Designator (Level 1 or Level 2), 2 indicates it is an Elevations sheet, and NN is the Sheet Sequence Number (01-99).

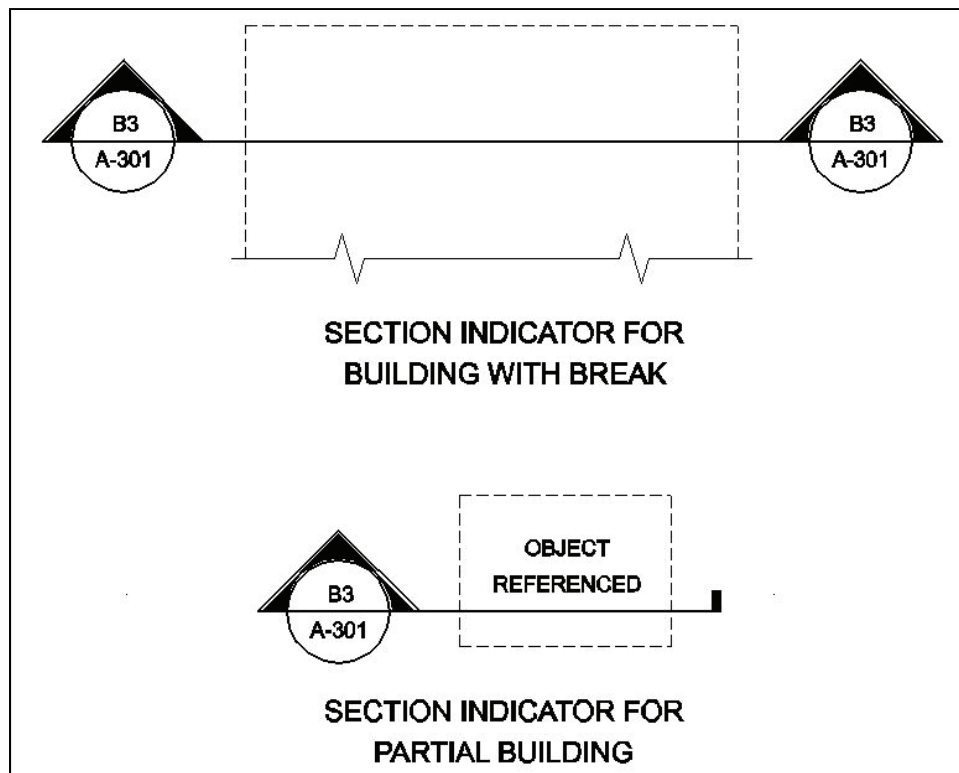


Figure 22. Section indicator symbol.

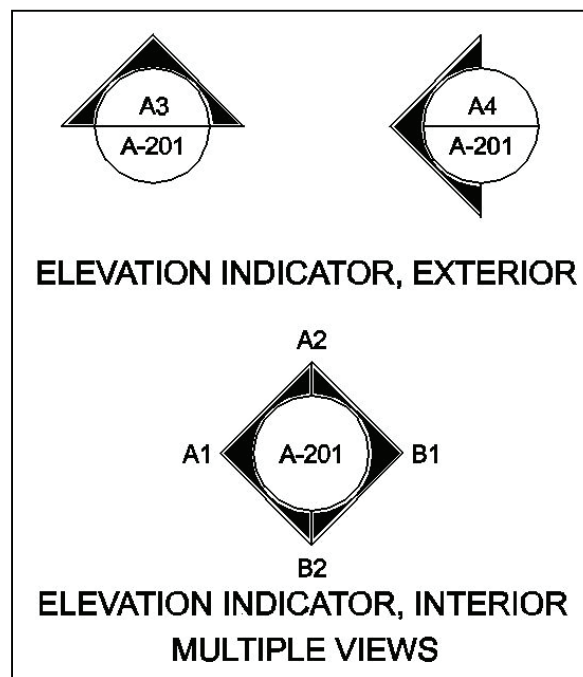


Figure 23. Elevation indicator symbol.

8 Schedules

According to the NCS, the purpose of a schedule is to “communicate information about a related group of items.” 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 24). While a minimum of three columns is required in a schedule, additional columns are allowed (UDS Module 3 – Schedules (CSI 2011)).

HEADING		
MARK	ITEM DESCRIPTION	DISTINGUISHING FEATURE

Figure 24. Schedule.

The NCS already has specified content that should be contained in certain schedules. For those particular schedules, the NCS should be adhered to. However, the schedules provided in the NCS are not intended to be all-inclusive. For those schedules that are not included in the NCS, the look and content should follow the NCS guidelines as closely as possible.

As far as graphic conventions for schedules, the NCS is specific about the line widths for the schedule linework (Figure 25):

- Schedule outlines – 0.70 mm
- Schedule grid accent lines – 0.35 mm
- Schedule grid lines – 0.25 mm

The NCS does not specify text heights for schedules. Therefore it is recommended that headings be at least 1/4 in. (6 mm) in height and all other text within the schedule be at least 3/32 in. (2.5 mm) in height (although 1/8 in. (3 mm) is preferable).

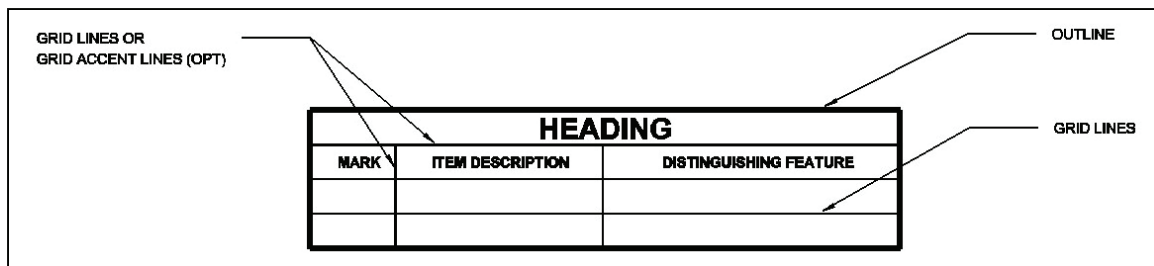


Figure 25. Schedule linework.

9 Identifying spaces and objects

Numbering of floors

The ground floor should be designated as the first floor. All occupied floors above the first floor are to be numbered sequentially upward (second floor, third floor, fourth floor, etc.). The floor below the first floor is considered to be a basement and should be designated as B1 (UDS Module 4 – Drafting Conventions (CSI 2011)). Subsequent floors below B1 are numbered sequentially (B2, B3, B4, etc.). 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).

Numbering of rooms

All floor plans (except structural) shall show room numbers. According to the NCS, “The first part of a room identifier should match the floor number. Room numbering should start at the most prominent means of access to the floor. For instance, the first room to the right of the major elevator or stair on the third floor would be 301 [the first room to the right of the major elevator or stair on the sixteenth floor would be 1601, and the first room to the right of the major elevator or stair on the basement would be B101]. Number rooms sequentially moving clockwise around the building” (UDS Module 4 – Drafting Conventions (CSI 2011)). 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 with the first room to the right. The remaining rooms on that floor would be numbered sequentially moving clockwise around the building.

Per the NCS (UDS Module 6 – Symbols (CSI 2011)), the room name (Figure 26) should be centered 1/16 in. (1.5 mm) above the room identifier symbol (symbols ROMID3 or ROMID4 in the A/E/C CAD Standard).

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. Since there are not really any specific

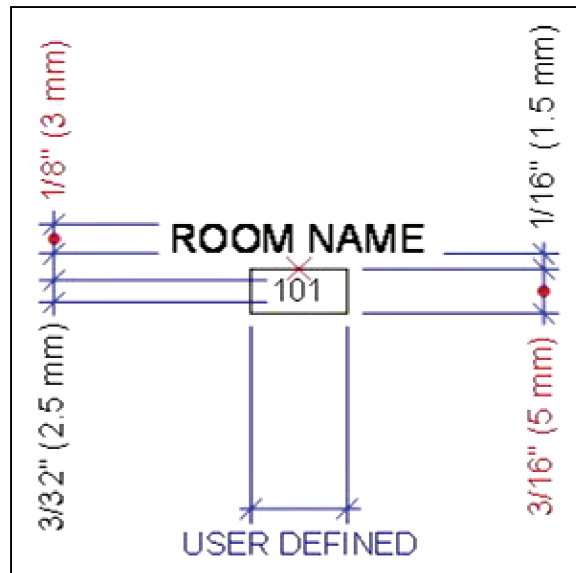


Figure 26. Room identifier symbol.

guidelines from an organization such as the American Institute of Architects regarding room numbering, the NCS methodology could be considered as a room numbering option. For instance, in Figure 27, the room to the right of the main entrance to the building is numbered 101; however, the building layout resulted in the decision to number rooms sequentially in a counterclockwise fashion. Regardless, the room numbering symbology should follow that of NCS.

Numbering of doors

According to the NCS, “Each door opening in a building must have a unique identifier. If a room has one door opening, the door opening number is the same as the secure side room number. If more than one door opening in a room exists, door openings within that room are identified by the room number followed by an alphabetical character starting clockwise from the corridor access door opening” (UDS Module 4 – Drafting Conventions (CSI 2011)). For example, for Room 126 (Figure 28), the corridor access door opening would be numbered 126A and the second door opening within Room 126 would be numbered 126B.

Numbering of stairs

The most prominent stair with the largest egress capacity is identified 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

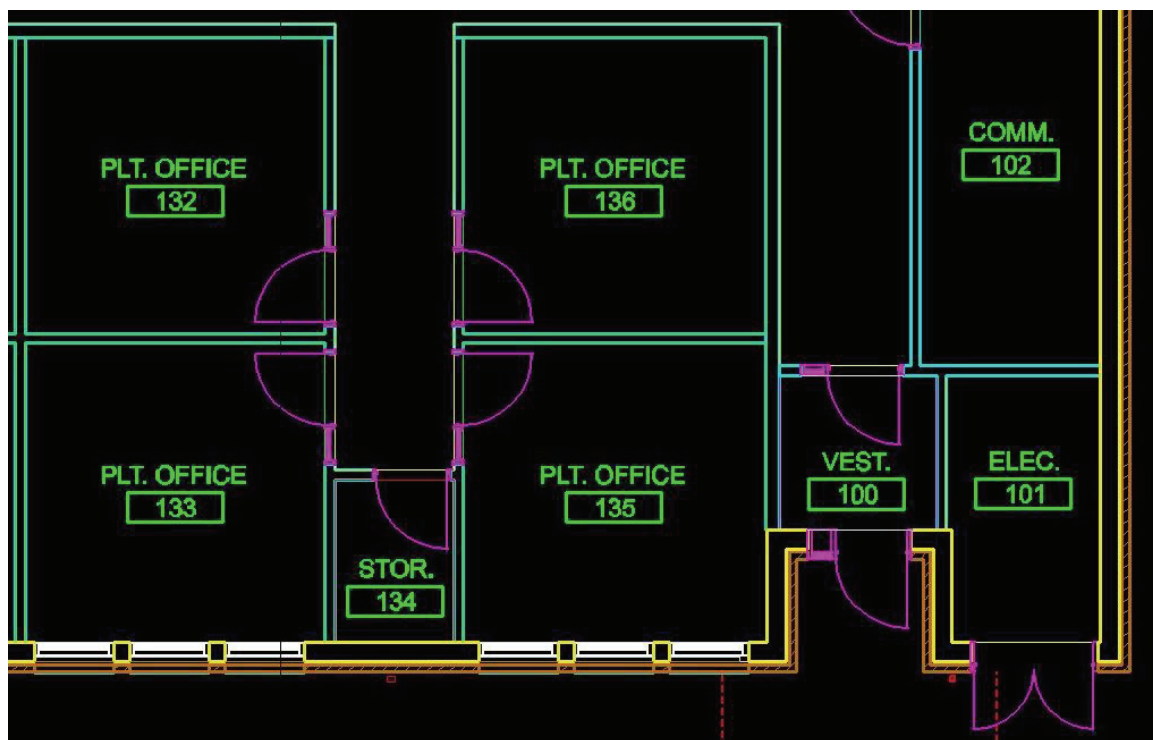


Figure 27. Room numbering example.

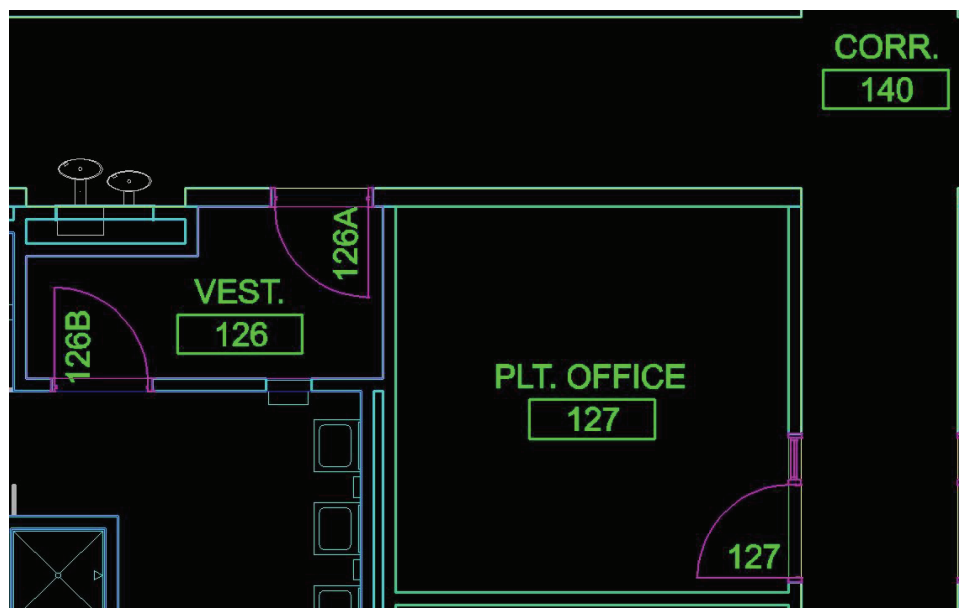


Figure 28. Numbering of doors.

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 previously (UDS Module 4 – Drafting Conventions (CSI 2011)).

Numbering of elevators

The elevator nearest to the building entrance with the largest access and egress capacity is identified 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 (UDS Module 4 – Drafting Conventions (CSI 2011)).

Identification of windows

According to the NCS, “Each type of window must have a unique identifier.” The window identifier symbol to be used from the A/E/C CAD Standard is WINID (Figure 29). This symbol with identifier number and/or letter should also be placed in the “Mark” column of Window Schedules that are developed.

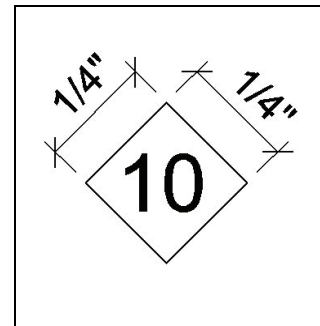
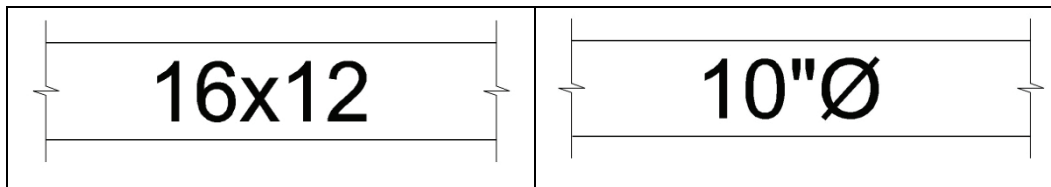


Figure 29. Window identifier symbol

Labeling of duct

The Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) labels rectangular duct as shown in Figure 30a. The first value represents the side of the duct shown (width), and the second value represents the side of the duct not shown (depth).



a. Rectangular duct

b. Round duct

Figure 30. Duct labeling.

Round duct is shown as the diameter of the duct, followed by a diameter symbol (Figure 30b).

10 Showing Work Conditions within a Drawing

New work versus demolition work

Separate plan views of demolition work and new work will be provided. Plan views of demolition work shall not be combined with those for new work to allow for clearer “as-built” record drawings to be turned over to the customer. Demolition plans shall not show features that have no contractual significance to the work in the construction contract. Notes shall state that all items shown on the demolition plans will be removed unless noted or specified. Dashed, dotted, or crosshatched versions of new equipment symbols shall not be used. Notes, keyed notes, symbol modifiers, or callouts shall be used to delineate items to be removed or relocated.

New work versus existing conditions

New work should be easily distinguishable from other information shown on the drawings. Show new work at 100 percent (unscreened) and show existing conditions, including text, screened at 50 percent. This screening is performed so that the new work will stand out from the existing conditions.

Background information shown for orientation or clarification may be screened at 50 percent.

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

11 Drawing Revisions

Revision strategies and symbology

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 award of a construction contract.

All revisions shall be flagged by a revision symbol (Figure 31). This symbol shall be an equilateral triangle as shown by symbols REVID1 or REVID2 in the A/E/C CAD Standard. These symbols comply with the look and format of the NCS symbol for revision indicators (UDS Module 6 – Symbols (CSI 2011)).

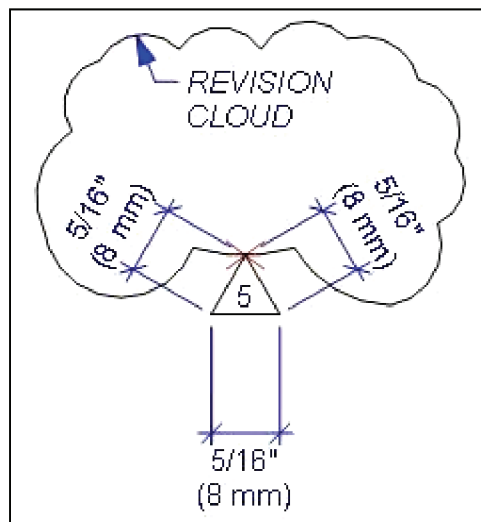


Figure 31. Revision symbol.

The revision symbol should be positioned adjacent to the revision. The revision shall be enclosed in a revision cloud (TREEL line style from the A/E/C CAD Standard could be used to create these clouds) drawn at medium thickness (0.35 mm). The revision triangle shall contain numbers or letters in sequence (i.e., 1, 2, 3, or a, b, c). The revision triangle shall also be shown in the border sheet Issue Block, including a description of the revision and the date. From the A/E/C CAD Standard (p. 33), “The first entry should be placed on the lower left-hand of the issue block and subsequent entries should be made above it.”

Southwestern Division revision strategy

While each District probably has a different approach to handling revisions, the general strategy is probably the same. A potential strategy developed by Southwestern Division and adapted to reflect specific criteria contained in Unified Facilities Criteria (UFC) 1-300-09N (Department of Defense 2011) is presented in the remainder of this chapter.

Notes:

1. The revision triangle is referred to as a Delta throughout the strategy.
2. If the CAD content was created from a model (e.g., Building Information Modeling, InRoads, Civil3D), revisions need to be performed on the source model which in turn updates the sheets. Changes to the sheets alone are not allowed unless they are changes that would not result from revisions to the source model.
3. The Issue Block portion of the Title Block from the Southwestern Division strategy (Figure 32) contains additional columns of information than the Issue Block in the Title Block available on the CAD/BIM Technology Center's website (Figure 33). This is not a conflict with either the A/E/C CAD Standard or the U.S. National CAD Standard. Per the A/E/C CAD Standard: "Local standards may modify the content of the title block but should not alter its size or configuration if possible."

Amendments – Solicitation stage

General notes

The following procedures will be followed when producing amendment drawings. Designers shall coordinate changes on all drawings that are affected by an amendment. All changes made to the drawings shall correspond to the actual size or proportion of the objects on the drawings. Changes to dimensions with no change to the amended object are not acceptable, except where details are designated as NTS (i.e., Not to Scale).

Noting amendment drawing changes inside the drawing area

- Position and scale the Revision Cloud where each amendment change occurs and without obscuring drawing details. The Amendment Delta shall be scaled accordingly and placed inside the Revision Cloud near the change.

Δ	DELETED SECTION F		AM 0002	OCT 11
Δ ³	CHANGED GENERAL NOTES 2, 5, 8		AM 0001	AUG 11
MARK	DESCRIPTION	TRACKING NO.	ACTION	DATE

Figure 32. Southwestern Division strategy issue block (NCS acceptable alternative).

MARK	DESCRIPTION	DATE	APPR.

Figure 33. A/E/C CAD Standard issue block (as available from Center website):

<http://cadbim.wes.army.mil/cad>

- Use a numeric character in the Amendment Delta to indicate the amendment number. Use “1” for the first proposed modification, “2” for the second, “3” for the third, etc.
- The Amendment Delta will not be numbered, as the total number of Deltas for each occurring amendment will appear in the title block Issue Block as described in the following paragraph.

Referencing amendment drawing changes inside the border area

- Each Amendment Delta in the drawing area shall be referenced by two corresponding Border Reference Deltas located outside the border of the drawing between the borderline and the paper edge line. Border Reference Deltas shall be placed in horizontal and vertical alignment with the referenced Amendment Delta and in the closest top and side borders or bottom and side borders from the Delta.

Noting amendment drawing changes in the border sheet issue block

- The Issue Block provides places for Mark, Description, Tracking No., Action, and Date information, beginning with the bottom row (Figure 34). As mentioned previously, successive revisions shall be shown progressing upward in the Issue Block. Designers should contact the District's Engineering Manager/Project Manager to obtain the Amendment Number before making changes.

Δ	DELETED SECTION F		AM 0002	OCT 11
Δ	CHANGED GENERAL NOTES 2, 5, 8		AM 0001	AUG 11
MARK	DESCRIPTION	TRACKING NO.	ACTION	DATE

Figure 34. Issue Block for amendment drawing changes.

- Place an Amendment Delta with corresponding numeric designator for each amendment within the Mark area and at half the size of the Delta placed in the Drawing Area. At the outer upper-right side of the Delta, indicate the total number of Deltas for each respective amendment. The number of Deltas should appear only in the Issue Block, and no numbers should appear next to the Deltas in the Drawing Area or next to the Border Reference Deltas.
- In the Description area, briefly describe the changes that occur for each amendment. Descriptions will be limited to one line and will describe the actual changes on the drawing.
Examples: "Changed General Note 3," "Revised Detail 4/A-501," "Inserted new Detail 5/A-501."
- The Tracking No. area is not used for amendments.
- In the Action area, identify the amendment by prefixing the amendment number with the letters *AM*.
Examples: AM 0001, AM 0002, AM 0003
- In the Date area, put the month and year that the amendment was done.
Example: Oct 11

Noting more than one amendment on a drawing

When there is more than one amendment, all previous Amendment Deltas shall remain; and only the most current amendment will be indicated with a Revision Cloud. Remove all Revision Clouds for previous amendments.

Narrative, write-in, or sketch Amendments

Amendments done by narrative, write-in, or sketch methods during the Solicitation Period shall be submitted to the District's Specifications Section. Amended hard-copy drawings and CAD files shall be submitted to the Engineering Manager/Project Manager within 3 days of the submission of the amendment.

Adding or deleting drawing sheets and index sheet procedures

- An added drawing shall be indicated as "NEW DRAWING" in the Sheet Title Block. The added drawing shall be shown on the index sheet by inserting the sequence, file name, drawing number, and title in the proper location and surrounding the entire identification with a Revision Cloud.
- To avoid renumbering other drawings, an added drawing shall be numbered as the previous drawing in the set and with an appended alphabetic character (i.e., a drawing following sheet M-101 would be labeled drawing M-101A, M-101B, etc.) (Figure 35).

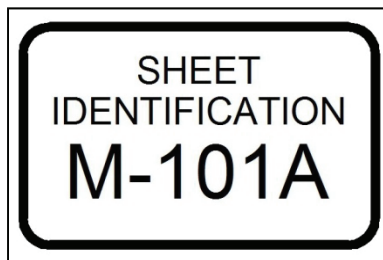


Figure 35. Numbering an added drawing.

- A deleted drawing shall be indicated as DELETED FROM CONTRACT or DELETED FROM SOLICITATION in the Description field of the Title Block. An X shall be placed across the extent of the drawing and the phrase "DELETED SHEET" in bold letters will be added.
- The deleted drawing shall not be included in the printed drawing set although the CAD file shall remain part of the CAD drawing files.

- On the index sheet, the sequence, file name, sheet number, and title shall remain; and the phrase “DELETED SHEET” shall be placed in bold letters over the description. Surround the entire line in the index by a Revision Cloud and corresponding delta. The sheets deleted shall be identified in the index Title Block amendment or proposed modification description area.

Amendments – Contract Award Stage

General notes

All narrative, write-in, or sketched amendments that were done during the solicitation stage shall be verified to have been incorporated into the drawings. Omitted amendments shall be incorporated at this time.

- The Contract Number shall be placed on the cover sheet on the right-side border area and below the Solicitation Number inside the border.
- All Amendment Deltas, Revision Clouds, and descriptions shall remain on the drawings as they appeared after the most recent amendment. No changes will be made to the drawings at Contract Award stage, except for insertion of the Contract Number.

Modifications – Proposed or awarded

General notes

These procedures will be followed when producing Proposed or Awarded Modification drawings. Designers shall coordinate changes on all drawings affected by a proposed modification. All changes made to the drawings shall correspond to the actual size or proportion of the objects on the drawings. Changes to dimensions with no change to the modified object are not acceptable, except where details are designated as NTS (i.e., Not to Scale).

Noting proposed modification drawing changes inside the drawing area

- Position and scale the Revision Cloud at the location of each proposed modification change and without obscuring drawing details. The Modification Delta shall be scaled accordingly and placed inside the Revision Cloud.
- Use a lower-case alphabetic character in the Modification Delta to indicate the modification number. Use character *a* for amendment number 0001, *b* for 0002, *c* for 0003, etc.

- The Modification Deltas will not be numbered, as the total number of Deltas for each occurring modification will appear in the title block Issue Block.
- Any Amendment Revision Clouds shall be removed when the first proposed modification is finalized. All previous Amendment Deltas and descriptions shall remain.

Referencing proposed modification drawing changes inside the border area

- Each Modification Delta in the drawing area shall be referenced by two corresponding Border Reference Deltas located outside the border of the drawing between the borderline and the paper edge line. Border Reference Deltas shall be placed in horizontal and vertical alignment with the referenced Modification Delta and in the closest top and side borders or bottom and side borders from the delta

Noting proposed modification drawing changes in the border sheet Issue Block

The Issue Block provides places for Mark, Description, Tracking No., Action, and Date information, beginning with the bottom row (Figure 36). As mentioned previously, successive revisions shall be shown progressing upward in the Issue Block. Designers should contact the District's Engineering Manager/Project Manager to obtain the Modification Tracking Number before making changes.

Δ ¹	DELETED SECTION F	M0002	PM	NOV 11
Δ ²	REVISED SECTIONS A, C, AND E	M0001	P0001	NOV 11
MARK	DESCRIPTION	TRACKING NO.	ACTION	DATE

Figure 36. Issue Block for proposed modification drawing changes.

- Place the Modification Delta with corresponding alphabetic character designator for each proposed change within the Mark area and at half the size of the Delta placed in the Drawing Area. At the outer upper-right side of the Delta, indicate the total number of Deltas for each respective proposed modification. The number of Deltas should appear

only in the Issue Block, and no numbers should appear next to Deltas in the drawing area or next to the Border Reference Deltas.

- In the Description field, briefly describe the changes that will occur for each proposed modification. Descriptions will be limited to one line and will describe the actual changes on the drawing.

Examples: “Changed General Note 3,” “Revised Detail 4/A-501,”
“Inserted new Detail 5/A-501.”

- In the Tracking No. field, identify the proposed modification with the Tracking Number from Construction Management.
- In the Action field, place a *PM* designator for Pending Modification.
- In the Date field, put the month and year in which the proposed modification was done.

Example: Nov 11

Noting awarded modification drawing changes in the border sheet Issue Block

When a proposed modification is awarded, a P0000 number (e.g., P0001, P0002, P0003, etc.) that corresponds to the Modification Tracking Number on the drawing will be assigned by Contracting Division.

- The P0000 number shall replace the *PM* designation in the Action field.
- The date the modification was awarded shall be placed in the Date field.
- The number in the Tracking No. field shall remain.
- Drawing sheet number shall not be changed for modifications.

Adding or deleting drawing sheets and index sheet procedures

- The same procedures shall be followed as listed under Amendments with the exception that the drawing shall remain as part of the drawing set.

Record drawing as-builts

- All Proposed Modifications shall be verified and the P0000 number inserted for all Awarded Modifications. Proposed Modifications that were not awarded shall be removed or replaced by the CAD drawing file that was saved before the Proposed Modification was done.
- All Revision Clouds on the drawings shall be removed. All previous Revision Deltas and descriptions for Amendments, Proposed Modifications, and Awarded Modifications shall remain on the drawing sheets.

- All field modifications that were done by sketched or written narrative shall be incorporated into the drawings.
- All redline markups submitted by the construction contractor shall be incorporated into the CAD drawing sheets. New drawing sheets will be created as necessary to show the record drawing as-built conditions.
- All updates shall incorporate the actual size or proportion of the objects on the drawings. Changes to the dimensions with no change to the changed object are not acceptable, except where details are not to scale. Designers or drafters shall coordinate and correct all dimensions on all drawings that are affected by the updates or changes.
- Upon completion of the record drawing sheet, the date shall be placed in the date area of the Issue Block and the words “RECORD DRAWING AS-BUILTS” shall be placed in the Description field. At the lower right portion of each drawing sheet, outside the border, the words “RECORD DRAWING AS-BUILTS” shall be placed.
- All final CAD files reflecting as-built construction conditions shall be submitted to the Corps of Engineers, Engineering Manager/Program Manager.

Bibliography

- CAD/BIM Technology Center for facilities, infrastructure, and environment. 2009. *A/E/C CAD Standard*, Release 4.0. Vicksburg, MS: U.S. Army Engineer Research and Development Center.
- Construction Specifications Institute. 2011. *Uniform drawing system: U.S. National CAD Standard Version 5.0*. Alexandria, VA: Construction Specifications Institute.
www.nationalcadstandard.org/ncs5/
- Department of Defense. 2011. *Design procedures*. Unified Facilities Criteria 1-300-09N, 25 May 2005, including Change 8, 17 February 2011. www.wbdg.org.
- Headquarters, U.S. Army Corps of Engineers. 2006. *Graphic standards manual*. EP 310-1-6. Washington DC: Headquarters, U.S. Army Corps of Engineers.
- National Park Service. 2001. *Guideline for preparation of design and construction drawings*. Reference Manual 10A. Denver, CO.
- Sheet Metal and Air Conditioning Contractors' National Association, Inc. 2001. *SMACNA CAD standard*. 2nd Edition. Chantilly, VA.
- U.S. Army Engineer District, Baltimore. 2008. *Enterprise CADD Standards, Version 4.1*. Baltimore, MD.
- U.S. Army Engineer District, Far East. 2008. *A/E/C CADD Standard Supplement*. Seoul, South Korea.
- U.S. Army Engineer District, Fort Worth. 2004. *SWF procedures for drawing revisions*. Fort Worth, TX.
- U.S. Army Engineer District, Jacksonville. 1976. *Jacksonville District Drafting Standards*. Jacksonville, FL.
- U.S. Army Engineer District, Vicksburg. 1969. *Drafting Standards Manual*. Vicksburg, MS.

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14. ABSTRACT The CAD Drafting Standard has been developed by the CAD/BIM Technology Center (Center) to document how proper hand-drafting practices can be achieved in Computer-Aided Design (CAD). It is through the collection and documentation of these practices that consistent CAD drawings shall be achieved throughout the U.S. Army Corps of Engineers, 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 the U.S. National CAD Standard. The documentation of these practices will help to achieve both clear and aesthetically pleasing CAD drafting techniques in CAD construction documents.					
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