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An Overview of
The United States
National CAD Standard

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Published in cooperation with:

The American Institute of Architects

The U.S. CADD/GIS Technology Center

The Construction Specifications Institute

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Today's topics:

- **Why do we need a National Standard?**
- **How the Standard came into being.**
- **What the National CAD Standard (NCS) is.**
- **What the National CAD Standard is NOT.**
- **Why the NCS is developed by consensus.**
- **How the NCS will evolve in the future.**
- **Overview of NCS content.**

http://www.nationalcadstandard.org

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What Standards do you use?

1. **All or part of the National CAD Standard *(CAD Layer Guidelines, Uniform Drawing System, Plotting Guidelines).***
2. **Proprietary office standards.**
3. **Client-imposed standards.**
4. **Combination of above as required.**
5. **None.**

http://www.nationalcadstandard.org

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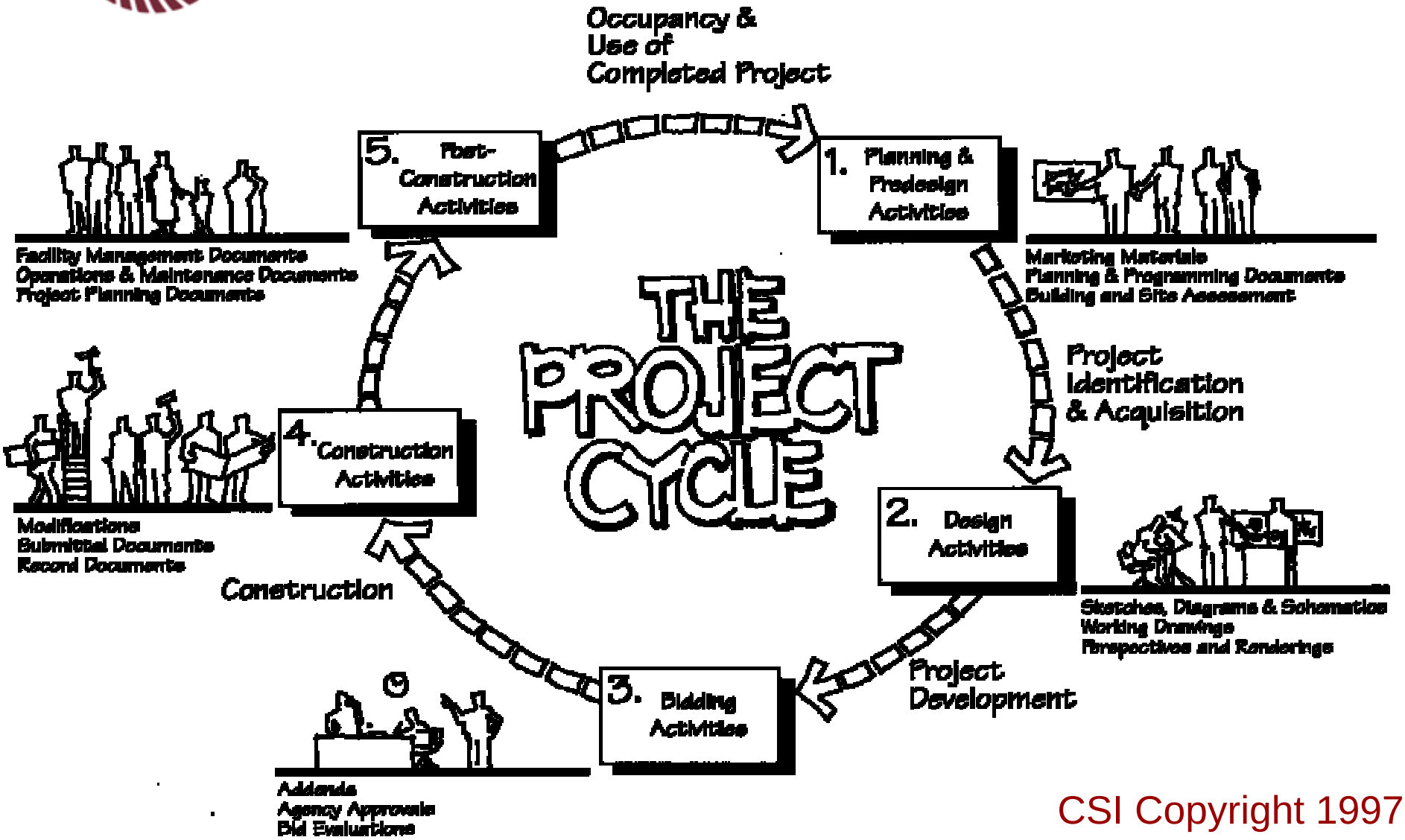

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Why do we need a National CAD Standard (1)?

- **AEC industry is now dependent on CAD data.**
- **Project team communication & collaboration is plagued by rampant, expensive problems, frustrating design firms and their clients.**
- **In the absence of universal standards, design firms have developed their own standards to reduce learning curve and improve efficiency.**
- **Collaboration is the heart of our business; we need a consistent data model.**

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Why do we need a National CAD Standard (2)?

- **Supporting different clients with different standards has negative impact on projects and profitability.**
- **Building owners and facility managers increasingly expect electronic deliverables; will enforce their own standards in absence of universal standards.**

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Why do we need a National CAD Standard (3)?

- **Bldg. owners want useful facilities data for use by wide variety of people & systems over facility life cycle. Data must be predictable.**
- **Software developers need predictable models to support software development and collaboration efforts.**
- **AEC industry needs a *common language* of organization and classification of building design data.**

http://www.nationalcadstandard.org

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How did the Standard come into being?

- **1994 - NIBS forms CADD Council**
  (now Facility Information Council)
- **1997 - FIC forms NCS Project Committee,**
  Memo of Understanding signed by:
  - **AIA**
  - **CSI**
  - **GSA**
  - **NIBS**
  - **SMACNA**
  - **U.S. CADD/GIS Technology Center**
  - **U.S. Coast Guard**

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NCS Project Committee reviews "Prior Art:"

- **AIA CAD Layer Guidelines**
  Version 1.0, 1992, Version 2.0, 1997
- **CSI Uniform Drawing System**
  Modules 1-8, 1997-2000
- **Tri-Service CADD Standards**
  through Version 1.8

Little overlap or conflict, high degree of compatibility found; could these be the foundation of a National CAD Standard?

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July 1997 - Memorandum of Understanding (1)

- **signatories agree to develop single, national CAD standard.**
- **publishing signatories agree to "contribute" their documents to the Standard and to submit to a consensus-based decision-making process, while retaining copyright, intellectual property rights, and ownership.**
- **development of the standard to be open to the public.**

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July 1997 - Memorandum of Understanding (2)

- **standard is to be published jointly.**
- **publishers agree to support, maintain, and revise constituent documents, and not to develop competing standards.**

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What the U.S. National CAD Standard *IS:*

A system for organizing and classifying "drawing centric" bldg. design data, including:

- ***a system for naming model files, drawing files, and drawing file layers.***
- ***a system for organizing the drawing set:***
  - ***drawing set hierarchy***
  - ***drawing sheet layout and format***
  - ***schedule layout and format***
- ***plotting guidelines***

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The resulting constituent documents:

- **CAD Layer Guidelines**
  NCS Edition, 2001, published by the AIA
- **Uniform Drawing System**
  Modules 1-8, 1997-2000, published by CSI
- **Plotting Guidelines**
  developed by Coast Guard, published by CADD/GIS Technology Center.
- **NCS Project Committee Report**
  resolves minor discrepancies among them.

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What the National CAD Standard *IS NOT:*

- **software protocols or standards for the sharing of electronic data files.**

Who is working on *that* problem?

- **International Alliance for Interoperability (IAI)**
- **aecXML Project Group**
  (see December 1999 AIArchitect for a detailed article about aecXML)

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Where is the boundary in these efforts?

- **NCS is a data classification and organization standard that can be defined by *CAD users.***
- **The mission of IAI is an open, electronic building information model, called *Industry Foundation Classes* (IFC's), which can only be defined by *software programmers,* in consultation with users.**
- **The aecXML Project will define a system of "data tags" to facilitate data transfer among applications and across the Internet; requires joint efforts of *users and programmers.***

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How are these related efforts coordinated?

- **High level of informal communication between the three groups.**
- **Many dual liaison appointments by AEC industry professional organizations.**
- **Formal liaison links appear unnecessary at this time.**

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Participants in the NCS initiative:

- ***Architects, Engineers, Contractors***
- ***Major AEC Professional Associations***
- ***Federal Agencies***
- ***AEC Software Vendors***
- ***AEC Publishers***
- ***YOU!***

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How does the NCS Project Committee Work (1)?

- **open to the public**
- **consensus-based decision-making process**
- **two ways to serve:**
  document reviewer (no travel required)
  active member (some travel required)
- **all participants participate in comment periods**
- **active committee judges comments:**
  relevant / irrelevant
  persuasive / non-persuasive

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How does the NCS Project Committee Work (2)?

- relevant and persuasive comments advance to final ballot
- rejected comments can be re-submitted
- all participants have single vote on final ballot
- Committee business is conducted via Internet

NCS Project Committee Listserv:

ncs-l@ls.aiaonline.com

To join Committee / Listserv, Email:

sshaw@nibs.org, tardifm@aiamail.aia.org

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Why the Standard develops by *consensus:*

- **NIBS required to maintain public, consensus-based decision-making processes.**
- **Widespread adoption is contingent upon broad representation by and agreement among major AEC industry stakeholders.**
- **Goal is to embody widest possible number of viewpoints, working conditions and applications.**
- **Success depends on constant parenting by AEC industry.**

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How will the NCS evolve in the future?

- **Project Committee is now a standing committee; new members can join at anytime.**
- **NCS will be updated annually to keep pace with evolving technology.**
- **Committee members recruited throughout AEC/FM industry (civil, survey, process, telecomm, & bldg. electronics engineers; bldg. operators & facility managers)**
- **NCS to be incorporated into software apps; no cost to users, nominal licensing fee to software developers.**

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Items new to NCS Version 2.0:

- **new layers for *survey/mapping, geotechnical, civil, civil works, landscape, structural, fire protection, plumbing, mechanical, and telecommunications***
- **ISO Layer Format compliance**
- **UDS Modules 4 - 8; (*drafting conventions, terms & abbreviations, drawing symbols, notations, code conventions)***

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Version 3.0 Issues:

Active outreach for broader industry participation

NCS / ISO Compatibility

Object Data Standards

External Libraries (details, blocks, symbols, etc.)

Printed Output Standards

Metadata Standards

IAI aecXML Interface / Coordination

IAI IFC Interface / Coordination

Implementation Guidelines

NCS Compliance Guidelines / Standards

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Version 3.0 Timeline:

AEC Recruitment :	**Ongoing**
Through August, 2001:	**Submittal Period Open**
Sept/ Oct 2001:	**Comment Period Open**
Nov 9-10, 2001:	**Project Committee Mtg.**
Jan 1, 2002:	**Final Ballot Prepared**
Jan / Feb 2002:	**Balloting Period**
March 2002:	**Project Committee Mtg.**
September 2002:	**NCS v. 3.0 ships**

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How do I get a copy of the Standard?

- **Download, print, and fax back the order form:**

  http://www.nationalcadstandard.org

- **Call NIBS at:**

  (202) 289-7800

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NCS Version 2.0 Cost:

$464.95 to the public

$344.95 to AIA, CSI, NIBS members

NCS Version 2.0 Upgrade Cost:

$289.95 to the public

$229.95 to AIA, CSI, NIBS members

NCS Version 2 - NIBS Report Only:

$114.95 to the public

$ 84.95 to AIA, CSI, NIBS members

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Questions about Process?

The American Institute of Architects

The U.S. CADD/GIS Technology Center

The Construction Specifications Institute

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U.S. National CAD Standard - Content

CAD Layer Guidelines, NCS Version 2.0 Edition

Defines:

- **History of CAD Layer Guidelines**
- **Layer Name Formats**
- **Layer list**
- **Commentary: US NCS & ISO 13567**

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Layer Name Format - Character Fields

A A A A A A A A A A A A A A A A

Discipline Designators

A A A A A A A A A A A A A A A

Major Group

A A A A A A **A A A A** A A A A

Minor Group

A A A A A A A A A A **A A A A**

Status Field

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Organizing Concept - Discipline Designators

A A A A A A A A A A A A A A

Discipline Designators

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

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Layer Name Format - Major Group Field

A□ - **W A L L**

Major Group

Major Group identifies the building system

WALL	Walls
DOOR	Doors
LITE	Lighting fixtures
FIXT	Plumbing fixtures
SECT	Sections
ELEV	Elevations
DETL	Details

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Layer Name Format - Minor Group Field

A□ - W A L L - **F U L L**

Minor Group (optional)

Minor Group further differentiates major group

FULL	Full Height	
PART	Partial	
IDEN	Identification	(common modifier)
PATT	Pattern	(common modifier)

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Layer Name Format - Status Field

A □ - W A L L - F U L L - **D**

Status Field
(optional)

OLD		NEW
NEWW	New work	**N**
EXST	Existing to remain	**E**
DEMO	Existing to be demolished	**D**
FUTR	Future work	**F**
TEMP	Temporary work	**T**
MOVE	Items to be moved	**M**
RELO	Relocated items	**R**
NICN	Not in contract	**X**

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Layer Name Format - Annotation (Major Group)

A □ - **A N N O - D I M S -** □

Annotation

Text, dimensions, sheet borders, detail references, and other elements do not represent physical aspects of a building or facility.

ANNO-TEXT	Text
ANNO-DIMS	Dimensions
ANNO-SYMB	Symbols
ANNO-TTLB	Border and title block

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U.S. National CAD Standard - Content

Plotting Guidelines

CADD/GIS Technology Center
United States Coast Guard

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The CADD/GIS Technology Center for facilities, infrastructure, and environment.

Plot Table (Partial)

MicroStation Color #	MicroStation line weight	AutoCAD Color #	Pen Plotter pen mm	Laser/Elec InkJet in.	PlotColor
3	0	1	0.18	0.007	Black
4	1	2	0.25	0.010	Black
2	2	3	0.35	0.014	Black
7	2	4	0.35	0.014	Black
1	3	5	0.50	0.020	Black
5	5	6	0.70	0.028	Black
0	1	7	0.25	0.010	Black
9	2	8	0.35	0.014	Halftone
14	7	9	1.00	0.040	Black
10	0	10	0.18	0.007	Black
19	2	11	0.35	0.014	Black
27	3	12	0.50	0.020	Black
35	5	13	0.70	0.028	Black
43	7	14	1.00	0.040	Black
51	15	15	2.00	0.080	Black
59	10	16	1.40	0.055	Black

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U.S. National CAD Standard - Content

Uniform Drawing System

Modules 1 - 8

Defines:

- **Drawing Set Organization**
- **Drawing Sheet Organization**
- **Schedule Organization**

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U.S. National CAD Standard - Content

Uniform Drawing System

continued

Defines:

- **Drafting Conventions**
- **Terms and Abbreviations**
- **Symbols**
- **Notations**

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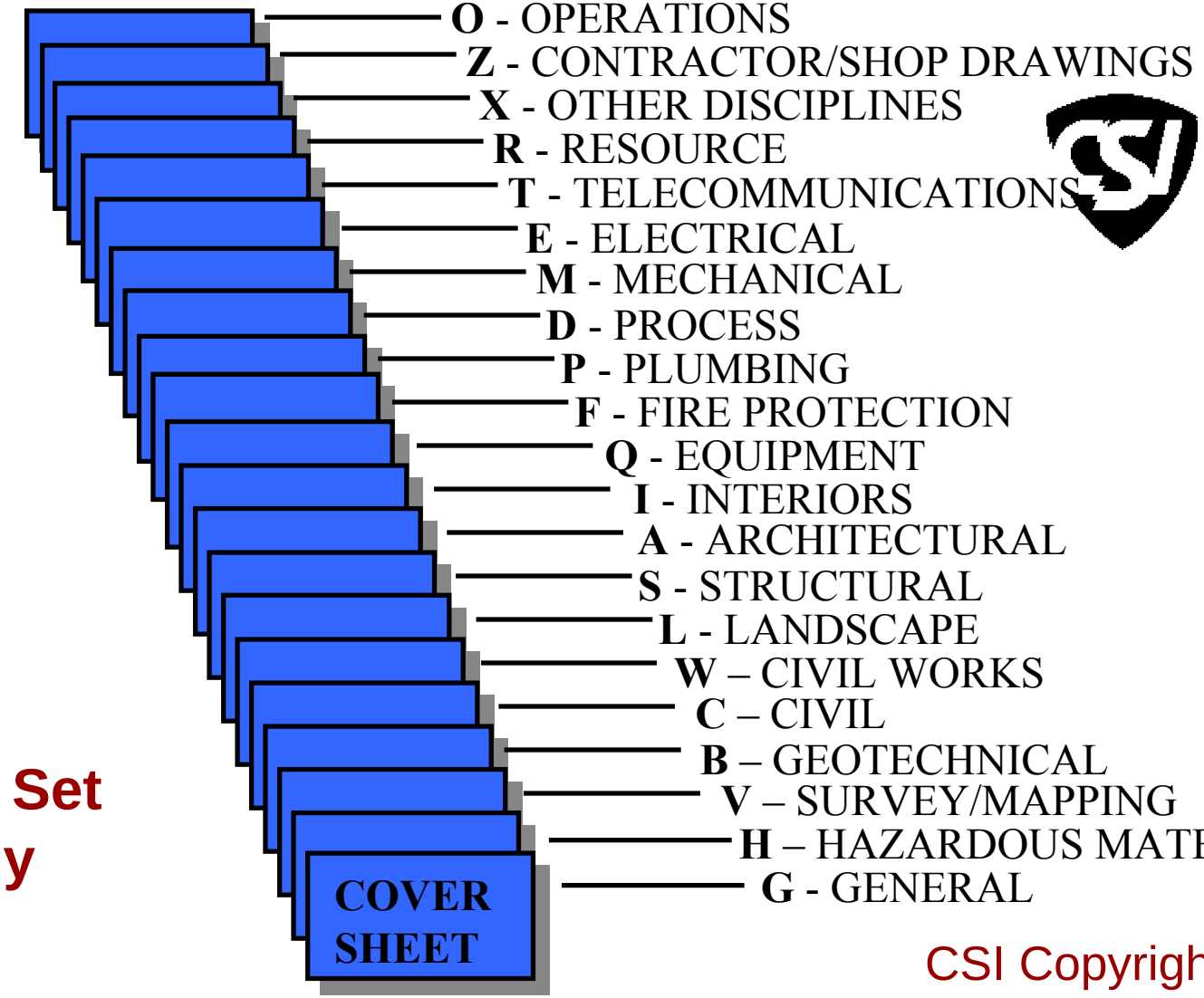
MODULE 01

Drawing Set Organization

Drawing Set Hierarchy



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MODULE 01

Drawing Set Organization

Standard Sheet Identification

- **discipline designator**
- **sheet type designator**
- **sheet sequence number**

A A N N N

Discipline Designators

A A **N** N N

Sheet Type Designator

A A N **N N**

Sheet Sequence Number

A = alphabetical character
N = numerical character

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MODULE 01

Drawing Set Organization

Discipline Designator

A - N N N

Level 1 Discipline Designator Only

A A N N N

Level 2 Discipline Designator w/modifier character

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MODULE 01

Drawing Set Organization

Discipline Designator - Level 1

A A N N N

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

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MODULE 01

Drawing Set Organization

Discipline Designator - Level 2

A A N N N

Designator	Description	Content
A	Architectural	Any or all
AS	Architectural Site	Site Plan
AD	Architectural Demolition	Protection & Removal
AI	Architectural Interiors	Interior Finishes

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MODULE 01

Drawing Set Organization

Sheet Type Designator

A A N N N

0	General (symbols legend, notes, etc.)
1	Plans (horizontal views)
2	Elevations (vertical views)
3	Sections (sectional views)
4	Large Scale Views (plans, elevations, sections)
5	Details
6	Schedules and Diagrams
7	User Defined
8	User Defined
9	3D Representations (isometrics, perspectives, photographs)

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MODULE 01

Drawing Set Organization

Sheet Sequence Number

A A N N N

The sheet sequence number identifies each sheet in a series of the same discipline and sheet type.

The first sheet of each series is numbered 01, followed by 02 through 99.

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MODULE 01

Drawing Set Organization

User-Defined Designators

A A N N N U U U

Examples - Supplemental Drawings

A - 1 0 2 R 1 (partially revised floor plan)

A - 1 0 2 X 1 (totally revised floor plan)

A - 1 0 2 A 1 (Phase 1 of a sequenced construction floor plan)

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MODULE 01

Drawing Set Organization

Sample Typical Drawing Set

Sheet	Sheet Title
G-001	Cover Sheet
A-001	Notes and Symbols
A-101	Floor Plan
A-102	Reflected Ceiling Plan
A-103	Roof Plan
A-201	Exterior Elevations
A-301	Building Sections
A-302	Wall Sections
A-401	Enlarged Toilet Plan
A-501	Details
A-601	Room Finish Schedule
A-602	Door & Window Schedules

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MODULE 01

Drawing Set Organization

Drawing Set Consistency

UDS establishes organization and provides consistency among disciplines. Thus, a floor plan may be located and identified as:

S - 101	**Structural First Floor Plan**
A - 101	**Architectural First Floor Plan**
M - 101	**Mechanical First Floor Plan**
E - 101	**Electrical First Floor Plan**

Sheet Organization

Architectural Sheet Sizes

(ANSI and ISO Sheet Sizes also defined)

	SIZE mm (in)	TYPICAL USES
A	229 x 305 (9 x 12)	Project book; supplemental drawings; mock-up sheets.
B	305 x 457 (12x 18)	Supplemental dwgs; mock-up sheets.
D	610 x 914 (24 x 36)	Projects in preferred plan scale; government projects.
E	914 x 1219 (36 x 48)	Large projects in preferred plan scale; mapping and GIS.
F	762 x 1067 (30 x 42)	Alternate size for projects in preferred plan scale.

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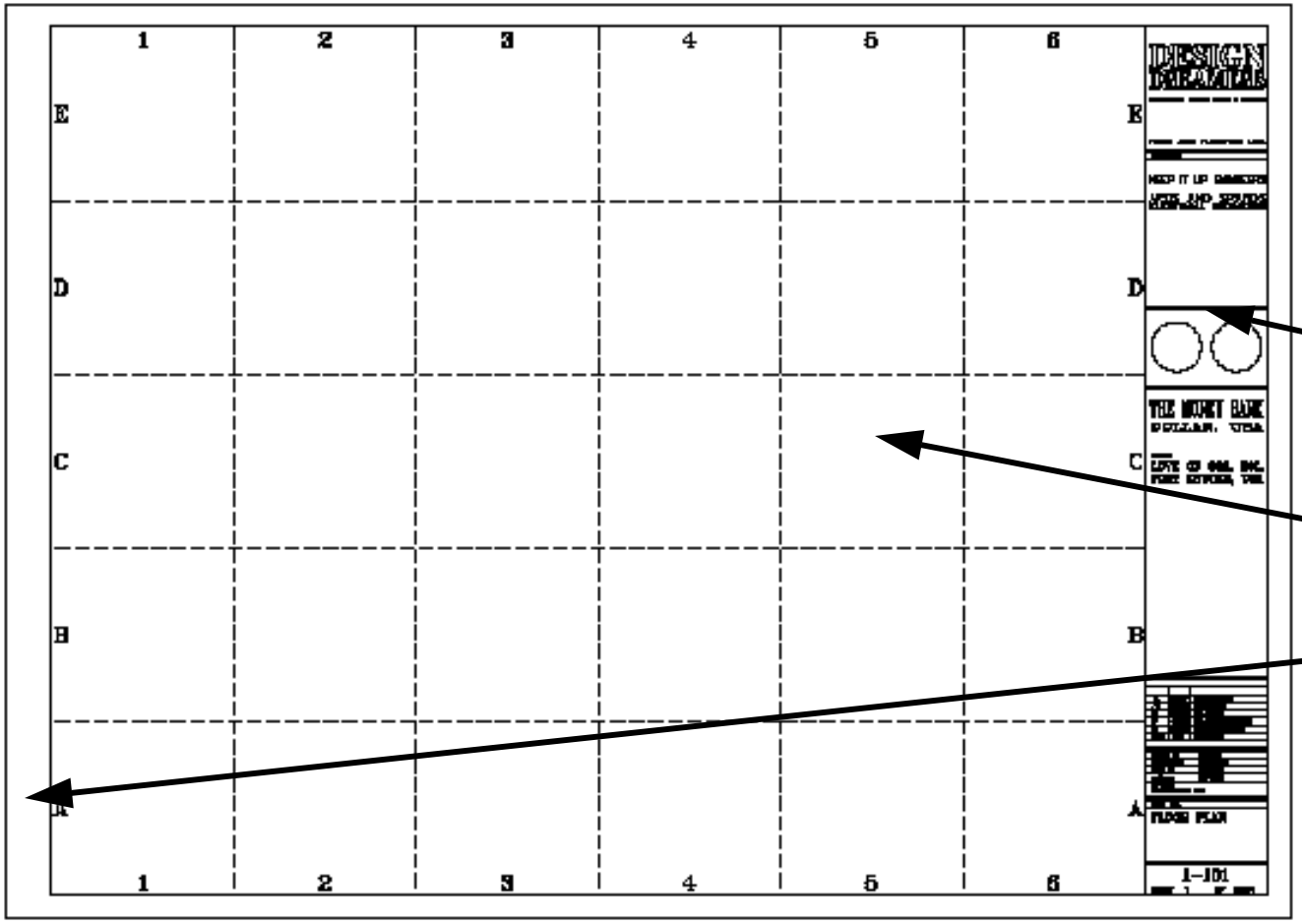
MODULE 02

Sheet Organization

Basic Sheet Layout



Title Block Area

Drawing Area

Production Data Area

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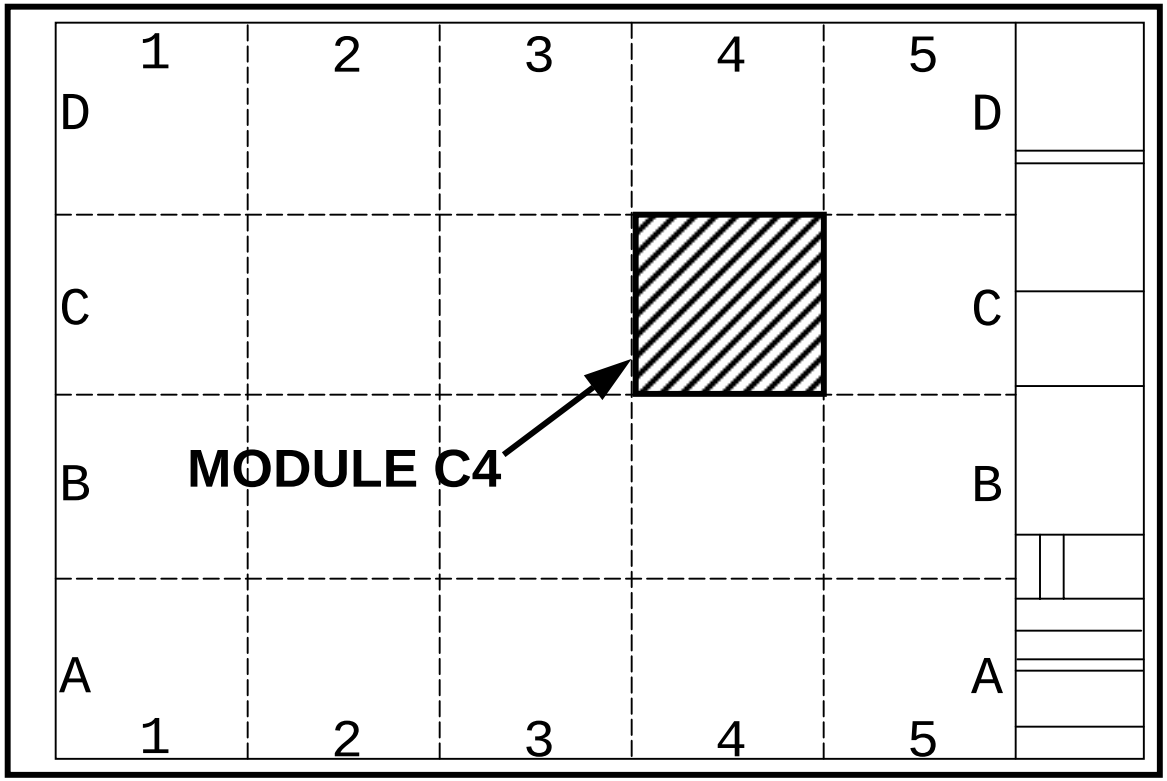
MODULE 02

Sheet Organization

Drawing Sheet Coordinate System



Each module is identified by a letter and a number.

Drawing may comprise one or more modules.

Module identification is established by the coordinates for the lower left hand corner of the module.

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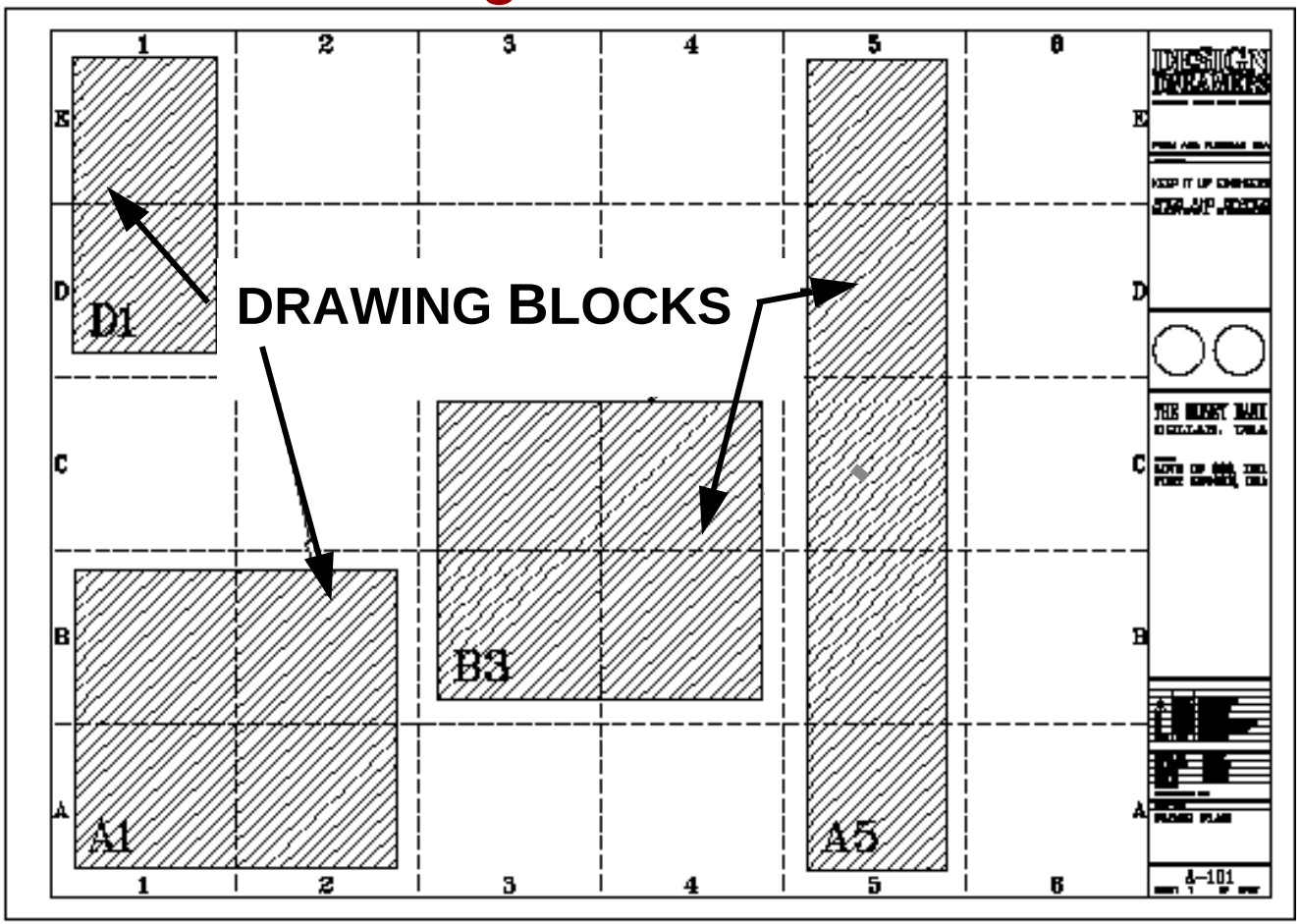
MODULE 02

Sheet Organization

Drawing Blocks



Drawing modules containing graphic or textural info are called drawing blocks.

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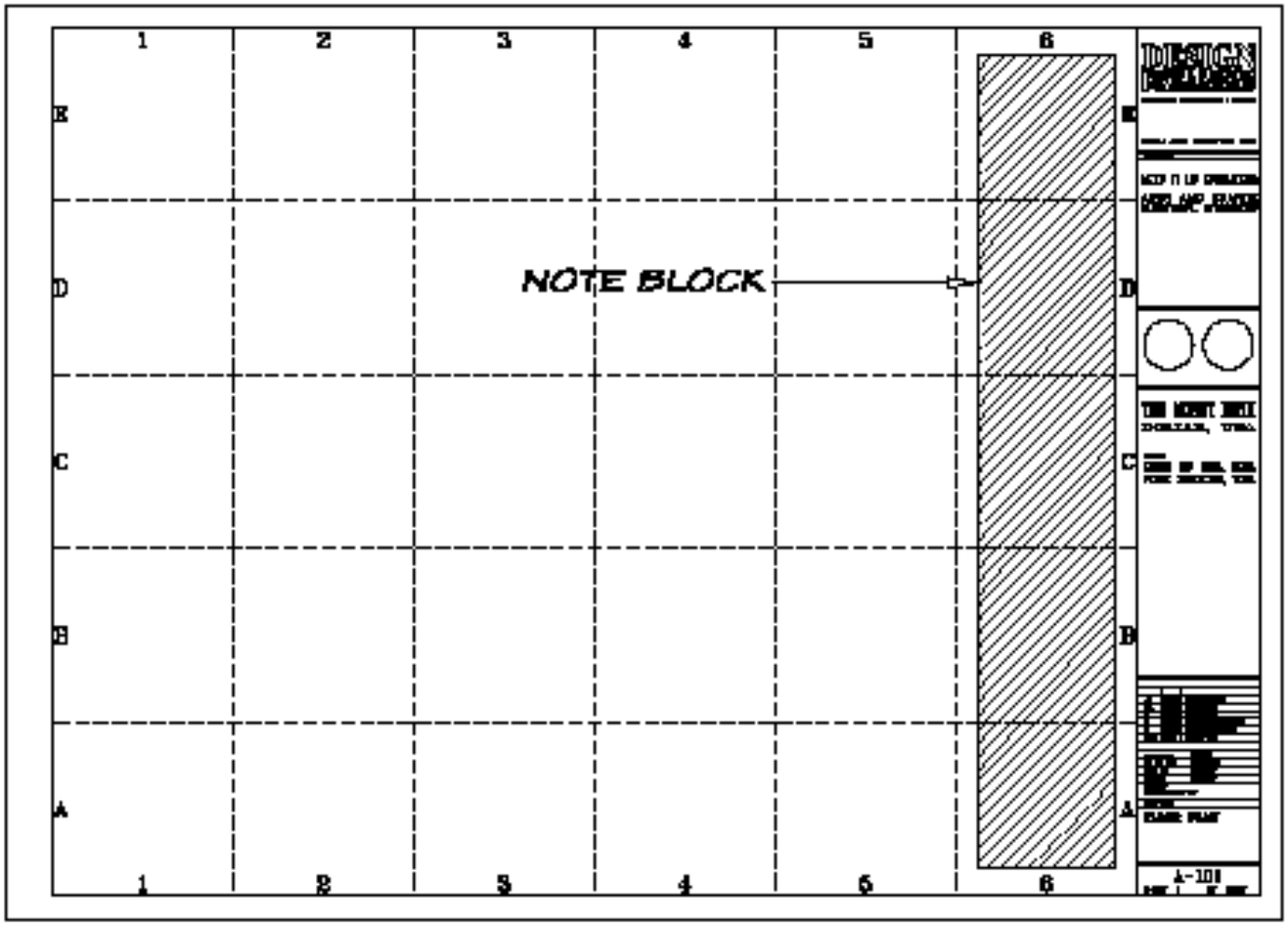
MODULE 02

Sheet Organization

Note Blocks



The Note Block is the module or modules in the drawing area for General Notes, Keynotes, and Key Plans.

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MODULE 02

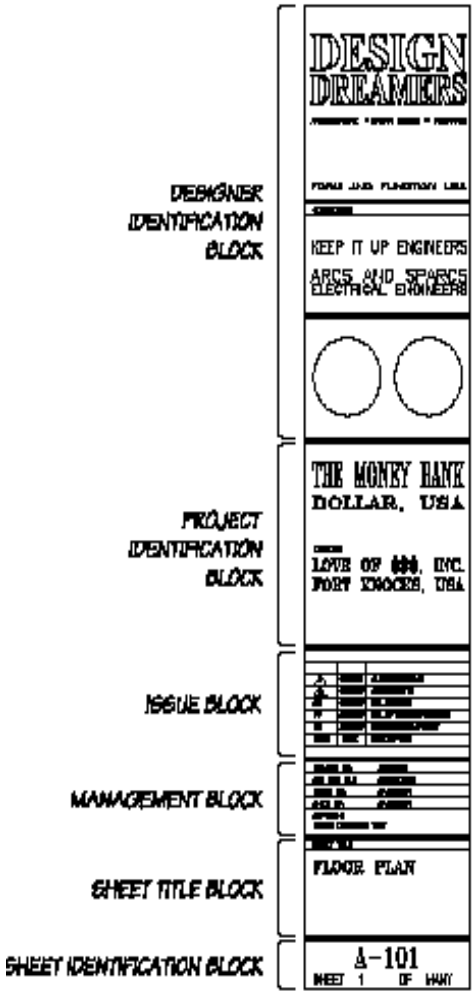
Sheet Organization

Title Block Area

Margins
Same as Drawing Area

Formats
Horizontal Text
Vertical Text

Data Blocks
Designer Identification
Project ID Block
Issue Block
Management Block
Sheet Title Block
Sheet ID Block



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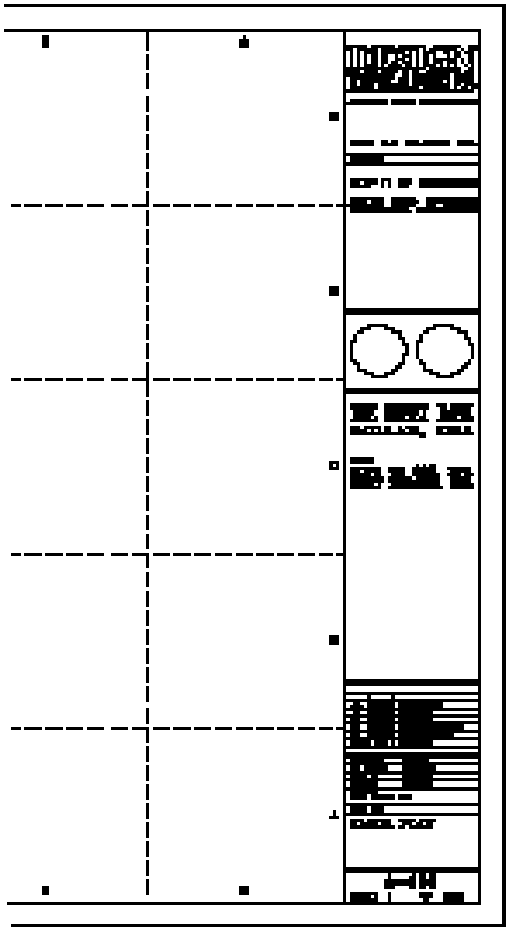
MODULE 02

Sheet Organization

Title Block Formats



Horizontal Text Format:

Title block text is oriented parallel to the bottom of the sheet.

The horizontal text format is the most commonly used, and is the preferred format.

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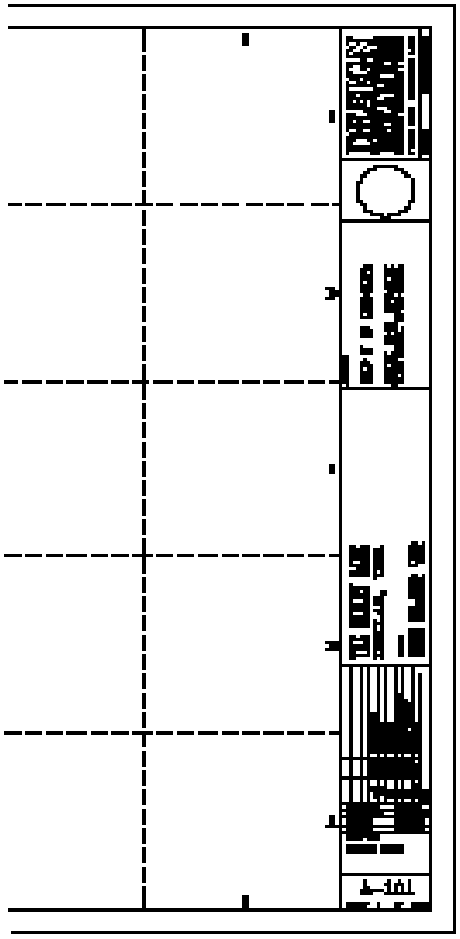
MODULE 02

Sheet Organization

Title Block Formats



Vertical Text Format:

Title block text is oriented parallel to the right side of the sheet.

Sheet title and sheet ID remain oriented parallel to the bottom of the sheet.

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MODULE 03

Schedules

Basic Schedules

In simplest form, schedules consists of four parts:

- Heading
- Column for Item Identifier (Mark)
- Column for Item Description
- Column for indicating Distinguishing Feature

HEADING		
MARK	ITEM DESCRIPTION	FEATURE

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MODULE 03

Schedules

Typical Elements of a Schedule

- Heading
- Mark Column
- Item Description Column
- Distinguishing Feature Column
- Notes Column

The notes column is used to locate special remarks about items in the schedule that do not necessarily warrant their own separate column identifier.

HEADING			
MARK	ITEM	FEATURE	NOTES
			1

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MODULE 03

Schedules

Basic Single Tier Schedule

Example of a simple schedule using a "single-tier" column identifier:

ROOM FINISH SCHEDULE						
ROOM NO	ROOM NAME	FLOOR	BASE	WALL	CEILING	NOTES
101	ENTRY	VCT	RUBBER	PAINT	SAP	1
102	OFFICE	CPT	RUBBER	PAINT	SAP	2

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MODULE 03

Schedules

Complex Schedules

Schedules can be expanded further with an additional tier of column sub-identifiers:

PLUMBING FIXTURE SCHEDULE

MARK	DESCRIPTION	MFR	MODEL	SUPPLY FITTING	SUPPLY PIPE(S)	DRAIN	TRAP	CONNECTIONS				NOTES
								CW	HW	WASTE	VENT	

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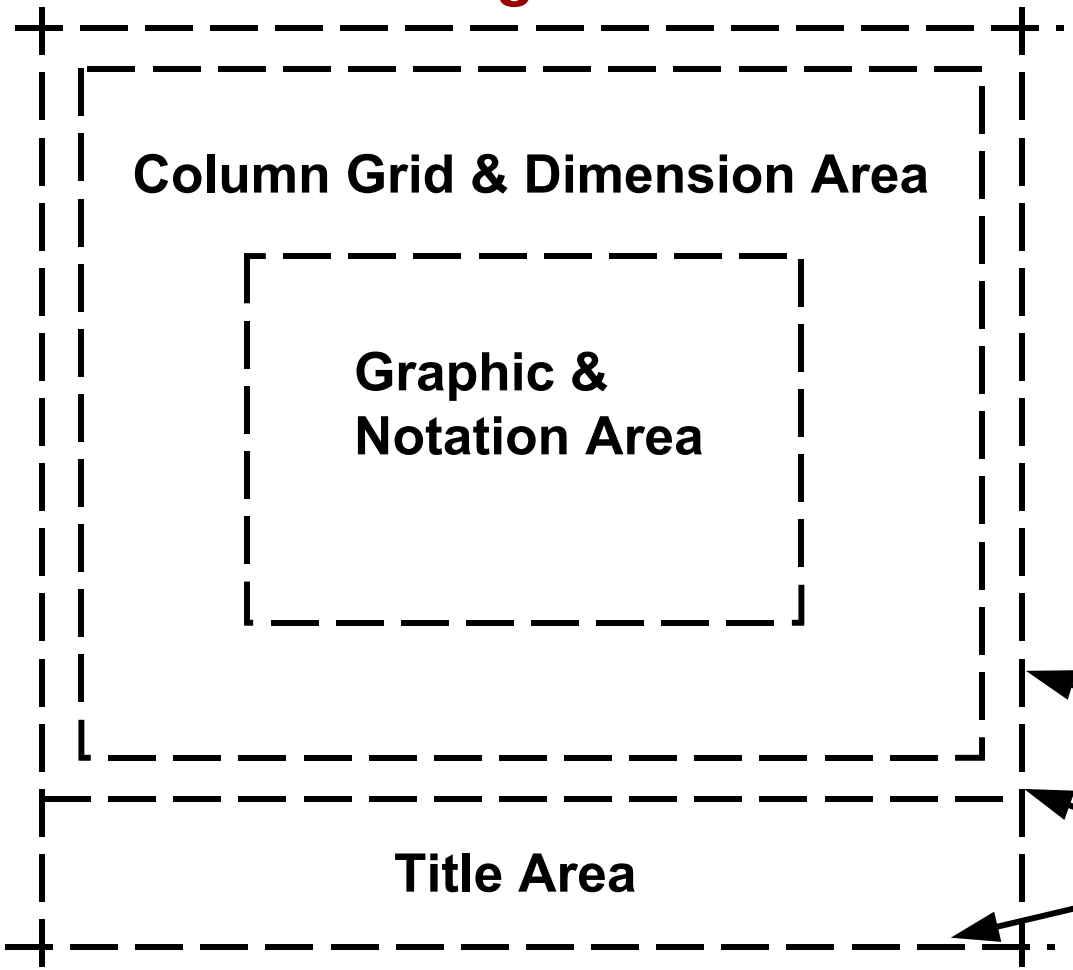
MODULE 04

Drafting Conventions

Drawing Block Format



Drawing blocks that contain plans, elevations, sections, and details are organized in a format that includes the elements shown.

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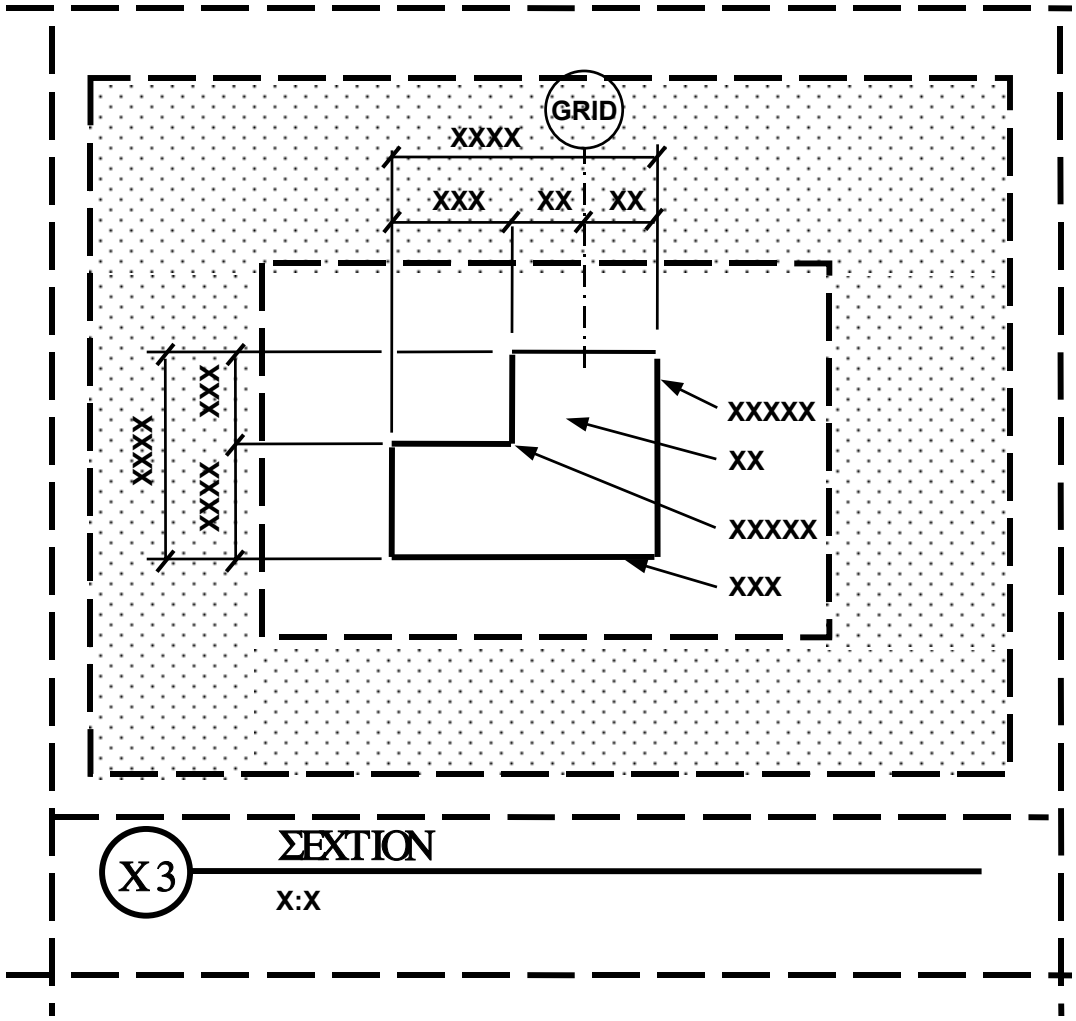
MODULE 04

Drafting Conventions

Drawing Block Format - Sample



A sample drawing block showing a simple plan layout.

Note the column grid and dimension area (shaded), the graphic and notation area, the drawing block title area, and the margins.

Line Width

LINE WIDTH (mm)		RECOMMENDED USE OF LINE
Fine	0.18	Material indications, surface marks, hatch lines.
Thin	0.25	3mm (1/8”) text, dimensioning, leaders, extension lines, break lines, hidden lines, dotted lines, dashed lines, setback line, center line, grid line.
Med.	0.35	4mm (5/32”) to 10mm (3/8”) text object lines, property line, lettering, dimension tick marks.
Wide	0.50	6mm (7/32”) to 10mm (3/8”) text, edges of interior and exterior elevations, profiling, cut lines, property line, section cutting plane line.
X-Wide	0.70	13mm (1/2”) to 25mm (1”) text, match line, border

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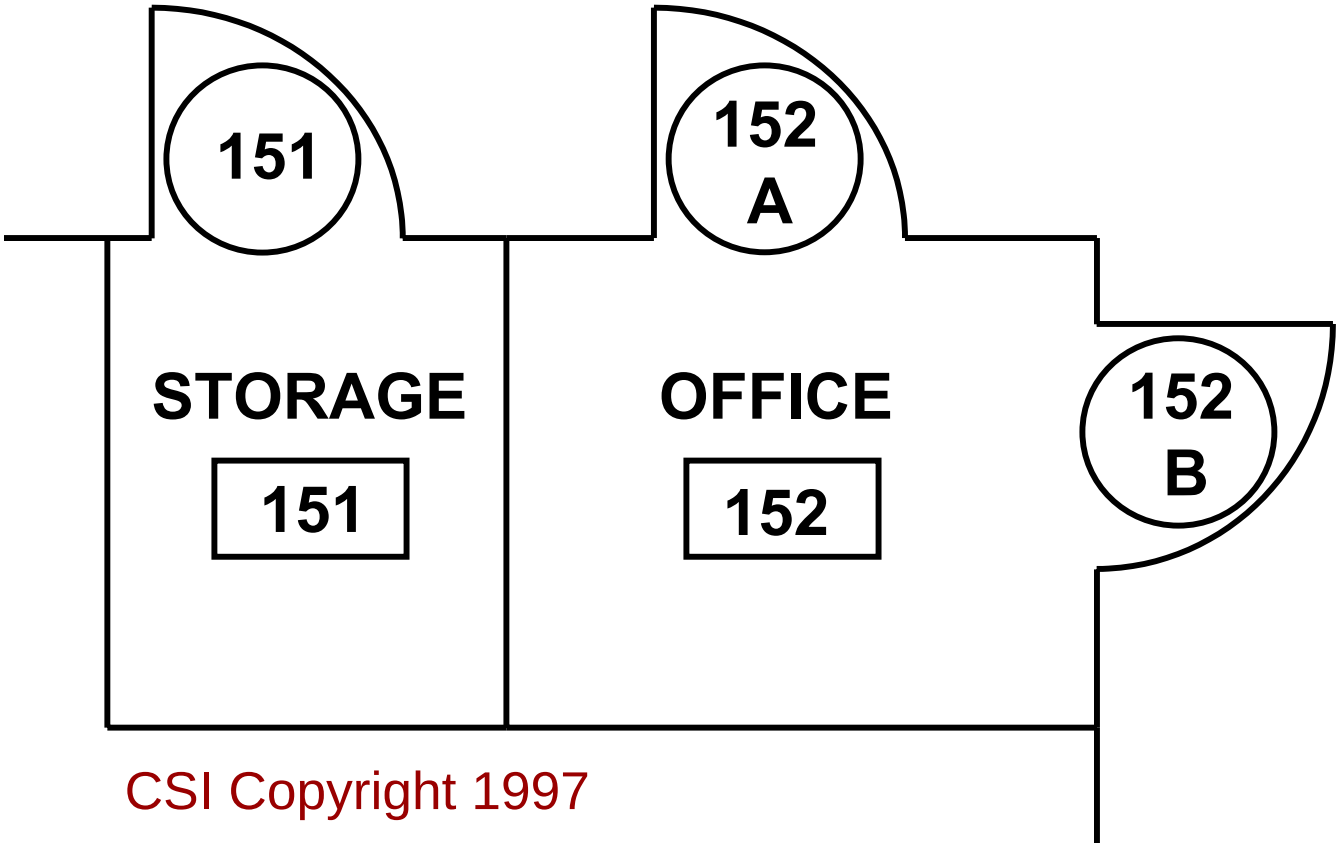
MODULE 04

Drafting Conventions

Identifying Spaces and Objects



Each door is to have a unique identifier; if a room has one door, the door number is the same as the secure side room number.

In rooms with multiple doors, the door number is followed by an alpha character.

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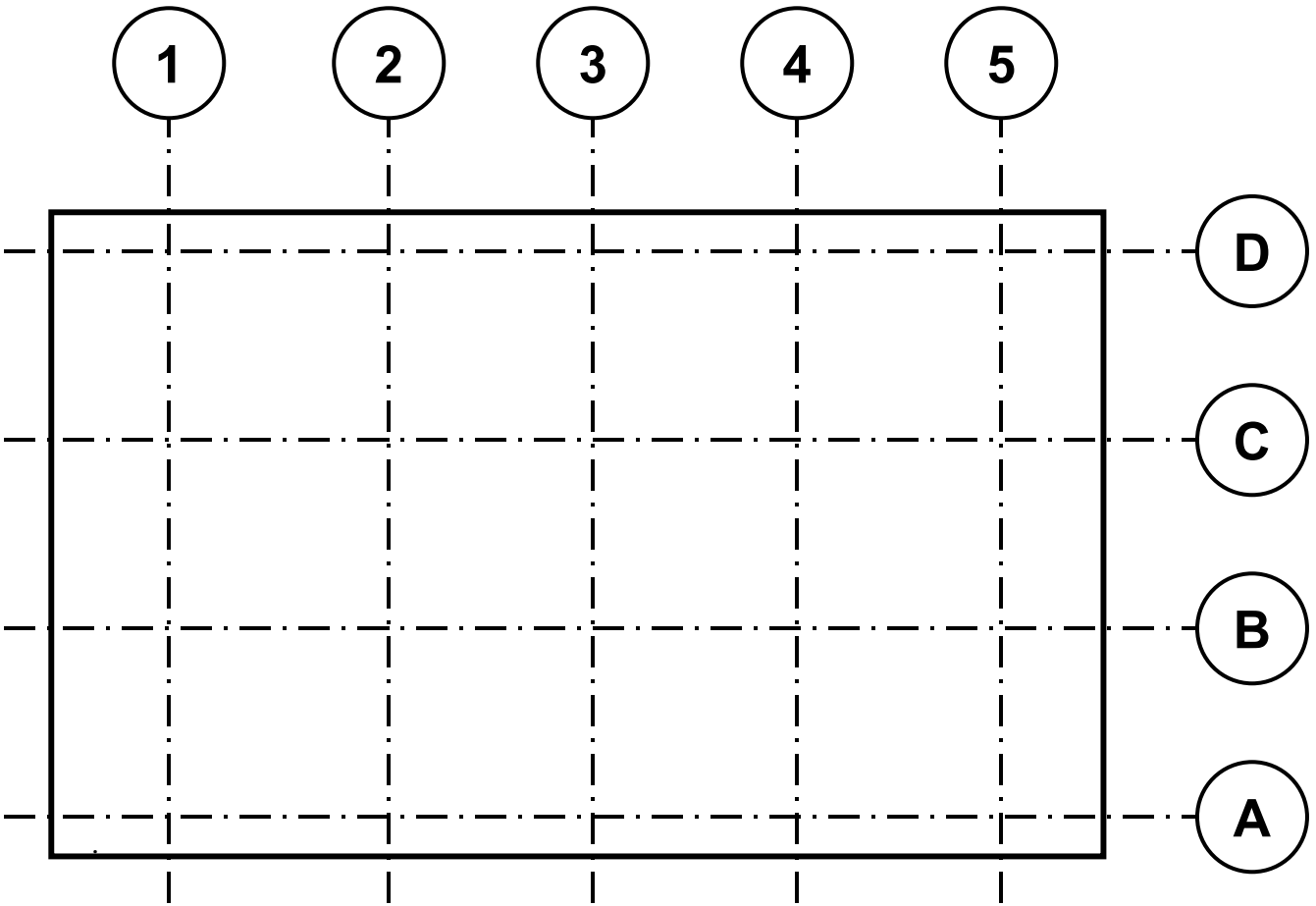
MODULE 04

Drafting Conventions

Column Grid Lines



Vertical grid lines are located across the top and are numbered from left to right.

Horiz. grid lines are located to the right and are alphabetized from bottom to top.

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MODULE 05

Terms and Abbreviations

Defines:

- A consistent nomenclature for construction documents.
- A searchable list of common AEC terms and abbreviations.
- Consistent spelling of terms and abbreviations.
- Notes on common usage and non-preferred terms.

Terms and Abbreviations

Examples

What do you think is the preferred term?

1. Gypsum Wallboard
2. Gypsum Board
3. Gypsum Panel
4. Sheet Rock
5. Drywall

Terms and Abbreviations

Examples

Preferred Term:

1. Gypsum Wallboard
2. **Gypsum Board**
3. Gypsum Panel
4. Sheet Rock
5. Drywall

Terms and Abbreviations

Examples

What do you think is the preferred abbreviation for hardware?

1. hdwr
2. Hdwr.
3. HDW.
4. hdw.
5. HDW

Terms and Abbreviations

Examples

Preferred abbreviation :

1. hdwr
2. Hdwr.
3. HDW.
4. hdw.
5. **HDW**

Symbols

For organizational purposes, symbols are classified by type:

- Reference Symbols
- Line Symbols
- Identity Symbols
- Object Symbols
- Material Symbols
- Text Symbols

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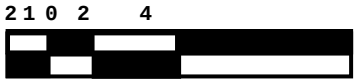
MODULE 06

Symbols

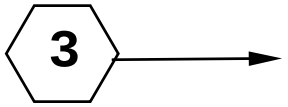
Reference Symbols

refer reader to another part of the document

Examples:



Graphic Scales

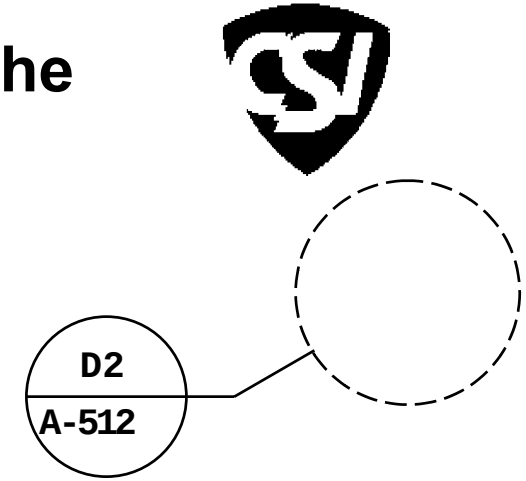


Sheet Keynote

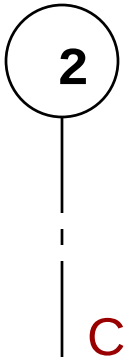
VESTIBULE

101

Room Identifier



Detail Indicator



Column Grid Indicator

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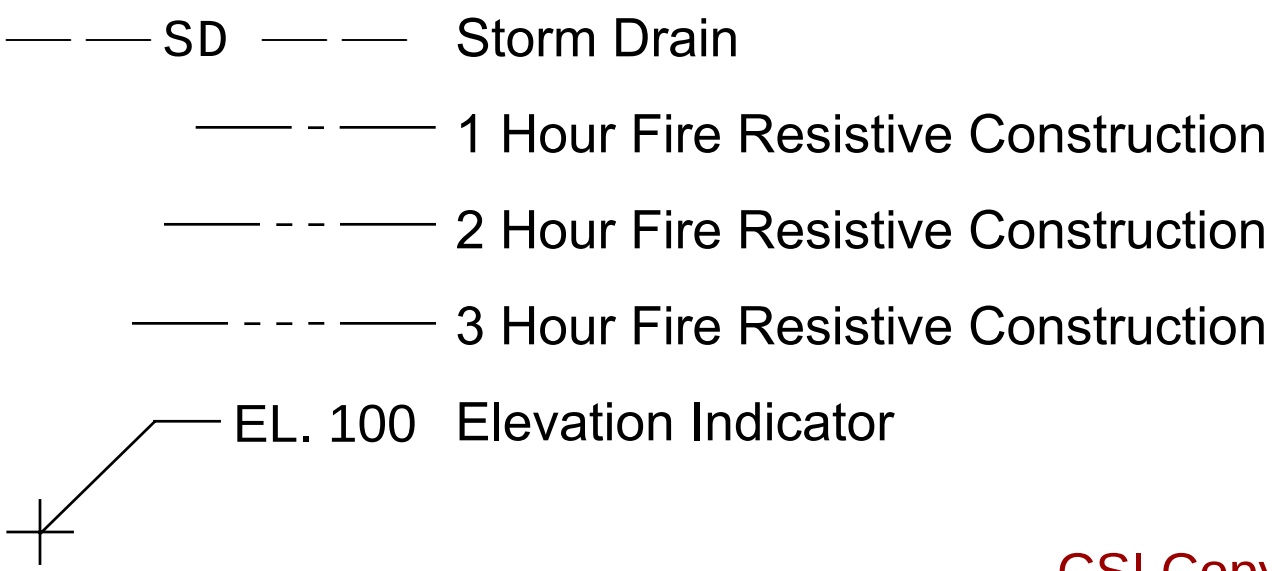
MODULE 06

Symbols

Line Symbols

continuous objects indicated using a particular line type

Examples:



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MODULE 06

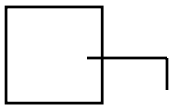
Symbols

Identity Symbols

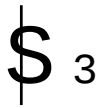
abstract representations of objects

Examples:

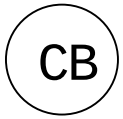
Exhaust Roof Vent Fan



Disconnect Switch



Three Way Switch



Round Catch Basin

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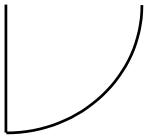
MODULE 06

Symbols

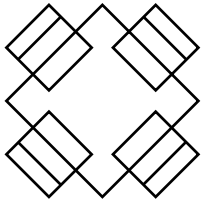
Object Symbols

scaled views of an object

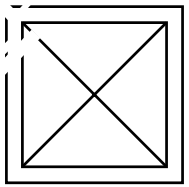
Examples:



Left Single Hinged Door



42” Square Table
w/ Armless Chairs



Shower Stall

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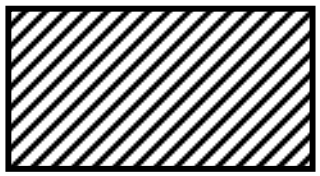
MODULE 06

Symbols

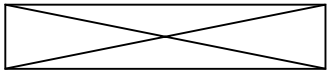
Material Symbols

portray a material graphically in plan, elevation, or section

Examples:

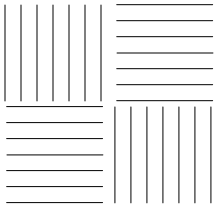


Brick



Continuous Wood Framing

Finish Wood



Earth

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MODULE 06

Symbols

Text Symbols

graphically indicates a word or words

Examples:

Foot (Feet)	‘
Inch (Inches)	“
And	&
At	@

Notations

General Notes

Notes that do not correspond directly to a graphic representation and are not directly “linked” to other drawings or specifications.

Three Types of General Notes:

- General Notes
- General Discipline Notes
- General Sheet Notes

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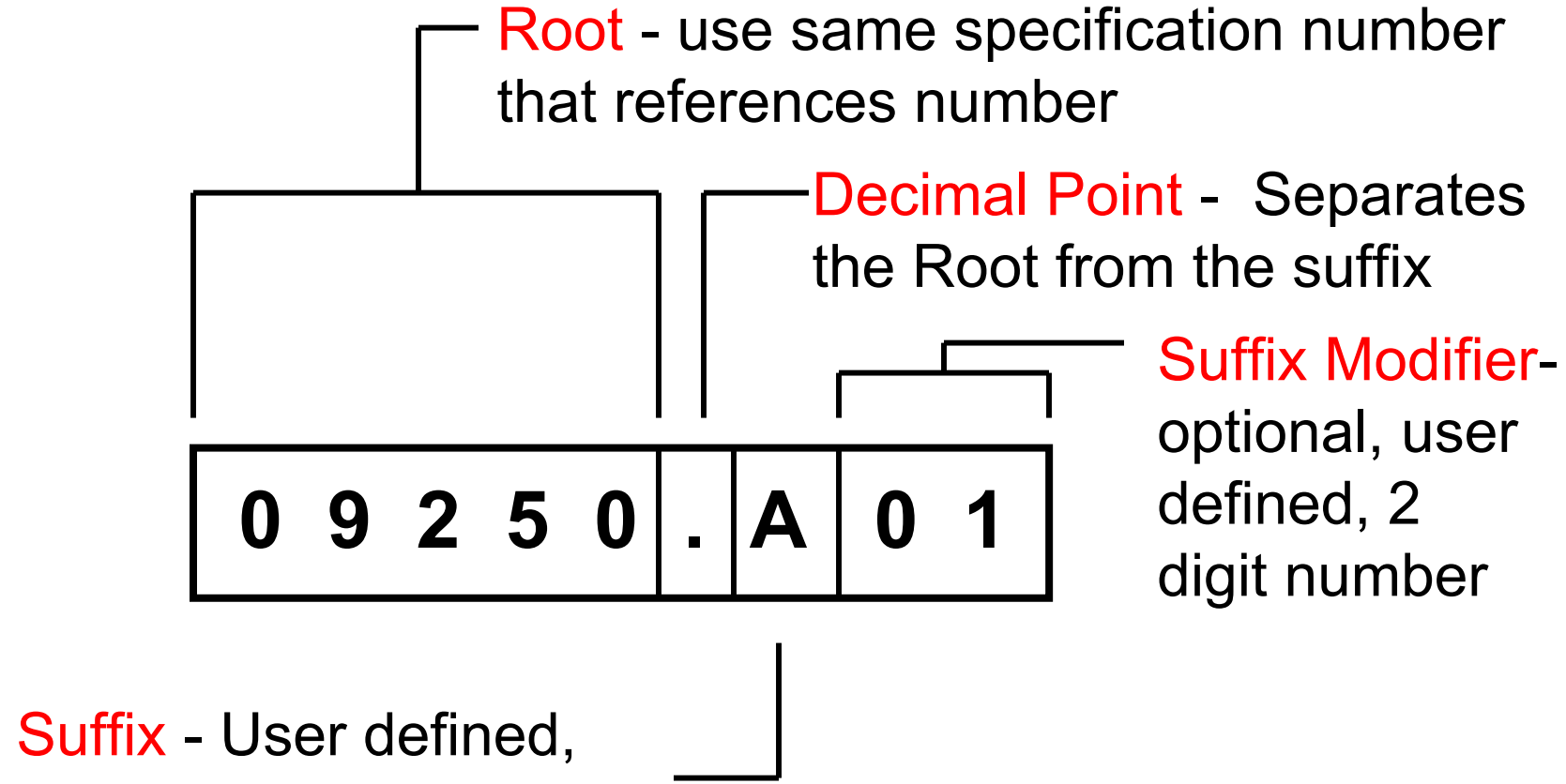
MODULE 07

Notations

Reference Keynotes



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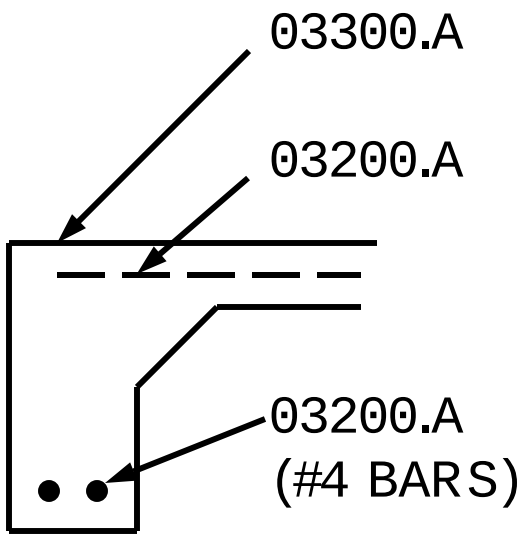
MODULE 07

Notations



REFERENCE KEYNOTES

DIVISION 3 - CONCRETE

03200.A REINFORCING STEEL
03200.B WELDED WIRE MESH
03300.A CAST-IN-PLACE CONCRETE

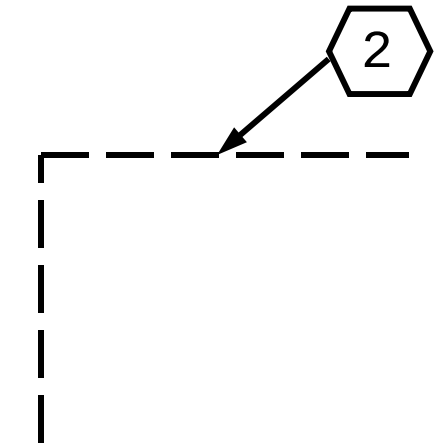
Reference Keynotes in Drawing Block

Reference Keynotes in Note Block

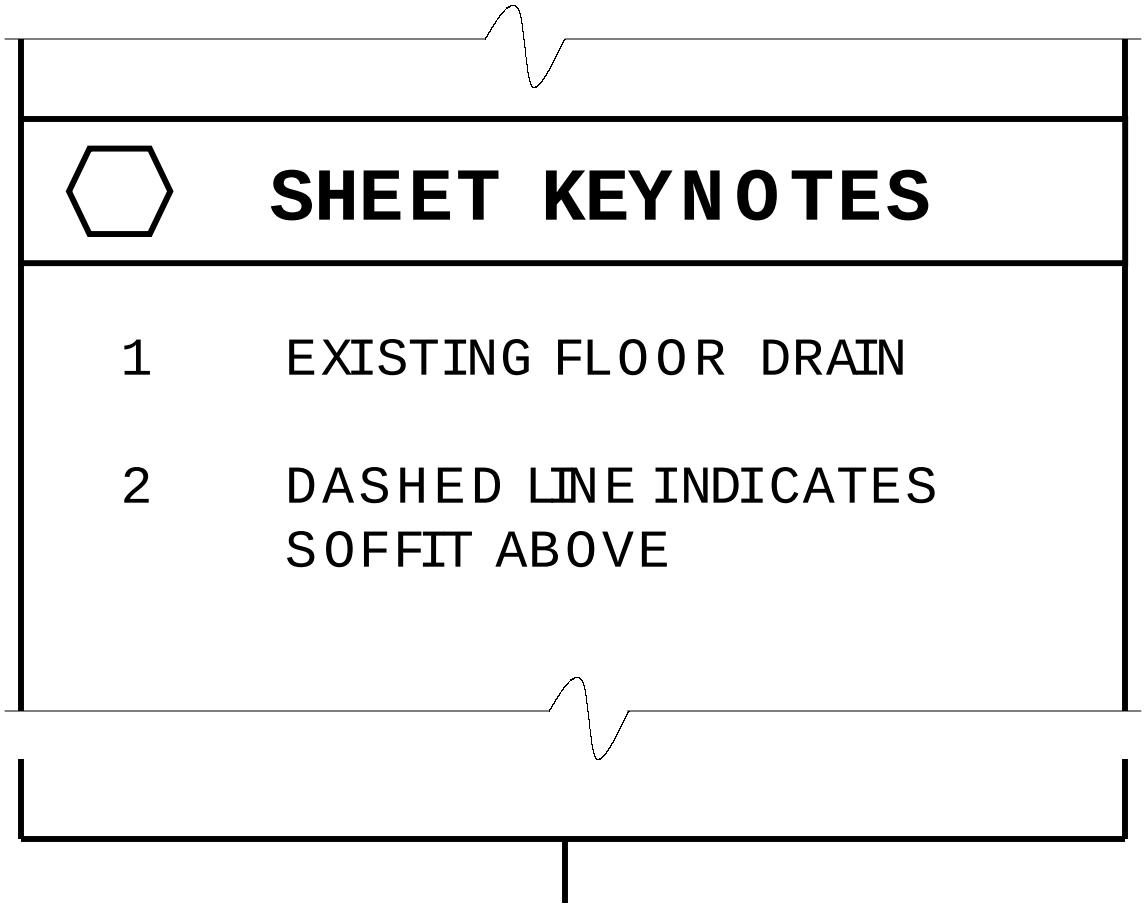
National Institute of BUILDING SCIENCES

MODULE 07

Notations



Sheet Keynotes in Drawing Block



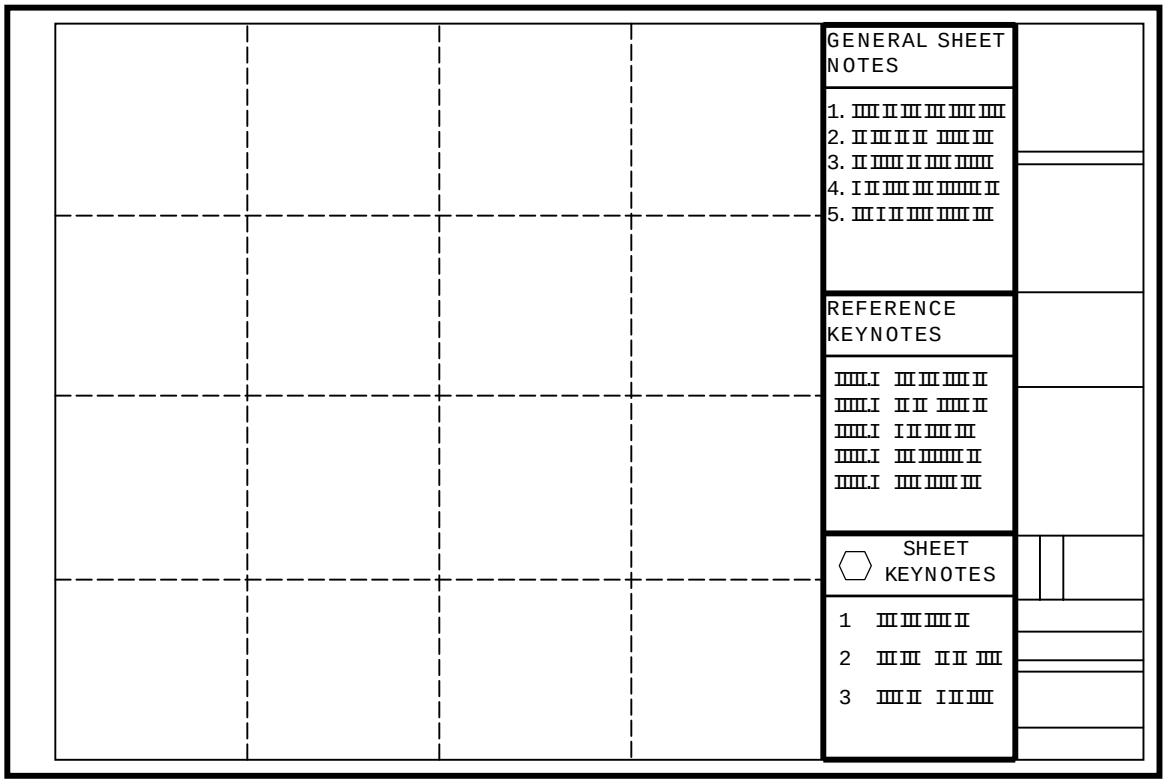
Sheet Keynotes in Note Block

National Institute of BUILDING SCIENCES

MODULE 07

Notations

Sheet Keynotes



Order of Sequence:

General Notes

Reference Notes

Sheet Keynotes

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MODULE
08

Code Conventions

Code Conventions Module

Objectives:

- identify the information necessary for code research during design.
- identify the type and location of regulatory information to appear on the drawings.
- provide standard graphics for regulatory information to appear on drawings.
- facilitate and expedite building permit (plan review) application process.

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MODULE
08

Code Conventions

Code Conventions Module

Content (1):

Overview of regulatory information

- **Historical overview**
- **Model codes (UBC, BOCA, SBCCI, ICC)**
- **Reference standards (ANSI, NFPA, ASTM)**
- **State/local codes and amendments**
- **Federal regulations (ADA, CPSC, EPA)**
- **Zoning ordinances and zoning codes**

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MODULE 08

Code Conventions

Code Conventions Module

Content (2):

Identification of regulatory information in the construction documents

The plan review process

Code Conventions Module

Other features:

- Use as a checklist during the design and review process
- Assist in updating, tracking, & implementing code-related decisions in the design process
- Instructional tool for professionals and students
- Documents created can serve as facility management tool to understand code issues for renovating, remodeling, or adding on to the building

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Final Poll:

As a result of this presentation, are you more or less inclined to consider adopting the U.S. National CAD Standard?

1. More inclined.
2. Less inclined.
3. Unchanged or unsure.

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Final Questions?

The American Institute of Architects

The U.S. CADD/GIS Technology Center

The Construction Specifications Institute