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Expenditure Efficiency & Projects Authority

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CAD Standards Procedure

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1.0 PURPOSE

The purpose of this document is to provide instruction for creating, sharing, reusing and managing 2D/3D CAD files on Entity's projects and providing a base for documenting future change. All personnel working with automation technology as set forth in this document are responsible for ensuring these standards are implemented. Entity employing use of the Building Information Management (BIM) on its projects shall set up BIM to be in line with this CAD procedure.

2.0 SCOPE

The processes and instructions established herein apply to the design of Entity's projects. This procedure shall apply to 2D/3D CAD deliverables and it does not exempt construction contractors, sub-contractors, suppliers, consultants, etc. produced 2D/3D CAD generated deliverables / Data from following this Procedure.

3.0 DEFINITIONS AND ABBREVIATIONS

Refer to document EPM-KE0-GL-000011 – Definitions and References for the definitions of general terms used in this document. Following are additional terms used in this document.

Definitions	Description
Attributes	Information attributed to a document to aid its retrieval from a repository-sometimes also referred to as metadata.
Annotation	The notes and dimensions clarifying the information contained within the drawing. For example, labels, leaders, notes or dimensions are all annotation.
Arrangement File	A CAD file which collects model files together into pre-determined graphical compositions relating to parts of the works.
As-Built Drawings	As-Built drawings incorporate all revisions, field changes and as-built surveys that occur during the construction phase of the work.
BIM	Building Information Model(ing) VERB: A cross-functional collaborative process of creating, collecting & managing information to virtually design, procure, schedule, construct, commission, start-up and operate a facility. BIM therefore develops a digital representation of the physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward NOUN: The collection of files and databases used in building the information model of the facility
BOQ	Bill of Quantities
Border	Frame around finished drawing containing drawing titles, revisions, notes and company information
CAD	Acronym for Computer Aided Design or Computer Aided Drafting. Computer Aided Drafting is the term to describe the base functionality of computer drafting software, e.g. to draw lines, arcs and text
Design Drawings	Design Drawings are those drawings that are not ready for construction use.
Contract Drawings	Contract Drawings are those drawings intended for construction.
ECMS	Electronic Content Management System
Engineering sketches	An Engineering sketch is a drawing used to establish design concepts and requirements and does not require the full approval and control procedures of design drawings that are to be issued for fabrication or construction; therefore, sketches shall never be used for fabrication or construction purposes. Sketches shall be provided in standard drawing format, complete with title block and sketch numbers assigned.
Project Drawings	Engineering Sketches, Design / Contract Drawings and As-Built Drawings.
Shop Drawings	The drawings submitted by a contractor, depicting the construction/ fabrication details of elements, and which are upon approval, used for the actual work on site.
Title block	Standard drawing title and number information contained inside the border

4.0 REFERENCES

1. EPM-KR0-PR-000001 - Project Document Management Procedure
2. EPM- KR0-PR-000002 - Project Standard Document Numbering Procedure
3. EPM- KR0-PR-000001 - Entity Standard Document Numbering Procedure
4. EPM-KE0-GL-000018 - Standard Drawing Template Guide
5. EPM-KED-GL-000001 – Graphical Blocks and Symbols Guide

5.0 PROJECT COORDINATE SYSTEM

5.1 Units

Working units for bSuildings are in Millimeters. Working units for Civil works are in Meters. All CAD model space data is to be drawn at Full Size (1:1).

5.2 Accuracy

All data shall be generated using precision input employing the most accurate source material available. For all graphic entities zero tolerance is required, all lines meet at intersections, straight lines are straight, blocks are inserted properly without overlap, etc.

5.3 Project Grid

The project grid will have a pre-defined origin that ensures that all grid coordinates on the project are positive. The project grid will be defined with a North/South axis.

Generally, it is best when all data (both 3D and 2D plan data) is to be placed at the true coordinate location on the Project Grid. This has many benefits for engineering, construction and survey departments. However, BIM file performance and accuracy of details is significantly improved when closer to XY axis of 0,0. BIM Source files and Drawing Product files extracted from BIM and other source file attachments shall follow the Architectural Base Point on the Project Grid. Survey and Civil Source files should be generated in real world location on the Project Grid.

Figure 5.3.A below illustrates the four factors in producing geospatially correct data based on the project grid; Origin, Orientation, Location and Units.

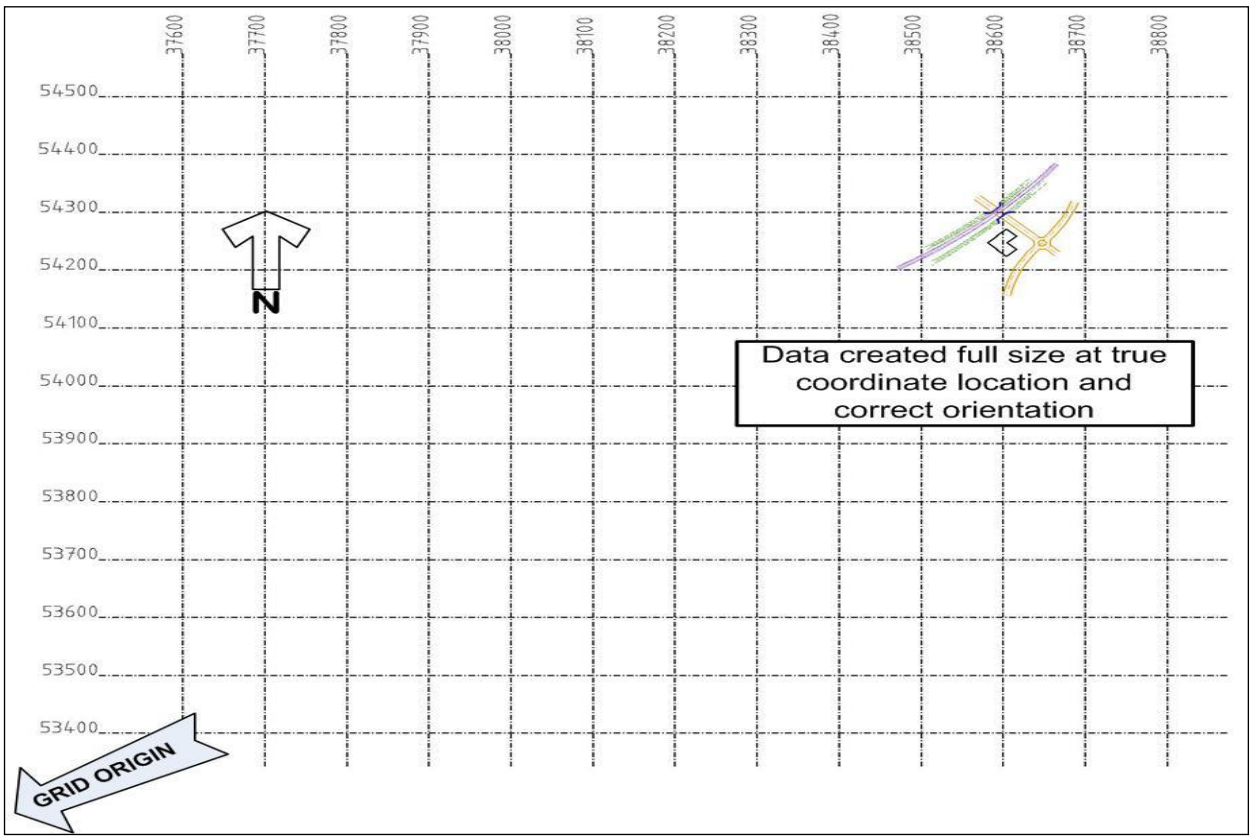


Figure 5.3.A – Definition of the Project Grid

5.4 Local Building or Structural Grids

Since all data must be positioned such that its coordinates are correctly aligned with the project grid, all elements, structures and buildings on the project will be placed at an angle to that project grid (unless by extreme coincidence or by design). Where these structures or buildings require a local structural grid for design, set out or coordination purposes (e.g. a column grid), which needs to be aligned with the structure or building rather than to true north, this can be defined in the normal way, with grid lines and references.

Dimensions may be given from the gridlines. However, a local grid origin is not to be defined, i.e. coordinates must not be given in terms of their relationship to the notional origin of the structural grid. Where coordinates of elements or of building grid intersections are given, they must be expressed in terms of the project grid (see Figure 5.4.A - Project Grid Coordinates).

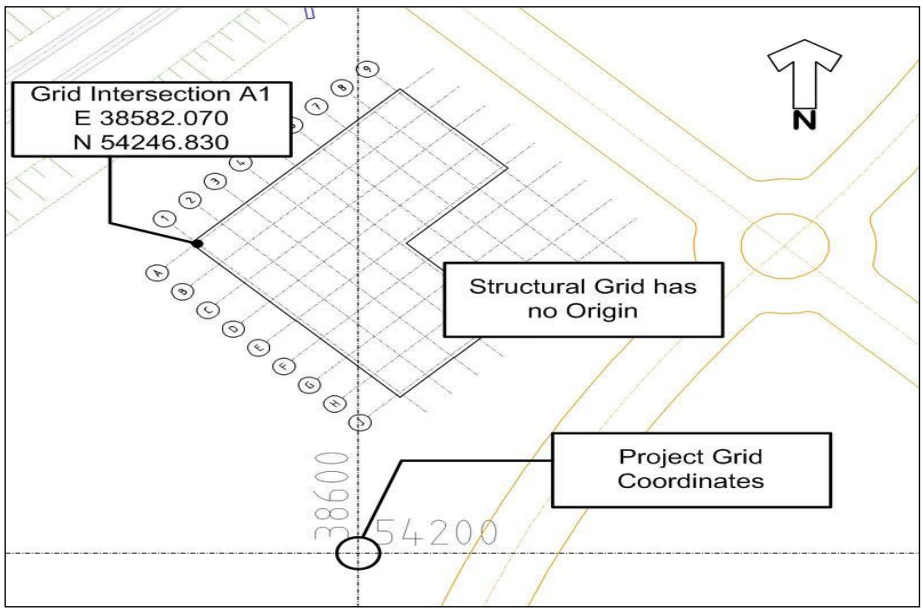


Figure 5.4.A – Project Grid Coordinates

6.0 REQUIREMENTS

6.1 CAD Standards

6.1.1 General

All drawings shall comply with required presentation, format, and nomenclature as set forth in this manual. All discipline plans concerning a common work area should be at the same scale and north orientation, and should use the same match lines consistently overall plan levels.

The intent of these CAD Guidelines is to assure that all Project Drawings are accurate, have a uniform appearance, reflect high quality workmanship, avoid complications due to differing drafting styles and CAD software, and to ensure delivery of consistent digital Plans and other contractually required electronic data submittals.

A/E shall follow these guidelines to ensure that the design output is of a consistent high quality, no matter who within their organization produced a drawing.

Entity shall define the 2D/3D CAD requirements for its projects in the RFP and furnish the procedure/template to the A/E-EPC contractors during the initial phase of design so that the Contractors can consider these requirements in their proposals/execution plans.

Although this CAD procedure is primarily designed for use on computer-generated drawings, the symbols and line types shall also be used on manually drawn plans, if the need arises, to maintain consistency.

6.2 Drawing Sheet Organization

6.2.1 Drawing Sizes

The various paper sizes and their suggested typical use are provided for reference in Table 6.2.A. Entity to define for A/E paper sizes to be used for the hard copy submittals.

ISO		Architectural		Typical Use
#	Size mm (inches)	#	Size mm (inches)	
A3	297 x 420 (11.7 x 16.5)	**B**	305 x 457 (12 x 18)	Reduced Drawings from A1 originals. Supplemental Drawings, Mock-up Sheets.
A1	594 x 841 (23.4 x 33.1)	**D**	610 x 914 (24 x 36)	Projects accommodating preferred plan scale.
A0	841 x 1189 (33.1 x 46.8)	**E**	914 x 1219 (36 x 48)	Large projects accommodating preferred scale. Mapping and GIS.

Table 6.2.A – Sheet Sizes

See Figure 6.2.A - Effective Sheet Size and Table 6.2.B - Effective Sheet Sizes with metric scales. All Design/Contract Drawings shall be A0 or A1 or as directed by the Entity.

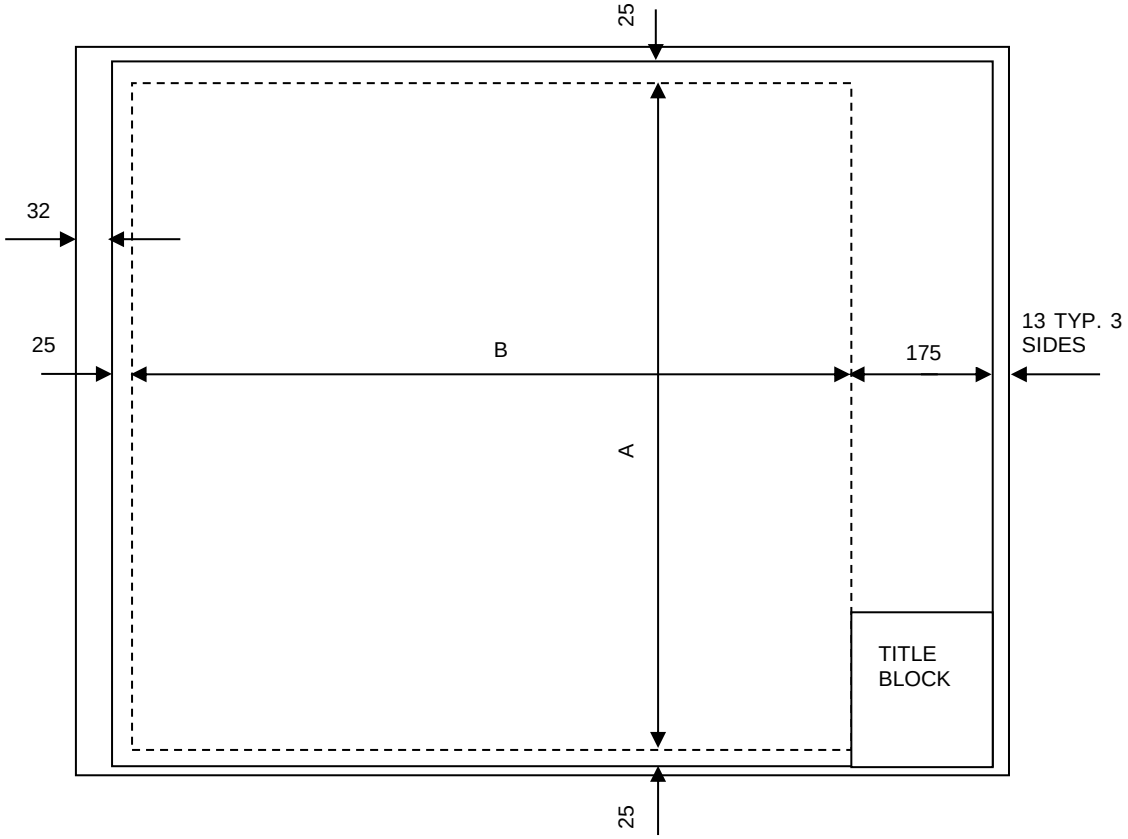


Figure 6.2.A – Effective Sheet Size
(all dimensions in mm)

SCALE	Effective Drawing Space (In Meters)	
	A	B
1 : 50000	38250	47200
1 : 25000	19125	23600
1 : 5000	3825	4720
1 : 2000	1530	1888
1 : 1000	765	944
1 : 500	383	472
1 : 100	77	94
1:75	57	71
1 : 50	38	47

Table 6.2.B – Effective Sheet Sizes: 787.5 x 887.5 (A x B)

6.2.2 Scale

Careful consideration should be given when selecting a scale. Refer to General Contract Requirements for mandated scales. Factors affecting a selection are as follows:

- Communication of the information for the work to be carried out.
- Economy of effort and time in preparation
- Maintaining the standard sheet size
- Client Requirements.

Within a CAD system it is simple to produce drawings at different scales showing the same graphics or data. Particular care should be taken to avoid this unless the larger scale drawings are clearly showing or conveying additional information.

The following drawing scales (compliant with ISO 5455) are to be used:

1:1	1:2	1:5
1:10	1:20	1:50
1:100	1:200	1:500
1:1000	1:250	1:5000
1:10000	1:2000	1:50000
1:100000	1:20000	1:500000
NOT TO SCALE	1:200000	AS SHOWN

Table 6.2.C – Drawing Scales

The scale used is dependent on the level of detail required. The scale should remain constant throughout the plans. The basic scale used on each drawing shall be noted in the Title Block of the drawing file. A graphic scale will be shown on Plan Sheets under each Profile Segment identified on the Plan sheet. Where various scales are used, graphic scales will be shown by notation directly below each section and detail callout, with the words ‘AS SHOWN’ entered in the title block. If an elevation, section, or detail is shown schematically and it is not intended to specify the scale, the view shall be noted “NTS” under its title or in the case of an entire drawing not drawn to scale, “NTS” shall be shown in the Scale Box.

If the vertical scale is different from the horizontal scale that is used in the same drawing, both scales shall be shown numerically, with each followed by either the letter “H” or “V”.

Examples: 1:50 H; 1:100 V

6.2.3 Key Plans

Key plans, if required, shall be drawn in a simple identifiable form so that it is readable when reduced. Key plans are to be the same orientation as the plan view and shading or cross-hatching shall reflect the same area as shown on the plan view. Key plans should be simple blocks showing graphically the site area and work within that site. Key plans shall not contain external references to site plans or other CAD files.

Key plan sheets will follow the coversheet of each submittal package when required. Key plans shall be omitted from drawings showing only details and sections.

6.2.4 Drawing Orientation

Every Plan sheet shall include a North arrow in the sheet space of the drawing. When possible, drawings shall be orientated such that the North Arrow points to the top of the drawing sheet.

Ideally building floor plans should be shown on one sheet. If they cannot fit on one sheet, the floor plan should be subdivided into convenient segments with match lines provided to show a continuation in the drawings. The sides of buildings should be drawn and shown parallel to the sheet edge. See Figure 6.2.B - Drawing Orientation.

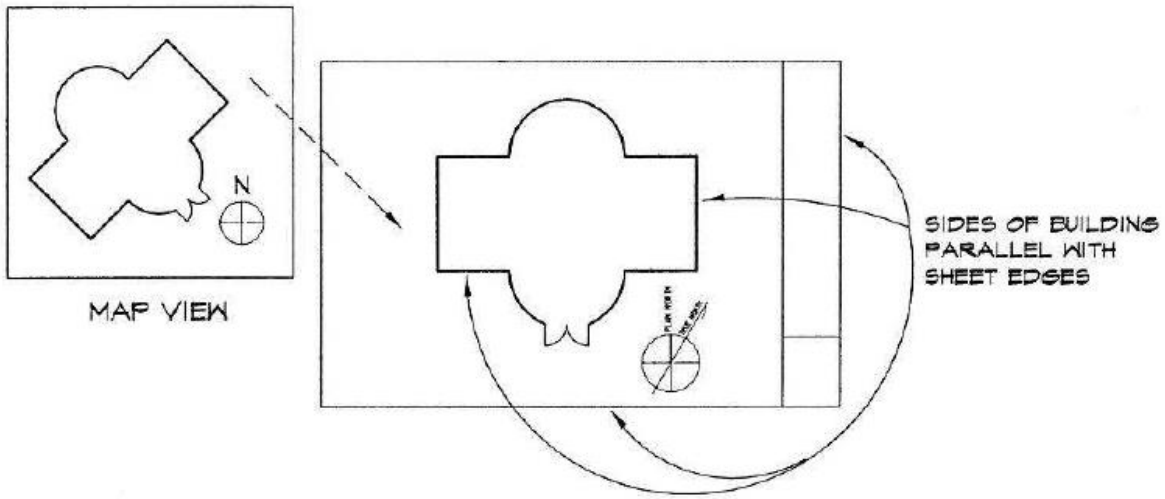


Figure 6.2.B – Drawing Orientation

Display throughout the drawing set must stay consistent. For example, a column plan detail should be shown in the same orientation as it is shown on the floor plan. See Figure 6.2.C - Drawing Orientation.

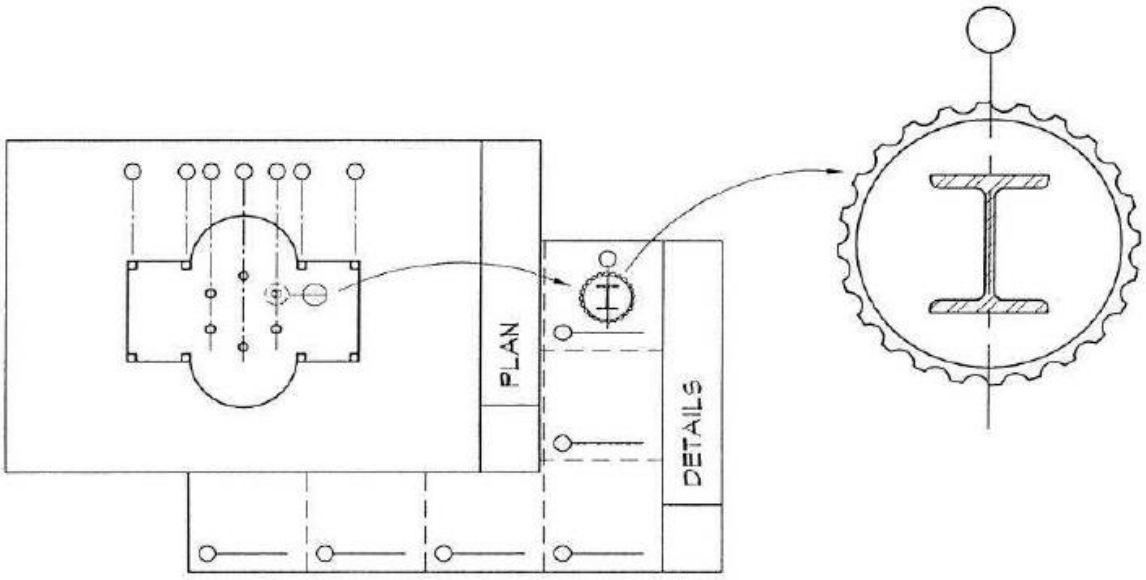


Figure 6.2.C – Drawing Orientation

Civil plans may orient the drawing in a manner that will allow the site plan to fit within the sheet boundary at the appropriate scale. Orient the site plan in the same manner as the floor plans whenever possible.

Alignment and Highway drawings shall be oriented so that the baseline stationing/ chainage shall progress from right to left across the sheet and based off established coordinate values. Plan sheets shall be oriented to match the alignment.

6.2.5 Drawing Borders

Standard project approved border(s) will be used for all project deliverables and are inserted into Discipline template files. Refer to EPM-KE0-GL-000018 - Standard Drawing Template Guide.

6.2.6 Reference Grid

Reference Grids, Structural Grids, etc., shall be consistently laid out. See Figure 6.2.D.
Vertical Grid Lines shall be labeled at the top, with numeric references reading from left to right.
Horizontal Grid Lines shall be labeled on the left, with alphabetic references reading from bottom to top.

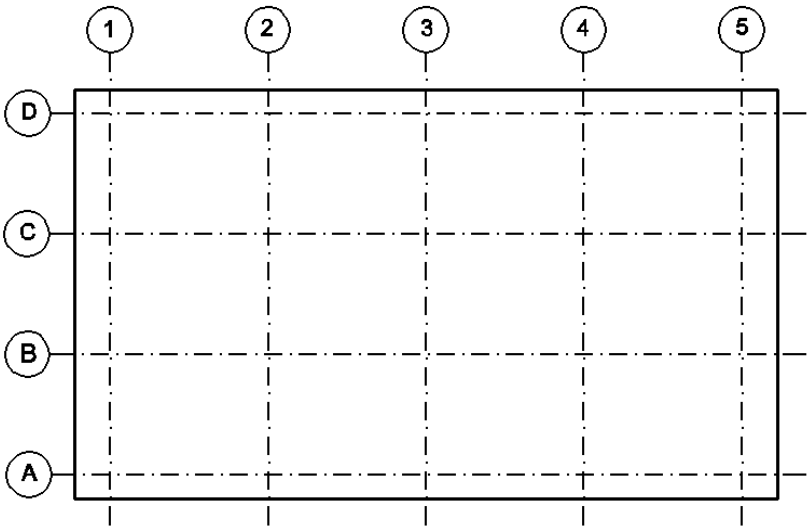


Figure 6.2.D – Column Grid Layout

6.3 Drawing Frame and Title Block Information

The following information is shown in the Title Block Area of the Drawing Frame:

- Sheet Identification Block
- The Sheet Identification block includes:
    - Project Reference (Entity Project Identification)
    - Scale and graphic scale
    - Drawing Number (Indicates Site Code, Author Code, Discipline and Sub-Discipline
    - Code, Coverage Area and Sequence)
    - Sheet Title (4-lines)
- Main-Title - Building and/or Area.
- Title1 - Floor or Zone. Refer to CAD Data Standards.
- Title2 - Sheet File (drawing) description, and / or Sheets in group (i.e. Sheet 2 of 4).
- Title3 - Sheet File (drawing) description, continued, and / or Station Boundary (i.e. STA 635+00 to STA 675+00,
- Sheet - Sheets in group (i.e. Sheet 2 of 4).
- Project Logo Block contains
    - EXPRO logo: to be replaced by Entity logo OR Entity logo together with PMC logo as determined by the Entity
    - A/E logo to be placed in space called Contractor Logo
- Issue / Revision Block
- The Issue / Revision Block consist of:
    - Version / Revision identifier - alpha/numeric
    - Issue date (this is the scheduled submittal date). Date format will follow as generated in the Plot Information Area DD/MMM/YY.
    - Reason for Issue. Whenever possible, revision description entries should be selected from pick list options if available in a data source such as ProjectWise. Otherwise, standard revision descriptions shall be provided by the project. Sample Revision Descriptions examples are:

ISSUED FOR APPROVAL
ISSUED FOR ACTION
ISSUED FOR CONSTRUCTION
ISSUED FOR REVIEW
ISSUED FOR INFORMATION
ISSUED FOR PURCHASE
ISSUED FOR QUOTATION
ISSUED FOR DESIGN
ISSUED FOR ESTIMATING
ISSUED FOR USE
ISSUED FOR HANDOVER
ISSUED FOR TENDER
INCORPORATED FCD# XXX & ISSUED FOR CONSTRUCTION
ADDRESSED FCD# XXX & ISSUED FOR CONSTRUCTION

    - Signature fields for originator of submitted document, checker of the submitted document, Supervisor approval and engineering approver (2-characters)
- Originator Block signature fields

The Originator Block includes history information for drawing originators - **Drawn** and **Designed** fields (engineer) , **Checked** (Design Group Project Engineer), **Reviewed** (Design Group Project Manager) and approvers –**Submitted** and **Approved** fields (for approvers such as Engineering Manager or Chief Engineer).

Date format DD/MMM/YYYY. The month shall be abbreviated to three letters as follows:

JAN	January
FEB	February
MAR	March
APR	April
MAY	May
JUN	June
JUL	July
AUG	August
SEP	September
OCT	October
NOV	November
DEC	December

Figure 6.3.A – Month Display Format

Refer to Attachment 1 for Drawing Title Block sample of A1 Border.

6.4 Drawing Settings

The typical settings in Table 6.4.A below will be used in all drawings. If files are not received from the A/E and/or EPC Contractor in the following format, final close out of the project and final payment will be delayed until the A/E or EPC Contractor has made the modifications to the files.

MENU	ACAD
VIEWRES	500
BLIPMODE period be	Off (Note period before command)
UCSICON	Off
COORDS	On (1)
GRIDMODE	Off (0)
SNAPMODE	Off (0)
COLOR	By Layer
LINETYPE	By Layer
UNITS	Decimal <MILLIMETRES> <NORTH> Direction for angle 0.00 (12 o'clock) Clockwise Box Checked On for Angles measured clockwise
AUPREC	Value = 3
LUPREC	Value = 3
PDMODE	Value = 1

TABLE 6.4.A: TYPICAL DRAWING SETTINGS

6.5 Components

- All components are to be stored in the file as objects (Blocks in AutoCAD), wherever practical in order to facilitate quantity take-offs and efficient revision. All such components are to exist on the same layer. Components in Revit modeling applications utilize BOQ features as Blocks do not exist. Entity to generate project instructions regarding the BIM Revit Modeling interface and AutoCAD differences and how its project will meet the Entity's criteria using both applications.

- Drawings created using non-standard fonts, line types and hatch patterns could result in content discrepancies in the delivered drawing set. To ensure the integrity of the drawing set, and minimize potential problems:
    - Entity to provide appropriate metric AutoCAD specific template files.
    - Use only Linetypes file: acadiso.lin
    - Use only Hatch file: acadiso.pat
    - Only native fonts, line types and hatch patterns installed as standard features during software installation and as provided within the Entity template files shall be used.
    - Custom fonts, line types and hatch patterns, including those provided by third party software shall not be used.

6.6 Graphics

- Project Drawings for all disciplines shall adhere to the following:
    - The United States National CAD Standard (NCS) which is comprised of the American Institute of Architects' (AIA) CAD Layer guidelines, the Construction Specification Institute's Uniform Drawing System (Modules 1-8), and the National Institute of Building Sciences Plotting Guidelines.
    - Saudi Arabian Standards Organization (SASO), Standards Nos. 16 and 17.
    - The International System of Units (SI).
- Line Styles, Weight, Color
    - All graphics shall be placed with ByLayer Symbology. That is to say that every layer has an associated Line Style, Weight and Color associated with it and in no case shall the ByLayer Symbology be disabled. When placing elements, instead of assigning a color, style, or weight, the user can assign the attribute ByLayer. This forces the element to adopt the color, style, and weight of the layer on which it is placed. ByLayer is a setting that takes the place of giving an element any specific color, style, or weight. It allows the symbology of the element to be dynamic.
- Use of Color, Hatching and Shading
- Where information on a drawing is to be conveyed by the use of hatching, grayscale shading or color, consideration must be given to the following before a decision is taken as to which method to use.
    - The ability of differing plotting devices to reproduce the hatch, shade or color
    - The likelihood of deterioration of shading or color through multiple copying of the document.
    - The cost of color reproduction
    - The requirement for recipients of the documents to acquire color plotting or printing Devices
    - Unless specifically required for presentations, all plots for construction are to be generated in black and white with use of grayscale entities as defined in the layer standards.

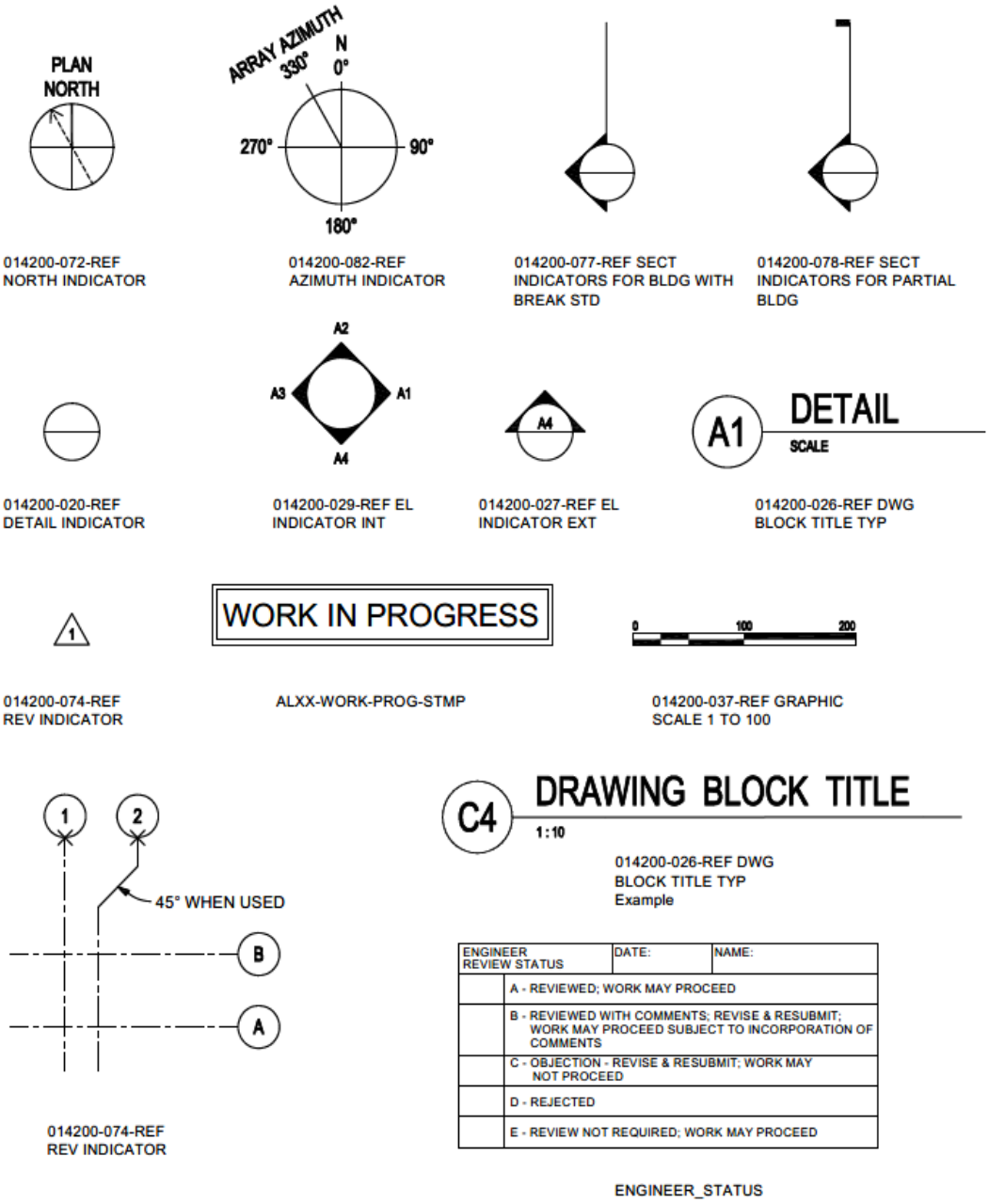
Project specific procedures should be consulted, and given these considerations, it is recommended wherever possible, only mono-hatching shall be used. Keep in mind that extensive use of hatching within CAD files will impact file performance.

- Symbols and Material Indications

All drawing symbols and material indications (hatching, etc.) must conform to the industry standard conventions pertaining to the discipline

- Graphical Blocks

CAD Templates have symbols common throughout all disciplines embedded within such as the following symbols shown below and in addition there are symbols specific to the engineering discipline. Symbols shall be used from the templates where they are available to promote consistency throughout the Entity drawings.



014200-072-REF NORTH INDICATOR

014200-082-REF AZIMUTH INDICATOR

014200-077-REF SECT INDICATORS FOR BLDG WITH BREAK STD

014200-078-REF SECT INDICATORS FOR PARTIAL BLDG

014200-020-REF DETAIL INDICATOR

014200-029-REF EL INDICATOR INT

014200-027-REF EL INDICATOR EXT

014200-026-REF DWG BLOCK TITLE TYP

014200-074-REF REV INDICATOR

ALXX-WORK-PROG-STMP

014200-037-REF GRAPHIC SCALE 1 TO 100

014200-074-REF REV INDICATOR

014200-026-REF DWG BLOCK TITLE TYP Example

ENGINEER_STATUS

TABLE 6.6.A: SAMPLE GRAPHICAL BLOCKS

Refer to EPM-KED-GL-000001 - Graphical Blocks and Symbols Guide for blocks available in the standard templates.

6.7 CAD Layers

CAD files are the basic package containing graphic information whereas layers are the principle means of categorizing the graphic data within those CAD files. The Entity CAD Layer Standard is based on the US National CAD Standard (NCS) Version 6, conforming to ISO 13567 international Computer-aided design (CAD) layer standard. Additional layers to the NCS layers have been added by the Entity.

The CAD Layer naming format is organized as a hierarchy and consists of distinct data fields separated from one another by dashes. A detailed list of abbreviations, or field codes, is prescribed to define the content of layers. Most field codes are mnemonic English abbreviations of construction terminology that are easy to remember. This legibility is particularly important when CAD files are distributed amongst different project designers and stakeholders.

The layer name convention is comprised of four fields separated by dashes. Fields are shown in Layer Naming Format example below.

CAD files must be constructed in a predictable manner to maintain information that can be reused with minimum effort. Standardization allows the greatest amount of reuse of information at the least cost. This section describes the rules for naming layers of data within CAD files.

Layer Libraries that are robust and controlled by Library Templates and are necessary to enable the Entity plotting configurations, and to control layer display/symbology throughout the reference structure. When NEW layers/levels are required, the Entity to define a) layer name, b) description, and c) desired thickness.

Discipline			Building System / Elements					Element Specification					Element Presentation			
X	X	-	X	X	X	X	-	X	X	X	X	-	X	X	X	X

TABLE 6.7.A: LAYER NAMING FORMAT

Disciplines are the primary method of classification for layer names. The discipline designation code provides a path back to the originator of the data and provides a logical categorization of CAD information. The discipline code is intended primarily to identify the author of the graphic information. Thus, a structural column placed by an architect would be AR-COLS rather than ST-COLS. The existence of both sets of information can in fact indicate the need for coordination. This accommodates the use of “IR” as a discipline code, allowing doors and walls to be recognized in both the Architectural and the Interiors disciplines.
The following list depicts samples from each discipline but is not comprehensive. Refer to the individual AutoCAD discipline templates for a full listing of layers:

AR-ARAT-COLS-CLDG	Architectural-Column Cladding
AR-ARAT-SLAB-ELVE	Architectural-Slab Elevation
AR-ARAT-SLAB-MVJN	Architectural-Movement Joint
AR-ARAT-WALL-PATT	Architectural-Structural Walls-pattern
AR-ARCH-DETA	Architectural-Roof
AR-ARCH-DETL	Architectural-Roof
AR-ARCH-PANL-MFAC	Architectural-Walls-Gypsum
CV-BEAM-CONC	Beams: concrete
CV-BEAM-CONCV-HIDD	Beams: concrete <Hidden>
CV-BEAM-HIDD	Beam Hidden
CV-BEAM-LINE	Beams Line
CV-BEAM-MRKD	Beam Marking
CV-BRDG	Road-Bridge Deck
CV-CLMN	Column
EL-LITE-CIRC-CBSX	Electrical-Sound/PA System-Circuits

EL-LITE-CIRC-CMXX	Electrical-Sound/PA System-Circuits
EL-LPFE-BCTF-1XXX	Bare copper tape Fuse 1
EL-LPFE-BCTF-2XXX	Bare copper tape Fuse 2
EL-MCXX-VAVX	Mechanical-VAV System-Supply Ductwork-Equipment
EL-POWR-BSBR	Electrical-busbar trunking
EL-POWR-CLNG-EMBD	Electrical-Power Circuit Numbers
FP-ANNO-NOTE	Annotation: Notes
FP-ANNO-NOTE-ALTE	Annotation: Notes Alternate
FP-ANNO-NPLT	Annotation: Non-Plotting Graphic Information
FP-ANNO-SCHD	Annotation: Schedules
FP-ANNO-SYMB	Fire Protection-Fire Alarm Symbols
MC-CWTR-RETN-HIDD	Mechanical-Chiller Water Systems-Return-Hidden Lines
MC-CWTR-RETN-INSU	Mechanical-Chiller Water Systems-Return-Insulation
MC-CWTR-RETN-PIPE	Mechanical-Chiller Water Systems-Return-Piping
MC-CWTR-RETN-RISR	Mechanical-Chiller Water Systems-Return-Risers
MC-CWTR-RETN-SKCH	Mechanical-Chiller Water Systems-Return-Sketch
MC-CWTR-SUPP	Mechanical-Chiller Water Systems-Supply

TABLE 6.7.A: SAMPLE LAYERS

6.8 Annotation Parameters

The first several layers of the sheet file are similar for every discipline, with the exception that the discipline designator changes depending on the discipline for that Layer type. The unique function of these annotation layers is to contain sheet specific information. A sample of these layers are as follows:

Note: With ** representing a discipline designator, refer to the Layer manager within the CAD file for the complete list of Layers. See Table 6.8.A - Annotation Layers.

Name	Description
**-ANNO-CTLN	Center Lines
**-ANNO-DIMS	Dimensions
**-ANNO-DIMS-ALT	Dimensions for Full scale drawings Alternate
**-ANNO-LABL	Labels, drawing & detail tiles, table headers
**-ANNO-LABL-ALT	Labels, drawing & detail tiles Alternate
**-ANNO-LEGN	Legends, symbol keys
**-ANNO-MARK	Markers, and break marks
**-ANNO-MATC	Match lines
**-ANNO-MATC-ALT	Match lines Alternate
**-ANNO-MATC-TEXT	Match lines text
**-ANNO-NOTE	Multileader and Sheet specific general notes
**-ANNO-NOTE-ALT	Notes for Full scale drawings Alternate
**-ANNO-NPLT	Non-plotting graphic information (Defpoint)
**-ANNO-RDME	Read-me layer (not plotted)
**-ANNO-REFR	Reference, external files
**-ANNO-SCHD	Schedule & Table lines
**-ANNO-SYMB	Architectural Annotation Symbols
**-ANNO-SYMB-ALT	Architectural Annotation Symbols Alternate
**-ANNO TABL	Data tables
**-ANNO-TEXT	Text
**-ANNO-TEXT-ALT	Text for Full scale drawings Alternate

Table 6.8.A – Annotation Layers

All text placed in the design file shall be placed on the correct layer for its intended purpose and shall not overlap other text.

Annotation is NOT permissible in a model file unless the model file is specifically for annotation or as described in Exception 2 below. Most annotation is related to a sheet and will be placed in the Drawing Files model space.

However, there are two exceptions to this rule:

Exception 1 - Identification Notes: In many cases limiting the information that is allowed in a model to graphics only without annotation may make it difficult to interpret the data shown, even where the examination of levels and other data structures could assist. Therefore, to help users clarify the data they create, annotation is allowed in a model where it is restricted to a simple note that identifies an element. The note is not to include methods or instructions but is restricted to descriptions of elements only. These element descriptions must be placed on a text only layer so they may be switched off when referenced into drawings not requiring this information.

Exception 2 - Spatially Located Annotation: Where annotation is location specific it is permissible to include it in the Model File, for example building or survey grid references, room or door numbers, chainage markers. These are generally labels that must stay spatially related to specific graphical elements. As with element descriptions, location specific annotation must be placed on a text only layer so they may be switched off when referenced into drawings not requiring this information.

All text is to be created to the heights defined in Table 6.8.B - Text Sizes.

Application	CAD Plotted Text Height (mm) (width factor 1)
Dimensions	2.5
Notes	2.5
Stationing	2.5
Symbols	3.5
Sheet Identification, Labels, and Sub-Titles	5.0
Main/Major Titles & Drawing Numbers	7.0

Table 6.8.B – Text Sizes

- Approved fonts for the Entity projects are True Type Fonts Arial, Arial Black and Monotxt, shall be used for all survey data and survey annotation.
- Arial shall be used for all plan text, general notes and key notes.
- Arial shall be used for Section and Elevation headers, Label text, Schedule headers, etc.
- Arial Black shall be used for presentation labels.
- Text shall be oriented to facilitate reading from the bottom or the right-hand edge of the drawing.
- All text shall be upper case, except for mapping or survey symbols and abbreviations.
- Section and Elevation Headers shall be inserted from block libraries and placed under each section or elevation in a drawing.
- Main titles shall be underlined with a line of the same length and line weight as the title.
- Full sheet plans and elevations do not require a label. Description in title block lines 2, 3, 4 should adequately describe the plan or elevation.
- Title text shall be Arial and plotted text height shall be 6.35 (mm)

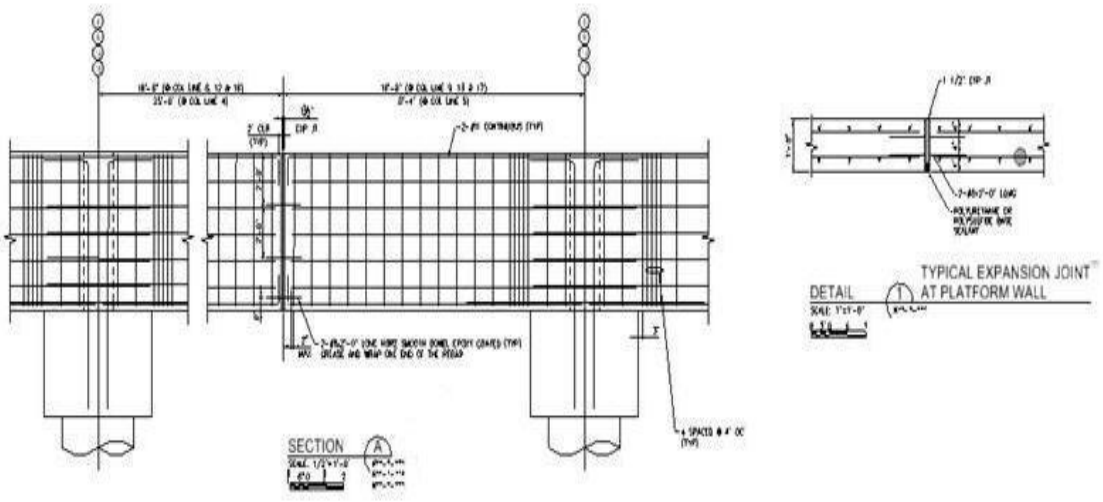


Figure 6.8.A – Section Header

6.9 Dimensioning

- Units of Measure
  - The appropriate unit of measure shall be defined on the drawings for all dimensions. Angle Units shall be in decimal-degrees and precision will be set to 0.000.
- For clarity, unique dimensions should be shown in one location in the drawing set and referred to from other drawings if necessary. Dimensions shall be shown using 2.5 (mm) text that is established automatically by selecting the Dimension Style matching the drawing plot scale. Dimensions shall be lettered parallel to and above the dimension line and shall be shown to identifiable, finite points, or lines. Neat, clear filled arrows at the ends of the dimension line shall identify these finite points or lines. Refer to the following example in Figure 6.9.A - Dimension Styles.

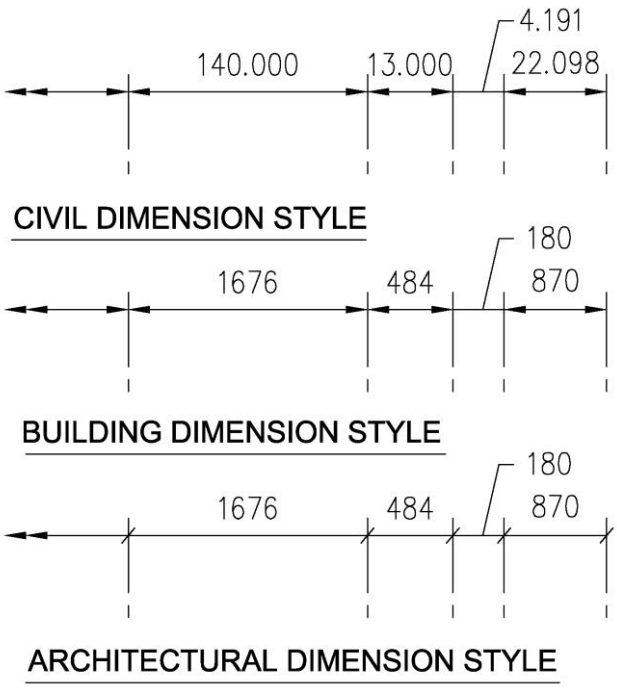


Figure 6.9.A – Dimension Styles

- Dimension repetition on the same drawing or part of the drawing shall be avoided. If several identical features have the same dimension, this dimension shall be shown on one of the features, accompanied by the notation “(TYP)”, Example: 255 (TYP)

- When a dimension is not drawn to scale, the dimension shall be denoted with the notation: “NTS”.
- CAD generated dimensions shall not have the dimension values edited or the dimension entities dropped to its constituent line and text primitives. All dimensioning shall be placed with association on so that if the object changes the dimension to the object will automatically update.
- Units of Measure
    - Length
- The SI base unit for length (the meter) is to be used as the basis for all dimensions - as defined below:
    - Civil/Structural/Rail Drawings are to be dimensioned in Meters (m)
- A standard note is to be placed on each drawing as follows:
    - “All dimensions shown in meters unless noted otherwise”
    - Building and Facility Drawings are to be dimensioned in Millimeters (mm)
- A standard note is to be placed on each drawing as follows:
    - “All dimensions shown in millimeters unless noted otherwise”
- Unit labels are not required to be shown against each dimension where the standard note above defining the units being used is included on the drawing.
- Although not recommended, where more than one unit of measure is used on a drawing each dimension must include the unit label.
- In addition, the following conventions apply:
    - Decimalized expressions taken to three places always indicate meters, e.g., 3.600;0.300; 0.025.
    - Whole numbers always indicate millimeters, e.g., 3600; 300; 25

6.10 Referencing other Drawings and Documents

6.10.1 Match Lines (MatchLines)

- Where a feature shown on one drawing continues on another drawing, a match line shall be provided at the end of the first drawing and at the beginning of the second drawing.
- The match line shall be a thick PHANTOM line, placed ByLevel - **-ANNO-MATC with the label “MATCHLINE - FOR CONTINUATION SEE DWG _____”, written outside the limits of drawing coverage. The drawing number will be that of the abutting drawing where the feature continues. The text height for match line text shall be 3.5 (mm) and shall be placed ByLevel - **-ANNO-MATC-TEXT See Figure 6.10.A- PHANTOM Match Line.

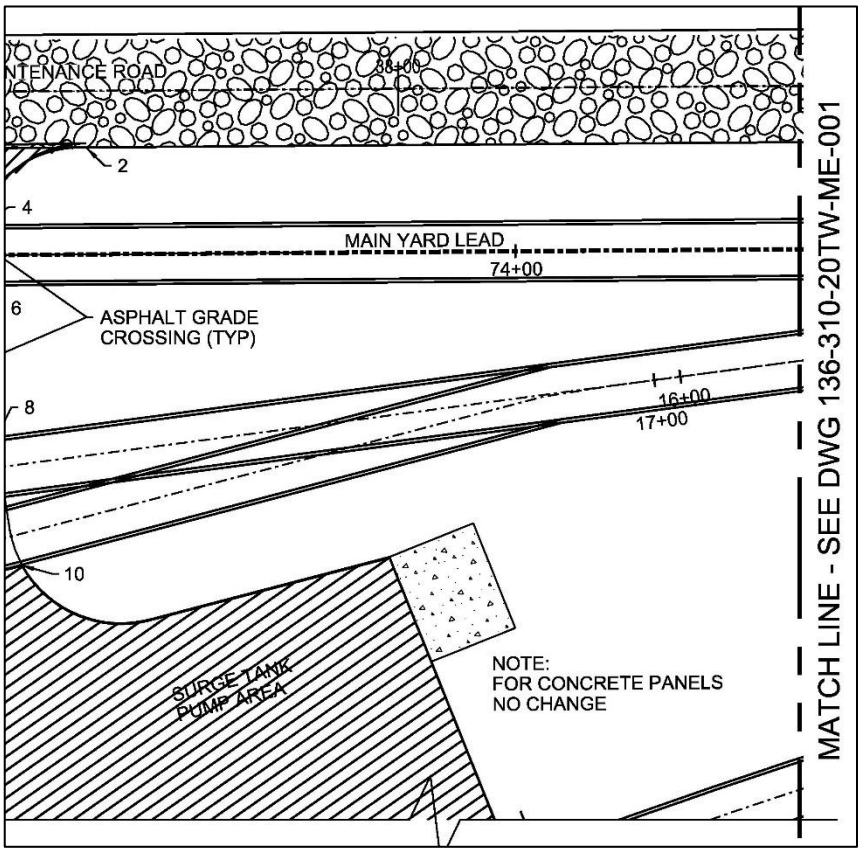


Figure 6.10.A – PHANTOM Match Line

6.10.2 Referencing Details

- A detail is a feature shown on a drawing that needs to be explained more fully. It shall be identified by a circle or rectangle drawn sufficiently large to cover the feature and connected by a line to an identifying reference. Details need not be shown on the same drawing where the original view appears. However, its orientation shall be the same on both the cross-reference drawing and the drawing where the detail view appears. Whenever several details are drawn on the same drawing align them when possible. Details shall be designated by numerals. Wherever practical, details shall be listed consecutively, 1, 2, 3, etc., from left to right and from top to bottom on the sheet on which they are drawn. This number should be located in the top half of the circle. When a detail is drawn on the same drawing where the detail view appears a hyphen should be entered in the bottom half of the circle. When a detail is drawn on a drawing other than where the detail view appears, enter the alpha-numeric characters of the cross-reference drawing number. When a section is cut on a detail, it should be drawn in the same scale and adjacent to the detail. See Figure 6.10.B - Reference Detail and 6.10.C - Reference Detail.

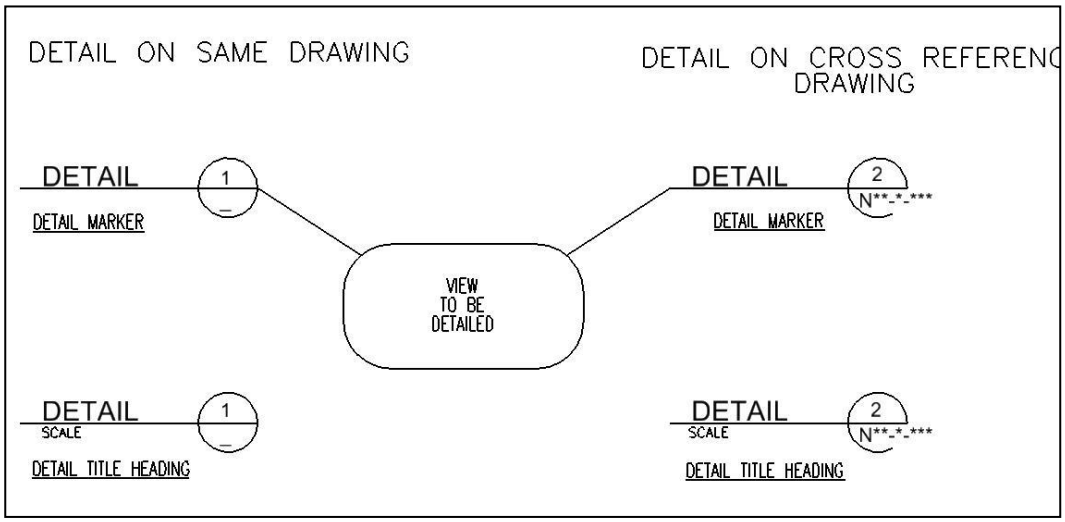


Figure 6.10.B – Reference Detail

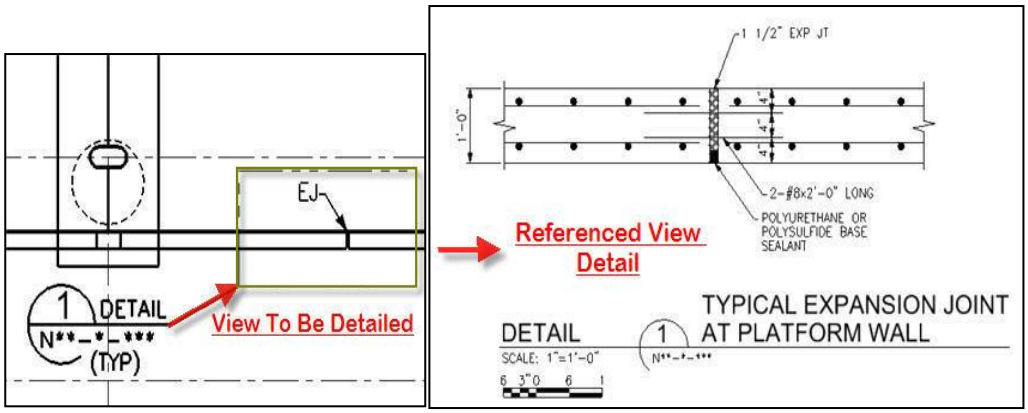


Figure 6.10.C – Reference Detail

6.10.3 Referencing Sections and Elevations

- Sections and Elevations should be arranged and drawn to show work in relation to column line and floor elevations. A section symbol is used for plans where sections/views/details are detailed and referred to a specific drawing located on the same sheet or elsewhere in the drawing set. A section symbol shown on a drawing shall be identified by a line broken at its middle and extended beyond the limits of the section by at least 12 (mm). Sections shall be designated by letters and should be identified such that the letters progress in consecutive order of the alphabet from left to right and from top to bottom of the drawing.
- All views cutting through an object shall be titled “SECTION” Sections should generally be cut looking toward the top or left side of the drawing sheet of Plan Views. Sections shall be designated by letters. Wherever practical, details shall be listed consecutively, A, B, C, etc., from left to right and from top to bottom on the sheet on which they are drawn. This letter should be in the top half of the circle. When a section is drawn on the same drawing where the section view appears a hyphen should be entered in the bottom half of the circle. When a section is drawn on a drawing other than where the section view appears, enter the alpha-numeric characters of the cross-reference drawing number. When a section is cut on a detail, it should be drawn in the same scale and adjacent to the detail. See Figure 6.10.D - Section Cut Labels and 6.10.E - Section Cut Samples.

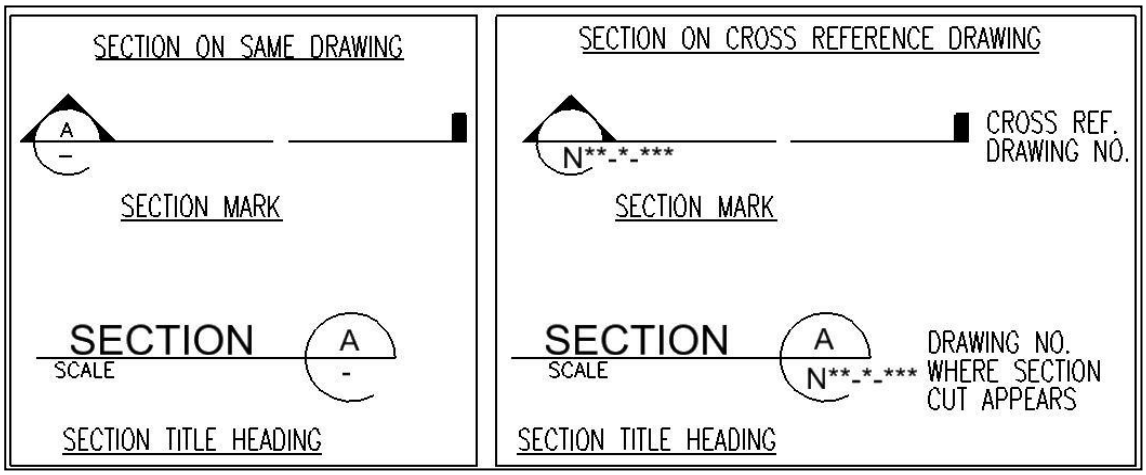


Figure 6.10.D – Section Cut Labels

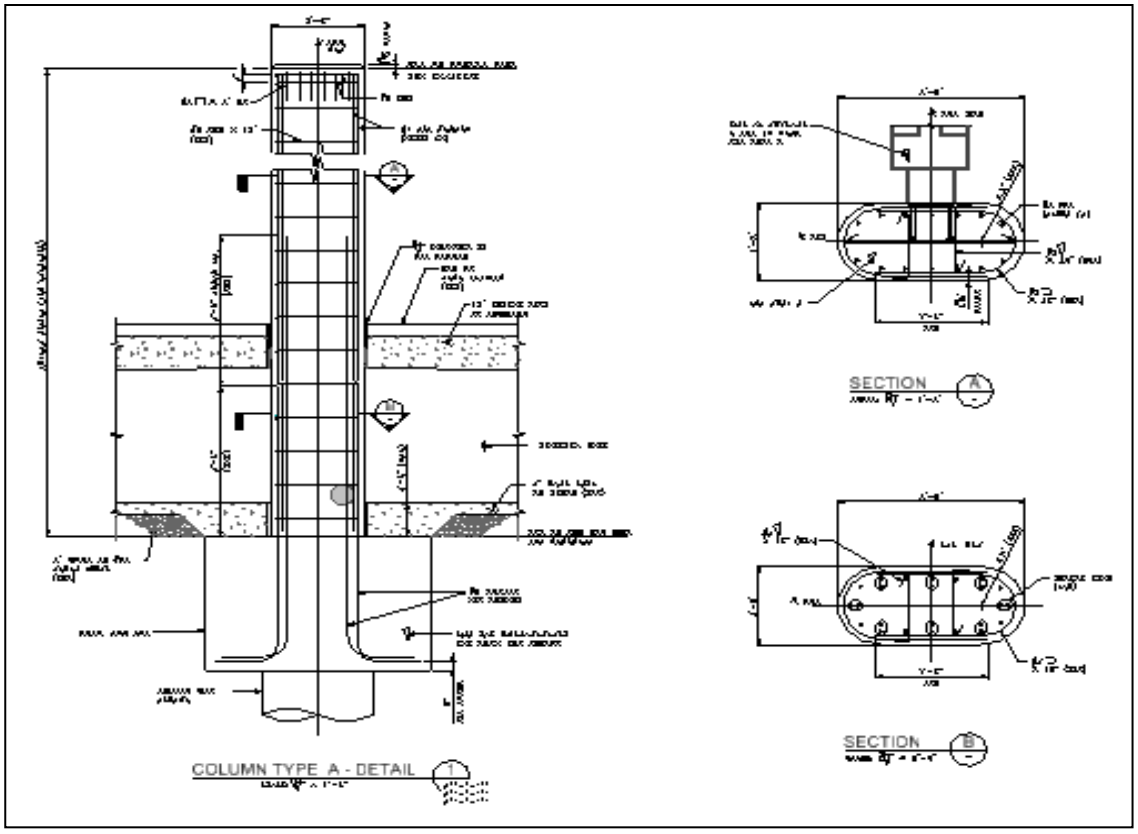


Figure 6.10.E – Section Cut Samples

- Where the number shown on the section or detail reference is not the complete drawing number there shall be a note placed in the notes column to indicate unambiguously the full document number of all cross references. Beginning with the words “This drawing to be read in conjunction with…..”.

6.10.4 External Reference Files (XREFs)

- If XREFS are included in submitted CAD files complete documentation, referenced files shall be in the form of overlays, not attachments. XREFs shall not be bound to drawings prior to delivery. Layers containing XREFs inserted as blocks shall conform to the Entity guidelines. If requested by the Entity, the A/E and/or EPC contractor shall provide a technician, on site, to de-bug any XREF insertions that may occur.
- Reference files may consist of prototype data files, standard borders, project logos, standard border text, and background drawings. All disciplines and agencies related to the project shall use these files

as provided without modification to name or contents. Only the person providing the master source of the Reference files shall modify them.

6.11 Revisions and HOLD's

6.11.1 Revisions

- Drawing revisions are noted on the drawings by numbers or letters in the Revision Box, including the appropriate narrative description, and by clouds and identifying symbols, i.e., revision letter or number enclosed in an 8 (mm) high triangle positioned on the drawing, near the bubble lines encircling revised drawing areas. See Figure 6.11.A - Revision Cloud.

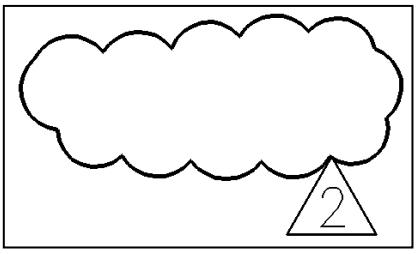


Figure 6.11.A – Revision Cloud

- Revision designations shall be consecutive, alphabetical during the design and development phase and numerical during the construction phase. Bubbles and revision triangles from previous revisions shall be removed. Specifically, the following information is to be indicated in the Revision Box:
    - Revision Letter (Design) or Number (Construction)
    - Date (DD/MMM/YY)
    - Description: The description of the revision shall be as complete as the space allowed but must as a minimum state the reason for the revision clearly identifying the initiating circumstances, i.e. Design Development, Client Change, Value Engineering etc. The first word of the description shall always be the past tense of a verb and shall include a brief statement of the purpose of the revision. Revision description entries shall be options provided by the project. The "Drawn", "SC.CHK", "MC.CHK", "SC.APP" and "MC.APP" columns are to be initialed by the appropriate individuals (Originator / CAD Draft person, Subcontractor checker, Main contractor checker, Subcontractor approver and Main contractor approver). Main Contractor engineering disciplines may use the "SC.CHK" and "SC.APP" fields for their own internal checking/approval process if required.
    - The responsible persons identified above shall sign all initials in blue ink. The initials for the previous revisions, if any, shall be replaced with CAD inserted text. When another revision to the same drawing is required, the existing bubble lines and revision triangles shall be removed and new bubble lines and triangles with the next alphabetical or numerical revision designation, shall be added to newly revised areas on the drawing. Take care not to place revision clouds over drawing entities.

6.11.2 Incorporating Change Documents

- All outstanding change documents must be reviewed and incorporated or addressed in associated drawings per the drawing revision. Disciplines shall write in the revision description field "Incorporated FCD #XXX….." when incorporation is required or write "Addressed FCD #XXX…" to indicate that the Change Document was reviewed but determined not to impact the drawing. Incorporation or Addressing is required anytime one of the following occurs:
    - The drawing is revised and reissued for any reason. Application to multi-sheet drawings requires incorporation of only those change documents affecting the sheets being issued. Drawings are not to be revised for the sole purpose of incorporating or addressing Change documents unless it is the final As-Built revision or as described below.
    - When the lack of incorporation could cause misunderstanding by Construction,
    - Startup, or other users (e.g., excessive number of outstanding change documents)

- When five or more change documents are posted against drawing the drawing revision description shall identify all change documents incorporated

6.11.3 Drawings and HOLD's

- When the details of a pending drawing change have not been finalized and issuances or distribution of the drawing is required for other purposes, the area of the drawing considered not final shall be clouded with an inverted cloud and clearly identified as "ON HOLD". When required, a 'HOLD' Schedule shall be used. See Figure 11. The 'HOLD' Schedule is to be located above the Title Block and shall contain the following fields:
- Hold Number: (There may be several HOLD's and they shall be consecutively numbered).
- Description / Reason: Reason for HOLD shall be provided.
- Responsible Engineer: Individual responsible for re-issuing drawing with HOLD Released
- Forecasted release date: Projected date that HOLD will be released.

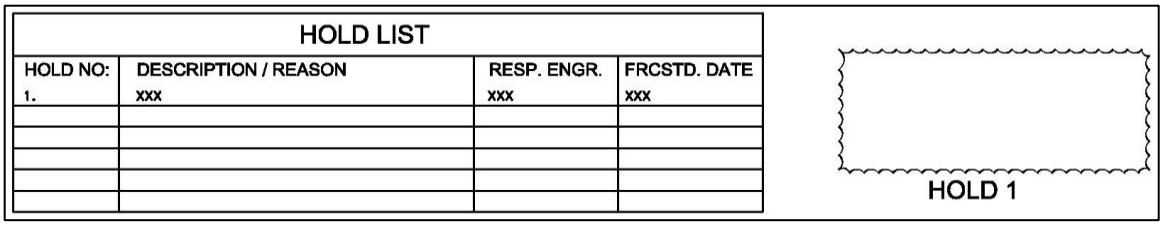


Figure 6.11.B – HOLD (List Schedule and Inverted Cloud)

6.11.4 Cancelled Drawings

- Cancelled drawings shall be "Issued for Cancellation" with the next revision designator and shall be clearly marked CANCELLED on the face of the drawing. See Figure 6.11.C - Cancelled Symbol. Cancelled drawing numbers shall not be reused.

Figure 6.11.C – Cancelled Symbol

6.12 Issued for Construction Stamp

- When drawings are ready to be issued for construction they shall be have an "Issued for construction" block inserted into the drawing.

Figure 6.12.A – Issued for Construction Stamp

7.0 CAD FILE MANAGEMENT

7.1 Information Hierarchy

The data that constitutes the lines, arcs, 3D objects, etc. that create the drawing information produced by CAD systems is stored into individual CAD files. However, those CAD files exist within a hierarchy of information defined below:

7.2 Folders / Files / Models / Layers / Elements

Folders: There will be many folders arranged in a hierarchy and each folder may contain many sub-folders and files. Folders are used to organize and sub-divide the information per project, zone, contract, originator, discipline and document type. Folders for ALL Project Files shall be established in the Project working location.

Files: Folders contain files; that is referred to as the basic unit of CAD work. Security settings or access permissions are set per groups and folder Workflow. Groups with folder ownership can edit files within the folder and only one user can edit data in a file at a time.

Models: Although there can be many models in a CAD file, this Project's CAD Data Standards Procedure restrict each file to only one model and one sheet space for operational and compatibility reasons as well as client requirement. Prior to issuing drawings the A/E shall break down into separate drawings containing single sheets. Each CAD file shall contain only one drawing and one title block per file.

Layers: Within each model, the graphical entities are separated onto layers. These have prescribed names and are used to allow selective viewing of the graphics.

Elements: Each layer contains graphical elements. These elements may be basic entities like lines, arcs, text and 3D solids that are assigned attributes such as color, style and weight, or composite elements which combine basic entities into one. Sometimes intelligent, objects can have attributes such as material or specification references.

7.3 Managing the Graphics

A finished drawing could have the graphic elements and text structured in many ways. For example; there could be just one folder, one file, one model and one level, with all the graphics on that one level, or there could be just one entity per level, one level per model, one model per file and one file per folder with therefore many folders combining to give the same hard copy output. These are two extremes - the first example, is unstructured without a means of easily manipulating or reusing the information; while the second is unwieldy and inefficient in creating, and managing the information sensibly.

This procedure establishes best practices for managing the files and models so produce information in the most efficient manner while maintaining a data structure that allows for flexibility, file sharing and coordination across disciplines.

7.4 File and Model Types

7.4.1 Files

Four (4) types of CAD files are used:

1. Drawing Files (DF) contain the digital drawing representation. This file type may also be referred to as a product file. Only Model Files, Arrangement Files and / or Detail Files may be attached as XREF's to Drawing Files with "Overlay Mode".
2. Model Files (MF) containing the graphical elements which represent, at full size, the project designs. This file type may also be referred to as a source file. Only Model Files may be attached as XREF's to Model Files and only in the "Overlay Mode".
3. Arrangement Files (AF) collect model files together into pre-determined graphical compositions relating to parts of the works. Arrangement Files contain no physical elements. Arrangement files are

to contain only references to Model Files. This file type may also be referred to as a source file. Generally, only Model Files should be attached to Arrangement Files as XREF's and only in "Attachment Mode". Note that this is the only time XREF's are allowed as attachments.

4. Detail Files (DE) which are a hybrid model file type containing fully drawn out and annotated details (particularly standard details) for efficient re-use in drawings. Detail Files should not have any XREF attachments.

7.4.2 Models

Within each CAD file there are two model types:

1. Paper Space - Paper space is analogous to paper, sometimes referred to as Sheet Space or layout, and usually has a drawing frame and title block inserted, and will display graphics and notes.
2. Model Space - Model space is the digital "real world" where virtual representations of real world objects like roads, bridges, buildings, furniture, etc. are contained.

To maintain compatibility between different CAD software, and to comply with this procedure each file must contain one paper space and one model space only.

7.5 Drawing Composition

7.5.1 Basic Composition

Figure 7.2.A - Basic Drawing Composition, illustrates the basic composition of the files required to assemble a Drawing File ready for plotting. Model Files are always attached into Model Space as an overlay Model Files may be composed into arrangement files to simplify the use of related models.

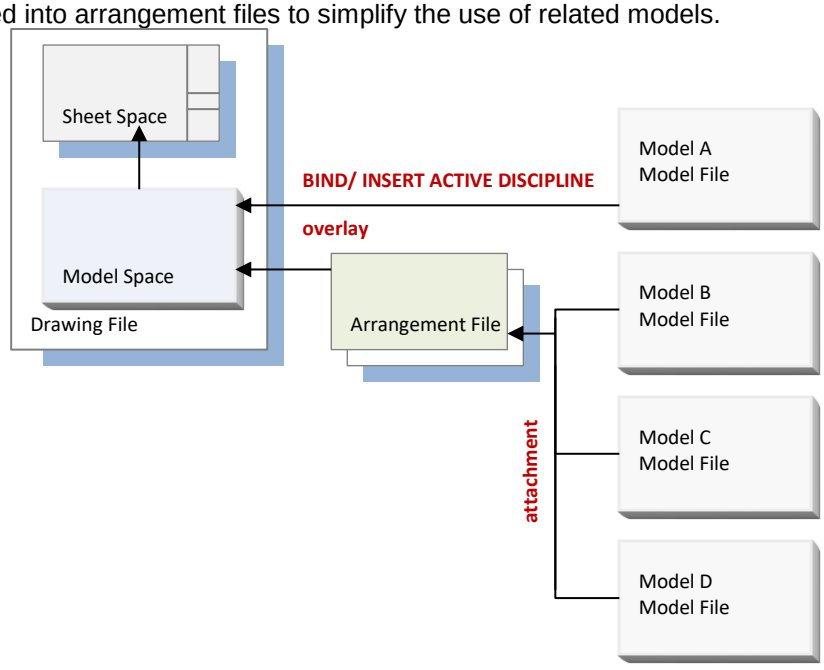


Figure 7.2.A - Basic Drawing Composition (Arrangement of Drawing and Model Files)

7.5.2 Nesting References using Overlays and Attachments

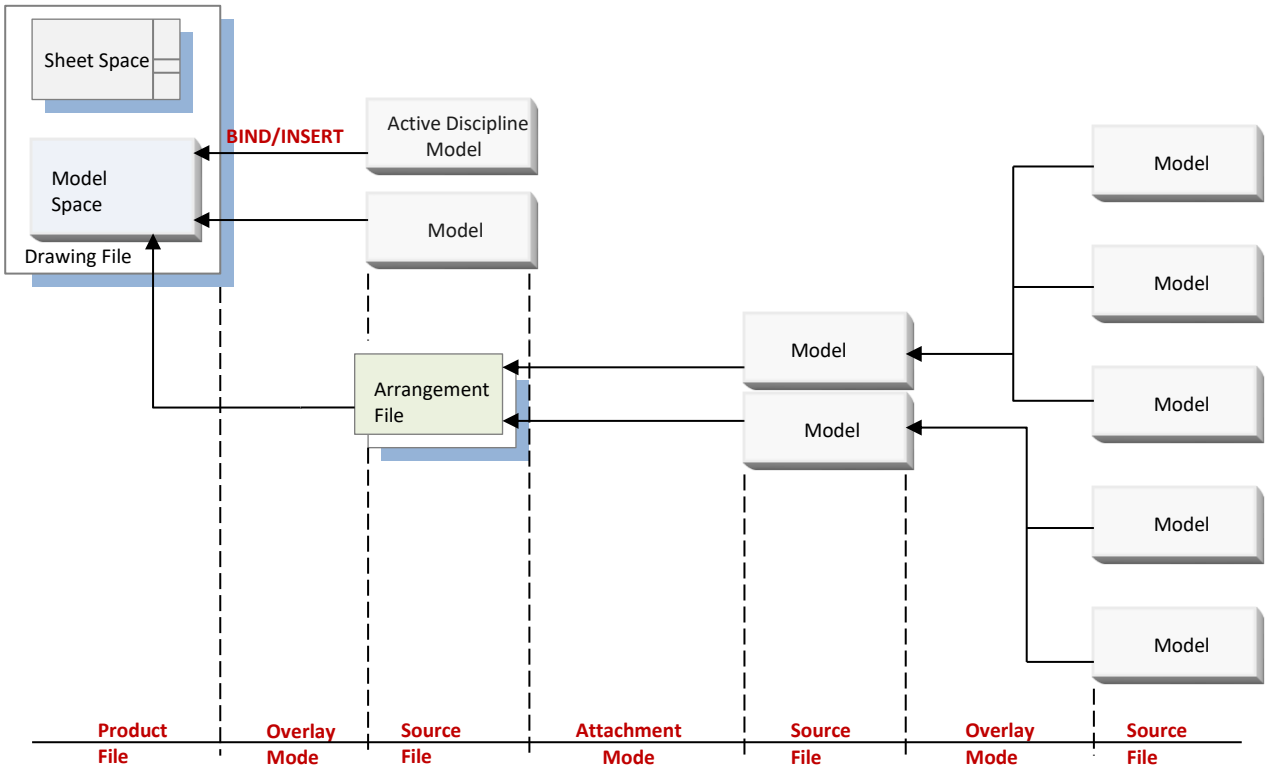
1. Many CAD applications use a referencing technique called "nesting", although the way this is implemented differs between them, they can support the concept of referencing Attachments and Overlays (Note: This is AutoCAD terminology). When references are nested, this means that attaching File A as a reference would also attach Files B1, C1 & D1 if they were attached to A, and attach B2, C2 & D2 if they were attached to B1 etc. This nesting continues until all references attached are included.

2. To control this potential explosion of files the concept of Reference Overlay is introduced. When a file is referenced as an overlay it does not get passed on to a nested reference attachment, i.e. the nesting search stops at an overlay reference without including the overlay file. Overlay attachments are therefore useful when files need to be referenced to each other for coordination and design checking purposes but where these references are not required for drawing arrangements.
3. Overlays and Attachments are used as follows for the three file types that are used in creating a drawing:
4. Drawing File references are always Overlays
5. Arrangement File references are always Attachments
6. Model File references are always Overlays.
7. These referencing rules ensure that nesting of references go no further than the model file level (and don't propagate multiple model file references). This ensures that model files referenced into arrangement files are also in turn referenced into the drawing file (which is the purpose of arrangement files). This is illustrated in Figure 7.2.B.

7.5.3 Advanced File Composition

Figure 7.2.B - Advanced File Composition illustrates the detailed connectivity of Drawing, Arrangement and Model Files, and introduces design files into the data environment.

Figure 7.2.B – Advanced File Composition
(Connectivity of Drawing, Arrangement, Model and Design Files)



Note: Drawing Files shall not be referenced into Arrangement, Model, Detail or Drawing Files.

File and Model Content

Table 7.3.A - CAD File and Model Content below shows what elements and references each file / model combination can contain.

Table 7.3.A - CAD File and Model Content

	SHEET SPACE (SS)		**MODEL SPACE** (MS)	
	Content	References	Content	References
DRAWING FILE (DF)	• Notes • Cross References • Title Block Information • Drawing Frame • Legend • Key plan	• DF-MS (Viewport Attachment)	• Annotations • Schedules • Tables • Bound Active discipline XREF • Drawing Specific 1:1 Explanatory Graphics *(e.g. Color Area Shading etc.)* • Dimensions	• AF-MS • MF-MS *Overlay*
MODEL FILE (MF)	×	×	• Element Graphics at Full Size 1:1 • Attributes • Location Specific Annotation *(e.g. Room Names, Chainage Markers etc.)*	• MF-MS *Overlay*
ARRANGEMENT FILE (AF)	×	×	×	• MF-MS *Attachment*
DETAIL FILE (DE)	×	×	• Element Graphics • Symbols • Hatching • Dimensions • Notes • Title	• MF-MS *Overlay*

MF-MS = Model Files Model Space, etc.

7.5.4 Default View

Model Files are to be saved with a default view (that is the view that appears upon opening the file) of the Model such that all the layers are switched on and the full extents of the elements contained in the model are displayed.

Drawing Files shall be saved in paper (sheet) space with the view fit to include the entire drawing frame.

Designers shall ensure that only necessary elements are contained within product and source files. All “Space Trash” shall be removed so that zoom extents shows only the required content in the display window.

7.6 Maintaining Geographical Location

7.6.1 Model References

Figure 7.4.A - Referencing models together onto a sheet by Scaling and Rotating, illustrates the correct method of referencing model files into model space and sheet space to maintain the correct relationship between the models geographical project location and that of all other models. All model files must be created as full size onto the project grid so they are all (by default) correctly positioned relative to each other. This positioning must not be altered when files are referenced to each other.

7.6.2 Reference Exceptions

There is only one condition where a model-file is not referenced at 1:1 coincidentally in its true location and this is when it is attached through a viewport to the paper sheet. The paper sheets drawing frame is inserted at full size (i.e. A0 size etc.) and therefore the model information must be scaled down as appropriate and rotated to position it onto the sheet to suit the drawing.

7.6.3 Reference Rules

The following rules apply:

1. Model Data is always created at full size with elements correctly located on the project grid.
2. Model & Arrangement Files are always referenced to each other at 1:1 coincidentally (i.e. maintaining the correct project grid location). There is no scaling permitted except as noted in 7.4.2 or rotation except in model space of drawing file.
3. Model & Arrangement Files are always referenced into the Model Space of a Drawing File at 1:1 coincidentally thereby maintaining project location and scale in the real-world units of the model space, again no rotation and scaling except as noted in 7.4.1.
4. Drawing Borders are created at the correct paper size ANSI E.
5. Drawing Border File is always inserted as block at 1:1 into the Sheet Space of a Drawing File coincidentally so that the bottom left corner of the drawing is point 0,0
6. The Model Space of a Drawing File is brought into the Sheet Space using a Viewport which is scaled as necessary onto the sheet.
7. Models are therefore scaled down onto a paper sheet and the paper sheet is plotted at full (paper) size, scale 1:1.
8. Drawing Files shall not be referenced into Model Source Files, Arrangement Files, or Product drawing files except for temporary use to copy a detail or a note. In no case, shall Drawing Files be left attached to any CAD file as this often creates a circular reference that degrades performance across all disciplines.
9. Drawing File Model Space shall have the active discipline bound/inserted into the file whereas other discipline backgrounds shall remain as XREF's.

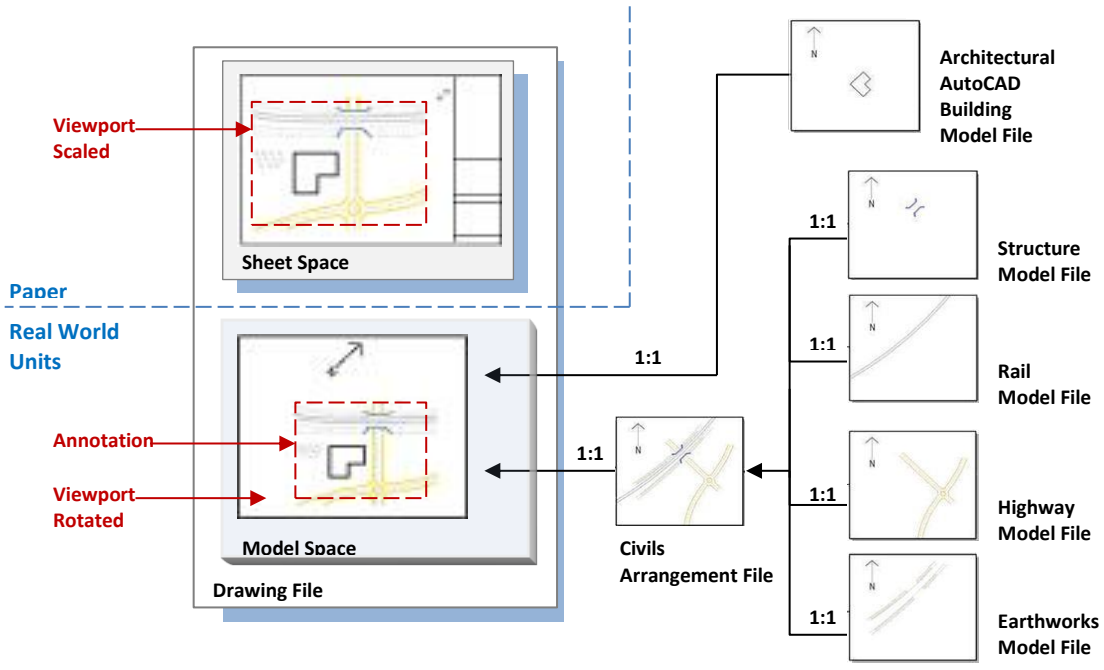


Figure 7.4.A – Referencing models together onto a sheet by Scaling and Rotating

8.0 SUBMISSION REQUIREMENTS

8.1 General Requirements

- Notes, references, etc., that apply to entire disciplines or multiple sheets, details, or subjects shall only be shown on a General or Main drawing. There will be no repetition of note descriptions from sheet to sheet. All drawings that use the same notes shall include the following text: “FOR GENERAL NOTES AND REFERENCES, SEE DRAWING NO._____
- All Drawings that contain plan views shall also contain a key plan. The appropriate area of the key plan shall be cross-hatched.
- Arrange sections and other views to show the work clearly in relation to column lines, steel framing, and finish floor elevations.
- Except where required by other considerations, section cut lines on plan views shall be shown looking up or to the left. Full height or full length sections shall be used where practical. View-directions of developed elevations shall be clarified (North, East, South, or West).
- Sectional plans shall be cut looking down. Orientation of sections shall be consistent with the reference view and the general plan orientation.
- Standard NCS symbols and hatch patterns shall be used to identify materials, components, etc., as needed.
- General Drawings contain index, general notes, and symbols. Control Drawings are overall plans of a design package indicating building location and orientation. General and Control Drawings may be combined when Project size and volume of information permits.
- Blocks
    - If blocks are used, they are to be consistent throughout the project without deviation.
    - Raster images are not acceptable. All images are to vector based.
    - At a minimum, the following elements shall be blocks: symbols, doors, water closets, windows, equipment, plumbing and bath fixtures, electrical devices, hardware, mechanical equipment, furniture, all tags/marks, room numbers, scales, and north arrows.
- Scale
    - Every drawing shall have the scale identified on the drawing. A graphic scale is also to be provided.
    - Metric drawing scales in multiples of 1:2, 1:5, and 1:10 shall be used as standard. Scales for types of drawings are outlined in the respective discipline drawing requirements within this Section.

8.2 Civil Engineering Drawing Requirements

- The Project Civil Engineering Drawings in the following categories shall conform to the general procedures stated in this Section:
    - Site Work

General Civil Notes

Topography

Alignments; Roadway, Railway, and Runway

- Alignment Data
- Stationing

Site Development

- Grading Plans
- Typical Cross Sections
- Typical Details
- Subdivision mapping

Drainage

- Channels and Culverts
- Drainage Details
- Cross Sections

Bridges

- Approaches
- Bridge Plan and Elevation
- Foundation Plans
- Structural Layout
- Structural Details

- The General Civil Notes sheet shall include notes, symbols, and abbreviations that pertain in general to Civil Engineering.
- Plan and Scale - The upper half of the sheet shall be a plan of scale 1:1000 or 1:500. The lower half of the sheet to be used for the vertical profile as referenced in Subsection 4.2.2.A.12.h 'Profile Grid.'
- Stationing
  - Stationing shall be indicated in relation to the scale as follows:

1:10000	Each 1000 M
1:5000	Each 500 M
1:1000	Each 100 M

  - The station shall be identified by a tick mark 6 (mm) long. The numerals shall be 5 (mm) high.

STATIONING SAMPLE:

Station equalities shall be shown as a 3 (mm) open square. The equation shall be shown on a line drawn perpendicular to the stationed line thus:

RL 32+750 M BK

RL 32+755 M AH

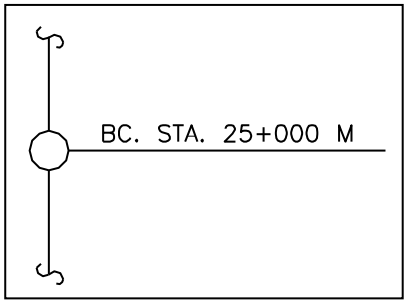
- Roadways - Where perimeter roads, access roads, etc., are to be constructed, these shall be shown by solid lines defining the edges of the proposed alignment. The centerlines of roads or structures shall be shown where applicable.
- Utilities - When a set of drainage plans is to be prepared, the plan and profile sheets need show only utilities that have a major effect on the runways, roadways, or structures.
- Match Lines and Profiles
  - Each sheet shall bear match lines at each end, drawn perpendicular to the alignment, preferably at a full station.
  - The match lines shall be labeled "MATCH LINE-STA 25+000 M" in letters and numbers 5 (mm) high.

- For Match Line Profiles, elevation of the profile grade shall be shown.

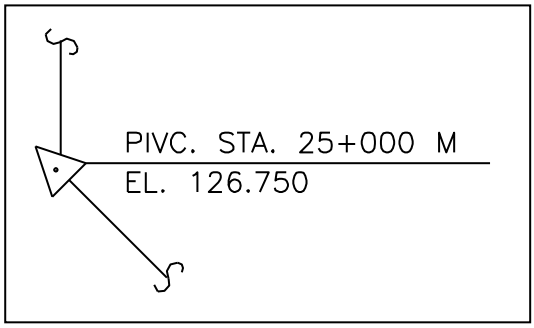
Profile Grid - The vertical scale of the profile shall be 1:100 and every meter interval shall be labeled. Stationing labels shall be entered at the bottom of the profile grid every 100 (mm) in actual length. Thus, for scales of 1:1000, 1:5000, and 1:10000 the distances shall be 100, 500, and 1000 m, respectively. The numbers for stationing and elevations shall be 5 (mm) high.

Runway and Roadway Profiles

- The profile shall be shown by a single solid line, the top edge of which defines the top of runway profile.
- Significant points designating changes in grade shall be shown by an open circle of 3 (mm) diameter. These points shall be identified by a fine vertical line drawn to the circle showing the station and the pertinent abbreviation:



Profile tangent intersections shall be identified by open 3 (mm) triangles. A vertical line shall be drawn to the triangle, and the station, abbreviation (PIVC), and elevation shall be shown thus:



- Ground Line - The profile of the existing ground along the centerline of the runway, road, etc., shall be shown by a freeform, broken line, and shall be labeled "EXISTING GROUND."
- Utilities - The utility lines shown in plan are to be also shown in profile, where they cross the runway or roadways.

- Alignment Data - These sheets shall be arranged in tabular form showing all horizontal points. The tables shall be arranged by runway, taxiway, etc., and read from the top to the bottom of the page. Table headings are in Table 8.2.A below:

Station Point	Y	X	R	△	L	E	TS	LS	AS

Where:

Y and X = coordinates
R = radius of curvature
△ = intersection angle
L = total curve length
E = superelevation in mm
TS = total curve tangent
LS = length of spiral
AS = spiral intersection angle

TABLE 8.2.A: TABLE HEADINGS FOR ALIGNMENT DATA

- Roadway and/or Runway Sections
    - Identifying Symbols and Titles - Road and runway alignment sections shall not be indicated on the plan by a section symbol, but shall be identified by station below the section detail as follows:
    - STATION 32 + 750 M
    - Orientation - Cross-sections shall be taken looking up stations on line. When more than one cross-section is drawn on one sheet, the cross-section shall be oriented so that the section stations increase from the bottom to the top of the sheet.
    - Typical Cross-Sections - These shall be shown at appropriate points along the roadway. They shall include the roadway, shoulders, and other miscellaneous typical details. The scale shall be: 1:50 or 1:20.
    - Special Cross-Sections - These shall be provided in areas where they will be useful in clarifying construction details. These sections shall be drawn at a scale of 1:100, 1:40 or 1:20.
- Typical Details - Typical details shall eventually become Project Standards. They shall include runway, taxiway, apron, roadway, and miscellaneous civil details. The scale shall be 1:50 or 1:20.
- Drainage - Drainage layout sheets shall include detailed layout information for all new utilities. These sheets shall be plan and profile sheets with 1:500 horizontal scale and 1:100 vertical scale and shall be referenced by number to the layout index.
- Utility Lines - The location shall be shown by a 6 (mm) long-dashed line, broken in 25 (mm) lengths, with a single letter code designating the type of utility, at 100 (mm) intervals.
- Drainage Details - these details shall include typical and special details with scales ranging from 1:500 to 1:200. Typical details will become Project Standards.
- Subdivision Mapping
    - General - A subdivision is a parcel of land which has been divided into lots and blocks along with street or road right-of-way and any other tracts which have been reserved for special use.
    - A map of the subdivision shall be prepared by the designer of the subdivision. This map shall be prepared in accordance with the following specifications, the intent of which is to ensure that conformity of maps is maintained, and mapping information is in such a form that it may be utilized in geo-location for a database retrieval and storage system.
    - There is no intent in this Section to require that all subdivisions be similar in layout, land use or configuration, but certain standard guidelines for elements of the presentation are standardized to maintain minimum city planning and architectural control. The guidelines are enumerated and discussed as follows:
    - All subdivision maps shall be plotted on "A0" size. Line work shall vary in width from very fine to heavy in the following ascending order:

Dimension lines, center lines, tangent lines, radii lines and plant grid lines at 100 m interval.

Building lines and public structure lines.

Lot lines.

Right-of-way lines and Block lines.

Sector Lines (in Community only).

Section or District lines.

Area lines.

- All subdivision Drawings shall be oriented so that Plant North shall be up and parallel to the end margin of the sheet. A dual north arrow shall be provided and labeled with both plant North and true North with the angle inscribed between. The bearing to Mecca shall also be shown.
- The scale of subdivision maps shall be 1:500. Subdivisions of only large tracts, such as the primary industries in the Industrial Area may be plotted at

1:1000. Where this scale is not sufficiently large enough to show all detail, a larger scale (i.e., 1:200, 1:100, etc.) may be used.

- Every map sheet shall have a Key Map of sufficient scale locating the individual sheet.
- Match lines between sheets, shall be along streets, other right-of-way, canals, railroads, lot lines or other physical barriers. Preferably entire Blocks shall be shown.
- All boundaries (lots, rights-of-ways, blocks and public lands) shall be mathematically closed.
- All boundary lines shall be dimensioned in meters, including curves and segments of curves. Curve data shall include but not be limited to radius, delta angle, length of curve, long chord, and tangent length. Curve data may be identified and placed in tabular form.
- All right-of-ways shall be of constant width throughout their length, or at least large segments if right-of-ways are very long.
- All computations shall be in plant grid, every corner, change in direction, line intersection, point of curve, point of tangent and point of compound curvature shall have coordinates. Coordinates shall be shown on the map at all block corners. Every point having coordinates shall be numbered on the map and identified with coordinates in tabular form on the map or on documents other than the map.
- Monuments shall be established at all Block corners and Section and District corners. All lot corners and intermediate changes in direction shall be staked using iron rods or other durable material at least 20 (mm) in least dimension and being 1 m in length.
- Control monuments of substantial construction shall be established on plan and placed on site at the intersection of street center lines and Block corners in sufficient numbers and locations, that if 25% of the monuments were destroyed, it would still be possible to replace control within any area so that any property point within the area may be replaced.
- The area of each lot shall be provided in square meters.

8.3 Landscape and Hardscape Drawing Requirements

- All Project Landscaping Drawings shall adhere to the Drafting Guidelines specified in this Section.
- Drawings shall be categorized by type of information and level of detail and numbers assigned in accordance with the Project numbering system. Depending on complexity and Project requirements, all or part of the Drawings on the following list shall be included. The general order shall be adhered to for uniformity; inapplicable drawings shall be omitted from the sequence shown and types of information combined when drawing compatibility permits.
    - Landscaping Plans
    - Plant Irrigation Plans
    - Plant Installation Details
    - Plant Schedule
    - Applicable notes

Landscaping Plans:

- shall be drawn at appropriate scale for legibility and to bid
- shall indicate the following:
    - Existing vegetation to remain
    - Existing site conditions to remain
    - Proposed site conditions (Site Plan)
    - Proposed new landscape material with key call outs indicating botanical name

- Plant Schedule with common and botanical names, container or box size, form and special notes.
- Required Landscape buffers
- Required Screening
- Utilities: (lighting and conduits, joint utility trenches, transformers, vaults, gas, water, sewer, storm drainage lines, manholes, easements)
- Planting details, Plant schedule, Applicable Standard Notes
- Fences and walls

Plant Irrigation Plans:

- Shall be drawn at a maximum scale of 1:30
- Shall indicate the following:
  - Location of water supply
    - Recycled Domestic Waste Water
    - Potable Water (if required)
- Irrigation controllers
- Pressure booster pumps, flow sensors, master valves
- Valves and circuits
- Main lines
- Sprinkler heads and type of head
- Sleeving
- Quick couplers, gate/isolation valves
- Drip irrigation
- Pipe, valve, and sleeve sizes
- Underground systems and type

Details:

- shall be at a scale of 1:5, 1:2, or 1:1 as required to indicate detailed construction requirements for installing plant material and plant irrigation elements.

Schedules and Notes:

- Plant material schedules shall list the types of plants (Latin and common names), size of plants, and quantities of plants required for the project. Notes shall indicate other specific requirements to the project.
  - Irrigation schedules shall list requirements controllers, valves, sprinkler or drip zones, and underground irrigation systems with type. Notes shall indicate other specific requirements to the project. Irrigation watering schedule shall show each valve, run time per week and GPM at peak season. Pressure calculations at critical valve and maximum l/min system demand.

8.4 Structural Engineering Drawing Requirements

- The Project Structural Engineering Drawings in the following categories shall conform to the general procedures stated in this Section:
  - Index of Drawings
  - General Structural Notes and Symbols
  - General Structural Arrangement
  - Foundation
  - Concrete Outline

- Concrete Reinforcement
- Structural Steel
- Roof Structural
- Precast Concrete
- Concrete Masonry
- Miscellaneous Metal Work
- Standard Details

- General Structural Notes
  - The general structural notes shall include notes, symbols, and abbreviations that pertain to the structural Drawings only.

Structural Layout Drawings

- Allow for a minimum of 25 (mm) clearance between the borderline and layouts. The right-hand side shall be reserved for notes, key plan, north arrow, etc.
- All plans shall be labeled, i.e. "FOUNDATION PLAN," "GROUND FLOOR PLAN," "PLAN AT ELEV. 6.95 m,"
- All partial plans shall be located with respect to column lines. Columns shall be identified on all plan views. Columns shall be in numerical order from west to east and in alphabetical order from north to south. Do not use the letters I, O, Q, and S.
- All concrete and masonry walls shall be shown on Structural Drawings. Architectural features shall be shown only where necessary.

- Recommended scales in **Table 4.2.E – Recommended Scales for Structural Drawings** below shall be used for Structural Drawings unless otherwise advised by the Entity.

Structural Plans	1:200 or 1:100
Concrete and/or Masonry Sectional Elevation	1:200, 1:100, or 1:50
Concrete and/or Masonry Section and Details	1:50, 1:20, or 1:10
Steel Sectional Elevation	1:200, 1:100, or 1:50
Steel Sections and Details	1:20, 1:10, or 1:5

TABLE 4.2.E: RECOMMENDED SCALES FOR STRUCTURAL DRAWINGS

- Structural Steel Drawings
  - Single lines for structural steel members shall be used, and a portion of the member shown only where necessary for member orientation or clarity at connections.
  - Structural shapes may be from any international source, such as American Institute of Steel Construction (AISC), British Standards (BS), German Institute for Standardization (DIN), etc. However, AISC equivalent designations shall be used in parentheses when other sources are used.
  - All plate sizes shall be dimensioned in millimeters.
  - All welding and symbols shall be in accordance with American Welding Society (AWS) Standards, except welding sizes shall be in millimeters.
  - Steel framing plans shall show the major floor openings or concrete outline (if required) with dotted lines.
  - Top of Steel (TOS) datum elevations shall be indicated on framing plans by note. Deviations from the datum elevation shall be marked on the individual beam(s) as plus or minus variations.

- Concrete Drawings
    - Reinforced concrete walls and concrete masonry walls shall be dimensioned and detailed on the concrete Drawings.
    - Other partition walls shall be located on the architectural Drawings. Details and engineering data shall be shown on the structural Drawings.
    - Structural anchors and expansion bolts shall be shown on the concrete Drawings and/or standard detail Drawing.
    - All requirements for reinforcing steel shall be clearly shown. Reinforcing steel shall be shown in elevation or plan by heavy solid lines and in section by a solid dot. Size, grade, spacing and mark shall be shown once only, on either the plan or on the elevation, and identified by mark only on the remaining views.
    - Special treatment of reinforcing steel shall be clearly shown by note.

      Example: BEND REINFORCING STEEL TO CLEAR PIPE.
    - Concrete structures shall be dimensioned to the nearest 5 (mm).
    - Floor openings shall be shown on the concrete floor plans. Dimensions shall be shown on the concrete outline Drawings.
    - Penetration in concrete walls shall be shown on the concrete outline Drawings. If the number of openings is limited, their centerline elevations and dimensions may be shown on the plans. Partial or full elevation of the wall shall be shown whenever the required work may not be fully described in the Concrete Outline or plan Drawings.
    - Temporary openings for equipment installation and knockout panels for equipment removal shall be shown.
    - Openings through concrete block walls shall be shown on the Architectural drawings.

- Precast Concrete
    - All drawings shall be prepared basically as outlined above for concrete drawings, as qualified:

Structural components shall reflect the "modular concept", i.e. variation of dimensions and details shall be minimized, and conversely, repetition of dimensions and utilization of identical building components shall be maximized.

Connection details to be completely detailed using corrosion resistant materials.

Locate lifting inserts for major components for handling and lifting purposes.

Provide schedules, details, and elevations for the precast concrete with dimensions.

- Concrete Masonry
    - Layout plan and/or wall runs using modular lengths of concrete masonry units (CMU) to avoid cutting.
    - Dimension all CMU using nominal sizes.
    - Identify shear walls in plan.
    - Indicate type bond to be used for courses of CMU, i.e., running, stack, etc.
    - Show complete details for all vertical and/or horizontal reinforcement.
    - Show all details for interfaces with reinforced concrete and/or structural steel frames and clearly detail each type connection.
    - Locate and detail all construction and expansion joints.

- Miscellaneous Metalwork
    - The following listing of items are considered to be representative of miscellaneous metalwork. This list is not exhaustive. These type of items shall be completely detailed or described on the Drawings.

Anchor bolts

Handrails

Steel stairs

Floor plates and/or trench covers

Grating
Vertical and ships ladders
Equipment support frames
Hatches and/or roof scuttles

8.5 Architectural Drawing Requirements

- All Project Architectural Drawings shall adhere to the Drafting Guidelines specified in this Section.
- Drawings shall be categorized by type of information and level of detail and numbers assigned in accordance with the Project numbering system. Depending on complexity and Project requirements, all or part of the Drawings on the following list shall be included. The general order shall be adhered to for uniformity; in applicable drawings shall be omitted from the sequence shown and types of information combined when drawing compatibility permits.
    - General/Control Drawings
    - Site Plans
    - Building Plans
    - Area Plans
    - Detail Plans
    - Reflected Ceiling Plans
    - Roof Plans
    - Building Sections
    - Wall Sections
    - Exterior Elevations
    - Interior Elevations
    - Details
    - Schedules

- Site Plans
    - Shall be drawn at a scale 1:200.
    - Shall indicate the location of the building relative to the project grid coordinate system, the design package (building) boundary limits, and plan indications of landscape and site work included in the Project.

- Building Plans
    - Shall be drawn to a scale of 1:200 or 1:100 and shall indicate general wall and partition layouts and openings, door swings, floor finishes and finish floor elevations.
    - Column indications and section indications shall correspond to structural Drawings.
    - Door types, window types, building sections, exterior elevations, and interior elevations shall be keyed on building plans.
    - The location of all fire-rated walls or partitions required by applicable code and the hourly rating shall be identified.

- Area Plans
    - Shall be drawn at a scale of not less than 1:50 and shall indicate wall or partition thickness and construction, flooring materials, location and outline of counters and/or cabinets, or other architectural elements as required to explain construction or fabrication requirements.
    - Detail plans, elevations, and construction details shall be keyed on area plans.
    - All area plans must be located with respect to column lines.

- Detail Plans
    - Shall be drawn at a scale of not less than 1:25 and shall be used only to described construction or fabrication requirements for architectural elements that may not be sufficiently described in area plans.

- Reflected Ceiling Plans
    - Shall be drawn at the same scale as building plans.
    - Shall indicate ceiling finishes, layouts of ceiling systems, sprinkler heads, and locations and outlines of major lighting fixtures.
    - Ceiling details shall be keyed on reflected ceiling plans.

- Roof Plans
    - Shall be drawn at a scale of 1:200.
    - Shall indicate top of roof elevations, type of roof construction, location of drains, scuppers, and/or downspouts, and roof slope direction.
    - Roof details shall be keyed on roof plans.
    - Where drawing scales, volume of information, and compatibility of drawings permit, roof plan and site plan shall be combined in the same drawing.

- Building Sections
    - Shall correspond to views and locations in structural drawing.
    - Shall be drawn to a scale of 1:100 or 1:50 only, and shall reference wall thickness, general dimensions, finish floor elevations, and column line locations.
    - Wall sections and details shall be keyed on building sections.

- Wall Sections:
    - Shall be drawn at a scale of 1:25, 1:20, or 1:10 to describe construction requirements for all building wall conditions.
    - Shall indicate materials, finish, construction thicknesses, and finish floor elevations.
    - All wall sections must be located with respect to column lines.

- Exterior Elevations
    - Shall be drawn at the same scale as the building plan.
    - Dimensions on exterior elevations shall not duplicate dimensions shown on plans or sections.

- Exterior material finishes, exterior details, building signage locations, and building sections shall be keyed on exterior elevations.

- Interior Elevations
  - Shall be drawn at a scale of 1:50.
  - Shall describe wall and partition finishes and location and appearance of architectural elements.
  - All interior elevations shall be keyed on building plans.
  - Dimensions on interior elevations shall not duplicate dimensions shown on plans or sections.
  - Interior details shall be keyed on interior elevations.
- Details:
  - Shall be drawn to a scale of 1:5, 1:2, or 1:1 as required to indicate detailed construction requirements for architectural elements.
  - Shall reference materials, finishes, construction thicknesses, special conditions, and fabrication instructions.
  - Where volume of information on a sheet permits, details shall be included with drawings on which the details are keyed.
- Schedules:
  - Shall list requirements for doors, windows, louvers, and room finishes.
  - All schedules shall be keyed to reference symbols on either plans or elevations.

8.6 Fixtures, Furnishings and Equipment (FFE) Drawing Requirements

- All FFE information documented by the A/E and/or EPC Contractor shall be fully coordinated with the permenent building construction.
- Required drawings to document the Project FFE include plans, elevations, sections, details, and schedules to fully describe the design intent.
- Drawing scales are to match those used for Architectural.
- Materials and hardware components shall be identified and scheduled.
- The A/E and/or EPC Contractor is responsible for submitting specification sheets for actual selected products including Manufacturer, model number, photograph, and a description of optional items or finish selections.

8.7 Mechanical Drawing Requirements

- All Project Mechanical Engineering Drawings shall follow the organization, scale, and other requirements for architectural drawings except as otherwise specified in this Section.
- Plumbing
  - Plumbing drawings: shall include plumbing floor plans and isometric diagrams of the piping. There shall be no Process and Instrumentation Diagrams (P&ID's). Pipe diameters shall be given in the International System of Units (SI) only.
  - Plumbing Floor Plans: The designer shall enlarge each toilet core to a scale of 1:50 and the small scale plan shall have a note saying, "FOR PIPING SEE LARGE SCALE PLAN." Do not repeat the piping on the small scale plan.
  - Piping Diagrams

All piping (hot water, cold water, domestic waste and vent systems) shall be shown in diagrammatic form. These diagrams shall be shown with all the Plumbing fixtures including floor drains, floor sinks, oil and grease separators and sand traps.

Depending on the systems complexity, separate diagrams will be required for each plumbing system.

The diagrams shall show core isolation valves, hose bibbs, fixture stop valves, traps, meters, shock absorbers, and the interface at public systems.

- Fire Protection
    - Fire protection drawings shall show all applicable fire protection components such as wet standpipes, dry standpipes, sprinkler systems and deluge spray systems. Smoke detectors, and fire alarm systems shall be shown on electrical drawings.
    - Each sprinkler shall be located on the floor plan of the fire protection drawing. Sprinkler location shall also be shown on the Architectural reflected ceiling plans.

- HVAC
    - Heating, ventilating, and air conditioning shall be in accordance with the HVAC Engineering Standards as described in the ASHRAE and SMACNA Guides.
    - All work, equipment and material shall be governed by the applicable Sections of Codes, Standards and guides.
    - High-Velocity, High-Pressure Ducts

The specification shall call for a different type of construction when the air in the duct is at a pressure of 748 Pa or more, or when its velocity exceeds 10 m/s. It is consequently necessary to show on the drawing which ducts are HVHP and which are LVLP.

It is permissible to use both types of construction in the same run of ductwork if the pressure is different.

Equipment Rooms and Areas: All equipment rooms shall be enlarged to at least 1:50 and all sections, elevations, and details included.

- Flow Diagrams: Systems flow diagrams for air and water systems shall be included, showing major equipment and flow medium and its quantities.

- Process and Instrumentation Diagrams (P & IDs)
    - The purpose of the P & ID is to translate the process and operational requirements, as established in the process Flow diagrams or otherwise, into a design concept that shows basic equipment, piping and control requirements which provide the basis for engineering and detail design of a functional system.
    - Content:

The process and instrumentation diagram must clearly present and identify all pieces of operational equipment and control elements and show all piping and other relationships that define the particular process or operation covered by the P&ID, as follows. Each piece of equipment to include:

- Service Names.
- Equipment Numbers.
- Number of units operating or standby.
- Sizes, duties or capacities.
- Material of construction.
- Insulation for thermal or personnel protection.
- Sizes and types of equipment connections if different from associated piping.

Process and Utility Piping, to include:

Valves, manifolding, blinds, hoses and flow directions.

Identification of main flow streams by heavy lines and auxiliary flow streams by medium lines.

Identification of flows from or to another P&ID.

Special piping items such as expansion joints, strainers and special valves.

Identification of all sumps and sump sizes.

Pipeline identification including facility number, line size and piping material specification.

Piping reducers (not shown at main line branches), line and equipment drains, vents, sample points, traps, separators, relief valves, equipment seal water and/or water purge connections, all with sizes indicated.

Insulation for thermal or personnel protection, steam or electric heat tracing.

- Instrumentation, to include:

Process control instrumentation, using symbols and letters shown in the International Society of Automation (ISA) S5.1.

Instrument signal lines (pneumatic, electric, capillary or other).

Control Valves and Actuators with bypass manifolds.

Block valves for pressure tops.

Instrumentation purchased with equipment packages that require field mounting, piping or wiring.

Instrument numbers.

Control, safety and relief valve sizes and fail positions.

Interlocks shown in simplified form.

- General

Appropriate notes, reference drawings and key plan.

8.8 Electrical Drawing Requirements

- All Project Electrical Engineering Drawings shall be in accordance with the general drawing procedure of this document.
- The drawings shall show in sufficient detail for bidding and construction purposes such features of lighting, motor, grounding, cable and raceway installation considered essential to system physical, function and circuitry characteristics and the interfaces with other disciplines.
- The design drawings shall include:
  - Single line diagrams, showing: primary and secondary power distribution systems; normal, stand-by, emergency and special power supply systems; switch gear, equipment and cable sizes and ratings; power and lighting systems; main and secondary distribution panels; and protective and control devices. Where appropriate a protection and relay three line drawing shall be provided.
  - Layout drawings, showing: switchgear and equipment locations and room layouts; primary and secondary power cable and raceway size and routing; lighting panel, fixture and switch locations; distribution panel, motor control center, motor, receptacle and miscellaneous power equipment locations and sizes; grounding grids and local connections, all in sufficient detail to permit coordination of the work with that of other disciplines and for construction.
  - Schematic, control, wire connection and riser diagrams; detail, typical and standard drawings, showing necessary installation to supplement data described above and in the specification to provide sufficient information for bidding and construction of the complete electrical work.
  - Cable and conduit, lighting panel schedules shall be provided.

- Provisions for Special Services
  - Certain provisions for special services will be included in the electrical drawings. These services pertain to the telecommunication and control systems design groups and in general involve the following systems:

Telephone

Public address

Fire and life safety

Security

Surveillance

Master clock

Process equipment and control

Environmental equipment and control

Directional signals

- Raceway, wiring and physical location of electrical connections to equipment and devices for the above services will be indicated on the electrical layout drawings. The connections will be shown in the form of riser diagrams in sufficient detail for the material take-off and for

determining routing of the raceway installation. The location of the equipment and instruments, type and size of wiring and the block diagrams of interconnections will be marked by the pertinent design groups on the electrical coordination prints, or sketches, for inclusion in the electrical drawing package.

- Electrial Standard Drawings, Details, Notes and Symbols
    - Installation arrangements, details and methods which are standard industry practice and typical for use on the project, are to be identified, developed and produced as standard or typical drawings for use in the individual packages, as necessary.
    - Symbols: per Uniform Drawing Standards (UDS).
    - The electrical symbols, abbreviations, and notes of typical or repetitive nature shall be shown on general or standard electrical drawings.

- Single Line Diagrams
    - The single line shall include the interface with the supply service; the main substation; stand-by generation plant; high and medium voltage switchgear; and distribution circuits. Local substations and loads shall be indicated on the diagram by a block identifying the substation and load size.
    - Single line diagrams shall also be prepared to detail each local substation indicating the primary switches and circuit breakers, transformers, secondary main and tie breakers, bus connections, feeder breakers, meters, relays, protective devices, motor control centers, power distribution panels, and auxiliary power services such as Alternating Current (AC) and Direct Current (DC) lighting and control power sources.

- Layout Drawings
    - Arrangement

Layout drawings showing area plan views shall contain an overall key plan. The appropriate area shall be cross hatched on the key plan to provide quick reference to the area covered in the particular drawing. A project north arrow shall be placed on the drawing for orientation.

Column lines shall be shown and identified on all plan views. Partial plans shall be located with respect to column lines. Sections and other views shall be arranged to clearly show work in relation to column lines and floor elevations.

Except where required for clarity, sections shall be cut looking to the top or to the left of the basic plan view sheet. Full height or full length sections shall be used where practical. View-directions of developed elevations shall be identified.

Sectional plans shall be cut looking down. orientation of sections shall be consistent with the reference view and the general plan orientation. The scale shall be 1:50 or larger.

    - Dimensions

Symbols identifying electrical equipment and apparatus shall have horizontal dimensions shown on plan view only, except in the event clarity is lost by this method. Vertical dimensions and elevations shall be shown on all sections and elevations.

Location of electrical equipment and raceways.

Dimensions shall be shown by dimensions preferably from adjacent column lines or floors and alternatively from adjoining major structures or equipment.

Repetition of dimensions within a single sheet shall be avoided. Where necessary, dimensions of lines crossing matchlines shall be made to the matchline to avoid overlapping of dimensions on matching sheets. Dimensions Not To Scale shall be identified by "NTS."

Every effort shall be made to produce drawings to scale.

Dimension arrows shall be small, sharp and neat. Dimension figures shall be lettered parallel to and above the dimension line and arranged to read from the bottom border or right hand border.

    - Electrical Equipment and Raceway Layout

Major electrical equipment such as switchgear, load centers, motor control centers, transformers and raceways, shall be shown on electrical layout drawings for the pertinent buildings. Items outside of the buildings such as underground distribution including primary and secondary power, street lighting, telecommunications

and control cable shall be shown on general utility drawings. Equipment and raceway numbers (except for lighting) shall be indicated on the drawings.

Cable trays, enclosed wireways and underground ducts will be shown on the layout drawings with appropriate notations as to their type, size, configuration and general location with respect to building lines and grades.

Conduits for power and power control cables shall be shown on the layout drawings whether run exposed or embedded. The conduit runs may be shown partially in a diagramatic form but in sufficient detail to show location of connections at the motors and at the motor controllers. The conduit runs between the motors and the remote controllers or power source, may be shown as a complete run or a partial run, assuming that, a suitable description of the destination of the "home runs," such as to motor control centers or distribution panels, will be given.

Conduits for lighting, convenience outlets and special service receptacles will be shown on the layout drawings only where embedded in floor, wall or ceiling. No exposed or hidden runs (such as above hung acoustical ceilings) will be shown.

Rules and Codes pertaining to the conduit type, size and installation and the number, type and size of wires that may be intalled within the conduits and methods of connection at the fixtures and devices, will be shown in the standard drawings, specifications and design criteria, as applicable. Where sizes, routing and destinations are shown on the drawings they may be shown either directly on the layouts or in the raceway schedules, whichever is considered more expeditious and appropriate. However, once the method for describing these conduit runs has been decided it shall be consistent within a given design package.

- Lighting Layout Drawings

All lighting fixtures, distribution panels transformers, switches, convenience outlets and circuity shall be shown on the drawings. When conduits are shown the number of wires in each raceway shall be indicated with short diagonal lines crossing the raceway and two lengths shall be used. The longer, about 6 (mm), shall indicate the number of phase wires and the shorter, about 3 (mm) shall indicate the number of neutral wires. Lighting panel designation and circuit number shall be shown for each fixture, switch, and outlet served by the particular panel and circuit.

A lighting fixture symbol, identified and described in the "Lighting Fixture Schedule" shall be shown for each fixture or group of fixtures on the lighting layout drawings.

- Arrangement Drawings and Details

These drawings shall be prepared for electrical equipment rooms, substations and any other areas where equipment location, arrangement and other requirements, such as access and environmental conditions are to be considered in detail.

- Schematic Diagrams

Schematic diagrams showing connections between devices and illustrating the scheme of operation shall be prepared for switchgear, generators, motor drives and control devices where it is deemed necessary for the proper description and coordination. Wherever possible, typical diagrams shall be used. All connections shall be numbered.

Control circuitry for motors and major electrical equipment shall be shown using, wherever possible, typical schematic diagrams of control and block diagrams to indicate connecting raceways and wiring. Where necessary, the typical schematic control diagrams may be supplemented with dissimilarity tables and tables showing interlocking between the motors and control devices. A typical schematic control diagram will be cross-referenced to the particular motor by notation in the equipment list on the layout drawings, or in the single line diagram drawing, whichever method is considered best for a given design package.

- Connection Diagrams (When Required)

Riser diagrams shall be prepared if necessary to supplement the layout drawings in showing various systems. These would typically be fire alarm, telephone, public address, security and systems controls.

- Schedules (When Required)

Circuit schedules shall list all power, control, instrumentation, and telecommunication cable showing origin, termination and cable description, including number of conductors and conductor sizes. Lighting wires shall not be shown in the circuit schedule.

Raceway schedules shall designate all raceways, showing their size, type, origin and terminations.

Panel (lighting and power) schedules shall depict each panel in tabulation-form, indicating type and size of main bus, main and branch circuit breakers, voltage, phases, circuit'numbers and. service designation, watts per phase and total watts.

8.9 Control Systems and Instrumentation Drawing Requirements

- The Project Control Systems and Instrumentation Drawings shall conform to the general procedures stated in the preceding text except if otherwise specified in this Section.
- Instrument Schedules or Summaries
    - Where applicable the following information shall appear on the Instrument Schedules:

Instrument identification number
Service
P & ID drawing number
Data sheet number
Location (panel or field)
Location plan number
Installation detail number
Material requisition number
Electrical schematic drawing number

- Data Sheets
    - Sufficient information shall be provided on instrument data sheets for procurement of instruments. The following shall be included in the information:

Instrument identification number, service, and function
Process conditions (normal, maximum and minimum)
Scales
Charts
Materials
Signal levels
Power sources
Calibration
Material requisition number
Accessories
Manufacturer and model number. (This information is to be completed after award)

- Installation Details
    - Sufficient information shall be provided to ensure proper field installation including:

Size of process connection
Elevation of instrument with respect to sensing tap locations
Material lists and material quantities

- Loop Diagrams
    - Loop diagrams shall be provided to show the interconnections and working relationships of individual components with complex control loops.
    - Typical control loop drawings shall, generally, be provided for simple repetitive control loops.
    - Loop diagrams may be either pneumatic or electronic, however, if electronic, they shall not replace the electrical schematic, or connection diagrams, but shall supplement such drawings.

- Control Panels
    - Control panel drawings shall show overall size, cross-sections, general arrangement of equipment and legend plates, but shall not include structural fabrication information except where critical to appearance or functional details.

- A key plan shall be provided to show panel location relative or other panels, building features, etc.

- Logic Diagrams
  - Logic diagrams shall be used as a means of communication for complex control circuits. Simple repetitive control circuits shall not require logic diagrams.
  - Logic diagrams shall be developed prior to the preparation of associated elementary electrical diagrams.

- Location Plans
  - Location plans shall show the locations of individual sensing elements, control elements and valves, pneumatic terminal boxes, and local control panels as required for field location and installation. Elevation of taps and components, if critical, shall be shown. The areas covered by these locations shall conform whenever possible to similar location drawings for electrical and mechanical systems or to master plan divisions developed for the project areas.
  - Indication shall be given on the drawing of the type of electrical connection required, i.e. power supply, control signal, instrumentation (4 to 20 mA), instrumentation low level (e.g. thermocouple, RTD, MV, etc).

8.10 Telecommunications Drawing Requirements

- All Project Telecommunications Drawings shall adhere to general organizational and project drafting Standards.
- Organization
  - The drawings shall be categorized by systems or subsystems and numbered in accordance with the project numbering system. Depending on complexity and project requirements, system or subsystem drawings may include all or a part of the drawings in the following list. The general order shall be adhered to for uniformity. Inapplicable drawings shall be omitted from the sequences shown:

Block Diagram of the Telecommunication systems
System or Subsystem Functional Block and Level Diagrams
System or Subsystem Site Plans
System or Subsystem Equipment Layouts
System or Subsystem Grounding Details
Underground Cable Routing Key Diagram
Cable Schematics
Cable Building Entrance and Termination Details
Cable Building Vault Layout and MDF Layout
Duct Plan
Hardware Details

- General Notes: The general telecommunications notes shall include all notes, symbols, and abbreviations pertaining to telecommunications engineering.
- Systems Block Diagram: The telecommunications systems block diagram is an overall systems block diagram.
- Functional Block and Level Diagram
  - The functional block and level diagram shall show major components or functions of a system indicated by blocks of variable sizes and shapes and the interconnecting path of the signal or electrical flow indicated by arrowheads on connecting lines.
  - Internal connections within the major items are usually omitted.
  - For convenience or clarity, partial internal connections, schematic, or circuit functions information may be included.

- Between each block shall be shown the proposed or expected level and circuit impedance. The level will normally be shown in dBm or dBmO.

- Layout Plans: The telecommunications site plan shall contain a plan view of the installations, locations, and dimensions of major equipment, and buildings, location of survey markers, and if applicable, antenna azimuths and take-off angles.
- Equipment Location
  - The equipment location shall contain a plan view of a room or an area. The drawing shall reference wall thickness, direction-of door swing, access openings, location and height of all partitions, columns, and sufficient dimensions to establish spatial limits in all directions.
  - All telecommunications equipment shall be shown to scale and identified in the equipment list.
- Grounding
  - The grounding system shall contain installation information for connections or terminations of a general grounding system.
- Cable Key Diagram
  - The underground cable routing key diagram shall be superimposed on an Area Plan Layout. It shall show an overview of the cable routing from distribution frame to various terminations.
- Cable Schematic
  - The cable schematic may include several sheets. The following includes, but is not limited to, information that shall be shown:

Cable lengths, cable types, cable sizes and gauges plus numbers and counts

Termination points and facility or building number

Terminal counts and types of terminals

Location of load coils if necessary

Location of any MDF or IDF

In some cases it will be necessary to show details of complex splicing

- Cable Termination
  - The cable building entrance and termination details shall show the details necessary to terminate cables on terminal blocks.
  - At locations other than buildings, structural details for the support of items or structures to mount the terminating device shall be provided together with the details of the device.
- Cable Vault and MDF Layout
  - The cable vault and MDF layout shall show location layout racking, cabling, splicing, steps and access ports. The drawing may show the relationship of the vault to the building, an elevation view showing length, width, headroom and duct arrangements.
  - Main distributing frame drawing may show the placement, layout, arrangement and numbering of wall or floor type main, intermediate and combined distributing frames.
- Duct Plan: The duct plan shall be a map type drawing (true to scale) of as many streets as required, showing:
  - Interface cabinet with coordinates (not more than one per drawing set)
  - Cross connection cabinet(s)
  - Distribution point locations
  - Line of duct route
  - Number of ducts and formation in each section
  - Position, type, identification number and coordinates of each jointing chamber
  - Center-to-center distances between jointing chambers

- Distance of duct rote center line from property line, center line of road or other designated bench mark

- Hardware Details: Detail drawings shall include sufficient information to clearly define type, mounting, etc., as needed for purchase and installation.

8.11 Sample Schedules

- Door and Frame Schedule: **Table 4.2.F – Sample Door and Frame Schedule** shows a sample of Door and Frame Schedule.

DOOR AND FRAME SCHEDULE								
Door						Fire Rating Label	Hardware Group	Notes
Mark	Size			Material	Glazing			
	W	H	Thk.					

TABLE 4.2.F: SAMPLE DOOR AND FRAME SCHEDULE

- Window Schedule: **Table 4.2.G –Sample Window Schedule** shows a sample Window Schedule

WINDOW SCHEDULE						
Mark	Size		Type	Material	Hardware Group	Notes
	W	H				

TABLE 4.2.G: SAMPLE WINDOW SCHEDULE

8.12 Submittal Organization

- All drawing information shall be submitted to the the Entity as described below. All drawing information submitted shall be in accordance with the Drawing Standards specified in this document and must comprise stamped and signed record drawings.
- A/E/s submissions fall into formal and informal submissions.
    - Informal Submissions may be made at any time during the process that the A/E and/or EPC Contractors determine is appropriate with the Entity for an interim review. Initially these Design Drawings are not ready for construction issue. At this stage these drawings may be issued as "Issued for Review," "Issued for Coordination" or "Issued for Information.” The revisions shall be indicated alphabetically A, B, C, etc. and dated at each revision.
    - Formal Submissions are for when completed Contract Drawings are issued for construction. When the Design/Contract Drawing is "Issued for Construction," Revision 0 shall be indicated with subsequent revisions indicated numerically as 1, 2, 3, etc. Each revision shall be dated. Contract Drawings shall be approved by the Entity and issued as follows:

Delete all reference to revisions for preliminary issues

Assign the revision "0" (zero)

Fill in the revision description block "Issued for Construction" and complete sign-off

- A reproducible record copy (reproducible hard-copy) of every Drawing issued, except those issued for interim review, must be made by the A/E for the permanent reference file.

- All plotted drawings, when submitted to the Entity, shall be neatly fan-folded to a same size, and kept sequentially within each package.
- Where applicable, issued prints shall be stamped to indicate the purpose of restrictions on release of the drawing. Canceled, superseded, or superseding drawings shall be clearly and boldly indicated on the Drawing and recorded in the form of a revision note; such as “VOID - SUPERSEDED BY DWG. NO._____”, or “SUPERSEDED DWG. NO._____.” File names and Drawing numbers of superseded and voided drawings shall not be reused.

- Quality Assurance / Quality Control (QA/QC) for CAD Documentation
  - The A/E and/or EPC Contractor is responsible for checking the CAD documentation for compliance with the Standards identified in this Engineering Manual. A signed and dated statement of compliance from the A/E and/or EPC Contractor must be included with the “Issued for Construction” drawings.
  - At the close of the project, the A/E will conduct an audit that will include comparing the CAD documents with the built Project. A visual examination of the CAD drawings will be conducted to ensure the presence, location, and approximate dimensional accuracy of all significant features including, doors, windows, walls, columns, stairs, ramps, and other general floor-plan layout items. Obvious errors or omissions will be noted on a review sheet. Depending on the results of the visual audit, the Entity may conduct field verification of actual dimensions to compare with the CAD drawings. The A/E and/or EPC Contractor is required to resolve all issues identified in the Entity review.

- In addition to the electronic copies of the Drawings, the electronic data deliverable package shall include the files mentioned below. Files as described below and related notes or specifications, if any, to be included in the deliverables are to be submitted in Adobe .pdf format as well as a printed copy.
  - A4 size prints of each drawing file to be used for reference (no scale required)
  - File Description Sheets
  - Layering Documentation
  - QA/QC Documentation
  - Plot Style or plot configuration document as requested
  - Readme file that includes a listing of the contents of the deliverable package as per the File Submission section below

- It is the responsibility of the A/E and/or EPC Contractor to organize drawing information coherently and maintain reasonable file sizes.
- Graphic/Drawing Files
  - The two types of drawing files to be included in the deliverables are Sheet Files and Model Files unless otherwise directed by the Entity.

A Sheet File is a single plot ready file. They are to be completely formatted and plot-ready. One Sheet File is required for each drawing sheet included in the construction document set. Sheet Files shall be formatted utilizing paper space. Plotting shall be set to plot a layout with a plot scale formatted to match the hardcopy submittals. Each sheet file must have all external-referenced drawings bound to it.

A Model File describes a subset of a building’s geometry and its physical components: walls, doors, windows, columns, beams, outlets, ducts, etc. A Model File is always drawn at 1 = 1.

Any reference files pertinent to the content of the Model or Sheet File constitutes required data and is to be included on the File Description print out. Drawings using reference files are to list referenced files on the title block layer as well as on the File Description sheet. This list shall give an account of dependent files for the complete document. This information shall also be added to the file description for Model or Sheet files. In all submittals reference files shall be in the same directory as the dependent files and shall NOT include path names in the reference file attachment. Refer to Subsection 6.3.2 of EPM-KR0-PR-000001 – Project Document Management Procedure for more information about referenced files and XREFs.

Files submitted in AutoCAD, version approved by the Entity, must be convertible to MicroStation without the loss of data which includes Line weights, Colors, or Layering. The accurate translation of files will be the responsibility of the A/E.

- File Transmittal
    - Electronic files shall be delivered on CD ROM in plastic cases, formatted using the Windows platform.
    - Electronic files submitted on floppy disks, flash disks, zip drives, etc. are not accepted.
    - All electronic file submittals shall be checked using latest anti-virus software prior to delivery to the Entity.
    - CD ROM labeling for typical drawing files shall be as shown in **Figure 4.2.D – CD Rom Labeling** below:

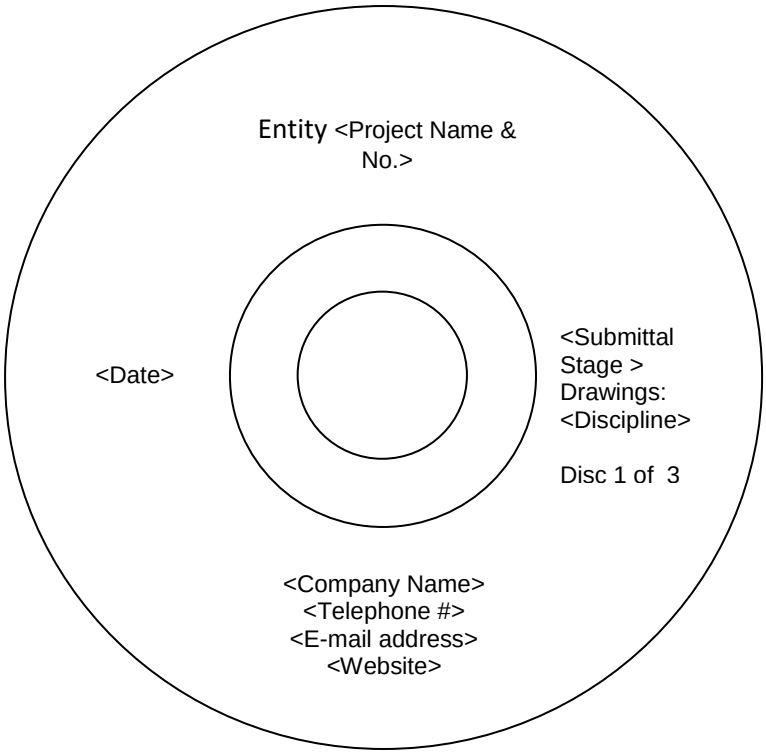


FIGURE 4.2.D: CD ROM LABELING

A readme file shall be included on disk number 1 that contains the above information along with an index of drawings that includes drawing file name, drawing title, drawing number within the set, scale, drawing date, and XREF listing and their paths. A hard copy of this readme file shall be delivered with the disks.

The content of electronic drawings must match the delivered original hard copy set. To ensure the integrity of the electronic drawing set upon delivery to the Entity, the A/E shall:

- Ensure the drawings adhere to the guidelines presented in this document. Review the procedures for preparing drawings for submittal as detailed in the preceding paragraphs.
- Include a hard copy index containing filenames and sheet numbers for each submittal. This ensures the completeness of the drawing set and assists in archival procedures.
- Include a transmittal sheet with all submittals indicating the Entity Project Number, Project Name and complete listing of all materials submitted.
- Include hard copy half-scale prints of all drawing submittals, when so directed.
- Include plot configuration files whenever possible. A copy of the Plot Style (. ctb or .stb) shall be submitted. The .plt files shall be submitted when requested.

The receipt of electronic drawings alone does not alleviate the responsibility of the A/E for providing hard copy documentation to the Entity.

The A/E Construction Record Drawings shall include updated drawings reflecting revisions issued during construction. The Contractor's As-Built Documentation shall be, both in electronic and hardcopy format, submitted to the A/E for approval. These as-built documents shall, upon approval, be submitted to the Entity for review.

- No compressed files will be acceptable on the CD ROM. To reduce disc space requirements, the A/E shall keep drawing sizes to the minimum.

8.13 CAD File Naming and Drawing Numbering

8.13.1 Purpose

The purpose of this section is to describe and define the naming and numbering system to be applied to all engineering drawings and CAD files prepared and issued for the Entity projects. This procedure applies to all engineering drawings and documents prepared and issued either by the project or by architect/engineer contractors, independent consultants, their subcontractors, and others engaged under a prime contract. The numbering of all drawings and documents will be in accordance with this procedure and with the Entity Document Numbering Register.

This section addresses naming conventions for CAD Reference Files (XREFs) and CAD Drawing (Sheet) Files only. Refer to the Entity Document Numbering Register for all other types of Engineering and Project documents.

8.13.2 Numbering System for Drawings

File naming conventions for electronic data (Working Files, Source Files, Drawing Files and As-Built Files) should enable all users, to recognize the contents of a CAD file without opening and displaying the graphical elements in the file. File naming conventions also provides a convenient and clear structure for organizing electronic data and documents within project directories, as well as providing searchable attributes for the Electronic Document Management Systems (EDMS) utilized on Entity projects. Refer to Project Standard Document Numbering Procedure EPM-KR0-PR-000002 for additional information on this section.

Engineering drawings originating in and issued by the project will contain six (8) elements consisting of a combination of numbers (N) and letters (A) as shown in Table 8.13.A – Drawing Number Format

NNAAAANNNNN	N		NNNAAA	AA	NN	NNNNNN
Project Number	Contract Code	Organization Codes	Location code	Discipline Code	Drawing Type Code	Sequence Number
Element 1	Element 2	Element 3	Element 5	Element 6	Element 7	Element 8
11 Characters	1 Character	3 Characters	6 Characters	2 Characters	2 Characters	6 Characters

TABLE 8.13.A – DRAWING NUMBER FORMAT

For example:

17MOHG00001	1	100	250MAT	0QA	04	000001

For legibility, the standard convention will be to use a dash between each element. The above number should therefore be written as:

17MOHG00001-1-100-250MAT-0QA-04-000001

Note that the Revision Code has its own separate block on Engineering Drawings.

All relevant codes defined in this procedure will be furnished to the A/E by the Project Document Management Center if they differ from the Attachments in this document.

8.13.2.1 Element 1 - Project Number

The first element of the number is an eleven (11) character field that will consist of alpha numeric characters to denote the project number

8.13.2.2 Element 2 - Contract Code

The second element of the drawing number is a one (1) alpha character field used by the Entity to divide the Project into sub projects if required.

8.13.2.3 Element 3 - Organizational Code

The third element of the number is a three (3) character field that defines the “Organization” which is the signatory of the document. It will be the responsibility of each PDMD to create and manage their own Organization codes for their specific projects.

8.13.2.4 Element 5 - Location Code

The fifth element of the number is a six (6) character field which is used to associate drawings with physical location within a project. The field should be split in to two sections with the first section used to designate the physical location within the project and the second section used to identify the delivery stream. It will be the responsibility of each PMT to create and manage their own location codes for their specific projects.

8.13.2.5 Element 6 - Discipline Code

The Discipline Code refers to the relevant engineering sub-discipline.

8.13.2.6 Element 7 - Drawing Type code

This is the sequential drawing number within the Facility/Function/Source/Discipline

8.13.2.7 Element 8 - Sequence Number

This is the sequential drawing number within the Facility/Function/Source/Discipline and shall contain 6 characters.

8.13.2.8 Sheet Numbering

Multi sheet drawings are permitted in all sizes.

- The first sheet of a multi sheet drawing shall always contain the complete Title block, List of Drawings, Revision Block, and General Notes.
- All Sheets of multi sheet drawings shall be of the same size.

- Sheet numbering for all sheets shall include the total number of sheets as SHEET 1 OF 1, SHEET 1 OF 2, etc. Numbering of continuation sheets shall be limited to stating the specific sheet number (e.g. SHEET2, SHEET 3) without specifying the total number of sheets.

9.0 ATTACHMENTS

1. EPM-KED-TP-000001 - Drawing Title Block

Attachment 1: Drawing Title Block