



18.1 SCOPE.

18.1.1 Purpose. This Section provides a standard for the preparation and interpretation of Facility Drawings. It applies to drawing types, format and procedure normally associated with the architectural and construction industry.

18.1.2 Drawing Types. This section covers only those drawing types, format and practices that are either not included or are purposefully excluded from other sections of this manual.

18.1.3 Facility Drawings Interconnected With Hardware Drawings. The practices recommended in this SECTION apply primarily to facility drawings that show designs of systems which are or will be interconnected to hardware. During the interconnected phase, the facility system or systems can be interpreted to be an integral part of the hardware. Then the facility system configuration may be subject to the same change and control as required of the hardware.

18.1.4 Preparation Of “ON SITE” Facility Construction Drawings. The general requirements and practices included are those necessary to prepare drawings required for “ON SITE” facility construction. The additional requirements necessary for shop detail and “OFF SITE” manufactured equipment are contained in other sections of this manual.

18.2 APPLICABLE DOCUMENTS. Note: DoD Policy Memo 05-3 “Elimination of Waivers to Cite Military Specifications and Standards in Solicitation and Contracts” has eliminated the need for waivers to use MIL-SPECS and MIL-STDS on DoD contracts. (See PREFACE 1, Section 2)

MIL-STD-17/1	Mechanical Symbols (Other Than Aeronautical, Aerospacecraft and Spacecraft Use) (INACTIVE)
MIL-STD-17/2	Mechanical Symbols For Aeronautical, Aerospacecraft And Spacecraft Use (INACTIVE)
ASME Y14.100	Engineering Drawing Practices
ANSI Y32.4	Graphic Symbols for Plumbing (INACTIVE)
IEEE STD 91 /91A	Graphic Symbols for Logic Diagrams (X-Ref: ANSI Y32.14)
IEEE STD 315 /315A	Graphic Symbols for Electrical & Electronic Diagrams
IEEE C37.20.1	Standard for Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear
IEEE C37.20.2	Metal-Clad and Station-Type Cubicle Switchgear
IEEE C37.20.3	Metal-Enclosed Interrupter Switchgear
ANSI/IEEE Y32.9	Graphic Symbols for Electrical Wiring and Layout Diagrams Used in Architecture and Building Construction.



18.3 DEFINITIONS.

18.3.1 Interconnected Facility Systems Drawings.

18.3.1.1 Diagrammatic Drawing. A diagrammatic drawing delineating features and relationship of items forming an assembly or system by means of symbols and lines. A diagrammatic drawing is a graphic explanation of the manner by which an installation, assembly or system (e.g., mechanical, electrical, electronic, hydraulic, pneumatic) performs its intended function. The following Standards IEEE STD 315/315A, IEEE C37.20.1, IEEE C37.20.2, IEEE C37.20.3, MIL-STD-17/1, MIL-STD-17/2, ANSI Y32.4 and IEEE Y32.9 provide directions for use of symbology relative to diagrammatic drawings.

18.3.1.1.1 Schematic Diagram. A schematic or elementary diagram shows, by means of graphical symbols, the electrical connections and functions of a specific circuit arrangement. A schematic diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or part. (See SECTION 22.)

18.3.1.1.2 Connection Diagram. A connection or wiring diagram shows the electrical connections of an installation or of its component devices or parts. It may cover internal or external connections, or both, and contains such detail as is needed to make or trace connections that are involved. A connection diagram usually shows general physical arrangement of the component devices or parts (See SECTION 22). A connection diagram may be prepared in the form of a “running (wire) list” (See 18.3.6.2).

18.3.1.1.3 Interconnection Diagram. An interconnection diagram is a form of connection or wiring diagram which shows only external connections between units, sets, groups, and systems (See SECTION 22).

18.3.1.1.4 Single Line Diagram. A single line or one line diagram shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein (See SECTION 22.)

18.3.1.1.5 Logic Diagram. A logic diagram shows, by means of graphic symbols, the sequence and function of logic circuitry (See SECTION 22). Logic diagrams shall be prepared per requirements of IEEE STD 91 (X-Ref: ANSI Y32.14).

18.3.1.1.6 Mechanical Schematic Diagram. A mechanical schematic diagram illustrates the operational sequence or arrangement of mechanical devices. (See SECTION 4.)

18.3.1.1.7 Piping Diagram. A piping (hydraulic, pneumatic, or fluid) diagram depicts the interconnection of components by piping, tubing or hose; and, when desired, sequential flow of fluids in the system (See SECTION 4). Sufficient detail shall be shown to explain (a) the arrangement of the piping, valves, etc. or (b) operational sequence. Symbolic line representation may be used to distinguish functions of various parts in accordance with MIL-STD-17/1. When the objective is to show arrangement, the following characteristics may be shown: routing of fluids, physical locations and arrangements of components, pipe diameters, types and sizes of fittings, flow, pressure, volume, etc.



18.3.2 Hardware. Any separable assembly interconnected to a facility for purpose of test, evaluation or checkout.

18.3.3 Kit Drawing. (See SECTION 4.)

18.3.4 Plant Equipment Drawings. (See SECTION 4.)

18.3.5 Construction Drawing. A construction drawing delineates the design of buildings, structures, or related construction, ashore or afloat, individually or in groups, and is normally associated with the architectural-construction-civil engineering operations. Construction drawings establish all the interrelated elements of an architectural-civil engineering design, including pertinent services, equipment, utilities, and other engineering details. Maps, except those accompanying or used in conjunction with construction drawings, sketches, presentation drawings, perspectives and renderings are not considered to be construction drawings.

18.3.5.1 Erection Drawing. An erection drawing shows procedures and operation sequence for erection or assembly of individual items or assemblies of items. An erection drawing shall show the location of each part in the structure, identification markings, types of fastenings required, approximate weight of heavy structural members, controlling dimensions, and any other information which will contribute to erection of the structure.

18.3.5.2 Plan Drawing. A plan drawing depicts a horizontal projection of a structure showing the layout of the foundation, floor, deck, roof, or utility system (See FIGURE 1). As applicable, a plan drawing shall show shapes, sizes and materials of the foundation, its relation to the superstructure and its elevation with reference to a fixed datum plane, location of walls, partitions, bulkheads, stanchions, companionways, openings, columns, stairs, shapes and sizes of roofs, parapet walls, drainage, skylights, ventilators, etc. A plan drawing shall specify materials of construction and shall show the arrangement of structural framing. As applicable, the location of equipment or furniture may be indicated. Also a plan drawing for services may depict individual layouts for heating, plumbing, air conditioning, electrical or other utility systems.

18.3.5.3 Plot (Plat) Plan Drawing. A plot (plat) drawing depicts areas on which structures are clearly indicated with detailed information regarding their relationship to other structures, existing and proposed utilities, topography, boundary lines, roads, walks, fences, the property lines and locations, contours and profiles, shrubbery, sewer and water lines, building lines, location of structures to be constructed, existing structures, finished grades and other pertinent data. (See SECTION 4.)

18.3.5.4 Vicinity Plan Drawing. A vicinity plan drawing (or vicinity map used with construction drawings) delineates the relationship of a site to features of the surrounding area such as towns, bodies of water, railroads, highways, etc. (See SECTION 4.)

18.3.6 Special Purpose Drawings. Special purpose drawings are other than end product drawings used to supplement end product requirements. These kinds of engineering drawings may be required for management control, logistic purposes, configuration management, manufacturing aids, and other functions unique to a Government Design Activity.



18.3.6.1 Book-Form Drawings. A book-form drawing is an assemblage of related data disclosing the engineering requirements of an item, a family of items, or a system by means of pictorial delineation's, technical tabulations or a combination thereof. A book-form drawing is used for special purpose application in which it is expeditious to provide a document consisting of numerous small sheets suitable for binding into book-form (See SECTION 4). A book-form drawing shall preferably be prepared on "A" size drawing formats. Other standard size formats may be used provided the final original document size sheets are reduced to 11-inch height and can be folded to 8.5 inch width, with resultant legibility maintained. Book-form drawings shall not be prepared to circumvent the requirements for furnishing the types of drawings normally required for the delineation of an item or system.

18.3.6.2 Running (Wire) List. A running (wire) list is a book-form drawing consisting of tabular data and instructions required to establish wiring connections within or between units of an equipment or between equipment's, sets, or assemblies of systems. A running (wire) list is a type of interconnection diagram. (See SECTION 4) Normally, the principal sections of a running (wire) list shall be as follows:

- a. Title sheet.
- b. Revision status of sheets tabulation.
- c. Table of contents.
- d. Referenced documents.
- e. Illustrations. The figures necessary to supplement the tabulations shall be provided.
- f. List of units. Units shall be listed by unit or reference designation and nomenclature.
- g. Summaries of cabling information by units.

18.3.7 Facilities Drawings.

18.3.7.1 "ON SITE" Facility Construction Drawings. Facilities drawings define the design of buildings, structures, sites, or related construction either individually or in groups. They shall establish all interrelated elements in engineering features of the design, including pertinent services, equipment, and utilities. The general requirements and practices are those necessary to prepare the drawings required for "on site" facility construction. The additional requirements necessary for shop detail and "off site" manufactured equipment are not included.

18.3.7.2 Facility Drawing Types.

18.3.7.2.1 Civil Drawings. Graphic and symbolic representations of existing and/or planned surface features of a region showing the necessary construction required to develop a site. Natural and man-made features or objects (such as hills, valleys, streams, swamps, buildings and structures, power transmission lines, railroads, etc.), indicating their geometric configuration and physical relationship to other structures and boundary lines, are shown. Certain important imaginary lines (such as state, community, and property boundaries, zoning boundaries, building setbacks, coordinate grid system, etc.) are also indicated for record and reference purposes. Included in the general planning and layout of construction required to develop a site are drawings depicting structure location, grading, roads and paving, underground piping, yard structures, etc.



18.3.7.2.2 Structural Drawings. Engineering drawings that delineate such items as structural steel framing for buildings, towers, and other structures and the construction details for bridges, barges, buildings, and many other facilities components. These drawings establish the basis for the construction of the structural components of facilities. The delineation of structural drawings, by the use of symbols, dimensions, specifications, schedules, lists, reference codes, etc., describes the size and placement of beams, reinforcing steel, concrete, rivets, bolts, plates, welds, columns, etc.

Structural drawings are of three types:

- a. Structural concrete.
- b. Structural steel.
- c. Structural shop drawings.

18.3.7.2.3 Architectural Drawings. The architectural requirements for buildings and other structures, including magnitude, appearance, interior and exterior materials, location for construction details of walls, partitions, foundations, floors, roofs, doors, windows, etc., and location and /or details of equipment such as lockers, shelves, tables, etc. For structures that are basically structural concrete, structural steel, or a combination of these, the architectural drawings become key or composite drawings. These drawings depict “go together” of all components, plus all other nonstructural details such as wall and roof materials and application, stair and handrail details, window and louver installation, suspended or acoustical ceiling details, built-in counters, cabinets, etc., and all other miscellaneous steel and iron work.

18.3.7.2.4 Mechanical Drawing. The mechanical requirements delineate piping to convey solids, liquids, or gases, the construction details for mechanical devices and air-conditioning installations, and the construction details for tanks, fire protection systems, etc. These drawings establish the requirements for construction and/or planning of interrelated elements of the facility design including pertinent services, equipment, and other features required to insure the performance of the mechanical equipment. These drawings incorporate dimensions, symbols, reference to codes, conventions, schedules, diagrams, etc. in describing the size and routing of pipes, the kind of material to be used, equipment criteria, duct sizes and shapes, amount of flow and the temperature of material in pipes and ducts, valve types and location, floor and wall penetrations, tank construction, and other facets of mechanical design.

18.3.7.2.5 Electrical Drawings. Graphic representations of facilities’ electrical design requirements. These drawings shall be provided when essential for planning, procurement, construction, evaluation, recording, repair, maintenance, and use of the particular facilities.

18.3.8 Drawing Package/Set. All drawings necessary to define the design of a facility or a system. It must contain all of those drawings prepared to delineate the work of a single contractor or a subcontractor.

18.3.9 Construction Specifications. Engineering requirements intended for primary use in construction which give clear, accurate, technical requirements for items, materials, utilities, and services, including the procedure by which it will be determined that the design requirements of the facility have been met. The construction specification contains the scope of work: references applicable codes, construction practices, and



18.3.9 Construction Specifications, (Continued)

installation requirements; recommends guides for materials, certain construction testing, and general design requirements that can be more adequately described in the specifications than in separate callouts on numerous drawings.

18.3.9.1 Contents Of The Design Package. The construction specification and the set of drawings comprise the design package. Duplication of information between drawings and specifications shall be avoided.

18.3.9.2 The Governing Entity. In the case of conflict between the construction drawings and construction specifications, the specifications govern.

18.4 REVISIONS. (CHANGES)

18.4.1 Methods Of Revision. Revisions shall be made by erasure, crossing out, addition of information, or redrawing.

18.4.2 Crossing Out. When the crossing-out method is used, a series of parallel lines shall be placed on the face of the drawing (preferably at 45° angle) in a manner not to obscure the information thus changed. The superseding data, if any, or reference to its location, shall be placed near the portion crossed out and shall be indicated by a revision letter.

18.4.3 Revision Locations. To be identified by one of the following methods:

- a. Revision symbols on field of drawing. See FIGURE 18-2
- b. Description in the revision block. See FIGURE 18-2
- c. Revision authorization document referenced on drawing. See FIGURE 18-3
- d. Zone in the revision authorization block. See FIGURE 18-2
- e. Combinations of a, b, c of the above, when required for clarity.

18.4.3.1 Exception Of Use. When revision symbols are used and many changes are involved in one area such that separate revision symbols would crowd the drawing, a single revision symbol may be used to identify the changes provided sufficient supplementary information is included within the referenced revision authorization document.

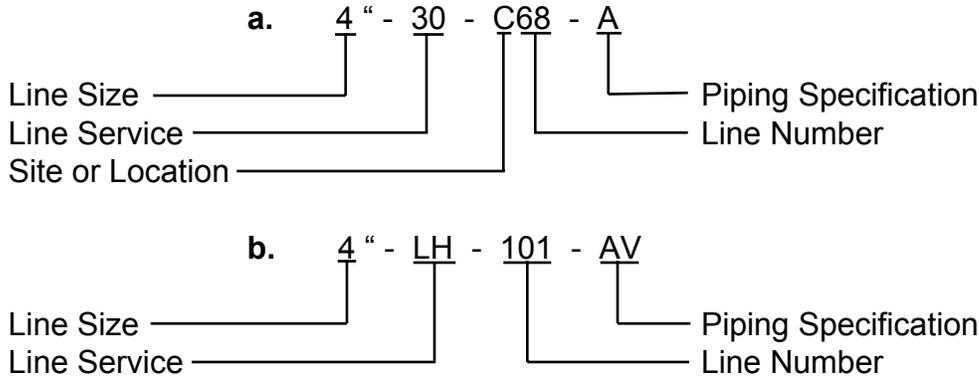
18.4.4 Deviation Of Use Of Revision Symbol. Revision symbols shall not be used on book-form drawings, master art-work or undimensioned drawings, and schematic or wiring diagrams where the use of such symbols may conflict with other symbols as used on these types of drawings.

18.5 IDENTIFICATION MARKING.

18.5.1 Identification Limited To Facility Drawings. See SECTION 11 for marking and identification of assemblies, end items, parts and plant equipment.



18.5.2 Identification Of Functional A Operation On Schematic Diagrams. Systems may be identified for functional operation by assigning line numbers on schematic diagrams.



18.5.2.3 Miscellaneous Line Identification Procedures.

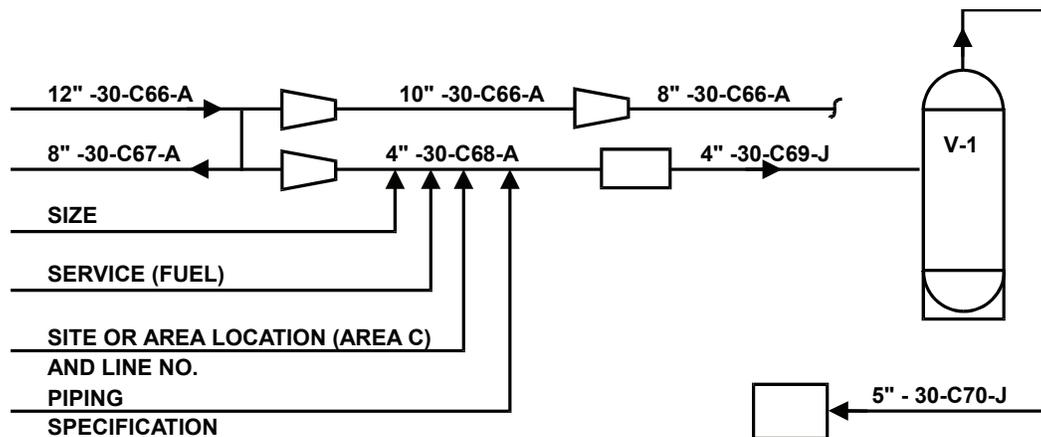
18.5.2.3.1 Stub Connections. Stub connections on manifold and headers carry the manifold or header line number.

18.5.2.3.2 Parallel Suction Lines. Parallel suction lines to two pumps, from common header, may carry the same line number.

18.5.2.3.3 Parallel Discharge Lines. Parallel discharge lines from two pumps to a common header may carry the same line number.

18.5.2.3.4 Distribution Headers. Distribution headers retain the same line number through size changes. Branches off main header are assigned different line numbers than header.

18.5.2.3.5 Changes. When material specification change occurs in a pipeline, a different line number shall be assigned.



EXAMPLE OF SYSTEM IDENTIFICATION



18.6 DRAWING SCALES.

18.6.1 Types Of Drawing Scales. Use one of the following scale methods for selecting a proper drawing scale.

18.6.1.1 Fractional Method. The fractional method expresses the ratio of the size of the object as drawn to its true size in the form of a common fraction.

18.6.1.2 Equation Method. The equation method expresses, the relationship of the size of the object as drawn to its true dimension in the form of an equation.

18.6.2 Typical Scales. The following typical scales are recommended for various types of drawings.

18.6.2.1 Civil.

Area Plot Plan: 1" = 200'

Grading, Plot Plan, Paving and Utilities Plan: 1" = 20' or 1" = 10'

18.6.2.2 Structural/Architectural.

Buildings and structure: 1/8" or 1/4" = 1'0"

Foundation details: 1/2" or 3/4" = 1'0"

Steel structure details: 3/4" or 1" = 1'0"

18.6.2.3 Mechanical.

Piping: 3/8" = 1'0"

Vessels: Scale to suit sheet size

Plumbing: 1/8" or 1/4" = 1'0"

Isometrics: No Scale

Mechanical Specialties: Full Size 1/1
Enlarged 2/1, 4/1, 10/1
Reduced 1/2, 1/4, 1/10, 1/20 up to 1/100



18.6.2.4 Electrical.

Wiring Diagram: No Scale

Building and Structures: 1/8, 1/4" or 1/2" = 1'0"

18.6.2.5 Instrumentation.

Wiring Diagrams: No Scale

Building and Structures: 1/8" or 1/4" = 1'0"

18.6.3 BAR SCALES. (Graphs)

18.6.3.1 Use Of Bar Scales. Bar scales (graphs) may be used on all drawings with the exception of schematics, sketches, wiring diagrams and tabulations, piping and shop drawings.

18.6.3.2 Bar Scale Placement. Place the bar scale a minimum of 2-1/2" to the left of the title block, and 1" above and parallel to the border line.

18.6.3.3 Use Of More Than One Bar Scale. If more than one scale is used on any drawing, show only the maximum and minimum scales (bar graphs) used. Indicate other scales at the respective views. See FIGURES 18-4 and 18-5

18.7 DRAWING FORMAT AND SIZES.

18.7.1 Drawing Size and Format. For drawing sizes and format see SECTION 6.

18.7.1.1 Drawing Size. All drawings in bid/construction packages shall use one size (normally "F" size). (See SECTION 6)

18.7.1.2 Drawing Sheet Number. All drawings in a bid/construction package shall be single sheet and individually numbered.

18.7.1.3 Index Sheet. The index sheet in a bid/construction package shall list all applicable drawings, reference drawings, and standard drawings.

18.7.1.4 Sheet Numbering. The package of drawings shall be numbered consecutively by sheet number in respect to the total bid/construction package.

18.7.1.5 "Reference Only" Drawings. "Reference Only" drawings are not considered as contract drawings and do not contain a sheet number of the package.

18.7.2 Multiple Engineering Disciplines Involved. When more than one engineering discipline is involved such as civil, mechanical, electrical, etc., secondary top drawings should be made to show features peculiar to the discipline. Secondary top drawings and subordinate drawings must show the drawing type in the title.



18.7.3 Sample Format Blocks.

18.7.3.1 Title Block. (See SECTION 6)

18.7.3.2 Parts List.

18.7.3.2.1 Parts List Preparation. For drawings on shop detail, off-site manufactured equipment, or fabrication drawings. See SECTION 10.

18.7.3.2.2 Parts List Restriction. Parts lists are not normally used on construction drawings.

18.7.3.3 Reference Drawing Block. This block is for the entry of reference drawing numbers and titles. The following examples indicate the intended use of this block: See FIGURE 18-6.

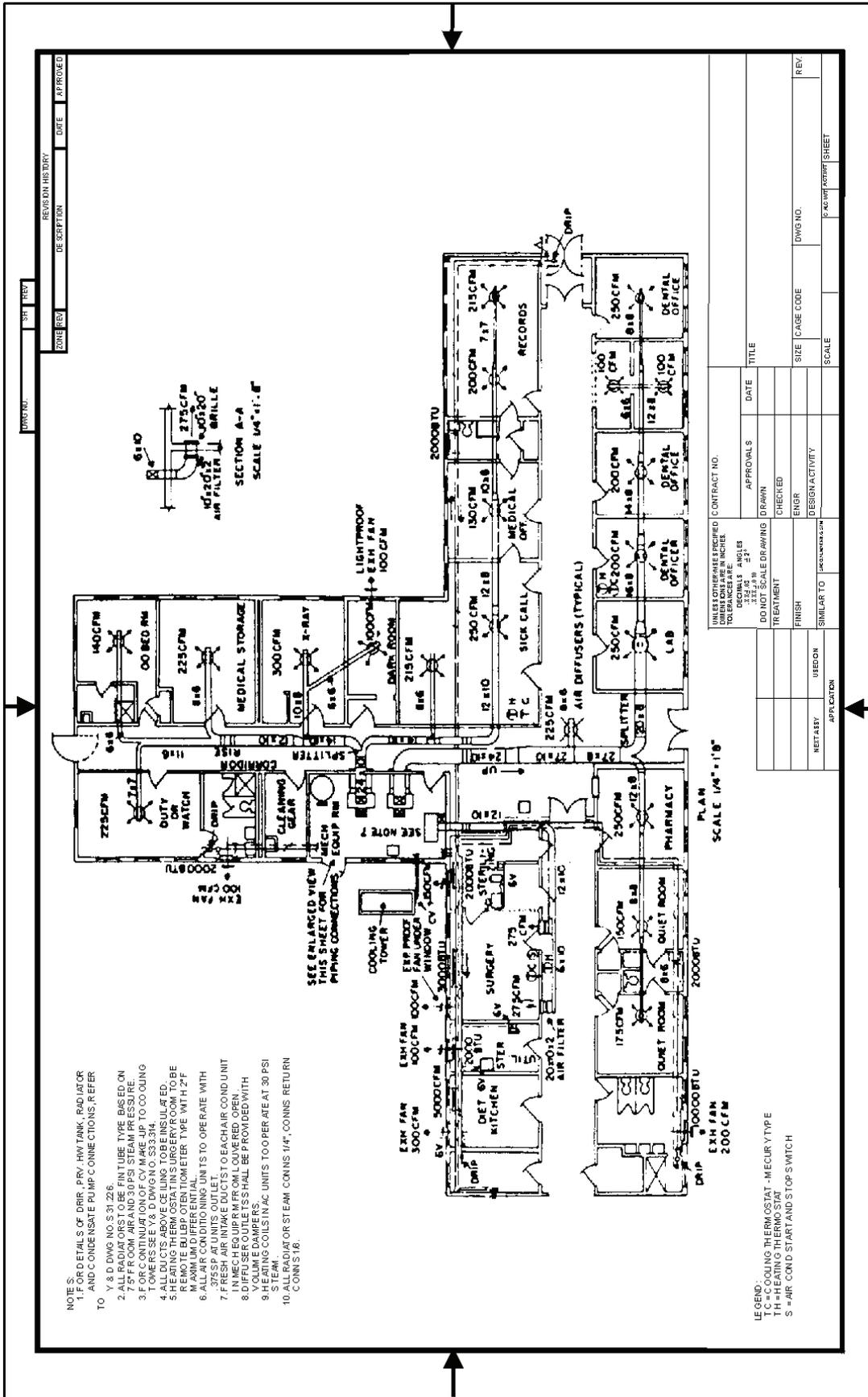
- a. Package index of all drawings.
- b. Floor plan drawings shall reference their related plot plans, steel framing plans and details.
- c. Installation drawings shall reference their related civil, structural, or plot plan drawings.
- d. Electro/Mechanical Assembly drawings shall reference their related schematic and wiring diagrams.
- e. Bay group drawings shall reference their related interconnection diagrams, block diagrams, system schematics or tabulations.
- f. Schematic diagram drawings shall reference their related wiring diagrams, block diagrams or tabulations.

18.7.3.4 Drawing Notes. See SECTION 9.

18.7.3.5 Tabulation Blocks. (Schedules) See FIGURES 18-1 and 18-6.

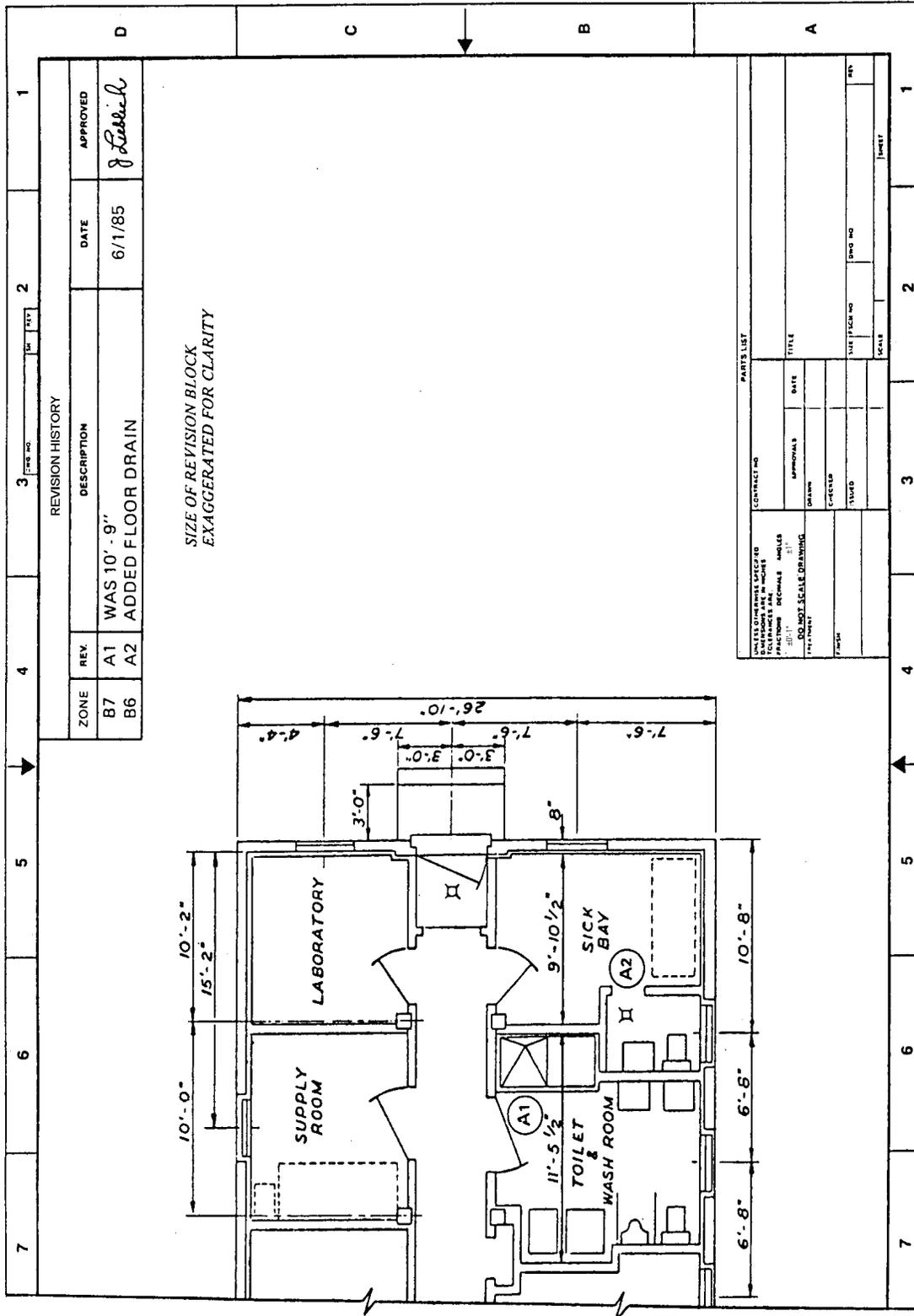
18.7.3.6 Revision Blocks. (Changes) See FIGURES 18-2 and 18-3.

18.7.3.7 Legend Blocks. See FIGURE 18-6.



THIS SAMPLE DRAWING IS INFORMATIONAL ONLY AND COMPLETE TO THE DEGREE NECESSARY TO ILLUSTRATE THE TYPE OF DRAWING BEING DESCRIBED.

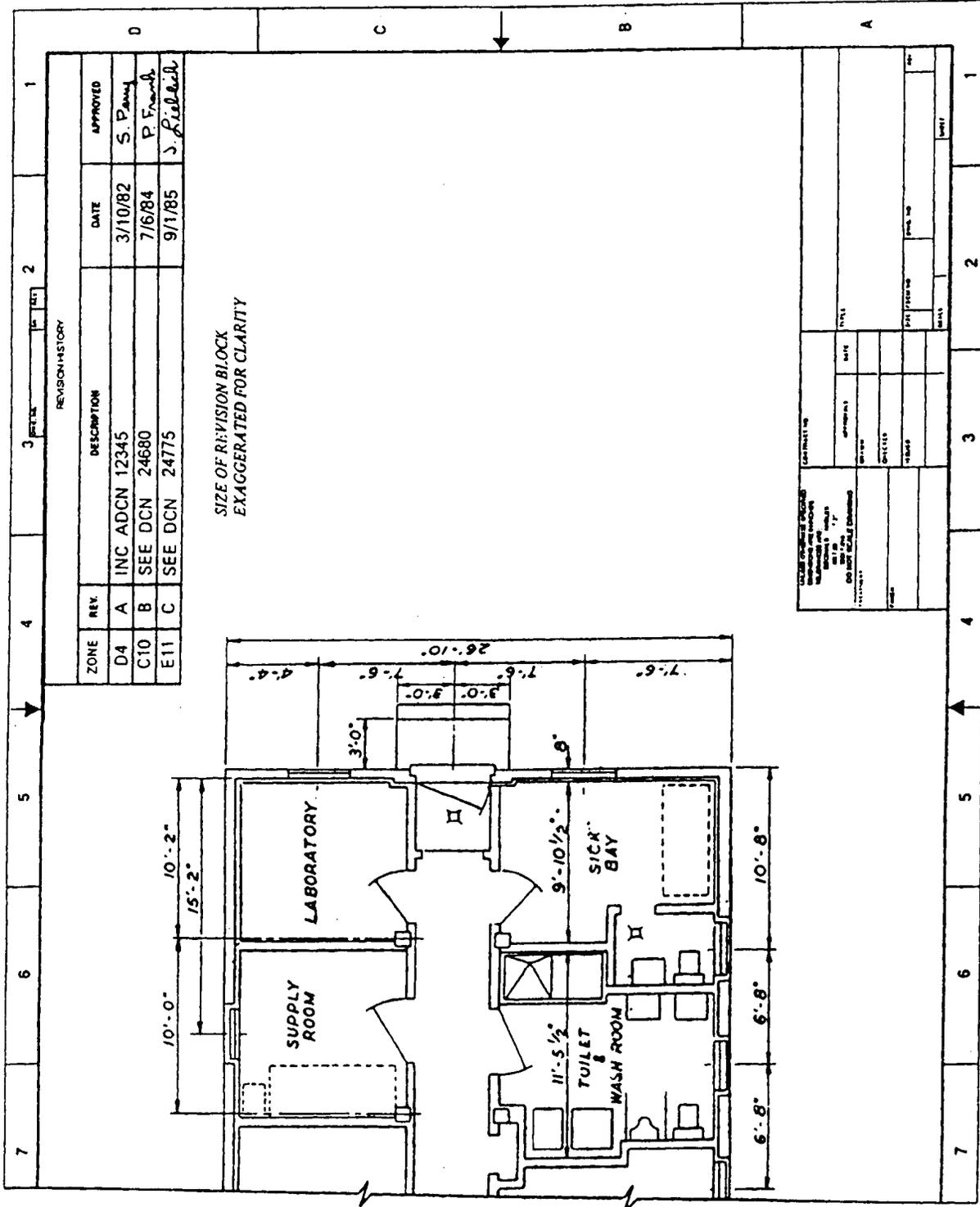
PLAN DRAWING
FIGURE 18-1



REVISION SYMBOL ON FIELD OF DRAWING.

FIGURE 18-2

THIS SAMPLE DRAWING IS INFORMATIONAL ONLY AND COMPLETE TO THE DEGREE NECESSARY TO ILLUSTRATE THE TYPE OF DRAWING BEING DESCRIBED.



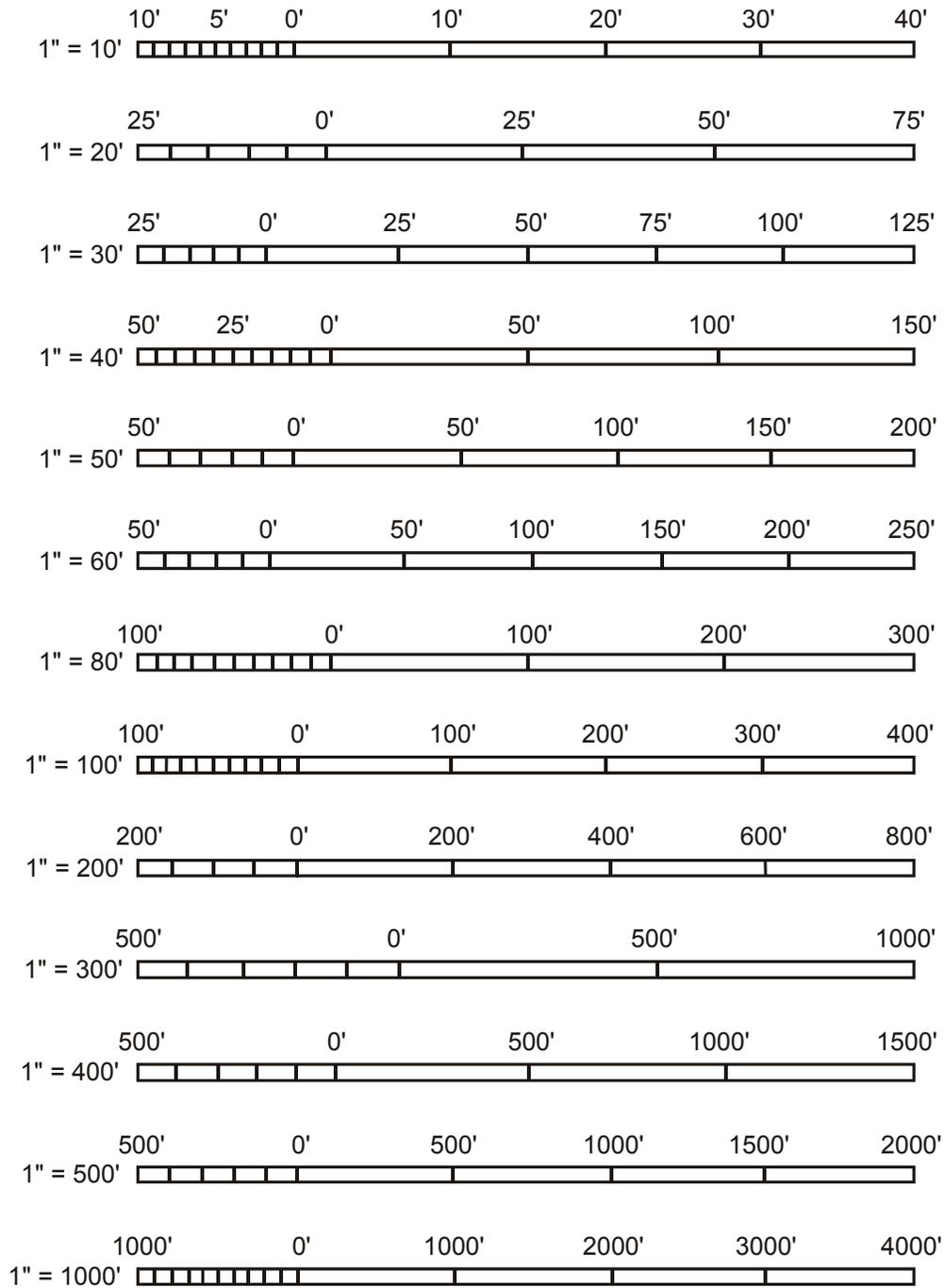
THIS SAMPLE DRAWING IS INFORMATIONAL ONLY AND COMPLETE TO THE DEGREE NECESSARY TO ILLUSTRATE THE TYPE OF DRAWING BEING DESCRIBED.

REVISION BLOCK CHANGES.

FIGURE 18-3

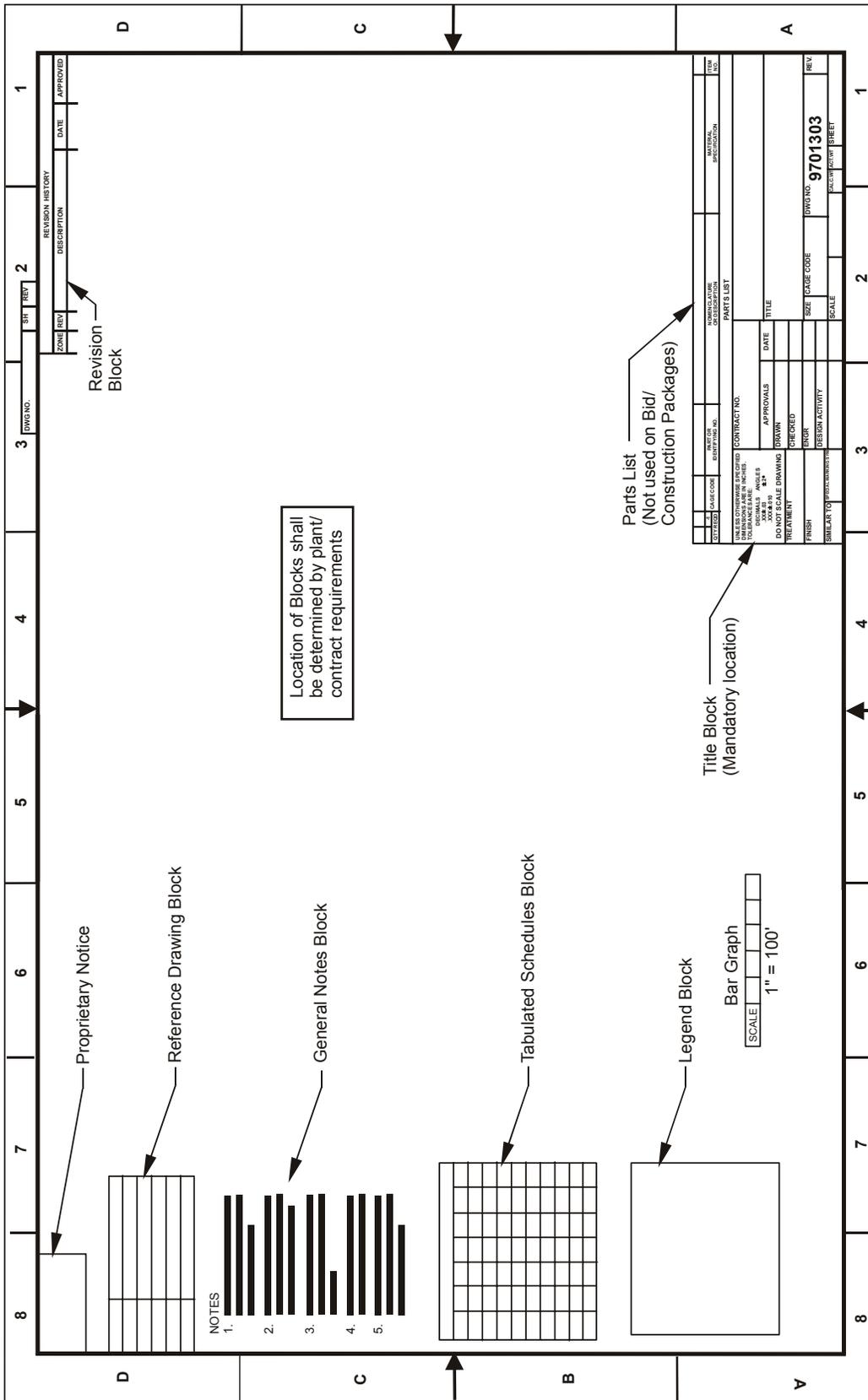


GRAPHIC SCALE
ARCHITECTURAL TYPE
FIGURE 18-4



GRAPHIC SCALE
ENGINEERING TYPE.

FIGURE 18-5



LOCATION OF INFORMATION BLOCKS ON DRAWING

FIGURE 18-6

THIS SAMPLE DRAWING IS INFORMATIONAL ONLY AND COMPLETE TO THE DEGREE NECESSARY TO ILLUSTRATE THE TYPE OF DRAWING BEING DESCRIBED.