Chapter 3

Drawings and Specifications

Topics

1.0.0 Design of Structural Members
2.0.0 Drawings
3.0.0 Sectional Views
4.0.0 Schedules
5.0.0 Written Specifications
6.0.0 Electronic Drawings

Overview

By this time in your Navy career, you have probably worked as a crewmember on various building projects. You probably did your tasks without thinking much about how to lay out structures to conform to location, size, shape, and other building features. In this chapter, you will learn how to extract this information from drawings and specifications. This chapter will cover basic print reading skills and the symbols, abbreviations, and conventions that show and describe building materials. You will learn how to draw, read, and work from simple shop drawings and sketches. If you are using an electronic version of this rating manual, you will also learn to read and manipulate electronic drawings.

Project drawings and specifications thoroughly detail everything that your crew will need to estimate, plan, and construct a building; in addition to developing a Material Take Off (MTO)/Bill of Material (BM). You can bring projects in at or below cost by producing complete MTO/BM that conveys an adequate level of detail.

Objectives

When you have completed this chapter, you will be able to do the following:

1. Identify different types of structural members.
2. Recognize different types of drawings and their uses.
3. Interpret sectional views.
4. Interpret building schedules.
5. Interpret written construction specifications.
Prerequisites

None

This course map shows all of the chapters in Builder Basic. The suggested training order begins at the bottom and proceeds up. Skill levels increase as you advance on the course map.

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<thead>
<tr>
<th>Chapter</th>
<th>Skill Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expeditionary Structures</td>
<td>B</td>
</tr>
<tr>
<td>Finishes</td>
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<td>Moisture Protection</td>
<td>I</td>
</tr>
<tr>
<td>Finish Carpentry</td>
<td>L</td>
</tr>
<tr>
<td>Rough Carpentry</td>
<td>D</td>
</tr>
<tr>
<td>Carpentry Materials and Methods</td>
<td>E</td>
</tr>
<tr>
<td>Masonry</td>
<td>R</td>
</tr>
<tr>
<td>Fiber Line, Wire Rope, and Scaffolding</td>
<td>B</td>
</tr>
<tr>
<td>Concrete Construction</td>
<td>A</td>
</tr>
<tr>
<td>Site Work</td>
<td>S</td>
</tr>
<tr>
<td>Construction Management</td>
<td>I</td>
</tr>
<tr>
<td>Drawings and Specifications</td>
<td>C</td>
</tr>
<tr>
<td>Tools</td>
<td></td>
</tr>
<tr>
<td>Basic Math</td>
<td></td>
</tr>
</tbody>
</table>

Features of this Manual

This manual has several features which make it easy to use online.

- Figure and table numbers in the text are italicized. The figure or table is either next to or below the text that refers to it.

- The first time a glossary term appears in the text, it is bold and italicized. When your cursor crosses over that word or phrase, a popup box displays with the appropriate definition.

- Audio and video clips are included in the text, with an italicized instruction telling you where to click to activate it.

- Review questions that apply to a section are listed under the Test Your Knowledge banner at the end of the section. Select the answer you choose. If the answer is correct, you will be taken to the next section heading. If the answer is incorrect, you will be taken to the area in the chapter where the information is for
review. When you have completed your review, select anywhere in that area to return to the review question. Try to answer the question again.

- Review questions are included at the end of this chapter. Select the answer you choose. If the answer is correct, you will be taken to the next question. If the answer is incorrect, you will be taken to the area in the chapter where the information is for review. When you have completed your review, select anywhere in that area to return to the review question. Try to answer the question again.
1.0.0 DESIGN OF STRUCTURAL MEMBERS

From the Builder’s standpoint, building designs and construction methods depend on many factors. No two building projects are alike. The factors usually considered before a structure is designed are its geographical location and the availability of construction materials.

It is easy to see why geographical location is important to the design of a structure, especially its main parts. In a northern temperate zone, for example, the roof of a structure must be sturdy enough to avoid collapsing under the weight of snow and ice. Also, the foundation walls have to extend below the frost line to guard against the effects of freezing and thawing. In the tropics, a structure should have a low-pitch roof and be built on a concrete slab or have shallow foundation walls.

Likewise, the availability of construction materials can influence the design of a structure. This happens when certain building materials are scarce in a geographical location, and the cost of shipping them is prohibitive. In such a case, particularly overseas, the structure is likely to be built with materials purchased locally. This can affect the way you use construction materials; it means working with foreign drawings and metric units of weights and measures.

By comparing the designs of the two structures shown in Figures 3-1 and 3-2, you can see that each is designed according to its function.

Figure 3-1 – Typical light frame construction.
For example, light frame construction is usually found in residential buildings that require a number of small rooms.

**Figure 3-2 – Typical concrete masonry and steel structure.**

Concrete masonry and steel construction is used for warehouse type facilities, which require large open spaces. You should study these figures carefully and learn the terminology. Depending on the use of the structure, you may use any combination of structural **members**.

### 1.1.0 Dead and Live Loads

The main parts of a structure are the load-bearing members. These support and transfer the loads on the structure while remaining equal to each other. The places where members are connected to other members are called joints. The total sum of the load supported by the structural members at a particular instant is equal to the total **dead load** plus the total **live load**.

The total **dead load** is the total weight of the structure, which gradually increases as the structure rises and remains constant once it is complete. The total **live load** is the total weight of movable objects, such as people, furniture, and bridge traffic, the structure happens to be supporting at a particular instant.

A structure transmits live loads through the various load-bearing structural members to the ultimate support of the earth. First, horizontal members provide immediate or direct support for the live loads. Vertical members, in turn, support the horizontal members. Finally, the vertical members are supported by foundations or **footings**, which are
supported by the earth. Look at Figure 3-1, which illustrates both horizontal and vertical members of a typical light frame structure. The weight of the roof material is distributed over the top supporting members and transferred through all joining members to the soil.

The ability of the earth to support a load is called its soil-bearing capacity. This varies considerably with different types of soil. A soil of a given **bearing capacity** bears a heavier load on a wide foundation or footing than on a narrow one.

Loads are covered in much greater detail in the Builder Advanced rate training manual. This section is meant to be a brief introduction to the concept of load.

### 1.2.0 Vertical Structural Members

In heavy construction, vertical structural members are high-strength **columns**. In large buildings, these are called **pillars**. Outside wall columns and inside bottom floor columns usually rest directly on footings. Outside wall columns usually extend from the footing or foundation to the roof line. Inside bottom floor columns extend upward from footings or foundations to the horizontal members, which, in turn, support the first floor or roof, as shown in Figure 3-2. Upper floor columns are usually located directly over lower floor columns.

In building construction, a **pier**, sometimes called a short column, rests either directly on a footing, as shown in the lower center of Figure 3-3, or is simply set or driven into the ground. Building piers usually support the lowermost horizontal structural members.
The chief vertical structural members in light frame construction are called **studs**, shown in *Figures 3-1 and 3-3*. They are supported by horizontal members called **sills** or **soleplates**, shown in *Figure 3-3*. **Corner posts** are enlarged studs located at the building corners. At one time, in full frame construction, a corner post was usually a solid piece of larger timber. Most modern construction uses built-up corner posts. These consist of various members of ordinary studs nailed together in various ways.

In bridge construction, a pier is a vertical member that provides intermediate support for the bridge **superstructure**, as shown in *Figure 3-4*.

![Figure 3-4 – Pier supporting bridge superstructure.](image)

### 1.3.0 Horizontal Structural Members

Any horizontal load-bearing structural member that spans a space and is supported at both ends is considered a **beam**. A member fixed at only one end is called a **cantilever** beam. A **joist** is a horizontal supporting member generally smaller than a beam. Steel members that consist of solid pieces of regular structural steel are referred to as structural shapes. The **girder**, shown in *Figure 3-2*, is a structural shape. Other prefabricated, open-web, structural-steel shapes are called **bar joists**, also shown in *Figure 3-2*.

Horizontal structural members that support the ends of floor beams or joists in wood-frame construction are called sills or girders, shown in *Figures 3-1 and 3-3*, depending on the type of framing and the location of the member in the structure. Horizontal members that support studs are called soleplates. They may also have other names, depending on the type of framing. Horizontal members that support the wall ends of **rafters** are called **rafter plates**. Horizontal members that assume the weight of concrete or masonry walls above door and window openings are called **lintels**, shown in *Figure 3-2*.

The horizontal or inclined members that provide support to a roof are called **rafters**, shown in *Figure 3-1*. The lengthwise member at a right angle to the rafters, which supports the peak ends of the rafters in a roof, is called the **ridge**. The ridge may be called a **ridgeboard**, the ridge piece, or the **ridgepole**. Lengthwise members other than ridges are called purlins. In wood frame construction, the wall ends of rafters are supported on horizontal members called rafter plates, which are in turn supported by the

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**NAVEDTRA 14043A 3-7**
outside wall studs. In concrete or masonry construction, the wall ends of rafters may be anchored directly on the walls or on plates bolted to the walls.

A beam of given strength, without intermediate supports below; can support a given load over only a specific maximum span. When the span is wider than this maximum space, the beam requires intermediate supports such as columns. Sometimes it is either not feasible or impossible to increase the beam size or to install intermediate supports. In such cases, a **truss** provides the required support. A truss is a combination of members, such as beams, bars, and ties, usually arranged in triangular units, that forms a rigid framework for supporting loads over a span.

The basic components of a roof truss are the top and bottom **chords** and the web members. The top chords serve as roof rafters. The bottom chords act as ceiling joists. The web members run between the top and bottom chords. The truss parts are usually made of 2 by 4 inch or 2 by 6 inch material and tied together with metal or plywood **gusset plates**, shown in [Figure 3-5](#).

![Figure 3-5 – A truss rafter.](image)

Roof trusses come in a variety of shapes and sizes. The most commonly used roof trusses for light frame construction are the king-post, the W-type, and the scissors trusses, shown in [Figure 3-6](#).
The simplest type of truss used in frame construction is the king-post truss. It is mainly used for spans up to 22 feet. The most widely used truss in light frame construction is the W-type truss. The W-type truss can be placed over spans up to 50 feet. The scissors truss is used for buildings with sloping ceilings. Generally, the slope of the bottom chord equals one half the slope of the top chord. It can be placed over spans up to 50 feet.

**Test your Knowledge (Select the Correct Response)**

1. At any given time, building structural members must be able to support which of the following loads?

   A. Dead loads only  
   B. Live loads only  
   C. Total dead plus total live loads  
   D. Dead load minus live load

**2.0.0 DRAWINGS**

The building of any structure is described by a set of related drawings that give the Builder a complete, sequential, graphic description of each phase of the construction process. In most cases, a set of drawings begins by showing the location, boundaries, contours, and outstanding physical features of the construction site and its adjoining areas. Succeeding drawings give instructions for the excavation and disposition of existing ground; construction of foundations and superstructure; installation of utilities,
such as plumbing, heating, lighting, air conditioning, interior and exterior finishes; and whatever else is required to complete the structure.

The engineer works with the architect to decide what materials to use in the structure and the construction methods to follow. The engineer determines the loads that supporting members will carry and the strength qualities the members must have to bear the loads. The engineer also designs the mechanical systems of the structure, such as the lighting, heating, and plumbing systems. The end result is the architectural and engineering design sketches. These sketches guide draftsmen in preparing the construction drawings.

Any field adjustments to the designs have to be approved by the designer. Submit a Field Adjustment Request (FAR) to request any adjustments.

### 2.1.0 Construction Drawings

Generally, construction or working drawings furnish enough information for the Builder to complete an entire project and incorporate all five main groups of drawings listed below:

**Architectural – A**
- Site Plan
- Foundation Plan
- Floor Plans
- Interior/Exterior Elevations
- Sections
- Details
- Schedules

**Structural – S**

**Plumbing – P**

**Mechanical – M**

**Electrical – E**

In drawings for simple structures, this grouping may be hard to discern because a single drawing may contain both the electrical and mechanical layouts. In complicated structures, a combination of layouts is not possible because of overcrowding. In this case, the floor plan may be traced over and over for separate drawings for the electrical and mechanical layouts.

All or any one of the five types of drawings gives you enough information to complete a project. The specific one to use depends on the nature of construction involved. The construction drawing furnishes enough information for the particular tradesman to complete a project, whether architectural, structural, plumbing, mechanical, or electrical. Normally, construction drawings include the detail drawings, assembly drawings, and the specifications in order to develop a complete MTO/BM.
Construction drawings consist mostly of right angle and perpendicular views prepared by draftsmen using standard technical drawing techniques, symbols, and other designations as stated in military standards (MIL-STDS). The first section of the construction drawings consists of the site plan, plot plan, foundation plans, floor plans, and framing plans. General drawings consist of plans (views from above) and elevations (side or front views) drawn on a relatively small scale. Both types of drawings use a standard set of architectural symbols. Figures 3-7 and 3-8 show some examples of construction drawings.

Figure 3-7 – Construction drawings – architecture.
Figure 3-8 – Construction drawing – plot plan.

A detail drawing shows a particular item on a larger scale than that of the general drawing in which the item appears. Or, it may show an item too small to appear at all on a general drawing.

An assembly drawing is either an exterior or a sectional view of an object showing the details in proper relationship to one another. Assembly drawings are usually drawn to a smaller scale from the dimensions of the detail drawings. This provides a check on the accuracy of the design drawings and often discloses errors.

The title block shown in Figure 3-9 is the logical place to begin reading a set of prints. Information in the title block includes:

- Name and number of the project
- Project location
- Architect and engineer names
- Drafter
- Number of sheets
- Name of sheets and revisions (if applicable)
Construction drawings use many symbols. Figure 3-10 illustrates the conventional symbols for the more common types of material used on structures.

- **Sections**
- **Elevations**

**Brick**
- **Sections**
- **Elevations**

**Concrete**
- **Sections**
- **Sand**
- **Water**
- **All Materials Elevations**

**Earth, etc.**
- **Glass**
- **Plaster Sections**
- **Tile**
- **Glass Elevations**
- **Plaster Elevations**

**Glass, etc.**
- **Aluminum**
- **Brass**
- **Cast Iron**
- **Steel**
- **All Materials Elevations**

**Metals**
- **Cast Sections**
- **Rubble**
- **Cut Elevations**

**Stone**
- **End**
- **Finish Sections**
- **Rough**
- **Grain**
- **Finish Elevations**

**Wood**
- **Siding**

Figure 3-10 – Architectural symbols for plans and elevations.
Figure 3-11 shows topographic symbols used in site plans and plot plans.

- **Paved Road**
- **Unpaved Road**
- **Railroad Track**
- **Property Line**
- **Telephone Line**
- **Power Line**
- **Gas Line**
- **Water Line**
- **Sewer Line**
- **Storm Sewer**
- **Leaching Field**
- **Sidewalk**
- **Bench Marks**
- **Monument**
- **Property Corner**
- **Required Contour**
- **Existing Contour**
- **Existing Spot Elevation**
- **Required Spot Elevation**
- **North Arrow**

**Figure 3-11 – Topographic symbols.**
Figure 3-12 shows Steel Structural Shapes and Designations.

<table>
<thead>
<tr>
<th>Description</th>
<th>Example</th>
<th>Symbol</th>
<th>Illustrated Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-Shape (Wide Flange)</td>
<td>W</td>
<td>W24 x 78</td>
<td></td>
</tr>
<tr>
<td>Bearing Pile</td>
<td>BP</td>
<td>BP14 x 73</td>
<td></td>
</tr>
<tr>
<td>S-Shape (American STD I-Beam)</td>
<td>S</td>
<td>S15 x 42.9</td>
<td></td>
</tr>
<tr>
<td>C-Shape (American STD Channel)</td>
<td>C</td>
<td>C9 x 13.4</td>
<td></td>
</tr>
<tr>
<td>M-Shape (Misc Shapes Other Than W, BP, S, &amp; C)</td>
<td>M</td>
<td>M5 x 34.3</td>
<td></td>
</tr>
<tr>
<td>M5 x 17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MC-Shape (Channels Other Than American STD)</td>
<td>MC</td>
<td>MC 12 x 45</td>
<td></td>
</tr>
<tr>
<td>MC 12 x 12.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3x3x3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angles:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal Leg</td>
<td>L</td>
<td>L 3x 3x 1/4</td>
<td></td>
</tr>
<tr>
<td>Un-equal Leg</td>
<td>L</td>
<td>L 7x 4x 1/2</td>
<td></td>
</tr>
<tr>
<td>Tees, Structural:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cut From W-Shape</td>
<td>WT</td>
<td>WT 12x38</td>
<td></td>
</tr>
<tr>
<td>Cut From S-Shape</td>
<td>ST</td>
<td>ST 12x38</td>
<td></td>
</tr>
<tr>
<td>Cut From M-Shape</td>
<td>MT</td>
<td>MT 12x38</td>
<td></td>
</tr>
<tr>
<td>Plate</td>
<td>PL</td>
<td>PL 1/2x18&quot;x30&quot;</td>
<td></td>
</tr>
<tr>
<td>Flat Bar</td>
<td>BAR</td>
<td>BAR 2 1/2 x 1/4</td>
<td></td>
</tr>
<tr>
<td>Pipe, Structural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe 4 STD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe 4x-STRG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe XX-STRG</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 3-13 shows basic weld symbols.

<table>
<thead>
<tr>
<th>BEAD</th>
<th>FILLET</th>
<th>PLUG OR SLOT</th>
<th>SQUARE</th>
<th>V</th>
<th>BEVEL</th>
<th>U</th>
<th>J</th>
<th>FLARE V</th>
<th>FLARE BEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
<td><img src="image10.png" alt="Image" /></td>
</tr>
</tbody>
</table>

Figure 3-13 – Basic weld symbols.
Figure 3-14 shows contour symbols for welds.

![Contour symbols for welds](image)

**Figure 3-14 – Contour symbols for welds.**

Figure 3-15 shows line standards for welds.

![Line standards for welds](image)

**Figure 3-15 – Line standards for welds.**
Figure 3-16 shows symbols for HVAC components.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Symbol" /></td>
<td>Ceiling Diffuser (Arrows Indicate Direction of Air Flow)</td>
</tr>
<tr>
<td><img src="image2" alt="Symbol" /></td>
<td>Return Air Grille</td>
</tr>
<tr>
<td><img src="image3" alt="Symbol" /></td>
<td>Supply Duct Up</td>
</tr>
<tr>
<td><img src="image4" alt="Symbol" /></td>
<td>Supply Duct Down</td>
</tr>
<tr>
<td><img src="image5" alt="Symbol" /></td>
<td>Return Duct Up</td>
</tr>
<tr>
<td><img src="image6" alt="Symbol" /></td>
<td>Return Duct Down</td>
</tr>
<tr>
<td><img src="image7" alt="Symbol" /></td>
<td>Neck Size/ Air Device</td>
</tr>
<tr>
<td><img src="image8" alt="Symbol" /></td>
<td>Thermostat</td>
</tr>
</tbody>
</table>

Legend:
- Square to Round Transition
- Parallel Blade Damper
- Fire Damper (Wall) (Floor)
- Airfoil Blade Turning Vanes
- Air Extractor
- Diameter
- CFM (Cubic Feet Per Minute)
- RA Return Air
- OSA Outside Air
- CD Condensate Drain

Figure 3-16 – HVAC symbols.
Figure 3-17 shows symbols for electrical components.

<table>
<thead>
<tr>
<th>General Outlets</th>
<th>Receptacle Outlets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction Box, Ceiling</td>
<td>Single Receptacle</td>
</tr>
<tr>
<td>Fan, Ceiling</td>
<td>Duplex Receptacle</td>
</tr>
<tr>
<td>Recessed Incandescent, Wall</td>
<td>Triplex Receptacle</td>
</tr>
<tr>
<td>Surface Incandescent, Ceiling</td>
<td>Split-Wired Duplex Recep.</td>
</tr>
<tr>
<td>Surface or Pendant Single</td>
<td>Single Special Purpose Recep.</td>
</tr>
<tr>
<td>Fluorescent Fixture</td>
<td>Duplex Special Purpose Recep.</td>
</tr>
<tr>
<td></td>
<td>Range Receptacle</td>
</tr>
<tr>
<td><strong>Switch Outlets</strong></td>
<td>Switch &amp; Single Receptacle</td>
</tr>
<tr>
<td>Single-Pole Switch</td>
<td>Grounded Duplex Receptacle</td>
</tr>
<tr>
<td>Double-Pole Switch</td>
<td>Duplex Weatherproof Receptacle</td>
</tr>
<tr>
<td>Three-Way Switch</td>
<td>GFCI</td>
</tr>
<tr>
<td>Four-Way Switch</td>
<td><strong>Auxiliary Systems</strong></td>
</tr>
<tr>
<td>Key-Operated Switch</td>
<td>Telephone Jack</td>
</tr>
<tr>
<td>Switch w/ Pilot</td>
<td>Meter</td>
</tr>
<tr>
<td>Low-Voltage Switch</td>
<td>Vacuum Outlet</td>
</tr>
<tr>
<td>Door Switch</td>
<td>Electric Door Opener</td>
</tr>
<tr>
<td>Momentary Contact Switch</td>
<td>Chime</td>
</tr>
<tr>
<td>Weatherproof Switch</td>
<td>Pushbutton (Doorbell)</td>
</tr>
<tr>
<td>Fused Switch</td>
<td>Bell and Buzzer Combination</td>
</tr>
<tr>
<td>Circuit Breaker Switch</td>
<td>Kitchen Ventilating Fan</td>
</tr>
<tr>
<td></td>
<td>Lighting Panel</td>
</tr>
<tr>
<td></td>
<td>Power Panel</td>
</tr>
<tr>
<td></td>
<td>Television Outlet</td>
</tr>
</tbody>
</table>

Figure 3-17 – Electrical symbols.
Figure 3-18 shows symbols for plumbing and piping.

<table>
<thead>
<tr>
<th>Plumbing</th>
<th>Piping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corner Bath</td>
<td>Soil and Waste</td>
</tr>
<tr>
<td>Recessed Bath</td>
<td>Soil and Waste, Underground</td>
</tr>
<tr>
<td>Roll Rim Bath</td>
<td>Vent</td>
</tr>
<tr>
<td>Sitz Bath</td>
<td>Cold Water</td>
</tr>
<tr>
<td>Floor Bath</td>
<td>Hot Water</td>
</tr>
<tr>
<td>Bidet</td>
<td>Hot Water Return</td>
</tr>
<tr>
<td>Shower Stall</td>
<td>Fire Line</td>
</tr>
<tr>
<td>Shower Head</td>
<td>Gas</td>
</tr>
<tr>
<td>Overhead Gang Shower</td>
<td>Acid Waste</td>
</tr>
<tr>
<td>Pedestal Lavatory</td>
<td>Drinking Water Supply</td>
</tr>
<tr>
<td>Wall Lavatory</td>
<td>Drinking Water Return</td>
</tr>
<tr>
<td>Corner Lavatory</td>
<td>Vacuum Cleaning</td>
</tr>
<tr>
<td>Manicure Lavatory</td>
<td>Compressed Air</td>
</tr>
<tr>
<td>Medical Lavatory</td>
<td></td>
</tr>
<tr>
<td>Dental Lavatory</td>
<td></td>
</tr>
<tr>
<td>Plain Kitchen Sink</td>
<td></td>
</tr>
<tr>
<td>Kitchen Sink, R &amp; L Drain Board</td>
<td></td>
</tr>
<tr>
<td>Kitchen Sink, L H Drain Board</td>
<td></td>
</tr>
<tr>
<td>Combination Sink and Dishwasher</td>
<td></td>
</tr>
<tr>
<td>Combination Sink &amp; Laundry Tray</td>
<td></td>
</tr>
<tr>
<td>Service Sink</td>
<td></td>
</tr>
<tr>
<td>Wash Sink (Wall Type)</td>
<td></td>
</tr>
<tr>
<td>Wash Sink</td>
<td></td>
</tr>
<tr>
<td>Laundry Tray</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 3-18 – Plumbing and piping symbols.
Figure 3-19 shows the more common symbols used for doors and windows.

### Door Symbols

<table>
<thead>
<tr>
<th>Type</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-swing with threshold in extended masonry wall</td>
<td><img src="image1" alt="Symbol" /></td>
</tr>
<tr>
<td>Single door, opening in</td>
<td><img src="image2" alt="Symbol" /></td>
</tr>
<tr>
<td>Double door, opening out</td>
<td><img src="image3" alt="Symbol" /></td>
</tr>
<tr>
<td>Single-swing with threshold in exterior frame wall</td>
<td><img src="image4" alt="Symbol" /></td>
</tr>
<tr>
<td>Single door, opening out</td>
<td><img src="image5" alt="Symbol" /></td>
</tr>
<tr>
<td>Double door, opening in</td>
<td><img src="image6" alt="Symbol" /></td>
</tr>
<tr>
<td>Refrigerator door</td>
<td><img src="image7" alt="Symbol" /></td>
</tr>
</tbody>
</table>

### Window Symbols

<table>
<thead>
<tr>
<th>Type</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double hung</td>
<td><img src="image8" alt="Symbol" /></td>
</tr>
<tr>
<td>Casement - Double, opening out</td>
<td><img src="image9" alt="Symbol" /></td>
</tr>
<tr>
<td>Casement - Single, opening in</td>
<td><img src="image10" alt="Symbol" /></td>
</tr>
</tbody>
</table>

Figure 3-19 – Architectural symbols for doors and windows.
The architect's scale shown in Figure 3-20 provides a way to translate construction measurements to a smaller scale. This allows for detail drawings of construction projects in a manageable size.

**Figure 3-20 – Architect's scale.**

<table>
<thead>
<tr>
<th>Scale</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; = 1'-0&quot;</td>
<td>1/4 Actual Size</td>
</tr>
<tr>
<td>1 1/2&quot; = 1'-0&quot;</td>
<td>1/8 Actual Size</td>
</tr>
<tr>
<td>1&quot; = 1'-0&quot;</td>
<td>1/12 Actual Size</td>
</tr>
<tr>
<td>1/3&quot; = 1'-0&quot;</td>
<td>1/36 Actual Size</td>
</tr>
<tr>
<td>3/4&quot; = 1'-0&quot;</td>
<td>1/16 Actual Size</td>
</tr>
<tr>
<td>3/8&quot; = 1'-0&quot;</td>
<td>1/32 Actual Size</td>
</tr>
<tr>
<td>1/4&quot; = 1'-0&quot;</td>
<td>1/48 Actual Size</td>
</tr>
<tr>
<td>1/8&quot; = 1'-0&quot;</td>
<td>1/96 Actual Size</td>
</tr>
<tr>
<td>3/16&quot; = 1'-0&quot;</td>
<td>1/64 Actual Size</td>
</tr>
<tr>
<td>3/32&quot; = 1'-0&quot;</td>
<td>1/128 Actual Size</td>
</tr>
</tbody>
</table>

*SCALE DESIGNATION

1"-3" SHOWN ON THE 16, 1, 1/2, 3/32, 3/16, 1/8, AND 1/4 SCALES ON 3/16, 1/4, AND 1 SCALES, READ BOTTOM NUMBERS. ON 3/32, 1/16, AND 1/2 SCALES, READ TOP NUMBERS.
2.1.1 Site Plan

The site plan shown in *Figure 3-21* shows the contours, boundaries, roads, utilities, trees, structures, and any other significant physical features on or near the construction site. It shows the locations of proposed structures in outline. This plan also shows corner locations relative to reference lines, shown on the plot, that can be located at the site. By showing both existing and finished contours, the site plan furnishes essential data for the graders.

*Figure 3-21 – Site plan.*
2.1.2 Plot Plan

The plot plan shows the survey marks, including the *bench mark* (BM), with the elevations and the grading requirements. Engineering Aids use the plot plan shown in *Figure 3-22* to set up the corners and perimeter of the building using *batter boards* and line stakes. The plot plan furnishes the essential data for laying out the building.

*Figure 3-22 – Plot plan.*
2.1.3 Foundation Plan

A foundation plan is a plane view of a structure. That is, it looks as if it were projected onto a horizontal plane and passed through the structure. In the case of the foundation plan, the plane is slightly below the level of the top of the foundation wall. The plan in Figure 3-23 shows that the main foundation consists of 12 inch and 8 inch concrete masonry unit (CMU) walls measuring 28 feet lengthwise and 22 feet crosswise. The lower portion of each lengthwise section of wall is to be 12 inches thick to provide a concrete ledge 4 inches wide.

A girder running through the center of the building will be supported at the ends by two 4 by 12 inch concrete *pilasters* butting against the end foundation walls. Intermediate support for the girder will be provided by two 12 by12 inch concrete piers, each supported on 18 by 18 inch *spread footings*, which are 10 inches deep. The dotted lines around the foundation walls indicate that these walls will also rest on spread footings.

![Figure 3-23 – Foundation plan.](image-url)
2.1.4 Floor Plan

Floor plans are views of a building as though cutting planes were made through the building horizontally. The cutting plane is generally taken 5'-0" above the floor being shown.

*Figure 3-24* shows the way a floor plan is developed from elevation, to cutting plane, to floor plan. An architectural or structural floor plan shows the structural characteristics of the building at the level of the plane of projection. A mechanical floor plan shows the plumbing and heating systems and any other mechanical components other than those that are electrical. An electrical floor plan shows the lighting systems and any other electrical systems.

![Perspective View Of A Typical T.O. Building Showing Cutting Plane WXY](image1)

![Previous Perspective View At Cutting Plane WXYZ (Top Removed)](image2)

![Developed Floor Plan WXYZ](image3)

*Figure 3-24 – Floor plan development.*

*Figure 3-25* is a floor plan showing the lengths, thicknesses, and character of the outside walls and partitions at the particular floor level. It also shows the number, dimensions, and arrangement of the rooms, the widths and locations of doors and windows, and the locations and character of bathroom, kitchen, and other utility features. You should carefully study *Figure 3-25*. In dimensioning floor plans, it is very important to check the overall dimension against the sum of the partial dimensions of each part of the structure.
2.1.5 Elevations

*Elevations* show the front, rear, and sides of a structure, as they would appear projected on vertical planes. Studying the elevation drawing gives you a working idea of the appearance and layout of the structure.

*Figure 3-26* shows elevations for a small building. Note that the wall surfaces of this house will consist of brick and the roof covering of composition shingles. The top of the rafter plate will be 8 feet 2 1/4 inches above the level of the finished first floor, and the tops of the finished door and window openings 7 feet 1 3/4 inches above the same level. The roof will be a gable roof with 4 inches of rise for every 12 inches length. Each window shown in the elevations is identified by a capital letter that goes with the window schedule, which we'll discuss later in this chapter.
2.1.6 Framing Plans

Framing plans show the size, number, and location of the structural members (steel or wood) that make up the building framework. Separate framing plans may be drawn for the floors, walls, and roof. The floor framing plan must specify the sizes and spacing of joists, girders, and columns used to support the floor. When detail drawings are necessary, they must show the methods of anchoring joists and girders to the columns and foundation walls or footings. Wall framing plans show the location and method of framing openings and ceiling heights so that studs and posts can be cut. Roof framing plans show the construction of the rafters used to span the building and support the roof. They also show size, spacing, roof slope, and all details.

Floor Plans - Framing plans for floors are basically plane views of the girders and joists. Figure 3-27 is an example of a typical floor framing plan.
Figure 3-27 – Floor framing plan.

The unbroken double line symbol is used to indicate joists, which are drawn in the positions they will occupy in the completed building. This type of plan also shows double framing around openings and beneath bathroom fixtures where used. **Bridging** is shown by a double-line symbol that runs perpendicular to the joists. The span of the joists controls the number of rows of cross bridging. They should not be placed more than 7 or 8 feet apart. A 14 foot span needs only one row of bridging, but a 16 foot span needs two rows.

Notes identify floor openings, bridging, and **girts** or plates. Nominal sizes are used in specifying lumber. Dimensions need not be given between joists. Such information is given along with notes. For example,

1" x 6" joists @ 2' 0" o.c.

indicates that the joists are to be spaced at intervals of 2 feet 0 inches from center to center. Framing plans might not indicate lengths. If you find this to be the case, the overall building dimensions and the dimensions for each bay or distances between columns or posts provide such information.

Roof Plans – Framing plans for roofs are drawn in the same manner as floor framing plans. A Builder should visualize the plan as looking down on the roof before any of the roofing material (sheathing) has been added. Rafters are shown in the same manner as joists.
2.1.7 Shop Drawings

Shop drawings are sketches, schedules, diagrams, and other information Builders prepare to illustrate some portion of the work. As a Builder, you will have to make shop drawings for minor shop and field projects. These may include shop items such as doors, cabinets, and small portable buildings forming plans; prefabricated berthing quarters; and modifications of existing structures.

Shop drawings are prepared from portions of design drawings, or from freehand sketches based on the Builder’s past building experience. They must include enough information for the crew to complete the job. Normally, the Builder bases the amount of required detailing on the experience level of the crew expected to complete the project. When an experienced building crew will be doing the work, it is not necessary to show all the fine standard details.

When you make actual drawings, use any available templates for standard symbols. Standard technical drawing techniques are recommended but not mandatory. For techniques in the skill of drawing, refer to *Blueprint Reading and Sketching*, NAEDTRA 10077.

2.1.8 Freehand Sketches

Builders must be able to read and work from drawings and specifications and make quick, accurate sketches to convey technical information or ideas. You may prepare sketches for your own use or for use by other crewmembers. One of the main advantages of sketching is that it requires few materials. Basically, pencil and paper are all you need. The type of sketch prepared and personal preference determine the materials you use.

You will do most of your sketches on some type of scratch paper. The advantage of sketching on tracing paper is the ease with which sketches can be modified or redeveloped simply by placing transparent paper over previous sketches or existing drawings. You may use cross-sectional or graph paper to save time when you need to draw sketches to scale. For making dimensional sketches in the field, you will need a measuring tape or pocket rule, depending on the extent of the measurements taken. In freehand pencil sketching, draw each line with a series of short strokes instead of with one stroke. Strive for a free and easy movement of your wrist and fingers. You don’t need to be a draftsman or an artist to prepare good working sketches.

Freehand sketches are prepared by the crew leader responsible for the job. He or she may include any information that will make the project more understandable, although sketches needn’t be prepared in great detail.

**Test your Knowledge (Select the Correct Response)**

2. Of the following types of drawings, which is NOT one of the five main drawing groups?

A. Architectural  
B. Mechanical  
C. Detail  
D. Electrical
3.0.0 SECTIONAL VIEWS

Sectional views, or sections, provide important information about the height, materials, fastening and support systems, and concealed features of a structure. Figure 3-28 shows the initial development of a section and how a structure looks when cut vertically by a cutting plane. The cutting plane is not necessarily continuous, but, as with the horizontal cutting plane in building plans, may be staggered to include as much construction information as possible. Like elevations, sectional views are vertical projections. They are also detail drawings drawn to large scale. This aids in reading, and provides information that cannot be given on elevation or plan views. Sections are classified as typical and specific.

Typical sections represent the average condition throughout a structure and are used when construction features are repeated many times. Figure 3-29 shows typical wall section A-A of the foundation plan in Figure 3-18. You can see that it gives a great deal of information necessary for those constructing the building. Let’s look at these a little more closely.

The foundation plan shown in Figure 3-23 specifies that the main foundation of this structure will consist of a 22 by 28 foot concrete block rectangle. Figure 3-29, which is section A-A of the foundation plan, shows that the front and rear portions of the foundation (28 foot measurements) are made of 12 by 8 by 16 inch CMUs centered on a 10 by 24 inch concrete footing to an unspecified height. These are followed by 8 inch CMUs, which form a 4 inch ledger for floor joist support on top of the 12 inch units. In this arrangement, the 8 inch CMUs serve to form a 4 inch support for the brick. The main wall is then laid with standard 2 1/2 by 4 by 8 inch face brick backed by 4 by 8 by 16 inch CMUs.
Section B-B, shown in Figure 3-30 of the foundation plan, shows that both side walls (22 foot measurements) are 8 inches thick centered on a 24 inch concrete footing to an unspecified height. It also illustrates the pilaster, a specific section of the wall to be constructed for support of the girder. It shows that the pilaster is constructed of 12 by 8 by 16 inch CMUs alternated with 4 by 8 by 16 inch and 8 by 8 by 16 inch CMUs. The hidden lines (dashed lines) on the 12 inch wide units indicate that the thickness of the wall beyond the pilaster is 8 inches. Note how the extra 4 inch thickness of the pilaster provides a center support for the girder, which will support the floor joists.

**Details** are large-scale drawings that show the builders of a structure how to connect and place its various parts. Although details do not use the cutting plane indication, they are closely related to sections. Detail drawings of buildings customarily show the construction of doors, windows, and eaves. Typical door and window details are shown in Figure 3-31 and 3-32. Detail drawings are used whenever the information provided in elevations, plans, and sections is not clear enough for the constructors on the job. These drawings are usually grouped so that references may be made easily from the general drawing.
4.0.0 SCHEDULES

A schedule is a group of general notes, usually grouped in a tabular form, according to materials of construction. “General notes” refers to all notes on the drawing not accompanied by a leader and an arrowhead. Item schedules for doors, rooms, footings, and so on, are more detailed. Typical door and window finish schedule formats are presented in the next section.

4.1.0 Door Schedule

A plan may identify doors by size, type, and style with code numbers placed next to each symbol in the plan view. This code number, or mark, is then entered on a line in a door schedule, and the principal characteristics of the door are entered in successive columns along the line. The Amount Required column allows a quantity check on doors of the same design as well as the total number of doors required. By using a number with a letter, you will find that the mark serves a double purpose; the number identifies the floor on which the door is located, and the letter identifies the door design. The Remarks column allows identification by type (panel or flush), style, and material. The door schedule is a convenient way of presenting pertinent data without making the Builder refer to the specification. Table 3-1 shows a typical door schedule.

<table>
<thead>
<tr>
<th>MARK</th>
<th>SIZE</th>
<th>AMOUNT REQUIRED</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2’0” x 6’8” x 1 3/8”</td>
<td>3</td>
<td>Flush door</td>
</tr>
<tr>
<td>2</td>
<td>2’6” x 6’8” x 1 3/8”</td>
<td>4</td>
<td>Flush door</td>
</tr>
<tr>
<td>3</td>
<td>2’6” x 6’8” x 1 3/8”</td>
<td>1</td>
<td>Ext flush door, 1 light</td>
</tr>
<tr>
<td>4</td>
<td>3’0” x 7’0” x 1 3/4”</td>
<td>1</td>
<td>Ext flush door, 4 lights</td>
</tr>
<tr>
<td>5</td>
<td>1’8” x 6’8” x 1 3/8”</td>
<td>1</td>
<td>Flush door</td>
</tr>
</tbody>
</table>

4.2.0 Window Schedule

A window schedule is similar to a door schedule in that it provides an organized presentation of the significant window characteristics. The mark used in the schedule is placed next to the window symbol that applies on the plan view of the elevation view as shown in Figure 3-21. A similar window schedule is shown in Table 3-2.

<table>
<thead>
<tr>
<th>MARK</th>
<th>SIZE</th>
<th>AMOUNT REQUIRED</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4’5 1/8” x 4’2 5/8”</td>
<td>3</td>
<td>Metal frame</td>
</tr>
<tr>
<td>B</td>
<td>3’1 1/8” x 4’2 5/8”</td>
<td>2</td>
<td>Metal frame</td>
</tr>
<tr>
<td>C</td>
<td>3’4 1/8” x 4’2 5/8”</td>
<td>1</td>
<td>Metal frame</td>
</tr>
<tr>
<td>D</td>
<td>3’1” x 4’2 5/8”</td>
<td>1</td>
<td>Metal frame</td>
</tr>
<tr>
<td>E</td>
<td>1’7 5/8”</td>
<td>2</td>
<td>Metal frame</td>
</tr>
</tbody>
</table>
4.3.0 Finish Schedule

A finish schedule specifies the interior finish material for each room and floor in the building. The finish schedule provides information for the walls, floors, ceilings, baseboards, doors, and window trim. *Table 3-3* shows an example of a finish schedule.

<table>
<thead>
<tr>
<th>ROOM</th>
<th>FLOOR</th>
<th>WALLS</th>
<th>CEILING</th>
<th>BASEBOARD</th>
<th>TRIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dining &amp; living</td>
<td>1” x 3” oak</td>
<td>½” Drywall paint white</td>
<td>½” Drywall paint white</td>
<td>Wood</td>
<td>Wood</td>
</tr>
<tr>
<td>Bedroom</td>
<td>1” x 3” oak</td>
<td>½” Drywall paint white</td>
<td>½” Drywall paint white</td>
<td>Wood</td>
<td>Wood</td>
</tr>
<tr>
<td>Bathroom</td>
<td>Linoleum-tan</td>
<td>½” Drywall paint white</td>
<td>½” Drywall paint white</td>
<td>Lino-cove</td>
<td>Wood</td>
</tr>
<tr>
<td>Kitchen</td>
<td>Linoleum-tan</td>
<td>½” Drywall paint white</td>
<td>½” Drywall paint white</td>
<td>Lino-cove</td>
<td>Wood</td>
</tr>
<tr>
<td>Utility room</td>
<td>Linoleum-tan</td>
<td>½” Drywall paint white</td>
<td>½” Drywall paint white</td>
<td>Lino-cove</td>
<td>Wood</td>
</tr>
<tr>
<td>Hall</td>
<td>1’ X 3” oak</td>
<td>½” Drywall paint white</td>
<td>½” Drywall paint white</td>
<td>Wood</td>
<td>Wood</td>
</tr>
</tbody>
</table>

4.4.0 Notes on Schedules

Notes are generally placed a minimum of 3 inches below the Revision block on the right-hand side of the first sheet. The purpose of these notes is to give additional information that clarifies a detail or explains how a certain phase of construction is to be performed. You should read all notes, along with the specifications, while you are planning a project.

5.0.0 WRITTEN SPECIFICATIONS

Because many aspects of construction cannot be shown graphically, even the best prepared construction drawings often inadequately show some portions of a project. For example, how can anyone show on a drawing the quality of workmanship required for the installation of doors and windows? Or, who is responsible for supplying the materials? These are things that can be conveyed only by hand lettered notes. The standard procedure is to supplement construction drawings with detailed written instructions. These written instructions, called specifications, or more commonly specs, define and limit materials and fabrication to the intent of the engineer or designer.

The design engineer usually has the responsibility of preparing project specifications. As a Builder, you will be required to read, interpret, and use these in your work as a crew leader or supervisor. You must be familiar with the various types of federal, military, and nongovernmental reference specifications used in preparing project specs. When assisting the engineer in preparing or using specifications, you also need to be familiar with the general format and terminology they use.
5.1.0 NAVFAC Specifications

NAVFAC specifications are prepared by Naval Facilities NAVFAC, which sets standards for all construction work performed under its jurisdiction. This includes work performed by the Seabees. There are three types of NAVFAC specifications.

5.1.1 Unified Facilities Guide Specifications

Unified Facilities Guide Specifications (UFGS) consolidate specifications for USACE, NAVFAC, AFCESA, and NASA, and are the primary basis for preparing specifications for construction projects. These specifications define and establish minimum criteria for construction, materials, and workmanship and must be used as guidance in the preparation of project specifications. Each of these guide specifications, of which there are more than 300, has been written to encompass a wide variety of different materials, construction methods, and circumstances. They must also be tailored to suit the work actually required by the specific project.

To better explain this, let’s look at Figure 3-27, which is part of a page taken from a United Facilities guide specification.

---

**NOTE:** Select the applicable paragraph(s) from the following.

3.3 APPLICATION

Apply roofing materials as specified herein unless specified or recommended otherwise by shingle manufacturer’s written instructions [or by NRCA 0408].

3.3.1 Underlayment

The installation of asphalt strip shingles at maximum exposure is not recommended on roofs having a slope of less than 1:4. In locations where the January mean temperature is minus one degree C (30 degrees F) or less, a leak barrier underlayment membrane should be used. The leak barrier underlayment membrane may consist of: two plies of No. 15 asphalt saturated felt, one nailed to the deck and the second set in Type III or Type IV hot asphalt or asphalt lap cement; a heavyweight coated base sheet nailed to the deck and another felt ply or plysheet set in hot asphalt or asphalt lap cement; or a self adhering modified bitumen membrane.

**NOTE:** In locations where the average daily January temperature is minus 4 degrees C 25 degrees F or below, use the second optional paragraph instead of the first optional paragraph.
[Provide for roof slopes one in three 4 inches per foot and greater. Apply one layer of shingle underlayment to roof deck. Lay underlayment parallel to roof eaves, starting at eaves. Provide minimum 50 mm 2 inch head laps, 100 mm 4 inch end laps, and 150 mm 6 inch laps from both sides over hips and ridges. Nail sufficiently to hold until shingles are applied. Turn up vertical surfaces a minimum of 100 mm 4 inches.]

Figure 3-27 – Sample from a United Facilities Guide Specification.

In this figure, you can see that there are options that indicate that the spec writer must choose the paragraph that best suits the particular project for which he is writing the specification. You can see that some of the information in Figure 3-27 is enclosed in brackets ([ ]). This indicates there are choices that the spec writer must make. Guide specifications should be modified and edited to reflect the latest proven technology, materials, and methods.

5.1.2 NAVFAC Regional Specifications

NAVFAC Regional Specifications are used in the same way as the United Facilities Guide Specifications but only in areas under the jurisdiction of an Engineering Field Division of the Naval Facilities Engineering Field Command. When the spec writer is given a choice between using a regional guide specification or a United Facilities Guide Specification with the same identification number, the writer must use the one that has the most recent date. This is because there can only be one valid guide specification for a particular area at any one time.

5.1.3 Standard Specifications

Standard specifications are written for a small group of specialized structures that must meet rigid operational requirements. NAVFAC standard specifications contain references to federal, military, other command and bureau, and association specifications. NAVFAC standard specifications are referenced or copied in project specifications, and can be modified with the modification noted and referenced. An example of a standard specification with modification is shown below:

“The magazine shall be Arch, Type I, conforming to specifications S-M8E, except that all concrete shall be class

5.2.0 Other Specifications

The following specifications establish requirements mainly in terms of performance. Referencing these documents in project specifications assures the procurement of economical facility components and services while considerably reducing the number of words required to state such requirements.

5.2.1 Federal and Military Specifications

Federal specifications cover the characteristics of materials and supplies used jointly by the Navy and other government agencies. These specifications do not cover installation or workmanship for a particular project, but specify the technical requirements and tests
for materials, products, or services. The engineering technical library should have all the commonly used federal specifications pertinent to Seabee construction.

Military specifications are those specifications the Department of Defense has developed. Like federal specifications, they also cover the characteristics of materials. They are identified by DOD or MIL preceding the first letter and serial number.

5.2.2 Technical Society and Trade Association Specifications

Project specifications should reference technical society specifications when applicable. The organizations publishing these specifications include, but are not limited to, the American National Standards Institute (ANSI), the American Society for Testing and Materials (ASTM), the Underwriters Laboratories (UL), and the American Iron and Steel Institute (AISI). Trade association specifications contain requirements common to many companies within a given industry.

5.2.3 Manufacturer's Specifications

Manufacturer’s specifications contain the precise description for the manner and process for making, constructing, compounding, and using any items the manufacturer produces. They should not be referenced or copied verbatim in project specifications but may be used to aid in preparing project specifications.

5.3.0 Project Specifications

Construction drawings are supplemented by written project specifications. Project specifications give detailed information regarding materials and methods of work for a particular construction project. They cover various factors relating to the project, such as general conditions, scope of work, quality of materials, standards of workmanship, and protection of finished work.

The drawings, together with the project specifications, define the project in detail and show exactly how to construct it. Usually, drawings for an important project are accompanied by a set of project specifications. The drawings and project specifications are inseparable. Drawings indicate what the project specifications do not cover. Project specifications indicate what the drawings do not portray, or they further clarify details that are not covered amply by the drawings and notes on the drawings. When you are preparing project specifications, it is important that you closely coordinate the specifications and drawings in order to minimize discrepancies and ambiguities.

When there is conflicting information between the drawings and project specs, the specifications take precedence over the drawings.

5.3.1 Organization of Specifications

For consistency, the Navy has organized the format of specifications into 17 basic divisions. These divisions, used throughout the military, are listed in order as follows:

**General Requirements** include information that is of a general nature to the project, such as inspection requirements and environmental protection.

**Site Work** includes work performed on the site, such as grading, excavation, compaction, drainage, site utilities, and paving.
Concrete Construction includes precast and cast-in-place concrete, formwork, and concrete reinforcing.

Masonry includes concrete masonry units, brick, stone, and mortar.

Metals includes such items as structural steel, open web steel joists, metal stud and joist systems, ornamental metal work, grills, and louvers. Sheet metal work is usually included in Division 7.

Carpentry includes wood and wood framing, rough and finish carpentry, foamed plastics, fiberglass reinforced plastics, and laminated plastics.

Moisture Protection includes such items as waterproofing, dampproofing, insulation, roofing materials, sheet metal and flashing, caulking, and sealants.

Doors, Windows, and Glass includes doors, windows, finish hardware, glass and glazing, storefront systems, and similar items.

Finishes includes such items as floor and wall coverings, painting, lathe, plaster, and tile.

Specialties includes prefabricated products and devices, such as chalkboards, moveable partitions, fire fighting devices, flagpoles, signs, and toilet accessories.

Architectural Equipment includes such items as medical equipment, laboratory equipment, food service equipment, kitchen and bath cabinetwork, and counter tops.

Furnishings includes prefabricated cabinets, blinds, draperies, carpeting, furniture, and seating.

Special Construction includes such items as prefabricated structures, integrated ceiling systems, and swimming pools.

Conveying Systems includes dumbwaiters, elevators, moving stairs, material handling systems, and other similar conveying systems.

Mechanical Construction includes plumbing, heating, air conditioning, fire protection systems, and refrigeration systems.

Electrical Construction includes electrical service and distribution systems, electrical power equipment, electric heating and cooling systems, lighting, and other electrical items.

Expeditionary Structures includes tension fabric structures and K-span buildings.

Each of the above divisions is further divided into sections. You can find a listing of the sections in the Seabee Crewleader’s Handbook.

5.3.2 Guidance

Usually, the engineer or spec writer prepares each section of a specification based on the appropriate guide specification listed in the Design Guidance page of the Whole Building Design Guide, which can be found at http://www.wbdg.org/design/index.php.

As discussed earlier, when writing the specifications for a project, you must modify the guide specification you are using to fit the project. Delete portions of guide specifications that concern work not included in the project. When portions of the required work are not included in a guide specification, then you must prepare a suitable
section to cover the work, using language and form similar to that of the guide specification. Do not combine work covered by various guide specifications into one section unless the work is minor in nature. Do not reference the guide specification in the project specifications. You must use the guide spec only as a manuscript that can be edited and incorporated into the project specs.


Test your Knowledge (Select the Correct Response)

3. **(True or False)** Whenever there is conflicting information between the drawings and project specs, the specifications take precedence over the drawings.

   A. True
   B. False

**Summary**

An important skill for Builders is knowing how to lay out structures so they will conform to their location, size, shape, and other building features. You learned how to extract this information from drawings and specifications. You also learned how to draw, read, and work from simple shop drawings and sketches.

Schedules of materials to be used in a project are an important component of the project plans. Project plans also incorporate specifications, written notes that supplement construction drawings with detailed written instructions. You must also be familiar with the various types of federal, military, and nongovernmental reference specifications used in preparing project specifications.
Review Questions

1. Which of the following building structural members provide immediate support for live loads?
   
   A. Footings  
   B. Horizontal members  
   C. Vertical members  
   D. Diagonal members

2. Which of the following statements best applies to an outside wall column?
   
   A. It is usually located directly over the inside lower floor columns.  
   B. It rests on the ground and extends to the roof line.  
   C. It is a high-strength horizontal structural member.  
   D. It is a high-strength vertical structural member usually extending from the footing to the roof line.

3. What type of column is used to support the lowest horizontal building member?
   
   A. Bottom floor inside  
   B. Outside-wall  
   C. Upper floor  
   D. Short

4. The building components supporting the chief vertical structural members (studs) are known as
   
   A. Piers  
   B. Sills or soleplates  
   C. Beams  
   D. Bar joists

5. The building component above the wall studs and supporting roof framing members is called a
   
   A. Header  
   B. Rafter plate  
   C. Stud  
   D. Sill

6. **(True of False)** Rafters are horizontal or inclined members providing roof support.
   
   A. True  
   B. False
7. The peak ends of rafters are supported by
   A. Purlins
   B. Rafter plates
   C. A ridgeboard
   D. Studs

8. A load on a beam is too great for structural integrity and supports cannot be used under the beam. What other structural member can be used to adequately support the load?
   A. Pier
   B. Truss
   C. Suspension cable
   D. Rafter

9. In light frame construction, which of the following trusses is the simplest type used?
   A. W-type
   B. Scissors
   C. Hip
   D. King-post

10. Engineering and architectural design sketches are combined to form what type of drawings?
    A. Construction
    B. Perspective
    C. Combination
    D. Symbol

11. Drawings that are adequate for a Builder to complete a project are known as
    A. Assembly drawings
    B. Working drawings
    C. Detail drawings
    D. A bill of materials

12. Where are you most likely to find information on items too small to appear on general drawings?
    A. Detail drawings
    B. Assembly drawings
    C. Bill of material
    D. Specifications
13. What type of drawing is either an exterior or sectional view of an object showing details in proper relationship to one another?
   A. Design
   B. Construction
   C. Assembly
   D. General

14. The contours, boundaries, utilities, structures, and other significant physical features of a piece of property are shown on what type of plan?
   A. Plot
   B. Site
   C. General
   D. Elevation

15. What plan should be used to set batter boards and line stakes?
   A. Plot
   B. Site
   C. Detail
   D. General

16. For a footing, the material used and the depth are shown on what type of plan?
   A. Floor
   B. Site
   C. Foundation
   D. Elevation

17. The dimensions, number, and arrangement of structural members in wood-frame or steel construction are shown in what type of plan?
   A. Foundation
   B. Floor
   C. Framing
   D. Detail

18. To check the overall height of finished floors, doors, and windows, you should consult what plan?
   A. Plot
   B. Elevations
   C. Section
   D. Floor

19. What plan shows the type of wall and roof covering required?
   A. Elevation
   B. Floor
   C. Plot
   D. Foundation
20. What plan specifies the sizes and spacing of joists, girders, and columns used to support the floor?

A. Plot  
B. Floor framing  
C. Section  
D. Elevations

21. **True or False** Sectional views, or sections, provide important information about the height, materials, fastening and support systems, and concealed features of a structure.

A. True  
B. False

22. Detail drawings give construction information about which of the following items?

A. Doors  
B. Windows  
C. Eaves  
D. All of the above

23. **True or False** A schedule is a table or list of working drawings giving number, sizes, and placement of similar items.

A. True  
B. False

24. Which of the following items supplement construction drawings with detailed written instructions?

A. Specifications  
B. Notes  
C. Revisions  
D. Details

25. How many types of NAVFAC specifications govern work performed by Seabees?

A. One  
B. Two  
C. Three  
D. Four

26. Which of the following NAVFAC specifications are written for a small group of specialized structures that must have uniform construction to meet rigid operational requirements?

A. NAVFACENGCOM guide specifications  
B. EFD regional guide specifications  
C. Standard specifications  
D. Other specifications
27. Which of the following specifications do NOT cover installation or workmanship for a particular project?

A. Technical society and trade association specifications
B. Federal and military specifications
C. Manufacturer’s specifications
D. Project specifications

28. Specifications from which of the following sources, combined with drawings, define the project in detail and show exactly how it is to be constructed?

A. The American Society for Testing and Materials
B. The American National Standards Institute
C. Manufacturer’s specifications
D. Project specifications

29. Which of the following specifications divisions provides information on concrete masonry units, brick, stone, and mortar?

A. Concrete
B. Masonry
C. Site work
D. General requirements

30. Which of the following specifications provides information on prefabricated cabinets, blinds, draperies, carpeting, furniture, and seating?

A. Finishes
B. Furnishings
C. Special Construction
D. Specialties
Trade Terms Introduced in this Chapter

**Bar joists**
Light steel joists of open-web construction with a single zigzag bar welded to upper and lower chords at the points of contact. Used as floor and roof supports.

**Batter boards**
Pairs of horizontal boards nailed to wood stakes adjoining an excavation. Used with strings as a guide to elevation and to outline a proposed building. The strings strung between boards can be left in place during excavation.

**Beam**
A horizontal structural member, such as a girder, rafter, or purlin, which transversely supports a load and transfers the load to vertical members, such as columns and walls.

**Bearing capacity**
The maximum unit pressure that soil or other material can withstand without failure or excessive settlement.

**Bench Mark**
A mark made by a surveyor or general contractor to be used as a reference point when measuring the elevation or location of other points.

**Bill of Material**
A detailed analysis of material and equipment required to construct a project.

**Bridging**
A method of lateral bracing between joists for stiffness, stability, and load distribution.

**Cantilever**
A structural member supported at one end only.

**Chords**
The top or bottom members of a truss (typically horizontal), as distinguished from the web members.

**Columns**
Long, relatively slender, supporting pillars. Columns are usually loaded axially in compression.

**Concrete masonry**
(1) Concrete blocks laid with mortar or grout in a manner similar to bricks. (2) Concrete that may be poured in place or as special tilt-up building walls.

**Construction drawings**
The portion of the contract documents that provide the requirements of a construction project.

**Corner posts**
Vertical members located at the corners of a timber structure.

**Dead load**
A calculation of the weight of a building’s structural components, fixtures, and permanently attached equipment (used in designing a building and its foundations).

**Details**
Large scale architectural or engineering drawings indicating specific configurations and dimensions of construction elements. If the large scale drawing differs from the general drawing, it is the architect’s or engineer’s intention that the large scale drawing be used to clarify the general drawing.
Divisions
One of the standard sixteen major Uniform Construction Index (CSI) classifications used in specifying, pricing, and filing construction data.

Door schedule
A table in the contract documents listing all the doors by size, specifications, and location.

Drawings
Graphic illustrations depicting the dimensions, design, and location of a project. Generally including plans, elevations, details, diagrams, schedules, and sections.

Electrical drawing
A drawing that includes the complete power layout for a construction project.

Elevations
Views or drawings of the interior or exterior of a structure as if projected onto a vertical plane.

Finish schedule
A listing that provides information on finishes for the walls, floors, ceilings, baseboards, doors, and window trim.

Floor plans
Drawings showing the outline of a floor, or part of a floor, interior and exterior walls, doors, windows, and details such as floor openings and curbs. Each floor of a building has its own floor plan.

Footings
Enlargements at the lower end of a wall to distribute the load to a wider area of supporting soil.

Foundation plans
Drawings of plane views of a structure. The plane in this case is slightly below the top of the foundation wall.

Framing plans
Drawings of each floor of a building showing exact locations of framing members and their connections. May include wall elevations and details.

Frost line
The depth to which frost penetrates the ground. This depth varies from one part of the country to another. Footings should be placed below the frost line to prevent shifting.

Girder
A large principal beam of steel, reinforced concrete, wood, or a combination of these, used to support other structural members at isolated points along its length.

Girts
Horizontal braces used on outside walls covered with vertical siding.

Gusset plates
Plates fastened across a joint, as in wood or steel framework members.

Joist
A horizontal supporting member that runs from wall to wall, wall to beam, or beam to beam to support a ceiling, roof, or floor.

Lintels
Horizontal supporting members, installed above an opening such as a window or door, which serve to carry the weight of the wall above it.
Live load
The load superimposed on structural components by the use and occupancy of the building, not including the wind load, earthquake load, or dead load.

Mechanical drawing
Plans showing the HVAC and plumbing layout of a building.

Members
A general term for structural components of a building, such as a beam or column.

Pier
A short column to support a concentrated load. Also known as a short column.

Pilasters
Columns built within a wall, usually projecting beyond the wall.

Pillars
Posts or columns.

Plot plan
A ground plan of a building and adjacent land.

Purlins
Horizontal structural members that support roof loads and transfer them to roof beams.

Rafters
A series of sloping parallel beams used to support a roof covering.

Rafter plates
Plates used to support the lower ends of rafters and to which they are fastened.

Ridge
The horizontal line formed by the upper edges of two sloping roof surfaces.

Ridgeboard
The longitudinal board set on edge used to support the upper ends of the rafters. Also known as a ridgepole.

Ridgepole
The longitudinal board set on edge used to support the upper ends of the rafters. Also known as a ridgeboard.

Sectional views
Drawings of an object or construction member cut through to show the interior makeup. Also known as a section.

Shop drawings
Drawings that illustrate construction, materials, dimensions, installation, and other pertinent information for the incorporation of an element or item into the construction.

Sills
The lowest members of the frame of the structure, resting on the foundation and supporting the frame.

Site plan
A plan that shows the contours, boundaries, roads, utilities, trees, structures, and other significant physical features on or near the construction site.

Sketches
Hasty or undetailed drawings often made as a preliminary study.

Soleplates
A solepiece or shoe that serves as a base for studs in a core of solid wood or mineral composition, as opposed to a partition.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>Spread footings</td>
<td>Generally rectangular prisms of concrete, larger in lateral dimensions than the column or wall they support; used to distribute the load of a column or wall to the subgrade.</td>
</tr>
<tr>
<td>Studs</td>
<td>Framing members, usually cut to a precise length at the mill, designed to be used in framing building walls with little or no trimming before being set in place. Studs are most often 2” x 4”, but 2” x 3”, 2” x 6”, and other sizes are also included in the stud category. Studs may be of wood, steel, or composite material.</td>
</tr>
<tr>
<td>Superstructure</td>
<td>The part of a bridge above the beam seats or the spring line of an arch.</td>
</tr>
<tr>
<td>Truss</td>
<td>A structural component composed of a combination of members, usually in a triangular arrangement, to form a rigid framework; often used to support a roof.</td>
</tr>
<tr>
<td>Window schedule</td>
<td>A tabulation, usually on a drawing, listing all windows on a project; and indicating sizes, number of lights, type of sash and frame, and hardware required.</td>
</tr>
</tbody>
</table>
Additional Resources and References

This chapter is intended to present thorough resources for task training. The following reference works are suggested for further study. This is optional material for continued education rather than for task training.

*Blueprint Reading and Sketching*, NAVEDTRA 14040, Naval Education and Training Professional Development and Technology Center, Pensacola, Fla., 2003.


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