CSI MasterFormat Document Organization
In the early 1960s the need for a uniform system for organizing specifications was identified and resulted in the publishing of the “CSI MasterFormat”, named after its author, the Construction Specifications Institute (CSI). The CSI MasterFormat introduced the seventeen division format associated with the ability to organize an infinite number of subject sections. In 1978, Construction Specifications Canada (CSC) joined with CSI to produce the first edition of MasterFormat.

The MasterFormat incorporates a complete organizational format for project manuals by including bidding requirements, contract forms, conditions of the contract and the General Requirements, in addition to the Technical Specifications Divisions 02 through 16. This document has been the construction industry’s consensus standard for the organization of technical information. It is accepted by the U.S. federal agencies and most state and local governments. It was subsequently adopted by the McGraw-Hill Sweets Catalogs, the R.S. Means cost estimating books, and other organizations.

MasterFormat is intended to classify detailed construction information into a standard order or sequence by materials and methods. This is done by establishing a detailed master list of divisions, sections and parts. The MasterFormat facilitates construction communication, promotes standardization in the industry, and facilitates the retrieval of information. It is primarily used for the organization of project manuals, detailed construction cost estimates, and product data filing.

CSI MasterFormat Structure
The MasterFormat groups information into these areas:

- Bidding Requirements and Forms
- Contract Forms (Agreement)
- Conditions of the Contract (General and Supplementary)
- General Requirements (Division 01)
- Technical Specifications Division (02 through 16)
MasterFormat Numbering System
The MasterFormat number system categorizes the Bidding Requirements and Forms, Contract Forms and Conditions of the Contract into Division 0 - Bidding Requirements. Second, the MasterFormat uses a series of numbers associated with the sixteen divisions which address detailed construction specifications associated with products and systems. Division 1 - General Requirements outlines the specific administrative and procedural requirements that apply to all of the Technical Specification sections. Divisions 02 through 16 - Technical Specifications contain a written description of the specific requirements relating to a specific product or system. The Construction Specifications Institute (CSI) has developed the following Standard MasterFormat numbering system consisting of the following Documents and Divisions.

CSI MasterFormat Divisions

DIVISION 00 - BIDDING REQUIREMENTS
DIVISION 01 - GENERAL REQUIREMENTS
DIVISION 02 - SITE WORK
DIVISION 03 - CONCRETE
DIVISION 04 - MASONRY
DIVISION 05 - METALS
DIVISION 06 - WOOD AND PLASTICS
DIVISION 07 - THERMAL AND MOISTURE PROTECTION
DIVISION 08 - DOORS AND WINDOWS
DIVISION 09 - FINISHES
DIVISION 10 - SPECIALTIES
DIVISION 11 - EQUIPMENT
DIVISION 12 - FURNISHINGS
DIVISION 13 - SPECIAL CONSTRUCTION
DIVISION 14 - CONVEYING SYSTEMS
DIVISION 15 - MECHANICAL
DIVISION 16 - ELECTRICAL

CSI MasterFormat Sections
The CSI MasterFormat breaks down Divisions 02 - 16 into Sections using a three-digit numbering system. For example, in Division 02 - Sitework the Earthwork is under section number 200. Therefore, the complete Division and Section number is 02200.
**Masterformat - Broadscope Section Titles**

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**TECHNICAL SPECIFICATIONS**

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**Note:** Since the items listed above are not specification sections, they are referred to as "Documents" in lieu of "Divisions or Sections" in the Master List of Section Titles, Numbers, and Broadscope Explanations.
### LEVEL 1 CONSTRUCTION FUNDAMENTALS STUDY GUIDE

#### DIVISION 9 - FINISHES
- 09100 Metal Support Systems
- 09200 Lathing and Plaster
- 09230 Aggregate Coatings
- 09250 Gypsum Board
- 09300 Tile
- 09400 Terrazzo
- 09500 Acoustical Treatment
- 09540 Special Surfaces
- 09550 Wood Flooring
- 09600 Stone Flooring
- 09630 Unit Masonry Flooring
- 09650 Resilient Flooring
- 09680 Carpet
- 09700 Special Flooring
- 09780 Floor Treatment
- 09800 Special Coatings
- 09900 Painting
- 09950 Wall Covering

#### DIVISION 10 - SPECIALTIES
- 10100 Chalkboards and Tackboards
- 10150 Compartments and Cubicles
- 10200 Louvers and Vents
- 10240 Grilles and Screens
- 10250 Service Wall Systems
- 10260 Wall and Corner Guards
- 10270 Access Flooring
- 10280 Specialty Modules
- 10290 Pest Control
- 10300 Fireplaces and Stoves
- 10340 Prefabricated Exterior Specialties
- 10350 Flagpoles
- 10400 Identifying Devices
- 10450 Pedestrian Control Devices
- 10480 Fire Protection Specialties
- 10500 Protective Covers
- 10550 Postal Specialties
- 10600 Partitions
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- 10750 Telephone Specialties
- 10800 Toilet and Bath Accessories
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- 11100 Mercantile Equipment
- 11110 Commercial Laundry and Dry Cleaning Equipment
- 11120 Vending Equipment
- 11130 Audio-Visual Equipment
- 11140 Service Station Equipment
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- 11200 Water Supply and Treatment Equipment
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- 11500 Industrial and Process Equipment
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#### DIVISION 12 - FINISHINGS
- 12010 Fabrics
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- 12300 Manufactured Casework
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- 12600 Furniture and Accessories
- 12670 Rugs and Mats
- 12700 Multiple Seating
- 12800 Interior Plants and Planters

#### DIVISION 13 - SPECIAL CONSTRUCTION
- 13010 Air Supported Structures
- 13020 Integrated Assemblies
- 13030 Special Purpose Rooms
- 13050 Sound, Vibration, and Seismic Control
- 13090 Radiation Protection
- 13100 Nuclear Reactors
- 13120 Pre-Engineered Structures
- 13150 Pools
- 13160 Ice Rinks
- 13170 Kennels and Animal Shelters
- 13180 Site Constructed Incinerators
- 13200 Liquid and Gas Storage Tanks
- 13220 Filter Underdrains and Media
- 13230 Digestion Tank Covers and Appurtenances
- 13240 Oxygenation Systems
- 13260 Sludge Conditioning Systems
- 13300 Utility Control Systems
- 13400 Industrial and Process Control Systems
- 13500 Recording Instrumentation
- 13550 Transportation Control Instrumentation
- 13600 Solar Energy Systems
- 13700 Wind Energy Systems
- 13800 Building Automation Systems
- 13900 Fire Suppression and Supervisory Systems

#### DIVISION 14 - CONVEYING SYSTEMS
- 14100 Dumbwaiters
- 14200 Elevators
- 14300 Moving Stairs and Walks
- 14400 Lifts
- 14500 Material Handling Systems
- 14600 Hosts and Cranes
- 14700 Turntables
- 14800 Scaffolding
- 14900 Transportation Systems

#### DIVISION 15 - MECHANICAL
- 15050 Basic Mechanical Materials and Methods
- 15250 Mechanical Insulation
- 15300 Fire Protection
- 15400 Plumbing
- 15500 Heating, Ventilating, and Air Conditioning (HVAC)
- 15550 Heat Generation
- 15600 Refrigeration
- 15750 Heat Transfer
- 15850 Air Handling
- 15880 Air Distribution
- 15950 Controls
- 15990 Testing, Adjusting, and Balancing

#### DIVISION 16 - ELECTRICAL
- 16050 Basic Electrical Materials and Methods
- 16200 Power Generation
- 16300 High Voltage Distribution (Above 600-Volt)
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- 16500 Lighting
- 16600 Special Systems
- 16700 Communications
- 16850 Electric Resistance Heating
- 16900 Controls
- 16950 Testing

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CSI MaterFormat Parts

Each technical Specification Section within a Division is further broken down into Parts. Part 1 is titled General. Part 2 is titled Products, and Part 3 is titled Execution. Part 1 contains these titles: Work Included, References, Quality Assurance, Submittals, Storage, and Environmental Requirements. Part 2 contains these titles: Acceptable Manufacturers, Types of Materials and Product Standards. Part 3 contains these titles: Preparation, Installation, Tolerances, Cleaning and Protection of the finished work. The discussion and example below will primarily focus on Part 1 titled General and the subsection titled Reference standards because it utilizes the law principle called Incorporated by Reference.

Part 1 generally contains a list of additional reference standards with complete designations and titles. It also identifies specific requirements for the submittal of shop drawings and product data sheets for each section. Reference standards are documents that are not physically attached with the Documents, but are referenced to in the documents may be part of the contract. The most common clause used to incorporate an item by reference is to state in the documents that the Reference Standards are "herewith made a part of the Specifications." This normally requires the Contractor to have these available at the job site. The specific Reference Standards that the Contractor must refer to are stated at the beginning of each Section of the Technical Specifications under Part 1. For example, Division 3 is Concrete and Section 200 is Concrete Reinforcement, PART 1.03 is Reference Standards and the A - J refers to the specific reference Standards required. Numerous CSI Division numbers, Section numbers with Part 1 Reference Standards and their abbreviations are shown below.

03100 Concrete Formwork
PART 1 GENERAL
1.03 Reference Standards
B. ACI SP-4 “Formwork for Concrete”
   American Concrete Institute. Special Publication -4.

03200 Concrete Reinforcement
1.03 Reference Standards
I. CRSI 65 “Recommended Practice for Placing Bar Supports, Specifications and Nomenclature.” Concrete Reinforcing Steel Institute.

03300 Cast-in-Place Concrete
1.03 Reference Standards
N. ASTM C-94 “Specifications for Ready-mixed concrete.”
   American Society for Testing Materials

02200 Excavation
1.06 Reference Standards
AASHTO - MI47-65 - Materials for Aggregate and Soil - Aggregate.
   Am. Association of State Highway/Transportation Officials.
05120 Structural Steel
1.03 Reference Standards
AISC - Specification for the Design, Fabrication and Erection
American Institute of Steel Construction
AWS - D1.1 - Structural Welding Code
American Welding Society
SJI - Standard Specifications for Open Web Steel Joists
Steel Joist Institute

09250 Gypsum Board Systems
1.04 Reference Standards
ANSI/ASTM C36 - Gypsum Wallboard.
American National Standards Institute.
American Society for Testing Materials.

15050 Basic Mechanical Materials and Methods
1.06 Reference Standards
ASME B16 - Boiler and Pressure Vessel Code
American Society of Mechanical Engineers
ASHRAE 15 - Safety Code for Mechanical Refrigeration
American Society for Heating, Refrigerating, and Air Conditioning Engineers.
AWWA C601 - Standard Methods for the Examination of Water & Waste
American Water Works Association
UL 378 - Standard for Draft Equipment.
Underwriter Laboratories, Inc.
AMCA 99 - Standards Handbook.
Air Movement and Controls Association

15300 Fire Protection Piping
1.03 Quality Assurance
NFPA 13 - Sprinkler Systems

15880 Air Distribution
1.03 Reference Standards
SMACNA Symbols for Ventilation and Air Conditioning,
Sheet Metal and Air Conditioning Contractors’ National Association.

16700 Communications
1.03 Reference Standards
NEC - National Electrical Code
TIA - Telecommunication Industry Association.
CSI Master Format Exercise

1. What CSI Division contains technical information on Soil Compaction requirements?
   A. 01  
   B. 02  
   C. 04  
   D. 16

2. What CSI Division contains technical information on Structural Steel?
   A. 01  
   B. 03  
   C. 05  
   D. 15

3. What CSI Division contains technical information on Drywall?
   A. 06  
   B. 09  
   C. 10  
   D. 14

4. What CSI Division contains technical information on Plumbing?
   A. 03  
   B. 05  
   C. 11  
   D. 15

5. What CSI Division contains technical information on the Air Handling system?
   A. 11  
   B. 13  
   C. 14  
   D. 15
CSI Master Format Exercise

6. What CSI Division contains technical information on the Conveyor System?
   - A. 11
   - B. 13
   - C. 14
   - D. 15

7. What CSI Division contains technical information on the Boiler System?
   - A. 11
   - B. 13
   - C. 14
   - D. 15

8. What CSI Division contains technical information on Painting?
   - A. 02
   - B. 06
   - C. 09
   - D. 16

9. What CSI Division contains technical information on Roofing?
   - A. 04
   - B. 06
   - C. 07
   - D. 10

10. What CSI Division contains technical information on Food Service Equipment?
    - A. 10
    - B. 11
    - C. 13
    - D. 15
CSI Master Format Exercise

11. According to CSI, What Division(s) are considered the Technical Specifications?

   ○ A.  00 - 01.
   ○ B.  01
   ○ C.  01 - 16.
   ○ D.  02 - 16.

12. What CSI Division applies to all contractors and subcontractors?

   ○ A.  01
   ○ B.  02
   ○ C.  09
   ○ D.  15

13. What CSI Division contains the Bid Requirements for a project?

   ○ A.  00
   ○ B.  01
   ○ C.  04
   ○ D.  16

14. What is the name of the legal principle for referring the contractor to other documents that are not contained in the documents provided?

   ○ A.  Reference Standards.
   ○ B.  Incorporated by Reference.
   ○ C.  Standard General Conditions
   ○ D.  General Conditions of the Contract.

15. What is the official name of the technical reference source that is mentioned in the documents to Design the Formwork and it is published by ACI?

   ○ A.  Formwork Handbook.
   ○ B.  Formwork for Concrete.
   ○ C.  Formwork Design Manual.
   ○ D.  Concrete Formwork Design Manual.
CSI Master Format Exercise

16. What is the official name of the technical reference source that is mentioned in the documents to Place the Slab Bolsters and it is published by CRSI?
   - A. Steel Riggers Handbook.
   - B. Steel Reinforcement Guide.
   - C. Recommended Practice for Placing Bar Supports, Specifications & Nomenclature.

17. Your specifications reference this construction organization Acronym of ACI that publishes numerous Technical Reference Sources. What is the correct name of ACI?
   - A. American Concrete Institute.
   - B. Associated Contractors Institute.
   - C. American Construction Institute.
   - D. Associated Constructors Institute.

18. Your specifications reference this construction organization Acronym of CSI that publishes numerous Technical Reference Sources. What is the correct name of CSI?
   - A. Cost System Information.
   - B. Construction Standards Institute.
   - C. Construction Standards Information.
   - D. Construction Specifications Institute.

19. Your specifications reference this construction organization Acronym of CRSI that publishes numerous Technical Reference Sources. What is the correct name of CRSI?
   - A. Concrete Reinforcing Steel Institute.
   - B. Crane and Riggers Specification Institute.
   - C. Concrete Reinforcement Standards Institute
   - D. Concrete Reinforcement Specifications Institute.

20. Your specifications reference this construction organization Acronym of AISC that publishes numerous Technical Reference Sources. What is the correct name of AISC?
   - A. American Institute of Steel Contractors.
   - B. American Institute of Steel Constructors.
   - C. American Institute of Steel Construction.
   - D. American Institute of Structural Concrete.
CSI Master Format Exercise

21. Which CSI part number contains information on Reference Standards the contractor or subcontractor must consult?

○ A. 1
○ B. 2
○ C. 3
○ D. 4

22. Which CSI part number contains information on the installation procedures the contractor or subcontractors must consult?

○ A. 1
○ B. 2
○ C. 3
○ D. 4

23. Which Division and Section number contains technical information on the interior plumbing?

○ A. 02660
○ B. 02700
○ C. 15300
○ D. 15400

24. Which Division and Section number contains technical information on the exterior sewerage and drainage system?

○ A. 02660
○ B. 02700
○ C. 15300
○ D. 15400

25. Which Division and Section number contains technical information on the interior Electrical Service and Distribution system?

○ A. 02600
○ B. 02780
○ C. 15950
○ D. 16400
CSI Master Format Exercise

26. Which Division and Section number contains technical information on the communications systems?

- A. 02780
- B. 15950
- C. 16500
- D. 16700

27. Your specifications reference this construction organization Acronym of ASHRAE that publishes numerous Technical Reference Sources. What is the correct name of ASHRAE?

- A. American Steel Housing Rating Association of Engineers.
- B. Associated Structural Hoists Rating Association of Engineers.
- C. American Society for Heating, Refrigerating and Air Conditioning Engineers.
- D. Associated Society for Heating, Refrigerating and Air Conditioning Engineers.

28. Your specifications reference this construction organization Acronym of TIA that publishes numerous Technical Reference Sources. What is the correct name of TIA?

- C. Transportation Industry of America.
- D. Telecommunication Industry Association.

29. Your specifications reference this construction organization Acronym of UL that publishes numerous Technical Reference Sources. What is the correct name of UL?

- A. Union Laboratories.
- B. United Laboratories.
- C. Utility Laboratories.
- D. Underwriter Laboratories.

Check Answers
Construction Methods. Materials and Equipment

The contractor is responsible for the temporary shoring system selected and the design of the shoring system. These are not shown on the plans or described in any detail within the construction documents. The estimator is responsible for determining the number, size and cost for all temporary structures. These structures are normally utilized to restrain water, soil, existing structures, etc. Some of the more common temporary systems are described below.

Temporary Shoring Systems
The **cofferdam** is a water tight rectangular structure built to restrain water and soil. It is utilized around the foundations of bridge piers or to have working space to place an item below grade. A cofferdam contains driven sheet piling (Uprights), wales(Walers) and Cross braces (Struts). To ensure structural soundness of the cofferdam, the sheet piles are driven beyond the bottom of the excavation at least two feet. This extension is called the **Toe**. The most common materials for construction of a cofferdam are wood timber and structural steel. If moderate ground water is encountered, Tongue & Groove sheeting is normally utilized to keep out the water. If considerable water is present, steel sheet piling is used.

**Cribbing and Tie Backs** shoring is a method of restraining a vertical wall of soil where it is impractical to slope the soil such as in a downtown area where the excavation and new substructure are below the street level. This system requires timbers called cribbing to be placed horizontally with rods (tiebacks) drilled through the cribbing at an angle back into the soil. This shoring system allows the contractor to maximize the open space.

**Underpinning** is the process of supporting an existing structure when the new excavation will be below the existing structures foundation. This requires temporary supports to support the structure while an extension to the existing foundation is being placed.

**Dewatering** is the process of removing water or in some cases lowering the water table to install an item below the existing water table. There are two dewatering methods. The first method is by utilizing a pump with a suction hose and discharge hose. The second method is to utilize wells points placed at specified intervals to lower the water table temporarily.

**Equipment Mobilization** is the process of loading off-road equipment, transporting it to the job site and assembling at the site. The assembly of a large lifting crane can require 7-9 workers approximately three days if the crane requires the boom to be assembled and the cables to be run through the crane’s jib. **Equipment Demobilization** is the process of disassembling equipment.
Excavation Shoring Systems

A Support or Shoring System is a structure such as a timber shoring system or hydraulic shoring system that supports the sides of an excavation and protects employees against cave-ins. According to the OSHA Excavation Safety Standards, anytime a worker enters a trench at least five (5) feet deep you must provide protection from cave-ins. After a qualified person has determined the type of soil, they have a few options. First, they can design a shoring system using the Shoring Designs provided in the Standards. The Second option is to design a support system using a Manufacturer's system. Finally, they can use a trench box. Below we will define the shoring options outlined in the excavation safety standards for shoring systems less than twenty feet deep. According to the OSHA Construction Standards, for excavations more than twenty (20) feet deep you must contact a Registered Professional Engineer (RPE) to design the protection system.

The OSHA Standards for the Construction Industry 29 CFR Part 1926.650(b) titled, Definitions applicable to subpart P - Excavations defines the following shoring terms.

The Sheeting means the individual members of a shoring system that are closely spaced together to retain the earth. Sheeting is also called Uprights or Sheet Piling. OSHA defines the term “Uprights” as the vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not contact each other (p 253).

The Wales means the horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system. They are set perpendicular to the sheeting. The Crossbraces or Struts are the horizontal members of the shoring system that span across the width of an excavation. They are installed perpendicular to the sides of the excavation and the ends are connected to either uprights or wales.

OSHA also defines Tight Sheeting as the use of specially-edged timber planks (e.g. Tongue and Groove) at least three inches thick. These are used when conditions are saturated or submerged in water as defined in the OSHA 1926.652(g). Also, Close Sheeting refers to the space between the timber planks not to exceed ½ inch when placed edge to edge according to OSHA 1926.652(g), titled Notes for all Tables in paragraph 2.

The Shield or Trench Box is a structure that normally does not prevent a cave-in but protects employees within the structure. Shields may be permanent structures or may be designed to be portable and moved along the trench. Shields used in trenches are usually referred to as "trench boxes" or "trench shields."
Concrete Support Systems
Concrete Formwork is a temporary support system for restraining the compressive force from the concrete. The OSHA Standards for the Construction Industry 29 CFR Part 1926.700(b) titled, Definitions applicable to subpart Q - Concrete and Masonry Construction defines the following formwork terms. *Formwork* is the total system of support for freshly placed or partially cured concrete, including the sheeting that is in contact with the concrete as well as all supporting members including shores, reshores, hardware, braces, and related hardware. *Shoring* means a supporting member that resists a compressive force imposed by a load. *Reshoring* means the construction operation in which shoring equipment called reshores is placed, as the original forms and shores are removed, in order to support partially cured concrete and construction loads for elevated slab and beams. The *slip form system* is used to make a continuous vertical concrete pour which moves up on the freshly poured concrete at a constant speed.

Another temporary operation is called a *Lift-Slab or a jacking operation* which takes cured concrete slabs and lifts them vertically into placed using hydraulic jacks. An additional temporary system is called *tilt-up construction*. This system has the concrete poured on the ground into panels and after they are cured they are lifted or tilted up into place vertically. Finally, there is a formwork system called a *flying deck form system* which is a complete formwork support system that is repositioned using a crane for the next pour.

There are various methods for pouring the concrete such as direct chute, crane and bucket, concrete buggies, concrete pumping, tremie, shotcrete and sometimes by conveyor. The *Concrete bucket* is attached to the crane and a person pulls on a handle which opens the bottom of the bucket and pours concrete. This method is called the crane and bucket operation. There are two types of concrete buggies: Hand or Georgia buggies and the motorized buggies. The hand *Georgia buggy* has a very limited capacity of about 1.5 cubic feet, therefore, it is used to move small amounts of concrete. The *Motorized Concrete Buggy* is a small rubber tired vehicle with a dump box that carries up to 14 cubic feet. A *Concrete pump* is a truck mounted equipped with a placement boom or hose which pressurizes the hose system to pump the concrete to elevated locations or an inaccessible location. *Tremie* is the process of pouring concrete under water using a tube that is submerged into the fresh concrete at all times.

The Structural Engineering Institute (SEI) of the American Society of Civil Engineers (ASCE) insists that “more failures occur during construction than after completion”, therefore, they have developed a standard titled, SEI/ASCE 37-02, Design Loads on Structures During Construction. Another temporary area that fails during construction is the masonry wall bracing. Under the Construction OSHA Standards Part 1926.700 titled Masonry Construction it states that temporary bracing should be provided for walls more than 8 feet high and the bracing shall not exceed 20 feet horizontally. Recently, the Masonry Institute has developed a temporary masonry bracing standard for construction.
Lifting Systems
The Jin Pole is a lifting system which utilizes a single pole or double pole above grade vertical lifting system with the intended purpose of lifting an unusually long horizontal piece of equipment into its permanent vertical position. The Jin poles are attached to a temporary foundation and the guy lines are attached to the top of each Jin pole and tied to deadmen buried in the ground.

Cranes are used to hoist and move loads from one location to another and it is necessary to know the lifting capacity and working range of a crane selected to perform a given service. Manufacturers and suppliers furnish this information in literature describing their products. When a crane lifts a load there is a tendency to tip the machine over. This introduces what is defined as the tipping condition. A machine is considered to be at the point of tipping when a balance is reached between the overturning moment of the load and the stabilizing moment of the machine when the crane is on a firm level supporting surface. A track mounted or a crawler mounted crane sets on a track base which rotates 360 degrees and the boom is attached at the base of the crane. A rubber tired crane is extremely mobile and it can be easily transported from one job site to another over the road. The crane mat is normally made of large square timbers tied together using cables threaded through the center of the timbers at specified spacings. It is best to place the crane on a mat to ensure that the load is distributed evenly.

Tower Cranes are available as rail mounted units, stationary units, climbing units and mobile units. The rail mounted units can be equipped with fixed or slewing towers. Tower cranes generally have a larger area of coverage than climbing and stationary tower cranes. Tower cranes have their boom above the structure and it lifts the load vertically until it is above the structure, then it can move the load horizontally. A tower crane looks like an offset Tee.

A Crane Load Capacity Chart is provided with each crane by the crane manufacturer which indicates its safe lifting capacity under differing conditions. The major factor for safely lifting a load by a crane is its operating radius which is the horizontal distance from the center of the rotation to the hook. Some other factors which affect lifting capacity are the position of the crane in relationship to its base, the placement or use of outriggers and the soil conditions. Also, the boom angle for a crawler mounted lifting crane is normally between 55 degrees and 80 degrees.

Working Range of a Crane Chart
This crane table shows lifting ranges for a dragline, a clamshell and a lifting crane. From the crane table, the working range of a dragline is from 25 degrees to 39 degrees, the clamshell range is between 40 degrees and 54 degrees and the crane lifting range is between 55 degrees and 80 degrees. The crane chart also contains the distance from the center line rotation in feet along the horizontal axis and the height of a structure in feet such as a wall along the vertical structure. To utilize the chart, let’s assume that you are lifting an item over a vertical wall that is 45 feet above the ground and the horizontal distance from the centerline of the rotation is 60 feet.
The first step is to find the working range for a lifting crane which is between 55 degrees and 80 degrees. Next, find the length of boom in feet required by determining if the rotation distance or the height above the ground is the controlling factor. In this example, using the height in feet above the ground of 45 feet and in the lifting crane range of 55 - 80 degrees the length of boom, the curved lines, needed is 50 feet. Now, using the center line rotation in feet of 60 feet and in the lifting crane range of 55 - 80 degrees the length of boom needed is 100 feet. This is found by entering the table along the horizontal axis at 60 feet and following the vertical line until it is within the lifting crane range and finding the intersection of the length of boom in feet curved line and the vertical (60 feet) line. The Crane Chart below indicates the working range of a crane.

Sling Angles are formed by the legs of the sling and the horizontal plane and the rated capacity of any sling depends on its size, its configuration and the angles. A sling with two legs that is used to lift a 1000 pound object will have a 500 pound load in each leg when the sling angle is 90 degrees. The load in each leg will increase as the angle is decreased and at 30 degrees the load will be 1000 pounds in each leg. Therefore, it is extremely important to keep the sling angles greater than 45 degrees. Hence, sling angles approaching 30 degrees should be considered extremely hazardous and avoided at all costs. Some load tables list sling angles as low as 15 degrees but the use of any sling at an angle less than 30 degrees is extremely dangerous. This is not only because of the high loads associated with them but because of the effect on the load of an error in sling angle measurement of as little as 5 degrees. It has been shown that an assumed sling angle of 15 degrees has an assumed load of 1,932 pounds per Leg but, if the actual angle is actually 10 degrees then the actual load is 2,880 pounds per leg. This illustrates how cautious you must be in ensuring that the angle is greater than 45 degrees and the importance of measuring the angle accurately.

The major types of crane attachments are the lift hook, the lifting beam and hook, the concrete bucket, the clamshell bucket, orange peel bucket, the pile driver, the auger or drilled attachment, and the dragline. Each attachment is described below. The Lift Hook has a sling or a configuration of slings connected to the hook on the crane. The Lifting Beam is utilized to lift long items such as beams for a bridge. The Beam has two lifting at each end with the crane hook connected to the center of the lifting beam. The Clamshell bucket opens and is dropped straight down into the soil being excavated and the jaws close toward each other. The Clamshell bucket is utilized to excavate inside the cofferdam after the sheet piles are driven. The Orange Peel bucket is similar to the Clamshell bucket but it opens and has straighter sides and it is dropped straight down into the soil being excavated and the jaws close toward each other. The Pile Driver can replace the boom or it can be attached to the boom via the hook and suspended from the crane. The Auger or Drilled pile is an attachment to the crane for drilling Caissons. These drill attachments have a mechanical device at the bottom of the caisson to form the bell.

Finally, the Dragline is used to excavate earth and load it into hauling units, such as trucks or tractor-pulled wagons, or to deposit it in levees, dams, and spoil banks near the pits from which it is excavated. A dragline usually does not have to go into a pit or hole in order to excavate. It may operate on natural ground while excavating material from a pit with its bucket. This will be very advantageous when earth is removed from a ditch, canal, or pit containing water. If the earth is hauled with trucks, they do not have to go into the pit and contend with mud. If the earth can be deposited along a canal or ditch or near a pit, it frequently is possible to use a dragline with a boom long enough to dispose of the earth in one operation, eliminating the need for hauling units, which will reduce the cost of handling the soil. A Dragline is an excellent unit for excavating trenches when an angle of repose can be utilized without shoring.
Excavation Equipment

*Power Shovels* are normally utilized in an area where the excavation is above the location of the machine. The shovel’s bucket opens at the bottom to place the soil into trucks. They are capable of excavating all classes of earth, except solid rock, without prior loosening. They may be mounted on crawler tracks, in which case they are referred to as crawler-mounted. They may also be mounted on rubber-tired wheels. The non-self-propelled units mounted on the rear of trucks, which are refereed to as truck-mounted, have separate engines for operating them. The *Hydraulic Backhoe* is normally utilized in an area where the excavation is below the location of the machine. The bucket action of a Backhoe is to pull the excavated material toward the machine.  

*Front End Loaders* are used extensively to excavate earth, gravel or rock materials from a pile and place the material into a truck to be transported over a road and deposited at another location. There are basically two types of front-end-loaders, the crawler-tractor-mounted and the wheel-tractor-mounted. They may be further classified by the capacities of the buckets or the weights that the buckets can lift.  

*Scrapers* are used to move large quantities of earth economically for relatively short haul distances. There are a number of different types of scrapers such as the crawler-type tractor, pulling a rubber-tired self-loading scraper. The high draw-bar pulls in loading a scraper, combined with good traction, even on poor haul roads, gives the crawler tractor an advantage for short hauls. However, as the haul distance is increased, the low speed of a crawler tractor is a disadvantage compared with a wheel tractor. Unless the loading operation is difficult, a crawler tractor can load a scraper without the aid of a bulldozer. However, if there are several scraper units on a job, the increased output resulting from using a bulldozer to help load the scrapers usually will justify the use of a bulldozer.  

Te wheel-tractor scrapers are for longer haul distances because of their higher speed. Also, a wheel type tractor-pulled self-loading scraper will permit it to move earth more economically than a crawler-type tractor. Although, the wheel-type tractor scraper lacks loading ability, the higher travel speed, which may exceed 30 mph for some models, will offset the disadvantage in loading when the haul distance is sufficiently long. The size of a scraper may be specified as the struck, or heaped, capacity of the bowl, expressed in cubic yards. The struck capacity is the volume of the material that a scraper will hold when the top of the material is struck off even with the top of the bowl. In specifying the heaped capacity of a scraper, some manufacturers specify the slope of the material above the sides of the bowl with the designation SAE which means the Society of Automotive Engineers. The SAE specifies a slope of 2:1, measured horizontally and vertically, respectively. Since, the slope will vary with the class of material being hauled, the heaped capacity is only an approximate value.  

The *Bottom-dump Wagons* are to be used to haul materials, such as sand, gravel, reasonably dry earth, coal, etc., which flow easily, the use of bottom-dump wagons will reduce the time required to unload the units. Such units are particularly suitable for use where the materials are distributed in layers on a fill or are discharged through grizzlies into hoppers. The rapid rate of discharging the load gives these wagons a time advantage over rear-dump trucks.
Compaction Equipment
The Technical Specifications normally state the compaction method and the optimum moisture content range. The measurement testing method for determining if the desired compaction has been attained is the Modified Proctor Test or the Standard Proctor Test. For a contractor to attain the prescribed compaction, it must determine the number of passes for a roller with a specified unit pressure under the roller areas and the depth of each layer of soil to produce the desired compaction. Compaction is attained by applying energy to a soil by one or more of the following methods. The different methods to apply the energy is by a kneading or tamping action, a static weight, a vibrating action, or an impacting force. The common pieces of compaction methods are described below.

A kneading roller is the sheep's-foot type. This roller, which may be towed by a tractor or self-propelled, consists of a hollow steel drum on whose outer surface there are welded a number of projecting steel feet, which on different pieces of equipment may be of varying lengths and cross sections. A unit may consist of one or several drums mounted on one or more horizontal axles. The weight of a drum may be varied by adding water or sand to produce unit pressures under the feet up to 750 psi or more. As a sheep’s foot roller moves over the surface, the feet penetrate the soil to produce a kneading action and a pressure to mix and compact the soil from the bottom to the top of the layer. With repeated passages of the roller over the surface, the penetration of the feet decreases until the roller is said to walk out of the fill. The Sheep's-foot rollers are quite effective in compacting clays and clay mixtures. However, they cannot compact granular soils such as sand and gravel. Also, the depth of a layer of soil to be compacted is limited to approximately the length of the feet.

Smooth-wheel Rollers may be classified by weight, which is usually stated in tons. A three-wheel two-axle roller. The front wheel is used for steering, while the two rear wheels are used for driving the unit. A two-wheel tandem roller of varying size is available. A three-wheel tandem roller differs from the two-wheel tandem unit in that it has three drums and three axles. This unit can be more effective than the two-wheel tandem or the three-wheel two-axle units in eliminating or reducing transverse surface roughness because of the concentration of pressure on the middle wheel when the unit passes over high spots in the surface being compacted. The rolls are steel drums, which may be ballasted with water or sand to increase the weights. If a roller is designated as 14-20 tons, it means that the minimum weight of the machine only is 14 tons and that it can be ballasted to give a maximum weight of 20 tons. These rollers are effective in compacting granular soils, such as sand, gravel, and crushed stone, and they are also effective in smoothing surfaces of soils that have been compacted by tamping rollers. Another type designates the weight per linear inch of roller, such as 300 lb. per inch of roller width. Specifying the minimum weight per linear inch of width is a more definitive method.

Pneumatic-tired Rollers are surface rollers which apply the principle of kneading action to affect compaction below the surface. They may be self-propelled or towed and they may be small or
large-tired units. The small-tired units usually have two tandem axles with four to nine tires on each axle. The rear wheels are spaced to travel over the surfaces between the front wheels, which produces a complete coverage of the surface. The wheels may be mounted in a manner that will give them a wobbly-wheel effect to increase the kneading action on the soil. The Large-tired rollers are available in sizes varying from 15 to 200 tons gross weight. These units are frequently used to compact subgrade and base material on airfields and earth-fill dams.

*The Manually Operated Vibratory Tamping Compactor* is used in locations where larger units are not practical. These are self-propelled and they are called a vibrating plate for compacting sand or a vibrating sheepsfoot compactor for compacting clay.

*The Manually Operated Rammer Compactor* is normally gasoline-engine-driven rammer used for compacting cohesive or mixed soils in confined areas. These units range in impact from about 300 to 900 or more ft-lb per sec at an impact rate up to 850 per minute, depending on the specific model. Performance criteria include pounds per blow, area covered per hour, and depth of compaction (lift) in inches. Rammers are self-propelled in that each blow moves them ahead slightly to contact new soil.

### Types of Equipment Suited for Compacting Different Types of Soils

<table>
<thead>
<tr>
<th>Type compactor</th>
<th>Soil best suited for</th>
<th>Max. effect in loose, lift, in.</th>
<th>Density gained in lift</th>
<th>Max. Tons.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep's foot</td>
<td>Clay, silty clay, gravel with clay binder</td>
<td>7 to 12</td>
<td>Nearly uniform</td>
<td>20</td>
</tr>
<tr>
<td>Steel tandem two-axle</td>
<td>Sandy silts, most granular material with some clay binder</td>
<td>4 to 8</td>
<td>Average*</td>
<td>16</td>
</tr>
<tr>
<td>Steel tandem three-axle</td>
<td>Same as above</td>
<td>4 to 8</td>
<td>Average*</td>
<td>20</td>
</tr>
<tr>
<td>Steel three-wheel</td>
<td>Granular or granular-plastic material</td>
<td>4 to 8</td>
<td>Average* to uniform</td>
<td>20</td>
</tr>
<tr>
<td>Pneumatic, small-tire</td>
<td>Sandy silts, sandy clays, gravelly sand and clays with few fines</td>
<td>4 to 8</td>
<td>Average* to uniform</td>
<td>12</td>
</tr>
<tr>
<td>Pneumatic large-tire</td>
<td>All types</td>
<td>? to 24</td>
<td>Uniform</td>
<td>50</td>
</tr>
<tr>
<td>Vibratory</td>
<td>Sand, silty sands, silty gravels</td>
<td>3 to 6</td>
<td>Uniform</td>
<td>30</td>
</tr>
<tr>
<td>Combinations</td>
<td>All</td>
<td>3 to 6</td>
<td>Uniform</td>
<td>20</td>
</tr>
</tbody>
</table>

* The density may decrease with depth
Temporary Material and Equipment Exercise

1. Which party is normally responsible for estimating and pricing the temporary structures?
   - A. Owner.
   - B. Vendor.
   - C. Contractor.
   - D. Architect/Engineer.

2. Which party is normally responsible for designing the temporary structures?
   - A. Owner.
   - B. Vendor.
   - C. Contractor.
   - D. Architect/Engineer.

3. Which of the following systems is designed to restrain horizontal temporary loads such as soil and water?
   - A. Steel Piling.
   - B. Sheet Piling.
   - C. Wood Piling.
   - D. Concrete Piling.

4. Which of the following systems is designed to carry the vertical load of the structure?
   - A. Piling.
   - B. Cofferdam.
   - C. Timber Shoring.
   - D. Cribbing and Tie-backs.

5. Which of the following systems is utilized for supporting an existing structure when the new excavation will be below the existing structures foundation while the extension to the existing foundation is being placed?
   - A. Piling.
   - B. Cofferdam.
   - C. Underpinning.
   - D. Cribbing and Tie-backs.
Temporary Material and Equipment Exercise

6. Which of the following systems is utilized for restraining a vertical wall of soil and other loads where it is impractical to slope the soil such as in a downtown area where the excavation and new substructure are below the street level?
   - A. Piling.
   - B. Cofferdam.
   - C. Underpinning.
   - D. Cribbing and Tie-backs.

7. Which of the following systems is designed as an enclosed structure to restrain soil and water, therefore, allowing workers to work inside safely?
   - A. Caisson.
   - B. Jin Poles.
   - C. Cofferdam.
   - D. Underpinning.

8. In construction, what is the proper terminology for transporting the off road equipment to the job site?
   - A. Hauling.
   - B. Mobilization.
   - C. Militarization.
   - D. Transportation.

9. What is the lifting system called which consists of two vertical towers with a cross beam on top with the intended purpose of lifting an unusually long piece of equipment which was transported horizontally and it is lifted into its permanent vertical position?
   - A. Caisson.
   - B. Jin Pole.
   - C. Cofferdam.
   - D. Tower Crane.
Temporary Material and Equipment Exercise

10. What are the components of a cofferdam or a support system?
   - A. Sheeting, Wales, and Cross braces.
   - B. Posts, Stringers, Joists and Pans.
   - C. Posts, Stringers, Joists and Plyform.
   - D. Wall forms, Wall Ties, Wales, Hairpins and Braces.

11. What is a toe in relationship to a Cofferdam?
   - A. The Tie Back extension beyond the Cribbing at least 2 feet.
   - B. The horizontal Wales which extends beyond the wall at least 2 feet.
   - C. The braces set at a 45-degree angle and extended into the ground at least 2 feet.
   - D. The vertical sheeting extended below the bottom of the excavation at least 2 feet.

12. According to the OSHA Construction Safety Standards, what is required for shoring systems more than 20 feet deep?
   - A. The Architect shall design the protection system.
   - B. The Project Engineer shall design the protection system.
   - C. The designated Competent Person shall design the protection system.
   - D. The Registered Professional Engineer shall design the protection system.

13. What is another name for Sheeting?
   - A. Piles.
   - B. Struts.
   - C. Uprights.
   - D. Caissons.

14. What does “close sheeting” mean in relationship to a shoring system?
   - A. The span across the width of an excavation.
   - B. The spacing between timber planks not to exceed ½ inch.
   - C. Tongue and groove timber planks at least 3 inches thick.
   - D. The use of a trench box or trench shield while working in the excavation.
Temporary Material and Equipment Exercise

15. Which piece of equipment and attachment would be the most efficient method to excavate inside a cofferdam?

   ○ A. Shovel with a 3-CY bucket.
   ○ B. Backhoe with a 3-CY bucket.
   ○ C. Crane with an Auger Attachment.
   ○ D. Crane with a Clamshell attachment.

16. Which piece of equipment sets below the excavation and the bucket pushes up?

   ○ A. Power Shovel.
   ○ B. Hydraulic Backhoe.
   ○ C. Dragline.
   ○ D. Wheel-tractor Scraper.

17. Which piece of equipment is used to excavate ponds or soil under water?

   ○ A. Shovel.
   ○ B. Backhoe.
   ○ C. Dragline.
   ○ D. Wheel-tractor Scraper.

18. Which piece of equipment has its boom above the structure and it lifts the load vertically until it is above the structure, then it can move the load horizontally?

   ○ A. Shovel.
   ○ B. Backhoe.
   ○ C. Tower Crane.
   ○ D. Track-mounted Crane.

19. Which piece of equipment is most efficient for compacting granular soils such as sand, gravel, and crushed stone?

   ○ A. Backhoe.
   ○ B. Sheepsfoot.
   ○ C. Smooth-Wheel Roller.
   ○ D. Wheel-tractor Scraper.
Temporary Material and Equipment Exercise

20. Which of the following temporary systems is utilized to support freshly placed concrete which is poured continuously in a vertical direction?
   - A. Slip form system.
   - B. Tilt-up for system.
   - C. Flying form system.
   - D. Lift slab form system.

21. Which of the following temporary systems is utilized to support freshly placed concrete which is poured on the ground as a slab and lifted up to its final horizontal elevation using hydraulic jacks?
   - A. Slip form system.
   - B. Tilt-up for system.
   - C. Flying form system.
   - D. Lift slab form system.

22. What is the concrete pouring method called that is used to pour concrete under water?
   - A. Tremie.
   - B. Conveyor.
   - C. Direct Chute.
   - D. Underpinning.

23. Which organization has published a new design standard targeting loads on structures during construction?
   - A. American Concrete Institute.
   - B. Concrete Reinforcing Steel Institute.
   - C. American Society for Testing Materials.
   - D. Structural Engineering Institute of the American Society of Civil Engineers.

24. What is the primary cause for a masonry wall to collapse while under construction?
   - A. Poor soil conditions.
   - B. Lack of vertical reinforcement.
   - C. Lack of horizontal reinforcement.
   - D. Lack of masonry wall bracing and a change in wind conditions.
Temporary Material and Equipment Exercise

25. Which of the following sling angle ranges is best for lifting without making the lift extremely dangerous?

☐ A. 1 degree to 14 degrees.
☐ B. 15 degrees to 30 degrees.
☐ C. 31 degrees to 44 degrees.
☐ D. 45 degrees to 90 degrees.

26. You have an assumed sling angle of 24 degrees but the actual angle is 19 degrees. What effect does this have on the pounds per leg on the sling?

☐ A. The pounds per leg will decrease.
☐ B. The pounds per leg will increase.
☐ C. The pounds per leg stays constant.
☐ D. The pounds per leg does not matter since the cranes lifting capacity is not effected

Using the Working Range of a Crane Chart attached, answer questions 27 through 33.

27. What is the working range of a Clam Shell?

☐ A. 00 - 24 degrees
☐ B. 25 - 39 degrees
☐ C. 40 - 54 degrees
☐ D. 55 - 80 degrees

28. What is the working range of a Lift Crane?

☐ A. 00 - 24 degrees
☐ B. 25 - 39 degrees
☐ C. 40 - 54 degrees
☐ D. 55 - 80 degrees

29. What is the working range of a Dragline?

☐ A. 00 - 24 degrees
☐ B. 25 - 39 degrees
☐ C. 40 - 54 degrees
☐ D. 55 - 80 degrees
Temporary Material and Equipment Exercise

30. Assume you are lifting an item onto the roof. The height of the exterior wall is 27 Feet above the ground and the horizontal distance from the centerline of the rotation is 40 feet. What is the minimum length of the boom required?

○ A. 20 Feet.
○ B. 50 Feet.
○ C. 60 Feet.
○ D. 70 Feet.

31. Assume you are lifting an item onto the bridge deck. The deck is 27 feet above the ground and the horizontal distance from the centerline of the rotation is 40 feet. What is the minimum boom angle?

○ A. 30 degrees.
○ B. 40 degrees.
○ C. 57 degrees.
○ D. 72 degrees.

32. Assume you are lifting an item onto the bridge deck. The deck is 37 feet above the ground and the horizontal distance from the centerline of the rotation is 70 feet. What is the minimum length of the boom required?

○ A. 70 Feet.
○ B. 87 Feet.
○ C. 110 Feet.
○ D. 120 Feet.

33. Assume you are lifting an item onto the bridge deck. The deck is 37 feet above the ground and the horizontal distance from the centerline of the rotation is 70 feet. What is the minimum boom angle?

○ A. 26 degrees.
○ B. 40 degrees.
○ C. 47 degrees.
○ D. 57 degrees.
Schedules on Plans and in the Technical Specification
Many of the CSI Divisions utilize schedules to represent the work. Therefore, it is essential that a Constructor be able to identify and interpret information from various schedules as well as from the technical specifications and the plans. Some of the most common schedules, construction specifications and plans from various divisions will be discussed below.

Concrete Beam Schedule for Division 03 - Concrete
The Concrete Reinforcing Steel Institute (CRSI) defines reinforced concrete as a combination of both reinforcing steel and concrete using the best properties of each. They take into consideration the compression properties of the concrete and the tension strength of reinforcing steel.

The Reinforcing Steel Bars are also referred to as deformed bars. Reinforcing steel is most common in the form of deformed bars which contains ridges which makes a good bond with the concrete instead of smooth reinforcing. Each reinforcing bar contains identifying marks. The uppermost designation is usually a letter identifying the manufacturer, the next mark the bar size such as a #11. The bar numbers designate eighths of an inch beginning with a No. 3. The rebar diameter is determined by taking the bar # and dividing by eight. Therefore, a #3 bar is 3/8 inch in diameter. A #4 bar is 4/8 or ½ inch. The third mark down is type of steel used. Reinforcing bars are made of either new billet, axle, or rail steel. The fourth identifying mark may be shown on the bar is the tensile yield point. The tensile yield point indicates the minimum pounds per square inch (psi). A grade of 40 reinforcing bar has a minimum yield of 40,000 psi. Other grades are 50 and 60.

Welded Wire Fabric (WWF) is used in slabs-on-grade and highways. It is made of wire generally arranged to cross at right angles at each intersection. The welded wire fabric is made and delivered in rolls or as sheets. The designation is 6 x 6 - W1.4 x W1.4 (10 x 10). The 6 x 6 means that the spacing is 6 inches by 6 inches and the W1.4 xW1.4 is the wire (number) size for a 10-gauge material. The parenthesis indicates the old designation indicating the wire gauge.

Bar supports are normally incorporated by reference and they are not shown on the plans. It is the Contractors responsibility to ensure that they are placed properly. This requires the contractor to review the CRSI 65 Recommended Practice for Placing Bar Supports, Specifications and Nomenclature. Typically they are designed to raise the reinforcing bars to the required height above the bottom of the forms and to hold the bars in place. Many times bar supports are placed in the upper third of the slab and the lower third of the slab. This requires two sets of bar supports placed in a slab or beam. Normally these bar supports are called slab bolsters and beam bolsters and if their location is in the upper third of the slab or beam, then a U is placed at the end of the abbreviation. For example, BB means Beam Bolster and BBU means Beam Bolster Upper. The Concrete Reinforcing Steel Institute (CRSI) publication titled, Manual of Standard Practice and the adapted table titled Bar Support Designations is shown below.
The CSI Master Format has the bar supports under Division 03 CONCRETE, Section 200 REINFORCEMENT and Part 1.03 REFERENCE STANDARDS. A typical specification would indicate that the Contractor must be in compliance with CRSI 65 Recommended Practice for Placing Bar Supports, Specifications and Nomenclature. CRSI is an abbreviation for the Concrete Reinforcing Steel Institute. Some of the typical Types and Sizes of Wire Bar Support with their abbreviations, the type of support and the typical sizes are identified below.

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>TYPE OF SUPPORT</th>
<th>TYPICAL HEIGHTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Slab Bolster</td>
<td>3/4, 1, 1-1/2, 2 inches</td>
</tr>
<tr>
<td>SBU</td>
<td>Slab Bolster Upper</td>
<td>Same as SB</td>
</tr>
<tr>
<td>BB</td>
<td>Beam Bolster</td>
<td>1,1-1/2, 2 to 5 inches in 1/4” increments</td>
</tr>
<tr>
<td>BBU</td>
<td>Beam Bolster Upper</td>
<td>Same as BB</td>
</tr>
<tr>
<td>BC</td>
<td>Individual Bar Chair</td>
<td>3/4, 1, 1-1/2 and 1-3/4 inches</td>
</tr>
<tr>
<td>JC</td>
<td>Joist Chair</td>
<td>3/4, 1, and 1-1/2 and 4, 5, 6 inches in widths</td>
</tr>
<tr>
<td>HC</td>
<td>Individual High Chair</td>
<td>2 to 15 inches in 1/4” increments</td>
</tr>
<tr>
<td>HCM</td>
<td>High Chair for Metal Decking</td>
<td>2 to 15 inches in 1/4” increments</td>
</tr>
<tr>
<td>CHC</td>
<td>Continuous High Chair</td>
<td>Same as HC</td>
</tr>
<tr>
<td>CHCU</td>
<td>Continuous High Chair Upper</td>
<td>Same as CHC</td>
</tr>
<tr>
<td>JCU</td>
<td>Joist Chair Upper</td>
<td>Heights -1 thru +3-1/2 in; 14 inch span</td>
</tr>
</tbody>
</table>


Column, Beam and Slab Schedules
Are utilized to provide the Constructor with detailed information for placing the reinforcing bars, the stirrups, and the bar supports. Reinforcing bars are designated as either straight bars or bar bends which are fabricated by the manufacturer in the shop and shipped to the job site.

Stirrups are also known as ties and they are used to wrap the around the horizontal or vertical bars at specified on center spacings. A Beam schedule is provided below as an exercise.
Concrete Beam Exercise

Given the Beam Schedule attached, and Using Mark 1B1. Answer the following questions.

1. What is the Size of the Beam?
   - A. 12" wide x 24" deep.
   - B. 12" wide x 33" deep.
   - C. 24" wide x 12" deep.
   - D. 24" wide x 10.5" deep.

2. How many total beams for Mark 1B1?
   - A. 1
   - B. 2
   - C. 12
   - D. 24

3. How many layers or mats of reinforcement are required for Mark 1B1?
   - A. 1
   - B. 2
   - C. 12
   - D. 24

4. What is the Reinforcing in the top mat?
   - A. 4 Pieces - #6 bar, 20' 8 inches long.
   - B. 12 Pieces - #6 bar - 20' 8 inches long.
   - C. 2 Pieces - #6 bar - 15' 8 inches long.
   - D. 2 Pieces - #6 bar - 15' 8 inches long and 4 pieces - #6 - 16' 0 inches long.

5. What is the size of the rebar in inches of the stirrups?
   - A. 3/8"
   - B. 4/6"
   - C. 6/8"
   - D. 36"
Concrete Beam Exercise

6. How are the stirrups labeled for Mark 1B1 at column #4?

☐ A. IB1
☐ B. 3A2
☐ C. 3A3
☐ D. 6A1

7. What is the on-center spacing of the stirrups for Mark 1B1 at column #4?

☐ A. 4" and 8"
☐ B. 6" and 8"
☐ C. 6" and 10"
☐ D. 8" and 12"

8. What are the quantity and length of the stirrup support bars for Mark 1B1?

☐ A. 2 each, 15' - 8" long
☐ B. 4 each, 16' - 0" long.
☐ C. 4 each, 20' - 8" long
☐ D. 5 each, 21' - 7" long

9. What are the size, and type of bar supports?

☐ A. 2 inch Slab Bolsters.
☐ B. 2 inch Beam Bolsters.
☐ C. 5 inch High Chairs.
☐ D. 5 inch Beam Bolsters.

10. What does the bar support abbreviation CHCU mean?

☐ A. Concrete High Chair Upper.
☐ B. Continuous High Chair Upper.
☐ C. Concrete High Chair Unidentified.
☐ D. Continuous High Chair Unidentified.
Concrete Beam Exercise

11. What does the bar support abbreviation BBU mean?
   - A. Broad Beam Upper.
   - B. Beam Bolster Upper.
   - C. Bottom Bar Unidentified.
   - D. Beam Bolster Unidentified.

12. What does the bar support abbreviation SB?
   - A. Slab Bar.
   - B. Slab Bolster.
   - C. Slab Bottom.
   - D. Beam Bolster.

13. Which of the following items are not shown or specified in the construction documents for a reinforced concrete structure?
   - A. Rebar.
   - B. Concrete.
   - C. Bar Supports.
   - D. Welded Wire Mesh.

14. What is the name of the organization which publishes a manual on the spacing requirements for bar supports?
   - A. American Concrete Institute.
   - B. Concrete Reinforcing Steel Institute.
   - C. Concrete Reinforcement Standards Institute.
   - D. Concrete Reinforcing Specifications Institute.
## Concrete Beam Exercise - Schedule

<table>
<thead>
<tr>
<th>Mark</th>
<th>No.</th>
<th>Beam Size (inches)</th>
<th>Reinforcing</th>
<th>#3 Stirrups</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bottom</td>
<td>Top</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Width</td>
<td>Depth</td>
<td>No.</td>
</tr>
<tr>
<td>1B1</td>
<td>2</td>
<td>12</td>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td>1B2</td>
<td>1</td>
<td>24</td>
<td>10.5</td>
<td>7</td>
</tr>
<tr>
<td>1B2A</td>
<td>1</td>
<td>24</td>
<td>10.5</td>
<td>7</td>
</tr>
<tr>
<td>1B3</td>
<td>6</td>
<td>24</td>
<td>10.5</td>
<td>6</td>
</tr>
<tr>
<td>1B4</td>
<td>1</td>
<td>24</td>
<td>10.5</td>
<td>4</td>
</tr>
<tr>
<td>1B5</td>
<td>2</td>
<td>24</td>
<td>10.5</td>
<td>4</td>
</tr>
<tr>
<td>1B7</td>
<td>1</td>
<td>24</td>
<td>10.5</td>
<td>8</td>
</tr>
<tr>
<td>1B10</td>
<td>1</td>
<td>12</td>
<td>33</td>
<td>2</td>
</tr>
<tr>
<td>1B12</td>
<td>2</td>
<td>12</td>
<td>18</td>
<td>3</td>
</tr>
</tbody>
</table>
Door and Window Exercise

Using the door schedule attached. Answer the following questions.

1. What is the location of Door number 104 B?
   - A. Crib.
   - B. Women.
   - C. Nursing.
   - D. Corridor.

2. What is the door size, type, door material, frame Material for Door No. 104 A?
   - A. 3' - 6" x 7' -2" x 1-3/4", Type C Solid hollow metal door in a hollow metal frame.
   - B. 3' - 0" x 7' -0" x 1-3/4", Type A Aluminum glass door in an aluminum frame.
   - C. 3' - 0" x 7' - 2" x 1-3/4", Type D Wood door, w/sm. Window in a wood frame.
   - D. 3' - 0" x 7' - 2" x 1-3/4", Type D Wood door w/sm. Window, a hollow metal frame.

3. What does the Abbreviation HM stand for on the door schedule?
   - A. Half Metal Frame
   - B. Hallway Metal Frame
   - C. Hollow Metal Frame.
   - D. Halloway Metal Frame.

4. What is the door size, type door material frame material for Door 107?
   - A. 3' -0" x 7'-2" x 1-3/4”, Type D Wood w/sm window in a hollow metal frame.
   - B. 3' -0"  x 7' -0" x 1-3/4”, Type A, Aluminum, in an aluminum frame.
   - C. 3’-6" x 7’-2” x 1-3/4”, Type C, Solid Wood door in a hollow metal frame.
   - D. 3’-6”x 7’-2” x 1-3/4”, Type C, Hollow metal door in a hollow metal frame.

5. What is the Fire rating of the door and the type of glass for Door No. 108B?
   - A. No rating, standard glass.
   - B. No rating, 1/4" Tempered
   - C. 20 minute rating, 1/4" Wired Glass.
   - D. 45 minute Rating, 1/4" Wired Glass.
Door and Window Exercise

6. What is the Fire rating of the door and the type of glass for Door No. 102?

○ A. No rating, standard glass.
○ B. No rating, 1/4" Tempered
○ C. 20 minute rating, 1/4" Wired Glass.
○ D. 45 minute Rating, 1/4" Wired Glass.

7. What is the Finish on the Frame for Door No. 111?

○ A. Stain.
○ B. Paint.
○ C. Aluminum.
○ D. Dark Bronze.

8. What is the Finish on the Door No. 108 B?

○ A. Stain.
○ B. Paint.
○ C. Aluminum.
○ D. Dark Bronze.

9. What is the Finish on the Door No. 108A?

○ A. Stain.
○ B. Paint.
○ C. Aluminum.
○ D. Dark Bronze.

10. How many sets of Hardware are needed for Door Number 106?

○ A. 1
○ B. 3
○ C. 5
○ D. 10
### Door and Window Exercise - Door Schedule

<table>
<thead>
<tr>
<th>Door No.</th>
<th>Location</th>
<th>Size</th>
<th>Type</th>
<th>Material</th>
<th>Finish</th>
<th>Frame Material</th>
<th>Finish</th>
<th>Label</th>
<th>Glass</th>
<th>Hrdwr</th>
<th>Sets</th>
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<tbody>
<tr>
<td>101</td>
<td>Lower Narthex</td>
<td>3’x7’x1-3/4” (pr)</td>
<td>A</td>
<td>Alum</td>
<td>Dk Bronz</td>
<td>Alum</td>
<td>Dk Bronz</td>
<td>-</td>
<td>1/4”</td>
<td>Temp</td>
<td>1</td>
</tr>
<tr>
<td>102</td>
<td>Infants</td>
<td>3’x7’-2”x1-3/4”</td>
<td>D</td>
<td>Wood</td>
<td>Stain</td>
<td>HM</td>
<td>Paint</td>
<td>45</td>
<td>min</td>
<td>1/4”</td>
<td>Wired</td>
</tr>
<tr>
<td>103</td>
<td>Crib</td>
<td>3’x7’-2”x1-3/4”</td>
<td>D</td>
<td>Wood</td>
<td>Stain</td>
<td>HM</td>
<td>Paint</td>
<td>-</td>
<td>-</td>
<td>1/4”</td>
<td>Temp</td>
</tr>
<tr>
<td>104A</td>
<td>Nursing</td>
<td>3’x7’-2”x1-3/4”</td>
<td>D</td>
<td>Wood</td>
<td>Stain</td>
<td>HM</td>
<td>Paint</td>
<td>20</td>
<td>min</td>
<td>1/4”</td>
<td>Wired</td>
</tr>
<tr>
<td>104B</td>
<td>Nursing</td>
<td>3’x7’-2”x1-3/4”</td>
<td>D</td>
<td>Wood</td>
<td>Stain</td>
<td>HM</td>
<td>Paint</td>
<td>-</td>
<td>-</td>
<td>1/4”</td>
<td>Temp</td>
</tr>
<tr>
<td>105</td>
<td>Women</td>
<td>3’x7’-2”x1-3/4”</td>
<td>C</td>
<td>Wood</td>
<td>Stain</td>
<td>HM</td>
<td>Paint</td>
<td>20</td>
<td>min</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>106</td>
<td>Men</td>
<td>3’x7’-2”x1-3/4”</td>
<td>C</td>
<td>Wood</td>
<td>Stain</td>
<td>HM</td>
<td>Paint</td>
<td>20</td>
<td>min</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>107</td>
<td>Mechanical</td>
<td>3’-6”x7’-2”x1-3/4”</td>
<td>C</td>
<td>HM</td>
<td>Paint</td>
<td>HM</td>
<td>Paint</td>
<td>20</td>
<td>min</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>108A</td>
<td>Corridor</td>
<td>2’-10”x7’-2”x1-3/4” (pr)</td>
<td>D</td>
<td>Wood</td>
<td>Stain</td>
<td>HM</td>
<td>Paint</td>
<td>45</td>
<td>min</td>
<td>1/4”</td>
<td>Wired</td>
</tr>
<tr>
<td>108B</td>
<td>Corridor</td>
<td>3’x7’x1-3/4”</td>
<td>A</td>
<td>Alum</td>
<td>Dk. Bronz</td>
<td>Alum</td>
<td>Dk Bronz</td>
<td>-</td>
<td>-</td>
<td>1/4”</td>
<td>Temp</td>
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<tr>
<td>109</td>
<td>Classroom</td>
<td>3’x7’-2”x1-3/4”</td>
<td>D</td>
<td>Wood</td>
<td>Stain</td>
<td>HM</td>
<td>Paint</td>
<td>20</td>
<td>min</td>
<td>1/4”</td>
<td>Wired</td>
</tr>
<tr>
<td>111</td>
<td>Classroom</td>
<td>3’x7’-2”x1-3/4”</td>
<td>D</td>
<td>Wood</td>
<td>Stain</td>
<td>HM</td>
<td>Paint</td>
<td>20</td>
<td>min</td>
<td>1/4”</td>
<td>Wired</td>
</tr>
<tr>
<td>112</td>
<td>Classroom</td>
<td>3’x7’-2”x1-3/4”</td>
<td>D</td>
<td>Wood</td>
<td>Stain</td>
<td>HM</td>
<td>Paint</td>
<td>20</td>
<td>min</td>
<td>1/4”</td>
<td>Wired</td>
</tr>
<tr>
<td>113</td>
<td>Storage</td>
<td>3’x7’-2”x1-3/4”</td>
<td>C</td>
<td>Wood</td>
<td>Stain</td>
<td>HM</td>
<td>Paint</td>
<td>20</td>
<td>min</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>114A</td>
<td>Stair</td>
<td>3’x7’-2”x1-3/4”</td>
<td>D</td>
<td>Wood</td>
<td>Stain</td>
<td>HM</td>
<td>Paint</td>
<td>1</td>
<td>hour</td>
<td>1/4”</td>
<td>Wired</td>
</tr>
</tbody>
</table>
Door and Window Exercise - Diagrams
Finish and Paint Exercise

Using the Room Schedule attached, answer the following questions.

1. In room no. 105, which materials will be utilized on the floor?
   
   ☐ A. Vinyl.
   ☐ B. Concrete.
   ☐ C. Carpet #1.
   ☐ D. Carpet #2.

2. In Room No. 201, which material and finish will be on the W/NW Wall?
   
   ☐ A. CMU and paint.
   ☐ B. SF CMU, unpainted.
   ☐ C. SF CMU/Wood, stain.
   ☐ D. SF CMU/Wood, unpainted.

3. What does the abbreviation CMU on the Room Finish Schedule mean?
   
   ☐ A. Cast Metal Unit.
   ☐ B. Cabinet Metal Unit.
   ☐ C. Corrugated Metal Unit.
   ☐ D. Concrete Masonry Unit.

4. What is the height of the ceiling in room No. 107?
   
   ☐ A. 8' - 0"
   ☐ B. 9' - 0"
   ☐ C. 10' - 3"
   ☐ D. 13' - 0"

5. What are the ceiling material and finish in room No. 132?
   
   ☐ A. ACT #1 and paint.
   ☐ B. SF CMU and no paint.
   ☐ C. ACT #1 and no paint.
   ☐ D. Gypsum board and paint.
Finish and Paint Exercise

Using the Paint Specifications. Answer the following questions.

6. What types of paint are required on the interior gypsum board with a special finish?
   - A. First coat stain, second coat sealer, third coat Satin finish varnish.
   - B. First coat Vinyl primer-sealer, second coat Multicolored speckled paint.
   - C. First coat Vinyl primer-sealer, second coat Latex eggshell or semigloss, third coat Latex eggshell or semigloss (deep accent colors).
   - D. First coat stain, second coat Chemgard Sealer, Guardsman Chemical coatings, I, third coat Super Chemveer No. 20 Guardsman Chemical Coatings, 4 coats.

7. Which room(s) require the special paint finish on gypsum board walls?
   - A. Stairwell 2 room 132.
   - B. 116, 117, 118, 119, 120, 121, 122, 123, 124, 208, 209, 210, 211, 214 and 132.

8. What is the second coat of paint on the natural finish wood?
   - A. Sealer.
   - B. Semigloss enamel.
   - C. Alkyd flat enamel.
   - D. Stain. Use stain filler for open grain wood.

9. What is the second coat of paint on the Exposed Piping, Hangers, Ductwork, and Equipment (Galvanized)?
   - A. Alkyd flat enamel.
   - B. Vinyl primer-sealer.
   - C. Zinc-chromate primer (Federal Spec TTP-57a).
   - D. Zinc-dust primer (Federal Spec. TTP641b, Type II).

10. What is the second coat on the aluminum jackets for the insulated piping?
    - A. No paint.
    - B. Epoxy paint.
    - C. Alkyd flat enamel.
    - D. Vinyl primer-sealer.
## Finish and Paint Exercise - Room Finish Schedule

<table>
<thead>
<tr>
<th>Rm. No</th>
<th>Room Name</th>
<th>Floor Material</th>
<th>Floor Base Material</th>
<th>N/NE &amp; S/SW Wall Material</th>
<th>E/SE Wall Material</th>
<th>W/NW Wall Material</th>
<th>Ceiling Material</th>
<th>Finish Material</th>
<th>Finish</th>
<th>HT</th>
</tr>
</thead>
</table>
| 101    | Lower Narthex | Carpet #1       | Carpet #1          | CMU Paint                | CMU Paint          | CMU Paint          | ACT #1           | 9' -0"
| 102    | Infants       | Carpet #2       | Carpet #2          | CMU Paint                | CMU Paint          | CMU Paint          | ACT #2           | 8' -0"
| 103    | Crib          | Carpet #2       | Carpet #2          | CMU Paint                | CMU Paint          | CMU Paint          | ACT #2           | 8' -0"
| 104    | Nursing       | Carpet #2       | Carpet #2          | CMU Paint                | CMU Paint          | CMU Paint          | ACT #2           | 8' -0"
| 105    | Women         | Vinyl           | Vinyl              | CMU Paint                | CMU Paint          | CMU Paint          | Gyp Bd Paint     | 8' -0"
| 106    | Men           | Vinyl           | Vinyl              | CMU Paint                | CMU Paint          | CMU Paint          | Gyp Bd Paint     | 8' -0"
| 107    | Mechanical    | Concrete        | - - - - - - - -     | CMU Paint                | CMU Paint          | CMU Paint          | Exposed Paint    | 10'-3"
| 127    | Stair         | Carpet #1       | Carpet #1          | Glass - - - - - - -     | SP CMU             | Glass             | ACT #1           | - - -
| 132    | Stair         | Carpet #1       | Carpet #1          | SF CMU - - - - - - -    | SF CMU             | SF CMU            | ACT #1           | 8' -0"
| 201    | Narthex A     | Carpet #1       | Carpet #1          | Glass - / - / - / -     | SF CMU             | SF CMU/ Wood      | ACT #1           | 13'-0"
| 206    | Narthex B     | Carpet #1       | Carpet #1          | SF CMU - - - - - - -    | SF CMU             | - - -             | ACT #1           | 13'-0"

### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acoustical Ceiling Tile</td>
<td>ACT</td>
<td>CMU</td>
</tr>
<tr>
<td>Concrete Masonry Unit</td>
<td>CMU</td>
<td>CMU</td>
</tr>
<tr>
<td>Gypsum Board</td>
<td>Gyp Bd</td>
<td>Gyp Bd</td>
</tr>
<tr>
<td>SF CMU</td>
<td>Specified cmu</td>
<td>SP</td>
</tr>
<tr>
<td>Vinyl Composite Tile</td>
<td>VCT</td>
<td>VCT</td>
</tr>
</tbody>
</table>
Finish and Paint Exercise - Painting Specifications

09900 - PAINTING SPECIFICATIONS

PART 1 GENERAL

1.01 WORK INCLUDED
A. The term “paint” or “painting” as used in this section have reference to sealers, primers, stains, paints, varnishes, and the application of these materials.
B. Surface preparation.
C. Surface finish.

1.02 RELATED WORK
A. Division 3 - Concrete.
B. Section 04300 - Unit Masonry System.
C. Division 5 - Metals.
D. Division 6 - Carpentry.
E. Section 80111 - Standard Steel Doors and Frames.
F. Section 09260 - Gypsum Board System.
G. 10522 - Fire Extinguisher Cabinets.
I. Division 16 - Electrical Equipment, Identification.

1.03 REFERENCES

PART 3 EXECUTION

3.07 SCHEDULE - EXTERIOR SURFACES
A. Exterior Metal (Ungalvanized Ferrous):
   2. Second Coat: Exterior latex enamel (semigloss or gloss).
   3. Both coats in addition to any factory primer.

B. Exterior Metal (Galvanized):
   1. Treat metal with Galva-prep, as manufactured by Am-chem, Inc.
   2. First Coat: Zinc-dust primer (Federal Spec. TTP641b, Type II).

C. Exterior Metal (Aluminum):
   1. Treat metal with Galva-prep, as manufactured by Am-chem, Inc.
Finish and Paint Exercise - Painting Specifications

3.08 SCHEDULE - INTERIOR SURFACES

A. Interior Gypsum Board (Standard Finish):
   1. First Coat: Vinyl primer-sealer.
   2. Second Coat: Latex eggshell or semigloss.
   3. Third Coat: Latex eggshell or semigloss (deep accent colors).

B. Interior Gypsum Board (Special Finish):
   1. First Coat: Vinyl primer sealer.
   2. Second Coat: Multicolored speckled paint.
   3. Apply per manufacturer’s instructions.

C. Interior Block.
   1. First Coat: Clear Block Sealer.
   2. Spray finish.

D. Interior Roof Deck (Exposed Deck, Beams, and Joists).
   1. 1 coat of spray flat.

E. Interior Metal (Ungalvanized Ferrous):
   1. Both coat in Addition to any factory primer.
   2. First Coat: Zinc-chromate primer (Federal Spc TTP-57a) tinted

F. Interior Metal (Galvanized):
   1. Treat metal with Galva-prep, as manufactured by Am-chem, Inc
   2. First Coat: Zinc-dust primer (Federal Spec. TTP641b, Type II).

G. Interior Wood - Natural Finish:
   1. First Coat: Stain. Use stain filler for open grain wood.
   2. Second Coat: Sealer.
   3. Third Coat: Satin finish varnish.

Or in lieu of the above, Contractor has the option of using:
   1. First Coat: Stain. Use stain filler for open grain wood.
   2. Second Coat: Chemgard Sealer, Guardsman Chemical Coatings, Inc
   3. Third Coat: Super Chemveer No. 20 Guardsman Chemical Coatings.
Finish and Paint Exercise - Painting Specifications

H. Interior Wood Painted:
1. First Coat: Wood primer undercoater.
2. Second Coat: Semigloss enamel.

I. Exposed Piping, Hangers, and Equipment (Ungalvanized):
1. First Coat: Zinc-chromate primer (Federal Spec TTP-57a)
2. Second Coat: Alkyd flat enamel.
3. Note: Cast iron pipe shall first be thoroughly cleaned with rags soaked in mineral spirits to remove oily film, then primed and finished as indicated above.

J. Exposed Piping, Hangers, Ductwork, and Equipment (Galvanized):
1. Treat metal with Galva-prep, as manufactured by Am-chem, Inc
2. First Coat: Zinc-dust primer (Federal Spec. TTP641b, Type II).
4. Note: Use epoxy paint for PVC pipe.

K. Covered (Insulated) Piping and Ductwork (Unprimed):
1. First Coat: Vinyl primer-sealer.
2. Second Coat: Alkyd flat enamel.
3. Note: Aluminum jackets for insulated piping shall not be painted.

L. Back Priming (Interior Millwork and Trim):
1. 1 coat of white oil base primer for wood to receive paint finish.
2. Clear sealer for wood to receive natural finish.
3. Back prime interior millwork on unexposed areas as specified in Div.6.

M. Apply special paint finish on gypsum board walls in the following rooms: 101, 102, 103, 105, 106, 130, 202, 203, 204, 212, 213, 215, 223, 227, and 127 (stair 1). See Item B above.

N. Exposed piping, hangers, ductwork, and equipment shall be painted the same color as adjacent structure and deck.

END OF SECTION
Plumbing Schedule Exercise

1. The plumbing plans have the abbreviation DWV on them. What does the DWV mean?

   ☐ A. Drain Waste and Vent.
   ☐ B. Drain, Water and Vent.
   ☐ C. Domestic Waste Valve.
   ☐ D. Domestic Water Valve

2. The plumbing plans have the abbreviation DS on them. What does DS mean?

   ☐ A. Drain Spigot.
   ☐ B. Down Spout.
   ☐ C. Drain System.
   ☐ D. Domestic System.

3. What system is the DS connected to?

   ☐ A. Storm Sewer.
   ☐ B. Sanitary Sewer.
   ☐ C. Domestic Water.
   ☐ D. Sprinkler System.

4. The Site utility plans have the abbreviation I.E. on them. What does I.E. mean?

   ☐ A. Invert Elevation.
   ☐ B. Inside Elevation.
   ☐ C. Initial Elevation.
   ☐ D. Interior Elevations.

5. At what point is the I.E. calculate to:

   ☐ A. Top inside of the pipe.
   ☐ B. Top outside of the pipe.
   ☐ C. Bottom inside of the pipe.
   ☐ D. Bottom outside of the pipe.
Plumbing Schedule Exercise

6. What is the purpose of a water hammer arrestor?
   - A. Reduce the pressure in the line.
   - B. Reduce the vibration in the line.
   - C. Maintain a constant flow in the line.
   - D. Maintain a constant pressure in the line.

Given the Plumbing Pipe Size Schedule and the Natatorium Plumbing Plan, Answer the following questions.

7. What does the plumbing abbreviation VTR mean?
   - A. Vent Thru Roof.
   - B. Vent Top Return.
   - C. Vertical Top of Roof.
   - D. Vertical Transfer Run.

8. What system is the VTR connected to?
   - A. Storm Sewer.
   - B. Sanitary Sewer.
   - C. Domestic Water.
   - D. Sprinkler System.

9. What system is the CO connected to?
   - A. Storm Sewer.
   - B. Sanitary Sewer.
   - C. Domestic Water.
   - D. Sprinkler System.

10. What is the size of the connection to the HB?
    - A. 0" 
    - B. ½" 
    - C. 3/4" 
    - D. 1"
Plumbing Schedule Exercise

11. What is the size of the Domestic hot water connection to the EWC?
   - A. 0"
   - B. ½"
   - C. 3/4"
   - D. 1"

12. What is the size of the waste line connection to the WC-2?
   - A. 0"
   - B. 1"
   - C. 2"
   - D. 4"

13. What is the size of the cold water connection to the LAV-1?
   - A. 0"
   - B. ½"
   - C. 3/4"
   - D. 1-1/2"

---

Plumbing Exercise - Pipe Size Schedule

<table>
<thead>
<tr>
<th>FIXTURE</th>
<th>COLD</th>
<th>HOT</th>
<th>WASTE</th>
<th>REVENT</th>
<th>MAIN VENT</th>
<th>TRAP SIZE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>WATER CLOSET</td>
<td>1&quot;</td>
<td>-</td>
<td>4&quot;</td>
<td>2&quot;</td>
<td>3&quot;</td>
<td>4&quot;</td>
<td>FLUSH VALVE</td>
</tr>
<tr>
<td>URINAL</td>
<td>3/4&quot;</td>
<td>-</td>
<td>2&quot;</td>
<td>2&quot;</td>
<td>2&quot;</td>
<td>2&quot;</td>
<td>WALL MTD.</td>
</tr>
<tr>
<td>LAVATORY</td>
<td>1/2&quot;</td>
<td>1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/4&quot;</td>
<td></td>
</tr>
<tr>
<td>SINK</td>
<td>1/2&quot;</td>
<td>1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>2&quot;</td>
<td>1-1/2&quot;</td>
<td>Or as Noted</td>
</tr>
<tr>
<td>ELECTRIC WATER COOLER</td>
<td>1/2&quot;</td>
<td>-</td>
<td>1-1/4&quot;</td>
<td>1-1/4&quot;</td>
<td>-</td>
<td>1-1/4&quot;</td>
<td></td>
</tr>
<tr>
<td>HOSE BIB</td>
<td>3/4&quot;</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>NON-FREEZE</td>
</tr>
<tr>
<td>FLOOR DRAIN</td>
<td>-</td>
<td>-</td>
<td>3&quot;</td>
<td>2&quot;</td>
<td>3&quot;</td>
<td>3&quot;</td>
<td>OR A NOTED</td>
</tr>
<tr>
<td>SERVICE SINK</td>
<td>3/4&quot;</td>
<td>3/4&quot;</td>
<td>3&quot;</td>
<td>2&quot;</td>
<td>2&quot;</td>
<td>3&quot;</td>
<td></td>
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</tbody>
</table>
Plumbing Schedule Exercise - Natatorium Plans

NATATORIUM PLUMBING PLAN

SEE DRAWING 413 FOR CONTINUATION
Mechanical Equipment Exercise

Using the Mechanical Equipment tables provided, answer the following questions.

1. What does the mechanical abbreviation FT mean?
   - A. Fan Tube.
   - B. Fin Tube.
   - C. Fire Tube.
   - D. Furnace Tube.

2. What are the Depth and Height of FT-4?
   - A. 4" D, 5" Height.
   - B. 5" D, 12" Height.
   - C. 4" D, 14" Height.
   - D. 4" D, 12" Height.

3. What room does EF-3 service?
   - A. Toilet Room 105.
   - B. Toilet Room 125.
   - C. Toilet Room 209.
   - D. Prayer Room 205.

4. Where is AHU-1 located?
   - A. Narthex 201.
   - B. Prayer Room 205.
   - C. Sanctuary Room 202.
   - D. Mechanical Room 107.

5. Where is CC-1 located?
   - A. Inside B-1.
   - B. Inside AHU-1.
   - C. Inside CUH-1.
   - D. Inside RTU-1.
Mechanical Equipment Exercise

6. What service is P-3 connected to?
   - A. B-1
   - B. HC-1.
   - C. Heating Loop.
   - D. Chilled Water.

7. What does the mechanical abbreviation CUH mean?
   - A. Cabinet Unit Heater.
   - B. Chiller Unit Handler.
   - C. Cooling Unit Handler.
   - D. Convector Unit Heater.

8. What area does RTU-3 service?
   - A. Narthex 201.
   - C. Lower Level.
   - D. Sanctuary 202.
   - D. Prayer Room 205.

9. What service is L-2 connected to?
   - A. AHU-1 INTAKE.
   - B. EF-3 EXHAUST.
   - C. AHU-1 EXHAUST.
   - D. CEILING SUPPLY DIFFUSER.

10. What are the length and height in inches of L-1?
    - A. 16" L and 16" H.
    - B. 24" L and 18" H.
    - C. 42" L and 84" H.
    - D. 60" L and 84" H.
# Mechanical Equipment Exercise - Fan and Fin Tube Schedules

## FAN SCHEDULE

<table>
<thead>
<tr>
<th>Mark</th>
<th>Service</th>
<th>Model</th>
<th>CFM</th>
<th>S.P.</th>
<th>HP/AMPS.</th>
<th>RPM</th>
<th>T.S./O.V.</th>
<th>WHEEL DIA.</th>
<th>SONES</th>
<th>VOLTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>EF-1</td>
<td>TOILET 105,106</td>
<td>DB-8</td>
<td>825</td>
<td>½&quot;</td>
<td>1/4</td>
<td>1000</td>
<td>2100</td>
<td>----</td>
<td>9.2</td>
<td>120v-1PH</td>
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<tr>
<td>EF-2</td>
<td>TOILET 125</td>
<td>360</td>
<td>125</td>
<td>1/8&quot;</td>
<td>1.2</td>
<td>1200</td>
<td>0000</td>
<td>0000</td>
<td>2</td>
<td>120V-1PH</td>
</tr>
<tr>
<td>EF-3</td>
<td>PRAYER 205</td>
<td>GN-720</td>
<td>500</td>
<td>1/4&quot;</td>
<td>1/4</td>
<td>1325</td>
<td>2200</td>
<td>0000</td>
<td>3.5</td>
<td>120V-1PH</td>
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<tr>
<td>EF-4</td>
<td>TOILET 208,209</td>
<td>GN-820</td>
<td>600</td>
<td>1/4&quot;</td>
<td>1/4</td>
<td>700</td>
<td>1600</td>
<td>----</td>
<td>2.3</td>
<td>120v-1PH</td>
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</table>

1 Based on Cook  
2 Based on Broan, Provide with wall cap

## FIN TUBE SCHEDULE

<table>
<thead>
<tr>
<th>MARK</th>
<th>LOCATION</th>
<th>ELEMENT</th>
<th>BTH/FT</th>
<th>FIN LENGTH</th>
<th>GPM</th>
<th>ROWS</th>
<th>ENCLOSURE</th>
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<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>STYLE</td>
</tr>
<tr>
<td>FT-1</td>
<td>SEE PLANS</td>
<td>3/4&quot;C.-2 3/4&quot;X3-48</td>
<td>720</td>
<td>SEE PLAN</td>
<td>SEE PLAN</td>
<td>1</td>
<td>FS-210</td>
</tr>
<tr>
<td>FT-2</td>
<td>SEE PLANS</td>
<td>3/4&quot;C-2 3/4&quot;X3-48</td>
<td>720</td>
<td>SEE PLAN</td>
<td>SEE PLAN</td>
<td>1</td>
<td>FS-210</td>
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<tr>
<td>FT-3</td>
<td>SEE PLANS</td>
<td>1&quot;C.-3 1/4&quot;-48</td>
<td>750</td>
<td>SEE PLAN</td>
<td>SEE PLAN</td>
<td>1</td>
<td>AA-1r2</td>
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<tr>
<td>FT-4</td>
<td>SEE PLANS</td>
<td>3/4&quot;C.-2 3/4&quot;X 4 1/4&quot;</td>
<td>1050</td>
<td>SEE PLAN</td>
<td>SEE PLAN</td>
<td>1</td>
<td>DV4</td>
</tr>
</tbody>
</table>

1 BASED ON VULCAN, 180* EWT, 160* LWT, 65* EAT  
2 MOUNT INVERT AT 7'-6: A.F.F.  
3 PROVIDE W/ 14GA PIPE ENCLOSURE AND PRESSURE CLIP FASTENERS AT LOCATIONS SHOWN ON PLANS
## Mechanical Equipment Exercise - Convector, Unit Heaters and Cabinet Unit Heater Schedules

### Convector Schedule

<table>
<thead>
<tr>
<th>MARK</th>
<th>MODEL</th>
<th>LOCATION</th>
<th>MBH</th>
<th>GPM</th>
<th>CABINET DIMENSIONS</th>
<th>CONTROL</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-1</td>
<td>FWG-A-24</td>
<td>SEE PLANS</td>
<td>2.1</td>
<td>1.0</td>
<td>24&quot; 24&quot; 4&quot; 4&quot;</td>
<td>DAMPER</td>
<td></td>
</tr>
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</table>

1 Based on Vulcan, 180* EWT, 160* LWT, 65* EAT

### Unit Heater Schedule

<table>
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<tr>
<th>MARK</th>
<th>SERVICE</th>
<th>MODEL</th>
<th>CFM</th>
<th>MBH</th>
<th>GPM</th>
<th>LAT</th>
<th>RPM</th>
<th>HP</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UH-1</td>
<td>MECH RM 107</td>
<td>HV-24</td>
<td>350</td>
<td>15.6</td>
<td>2.0</td>
<td>98</td>
<td>1350</td>
<td>1/20</td>
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</tbody>
</table>

1 Based on Vulcan, 180* EWT, 160* LWT, 65* EAT

### Cabinet Unit Heater Schedule

<table>
<thead>
<tr>
<th>MARK</th>
<th>MODEL</th>
<th>CFM</th>
<th>MBH</th>
<th>GPM</th>
<th>LAT</th>
<th>CABINET DIMENSIONS</th>
<th>RPM</th>
<th>HP</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUH-1</td>
<td>RWI-1130-06</td>
<td>630</td>
<td>38.4</td>
<td>3.0</td>
<td>125</td>
<td>59&quot; 25' 9 ½&quot; 6&quot;</td>
<td>1050</td>
<td>1/10</td>
<td>1</td>
</tr>
</tbody>
</table>

1 Based on Vulcan, 180* EWT, 160* LWT, 65* EAT
Level 1 Construction Fundamentals Study Guide

Mechanical Equipment Exercise - Air Handling, Cooling Coil and Heating Coil Schedules

### AIR HANDLING UNIT SCHEDULE

<table>
<thead>
<tr>
<th>MARK</th>
<th>LOCATION</th>
<th>SERVICE</th>
<th>MODEL</th>
<th>CFM</th>
<th>S.P.</th>
<th>O.V.</th>
<th>RPM</th>
<th>H.P.</th>
<th>REMARKS</th>
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<tbody>
<tr>
<td>AHU-1</td>
<td>MECH RM 107</td>
<td>LOWER LEVEL</td>
<td>LML-122</td>
<td>10,100</td>
<td>1 1/4&quot;</td>
<td>2 1/4&quot;</td>
<td>1417</td>
<td>1291</td>
<td>7 ½ 1,2</td>
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</table>

1 BASED ON McQUAY
2 PROVIDE 4" HIGH RAIL UNDER UNIT

### COOLING COIL SCHEDULE

<table>
<thead>
<tr>
<th>MK</th>
<th>Location</th>
<th>CFM</th>
<th>MBH TOT/SEN</th>
<th>CHILLED WATER</th>
<th>AIR P.D.</th>
<th>WATER P.D.</th>
<th>EDB</th>
<th>EWB</th>
<th>LDB</th>
<th>LWB</th>
<th>COIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC-1</td>
<td>AHU-1</td>
<td>10,100</td>
<td>340/282</td>
<td>78</td>
<td>55*</td>
<td>458</td>
<td>.56</td>
<td>15.9</td>
<td>80*</td>
<td>65*</td>
<td>55*</td>
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</table>

1 BASED ON MCQUAY

### HEATING COIL SCHEDULE

<table>
<thead>
<tr>
<th>MK</th>
<th>Location</th>
<th>CFM</th>
<th>MBH</th>
<th>GPM</th>
<th>WATER P.D.</th>
<th>EWT</th>
<th>LWT</th>
<th>AIR P.D.</th>
<th>EAT</th>
<th>LAT</th>
<th>COIL</th>
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<tbody>
<tr>
<td>HC-1</td>
<td>AHU-1</td>
<td>10,100</td>
<td>403</td>
<td>39</td>
<td>11.7</td>
<td>140*</td>
<td>119*</td>
<td>.72</td>
<td>55*</td>
<td>90*</td>
<td>②</td>
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</tbody>
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1 BASED ON McQUAY
2 MODEL #5WH1102C
### Mechanical Equipment Exercise - Boiler and Pump Schedules

#### BOILER SCHEDULE

<table>
<thead>
<tr>
<th>MARK</th>
<th>MODEL</th>
<th>MBH</th>
<th>RECOVERY GPH</th>
<th>SUPPLY TEMP.</th>
<th>FULL SIZE</th>
<th>REMARKS</th>
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</thead>
<tbody>
<tr>
<td>B-1</td>
<td>CHN0990</td>
<td>990</td>
<td>831</td>
<td>00</td>
<td>180°</td>
<td>10&quot;</td>
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</table>

1 BASED ON LOCHINAR COPPER - FIN II
2 PROVIDE POWERED VENT CAP FOR SIDEWALL VENT & SEALED COMBUSTION
3 PROVIDE TEKMAR #254 4-STAGE BOILER CONTROL, INSTALLED & WIRED BY T.C.C.

#### PUMP SCHEDULE

<table>
<thead>
<tr>
<th>MARK</th>
<th>SERVICE</th>
<th>MODEL</th>
<th>GPM</th>
<th>FT. HEAD</th>
<th>RPM</th>
<th>IMPELLER DIA.</th>
<th>HP</th>
<th>VOLTAGE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-1</td>
<td>HEATING LOOP</td>
<td>1510-2 ½&quot;AB</td>
<td>65</td>
<td>45'</td>
<td>1750</td>
<td>7&quot;</td>
<td>2</td>
<td>480V-3PH</td>
<td>1</td>
</tr>
<tr>
<td>P-2</td>
<td>HEATING LOOP</td>
<td>1510-2 ½&quot;AB</td>
<td>65</td>
<td>45'</td>
<td>1750</td>
<td>7&quot;</td>
<td>2</td>
<td>480V-3PH</td>
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<tr>
<td>P-3</td>
<td>HC-1</td>
<td>60-2&quot;A</td>
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<td>30'</td>
<td>1750</td>
<td>6 ½&quot;</td>
<td>1</td>
<td>480V-3PH</td>
<td>1</td>
</tr>
<tr>
<td>P-4</td>
<td>CHILLED WATER</td>
<td>1510-2 ½&quot;AB</td>
<td>78</td>
<td>45'</td>
<td>1750</td>
<td>7&quot;</td>
<td>2</td>
<td>480V-3PH</td>
<td>1</td>
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1 BASED ON BELL & GOSSETT
## Mechanical Equipment Exercise - Gas Fired Package Rooftop Unit Schedules

<table>
<thead>
<tr>
<th>MK</th>
<th>LOCATION</th>
<th>MODEL</th>
<th>CFM</th>
<th>EXT S.P.</th>
<th>SAF HP</th>
<th>SAF RPM</th>
<th>VOLTAGE</th>
<th>HTG. MBH IN/OUT</th>
<th>COOLING TOT/SEN</th>
<th>COMpressors</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTU-1</td>
<td>SANC. 202</td>
<td>558DE240</td>
<td>7500</td>
<td>1&quot;</td>
<td>7 ½</td>
<td>1210</td>
<td>480v-3PH</td>
<td>270/216</td>
<td>235/173</td>
<td>20.6</td>
<td>31.4</td>
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<tr>
<td>RTU-2</td>
<td>SANC. 202</td>
<td>558DE240</td>
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<td>1&quot;</td>
<td>7 ½</td>
<td>1210</td>
<td>480v-3PH</td>
<td>270/216</td>
<td>235/173</td>
<td>20.6</td>
<td>31.4</td>
</tr>
<tr>
<td>RTU-3</td>
<td>Narthex 201</td>
<td>558DE090</td>
<td>3000</td>
<td>3/4&quot;</td>
<td>3</td>
<td>1470</td>
<td>480V-3PH</td>
<td>180/144</td>
<td>73/84</td>
<td>7.69</td>
<td>6.2</td>
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1. BASED ON BRYANT
2. PROVIDE W/INSULATED 24" HIGH ROOF CURB FOR SIDEWALL SUPPLY & RETURN
3. PROVIDE 2/100% ECONOMIZER
## Mechanical Equipment Exercise - Louver, Diffuser, Register and Grille Schedules

<table>
<thead>
<tr>
<th>LOUVER SCHEDULE</th>
<th>MARK</th>
<th>SERVICE</th>
<th>DIMENSIONS</th>
<th>CFM</th>
<th>FREE AREA SQ. FT.</th>
<th>S.P. IN W.G.</th>
<th>AIR VELOCITY FPM</th>
<th>Notes</th>
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<tr>
<td></td>
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<td>LENGTH</td>
<td>HEIGHT</td>
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<tr>
<td></td>
<td>L - 1</td>
<td>AHU-1 INTAKE</td>
<td>60&quot;</td>
<td>84&quot;</td>
<td>10,100</td>
<td>19.85</td>
<td>.05</td>
<td>510</td>
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<td>L - 2</td>
<td>AHU-1 EXHAUST</td>
<td>42'</td>
<td>84&quot;</td>
<td>9,100</td>
<td>13.69</td>
<td>.07</td>
<td>660</td>
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<td>L - 3</td>
<td>EF-3 EXHAUST</td>
<td>16&quot;</td>
<td>16&quot;</td>
<td>500</td>
<td>0.81</td>
<td>.06</td>
<td>620</td>
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<td>L - 4</td>
<td>EF-4 EXHAUST</td>
<td>24&quot;</td>
<td>18&quot;</td>
<td>600</td>
<td>1.11</td>
<td>.05</td>
<td>540</td>
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<tr>
<td>1 Based on Rusken</td>
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<tr>
<th>DIFFUSER, REGISTER AND GRILLE SCHEDULE</th>
<th>MARK</th>
<th>SERVICE</th>
<th>MODEL</th>
<th>VOLUME DAMPER</th>
<th>FINISH</th>
<th>REMARKS</th>
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<tr>
<td>D -1 CEILING SUPPLY DIFFUSER</td>
<td>TDC -3</td>
<td>- - - - -</td>
<td>OFF-WHITE</td>
<td>1, 2</td>
<td></td>
<td></td>
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<tr>
<td>D -2 CEILING SUPPLY DIFFUSER</td>
<td>TDC -1</td>
<td>- - - - -</td>
<td>OFF-WHITE</td>
<td>1</td>
<td></td>
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<tr>
<td>D -3 FLOOR SUPPLY DIFFUSER</td>
<td>CT - PP - 0</td>
<td>AG - 35</td>
<td>CLEAR ANODIZED</td>
<td>1, 3</td>
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<tr>
<td>R -1 SIDEWALL SUPPLY REGISTER</td>
<td>1700</td>
<td>AG - 15</td>
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<td>1</td>
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<tr>
<td>R -2 CEILING EXHAUST REGISTER</td>
<td>350FL</td>
<td>AG - 15</td>
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<td></td>
<td></td>
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<tr>
<td>G -1 CEILING RETURN GRILLE</td>
<td>50F</td>
<td>- - - - -</td>
<td>OFF-WHITE</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Electrical Exercise

Using the Electrical Plans, Schedules provided below and the Mechanical Equipment Schedules previously attached, answer the following questions.

1. Using the One-line Diagram, what are the electrical power requirements to the Chiller?
   - A. 3 #4, 1" C
   - B. 3 #4/0, 2" C
   - C. 4 #1/0, 2-1/2" C
   - D. (4) #350 MCM & #2 Ground, 3" PVC

2. Using the One-line Diagram, what are the electrical power requirements from the Pad Mounted Transformer to the Main Switchboard?
   - A. 3 #4, 1" C
   - B. 3 #4/0, 2" C
   - C. 4 #1/0, 2-1/2" C
   - D. (4) #350 MCM & #2 Ground, 3" PVC

3. Using the One-line Diagram, what are the Feeders on the Main Switch Board going to?
   - A. Panel “PP”, Panel “DP”.
   - B. Panel “PP”, Panel “DP”, and the Existing Service Panel.

4. Using the One-line Diagram, what are the Feeders on the Distribution Panel going to?
   - A. Panel “PP”, Panel “DP”.

5. Using the One-line Diagram, what phase motor is required for the Chiller?
   - A. 1
   - B. 3
   - C. 4
   - D. 17
Electrical Exercise

6. Using the Diagrams, you will see the symbol ● and the abbreviation’s EF-4 and 17, F. What phase motor is required?
   ○ A. 1
   ○ B. 3
   ○ C. 4
   ○ D. 17

7. What does the abbreviation 17, F refer to?
   ○ A. Fan #17.
   ○ B. EF #17 on Panel F.
   ○ C. Circuit #17 on Panel F.
   ○ D. Panel #17 on Circuit F.

8. Which one of the following electrical receptacles is attached to 20, F?
   ○ A. RTU-3, 201.
   ○ B. Outlets Room 201.
   ○ C. Outlets in Room 206.
   ○ D. EF-3, Outlets in Room 205.

9. What is the horsepower for UH-1?
   ○ A. 1/10
   ○ B. 1/20
   ○ C. 1.0
   ○ D. 7-1/2

10. What is the voltage requirement for RTU-2?
    ○ A. 120
    ○ B. 208
    ○ C. 240
    ○ D. 480
Electrical Exercise

11. What phase motor is required for P-2?

☐ A. 1
☐ B. 2
☐ C. 3
☐ D. 480

12. What is the horse power required for P-3?

☐ A. 1/10
☐ B. 1.0
☐ C. 2.0
☐ D. 7-1/2

13. What size breaker in amperes is required for RTU-1?

☐ A. 1
☐ B. 3
☐ C. 20
☐ D. 50.

14. What is the mounting height of the outlet near the Narthex and on the south wall referred to as 18, F?

☐ A. 16 inches.
☐ B. 40 inches.
☐ C. 42 inches.
☐ D. 80 inches.

15. What is the mounting height of the Fire Alarm Smoke detector?

☐ A. 16 inches.
☐ B. 40 inches.
☐ C. 42 inches.
☐ D. 80 inches.
Level 1 Construction Fundamentals Study Guide

Electrical Exercise

16. Which of the following pieces of electrical equipment has a disconnect switch?
   - O A. EF-3
   - O B. CUH
   - O C. EWC
   - O D. RTU-2.

17. What does the abbreviation GFI, WP mean?
   - O A. Ground Fixture Inside and Waterproof.
   - O B. Ground Fault Interrupter and Waterproof.
   - O C. Ground Fault Interrupter and Weatherproof.
   - O D. Ground Fluorescent Inside and Weatherproof.

18. What does the abbreviation EWC mean?
   - O A. Eye Wash Container.
   - O B. Electric Water Cooler.
   - O C. Exhaust Waste Convenience.
   - O D. Equalization Water Container.

19. Where are the lighting fixtures C 4 located?
   - O A. Narthex.
   - O B. Exterior.
   - O C. Bathrooms.
   - O D. Stairs and Entrances.

20. Which Fixture types are attached to a Photo-cell?
   - O A. A1 and EM1.
   - O B. B2. and K.
   - O C. E and EM1.
   - O D. M and N.
Electrical Exercise

21. What type of light is a B2 light?

☐ A. 2' x 2' Fluorescent Troffer with Prismatic lens.
☐ B. 2' x 4' Fluorescent Troffer with Prismatic lens.
☐ C. 2' x 4' Fluorescent Troffer with Prismatic lens with 3 lamps.
☐ D. 2' x 2' Fluorescent Troffer with Parabolic lens and 30K lamps.

22. How are the EM-2 lights mounted?

☐ A. Ceiling.
☐ B. Surface.
☐ C. Pendant.
☐ D. Recessed.

23. How many lamp(s) are in fixture A2?

☐ A. 1
☐ B. 2
☐ C. 3
☐ D. 4

24. What is the electrical symbol Ø with an E inside the circle mean?

☐ A. Exit Sign.
☐ B. Existing Sign.
☐ C. Electrical Fixture.
☐ D. Emergency Fixture.

25. Which of the following wire sizes has the greatest diameter?

☐ A. #0
☐ B. #1
☐ C. #10
☐ D. #14.

Check Answers
## Electrical Exercise - Electrical Symbols Legend and Mounting Heights

### Electrical Symbol Legend

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Mounting Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Single Pole Switch</td>
<td>40&quot;</td>
</tr>
<tr>
<td>S3</td>
<td>Three-Way Switch</td>
<td>40&quot;</td>
</tr>
<tr>
<td>D</td>
<td>Dimmer Switch</td>
<td>40&quot;</td>
</tr>
<tr>
<td>O</td>
<td>Convenience Outlet</td>
<td>16&quot; OR AS NOTED</td>
</tr>
<tr>
<td>O GFI</td>
<td>Convenience Outlet With GFI</td>
<td>16&quot; OR AS NOTED</td>
</tr>
<tr>
<td>O WP</td>
<td>Weatherproof Outlet</td>
<td>16&quot; OR AS NOTED</td>
</tr>
<tr>
<td>O</td>
<td>Safety Convenience Outlet</td>
<td>16&quot; OR AS NOTED</td>
</tr>
<tr>
<td>J</td>
<td>Disconnect Switch</td>
<td>16&quot; OR AS NOTED</td>
</tr>
<tr>
<td>●</td>
<td>Single Phase Motor</td>
<td>----</td>
</tr>
<tr>
<td>○</td>
<td>3-Phase Motor</td>
<td>----</td>
</tr>
<tr>
<td>-</td>
<td>Branch Circuit Panel Board</td>
<td>----</td>
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<tr>
<td>♡</td>
<td>Telephone Outlet</td>
<td>----</td>
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<tr>
<td>●</td>
<td>Data Outlet</td>
<td>16&quot; OR AS NOTED</td>
</tr>
<tr>
<td>□</td>
<td>Magnetic Door Holder</td>
<td>16&quot; OR AS NOTED</td>
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<td>J</td>
<td>Junction Box</td>
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<tr>
<td>1</td>
<td>Fire Alarm Pull Station</td>
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<tr>
<td>2</td>
<td>Fire Alarm Audio/Visual Device</td>
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<td>3</td>
<td>Fire Alarm Visual Device</td>
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<td>4</td>
<td>Fire Alarm Smoke Detector</td>
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<td>5</td>
<td>Fire Alarm Duct Smoke Detector</td>
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<td>●</td>
<td>Recessed Incand. or Fluorescent</td>
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<tr>
<td>●</td>
<td>HID Fixture, Surface or Pendant</td>
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<tr>
<td>□</td>
<td>Incand. Fixture, Surface or Pendant</td>
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<td>EM</td>
<td>Exit Sign</td>
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<td>ETR</td>
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<td>ETBR</td>
<td>Strip Fluorescent Fixture</td>
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<tr>
<td>■</td>
<td>Surface Fluorescent Fixture</td>
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<td>▼■▼</td>
<td>Battery Emergency Fixture</td>
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<tr>
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*Note: All Mounting Heights are to Bottom.*
Electrical Exercise - One Line Diagram
Electrical Exercise - Power Plan Upper Level
## Electrical Exercise - Panel Board Load Sheet

**Panel:** F  
**Mounting:** Recessed  
**Main:** 3P100A MLD  
**Panel Location:** 209  
**Voltage:** 120/480 -3  
**Feeder Size:** 4#3, 1-1/4 C  
**Feeder From:** DP

<table>
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<tr>
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<th>Load in Volt Amps</th>
<th>BKR CKT</th>
<th>CKT P AMP</th>
<th>Location</th>
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<td>Outlet Motor P AMP</td>
<td>NO</td>
<td>NO P AMP</td>
<td>Light</td>
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<tr>
<td>RTU-1, 202</td>
<td></td>
<td>3 50</td>
<td>1 2</td>
<td>Lighting, 206</td>
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<tr>
<td>Lighting, 209</td>
<td></td>
<td>1 20</td>
<td>5 6 1</td>
<td>Outlet 201, P. CEL</td>
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<td>RTU-2, 202</td>
<td></td>
<td>3 50</td>
<td>7 8 1</td>
<td>WP GFI, 202C</td>
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<td>EF-3, 205</td>
<td></td>
<td>1 20</td>
<td>11 12 1</td>
<td>WP GFI Roof</td>
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<tr>
<td>EWC</td>
<td></td>
<td>1 20</td>
<td>13 14 1</td>
<td>Outlet R 206, 202B</td>
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<td>CUH</td>
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<td>3 20</td>
<td>15 16 1</td>
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<td>EF-4 208, 209</td>
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<td>3 20</td>
<td>17 18 1</td>
<td>Outlets Room 206</td>
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<td>1 20</td>
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Electrical Exercise - Lighting Plan Upper Level
## Electrical Exercise - Lighting Fixture Legend

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<th>DESCRIPTION</th>
<th>MOUNTING</th>
<th>LAMPS</th>
<th>MANUFACTURER</th>
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<tbody>
<tr>
<td><strong>A1</strong> 2' X 4' FLUORESCENT TOFFER W/ PRISMATIC LENS</td>
<td>RECESSED</td>
<td>(2) F40CW/RS/WM</td>
<td>LITHONIA #2SPG-240</td>
</tr>
<tr>
<td><strong>A2</strong> 2' x 4' SIMILAR TO A1 EXCEPT W/ 3 LAMPS</td>
<td>RECESSED</td>
<td>(3) F40CW/RS/WM</td>
<td>LITHONIA #2SPG-340</td>
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<tr>
<td><strong>B1</strong> 2' X 2' FLUORESCENT TROFFER W/PRISMATIC LEN</td>
<td>RECESSED</td>
<td>(2) FB40CW/6</td>
<td>LITHONIA #2SPG-2U40</td>
</tr>
<tr>
<td><strong>B2</strong> SIMILAR TO B1 EXCEPT W/ PARABOLIC LENS &amp; 30K LAMPS</td>
<td>RECESSED</td>
<td>(2) F40SPX30/U/6</td>
<td>LITHONIA #2PM3</td>
</tr>
<tr>
<td><strong>C1</strong> INCANDESCENT DOWNLIGHT</td>
<td>RECESSED</td>
<td>(1)15ORFL120WM</td>
<td>KURT VERSEN #150</td>
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<tr>
<td><strong>C2</strong> SIMILAR TO C1 EXCEPT W/ LAMP</td>
<td>RECESSED</td>
<td>(1)300RFL</td>
<td>KURT VERSEN #300</td>
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<td><strong>C3</strong> SIMILAR TO C1 EXCEPT W/ LAMP</td>
<td>RECESSED</td>
<td>(1)Q500 T4</td>
<td>KURT VERSEN #500</td>
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<tr>
<td><strong>C4</strong> SIMILAR TO C1 EXCEPT W/ FLUORESCENT LAMP</td>
<td>RECESSED</td>
<td>(2)PLC26W/27</td>
<td>KURT VERSEN #120</td>
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<tr>
<td><strong>C5</strong> SIMILAR TO C1 EXCEPT WALLWASH</td>
<td>RECESSED</td>
<td>(2)PLC26W/27</td>
<td>KURT VERSEN #120</td>
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<tr>
<td><strong>D</strong> PENDANT INCANDESCENT FIXTURE, ACRYLIC DIFFUSER</td>
<td>PENDANT</td>
<td>(8)N150</td>
<td>VISA #CB3616</td>
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<tr>
<td><strong>K</strong> INCANDESCENT UP/DOWN LIGHT</td>
<td>WALL PER DETAIL</td>
<td>(1)100A21/99</td>
<td>MANNING #DS89</td>
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<td><strong>M</strong> HID DOWNLIGHT</td>
<td>RECESSED</td>
<td>(1)MS100BU/BDW</td>
<td>HALO #M6024</td>
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<tr>
<td><strong>N</strong> HID WELL UPLIGHT</td>
<td>WELL IN GROUND</td>
<td>(1)MS100BU/BDW</td>
<td>HYDREL #9305</td>
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<tr>
<td><strong>EM 1</strong> EMERGENCY BATTERY FIXTURE</td>
<td>SURFACE</td>
<td>PER UNIT</td>
<td>LITHONIA #ELM-H</td>
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<tr>
<td><strong>EM 2</strong> SAME AS EM1 EXCEPT CEILING MOUNTED</td>
<td>CEILING</td>
<td>PER UNIT</td>
<td>LITHONIA #ELM-H</td>
</tr>
</tbody>
</table>

239
1. ALL BALLAST SHALL BE ENERGY SAVING TYPE, FLUORESCENT (T12) BALLAST.

2. HID LAMPS BY VENTURE, ‘PL’ LAMPS BY OSRAM AND ALL OTHER LAMPS BY G.E. WITH EQUAL BY SYLVANIA.

3. EXIT SIGNS ARE BATTERY POWERED LED TYPE.

4. PARTIALLY SHADDED FIXTURES SHALL INCLUDE 1/3 OR ½ OF LAMPS ON BATTERY BACKUP EMERGENCY PACK SUCH FIXTURES ARE NORMAL MANUALLY CONTROLLED AND AUTOMATICALLY LIGHT DURING LOSS OF POWER.

5. EQUAL FIXTURES BY LITHONIA, DAYBRITE, METALUX, HALO, AND CAPRI, ARE APPROVED. FIXTURE CUTS MUST BE SUBMITTED FOR SPECIFIC FIXTURES NOT LISTED ABOVE.

6. NOT THE USE OF 30K LAMPS FOR THE PARABOLIC 2 X 2 FIXTURES.

7. FIXTURES TYPE ‘E1’ & ‘E2’ SHALL MATCH ‘D’, INCLUDING THE BRASS RING AROUND THE UPPER PART OF THE FIXTURE. FIXTURE ‘E2’ IS ONLY 1/4 OF A SPHERE FOR CORNER MOUNTING, ACRYLIC OR MATCHING PAINT FINISH. FIXTURE TO SET OUT FROM WALL.

8. OF THE 18 TYPE ‘F’ FIXTURES, PROVIDING AT LEAST THREE (3) FIXTURES OF EACH BEAM TYPE CL, VNSP, NSP, MFL, & WFL. INCLUDE THREE (3) SETS OF SPARE LENS #S4PAR-LS. EQUAL FIXTURES BY STRAND SHALL BE APPROVED EQUALS. SEE ELEC. & ARCH DETAILS FOR INSTALLATION.

9. FIXTURE ‘G’ TO HAVE CLEAR LENS TO PREVENT COLLECTION OF DUST IN REFLECTOR. PROVIDE PHOTOMETRICS OF SIDE, FRONT & REAR WITH FIXTURE INVERTED PER DETAIL #7 ON DWG. E2.

10. UP/DOWN FIXTURE ‘K’ TO MOUNT DIRECTLY TO WALL PER DETAIL #1 ON DWG. E2.

11. FLOOD LIGHTING FIXTURE ‘P’ COLOR TO MATCH ROOF FINISH.

12. FIXTURE MUST BE ‘IC’ RATED.

13. ‘D’ FIXTURE BY VISA WITH WHITE PENDANT, LBZ RING & NO FINAL. ‘D’ FIXTURE BY MANNING WITH WHITE PENDANT ‘DB’ RING & NO FINAL.