Chapter 4
Construction Management

Topics

1.0.0 Definitions
2.0.0 Planning
3.0.0 Estimating
4.0.0 Scheduling
5.0.0 Execution
6.0.0 Administration
7.0.0 Safety
8.0.0 Operational Risk Management
9.0.0 Quality Control

To hear audio, click on the box.

Overview

As a candidate for Petty Officer Third or Second Class, you are an emerging leader who will provide critical support to sustain the U.S. Navy’s mission throughout the world. When you have achieved Petty Officer Third Class, you will have the responsibility, authority, and accountability to manage the sailors working for you, always maintaining safe work practices.

The first and most important thing for any Seabee project is planning, estimating, and scheduling. Proper execution of these tasks ensures the correct amount of the appropriate materials is on site at the right time. This also ensures that the right staff is available for the work when needed. Before the project begins, and while it is being executed, good administration helps keep it on track. Safety is a major responsibility of the crewleader; operational risk management can help identify and correct potential safety concerns. Quality control is another crewleader responsibility, in coordination with the Quality Control Division.
Objectives

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

1. Identify basic planning, estimating, and scheduling terms.
2. Give documentation requirements necessary in planning a construction project.
3. Explain estimating requirements for a construction project.
4. Explain the scheduling requirement for a construction project.
5. Explain the responsibilities of the various project management levels for executing a construction project.
6. Explain the administrative responsibilities of the crewleader.
7. Explain the safety responsibilities of the crewleader.
8. Explain the five step Operational Risk Management process.
9. Explain the responsibilities of the crewleader for Quality Control.

Prerequisites

None

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

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

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

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

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

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

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

In planning any project, you must be familiar with the vocabulary commonly associated with planning, estimating, and scheduling. Here, we’ll define a number of terms you need to know as a Builder.

1.1.0 Planning

Planning is the process of determining requirements and devising and developing methods and action for constructing a project. Good construction planning is a combination of many elements:

- the activity, material, equipment, and manpower estimates
- project layout
- project location
- material delivery and storage
- work schedules
- quality control
- special tools required
- environmental protection
- safety
- progress control

All of these elements depend upon each other. You must consider them all in any well-planned project.

1.2.0 Estimating

Estimating is the process of determining the amount and type of work to be performed, quality and the quantities of material, equipment, and labor required. Lists of these quantities and types of work are called estimates. There are a number of estimates you will work with, including preliminary estimates, detailed estimates, activity estimates, material estimates, equipment estimates, and manpower estimates.

1.2.1 Estimator

An estimator is a person who evaluates the requirements of a task. A construction estimator must be able to mentally picture the separate operations of the job as the work progresses through the various stages of construction and be able to read and obtain accurate measurements from drawings. The estimator must have an understanding of math, previous construction experience, and a working knowledge of all branches of construction. The estimator must use good judgment when determining what factors and conditions have effects on construction projects and what allowances to make for each of them. The estimator must be able to do accurate work. A Seabee estimator must have access to information about the material, equipment, and labor to perform various types of work under any conditions encountered on Seabee
deployments. The collection of such information on construction performance is part of estimating. Since this kind of reference information may change from time to time, the estimator must frequently review the information.

1.3.0 Scheduling

Scheduling is the process of determining when an action must be taken and when material, equipment, and manpower are required. There are four basic types of schedules: progress, material, equipment, and manpower.

Progress schedules coordinate all the projects of a Seabee deployment or all the activities of a single project. They show the sequence, the starting time, the performance time required, and the time required for completion.

Material schedules show when the material is needed on the job. They may also show the sequence in which materials should be delivered.

Equipment schedules coordinate all the equipment to be used on a project. They also show when it is to be used and the amount of time each piece of equipment is required to perform the work.

Manpower schedules coordinate the manpower requirements of a project and show the number of personnel required for each activity. In addition, it may show the number of personnel of each rating (Builder, Construction Electrician, Equipment Operator, Steelworker, and Utilitiesman) required for each activity for each period of time. The time unit shown in a schedule should be some convenient interval, such as a day, a week, or a month.

2.0.0 PLANNING

There are two basic ground rules in analyzing a project. First, planning and scheduling are separate operations. Second, planning must always precede scheduling. If you don’t plan sequentially, you will end up with steps out of sequence and may substantially delay the project. Everyone concerned should know precisely the following aspects of a project:

1. What it is
2. Its start and finish points
3. Its external factors, such as the schedule dates and requirements of other trade groups
4. The availability of resources, such as manpower and equipment
5. What you need to make up the project planning files

Test your Knowledge (Select the Correct Response)

1. (True or False) In analyzing a project, scheduling always precedes planning.
   A. True
   B. False
2.1.0 Planning Documentation – Seabee Project Package

2.1.1 Instructions for the Seabee Project Package

Listed below are the instructions needed to complete a typical Seabee project package. There are five main sections, each containing forms for that section. Those forms marked with an asterisk (*) are mandatory on all projects. In a contingency operation, requirements for forms marked with a double asterisk (**) may be waived. Small projects of short duration or Advanced Base Functional Component (ABFC) projects may require only the mandatory forms. Other forms are used as needed. Forms may be computer generated but must have the content shown. Details on the forms are in Chapter 15 of the Seabee Crewleader’s Handbook.

A. Seabee Project Package Contents: To be placed at the beginning of the project package 3-ring binder.

B. Section #1: General Information and Correspondence:

1. 1A Cover Sheet: Recommend using tabbed dividers for all section cover sheets.
   a.*Tasking Letter/Correspondence: Distributed by S3 early in homeport, sample in Seabee Crewleader’s Handbook.
   b.*Outgoing Messages and Correspondence: File in chronological order, oldest on bottom to newest on top.
   c.*Incoming Messages and Correspondence: File in chronological order, oldest on bottom to newest on top.

2. 1B Cover Sheet:
   a.Project Scope Sheet: Outlines the scope of the project in paragraph format, sample in Seabee Crewleader’s Handbook.
   b.Project Organization: In addition to this, include a complete list of all prime and sub personnel assigned to the project.
   c.Project Planning Milestones: This list can be added to if necessary. Contact Ops when assigning dates.
   d.Project Package Sign-Off Sheet: To be signed off prior to the RDE.
   e.Deployment Calendar: Outlines the important dates for deployment, sample in Seabee Crewleader’s Handbook.
   g.Predeployment Site Visit Summary: Outlines information gathered during a site visit before deployment signed off by ROICC Representative and S3, sample in Seabee Crewleader’s Handbook.
   h.Joint Turnover Memorandum: Both battalions’ personnel will complete this jointly for turnover projects. After completion forward to Ops. Also include the minutes of the turnover conference.
i. Pre-BOD Inspection Request: The crewleader will complete this two working days prior to the requested date of inspection.

C. Section #2 Activities and Network.

1. 2A Cover Sheet:
   a. *Level II Barchart: Take particular care in manday totals recorded on this form. All numbers will match Level III calculations. Horizontal and vertical totals will match exactly.
   b. *Two week Schedule: The crewleader will complete this each week. The company will present it to Ops at the weekly Ops meeting. The crewleader will brief the crew on this and post on the job site.
   c. *Master Activity Listing: List each master activity and describe exactly what is included in it. This will make clear to all personnel where one master activity stops and another begins.
   d. *Master Activity Summary Sheets: Complete this after the Level III barchart and CAS sheets are finalized.
   e. **Level III Precedence Diagram:

2. 2B Cover Sheet:
   a. Level III Barchart: Complete this after you determine the construction schedule on the precedence network.
   b. Construction Activity Summary Sheets: This is one of the most important forms in the project package. Almost all the rest of the project package and project execution are driven by the CAS Sheet. Be sure all entries are as accurate as possible. Be specific (but use plain language) on the Safety, QC, and Environmental blocks. Include all requirements. Your Safety, QC, and Environmental Plans will match this.
   c. Completed Activities CAS Sheets: File in numerical order as construction activities are completed. Be sure to record actual mandays and duration.
   d. Two Week Labor Summary: The crewleader completes this daily prior to submitting time cards to company.
   e. SITREP Feeders: Forward to Ops on a biweekly basis.
   f. Other Computer Printouts/Reports:

D. Section #3 Resources:

1. 3A Cover Sheet:
   a. *30/60/90-Day Material List: Forward a copy to MLO upon completion. MLO will enter material status from PCR/PSR and forward to Ops for action. Submit a separate form for each (30/60/90-day) requirement.
   b. *30/60/90-Day Material List Letter: Ops will forward this to the cognizant regiment after receiving material status from MLO. You may use one form as long as you separate 30/60/90-day requirements.
c.*Typical Bill of Materials: Ops will supply to the company after the detailed MTO is completed. Transfer information from this to the BM/MTO Comparison Worksheet.

d.*Tool Requirement Summary: Submit Add-on BM for special tools if not already on the BM.

e.*Equipment Requirement Summary: Ensure a copy is routed to ALFA Company after completion.

2. 3B Cover Sheet:

a.List of Possible Long Lead Items: This does not need to be kept in the project package. It is provided for planning purposes only.

b.List of Long Lead Items: Forward a copy to MLO after completion. Crewleader and MLO will track through homeport.

c.Material Take Off Worksheet: Use this form when doing a detailed MTO. Transfer information to the BM/MTO Comparison Worksheet.

d.BM/MTO Comparison Worksheet: For any shortage of material, forward an Add-on/Reorder BM to MLO.

e.Material Transfer Request: Forward to MLO for project to project transfer only. Do not use for excess material.

f.Add-on/Reorder Justification: Attach this to all Add-on/Reorder BMs.

g.Add-on/Reorder BM: Use this along with the Justification Form. When adding or reordering material circle Add-on or Reorder. For excess material forward this as an Add-on BM along with a 1250-1 signed by S3. Remember, an Add-on is adding another line item to the BM. A Reorder is ordering more of the same materials already on the BM.

h.Borrow Log: Crewleader will log all project to project transfers. This is used to keep track of transfers because MLO keeps the Material Transfer Request until receiving the replacement material.

E. Section #4 Plans:

1. 4A Cover Sheet:

a.*Quality Control Plan Cover Sheet: First sheet of the QC Plan.

b.*Quality Control Plan: The project QC Plan will come directly from the CAS sheets. QC will produce a separate plan. Project and QC will compare plans and resolve any differences.

c.*Safety Plan Cover Sheet: First sheet of the project Safety Plan.

d.*General Safety Plan: Second sheet of the project Safety Plan. These are general items that apply to almost all construction activities. Specific items will be included on the Safety Plan.

e.*Safety Plan: The project Safety Plan will come directly from the CAS sheets. Include all safety items not covered on the General Safety
Plan. The Safety Department will produce a separate plan. Project and Safety will compare plans and resolve any differences.

f. **Environmental Plan:** The project Environmental Plan will come directly from the CAS sheets.

2. **4B Cover Sheet:**
   
a. **Daily Quality Control Inspection Report:** Completed daily by the QC inspector.
   
b. **Field Adjustment Request (FAR) Submittal Log:** Use this to record all FARs whether approved or disapproved.
   
c. **FAR:** Use for all changes to the project. Keep these to a minimum. Construct project according to plans and specifications if possible. Be clear and concise when completing this. Attach drawings and extra items as needed.
   
d. **Request for Information (RFI) Submittal Log:** Self explanatory.
   
e. **RFI:** Use for clarification of plans or specifications only. All requests for changes on the project will be submitted on a FAR.
   
f. **Design Change Directives (DCD):** Include all ROICC directed changes to the project.
   
g. **Concrete Placement Clearance Form:** Must be completed at a minimum 24 hours in advance of concrete placement.
   
h. **Pre-placement photos for concrete placement:** Include views of forms, RST and anchor bolts.
   
i. **Asphalt Placement Clearance Form:** Must be completed at a minimum 24 hours in advance of asphalt placement.
   
j. **Utility Interruption request:** This is a typical form. Each deployment site may be different. Submit to Ops at least two weeks in advance of required outage or within the host required time frame.
   
k. **Excavation Request:** This is a typical form. Each deployment site may be different. Submit to Ops at least two weeks in advance of required excavation or within the host required time frame.
   
l. **Road Closure Request:** This is a typical form. Each deployment site may be different. Submit to Ops at least two weeks in advance of required closure or within the host required time frame.
   
m. **Engineering Service Request:** Submit to Ops at least five days in advance of required service.
   
n. **Mineral Products Request:** Submit to MLO at least two weeks in advance of required delivery date.
   
o. **Other QC Forms:**
   
p. **Daily Safety Inspection Report:** Battalion’s Safety inspector will complete daily.
q. Emergency Phone Numbers: Remove this from the project package and post on the job site.

r. Navy Employee Report of Unsafe or Unhealthful Working Conditions: This will be removed from the project package and posted on the job site.

s. Required Safety Equipment: Check the Safety Plan to verify the equipment required for this project.

t. Daily Safety Lecture Log: Record daily and forward a copy to Safety as required.

u. Accident/Near Mishap/Mishap Reports: In the event of a mishap, submit this to Safety as required. This does not take the place of medical reports or other reports that may be required by Safety.

v. Highlighted 29 CFR 1926:

w. Hazardous Materials Inventory Sheet: Submit a copy to Environmental/Safety as required.

x. Other Safety Forms:

F. Section #5 Drawings/Specifications:

1. 1A Cover Sheet:
   a. *Project Plans:
   b. **Highlighted Specifications:

2. 1B Cover Sheet:
   a. Site Layout:
   b. Shop Drawings:
   c. Detailed Slab Layout Drawings:
   d. Forming Plans:
   e. Rebar Bending Schedule:
   f. Other Sketches/Drawings:
   g. Technical Data:

Test your Knowledge (Select the Correct Response)

2. A Seabee project package contains what total number of main sections?

   A. 3
   B. 5
   C. 7
   D. 9
2.2.0 Project Planning Steps and Flowcharts

There are numerous steps to take in planning a project. Some of them are usually completed by the Company Commander or Operations Chief, as shown below.

A. Preliminary Project Planning Steps

1. Obtain and review plans and specifications.
2. Write scope paragraph.
3. Develop master activities.
4. Place master activities into logical connection sequence (Logic Network).
5. Rough manday estimate for master activities (crew size x duration).
6. Select construction methods.
7. Identify long lead time materials.
8. Visit site, if practical.

Other steps are usually completed by the Crewleader, as shown below.

B. Detailed Project Planning Steps

1. Develop construction activities.
2. Place construction activities into Logic Network.
3. Identify training required and ensure it is provided.
4. Write quantity estimates for detailed activities:
   - permanent material
   - construction support
   - material (consumables)
   - crew size and ratings
   - tools and equipment
   - durations
   - mandays
5. Complete CAS sheets for each construction activity.
6. Compare Material Take Off to BM.
7. Make or request shop drawings in conjunction with the estimate.
8. Revise scope or methods, based on site visit.
9. Develop Safety and Quality Control plans.
10. Monitor message traffic, Situation Reports and correspondence.
11. Obtain deployment calendar.
12. Enter project into computer.
13. Level resources and reschedule.
15. Supply Required Delivery Dates for material to cognizant regiment.

A summary of project planning steps is shown in Figure 4-1.

![Figure 4-1 – Project planning flowchart.](image)

### 2.3.0 Using Blueprints

Construction drawings are your main basis for defining the required activities for measuring the quantities of material. Accurate estimating requires a thorough examination of the drawings. Carefully read all notes and references and examine all details and reference drawings. Carefully check the orientation of sectional views. Dimensions shown on drawings or computed figures shown from those drawings take precedence over those obtained by scaling distances.

Check the Revision section near the title section to ensure that the indicated changes were made in the drawing itself. You must ensure that the construction plan, the specifications, and the drawings are for the same project. When there are inconsistencies between general drawings and details, follow the details. If there is a
controversy, request an RFI for further clarification. When there are inconsistencies between drawings and specifications, follow the specifications.

As an estimator, you must first study the specifications and then use them with the drawings when preparing quantity estimates. Become thoroughly familiar with all the requirements stated in the specifications. Some estimators may have to read the specifications more than once to understand these requirements in their mind. You are encouraged to make notes as you read the specifications. These notes will be helpful to you later as you examine the drawings and prepare your CAS sheet and MTOs. In the notes, list any unusual or unfamiliar items of work or materials and reminders for use during examination of the drawings. A list of activities and materials described or mentioned in the specifications is helpful in checking quantity estimates.

The tables and diagrams in the *Seabee Planner’s and Estimator’s Handbook*, NAVFAC P-405, should save you time in preparing estimates and, when used properly, provide accurate results. The tables and the diagrams used were based on Seabee experience. Where suitable information was not available, construction experience was adjusted to represent production under the range of conditions encountered in Seabee construction. A thorough knowledge of the project drawings and specifications makes you alert to the various areas where errors may occur.

One way to reduce errors is to keep track of the drawings and specifications for which you have already created estimates. Use highlighters to mark each section of the prints as you complete the estimate for it.

### 2.3.1 Accuracy as a Basis for Ordering and Scheduling

Quantity estimates are used as a basis for purchasing materials, determining equipment, and determining manpower requirements. They are also used in scheduling progress, which provides the basis for scheduling material deliveries, equipment, and manpower. Accuracy in preparing quantity estimates is extremely important; these estimates have widespread uses, and errors can be multiplied many times. For example, a concrete slab is to measure 100 feet by 800 feet. If you misread the dimension for the 800 foot side as 300 feet, the computed area of the slab will be 30,000 square feet, when it should actually be 80,000 square feet. Since area is the basis for ordering materials, there will be shortages. For example, concrete ingredients, lumber, reinforcing materials, and everything else involved in mixing and placing the concrete, including equipment time, material, manpower, and man-hours, will be seriously underestimated and under-ordered.

### 2.3.2 Checking Estimates

The need for accuracy is vital, and quantity estimates should be checked to eliminate as many errors as possible. One of the best ways to check your quantity estimate is to have another person make an independent estimate and then compare the two. Check any differences to determine which is right. A less effective way of checking is for another person to take your quantity estimates and check all measurements, recordings, computations, extensions, keeping in mind the most common error sources, which are listed in the next section.
2.3.3 Error Sources

Failure to read all the notes on a drawing or failure to examine reference drawings results in many omissions. For example, you may overlook a note that states “symmetrical about the center line” and thus compute only half the required quantity.

Errors in scaling obviously mean erroneous quantities. Although not recommended but sometimes required take care in scaling drawings so that you record correct measurements. Common scaling errors include using the wrong scale, reading the wrong side of a scale, and failing to note that a detail being scaled is drawn to a scale different from that of the rest of the drawing. Remember, some drawings are not drawn to scale. Since these cannot be scaled for dimensions, you must obtain dimensions from other sources.

Sometimes wrongly interpreting a section of the specifications causes errors in the estimate. If there is any doubt concerning the meaning of any part of the specification, request an explanation of that particular part.

Omissions are usually the result of careless examination of the drawings. Thoroughness in examining drawings and specifications usually eliminates errors of omission. Use checklists to assure that all activities or materials have been included in the estimate. If drawings are revised after material takeoff, new issues must be compared with the copy used for takeoff and appropriate revisions made in the estimate.

Construction materials are subject to waste and loss through handling, cutting to fit, theft, normal breakage, and storage loss. Failure to make proper allowance for waste and loss results in erroneous estimates. Other error sources are inadvertent figure transpositions, copying errors, and math errors.

2.4.0 Master Activities

Projects are broken down into master activities representing large, functional parts of the project. A good narrative description of each master activity clearly shows where each section of the project falls. This helps reduce the chance of omitting any items of work when estimating.

The standard master activities Seabees use are listed in Table 4-1. These are based on the same numbering system format used for the 16 divisions established by the Construction Specification Institute (CSI). Division 17 (Expeditionary Structures) was established specifically by NAVFAC.
Table 4-1 – Standard Master Activities.

<table>
<thead>
<tr>
<th>CODE</th>
<th>ACTIVITY</th>
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<tbody>
<tr>
<td>01XX</td>
<td>General</td>
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<tr>
<td>02XX</td>
<td>Site Work</td>
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<td>03XX</td>
<td>Concrete Construction</td>
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<tr>
<td>04XX</td>
<td>Masonry</td>
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<tr>
<td>05XX</td>
<td>Metals</td>
</tr>
<tr>
<td>06XX</td>
<td>Carpentry</td>
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<tr>
<td>07XX</td>
<td>Moisture Protection</td>
</tr>
<tr>
<td>08XX</td>
<td>Doors, Windows, and Glass</td>
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<tr>
<td>09XX</td>
<td>Finishes</td>
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<tr>
<td>10XX</td>
<td>Specialties</td>
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<tr>
<td>11XX</td>
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<td>12XX</td>
<td>Furnishings</td>
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<td>13XX</td>
<td>Special Construction</td>
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<td>14XX</td>
<td>Conveying Systems</td>
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<td>15XX</td>
<td>Mechanical Construction</td>
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<tr>
<td>16XX</td>
<td>Electrical Construction</td>
</tr>
<tr>
<td>17XX</td>
<td>Expeditionary Structures</td>
</tr>
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</table>

Each master activity is further broken down into construction activities identifying functional parts of the facility, often tied to a particular company or rating.

2.5.0 Construction Activity

The crewleader breaks the master activity down into construction activities. A typical NMCB project might have between fifteen and fifty construction activities. Construction activity numbers are four digits. The standard construction activities the Seabees use are listed in Table 4-2. The first two digits identify the master activity and the second two digits show a specific construction activity within a master activity.

Table 4-2 – Standard Construction Activities.

<table>
<thead>
<tr>
<th>01 General</th>
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<tr>
<td>010X</td>
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<td>Cast-in-Place Concrete</td>
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<td>Stone</td>
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<td>Finish Carpentry</td>
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<td>063X</td>
<td>Wood Treatment</td>
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<td>Insulation</td>
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<td>Shingles &amp; Roofing Tiles</td>
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<td>074X</td>
<td>Preformed Roofing &amp; Siding</td>
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<td>075X</td>
<td>Membrane Roofing</td>
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<td>076X</td>
<td>Flashing &amp; Sheet Metal</td>
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<td>077X</td>
<td>Roof Specialties &amp; Accessories</td>
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<td>Skylights</td>
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<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>081X</td>
<td>Metal Doors &amp; Frames</td>
</tr>
<tr>
<td>082X</td>
<td>Wood &amp; Plastic Doors</td>
</tr>
<tr>
<td>083X</td>
<td>Special Doors</td>
</tr>
<tr>
<td>084X</td>
<td>Entrances &amp; Storefronts</td>
</tr>
<tr>
<td>085X</td>
<td>Metal Windows</td>
</tr>
<tr>
<td>086X</td>
<td>Wood &amp; Plastic Windows</td>
</tr>
<tr>
<td>087X</td>
<td>Hardware</td>
</tr>
<tr>
<td>088X</td>
<td>Glazing</td>
</tr>
<tr>
<td>089X</td>
<td>Glazed Curtain Wall</td>
</tr>
<tr>
<td>09 Finishes</td>
<td>091X</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>092X Lath, Plaster, &amp; Gypsum Board</td>
<td>097X</td>
</tr>
<tr>
<td>093X Tile</td>
<td>098X</td>
</tr>
<tr>
<td>094X Terrazzo</td>
<td>099X</td>
</tr>
<tr>
<td>095X Acoustical Treatment &amp; Wood Flooring</td>
<td></td>
</tr>
<tr>
<td>10 Specialties</td>
<td>101X</td>
</tr>
<tr>
<td>102X Louvers, Corner Protection, &amp; Access Flooring</td>
<td>106X</td>
</tr>
<tr>
<td>103X Fireplaces, Exterior Specialties, &amp; Flagpoles</td>
<td>107X</td>
</tr>
<tr>
<td>104X Signs</td>
<td>108X</td>
</tr>
<tr>
<td>105X Lockers, Protective Covers, &amp; Postal Specialties</td>
<td>109X</td>
</tr>
<tr>
<td>11 Architectural Equipment</td>
<td>110X</td>
</tr>
<tr>
<td>111X Mercantile &amp; Commercial Equipment</td>
<td>115X</td>
</tr>
<tr>
<td>114X Food Service, Residential, Darkroom, &amp; Athletic Equipment</td>
<td>116X</td>
</tr>
<tr>
<td>117X Medical Equipment</td>
<td></td>
</tr>
<tr>
<td>12 Furnishings</td>
<td>123X</td>
</tr>
<tr>
<td>125X Window Treatment</td>
<td>127X</td>
</tr>
<tr>
<td>126X Furniture &amp; Accessories</td>
<td>128X</td>
</tr>
<tr>
<td>13 Special Construction</td>
<td>130X</td>
</tr>
<tr>
<td>131X Preengineered Structures, Pools, &amp; Ice Rinks</td>
<td>133X</td>
</tr>
<tr>
<td>132X Tanks, Tank Covers, &amp; Filtration Equipment</td>
<td>135X</td>
</tr>
<tr>
<td>14 Conveying Systems</td>
<td>141X</td>
</tr>
<tr>
<td>142X Elevators</td>
<td>144X</td>
</tr>
<tr>
<td>143X Moving Stairs &amp; Walks</td>
<td>145X</td>
</tr>
</tbody>
</table>
According to the list of master activities in Table 4-1 and the list of construction activities in Table 4-2, a project with a construction activity for “Install Footing RST” would be numbered 0325. The 03 represents the “Concrete Construction” master activity and the 25 distinguishes “Install Footing RST” from other construction activities in that master activity. 5 replaces the “X” in the standard construction activity “Concrete Reinforcement”.

2.6.0 Work Element

Construction activities are further broken down into work elements. A specific construction activity could have one or several work elements. A construction activity such as “Fabricate Forms for Footings” could require only one work element. A construction activity such as “Install PVC Pipes” could require several work elements depending on the different types of fittings involved. These work elements are placed on the back of the CAS sheet as line items in the construction comments block. NAVFAC P-405 uses the term “work element”. Other estimating guides use different terms, but the concept is the same. Figure 4-2 shows the front of a blank Construction Activity Summary sheet.
CONSTRUCTION ACTIVITY SUMMARY SHEET

PROJECT NUMBER:__________
TITLE:_____________________________________________________
BM CODE:_______  PREPARED BY:_____________________ CHECKED
BY:_____________________
START SCHEDULED:_______________________  FINISH SCHEDULE:________________________
ACTUAL:_______________________                    ACTUAL:________________________

ACT. NO.:___________________________ MASTER ACTIVITY:______________________________
ACT. TITLE:_________________________________________________________________________

DESCRIPTION OF WORK METHOD:_____________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________

DURATION: ESTIMATED__________________ MANDAYS: ESTIMATED______________________
ACTUAL:_________________________________ ACTUAL:_______________________________
Production Efficiency Factor:________________       Resulting Delay Factor:______________________
Travel Time:___________________                     Manday Equivalent:_________________________

LABOR RESOURCES:

<table>
<thead>
<tr>
<th>NO.</th>
<th>DESCRIPTIION</th>
<th>QTY.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EQUIPMENT/TOOL RESOURCES:

<table>
<thead>
<tr>
<th>NO.</th>
<th>DESCRIPTIION</th>
<th>QTY.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MATERIAL RESOURCES:

<table>
<thead>
<tr>
<th>NO.</th>
<th>DESCRIPTIION</th>
<th>QTY.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ASSUMPTIONS:_____________________________________________________________________
___________________________________________________________________________________
___________________________________________________________________________________

ACTIVITY NUMBER:___________ ACTIVITY DESCRIPTION:_________________________________

Figure 4-2 – Construction Activity Summary Sheet.

3.0.0 ESTIMATING

The construction activities provide a basis for preparing the estimates of material, equipment, and manpower requirements. A construction activity might call for rough-in piping in a floor slab. In a material estimate, your immediate concern is to identify the material necessary to do the task; pipe, fittings, joining materials, and so forth. The equipment estimate for this activity should consider vehicles for movement of material...
and special tools; such as portable power tools, kits, a threader, and a power vise. From the scope of the activity and the time restraints, you can estimate the manpower required. The information shown in the construction activity is also useful in scheduling progress and in providing the basis for scheduling deliveries of material, equipment, and manpower to the jobsite.

Before doing anything, become knowledgeable about the project by studying the drawings. Read the specifications and examine all available information concerning the site and local conditions. Only after becoming familiar with the project are you ready to identify individual activities. Here are two ideas that will help you make good estimates.

First, define activities. They may vary depending on the scope of the project. An activity is a clearly definable quantity of work. For estimating and scheduling, an activity for a single building or job should be a specific task or work element done by a single trade. For scheduling of large-scale projects, however, a complete building may be defined as an activity. For estimating, it should remain at the single-task, single-trade level.

Second, after becoming familiar with the project and defining its scope, proceed with identifying the individual activities required to construct the project. To identify activities, be sure each activity description shows a specific quantity of work with clear, definite limitations or cutoff points that everyone concerned with the project can readily understand. Prepare a list of these activities in a logical sequence to check for completeness.

As project estimator, you will need to assemble information about various conditions affecting the construction of the project. This enables you to prepare a detailed and accurate estimate. Drawings should be detailed and complete. Specifications should be exact and leave no doubt as to their intent. Information should be available about local material, such as quarries, gravel pits, spoil areas, types of soil, haul roads and distances, foundation conditions, the weather expected during construction, and the time allotted for completion. You should know the number and types of construction equipment available. Consider all other items and conditions that might affect the production or the progress of construction.

Test your Knowledge (Select the Correct Response)
3. When identifying an activity for an activity estimate, you must ensure that the
   A. Description is not complicated
   B. Description includes all trades required to do the task
   C. Manpower is available to accomplish the task
   D. Description identifies a specific quantity of work

3.1.0 Material Estimates
A material estimate consists of a listing and description of the various materials and the quantities required to construct a given project. Information for preparing material estimates is obtained from the activity estimates, drawings, and specifications. A material estimate is sometimes referred to as a Bill of Material (BM) or a Material Takeoff (MTO) Sheet.

Material estimates are used to procure construction material and to determine whether sufficient material is available to construct or complete a project. The sample forms shown in Figures 4-3, 4-4, and 4-5 may be used in preparing material estimates. The forms show one method of recording the various steps taken in preparing a material
estimate. Each step can readily be understood when the work sheets are reviewed. A work sheet must have the following headings: Project Title, Project Location, Drawing Number, Sheet Number, Project Section, Prepared By, Checked By, and Date Prepared.

### ESTIMATING WORK SHEET

<table>
<thead>
<tr>
<th>Prepared By:</th>
<th>Proj Location</th>
<th>Sheet <em>1</em> of <em>5</em></th>
<th>Drawing No</th>
<th>Proj Title</th>
<th>Cantonnment Area Interim Water System Bldg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diego Garcia</td>
<td></td>
<td></td>
<td>1,337,494/7,604,980</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Checked By:</th>
<th>Proj Section</th>
<th>Activity No</th>
<th>BM No.</th>
<th>MTO No.</th>
<th>Date Prepared</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Architectural</td>
<td>Node <em>71</em> to Node <em>64</em></td>
<td>DIW-112</td>
<td></td>
<td>19 FEB '92</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item No</th>
<th>Description</th>
<th>Prefab Forms</th>
<th>BM No.</th>
<th>BM Line Item No.</th>
<th>Unit of Issue</th>
<th>Total Qty</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building Footing</td>
<td>L W</td>
<td>T</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>¾&quot; plywood</td>
<td>2(26'-8&quot;)+(20')²+53'-4'+40'=93'-4&quot;</td>
<td>1</td>
<td>SH</td>
<td>0</td>
<td>3</td>
<td>Transmitter site bldg.</td>
</tr>
<tr>
<td></td>
<td>BB Exterior Type</td>
<td>8&quot; x 4' plywood ripped 12'; 32'</td>
<td>93.33/32' = 3 sheets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Lumber 1 x 6 x RL</td>
<td>6 length x 2 ea. corner X 4 corners</td>
<td>2</td>
<td>BF</td>
<td>15</td>
<td>30</td>
<td>Bldg layout</td>
</tr>
<tr>
<td></td>
<td>Gr 2 or better</td>
<td>8 pcs / 6 long</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>batter boards</td>
</tr>
<tr>
<td>3.</td>
<td>Lumber 2 x 4 x RL</td>
<td>16' – 48 pcs = 16' x 2 x 4 = 48 pcs</td>
<td>3</td>
<td>BF</td>
<td>15</td>
<td>590</td>
<td>Use reusable 2 x 4 at transmitter site bldg.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ramp and Door Stop Forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Beams</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Figure 4-3 – Typical estimating work sheet.**

### 3.1.1 Estimating Work Sheet

The Estimating Work Sheet shown in *Figure 4-3*, when completed, shows the various individual activities for a project with a listing of the required material. Material scheduled for several activities or uses is normally shown in the Remarks section. The work sheet should also contain an activity description, the item number, a material description, and the cost, the unit of issue, the waste factors, the total quantities, and the remarks. The field supervisor should keep the Estimating Work Sheets during construction to ensure the use of the material as planned.
3.1.2 Material Takeoff Sheet

The Material Takeoff Sheet (MTO) is shown in Figure 4-4. In addition to containing some of the information on the Estimating Work Sheet, the MTO also contains the suggested vendors or sources, supply status, and the required delivery date.

<table>
<thead>
<tr>
<th>MATERIAL TAKEOFF WORKSHEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Location: Diego Garcia</td>
</tr>
<tr>
<td>Project Title: Cantonment Area, Interim Water Sys Bldg</td>
</tr>
<tr>
<td>Project Number: 1938.97</td>
</tr>
<tr>
<td>BM Number: DIW-112</td>
</tr>
<tr>
<td>Date Prepared: 19 FEB '92</td>
</tr>
<tr>
<td>Project Section: Architectural</td>
</tr>
<tr>
<td>Master Activity Number:</td>
</tr>
<tr>
<td>Drawing Number: 1,337,494/7,604,980</td>
</tr>
<tr>
<td>Prepared By:</td>
</tr>
<tr>
<td>Checked By:</td>
</tr>
<tr>
<td>Construction Activity Number</td>
</tr>
<tr>
<td>Description/Calculations</td>
</tr>
<tr>
<td>MTO</td>
</tr>
<tr>
<td>U/I                                      Qty                                      Remarks:</td>
</tr>
</tbody>
</table>

Figure 4-4 – Typical material takeoff (MTO) worksheet.

3.1.3 Bill of Material

The Bill of Material (BM) sheet shown in Figure 4-5 is similar in content to the Material Takeoff Sheet. Here the information is presented in a format suitable for data processing. Use this form for requests of supply status, issue, or location of material and for preparing purchase documents. When funding data is added, use these sheets for drawing against existing supply stocks.

Between procurement and final installation, construction material is subject to loss and waste. This loss may occur during shipping, handling, storage, or from the weather. Waste is inevitable where material is subject to cutting or final fitting before installation. Frequently, material such as lumber, conduit, or pipe, has a standard issue length longer than required. More often than not, however, the excess is too short for use and ends up as waste. Waste and loss factors vary depending on the individual item and should be checked against the conversion and waste factors found in NAVFAC P-405, appendix C.
## BILL OF MATERIAL

<table>
<thead>
<tr>
<th>Project</th>
<th>Project Title</th>
<th>Authority/Originator</th>
<th>BM No</th>
<th>Section:</th>
</tr>
</thead>
<tbody>
<tr>
<td>EL8-830</td>
<td>Administration Bldg</td>
<td>31st NCR</td>
<td>GER-110</td>
<td>Struct</td>
</tr>
</tbody>
</table>

### RID M&S

<table>
<thead>
<tr>
<th>RID &amp; M&amp;S</th>
<th>DEM</th>
<th>SERV &amp; SUPP ADD</th>
<th>SIG</th>
<th>FUND</th>
<th>DIS</th>
<th>PRI</th>
<th>PRI</th>
<th>JON</th>
<th>ROS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-6</td>
<td>30-35</td>
<td>44</td>
<td>45-50</td>
<td>51</td>
<td>52-53</td>
<td>54</td>
<td>57-59</td>
<td>60-61</td>
<td>62-64</td>
</tr>
<tr>
<td>P96</td>
<td>N66450</td>
<td>R</td>
<td>N62604</td>
<td>A</td>
<td>BC</td>
<td>W</td>
<td>QOH</td>
<td>06</td>
<td>309</td>
</tr>
</tbody>
</table>

### Accounting Data

<table>
<thead>
<tr>
<th>DOC ID</th>
<th>COG</th>
<th>NSF</th>
<th>Unit of Issue</th>
<th>QTY</th>
<th>Document Number</th>
<th>ADV</th>
<th>L/I</th>
<th>Description/Vendor Source</th>
<th>Intended use</th>
<th>Unit Price</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-3</td>
<td>55-56</td>
<td>8-20</td>
<td>23-24</td>
<td>25-29</td>
<td>36-43</td>
<td>65-66</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AOE</td>
<td>5510-00-220-6146</td>
<td>BF</td>
<td>6508</td>
<td>0214-1744</td>
<td>1</td>
<td>Lumber 2&quot;x4&quot;x12'</td>
<td>.32</td>
<td>2082.56</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AOE</td>
<td>5510-00-220-6196</td>
<td>BF</td>
<td>420</td>
<td>0214-1745</td>
<td>2</td>
<td>Lumber 2&quot;x8&quot;x12'</td>
<td>.32</td>
<td>134.40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AOE</td>
<td>5315-00-010-4663</td>
<td>BX</td>
<td>3</td>
<td>0214-1746</td>
<td>3</td>
<td>Nail 16D Common 50 lb</td>
<td>16.86</td>
<td>50.58</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AOE</td>
<td>5640-00-847-0235</td>
<td>EA</td>
<td>90</td>
<td>0214-1747</td>
<td>4</td>
<td>Wallboard 5/8*x4'x8'</td>
<td>12.50</td>
<td>1125.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AOE</td>
<td>5315-00-753-3890</td>
<td>PG</td>
<td>2</td>
<td>0214-1748</td>
<td>5</td>
<td>Nail Finishing 6D</td>
<td>2.15</td>
<td>4.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AOE</td>
<td>5315-11-100-0139</td>
<td>BX</td>
<td>5</td>
<td>0214-1749</td>
<td>6</td>
<td>Hilti Nails 2 7/8'</td>
<td>21.20</td>
<td>106.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AOE</td>
<td>1377-11-100-0464</td>
<td>BX</td>
<td>8</td>
<td>0214-1750</td>
<td>7</td>
<td>Hilti Charges Purple</td>
<td>19.40</td>
<td>155.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AOE</td>
<td>5640-00-634-8891</td>
<td>RO</td>
<td>8</td>
<td>0214-1751</td>
<td>8</td>
<td>Tape, Wallboard 250'</td>
<td>1.40</td>
<td>11.20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Figure 4-5 – Sample bill of material (BM) sheet.

### 3.1.4 Checklists

Use checklists to eliminate any omissions from the material estimates. Prepare a list for each individual project when you examine the drawings, specifications, and activity estimates. This is the practical way to prepare a listing for the variety of material used in a project. The listing applies only to the project for which it has been prepared. If no mistakes or omissions have been made in either the checklist or estimate, the material estimate will contain a quantity for each item on the list.

### 3.1.5 Long Lead Times

Long lead items are not readily available through the normal supply system. They require your special attention to ensure timely delivery. Items requiring a long lead time are nonshelf items, such as steam boilers, special door and window frames, items larger than the standard issue, and electrical transformers for power distribution systems. Identify and order these items early. Make periodic status checks of the orders to avoid delays in completing the project.

### 3.1.6 Preparing Material Estimates

There are several steps for preparing a material estimate. First, determine the activity by using the activity description with the detailed information furnished by the drawings and plans to provide a quantity of work. Convert this quantity to the material required. Next, enter the conversion on a work sheet to show how each quantity was computed, as shown in Figure 4-3. Include sufficient detail; work sheets need to be self-explanatory. Anyone examining them should be able to determine how the quantities were computed without having to consult the estimator. Allowances for waste and loss are added after determining the total requirement. All computations should appear on the estimate work sheet, as must all notes related to the reuse of the material. Material
quantities for similar items of a project are entered on the Material Takeoff Sheet or Bill of Material. Figures 4-4 and 4-5 become the material estimate for the project.

Test your Knowledge (Select the Correct Response)
4. (True or False) When ordering construction materials, long lead items are readily available through the supply system.

A. True
B. False

3.2.0 Equipment Estimates

Equipment estimates are used with production schedules to determine the construction equipment requirements and constraints for Seabee deployment. Of these constraints, the movement of material over roadways is frequently miscalculated. In the past, estimators used the posted speed limit as an average rate for moving material. This was wrong. Equipment speed usually averages between 40 to 56 percent of the posted speed limit. Factors such as road conditions, number of intersections, amount of traffic, and hauling distances, affect the percentage of the posted speed limit for moving material. You should consider the types of material hauled; damp sand or loam, for example, is much easier to handle than clay. Safety (machine limitations), operator experience, condition of the equipment, work hours, and the local climate are other factors.

You must determine equipment production in order to select the amount and type of equipment. Equipment production rates are available in the Seabee Planner’s and Estimator’s Handbook. The tables in this handbook provide information about the type of equipment required. To estimate the production rate per day for each piece of equipment, consider the factors discussed above, along with information obtained from NAVFAC P-405 and your experience. The quantity of work divided by the production rate per day produces the number of days required to perform the project. After determining the number of days of required equipment operation, consult the project schedule to find the time allotted to complete the activities. Prepare the schedule for the total deployment. Use the project schedule to determine when to perform the work. The schedule should also indicate peak usage. It may have to be revised for more even distribution of equipment loading, thereby reducing the amount of equipment required during the deployment.

3.2.1 Estimate Sheets

After the reviews and revisions, prepare a list of equipment required. The list must include anticipated downtime. Add sufficient reserve pieces to cover any downtime.

To aid you in preparing the equipment estimate schedule, use such forms as those shown in Figure 4-6. The important information on the forms includes the sheet number, the name of the estimator, the name of the checker, date checked, battalion and detachment number, location of deployment, year of deployment, project number, and a brief description of the project.
### EQUIPMENT ESTIMATE

<table>
<thead>
<tr>
<th>NMCB</th>
<th>Location</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Guam</td>
<td>1992</td>
</tr>
</tbody>
</table>

**Project No. 013**  
**Description**  
**Site Preparation**

Earth Fill – 36,000 CY loose measurement required.  
Haul one way 2-1/2 miles.  
Use 2-1/2 CY front end loader and 10 CY dump trucks.

Front end loader capacity 100 CY/hours.

\[
\frac{36,000}{100} = 360 \text{ hours or 45 eight-hour days.}
\]

\[
\frac{100}{10} = 10 \text{ trucks loaded per hour.}
\]

Average hauling speed estimated at 15 MPH.

\[
2 \times 2.5 = 5 \text{ miles round trip.}
\]

\[
\frac{5}{15} \times 60 = 20 \text{ minutes hauling time.}
\]

\[
\frac{60}{10} = 6 \text{ Minutes loading time.}
\]

Estimated 4 minutes dumping time

30 minutes total time per truckload.

\[
\frac{60}{30} = 2 \text{ loads per hour per truck.}
\]

\[
\frac{10}{2} = 5 \text{ trucks required to keep front end loader working at capacity.}
\]

100 x 8 = 800 CY hauled per 8-hour day.

Need one bulldozer (can spread 1400 CY daily).

Need one grader to keep haul road in shape.

1 bulldozer (can spread 1400 CY daily).

1 tractor & tandem sheepfoot roller (can compact 1200 CY daily).

1 water truck with sprinkler for moisture control.

1 rubber-tired wobbly wheel roller on standby for compaction and sealing fill when rain is expected. (Can be towed by above bulldozer or tractor.)
NOTE: Preceding is not very efficient, as spreading equipment is not used to full capacity. Suppose that when the work schedule is prepared, completion of fill will be required in 18 days. Assume that climate is such that 3 days in every 17 working days will be lost due to rain. Therefore, 15 working days would be available in an 18 day schedule.

\[
\frac{3,600}{15} = 2,400 \text{ CY must be hauled daily to complete the work on schedule.}
\]

\[
\frac{2,400}{800} = 3 \text{ times the output of loading and hauling spread shown previously.}
\]

Equipment required for loading and hauling:
- 3 – 2-1/2 CY front end loaders.
- 1 – bulldozer to keep pit in shape.
- 1 – grader to keep haul road in shape.
- 15 – 10-ton trucks hauling (1 or 2 extra trucks should be used to assure that a truck will always be waiting to be loaded so that the front end loader will work at full capacity).

2,400 CY will be hauled each day.

\[
\frac{2,400}{1,200} = 2 \text{ tractors and tandem sheepfoot roller for compaction.}
\]

\[
\frac{2,400}{1,400} = 6 \text{ Minutes loading time.}
\]

1 wobbly-wheel roller (standby for sealing of fill before rains).

NOTE: This is a more efficient operation, as production has been tripled but equipment has not, and total equipment working at or close to capacity as can be expected.
3.2.2 TOA and Equipment Characteristics

The *table of allowance* (TOA) of the Naval Mobile Construction Battalion (NMCB) contains specific information on the quantities and characteristics of construction equipment available to the NMCBs. *Table 4-3* contains an abbreviated listing of such equipment.

### Table 4-3 – NMCB Construction Equipment Characteristics.

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>EQUIPMENT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>TRUCKS</td>
<td>Dump, 6 x 6, 5 ton, 5 cu. Yd. capacity</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Dump, 6 x 4, 15 ton, 10 cu. Yd. capacity</td>
</tr>
<tr>
<td>6</td>
<td>GRADERS</td>
<td>Motor, road, 12 ft. blade, 6 x 4, with scarifier</td>
</tr>
<tr>
<td>4</td>
<td>LOADERS</td>
<td>Scoop, full tracked, 1 ½ cu. yd. multipurpose bucket</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Scoop, wheeled, 4 x 4, 2 ½ cu. yd. std. bucket with forks</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Scoop, wheeled 4 x 2, 2 ½ cu. yd. std. bucket with forks backhoe, crane, dozer blade</td>
</tr>
<tr>
<td>2</td>
<td>ROLLERS</td>
<td>Oscillating, self-propelled, 9 wheel, pneumatic tired</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Vibrating, self-propelled, pneumatic tired, single drum</td>
</tr>
<tr>
<td>6</td>
<td>SCRAPERS</td>
<td>Tractor, wheeled, 14 to 20 cu. yd., hydraulic</td>
</tr>
<tr>
<td>5</td>
<td>TRACTORS</td>
<td>Crawler, hydraulic semi-U-tilt dozer</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Crawler, hydraulic angle dozer, winch</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Crawler, hydraulic semi-U dozer, hydraulic ripper</td>
</tr>
<tr>
<td>2</td>
<td>CRANES</td>
<td>Truck, mounted, 8 x 4, 35 ton, 60 ft. boom with extension</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Truck, mounted, 8 x 4, 25 ton, hydraulic</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Tractor, wheel mounted, 4 x 4, 12 ½ ton, telescoping boom, hydraulic</td>
</tr>
<tr>
<td>1</td>
<td>SPECIALIZED EQUIPMENT</td>
<td>Distributor, bituminous material, truck mounted, 6 x 4, 2,000 gal. capacity</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Distributor, water, truck mounted, 6 x 6, 2,000 gal. capacity</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Distributor, water, wagon mounted, 8,000 gal. capacity</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Ditching machine, ladder type, 8 to 24 in. width by 7 ft. depth, crawler mounted</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Excavator, multipurpose, hydraulic, 6 x 6, 11 ft. 1 in. digging depth, mounted</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Auger, earth, truck mounted</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Truck, forklift, rough terrain, 6,000 lb. capacity, pneumatic tire</td>
</tr>
</tbody>
</table>

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

5. Where can an estimator locate information on the quantities and characteristics of construction equipment?

A. SAMM program
B. NMCB TOA
C. NAVFAC P-405
D. NAVFAC P-437
3.3.0 Labor and Manday Estimates

The manpower estimate consists of a listing of the number of direct labor man-days required to complete the various activities of a specific project. These estimates may show only the man-days for each activity, or they may be in sufficient detail to list the number of man-days for each rating in each activity; Builder (BU), Construction Electrician (CE), Equipment Operator (EO), Steelworker (SW), and Utilitiesman (UT). Man-day estimates are used to determine the number of personnel and the ratings required on a deployment. They also provide the basis for scheduling manpower in relation to construction progress.

In the *Seabee Planner’s and Estimator’s Handbook*, NAVFAC P-405, a man-day is a unit of work performed by one person in one 8-hour day or its equivalent. One man-day is equivalent to a 10-hour day for contingency operations in the *Facilities Planning Guide*, NAVFAC P-437.

Battalions set their own schedules, as needed, to complete their assigned tasks. In general, the work schedule of the battalion is based on an average of 55 hours per person per week. The duration of the workday is 10 hours per day, which starts and ends at the jobsite. This includes 9 hours for direct labor and 1 hour for lunch. There are situations where travel to and from the job site is included in the 10 hours.

Direct labor includes all labor expended directly on assigned construction tasks, either in the field or in the shop, that contributes directly to the completion of the end product. Direct labor must be reported separately for each assigned construction item. In addition to direct labor, the estimator must also consider overhead labor and indirect labor. Overhead labor is considered productive labor that does not contribute directly or indirectly to the product, for example administrative tasks such as time cards and evaluations. It includes all labor that must be performed regardless of the assigned mission. Indirect labor includes labor required to support construction operations but that does not, in itself, produce an end product, for example toolkit inventories.

There are two types of labor estimates; preliminary manpower estimates and detailed manpower estimates.

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

6. When filling out a time card, what code should you give labor required to support construction operations but that does not itself produce an end product?

A. Direct  
B. Indirect  
C. Overhead  
D. Military

3.3.1 Preliminary

Use preliminary manpower estimates to establish budget costs and the project manpower requirements for succeeding projects and deployments. The estimates are prepared from limited information, such as general descriptions or preliminary plans and specifications that contain little or no detailed information. In some cases, you can make a comparison with similar facilities of the same basic design, size, and type of construction. A good preliminary estimate varies less than 15 percent from the detailed estimate.
3.3.2 Detailed

Use detailed manpower estimates to determine the manpower requirements for constructing a given project and the total direct labor requirements of a deployment. Take the individual activity quantities from the activity work sheet to prepare detailed estimates. Then, select the man-hours per unit figure from the appropriate table in NAVFAC P-405 and multiply it by the quantity to obtain the total man-hours required. When preparing the activity estimates in the format discussed earlier, you may use a copy of the activity estimates as a manpower estimate work sheet by adding four columns to it with the headings of Activity, Quantity, Man-Hours per Unit, and Total Man-Days Required. Prepare work sheets, whether on the activity work sheet or on another format, in sufficient detail to provide the degree of progress control desired. For example, the work sheets should show the information as in Figure 4-7.

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>QUANTITY</th>
<th>MAN-HOURS* PER UNIT</th>
<th>TOTAL MAN-DAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install 12 inch diameter concrete pipe</td>
<td>2,500 feet</td>
<td>20/100</td>
<td>62.5</td>
</tr>
<tr>
<td>Install 30 inch diameter concrete pipe</td>
<td>2,500 feet</td>
<td>80/100</td>
<td>250.0</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>5,000 feet</td>
<td></td>
<td><strong>312.5</strong></td>
</tr>
</tbody>
</table>

* 8 man-hours equal 1 man-day.

Figure 4-7 – Sample worksheet.

If the control is to be exercised only on concrete pipe installation without regard to detail, the manpower estimate should show the following information on the summary sheet, as shown in Figure 4-8.

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>QUANTITY</th>
<th>MAN-HOURS* PER UNIT</th>
<th>TOTAL MAN-DAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install concrete pipe</td>
<td>5,000 feet</td>
<td>50/100</td>
<td>312.5</td>
</tr>
</tbody>
</table>

Figure 4-8 – Sample manpower worksheet.

The man-hours per unit on the work sheet is obtained by dividing the total man-days shown in the detail estimate by the total feet of concrete pipe times the unit to obtain the average man-hours. Use the man-hours per unit for checking actual progress. Check manpower estimates against the activity estimate to ensure that no activities have been omitted. NAVFAC P-405 also provides labor estimates for the various projects undertaken by the Engineering Aids.

The *Facilities Planning Guide*, NAVFAC P-437, volumes 1 and 2, is an excellent source for preliminary estimates. Use it to find estimates for a wide range of facilities and assemblies commonly constructed. The P-437 not only gives the man-hours required, but it also gives a breakdown of the construction effort by rating (BU, CE, UT, and so forth) as well as lapsed day estimates.

You must bear in mind that the lapse time from the P-437 is calculated using the contingency norm of a 10 hour man-day instead of the 8 hour man-day used in the P-405. For example, a specific task from the P-437 requires 100 man-hours (MH) of effort by the Utilitiesman. The optimum crew size is four UTs. This yields the following lapse time:

\[
\frac{100}{4 \text{ UTs} \times 10 \text{ hr}} = 2.5 \text{ days (lapse time)}
\]

Using the P-405 and an 8-hour man-day, you will find that the same task yields the following:
In preparing manpower estimates, weigh the various factors affecting the amount of labor required to construct a project. These include weather conditions during the construction period, skill and experience of personnel who will perform the work, time allotted for completing the job, size of the crew to be used, accessibility of the site, and types of material and equipment to be used. The production efficiency guide chart shown in Table 4-4 lists eight elements that directly affect production.

Table 4-4 – Production Efficiency Guide Chart.

<table>
<thead>
<tr>
<th>ELEMENTS</th>
<th>LOW PRODUCTION</th>
<th>AVERAGE PRODUCTION</th>
<th>HIGH PRODUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Production Elements in Percent</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>25 35 45 55 65 75 85 90 95 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Work Load</td>
<td>Construction requirement high, miscellaneous overhead high</td>
<td>Construction requirement normal, miscellaneous overhead normal</td>
<td>Construction requirement low, miscellaneous requirement low</td>
</tr>
<tr>
<td>2. Site Area</td>
<td>Cramped working area, no area for material storage, work restricted to design,</td>
<td>Work area limited slightly, partial material storage, some</td>
<td>Large work are, adequate material storage, wide latitude</td>
</tr>
<tr>
<td></td>
<td>poor job layout</td>
<td>variation from design, average job layout</td>
<td>from design, good job layout</td>
</tr>
<tr>
<td>3. Labor</td>
<td>Poorly trained, low strength, low morale, high sick call</td>
<td>Average trained, normal strength, fair morale, normal sick call</td>
<td>Highly trained, over strength, high morale, low sick call</td>
</tr>
<tr>
<td>4. Supervision</td>
<td>Poor management, poorly trained personnel, low strength</td>
<td>Average management, average trained personnel, normal strength</td>
<td>Efficient management, highly trained personnel, over strength</td>
</tr>
<tr>
<td>5. Job Conditions</td>
<td>High quality work required, unfavorable site materials, short time operations,</td>
<td>Average work required, average site materials, reasonable</td>
<td>Passable work required, good site materials, long time operations,</td>
</tr>
<tr>
<td></td>
<td>insect annoyance high</td>
<td>operation time, insect annoyance normal</td>
<td>no insect annoyance</td>
</tr>
<tr>
<td>6. Weather</td>
<td>Abnormal rain, abnormal heat, abnormal cold</td>
<td>Moderate rain, moderate heat, moderate cold</td>
<td>Some rain, occasional heat, occasional cold</td>
</tr>
<tr>
<td>7. Equipment</td>
<td>Improper job application, equipment in poor condition, repair and maintenance</td>
<td>Fair job application, equipment in average condition, repair and</td>
<td>Efficient job application, equipment in good condition, efficient</td>
</tr>
<tr>
<td></td>
<td>inadequate</td>
<td>maintenance average</td>
<td>repair and maintenance</td>
</tr>
<tr>
<td>8. Tactical and</td>
<td>Slow supply delivery, frequent tactical delays</td>
<td>Normal supply delivery, occasional tactical delays</td>
<td>Prompt supply delivery, no tactical delays</td>
</tr>
<tr>
<td>Logistical</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Each production element is matched with three areas for evaluation. Each element contains two or more foreseen conditions from which to select for the job in question.
Evaluate each production element at some percentage between 25 and 100, according to your analysis of the foreseen conditions. The average of the eight evaluations is the overall production efficiency percentage. Now, convert the percentage to a delay factor, using the production efficiency graph in Figure 4-9.

![Production Efficiency Graph](image)

It is strongly recommended that the field or project supervisors reevaluate the various production elements and make the necessary adjustments to man-day figures based on actual conditions at the jobsite.

**NOTE**

The estimate of average Seabee production used in the NAVFAC P-405 tables falls at 67 percent production efficiency on the graph shown in Figure 4-9. As you see, this represents a delay factor of 1.00. A delay factor of 0.66 represents peak production efficiency, equivalent to 100 percent.

Note that on the graph the production elements have been computed into percentages of production efficiency, which are indicated at the bottom of the graph. First, place a straightedge so that it extends vertically from the desired percentage, and then place it horizontally from the point at which it intersected the diagonal line. You can now read the delay factor from the values given on the right-hand side of the chart. Let’s look at an example of the process of adjusting man-hour estimates.

Assume that from the work estimate taken from the tables in P-405, you find that a given unit of work requires 6 man-hours. To adjust this figure to the conditions evaluated on your job, assume that the average of foreseen conditions you rated is 87 percent. The corresponding delay factor read from the production efficiency graph is 0.80. You find the adjusted man-hour estimate by multiplying this delay factor by the man-hours from the estimating tables \((6MH \times 0.8 = 4.8\) as the adjusted man-hour estimate).

The man-hour labor estimating tables are arranged and grouped together into the 17 major divisions of work. This is the same system used to prepare government construction specifications. The 17 major divisions of work are as follows:
The activities in the various labor estimating tables are divided into units of measurement commonly associated with each craft and material takeoff quantities. There is only one amount of man-hour effort per unit of work. This number represents normal Seabee production under average conditions. As used herein, 1 man-day equals 8 man-hours of direct labor. Man-day figures do not include overhead items, such as dental or personnel visits, transportation to and from the jobsite, or inclement weather.

No two jobs are exactly alike, nor do they have exactly the same conditions. Therefore, you, as the estimator, must exercise some judgment about the project being planned. The production efficiency guide chart and graph shown in Table 4-6 and Figure 4-7 are provided to assist you in weighing the many factors that contribute to varying production conditions and the eventual completion of a project. You can then translate what is known about a particular project and produce a more accurate quantity from the average figures given on the labor estimating tables.

Test your Knowledge (Select the Correct Response)

7. When using the Seabee Planner’s and Estimator’s Handbook for manpower estimates, a man-day is equal to what hour work day?

A. 7
B. 7 1/2
C. 8
D. 10
4.0.0 SCHEDULING

After World War II, the construction industry experienced the same critical examination that the manufacturing industry had experienced 50 years before. Large construction projects came under the same pressures of time, resources, and cost that prompted studies in scientific management in the factories.

The emphasis, however, was not on actual building methods, but upon the management techniques of programming and scheduling. The only planning methods being used at that time were those developed for use in factories. Management tried to use these methods to control large construction projects. These techniques suffered from serious limitations in project work. The need to overcome these limitations led to the development of network analysis techniques.

4.1.0 Basic Concepts

In the late 1950s, this new system of project planning, scheduling, and control came into widespread use in the construction industry. The critical path analysis (CPA), critical path method (CPM), and project evaluation and review technique (PERT) are samples of about 50 different approaches. The basis of each of these approaches is the analysis of a network of events and activities. For this reason, the generic title covering the various networks is network analysis.

Network analysis techniques are now the accepted method of construction planning in many organizations. They form the core of project planning and control systems.

4.1.1 Advantages and Disadvantages

There are many advantages of network analysis. As a management tool, it readily separates planning from scheduling of time. The analysis diagram, a pictorial representation of the project, enables you to see the interdependencies between events and the overall project to prevent unrealistic or superficial planning. Resource and time constraints are easily detachable, to permit adjustments in the plan before its evaluation.

Because the system splits the project into individual events, estimates and lead times are more accurate. Deviations from the schedule are quickly noticed. Manpower, material, and equipment resources are easily identifiable. Since the network remains constant throughout its duration, it is also a statement of logic and policy. Modifications of the policy are allowed, and the impact on events is assessed quickly.

Identification of the critical path is useful when you have to advance the completion date. Attention can then be concentrated toward speeding up those relatively few critical events. The network allows you to accurately analyze critical events and provides an effective basis for the preparation of charts. This results in better control of the entire project.

The main disadvantage of network analysis as a planning tool is that it is a tedious and exacting task when attempted manually. Depending upon what the project manager wants as output, the number of activities that can be handled without a computer varies.

Calculations are made in terms of the sequence of activities. Now, a project involving several hundred activities may be attempted manually. However, the chance for error is high. Suppose the jobs are to be sorted by rating, so jobs undertaken by Utilitiesmen...
are together, as are those for Equipment Operators or Construction Electricians. The time required for manual operation would become costly.

On the other hand, standard computer programs for network analysis can handle project plans of 5,000 activities or more and can produce output in various forms. However, a computer assists only with the calculations and print plans of operations sorted into various orders. The project manager, not the computer, is responsible for planning and must make decisions based on information supplied by the computer. Also, computer output is only as accurate as its input, supplied by people. The phrase “garbage in, garbage out” applies.

4.1.2 Elements

A network represents any sequencing of priorities among the activities that form a project. This sequencing is determined by hard or soft dependencies. Hard dependencies are based upon the physical characteristics of the job, such as the necessity for placing a foundation before building the walls. A hard dependency is normally inflexible. Soft dependencies are based upon practical considerations of policy and may be changed if circumstances demand. The decision to start at the north end of a building rather than at the south end is an example.

4.2.0 Precedence Diagramming

Network procedures are based upon a system that identifies and schedules key events into precedence-related patterns. Since the events are interdependent, proper arrangement helps in monitoring the independent activities and in evaluating project progress. The basic concept is known as the critical path method (CPM). Because the CPM places great emphasis upon task accomplishment, a means of activity identification must be established to track the progress of an activity. The method currently in use is the activity-on-node precedence diagramming method (PDM), where a node is simply the graphic representation of an activity. An example of this is shown in Figure 4-10.

![Figure 4-10 – Precedence diagram.](image)

Precedence diagramming does not require the use of dummy activities. It is also easier to draw, and has greater applications and advantages when networks are put in the computer. In precedence diagrams, the activity is “on the node.”
Test your Knowledge (Select the Correct Response)

8. The basic concept behind precedence scheduling is known as

A. CPM
B. PERT
C. SAMM
D. ADM

4.2.1 Activities and Events

To build a flexible CPM network, the manager needs a reliable means of obtaining the project data to be represented by a node. An activity in a precedence diagram is represented by a rectangular box and identified by an activity number.

The left side of the activity box represents the start of the activity. The right side represents the completion. Lines linking the boxes are called connectors. The general direction of flow is evident in the connectors themselves.

Activities may be divided into three distinct groups:

Working Activities – With respect to a given activity, these representations indicate points in time for the associated activities. Although the boxes in the precedence diagram represent activities, they do not represent time and, therefore, are not normally drawn to scale. They only reflect the logical sequence of events.

Milestone Events – The network may also contain certain precise, definable points in time, called events. Examples of events are the start and finish of the project as a whole. Events have no duration and are represented by oval boxes in a network, as shown in Figure 4-10.

Milestones are intermediate goals within a network. For instance, “ready for print” is an important event that represents a point in time but has no time duration of its own. To reach this particular activity, all activities leading up to it must be completed.

Critical Activities – A critical activity is an activity within the network that has zero float time. The critical activities of a network make up the longest path through the network, known as the critical path, which controls the project finish date. The critical path is determined after the forward and backward pass analysis is complete. Slashes drawn through an activity connector, as shown in Figure 4-11, denote a critical path.

![Figure 4-11 – Designations of a critical path.](image)

The rule governing the drawing of a network is that the start of an activity normally must be linked to the ends of all completed activities before that start may take place. Activities taking place at the same time are not linked in any way. In Figure 4-10, both Activity 2 and Activity 3 start as soon as Activity 1 is complete. Activity 4 requires the completion of both Activities 2 and 3 before it may start.
Test your Knowledge (Select the Correct Response)

9. (True or False) The longest path through a network is the critical path.

A. True
B. False

4.2.2 Use of Diagram Connectors

Within a precedence diagram, connectors are lines drawn between two or more activities to establish logic sequence. In the next paragraphs, we will look at the diagram connectors commonly used in the NCFs.

Representing a Delay – In certain cases, there may be a delay between the start of one activity and the start of another. In this case, the delay maybe indicated on the connector itself, preceded by the letter d as in Figure 4-12. Here, Activity 2 may start as soon as Activity 1 is complete, but Activity 3 must wait 2 days. The delay is stated in the basic time units of the project, so the word days can be omitted.

Figure 4-12 – Representation of delay.

As seen in Figure 4-13, a lead or partial start is indicated by drawing the connector from the start of the preceding activity (1). In Figure 4-14, a lag or partial finish is indicated by drawing the connector from the end of the following activity (3). The values may be given in the basic time units of the project, as with a delay, or as a percentage of overlap. In certain circumstances, they can be stated as quantities if the performance of the activity can be measured on a quantitative basis. The indication of the type and amount of delay, lead, or lag is generally referred to as a lag factor.
In Figure 4-13, Activity 3 may start when Activity 1 is 1-day completed, although Activity 2 must wait for the final completion of Activity 1. In Figure 4-14, Activity 3 may start when Activity 2 is completed but will still have 1 day to go when Activity 1 is completed.

The last phase of Activity 3 may not begin until Activity 1 has been completed. In Figure 4-15, Activity 2 may start when Activity 1 is advanced 3 days but will still have 4 days of work left when Activity 1 is completed.

![Figure 4-15 – Start and finish lags on same activity.](image)

Splitting Connectors – The number of sequencing connectors becomes large when a network is of a great size. When two activities are remote from each other and have to be connected, the lines tend to become lost or difficult to follow. In such cases, it is not necessary to draw a continuous line between the two activities. Their relationship is shown by circles with the following activity number in one and the preceding activity number in the other. In Figure 4-16, view A, both Activities 2 and 6 are dependent upon Activity 1.

Splitting connectors can also be represented as a line jump, shown in view B. Computer printouts will show a line jump as in view B rather than a splitting connector as in view A.

![Figure 4-16 – Splitting connectors and line jumps.](image)

Direct Linking Using an Event – When the number of common preceding and succeeding activities in a particular complex is large, as in Figure 4-17, a dummy event or focal activity of zero duration may be introduced to simplify the network. The use of such a dummy event is shown in Figure 4-18, which is a simplification of Figure 4-17.
Although the effect in terms of scheduling is the same, the introduction of the dummy improves the clarity of the diagram.

**Figure 4-17 – Multiple predecessors and successors (direct linking).**

**Figure 4-18 – Multiple predecessors and successors (using dummy collector).**

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

10. The general flow of a precedence diagram is represented by

   A. An alphabetical sequence  
   B. A numerical sequence  
   C. Arrows  
   D. Connectors

Joining Connectors – In many instances, there are opportunities to join several connectors going to a common point to reduce congestion in the drawing. This practice is, however, discouraged. The diagrams in Figures 4-19 and 4-20 have precisely the same interpretation. The danger with the form of representation is evident in Figure 4-20, where several connectors have been joined. When the network is coded for the computer, you may lose sight of the fact that Activity D has three preceding activities since only one line actually enters Activity D.
4.3.0 Precedence Diagrams

Scheduling involves putting the network on a working timetable. Information relating to each activity is contained within an activity box, as shown in Figure 4-21.

4.3.1 Forward and Backward Pass Calculations

To place the network on a timetable, you must make time and duration computations for the entire project. These computations establish the critical path and provide the start and finish dates for each activity. Each activity in the network can be associated with four time values:

- **Early Start (ES)** – Earliest time an activity may be started
- **Early Finish (EF)** – Earliest time an activity may be finished
- **Late Start (LS)** – Latest time an activity may be started and still remain on schedule
- **Late Finish**
• **Late Finish (LF)** – Latest time an activity may be finished and still remain on schedule

The main objective of forward pass computations is to determine the duration of the network. The forward pass establishes the early start and finish of each activity and determines the longest path through the network (critical path).

The common procedure for calculating the project duration is to add activity durations successively, as shown in Figure 4-22, along chains of activities until you find a merge. At the merge, take the largest sum entering the activity at the start of succeeding activities. Continue the addition to the next point of merger, and repeat the step.

![Figure 4-22 – Example of forward pass calculations.](image)

The formula for forward pass calculations is as follows:

\[
ES = EF \text{ of preceding activity} \\
EF = ES + \text{activity duration}
\]

The backward pass latest possible start and computations provide the finish times that may take place without altering the network relationships. Obtain these values by starting the calculations at the last activity in the network and working backward, subtracting the succeeding duration of an activity from the early finish of the activity being calculated. When you encounter a “burst” of activities emanating from the same activity, calculate each path. Record the smallest or multiple value as the late finish.

The backward pass is the opposite of the forward pass. During the forward pass, add the early start to the activity duration to derive the early finish of that activity. During the backward pass, subtract the activity duration from the late finish to provide the late start time of that activity. This late start time then becomes the late finish of the next activity within the backward flow of the diagram.

\[
LS = LF - \text{activity duration}
\]

*Figure 4-23 shows a network with forward and backward pass calculations entered.*
Figure 4-23 – Example of forward and backward pass calculations.

The free and total float times are the amount of scheduled leeway allowed for a network activity, and are referred to as float or slack. For each activity, it is possible to calculate two float values from the results of the forward and backward passes.

Total Float – The accumulative time span in which the completion of all activities may occur and not delay the termination date of the project is the total float. If the amount of total float is exceeded for any activity, the project end date extends to equal the exceeded amount of the total float.

Calculating the total float consists of subtracting the earliest finish (EF) date from the latest finish (LF) date, that is:

\[ \text{Total float} = \text{LF} - \text{EF} \]

Free Float – The time span in which the completion of an activity may occur and not delay the finish of the project or the start of a successor activity is the free float. If this value is exceeded, it may not affect the project end date but will affect the start of succeeding, dependent activities.

Calculating the free float consists of subtracting the earliest start (ES) date from the latest start (LS) date, or:

\[ \text{Free float} = \text{LS} - \text{ES} \]

Figure 4-24 is an example of an activity-on-node precedence diagramming method (PDM) network with total and free float calculations completed.
Figure 4-24 – PDM network with total and free float calculations.

Independent Activity – An independent activity is an activity that is not dependent upon another activity to start. Activity 1, diagramed in Figure 4-25, is an example of an independent activity.

Dependent Activity – A dependent activity is dependent upon completion of one or more preceding activities before it can start. The relationship in Figure 4-26 states that the start of Activity 2 is dependent upon the finish of Activity 1.
Figure 4-26 – Dependent activity.

Frequently, an activity cannot start until two or more activities have been completed. This appears in the diagram as a merge or junction. In Figure 4-27, Activities 3 and 4 must be completed before the start of Activity 5.

Figure 4-27 – Merge.

Earlier we mentioned a “burst” of activities. A burst is similar to a merge. A burst exists when two or more activities cannot be started until a third activity is completed. In Figure 4-26, when Activity 2 is finished, Activities 3 and 4 may start.

4.3.2 Advantages of Diagramming

Precedence networks are easy to draw because the estimator can place all the activities on small cards, lay them out on a flat surface, and easily manipulate them until achieving a realistic logic. It is also easy to show the interrelationships and forward progress of the activities. Just draw connector lines. Figure 4-28 shows a typical precedence diagram for a 40 by 100-foot rigid frame building.
Note
Activities in the network are numbered from left to right and from top to bottom. When activities are added or deleted in the network, it will be necessary to recalculate the early start and early finish times through the network, then work back, making the required adjustments to the late finish and late start. This adjustment should be made at the earliest opportunity, to facilitate the computer update.

Figure 4-28 – Typical precedence diagram for a 40 by 100 foot rigid frame building.
5.0.0 EXECUTION

Construction management in the Seabees is comprised of three levels shown in Figure 4-29.

Figure 4-29 – Seabee multi-level construction management.

Planning is done in a top-down, bottom-up cycle as signified by the arrows in Figure 4-29. All three levels are eventually summarized on a barchart with a timeline shown horizontally across the top and a list of line items down the left hand side.

5.1.0 Level I

Level I construction management is used at the Operations Officer’s (S3) or detail Officer in Charge’s (OIC’s) level. The primary concern of S3 is management of the overall unit’s tasking. The timeline for a Level I barchart will show months of the deployment and the line items will be individual projects.

5.2.0 Level II

Level II construction management is used at the company level. Each company may have several projects to manage. The easiest way for the company commander to manage these projects is with a Level II barchart. The timeline for a Level II barchart will show weeks, and the line items will be master activities for that particular project.
5.3.0 Level III

Level III construction management is used at the crewleader’s level. The crewleader’s focus is on his/her particular project. He/she manages the day-to-day activity of that project. The timeline for a Level III barchart will show days, and the line items will be construction activities.

6.0.0 ADMINISTRATION

Being a petty officer carries many inherent responsibilities. These include your personal obligation to be a leader, an instructor, and an administrator in all the areas of your rating; military, technical, and safety.

As a petty officer, you need to develop an ability to control the work performed by your workers, as well as to lead them. As you gain experience as a petty officer and increase your technical competence as a Builder, you begin to accept a certain amount of responsibility for the work of others. With each advancement, you accept an increasing responsibility in military matters and in matters relating to the professional work of your rate. As you advance in rank, you will have not only increased privileges but also increased responsibilities. You begin to assume greater supervisory and administrative positions.

The proper administration of any project, large or small, is as important as the actual construction. This chapter will provide you with information to help you use and prepare the administrative paperwork that you encounter as a crew leader.

6.1.0 Planning Work Assignments

Planning means the process of determining requirements and developing methods and schemes of action for performing a task. Proper planning saves time and money and ensures a project is completed in a professional manner. We’ll look at some, but not all, of the factors you need to consider.

When you get a project, whether in writing or orally, make sure you clearly understand what is to be done. Study the plans and specifications carefully. If you have any questions, find the answers from those in a position to supply the information you need. Make sure you understand the priority of the project, the expected time of completion, and any special instructions.

Consider the capabilities of your crew. Determine who is to do what and how long it should take. Consider the tools and equipment you will need. Arrange to have them available at the jobsite at the time the work is to get under way. Determine who will use the tools and make sure they know how to use them properly and safely.

To help ensure that the project is completed properly and on time, determine the best method of getting it done. If there is more than one way of doing a particular assignment, analyze the methods and select the one most suited to the job conditions. Listen to suggestions from others. If you can simplify a method to save time and effort, do it.

Establish goals for each workday and encourage your crew to work as a team in meeting these goals. Set goals that keep your crewemployed, but make sure they are realistic. Discuss the project with the crew so they know what you expect from them. Daily briefings of this type cannot be overemphasized.
During an emergency, most crewmembers will make an all-out effort to meet a deadline. Don’t expect them to work continuously at an excessively high rate when there is no emergency.

6.2.0 Directing Work Teams

After properly planning a job, you must carefully direct the job. This ensures it is completed on time and with the quality that satisfies both the customer and the crew.

Make sure the crew knows what is expected before starting a project. Give instructions and urge the crew to ask questions on all points that are not clear. Be honest in your answers. If you don’t have an answer, say so; then find the answer and get back to the crew. Don’t delay in getting solutions to the questions asked. Timely answers keep projects moving forward. They also show the crew your concern for the project is as genuine as theirs.

Spot check to ensure that the work is progressing satisfactorily while a job is under way. Determine whether the proper methods, materials, tools, and equipment are being used. Determine the initial requirements early enough so there are no delays. If crewmembers are performing a task incorrectly, stop them and point out the correct procedures. When you check crewmembers’ work, make them feel the purpose of checking is to teach, guide, or direct; not to criticize or find fault.

Make sure the crew complies with applicable safety precautions and wear safety apparel when required. Watch for hazardous conditions, improper use of tools and equipment, and unsafe work practices. These can cause mishaps and possibly result in injury to personnel. There are no excuses for unsafe practices. Proper safety instructions and training eliminate the desire to work carelessly. Practice what you preach when directing construction crews.

Rotate crewmembers on various jobs when time permits. Rotation gives you the opportunity to teach. It also gives each crewmember an opportunity to increase personal skill levels.

As a crew leader, you need to ensure that your crew works together in getting the job done. Develop an environment where each crewmember feels free to seek your advice when in doubt about any phase of the work. Emotional balance is especially important. Don’t panic in view of your crew or be unsure of yourself when faced with a conflict.

Be tactful and courteous in dealing with your crew. It sounds obvious, but don’t show any partiality. Keep every crewmember informed on both work and personal matters that affect his or her performance. Try to maintain a high level of morale. Low morale has a definite effect on the quantity and quality of a crew’s work.

As you advance in rate, you spend more and more time supervising others. You have to learn as much as you can about supervision. Study books on both supervision and leadership. Watch how other supervisors, both good and bad, operate. Don’t be afraid to ask questions.
Test your Knowledge (Select the Correct Response)

11. Which of the following actions will aid you, as a crew leader, in developing teamwork?

A. Rotating crewmembers on various phases of the job
B. Developing an environment where the crewmembers feel free to seek you out for advice
C. Maintaining a high level of morale
D. All of the above

6.3.0 Tool Management

Good tool management is a key ingredient to a successful project. Crewleaders must know tool availability, application, accountability and maintenance. Without the tools, the job can't be done. With the correct tools, the job gets done right and more efficiently.

6.3.1 Planning

Early in the planning process, the Crewleader should look for efficiencies in the construction by choosing the right tools for the task (i.e. Choose a power-nailer over a roofing hammer for 3-tab shingling of a roof). Ensure the tables referenced in the P-405, Seabee Planner’s and Estimator’s Handbook, apply for the tasks you plan to use. Crewleaders must be familiar with the unit’s table of allowance (TOA) to know what to expect for tool availability at the deployment site. Additionally, the Crewleader must communicate with the on-site unit to verify tool condition and availability. All the deployment sites have extra tools that augment the TOA to add flexibility and enhance their construction capability. If required tools are not on site, they may be available elsewhere in the NCF, such as on another detail site or homeport regiment. Tools may be available from local Public Works/self-help shops. Also, if enough project funds are available, they may be rented or purchased.

6.3.2 Tool Kit Inventory

Tool kits contain all the craft hand tools required by one four-member construction crew or fire team of a given rating to pursue their trade. The kits may contain additional items required by a particular assignment. The types of items should not be reduced and should have 100 percent of kit assembly allowance at all times.

As a crew leader, you can order and are responsible for all the tools required by the crew. This incurs the following responsibilities:

- Maintaining complete tools kits at all times
- Assigning tools within the crew
- Ensuring proper use and care of assigned tools by the crew
- Preserving tools not in use
- Securing assigned tools
- Ensuring that all electrical tools and cords are inspected on a daily basis
6.3.3 Accountability

Crewleaders must maintain accountability for all tools on the jobsite. To make sure tools are maintained properly, the operations officer and the supply officer establish a formal tool kit inventory and inspection program. Tool inventories must be completed bi-weekly. Tools requiring routine maintenance are turned in to the central tool room (CTR) for repair and reissue. Damaged or worn tools should be returned to the CTR for replacement. You must submit requisitions for replacement items. Tool management is further specified in instructions issued by Commander, First Naval Construction Division (1NCD) and in the Crewleader Handbook.

The Crewleader should sub-custody tool kits to crewmembers to ensure proper chain of custody and safekeeping. Lost tools are charged to the Seabee who had custody using a pay-checkage form. At times there are also tools that require special attention. These are called Project Tools and are bought with the customer’s/project funds for use on that project. The customer owns these tools and will be offered them at the completion of the project.

6.3.4 Maintenance

Crewleaders must exercise proper maintenance and care to ensure safety and long tool life. A good time to visually inspect every tool is during the bi-weekly tool kit inventory. Look for wear and tear, cracks, lack of lubrication, frayed cords, etc. Pay close attention to safety devices and guards, ensuring that they are in proper working order and that crewmembers know the correct way to use them. Taking good care of the tools will prevent construction delays and facilitate good quality construction.

6.4.0 Material Management

Material management and accountability are the crewleader’s responsibility. The Material Liaison Office (MLO) is merely a tool used to buy materials for the job. You have already learned that all materials are tied to master activities and identified on the CAS sheets. In this chapter you will learn how to identify hard-to-get materials, how to track them through homeport and on deployment, and how to maintain accountability of the project’s money and materials.

6.4.1 Preparing the Requisition

As a crewleader, you must become familiar with the forms used to request material or services through the Navy Supply System. Printed forms are available that provide all the information necessary for the physical transfer of the material and accounting requirements. NAVSUP Form 1250, shown in Figure 4-30, is used most often.
Figure 4-30 – NAVSUP 1250.

Crewleaders are not usually required to complete the entire form. The Crewleader must list the stock number of the item, when available, the quantity required, and the name or description of each item needed. Turn this form in to the expediter, who checks it, fills in the remaining information, and signs it. The form then goes to the material liaison officer (MLO) or supply department for processing.

In ordering material, the Crewleader needs to know about the national stock number (NSN) system. Information on the NSN system and other topics about supply is given in Military Requirements for Petty Officer Third Class, NAVEDTRA 12044.

6.4.2 Storing Materials at the Job Site

Material receipt, storage and use are very important considerations for setting up the job site. The customer pays for all the materials on Seabee construction projects. The customer expects all U.S. Seabees to protect project materials from theft, misuse, abuse, and damage by handling, weather, or vandalism.

Is there easy access for material delivery and handling? Can you safely store material on your job site? How big an area do you have to store material on site? Has the activity Public Works organization approved a lay-down site? Can the material be secured? Has the activity Security organization been informed of the lay-down site? In some cases the battalion will submit this information for the ROICC to coordinate, or they will go directly to Public Works and Security for information and approval. These items may also be discussed at the Pre-construction Meeting. In either case, you will normally need to prepare a rough drawing of the limits of the areas, and provide all information regarding potential impact to buildings, sites, and personnel adjacent to the construction and lay-down areas. Are materials exposed to the weather? How much material do you need on site? Is the material stored properly? Do you have Material Safety Data Sheets (MSDS) on hazardous materials, and is it the right material? You should not store more than two weeks of material on the job. If you don’t need it now, don’t draw it. If you have to build a material storage area, try to place it in an area that is not going to be in the way of construction. You should inspect the material at MLO before you draw it so you will know what to consider for receipt and storage on the job site. Pay particular
attention to hazardous material. There are many important considerations for setting up the job site. Items to consider include noise and access impacts. See Appendix 4-A of the *Seabee Crewleader’s Handbook* for more specific guidance.

Requisition only the materials you will use for the next two weeks. Take into account pickup/delivery time. Materials required to complete the two week schedules are a good measure of this. Once materials are on the job, the crewleader must protect them from pilferage, weather and job site damage. They will be stored indoors if possible and off the ground outdoors. Lock up high value items that are easily pilfered. With a little prior planning (using the two week schedules) the crewleader can have the materials needed, when they are required, and not worry about them being damaged or stolen. Material management is very important. Copies of manufacturer’s installation instructions should be protected and stored in the project folder or elsewhere on the site. These instructions and manuals will need to be turned over to the ROICC at the end of the project, and should be available on site for inspection by QC and ROICC personnel at any time. Material waste by improper installation, poor construction, and damage onsite are the main reason materials are reordered. This is poor construction management and very unprofessional. In extreme cases the crewleader could be responsible under the UCMJ.

### 6.4.3 Hazardous Material

If project material is hazardous, the crewleader must ensure that MLO supplies a copy of the Material Safety Data Sheet (MSDS). Follow all guidelines listed on the MSDS. The MSDS is explained in Chapter 11 of the *Seabee Crewleader’s Handbook*.

### 6.5.0 Equipment Management

As crewleader you must be familiar with the proper care and maintenance of the equipment your personnel are using. This chapter covers first echelon maintenance, preventive maintenance, and general requirements of the current version of *COMFIRSTNCD Instruction 11200*.

#### 6.5.1 Scheduling

Coordinating equipment requirements between several companies and many projects takes a lot of communication. ALFA Company tracks their workload based on original schedules and weekly goals. When revisions to the schedules are necessary, it takes accurate forecasts on the part of the crewleader several weeks in advance. If the crewleader can see an activity requiring ALFA Company support is going to slip, the crewleader must contact the chain of command immediately to let them know they are not going to be ready and to re-schedule the equipment. The equipment requirements for the projects should be forwarded to ALFA Company as early as possible. This will enable ALFA Company to consolidate all equipment requirements and identify/resolve any constraints.

#### 6.5.2 Planned Maintenance System/PMS Program

PMS was developed to provide the organizational level with the tools to plan, schedule, and control planned maintenance effectively. The maintenance procedures developed in accordance with Reliability-Centered Maintenance (RCM) principles for planned maintenance are the minimum required to maintain equipment within specifications.
PMS is standard in concept and procedure, but flexible enough to be adjusted by the organization to be compatible with operational and other schedules.

PMS supercedes all previous planned or preventive maintenance systems or programs. Where a difference between the requirements and/or procedures of PMS and other technical publications or systems exists, PMS requirements will prevail. Differences shall be reported using PMS feedback reporting procedures.

Equipment not supported by PMS will continue to be maintained per existing procedures of the manufacturers, System Commands (SYSCOM) and/or Bureau of Medicine and Surgery's (BUMED) technical manuals, until PMS is developed and installed. The Fleet Technical Support Centers, Atlantic/Pacific (FTSCLANT/FTSCPAC) function as PMS coordinating activities and are responsible for the accountability and distribution of PMS documentation. The PMS is explained in the current version of NAVSEA Instruction 4790.8B.

6.6.0 Time Cards

The techniques used to evaluate the status of a project and compare the actual progress to the scheduled progress are called Project Monitoring. In order to monitor a project’s progress, crewleaders **MUST** be knowledgeable about completing time cards, figuring WIP, updating bar charts, submitting SITREP input and arranging project photos. This chapter will explain the techniques used to monitor a construction project.

Time cards are the most accurate way to record actual mandays on a construction project. They allow you to monitor the efficiency and accountability of your crew. They are the basis of your SITREP input, therefore it is imperative that time cards are filled out correctly and accurately. The current version of COMFIRSTNCD Instruction 5312 is the instruction that governs time keeping for the Seabees. Each crewleader should obtain a copy of it and become familiar with time keeping procedures. The standard form used for time keeping is shown in Figure 4-31.

<table>
<thead>
<tr>
<th>CREWLEADER</th>
<th>SIGNATURE</th>
<th>COMPANY</th>
<th>CREW SIZE</th>
<th>TRANSFERS THIS DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT NUMBER</td>
<td>PROJECT TITLE</td>
<td></td>
<td></td>
<td>DATE</td>
</tr>
<tr>
<td>CREW MEMBER’S RATE/NAME</td>
<td>DIRECT LABOR BY CONSTRUCTION ACTIVITY NUMBER</td>
<td>INDIRECT</td>
<td>READINESS AND TRAINING</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>TOTAL</td>
<td>TOTAL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTALS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 4-31 – Sample prime time card.**

Crewleaders will prepare time cards each day to reflect actual mandays by all personnel assigned to them. Crewleaders should be honest when recording actual mandays on the projects. Regardless of whether the crew worked 5 hours or 14 hours on the project, it should be recorded on the time cards. This is the only way to track the projects properly. Subcontractor crewleaders will use the time card in Appendix 9-E in lieu of the
standard time card. The sub crewleader will fill out the time card in duplicate while on the project. The time card will reflect all subcontractor labor and will be signed by both the prime and the sub crewleaders. The prime will keep a copy and turn it in with the time card for prime personnel. The sub will turn in the original to his company time keeper. This method will allow the prime crewleader and his chain of command to monitor the effort being expended by the subs and the time being charged against the project. Record all labor to the nearest whole manhour. If more than one labor category applies to a specific manhour, the dominant category shall be used for reporting.

Mandays are computed on the basis of an eight-hour day, regardless of the length of the scheduled workday. The reported mandays, therefore, are equal to the total hours worked by an individual divided by eight. Prior to submitting the time cards to the company, the crewleader will transfer the totals from both time cards to a Two Week Labor Summary. This will be used by the crewleader when completing the SITREP feeders. It can also be used to track actual mandays and crew availability. Maintain time cards on file in the company office for the duration of the deployment. Following is a list of labor accounting categories:

a. **Direct Labor.** Direct labor includes all actual mandays expended directly on an assigned construction task, either in the field or in the shop, which contributes directly to the completion of the project. All tasked projects are normally assigned a project number. Labor expended on a specific project will be reported under that project’s number. Record direct labor by construction activity number.

b. **Indirect Labor.** Indirect Labor includes actual mandays expended to support construction operations but which does not produce an end product in itself. Therefore, this time is not reported/recorded under a project number but under an indirect labor code. The codes are as follows:

X01 Equipment, Repair and Records: Work in this code includes:

- Maintenance or Repair
- All Common and Automotive Spare Parts Functions
- Record Keeping to Support Maintenance or Repair

X02 Project and Camp Maintenance Support: Work in this code includes:

- Planning and Estimating, and Material Take Offs
- Operation of the Trouble Desk
- Project Planning and Scheduling

X03 Project Management: Work in this code includes:

- Project and Shop Supervision
- Project Coordination and Management Functions such as:
  - Arranging for:
    - Equipment and Tools
    - Scheduling Utility Outages
    - Coordinating with Other Crews
Inspections, Meetings, and Turnover Functions

**X04 Location Moving:** Work in this code includes:
- Mobilization/Demobilization of Equipment, Tools, Field Offices, etc. To and From Project Sites
- Motor Pool Operations
- Taxi Drivers and Road Master

**X05 Project Travel:** Work in this code includes:
- All Travel Time To and From Project Sites (as it pertains to Direct Labor Personnel)

**X06 Material Support:** Work in this code includes:
- Receipt, Storage, Inventory, Issue and Delivery of Materials

**X07 Tools:** Work in this code includes:
- All Tool Maintenance and Repair
- Inventory Control
- Ordering Replacement Parts and Rental Equipment

**X08 Administration and Personnel:** Work in this code includes:
- Legal, DAPA, Career Counselor, Counseling with Chaplain, Driver’s License Examiner ESO, PAO, Post Office, Special Services, Supply, Disbursing, Security
- Military Sports Competition
- Armed Forces Police, Court Witness
- TAD Personnel not Covered Under Productive Labor
- Medical and Dental
- Leave and Liberty, Personnel Affairs
- Timekeeping

**X09 Lost Time:** Work in this code includes:
- Lost Time Due To:
  - Inclement Weather
  - Awaiting Transportation
  - Shortage of Tools and Materials
  - Unauthorized Absence and Confinement
X10 Other: Work in this code includes:

- All Indirect Labor Expended in Areas Not Specifically Addressed Elsewhere in This Category

c. Readiness and Training. Readiness and training are comprised of all functions related to preparation for and execution of military exercises, disaster preparedness, mobility, and technical training. Training includes attendance at service schools, factory and industrial training courses, fleet-type training, special Seabee training courses, safety training, military training, and any organized training conducted within the battalion. Report/record these manhours under a specific name.

6.6.1 Crewleader’s Logbook

Update all project documents daily. If for some reason this is not possible, the crewleader should keep a daily logbook of everything that transpires on the job site. If the crewleader relies on memory only, some items will be forgotten as time passes. The crewleader’s logbook is the best way to track the project’s daily activities. Figure 4-32 is a sample completed entry for a crewleader’s logbook.

```
May 21, Saturday

0700  Act. 03100, 2-Bus
       Act. 03200, 1-SW, 1-CE
       Act. 02200, 1-EQ, 1-UT
       "BUCN, UA"

1000  QC/Safety arrive, concerns of worn out GFCIs, CTR has new ones, change them out tonight

1025  QC/Safety depart

1100  BUC arrives with BUCN, Put him on Act. 03100

1115  BUC departs with EO3, he is still sick

1300  BU1 on Act. 03200

1400  Ops arrives

1430  Ops departs

1700  Job site secured

Construction Activity Total Work Work Complete % WIP
03100  1248 sf 1073 sf 86%
03200  1120 pcs 1120 pcs 100%
02200  2700 sf 1800 sf 67%

Material Received
03100  Form release 5 gal
03310  Cement type 1 3 bags
        Sand, washed 6 cubic ft
        3/8" Minus 12 cubic ft
        11S Mixer 1 ea

Typical time card

<table>
<thead>
<tr>
<th>Crew</th>
<th>Construction Activity No.</th>
<th>Indirect</th>
<th>Readiness and Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>BU1</td>
<td>03100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BU2</td>
<td>03200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BU3</td>
<td>02200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUCN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE3</td>
<td>03030</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SW3</td>
<td>03020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EO3</td>
<td>02020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UT2</td>
<td>01010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>22</td>
<td>29</td>
</tr>
</tbody>
</table>

Figure 4-32 – Sample crewleader’s logbook entry.

6.6.2 SITREP Input

The battalion sends out a monthly SITREP to higher headquarters to report on the progress of construction tasking. SITREP accuracy is a reflection on how well the
crewleaders have documented labor expended on the projects and the quality of the input provided by the crewleaders/companies. The crewleader will forward a SITREP feeder to Ops on a biweekly basis. A sample SITREP feeder is in the Seabee Crewleader’s Handbook Chapter 15 page 15-44. Figure 4-33 shows a completed portion of a SITREP feeder and describes each part.

<table>
<thead>
<tr>
<th>Master Activity</th>
<th>Origin Est</th>
<th>Weighted Percent</th>
<th>Master Activity % Complete (WIP)</th>
<th>Project % Complete</th>
<th>Mandays Remaining</th>
<th>Mandays Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td>Description</td>
<td>a</td>
<td>b</td>
<td>a x b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>General</td>
<td>20</td>
<td>4</td>
<td>30</td>
<td>1.2</td>
<td>14</td>
</tr>
<tr>
<td>02</td>
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<td>47</td>
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<td>55</td>
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<tr>
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<td>Conc. Const.</td>
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<td>30</td>
<td>69</td>
<td>20.7</td>
<td>44</td>
</tr>
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<td>Masonry</td>
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<td>0</td>
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<tr>
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<td>9</td>
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<td>0</td>
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<td>06</td>
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<td>07</td>
<td>Moist. Protect.</td>
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<tr>
<td>08</td>
<td>Doors/Wind./Glass</td>
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<td>0</td>
<td>0</td>
<td>10</td>
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<tr>
<td>09</td>
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<td>15</td>
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<td>66</td>
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<td>Specialties</td>
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</tr>
<tr>
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<td>44</td>
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<td>32</td>
<td>3.2</td>
<td>30</td>
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<tr>
<td>16</td>
<td>Elect. Const.</td>
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<td>13</td>
<td>.9</td>
<td>26</td>
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<td></td>
<td>454</td>
<td>100</td>
<td></td>
<td>38.5</td>
<td>248</td>
</tr>
</tbody>
</table>

Figure 4-33 – Sample SITREP feeder – master activities.

Weighted Percent – The weighted percent for each master activity in the table above is simply the mandays estimated for that master activity divided by the total project mandays. For master activity 01, General, the manday estimate was 20 and 20 divided by 454 is .04. Take .04 and multiply it by 100 to change the decimal to a percentage. .04 x 100 = 4%. The weighted percent column must total 100. If the total does not, go to the highest percent and add or subtract to get the total to be 100. For example, when calculating master activity 03, 140 ÷ 454 = .31 x 100 = 31%. The total of the weighted percent column would have been 101%. Master activity 03 was changed to .30 in order for the total to equal 100%. The weighted percent can only be changed at the 45-day review, during the project joint turnover, or when specifically approved by higher headquarters.

Master Activity % Complete by Work-in Place (WIP) – Obviously for master activities not started the percent WIP is zero and for completed master activities the percent WIP is 100. For master activities that are partially complete the crewleader must look at the status of individual construction activities. Refer to Figure 4-34 for master activity 03 (Concrete Construction):
<table>
<thead>
<tr>
<th>Construction Activity</th>
<th>a</th>
<th>b</th>
<th>a x b</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td>Description</td>
<td>Manday Estimate</td>
<td>Weighted Percent</td>
</tr>
<tr>
<td>03100</td>
<td>PF Forms F/S</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>03110</td>
<td>Set Forms F/S</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>03120</td>
<td>Strip Forms F/S</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>03130</td>
<td>PF Lintel Forms</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>03140</td>
<td>PF Forms B/C</td>
<td>32</td>
<td>22</td>
</tr>
<tr>
<td>03150</td>
<td>Set Forms B/C</td>
<td>25</td>
<td>18</td>
</tr>
<tr>
<td>03160</td>
<td>Strip Fms B/C Ext</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>03170</td>
<td>Strip Fms B/C Int</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>03200</td>
<td>PF RST F/S</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>03210</td>
<td>Set RST F/S</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>03220</td>
<td>PF RST B/C</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>03230</td>
<td>Set RST B/C</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>03300</td>
<td>Place Conc. F/S</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>03310</td>
<td>Place Conc. Lintels</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>03320</td>
<td>Place Conc. B/C</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>03400</td>
<td>Set Roof Panels</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>TOTALS</td>
<td>140</td>
<td>100</td>
<td>69</td>
</tr>
</tbody>
</table>

Figure 4-34 – Sample construction activities.

In evaluating the progress on master activity 03, we can see that we have completed the following construction activities: 03100, 03110, 03120, 03130, 03140, 03200, 03210, 03220, 03300, and 03310. These construction activities represent 60 percent of master activity 03 (6 + 8 + 2 + 4 + 22 + 5 + 3 + 5 + 4 + 1 = 60). We obtained these percents by multiplying the CA % Complete by the Weighted Percent. For construction activity 03150 (Set Forms Beams and Canopy) we obtained the 50% complete by actual measurement. In this case we measured and determined that one half of the forms have already been set. Activity 03150 represented 18% of the master activity. Since we are half done we get credit for 9%. 9 plus the previous 60 gives us a total 69% complete for master activity 03.

Project % Complete – Project % complete represents the percentage that the work completed on that master activity contributes to the overall project completion. We get the project % complete by multiplying the weighted percent by the master activity % complete (WIP) for each activity. For master activity 02, Site Work, the project % complete was determined by multiplying the weighted percent of .10 times the percent WIP of 55 to get a project % complete of 5.5 (.10 x 55 = 5.5).

Actual Percent Complete – Actual percent complete for the project is the total of the project % complete column. For the example above the actual percent complete for this project is 38.5%. We also put the scheduled percent complete at the top of the SITREPO feeder. We need to compare the actual progress to the scheduled progress. The
scheduled percent complete comes from the Level II bar chart in either the Deployment Execution Plan (within the first 45 days of the deployment) or the Revised Deployment Execution Plan (after the 45 day review). The allowable percent deviations between actual WIP and scheduled WIP are listed in Table 4-5.

<table>
<thead>
<tr>
<th>Total Project Manday Range</th>
<th>Allowable % Deviation Between Actual WIP vs. Scheduled WIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1000 MD</td>
<td>10%</td>
</tr>
<tr>
<td>1000-2000 MD</td>
<td>5%</td>
</tr>
<tr>
<td>2000 &amp; above MD</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

If the actual WIP is less than the scheduled WIP by more than the percentage shown in Figure 4-35, the battalion must advise higher headquarters by message. The message will include a plan to get the project back on track and request approval for any required changes to battalion Level I bar chart or the project Level II bar chart in the Revised Deployment Execution Plan.

Mandays Remaining – Mandays remaining are a reflection of how much work remains to be done on the project and has nothing whatsoever to do with how many mandays have been expended. For master activities that are complete (see master activity 04 in Figure 4-33) the mandays remaining is zero. For master activities not started, the mandays remaining will equal the original manday estimate for that master activity. For master activities under construction we must evaluate the completion status of the individual construction activities. Construction activities that are 100% complete have zero mandays remaining; construction activities that have not begun have mandays remaining equal to the original manday estimate. If a construction activity with an original estimate of 20 mandays is 25% complete the mandays remaining are 15 because 75% of the work is left to be done and (.75 x 20) is 15.

Actual Mandays – Actual mandays have nothing to do with percent complete and are not included in the SITREP when it leaves the battalion. It is included on the feeder so the company staff and Ops can see where your mandays have gone. It may provide insight on why a particular project is behind. The total actual mandays are also needed to update the Level II bar chart with actual progress and mandays actual.

Comments Line – The SITREP feeder also has a line for comments. This is for the crewleader’s draft input for the SITREP. The battalion must include in its SITREP brief comments describing work performed since the last SITREP. If actual WIP is less than scheduled WIP, the delay must be explained and a plan for getting the project back on schedule must be included.

Mandays Earned – Mandays earned is another method of calculating the actual project percent complete. Refer to Figure 4-35 for master activity 03. For construction activities that are completed, we get credit in mandays earned for all of the original manday estimates, as is the case with construction activity 0310 Prefab Forms Foundation/Slab. For activities not started, we do not get credit for any mandays earned, as is the case with construction activity 0316 Strip Forms Beams/Canopy Exterior. For activities in progress, we get credit in earned mandays for the percentage of the activity that is complete. Construction activity 0315, Set Forms Beams/Canopy is 50 percent complete. .50 x 25 = 12.5 or 13. The total mandays earned for master activity 03 is 140. To
calculate the percent complete for the master activity we divide total mandays earned by the total manday estimate (97 ÷ 140 = .69 or 69%).

<table>
<thead>
<tr>
<th>Construction Activity</th>
<th>Manday</th>
<th>CA % Complete</th>
<th>Mandays Earned</th>
</tr>
</thead>
<tbody>
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<tr>
<td>03100 PF Forms F/S</td>
<td>8</td>
<td>100</td>
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</tr>
<tr>
<td>03110 Set Forms F/S</td>
<td>11</td>
<td>100</td>
<td>11</td>
</tr>
<tr>
<td>03120 Strip Forms F/S</td>
<td>3</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>03130 PF Lintel Forms</td>
<td>5</td>
<td>100</td>
<td>5</td>
</tr>
<tr>
<td>03140 PF Forms B/C</td>
<td>32</td>
<td>100</td>
<td>32</td>
</tr>
<tr>
<td>03150 Set Forms B/C</td>
<td>25</td>
<td>50</td>
<td>13</td>
</tr>
<tr>
<td>03160 Strip Fms B/C Ext</td>
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<td>0</td>
</tr>
<tr>
<td>03170 Strip Fms B/C Int</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>03200 PF RST F/S</td>
<td>7</td>
<td>100</td>
<td>7</td>
</tr>
<tr>
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<td>100</td>
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<td>03310 Place Conc. Lintels</td>
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<td>100</td>
<td>2</td>
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<tr>
<td>03320 Place Conc. B/C</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>03400 Set Roof Panels</td>
<td>14</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTALS</td>
<td>140</td>
<td></td>
<td>97</td>
</tr>
</tbody>
</table>

Figure 4-35 – Sample mandays earned – construction activities.

Use the same process to calculate earned mandays for the entire project. Referring to Figure 4-36, we see that master activity 04 is complete and we get credit for 32 earned mandays. Master activities 05 through 10 have not started, and we do not get credit for any earned mandays. Master activity 01 is 30 percent complete. .30 x 20 = 6 earned mandays. Master activity 02 is 55 percent complete. .55 x 47 = 25.85 or 26 earned mandays. Master activities 03, 15, and 16 were calculated in the same manner. The total actual percent complete on the project is 39.4 percent (179 ÷ 454 = .394 or 39.4 %). The project percent complete will vary slightly between the WIP and Earned Mandays methods of calculation. This results from rounding to whole mandays. Either method is acceptable. Consult with your chain of command on which method to use.
Master Activity Status Sheet (MASS) – The MASS in the Seabee Crewleader’s Handbook Appendix 9-C-1 is used to aid the crewleader in completing the SITREP feeder. MASSs need only be completed for activities underway. The crewleader does not have to be concerned with activities that are 0% or 100% complete. The MASS combines all that we have discussed previously in this section. The step-by-step instructions for completing the MASS are as follows:

a. Construction Activity, Description and Estimated Mandays come from the CA

b. The Weighted Percent (WT%) is equal to the construction activity manday estimate divided by the total master activity manday estimate.

c. The Total Work is equal to the number of linear feet, square feet, cubic yards, etc. of work to be done.

d. The Work Completed is equal to the number of linear feet, square feet, cubic yards, etc. of work actually completed.

e. The Construction Activity Percent Complete (CA % COMP.) is equal to the amount of Work Completed divided by the Total Work.

f. The Master Activity Percent Complete (MA % Comp.) is equal to the Construction Activity Percent Complete Multiplied by the Weighted Percent.

g. The Mandays Actual (MDs Act.) comes from the time cards.

h. The Mandays Remaining (MDs Rem.) is equal to the percentage of work remaining to be completed multiplied by the original manday estimate.

---

<table>
<thead>
<tr>
<th>Master Activity</th>
<th>Original MD Est</th>
<th>Master Activity % Comp Earned MDs</th>
<th>Mandays Earned</th>
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</thead>
<tbody>
<tr>
<td>01 General</td>
<td>20</td>
<td>30</td>
<td>6</td>
</tr>
<tr>
<td>02 Site Work</td>
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<td>55</td>
<td>26</td>
</tr>
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<td>03 Conc. Const.</td>
<td>140</td>
<td>69</td>
<td>97</td>
</tr>
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<td>04 Masonry</td>
<td>32</td>
<td>100</td>
<td>32</td>
</tr>
<tr>
<td>05 Metals</td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>06 Carpentry</td>
<td>8</td>
<td>0</td>
<td>0</td>
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<tr>
<td>07 Moist. Protect.</td>
<td>16</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>08 Doors/Wind./Glass</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>09 Finishes</td>
<td>66</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10 Specialties</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15 Mech. Const.</td>
<td>44</td>
<td>32</td>
<td>14</td>
</tr>
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<td>16 Elect. Const.</td>
<td>30</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>454</strong></td>
<td></td>
<td><strong>179</strong></td>
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</table>

**Figure 4-36 – Sample mandays earned – master activities.**
i. The Estimated Mandays, the Weighted Percent, the Master Activity Percent Complete, the Mandays Expended and the Mandays Remaining are then totaled at the bottom of the page.

The following step-by-step instructions will help you complete the SITREP feeder:

   a. The % Complete Scheduled, Master Activity # and Description and the Original MD Estimate come from the project Level II barchart.
   
   b. The Weighted Percent (WT%) is equal to the master activity manday estimate divided by the total project manday estimate.

   c. The Master Activity % Complete (WIP), if other than 0% or 100% comes from the MASS.

   d. The Project % Complete is equal to the Weighted Percent multiplied by the Master Activity % Complete (WIP).

   e. The Mandays Remaining and Mandays Actual come from the MASS.

### 6.7.0 Two Week Schedules

Successful crewleaders must manage their project on three different planes. They must directly supervise the construction effort underway, they must look at activities scheduled for the next two weeks to ensure an uninterrupted flow of resources to the project and they must keep an eye on any long lead items which, if not tracked continuously, could eventually cause a work stoppage or delay. Long lead items should be tracked at least weekly. The two week schedule consists of 3 parts, as shown in Figure 4-37.

Part 1 includes the work scheduled for a 14 day period. The items of work listed on the two week schedules must be clear and measurable. The two week schedules must show the work shown on the Level III barchart for that period. If you are behind schedule, the two week schedules must also reflect why you are behind and how you are going to get back on track.

Part 2 lists the tool and equipment requirements for the two week period.

Part 3 lists the material requirements for the two week period. This tool is used primarily by the crewleader to ensure that all materials, equipment and tools required are either on the job site or requested with sufficient lead time to ensure availability.

The two week schedules will be used in the crew briefings described below, provide ongoing project status to the chain of command, and give heads up to MLO and the subcontractors. The two week schedules are normally submitted to Ops at the weekly Operations meeting. They typically cover a two week period and are revised weekly. Higher headquarters will look for these during visits, and they must be useful and accurate. Two week schedules are also referred to as weekly goals.
### TWO WEEK SCHEDULE

(Part 1)

<table>
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<tr>
<th>Construction Activity No.</th>
<th>Title</th>
<th>DATES</th>
<th>Crew Size</th>
<th>Remarks</th>
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<tr>
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</table>

**Assumptions:**

(Part 2)

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<tr>
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<th>Tool Requirements</th>
<th>Equipment Requirements</th>
<th>Remarks</th>
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<td></td>
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</table>

(Part 3)

<table>
<thead>
<tr>
<th>Activity No.</th>
<th>BMLI No.</th>
<th>Description</th>
<th>Unit of Issue</th>
<th>BM Qty.</th>
<th>On Hand Qty.</th>
<th>Needed Qty.</th>
<th>Date Req'd</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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**Figure 4-37 – Sample schedule.**
**Figure 4-38** is part 1 of a sample completed two week schedule.

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<th>Project Title:</th>
<th>Admin Building</th>
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</tr>
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<td>Company/Det:</td>
<td>C</td>
</tr>
<tr>
<td>Period Covered:</td>
<td>17 May 2005 to 27 May 2005</td>
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<tr>
<td>Date:</td>
<td>12 Apr 2005</td>
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<table>
<thead>
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<th>Remarks</th>
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<td>01600 Move In</td>
<td>SC</td>
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<td></td>
</tr>
<tr>
<td>02100 Clear &amp; Grub</td>
<td>S</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>03100 PF Forms Fd./Sl.</td>
<td>S</td>
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<td></td>
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<tr>
<td>02200 Subgrade F &amp; C</td>
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</tr>
<tr>
<td>02240 Level/comp. U/S</td>
<td>SC</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>03110 Set Frms Fd./SL.</td>
<td>S</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Assumptions:

**Figure 4-38** – Part 1 of two week schedule.

### 7.0.0 SAFETY

Safety responsibility falls to the crewleader. Any resources the crewleader needs, he/she can obtain through the Safety Office (equipment, material, education, training, etc.). The safety responsibilities for various levels in the chain of command are listed in the NCF Safety and Health Manual.

### 7.1.0 Safety Organization

The NMCB’s safety organization provides for the establishment of safety policy and control and reporting. As illustrated in **Figure 4-39**, the battalion safety policy organization contains several committees: policy; supervisors’; and equipment, shop, and crew.
The executive officer presides over the safety policy committee. Its primary purpose is to develop safety rules and policy for the battalion. This committee reports to the commanding officer, who approves all changes in safety policy.

The battalion safety officer presides over the safety supervisors’ committee. This committee includes safety supervisors assigned by company commanders, project officers, or officers in charge of a detail. It helps the safety officer manage an effective overall safety and health program. The committee provides a convenient forum for work procedures, safe practices, and safety suggestions. Its recommendations are sent to the policy committee.

The equipment, shop, and crew committees are assigned as required and are usually presided over by the company or project safety supervisor. The main objective of this committee is to propose changes in the battalion’s safety policy to eliminate unsafe working conditions or to prevent unsafe acts. It is your contact for recommending changes in safety matters. The equipment committee reviews all vehicle mishap reports, determines the cause of each mishap, and recommends corrective action. As a crew leader, you can expect to serve as a committee member. Each committee forwards reports and recommendations to the safety supervisors’ committee.

**7.2.0 Crewleader’s Responsibilities**

Crewleaders and other supervisors are the Key People in a successful and aggressive safety program. Responsibilities include but are not limited to:
- Familiarity with safety rules and regulations for jobs and facilities in his/her area, and acting in a safe manner.
- Enforcing safety rules and correcting unsafe acts.
- Inspecting jobs and work areas for hazards and taking corrective actions.
- Educating and training personnel in safe work procedures and rules.
- Reporting all mishaps and near misses to the Safety Office promptly and ensuring personnel receive immediate medical treatment.
- Investigating all mishaps or near misses in his/her area, determining basic causes, taking corrective action, and requesting assistance from the Safety Office when necessary.
- Reviewing safety and health records on employees and facilities in his/her area as required.
- Taking corrective action on hazards reported by employees without reprisal for their reporting of the hazard.
- Ensuring that correct personal protective equipment is provided to personnel and that they wear and maintain the equipment properly.
- Obtaining advice and assistance from the Safety Office in the positive implementation of the NAVOSH Program.
- Knowing the limitation of subordinate personnel and avoiding assignment of hazardous jobs to personnel who are not physically and mentally capable of performing work assignments in a safe manner.
- Removing from service any defective machinery, material, or tools until repairs can be made to ensure safe operation.
- Posting appropriate safety precaution signs in conspicuous areas near or on equipment, material, stowage areas and other designated hazards or hazardous areas.

Test your Knowledge (Select the Correct Response)

12. A crewmember is incorrectly doing a job. As crew leader, what action should you take?

A. Place the crewmember on report  
B. Assign extra work to the crewmember  
C. Stop the crewmember and give correct job procedures  
D. Transfer the crewmember to another crew

7.2.1 Safety Duties

As a crew leader you report to the safety chief, who directs the safety program of a project. The safety chief is inherently responsible for all personnel assigned to that shop or project. Some of the duties include indoctrinating new crewmembers, compiling mishap statistics for the project, reviewing mishap reports submitted to the safety office, and comparing safety performances of all crews.
The crew leader is responsible for carrying out safe working practices. This is done under the direction of the safety supervisor or others in positions of authority, such as the project chief, project officer, or safety officer. You, as the crew leader, ensure that each crewmember is thoroughly familiar with these working practices, has a general understanding of pertinent safety regulations, and makes proper use of protective clothing and safety equipment. You should be ready at all times to correct every unsafe working practice you observe, and report it immediately to the safety supervisor or the person in charge. When an unsafe condition exists, any crew or shop member can stop work until the condition is corrected.

In case of a mishap, make sure injured personnel get proper medical care as quickly as possible. Investigate each mishap involving crewmembers to determine its cause. Remove or permanently correct defective tools, materials, and machines. Do the same for environmental conditions contributing to a mishap. Afterward, submit required reports.

**7.3.0 Safety Training/Lectures**

The battalion Safety Office oversees and monitors project safety plans, and ensures compliance to safety regulations. It’s your job as the crewleader to ensure safety on your job site. According to the NCF Occupational Safety and Health Manual, the current version of COMFIRSTNCD Instruction 5100, the battalion Safety Office administers the battalion safety program and provides technical guidance, but it is the crewleader, the project supervisor, the company chief, the company commander, S3 and the Commanding Officer who are 100% responsible for safety on the job site. If you have any questions concerning safety on the project you are planning or executing, the battalion Safety Office is a good place to go to get your questions answered. The Safety Office can’t always prevent you from doing something you know is unsafe. They do not have the staff to be present on the job site at all times. Safe construction is your responsibility and ignorance is no excuse. It is your responsibility to find out how to do construction in a safe manner.

**7.3.1 Safety Training**

New methods and procedures for safely maintaining and operating equipment are always coming out. You must keep up to date on the latest techniques in maintenance and operation safety and pass them on to your crewmembers. One method of keeping your crewmembers informed is by holding stand-up safety meetings before the day’s work starts. You, as crew leader, are responsible for conducting each meeting and passing on material from the safety supervisor. Information such as the type of safety equipment to use, where to obtain it, and how to use it is often the result of safety suggestions received by the safety supervisors’ committee. Encourage your crew to submit ideas or suggestions. Don’t limit yourself to just the safety lecture in the morning. Discuss minor safety infractions when they occur or at appropriate break. You must impress safe working habits on your crewmembers through proper instructions, constant drills, and continuous supervision.

You may hold group discussions on specific mishaps to guard against. Be sure to give plenty of thought to what you are going to say beforehand. Make the discussion interesting and urge the crew to participate. The final result should be a group conclusion as to how the specific mishap can be prevented.
Your stand-up safety meetings also give you the chance to discuss prestart checks, and the operation or maintenance of automotive vehicles assigned to a project. Vehicles are used for transporting crewmembers as well as cargo. It is important to emphasize how the prestart checks are made and how to care for the vehicles.

You can use a stand-up safety meeting to solve safety problems arising from a new procedure. An example might be starting a particular piece of equipment just being introduced. First show the safe starting procedure for the equipment. Then have your crewmembers practice the procedure.

There are a variety of vehicles that may be assigned to a project, which means there are too many operating procedures for one person to remember. You need to know where to look for these procedures and other information on each vehicle. For specific information on prestart checks, operation, and maintenance of each vehicle assigned, refer to the manufacturer’s operator/maintenance manuals. Personnel from Alfa Company, the equipment experts, will instruct all personnel in the proper start-up procedures for new equipment.

In addition to stand-up safety meetings, conduct day-to-day instruction and on-the-job training. Although it is beyond the scope of this chapter to describe teaching methods, a few words on your approach to safety and safety training at the crew level are appropriate. Getting your crew to work safely, like most other crew leader functions, is essentially a matter of leadership. Don’t overlook the power of personal example in leading and teaching your crewmembers. They are quick to detect differences between what you say and what you do. Don’t expect them to measure up to a standard of safe conduct that you do not. Make your genuine concern for the safety of your crew visible at all times. Leadership by example is one of the most effective techniques you can use.

### 7.3.2 Required Safety Training

The safety training below is required by the NCF Safety and Health Manual for the identified crew personnel:

**Safety Supervisors** – Each Seabee unit will designate in writing a safety supervisor responsible for the Company/Department/Project. This individual will report to the Safety Office for all matters pertaining to the Occupational Safety and Health Program. Required minimum training is outlined in Appendix 11-A of the *Seabee Crewleader’s Handbook*.

**NAVOSH Training** – All personnel assigned to an Seabee unit are required to attend the initial and annual NAVOSH training outlined in Appendix 11-B of the *Seabee Crewleader’s Handbook*. This will be taught by the battalion’s Safety Office personnel during indoctrination.

**Seabee Specific Training** – All officers and enlisted personnel who may be assigned to work in a hazardous area will attend the Seabee specific training outlined in Appendix 10-B of the *Seabee Crewleader’s Handbook*. The battalion’s Safety Office personnel will teach this.

### 7.3.3 Electrical Safety

All job site electrical supplies are temporary power sources, even existing outlets in buildings being renovated. All temporary power sources must be inspected, certified safe, and tagged with the inspector’s name, company, and date prior to first use. Re-
certifications are required every two weeks thereafter. Ground Fault Circuit Interrupters (GFCIs) shall be used with all power tools, whether double insulated or not. GFCIs will be checked on a monthly basis with a representative from CTR and a proper record maintained. All electrical portable tools, extension cords, small gasoline, pneumatic and powder actuated tools (including those borrowed from other units) shall be visually inspected every day prior to their first use. These inspections will then be documented with the monthly tool inventory. Equipment or circuits that are de-energized shall be rendered inoperative and have tags attached at all points where such equipment or circuits can be energized. Ensure compliance with prescribed lockout/tagout procedures established in the NAVOSH Ashore Manual (OPNAVINST 5100.23) and the NCF Safety and Health Manual.

7.3.4 Asbestos Operations

Seabees do not normally conduct asbestos removal. The NCF Safety and Health Manual gives detailed guidance on the NCF asbestos policy and procedures.

7.3.5 Respiratory Protection

All of the following requirements must be met prior to the use of respirators:

- Correct equipment identified by the local Respiratory Protection Program Manager.
- Medical evaluation of potential users.
- Fit test performed by competent personnel.
- Respiratory protection training for all potential users.
- A written SOP developed for the job site, including emergency and rescue guidance, and posted on the job site.

7.3.6 Hazardous Materials

Crewleaders must recognize the threat that hazardous materials pose to all personnel present on the job site and take action to prevent mishaps. Listed below are basic measures in effect to minimize the risk of injury or mishap:

Material Safety Data Sheets (MSDS) – Upon drawing any hazardous material, MLO will provide the crewleader with an MSDS. The MSDS will identify any hazards associated with exposure to that specific material. It will also identify any personal protective equipment or other safety precautions required as well as first aid or medical treatment required for exposure. The crewleader is required by federal law to inform crewmembers of the risks and all safety precautions associated with any hazardous material present on the job site. This should be done during each daily safety lecture. Additionally, the MSDS must be posted conspicuously on the job site.

Hazardous Material Storage – The safest practice concerning hazardous material is not to draw any more material than can be used in a reasonable amount of time. Storing hazardous materials on the job site requires the use of approved storage containers. Consult with the battalion Safety Office, as many hazardous materials require separate storage containers (for example, corrosives and flammables cannot be stored together).
Hazardous Material Turn-in – Any excess material must be disposed of through an authorized hazardous material disposal facility. Check with the battalion MLO staff or Safety Office for procedures.

7.3.7 Safety Items Required on the Job Site

The following safety items are required on all project sites. See the 29 CFR 1926 for additional information.

Transportation/Communication – Required in order to have a rapid response in case of a mishap.

Emergency Plans – Each job site must have posted the location of the nearest phone, the telephone numbers and reporting instructions for ambulance, hospital, physician, police, and fire department personnel.

First Aid Qualified Personnel – If a medical facility is not readily accessible (due to time or distance) a crewmember must be first aid qualified and available on the job site.

First Aid Kits – First aid kits will be readily available and must be checked weekly for consumed items.

Toilet Facilities – If toilet facilities are not readily available, portable facilities must be provided.

Drinking Water – Water must be provided from an approved source and labeled for drinking only and not be used for other purposes. Common cups are not allowed.

Temporary Fencing/Barricades – Required if job site is in an area actively used by the public.

Warning Signs – Red for immediate hazards, yellow for potential hazards.

Eyewash Facility – Required where personnel are exposed to or handling poisons, acids, caustics or toxic chemicals.

Fire Extinguishers – One for every 3000 square feet (or major fraction thereof) of building space. Travel distance from any point to the nearest extinguisher will not exceed 100 feet.

Material Safety Data Sheets – For any hazardous material on the job site.

Hazardous Material Inventory Sheet – For any hazardous material on the job site.

Safety and Health Manual – The 29 CFR 1926 is required to be kept on the job site.

7.4.0 Safety Plan

For each construction activity, all hazards and corrective actions identified will be listed on the back of the CAS sheet. The project safety plan shown in Figure 4-40 is then drawn up listing the hazards and corrective action from the back of the CAS sheets.
Figure 4-40 – Project safety plan.

The cover sheet shown in Figure 4-41 is made up for the safety plan summarizing the training and equipment requiring review by the chain of command. The Chain of command will approve a Safety Plan for each project before any work starts. The project safety plan must be posted on the job site.
**PROJECT SAFETY PLAN**

Project Number and Title: 

Project Location: 

Prime Contractor: 

Subcontractor: (a) 

(b) 

Project Scope: 

Type of Inherent Risks (electrical, welding, etc.): 

Type of Associated Risk (fire, fumes, noise, etc.): 

Special Training Requirements: 

Special License Required: 

Engineering Controls (guard rails, welding curtains, shoring, etc.): 

Administrative Controls (policies, procedures, SOPs, etc.): 

Special Safety Equipment Required (state how it is to be used): 

Personal Protective Equipment Required: 

Safety Standards/Restrictions pertaining to Project Scope: 

<table>
<thead>
<tr>
<th>Project Planner:</th>
<th>Print name, rate and company/det</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Officer:</td>
<td>Approved/Disapproved</td>
</tr>
<tr>
<td></td>
<td>Signature</td>
</tr>
<tr>
<td>Reason for disapproval:</td>
<td></td>
</tr>
</tbody>
</table>

---

**Figure 4-41 – Project safety plan cover sheet.**
Safety Office personnel will perform a daily job site safety inspection using a form such as the one shown in Figure 4-42.

**DAILY SAFETY INSPECTOR'S REPORT**

**INSTRUCTIONS**

Form must be returned within 3 working days with the “Action Taken” section filled out correcting the hazards/deficiencies. Company Commanders will initial “Route To” prior to returning to S3C.

<table>
<thead>
<tr>
<th>Route to:</th>
<th>Initials:</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO Cdr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date: Time:</th>
<th>Project Number:</th>
<th>Project Title:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prime Contractor:</th>
<th>Subcontractor:</th>
<th>Weather:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Supervisor:</th>
<th>Project Safety Supervisor:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rates:</th>
<th>Description of Work:</th>
</tr>
</thead>
<tbody>
<tr>
<td>BU</td>
<td>EO</td>
</tr>
<tr>
<td>CE</td>
<td>SW</td>
</tr>
<tr>
<td>CM</td>
<td>UT</td>
</tr>
<tr>
<td>EA</td>
<td>Other</td>
</tr>
</tbody>
</table>

**Safety Inspection Plan Items:**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>A</th>
<th>YES</th>
<th>16</th>
<th>Ladders/Scaffolding: Safe cond/use?</th>
<th>N/A</th>
<th>YE</th>
<th>S</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>Safety Talk given? Subj:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>GFCI protection on project and used?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>Req’d PPE in use?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td>Hazmat/Hazflam inventory current?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>Material Safety Data Sheets available?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>Flammable liquids stored properly?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td>Eyewash/shower maintained IAW SOP?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>Lockout/tagout required and used?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td>Electrical boxes secured and labeled?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>Temporary power inspected and tagged?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td>Are construction signs in place?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td>Excavation: Permits/shoring approved?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td>Crewleader using safety plan?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td>Review daily safety report for trends?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td>Welding: Cutting and permits required?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SAFETY HAZARD/DEFICIENCY**

**ACTION TAKEN TO CORRECT HAZARD/DEFICIENCY**

<table>
<thead>
<tr>
<th>Project Supervisor</th>
<th>Project Safety Supervisor</th>
<th>Battalion Safety Inspector</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DISTRIBUTION:**

WHITE: ROUTING CHAIN  YELLOW: TEMPORARY FILE  PINK: PROJECT

**Figure 4-42 – Daily Safety Inspector’s report.**
8.0.0 OPERATIONAL RISK MANAGEMENT (ORM)

ORM is a decision making tool used by people at all levels to increase operational effectiveness by anticipating hazards and reducing the potential for loss. This increases the probability of a successful mission.

The five step ORM process is a standardized tool that will help you operate successfully in high risk environments. As military personnel, we have a responsibility at every level to identify hazards, take measures to reduce the associated risk, and accept risk only when the benefits of the operation exceed the accepted risk.

The goal is to make ORM part of our daily operations. This simple, logical process will help save lives, protect people, and preserve assets while we accomplish our missions efficiently and effectively.

8.1.0 Five Step Process

The five step process has a mnemonic, or memory acronym, to help you remember the steps; I AM IS

1. Identify Hazards
2. Assess Hazards
3. Make Risk Decisions
4. Implement Controls
5. Supervise

8.2.0 ORM in BAMCIS

One way to look at the five steps of ORM is that they are performed within, not instead of, BAMCIS (Begin the planning, Arrange for reconnaissance, Make reconnaissance, Complete the planning, Issue the order, Supervise), as shown in Table 4-6. Any time a new hazard is identified it triggers the remaining ORM steps.

Table 4-6 – ORM in BAMCIS.

<table>
<thead>
<tr>
<th>BAMCIS ORM</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Begin Planning ORM</td>
<td>Identify Hazards</td>
</tr>
<tr>
<td>Arrange Recon</td>
<td>Assess the Hazards</td>
</tr>
<tr>
<td>Make Recon</td>
<td>Make Risk Decisions</td>
</tr>
<tr>
<td>Complete the Plan</td>
<td>Implement Controls</td>
</tr>
<tr>
<td>Issue the Order</td>
<td>Supervise</td>
</tr>
</tbody>
</table>

Here is a breakdown of the five steps of ORM.

Step 1 Identify Hazards

- Conduct an Operational Analysis
  - List major steps of the operation
- Conduct a Preliminary Hazard Analysis
o List the hazards associated with each step

o List the possible causes of the hazards

Step 2 Assess Hazards

- Determine the degree of risk for each hazard in terms of severity and probability.
  - Use of a matrix is recommended but not required. A matrix provides a consistent framework for evaluation and shows the relative perceived risk between hazards and prioritizes which hazards to control first.
  - Any Matrix that supports the specific application may be used; an example is shown in Table 4-7.

### Table 4-7 – Risk matrix.

<table>
<thead>
<tr>
<th>Hazard Severity</th>
<th>RAC Matrix</th>
<th>Likely</th>
<th>Probably</th>
<th>May</th>
<th>Unlikely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Serious</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Minor</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Risk Assessment Code (RAC)

The risk matrix in Table 4-7 includes five classifications, as shown below.

1. Critical
2. Serious
3. Moderate
4. Minor
5. Negligible

Hazard Severity

The hazard severity shown in Table 4-7 has four levels, which are defined below.

- Critical – May cause death, loss of facility/asset, or grave damage to national interests.
- Serious – May cause severe injury, illness, property damage; or damage to national or service interests.
- Moderate – May cause minor injury, illness, property damage; or damage to national, service, or command interests.
- Minor – Minimal threat.

Mishap Probability

The mishap probability shown in Table 4-7 has four levels, which are defined below.

- Likely – Likely to occur immediately or in a short period of time. Expected to occur several times to an individual item or person, or continuously to a group.
- Probably – Probably will occur in time. Reasonably expected to occur some time to an individual item or person, or continuously to a group.
• May – May occur in time. Reasonably expected to occur some time to an individual item or person, or several times to a group.

• Unlikely – Unlikely to occur.

Step 3 Make Risk Decisions

• Develop controls for each hazard to eliminate the hazard or reduce the risk until the Benefit is greater than the Risk.

  o Develop controls for the most serious hazards first! You may not have time to control every hazard – so control the worst hazards first. Conduct a Preliminary Hazard Analysis

• Develop residual risk.

  o Assess each hazard’s risk again (step 2 repeated) with the controls in place to determine residual risk.

• Make Risk Decision – With the controls in place is the Benefit greater than the Risk?

  o Accept the risk if the Benefit > Risk.
  o Communicate with higher authority if

    • Risk is greater than the Benefit
    • Risk exceeds the Commander’s stated intent
    • Help is needed to implement controls

Step 4 Implement Controls

• Incorporate selected controls into:

  o SOPs

• Orders, Briefs, Training, and Rehearsals

• Communicate selected controls to the lowest level. Who will do what by when?

• Implementation goes wrong for the following reasons:

  o Wrong control for the problem
  o Operators dislike it
  o Leaders dislike it
  o It’s too costly
  o It’s overmatched by other priorities
  o It’s misunderstood
  o Nobody measures until it’s too late
Step 5 Supervise

- Enforce standards and controls.
  - Ensure crewmembers are performing tasks to standard.
  - Ensure controls are in place and having the desired effect.
- Remain alert for changes and unexpected developments that require Time Critical or Deliberate ORM.
- Take corrective action when necessary.

9.0.0 QUALITY CONTROL

The purpose of the NCF Quality Control Program COMSECONDNCB/COMTHIRDNCBTINST 4355.1 is to prevent discrepancies where the quality of workmanship and materials fail to match the requirements in the plans and specifications. The responsibility for quality construction rests with the crewleader and the chain of command. The Quality Control Division is responsible for conducting tests and inspections to ensure compliance with the plans and specifications. The Quality Control (QC) inspectors and crewleaders provide Contractor Quality Control (CQC). The battalion has the responsibility to control construction and inspect the work. Control is an ongoing and continual system of planning future activities. Inspection is the process by which ongoing and completed work is examined. Inspection is “after-the-fact” while control is “preventive”. The objectives of control are to insure that the crewleader is adequately prepared to begin a phase of work, to eliminate deficiencies, and to follow through in accomplishing the work in accordance with plans and specifications. The objective of inspection is to ensure that the work has been accomplished in accordance with plans and specifications. The crewleader will plan quality into the project and avoid discrepancies before the QC inspectors perform their inspections. Discrepancies identified by the QC inspector represent failures in the crewleader’s QC plan.

9.1.0 Three Phases of the Quality Control Program

QC is accomplished in three phases. The primary responsibility for these phases rests with the crewleader. The crewleader is the on-site quality control “manager” and as such “controls” the quality. The QC inspector, as the name implies, “inspects” the quality. The three phases, preparatory phase, initial phase, and follow up phase, are described below.

9.1.1 Preparatory Phase

Prior to starting the project and before the start of each construction activity, the crewleader will hold a QC preparatory phase meeting. The purpose of this meeting is to inform all personnel involved with the activity what the QC requirements are. The meeting will also address all items needed to accomplish the activity such as correct material on hand, correct tools, correct equipment, etc. The QC inspectors should attend these meetings if possible. Use NAVFAC P- 445, Construction Quality Management Program, for guidance in implementing the three-phase quality control program. Forms used for documentation are available at this website: http://navfacilitator.navfac.navy.mil/docs/default.cfm?type=1. A sample is shown in Figure 4-43. This form is two pages in length.
## PREPARATORY PHASE CHECKLIST

<table>
<thead>
<tr>
<th>Spec Section</th>
<th>Date (DD/MMM/YY)</th>
<th>Contract No</th>
<th>Definable Feature of Work</th>
<th>Schedule Act No</th>
<th>Index #</th>
</tr>
</thead>
</table>

### PERSONNEL PRESENT

<table>
<thead>
<tr>
<th>Government Rep</th>
<th>Notified Hours in Advance</th>
<th>Yes</th>
<th>No</th>
<th>Company/Government</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name Position</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### SUBMITTALS

<table>
<thead>
<tr>
<th>Review submittals and/or submittal register. Have all submittals been approved?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>If No, what items have not been submitted?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Are all materials on hand?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>If No, what items are missing?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Check approved submittals against delivered material. (This should be done as material arrives.)

Comments: 

### MATERIAL STORAGE

<table>
<thead>
<tr>
<th>Are materials stored properly?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>If No, what action is taken?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### SPECIFICATIONS

<table>
<thead>
<tr>
<th>Review each paragraph of specifications.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Discuss procedure for accomplishing the work.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clarify any differences.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

### PRELIMINARY WORK & PERMITS

<table>
<thead>
<tr>
<th>Ensure preliminary work is correct and permits are on file.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>If not, what action is taken?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**First page**
<table>
<thead>
<tr>
<th><strong>TESTING</strong></th>
<th><strong>SAFETY</strong></th>
<th><strong>MEETING COMMENTS</strong></th>
<th><strong>OTHER ITEMS OR REMARKS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify test to be performed, frequency, and by whom.</td>
<td>Activity hazard analysis approved?</td>
<td>Navy/ROICC comments during meeting.</td>
<td>Other items or remarks:</td>
</tr>
<tr>
<td>When required?</td>
<td>Yes ☐ No ☐</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Where required?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Review testing plan.</td>
<td>Review applicable portion of EM 385-1-1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have test facilities been approved?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Second page**

Figure 4-43 – Form for a Preparatory Phase Checklist.
### 9.1.2 Initial Phase

As soon as construction has started on an activity, the QC inspector and crewleader will inspect the work. The purpose of this inspection is to ensure that the work is being done correctly before too much time has elapsed. Any discrepancies can be corrected before we have a large rework problem. *Figure 4-44* is a sample of an Initial Phase Checklist.

<table>
<thead>
<tr>
<th>INITIAL PHASE CHECKLIST</th>
<th>Spec Section</th>
<th>Date (DD/MMM/YY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract No</td>
<td>Definable Feature of Work</td>
<td>Schedule Act No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Index #</td>
</tr>
<tr>
<td></td>
<td>Government Rep Notified</td>
<td>Hours in Advance</td>
</tr>
<tr>
<td></td>
<td>Name Position</td>
<td>Yes</td>
</tr>
</tbody>
</table>

#### PERSONNEL PRESENT

Identify full compliance with procedures identified at preparatory. Coordinate plans, specifications, and submittals.

**Comments:**

#### PROCEDURE COMPLIANCE

Ensure preliminary work is complete and correct. If not, what action is taken?

#### PRELIMINARY WORK

Establish level of workmanship. Where is work located?

Is sample panel required? Yes | No

Will the initial work be considered as a sample? Yes | No

(If Yes, maintain in present condition as long as possible and describe location of sample.)

#### WORKMANSHIP

Resolve any differences. Comments:

#### RESOLUTION

Review job conditions using EM 385-1-1 and Job Hazard Analysis.

Comments:

#### CHECK SAFETY

Other items or remarks:

<table>
<thead>
<tr>
<th>OC</th>
<th>Manager</th>
<th>Date</th>
</tr>
</thead>
</table>

*Figure 4-44 – Form for an Initial Phase Checklist.*

### 9.1.3 Follow up Phase

The crewleader will conduct continual inspection of the activities in progress. The QC inspectors will conduct spot checks during this phase. This will ensure that all work is
done in accordance with plans and specifications. A sample of a Contractor Quality Control Checklist is shown in Figure 4-45.

![Image of Contractor Quality Control Report]

**CONTRACTOR QUALITY CONTROL REPORT**

(Attach additional sheets if necessary)

<table>
<thead>
<tr>
<th>Phase</th>
<th>Contract No</th>
<th>Contract Title (Title and Location of Construction Contract)</th>
<th>Date (DD/MMM/YY)</th>
<th>Report No</th>
</tr>
</thead>
</table>

**PREPARATORY**

<table>
<thead>
<tr>
<th>Activity No</th>
<th>Definable Feature of Work</th>
<th>Index #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Was preparatory phase work performed today?

If Yes, fill out and attach supplemental preparatory phase checklist.

Yes ☐ No ☐

**INITIAL**

<table>
<thead>
<tr>
<th>Activity No</th>
<th>Definable Feature of Work</th>
<th>Index #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

Was initial phase work performed today?

If Yes, fill out and attach supplemental initial phase checklist.

Yes ☐ No ☐

**FOLLOW-UP**

<table>
<thead>
<tr>
<th>Activity No</th>
<th>Description of Work, Testing Performed &amp; By Whom, Definable Feature of Work, Specification Section, Location and List of Personnel Present</th>
<th>Index #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

Work complies with contract as approved during initial phase?

Yes ☐ No ☐

Work complies with safety requirements?

Yes ☐ No ☐

Rework items identified today (not corrected by close of business) | Rework items corrected today (from rework items list)

<table>
<thead>
<tr>
<th>Activity No</th>
<th>Description</th>
<th>Activity No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

Remarks (Also explain any follow-up phase checklist from above that was answered No), Manuf. Rep on-site, etc.

<table>
<thead>
<tr>
<th>Activity No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

On behalf of this contractor, I certify that this report is complete and correct and equipment and material used and work performed during this reporting period is in compliance with the contract drawings and specifications to the best of my knowledge except as noted in this report.

Authorized OC Manager at Site Date

**GOVERNMENT QUALITY ASSURANCE REPORT**

Date

Quality Assurance Representative’s Remarks and/or Exceptions to the Report

<table>
<thead>
<tr>
<th>Activity No</th>
<th>Description</th>
</tr>
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<tbody>
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</table>

Authorized OC Manager at Site Date

**Figure 4-45 – Form for a Contractor Quality Control Checklist.**

**9.2.0 Quality Control Organization**

The Quality Control Inspector is responsible for ensuring quality control during the preparatory, initial, and follow-up phases of the project. If the QC Inspector lacks
expertise in an area of the project that needs to be inspected, he or she can bring in a consultant who is more expert in that field. Figure 4-46 below shows this.

Figure 4-46 – Quality Control organization chart.

9.3.0 Change Requests and Project Specifications Questions

The QC staff provides direct liaison between the battalion and the ROICC on all matters, such as change requests and project specification questions. No field changes can be made without forwarding a request through QC and approval in writing by the ROICC. Change requests must include the same level of detail as the original specification. The Engineering Division can provide assistance on sketches.

9.3.1 Field Adjustment Request

There will be times when adjustments to projects need to be made from the field. The battalion recommends such changes to the Resident Officer-in-Charge of Construction (ROICC) using a Field Adjustment Request (FAR), as represented in Figure 4-47.
### FIELD ADJUSTMENT REQUEST (FAR)

<table>
<thead>
<tr>
<th>FAR Number:</th>
<th>Page _____ of _____</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Number:</td>
<td>Project Title:</td>
</tr>
<tr>
<td>Submitted By:</td>
<td>Date:</td>
</tr>
</tbody>
</table>

Description of and reason for request: (Include drawing and sheet numbers and attach drawings as necessary for description.)

<table>
<thead>
<tr>
<th>Route to:</th>
<th>Approved: (Initial)</th>
<th>Disapproved: (Initial)</th>
<th>Date:</th>
<th>Estimated Additional Cost:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime Co.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>QC</td>
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<tr>
<td>Eng.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3</td>
<td></td>
<td></td>
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<tr>
<td>ROICC</td>
<td></td>
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</tbody>
</table>

ROICC Signature: ______________________________________ (Initial)

As Built: ________ Date:______

Notes: 1. Route original and 3 copies to ROICC.
2. ROICC return original and 2 copies.

### Figure 4-47 – Form for a Field Adjustment Request (FAR).

A log of all FARs in the format shown in Figure 4-48 must be kept in the project package.

### FIELD ADJUSTMENT REQUEST (FAR) SUBMITTAL LOG

<table>
<thead>
<tr>
<th>FAR #</th>
<th>Description</th>
<th>Spec. Section</th>
<th>Drawing Number</th>
<th>Date to Ops</th>
<th>Date Returned</th>
<th>Approved/ Disapproved</th>
</tr>
</thead>
<tbody>
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### Figure 4-48 – Form for a Field Adjustment Request (FAR) Submittal Log.
9.3.2 Request for Information (RFI)

Clarification of prints or specifications may be directed to ROICC on a Request for Information (RFI) form, represented in Figure 4-49.

---

**REQUEST FOR INFORMATION (RFI)**

- **RFI Number:**
- **Page _____ of _____**
- **Route to Initial: Date:**
- **Prime Co.:**
- **Project Number:**
- **Project Title:**
- **QC Eng.:**
- **Submitted By:**
- **Date:**
- **S3 ROICC**

**Description of and reason for request:** (Include drawing and sheet numbers and attach drawings as necessary for description.)

**Signature/printed name of requestor**

**Date**

**Clarification from ROICC:**

**Signature/printed name of approving official**

**Date**

---

**Figure 4-49 – Form for a Request for Information.**

A log of all RFIs in the format shown in Figure 4-50 must be kept in the project package.

---

**REQUEST FOR INFORMATION (RFI) SUBMITTAL LOG**

<table>
<thead>
<tr>
<th>RFI #</th>
<th>Description</th>
<th>Spec. Section</th>
<th>Drawing Number</th>
<th>Date to Ops</th>
<th>Date Returned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

**Figure 4-50 – Form for a Request for Information (RFI) Submittal Log.**
9.3.3 Design Change Directive (DCD)

Any ROICC directed changes are forwarded to the battalion on a Design Change Directive (DCD). Scope changes require the approval of the customers’ major claimant. Changes that require 50 or more mandays of additional direct labor, or increase the cost of the project by $500 or more require approval of higher headquarters. All DCDs must be kept in the project package.

Summary

Planning, Estimating, and scheduling are key components of any well executed Seabee project.

Planning is the process of determining requirements, and devising and developing methods and action for constructing a project. Many elements must be considered in any well-planned project; including the activity, material, equipment, and manpower estimates; project layout, project location, material delivery and storage, work schedules, quality control, special tools required, environmental protection, safety, and progress control.

Estimating is the process of determining the amount and type of work to be performed and the quantities of material, equipment, and labor required.

Scheduling is the process of determining when an action must be taken and when material, equipment, and manpower are required. Schedules fall into four basic types: progress, material, equipment, and manpower.

Seabee construction projects are managed at three levels. Level I is used at the Operations Officer’s or detail OIC’s level. Level II is used at the Company level. Level III is used at the Crewleader’s level.

The proper administration of any project, large or small, is as important as the actual construction. You now have information to help you use and prepare the administrative paperwork that you encounter as a crewleader.

Safety responsibility falls with the crewleader; it is up to you to conduct a successful and aggressive safety program. Resources, including equipment, material, education, and training, are available through the Safety Office.

Operational Risk Management (ORM) is used to anticipate hazards and reduce the potential for loss, increasing the probability of a successful mission. As military personnel, we have a responsibility at every level to identify hazards, take measures to reduce the associated risk, and accept risk only when the benefits of the operation exceed the accepted risk.

The Quality Control Program is meant to prevent discrepancies where the quality of workmanship and materials fail to match the requirements in the plans and specifications. The responsibility for quality construction rests with the crewleader and the chain of command.
Review Questions (Select the Correct Response)

1. The process of determining requirements, and devising and developing methods for constructing a project is called
   A. Estimating
   B. Scheduling
   C. Planning
   D. Production standardization

2. The process of determining the amount and type of work to be performed and the quantities of material, equipment, and labor required is called
   A. Estimating
   B. Scheduling
   C. Planning
   D. Production standardization

3. The individual who evaluates a job, has a working knowledge of all phases of construction, and can mentally picture separate operations of the project as it progresses is called
   A. Scheduler
   B. Estimator
   C. Planner
   D. Builder

4. The process of determining when an action must be taken and when material, equipment, and manpower are required is called
   A. Estimating
   B. Planning
   C. Scheduling
   D. Coordination

5. What type of schedule is used to coordinate the manpower requirements of a project and show the number of personnel required for each activity?
   A. Progress
   B. Equipment
   C. Material
   D. Manpower

6. When using blueprints, what section should you check to ensure changes were recorded?
   A. Revisions
   B. Notes
   C. Specifications
   D. Construction drawings
7. On specifications, a list of unusual or unfamiliar items of work or materials is called

A. Revisions
B. Quantity estimates
C. Notes
D. Statistics

8. Which of the following procedures is the best way to check your estimates?

A. Have another person check the measurements
B. Have another person make an independent estimate and compare the two
C. Have another person initial the estimates as you complete them
D. Have a crewmember sign the estimate

9. Which of the following problems can lead to omissions in your quantity estimates?

A. Failure to read all notes on drawings
B. Errors in scaling
C. Failure to allow for waste and loss of construction material
D. All of the above

10. What should an experienced estimator do if he finds that details on a drawing are not drawn to scale?

A. Approximate to dimensions
B. Use the same scale that was used elsewhere on the drawings
C. Assume an approximate scale
D. Obtain the dimensions from another source

11. What type of estimate is used as a basis for purchasing materials, and determining equipment and manpower requirements?

A. Activity
B. Equipment
C. Quantity
D. Material

12. Which of the following activities provides information of material, equipment, and manpower requirements?

A. Planning activities
B. Scheduling activities
C. Construction activities
D. Specifications and drawings
13. For estimating purposes, how should an activity be defined?
   A. Single-task, single-trade
   B. Single-task, multi-trade
   C. Multi-task, multi-trade
   D. Multi-task, single-trade

14. Material estimates have which of the following uses?
   A. Procurement and determination of availability of materials
   B. Justification for and procurement of material
   C. Scheduling of equipment for projects
   D. Planning manpower needs

15. When estimating, which of the following forms should be used to list the required materials needed to complete each individual activity?
   A. Bill of material
   B. Material takeoff
   C. Estimating worksheet
   D. Material estimate

16. Which of the following NAVFAC publications contains conversion and waste factors for construction materials?
   A. P-405, App C
   B. P-437, Vol I
   C. P-458, Vol II
   D. DM-4.3

17. The average rate of speed for a vehicle moving materials over roadways is computed by using what percentage of the posted speed limit?
   A. 10% to 15%
   B. 20% to 30%
   C. 40% to 56%
   D. 60% to 76%

18. Which type of estimate consists of a listing of the number of direct labor man-days required to complete the various activities of a specific project?
   A. Activity
   B. Construction
   C. Manpower
   D. Equipment
19. Which type of labor includes all labor expended directly on assigned construction tasks, either in the field or in the shop that contributes directly to the completion of the end product?

A. Direct  
B. Indirect  
C. Manual  
D. Overhead

20. The man-hour estimating tables in NAVFAC P-405 are arranged into how many divisions of work?

A. 11  
B. 13  
C. 15  
D. 17

21. **(True or False)** The work schedule of a deployed Seabee battalion is based on an average of 65 hours per man per week.

A. True  
B. False

22. CPA, CPM, and PERT are techniques used in the analysis of events and activities of a construction project. What is the generic title covering these techniques?

A. Network analysis  
B. Planning and estimating  
C. Flow charting  
D. Project analysis

23. Placing underslab conduit runs before pouring concrete is considered what type of dependency?

A. Soft  
B. Continuing  
C. Flexible  
D. Hard

24. In precedence diagrams, how are activities represented?

A. An octagon box  
B. A rectangular box  
C. A start and finish node  
D. A round node
25. In a precedence diagram, what information about an activity can be found on the right side of an activity box?

A. The completion  
B. The start  
C. The man-hours  
D. The critical event  

26. In a precedence diagram, activities may be divided into how many distinct groups?

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

27. In a precedence diagram, intermediate goals with no time duration relate to what kind of activities?

A. Working  
B. Milestone  
C. Critical  
D. Support  

28. How are critical activities in a precedence diagram identified?

A. By arrows  
B. By slash marks through the activity box  
C. By a red circle around the activity  
D. By slash marks through the activity connector  

29. Which of the following rules governs the drawing of a network?

A. Activities must be numbered in sequence  
B. The start of an activity must be linked to the ends of all completed activities before the start may take place  
C. Activities taking place at the same time must be linked before the start may take place  
D. Only critical path activities may be linked to each other  

30. When two network activities are remote from each other but must be connected to show dependency, what type of connector should be used?

A. Direct  
B. Joining  
C. Splitting  
D. Parallel
31. In a network, what is the main objective of the forward pass?
   A. To determine the number of activities
   B. To allow for material delays
   C. To establish the late start and late finish of each activity
   D. To determine the duration of the network

32. What term identifies the amount of scheduled leeway allowed in a network?
   A. Free play
   B. Allowance of time
   C. Float or slack
   D. Dead time or null time

33. When you become a Builder petty officer, you automatically assume which of the following additional responsibilities?
   A. Company clerk
   B. Project manager
   C. Project estimator
   D. Crew leader

34. (True or False) When planning a project, you must consider both the tools and equipment you will need and the capability of the crew.
   A. True
   B. False

35. To ensure a job is completed on schedule, you should take which of the following actions?
   A. Order extra equipment
   B. Conduct disaster control training
   C. Demand quality work
   D. Encourage teamwork and establish goals

36. A standard Builder tool kit contains the hand tools required for what maximum size crew?
   A. Five persons
   B. Two persons
   C. Six persons
   D. Four persons

37. (True or False) As a crew leader, you are NOT authorized to draw the tools required by the individual crewmembers.
   A. True
   B. False
38. What form should a crew leader use to order materials?

A. DD 1148  
B. DD 1250  
C. NAVSUP 1149  
D. NAVSUP 1250

39. Information on the National Stock Number system is found in which of the following RTMs?

A. *Tools and Their Uses* 
B. *Military Requirements for Petty Officer 3 & 2* 
C. *Blueprint Reading and Sketching* 
D. *Constructionman TRAMAN*

40. Labor that includes actual mandays expended to support construction operations but which does not produce an end product in itself is what type?

A. Direct  
B. Indirect  
C. Overhead  
D. Military

41. **(True or False)** As a petty officer, you must be familiar with the safety program at your activity.

A. True  
B. False

42. The safety policy committee is presided over by what person?

A. The safety officer  
B. The company chief  
C. The administrative officer  
D. The executive officer

43. What is the primary purpose of the safety policy committee?

A. Develop safety rules and policy for the battalion  
B. Discipline personnel who are involved in accidents  
C. Elect a battalion safety chief and committee  
D. Review all vehicle accident reports and determine the causes of accidents

44. What is the primary purpose of the safety supervisors' committee?

A. Establish work procedures  
B. Encourage safe practices  
C. Review safety suggestions  
D. All of the above
45. Which of the following committees reviews vehicle mishaps?
   A. The safety supervisors’ committee
   B. The safety policy committee
   C. The responsible crew
   D. The equipment committee

46. (True or False) As a crew leader, you are NOT responsible for the safe working practices of individual crewmembers.
   A. True
   B. False

47. When an unsafe working condition exists, which of the following individuals can stop the work until the unsafe condition is corrected?
   A. The crewmember
   B. The crew leader
   C. The project safety supervisor
   D. Any of the above

48. Who among the following individuals is responsible for conducting stand-up safety lectures?
   A. The safety chief
   B. The safety officer
   C. The crew leader
   D. The company commander

49. Of the following, which is the best safety technique a crew leader can apply?
   A. Stand-up meetings
   B. Reprimanding violators in view of their peers
   C. Designating a crewmember as the safety representative
   D. Leadership by example

50. (True or False) The first step in Operational Risk Management (ORM) is to identify hazards.
   A. True
   B. False

51. Which of the following is part of the Assess Hazards step of ORM?
   A. Risk Assessment Code
   B. Hazard Severity
   C. Mishap Probability
   D. All of the above
52. Which of the following is part of the Supervise step of ORM?
   A. Develop residual risk
   B. Incorporate selected controls into SOPs
   C. Enforce standards and controls
   D. All of the above

53. Which of the following is a phase of Quality Control?
   A. Preparatory phase
   B. Initial phase
   C. Follow up phase
   D. All of the above

54. Who is responsible for ensuring quality control during the phases of a project?
   A. Crew Leader
   B. Quality Control Inspector
   C. Executive Officer
   D. Company Chief

55. Which form is used when the battalion recommends changes from the field to the Resident Officer-in-Charge of Construction (ROICC)?
   A. Field Adjustment Request
   B. Request for Information
   C. Design Change Directive
   D. RFI Submittal Log
## Trade Terms Introduced in this Course

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td><strong>Activity</strong></td>
<td>In Critical Path Method (CPM) scheduling, a task or item of work required to complete a project.</td>
</tr>
<tr>
<td><strong>Critical path</strong></td>
<td>A term used to describe the order of events (each of a particular duration) that results in the least amount of time required to complete a project.</td>
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<tr>
<td><strong>Delay</strong></td>
<td>An event or condition that results in work activity starting, or the project being completed, later than originally planned.</td>
</tr>
<tr>
<td><strong>Early finish (EF)</strong></td>
<td>In Critical Path Method (CPM) scheduling, the first day of a project on which no work is to be done for an activity, assuming work began on its early start time.</td>
</tr>
<tr>
<td><strong>Early start (ES)</strong></td>
<td>In Critical Path Method (CPM) scheduling, the first day of a project on which work on an activity can begin if all preceding activities are concluded as early as possible.</td>
</tr>
<tr>
<td><strong>Estimating</strong></td>
<td>The process of determining the anticipated cost of materials, labor, and equipment of a proposed project.</td>
</tr>
<tr>
<td><strong>Estimator</strong></td>
<td>One who is capable of predicting the probable cost of a building project.</td>
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<tr>
<td><strong>Free float</strong></td>
<td>A term used in project management, planning, and scheduling methods such as PERT and CPM. The free float of an activity is the amount by which the completion of that activity can be deferred without delaying the start of the following activities or affecting any other activity in the network.</td>
</tr>
<tr>
<td><strong>Late finish</strong></td>
<td>In the Critical Path Method of scheduling, a completion deadline for a particular activity. Work performed after this date will result in project delay.</td>
</tr>
<tr>
<td><strong>Late start</strong></td>
<td>In the Critical Path Method of scheduling, the deadline for starting a particular activity. A late start will throw off the schedule and delay the project.</td>
</tr>
<tr>
<td><strong>Material Safety Data Sheets</strong></td>
<td>A form containing data regarding the properties of a particular substance which is intended to give workers and emergency personnel procedures for handling or working with that substance in a safe manner.</td>
</tr>
<tr>
<td><strong>Planning</strong></td>
<td>The process of developing a scheme of a building or group of buildings by studying the layout of spaces within each building, and of building and other installations in an open space.</td>
</tr>
<tr>
<td><strong>Preliminary estimates</strong></td>
<td>Rough estimates made in an early stage of the design work, prior to receipt of firm bids.</td>
</tr>
<tr>
<td><strong>Specifications</strong></td>
<td>Detailed and exact statements of particulars, especially a statement prescribing materials, dimensions, and workmanship for something to be built or installed.</td>
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<tr>
<td><strong>Table of allowance</strong></td>
<td>An equipment allowance document which prescribes basic allowances of organizational equipment.</td>
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<tr>
<td><strong>Total float</strong></td>
<td>In Critical Path Method terminology, the difference between the time available to accomplish an activity and the estimated time required.</td>
</tr>
</tbody>
</table>
Additional Resources and References

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


CSFE Nonresident Training Course – User Update

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