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PROFESSIONAL CONSTRUCTION MANAGEMENT  
FOR THE  
UNITED STATES NAVAL CONSTRUCTION FORCE



BY  
JAMES JOSEPH CUMMINGS

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A REPORT PRESENTED TO THE GRADUATE COMMITTEE OF THE  
DEPARTMENT OF CIVIL ENGINEERING IN PARTIAL FULFILLMENT OF  
THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ENGINEERING

UNIVERSITY OF FLORIDA

SUMMER 1994

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# CHAPTER I

## INTRODUCTION

### 1.1 Purpose

This paper addresses professional construction management as applied to the Naval Construction Force, primarily Construction Battalions (The Seabees). Currently the Navy uses modern construction planning and execution techniques. Civil Engineer Corps Officers are assigned as construction project managers, however they typically have little or no training in construction management. This paper is designed to serve as an aid in construction management to Civil Engineer Corps Officers assigned to Naval Construction Battalions.

### 1.2 Background

The Naval Construction Force (NCF) was established during World War II to provide engineering and construction support of U. S. combat forces. Today the NCF has multiple missions. The war time support mission and peace time construction are the two primary roles. This paper addresses primarily the peace time construction mission. In peace time the NCF constructs facilities to support U. S. forces throughout the world. In this role the NCF maintains construction skills that may be

required during war time. The types of construction projects undertaken by the Seabees are similar to those constructed by private contractors. Projects range from simple to complex and involve both horizontal and vertical construction.

### 1.3 Organization

Naval Mobile Construction Battalions (NMCB) are organized into administrative departments and companies, see Appendix A. The "line" companies consist of Alfa, Bravo, Charlie, Delta, and Echo companies, and are tasked with the actual construction of projects. The Company Commanders are assigned as the project manager for their company's projects. Alfa company provides horizontal construction, Bravo Company utility support (e.g. electrical, plumbing), and Charlie Company is assigned vertical construction. Delta and Echo Companies are usually task organized to deploy as independent details away from the mainbody of the battalion.

#### 1.3.1 Company Commander

The Company Commander becomes the "prime" constructor for projects the Operations Officer has assigned. In this role the Company Commander acts as the project manager for the company's projects and is responsible for the project from initial planning to final acceptance by the customer or turnover to the next battalion.

Therefore, the Company Commander is responsible to properly manage the labor, materials, tools, and equipment required to construct the project.

### 1.3.2 Company Chief

The Company Chief is a senior enlisted man with years of construction experience who acts as an assistant Company Commander. The chief assists the Company Commander in construction, personnel administration, and supervises the platoon commanders.

### 1.3.3 Projects Chiefs

The projects chiefs are the platoon commanders and act as the project superintendent for the platoon's projects. The project chiefs are responsible to the Company Commander for the timely and efficient construction of all projects.

### 1.3.4 Project Supervisor

The project supervisor sometimes referred to as the crew leader, manages personnel, material, and equipment while supervising project construction. The project supervisor leads the planning and estimating effort and ensures safe and professional construction meeting the requirements of the plans and specifications.

#### 1.4 Operation

Construction battalions are on a fourteen month work cycle consisting of a homeport period of seven months followed by a seven month deployment. While in homeport the battalion undergoes training to prepare for the upcoming deployment. In addition to training, the battalion uses the homeport period to plan the assigned construction projects. At the end of the homeport period the battalion will deploy to a forward area and relieve another battalion that is completing its deployment. Once relieved the on site battalion will return to its homeport for training and planning. Higher headquarters, usually a brigade or regiment will assign construction projects to the battalions. Once assigned, the Battalion Operations Officer (S-3) will delegate authority to the Company Commanders to plan and construct the projects.

The battalions use a prime and sub "contractor" relationship for project execution. The S-3 assigns a project to the prime company which is composed of individuals skilled to construct the majority of the project, (e.g., horizontal projects are assigned to Alfa Company because they possess the equipment operators required to perform the majority of the work).

In the above example the Alfa Company Commander is assigned as the project manager and is responsible to the S-3 for professional planning and execution of the project. Alfa Company in turn may request the S-3 assign Bravo Company as a sub to

project. Alfa Company in turn may request the S-3 assign Bravo Company as a sub to work on any electrical, plumbing, or HVAC related work, or Charlie Company to provide support for any vertical construction required for the project. However, the prime company, in this case Alfa, is still responsible to coordinate all phases of the job, including subs.

The S-3 will act as an arbitrator if there are conflicts between primes and subs. In this type of organization the Company Commanders are given much of the same authority as a commercial contractor might assign his project managers. In addition, the Company Commanders are responsible to the operations officer in the same manner a civilian project manager would be responsible to the home office.

Higher headquarters will task the battalion based on their capability to perform work. Because of this, it is imperative the Operations Officer know the battalion's capability. This becomes even more important during war time. Military engineer units such as the Navy's Seabees, Army Combat Engineers, and Marine Corps Engineering Support Battalions must be able to provide the best support possible to accomplish the mission. Construction support requirements can change very rapidly during wartime. The Operations Officer must be able to inform higher headquarters not only of his ability to perform work already assigned but additional tasking as well. In order to accomplish this, the Company Commanders serving as project managers must be thoroughly knowledgeable in professional construction management.

A recent example of the importance of construction units to maximize their productivity was Operation Desert Storm. Engineer units from all services were tasked with providing construction support of allied forces. Of particular importance was the horizontal tasking assigned to improve existing roads and construct additional roads. These roads were designated as the main supply routes (MSR's) and were used for logistical support of combat units. The famous "End Around" maneuver executed by allied forces in the liberation of Kuwait depended in part on the engineering units timely construction and improvements to the MSR

## CHAPTER II

### PROJECT PLANNING

#### 2.1 Strategic Planning

To paraphrase Lou Holtz, the head football coach of Notre Dame, if you prepare there is no pressure, there is only pressure when you fail to prepare. The same is true for construction. The importance of planning is often overlooked during a busy homeport period. It is easy to fall into the trap of thinking that once on deployment the project will come together on its own.

Scheduling of manpower, material, and equipment is not an easy task and must be done in advance. Careful planning is required for professional construction management and it is the responsibility of the Company Commander to ensure the projects are accurately planned. There will be enough unexpected problems surfacing on deployment that you don't need to set your project up to fail by poor planning. The basic steps to strategic planning and how they apply to the Seabees are as follows [1]:

1. **Develop a mission** - The mission of the Seabees is to provide construction support to U. S. forces. The mission of the line company is to provide the actual hands on construction of facilities.

**2. Establish Goals** - In order to provide efficient and professional construction each crew must set challenging intermediate goals which lead to project completion.

The goals should directly correspond to the project schedule.

**3. Strategy** - Development of the plan that will allow you to reach your objective. This is your project schedule which is part of the battalion's Deployment Execution Plan.

**4. Implementation of the plan** - Actual construction.

**5. Evaluate and adjust the plan as needed** - During construction the Company Commander must continually evaluate construction progress and make changes as needed.

## 2.2 Project Tasking

As mentioned early, the brigade will assign project tasking to construction battalions. The tasking will identify the projects along with the expected status of projects when the battalion deploys to the site. The brigade will also assign the amount of work in place (WIP) the battalion must complete by deployment completion (i.e., the goal of each project) when the project is turned over to the relieving battalion. The Brigade will forward the initial tasking message while the battalion is approaching the end of its current deployment, about two months prior to returning to homeport. The battalion will receive additional information required to

plan the projects after it returns to homeport. Once in homeport the Company Commanders will begin planning the construction projects.

Company Commanders must optimize their resources to enable the battalion to provide the maximum amount of construction support possible. The amount of construction that can be expected of a company is easily calculated. This manday capability is calculated as follows:

$$MC = DL \times WD \times ME \times AF$$

MC = Total capability of direct labor personnel assigned

DL = Number of direct labor personnel assigned

WD = Number of available workdays in the deployment

ME = Manday equivalent (1.25 converts a 9 hour workday to an 8 hour manday)

AF = Availability Factor (This factor is used to account for time lost to illness, leave, or other duties and has historically been around .75 for the mainbody and .8 for detail sites)

The S-3 will calculate the battalion's capability based on the number of direct labor personnel in each company. The battalion will report its capability to the brigade who will use the capability information to assign construction projects. The brigade must have accurate data on battalion capabilities in order to know how much work it can take on. At the risk of sounding melodramatic, this has significant importance in war time.

### 2.3 Estimating

Project estimating is one of the most critical phases of construction planning. An accurate estimate is essential to successful project planning. In the homeport planning and training cycle, the Company Commander is saddled with numerous duties and responsibilities in addition to project planning. Because of this the actual estimating will be delegated to the project supervisor, however, the Company Commander is still responsible.

The Company Commander will assign a project supervisor and construction crews for each project assigned to the company. Once the project crews are determined, the project supervisor will organize and lead a planning and estimating team. This P & E team must also include personnel from the companies who will act as subs on the project. The P&E team must ensure all required resources to complete construction are identified.

The P & E team will begin planning by reviewing the plans and specifications and will list required resources on the Construction Activity Summary Sheet (CASS) [2]. The CASS, see Appendix B, ties the resources to the schedule and provides the project supervisor a tool for monitoring resources. The material estimate, referred to as the material take off (MTO), will list materials and their quantities required for

construction. This is the first step of the detailed estimate. In developing the estimate the project supervisor will follow the planning steps shown in Appendix C [3].

#### 2.4 Activity Listing

The project supervisor will break the project down into functional parts known as master activities. The master activities are usually eight to ten general activities such as site work, under slab utilities, or roofing. The master activities will be further broken down into at least five construction activities. The construction activities identify specific tasks to be completed. An example of this break down is shown in Table 2-1.

<b>Master Activity</b>	<b>Construction Activity</b>
1000 Site Work	1010 Clear and Grub
1000 Site Work	1020 Sub-grade Fill and Compact
1000 Site Work	1030 Building Layout
1000 Site Work	1040 Excavate Footers and Utilities
2000 Under slab Utilities	2010 Excavate Septic Tank & Leach Field
2000 Under slab Utilities	2020 Install Septic Tank & leach Field
2000 Under slab Utilities	2030 Backfill Septic Tank & Leach Field

**Table 2-1 Example of Master and Construction Activities.**  
Source: U.S. Navy, Seabee Construction Management I, Student Guide

## 2.5 Activity Duration Estimates

Once the material take off has been completed to determine quantities, the activity durations may be estimated. The duration estimates are based on published estimating guides and experience. The primary guide used in construction battalions is the Seabee Planner's and Estimator's Handbook, NAVFAC P-405. The P-405 provides estimating data for numerous construction tasks along with other valuable information to aid in planning. The P-405 follows the Construction Specifications Institute (CSI) Masterformat for divisions of work. In addition to the standard estimating data the P-405 provides other factors that may effect construction such as weather, crew experience, site location, and material waste.

## 2.6 Scheduling

### 2.6.1 Critical Path Method

Once the project is broken into construction activities and durations have been determined for these activities, the project supervisor can begin to schedule the project. The project supervisor will organize the activities into a logical sequence or logic network. The Seabees use the Critical Path Method (CPM) for scheduling and as a graphical display of activity dependencies. After the CPM is calculated, Gantt charts or bar charts are used to present the schedule in an easily understood format.

### 2.6.2 Bar Charts

The bar chart provides an easy to read display of the schedule, however, it does not show dependency relationships between activities. The Seabees use three bar charts each showing a different level of detail. The Level III is a very detailed bar chart displaying all of the construction activities for each day of construction, see Appendix D. The project supervisor will use the level III schedule on site to monitor construction progress. The Level II schedule is less detailed, only breaking the project down by master activities on a monthly time scale, see Appendix E. The Company Commander and others use this schedule to track construction progress off site. The Level I is used as master schedule of all projects for the battalion's mainbody, separate Level I's are generated for each of the detail sites, see Appendix F. The S-3 uses the Level I schedules to track all of the battalion's projects. A smart Company Commander will also use a Level I schedule to track the company's projects.

### 2.6.3 Software Applications

There are several software applications available to assist in scheduling. Currently the Seabees use Micro Trak software which will calculate the CPM and generate bar charts. The level III schedule in Appendix D is an example of Micro Trak output. There are more sophisticated software applications such as Primavera,

however, Micro Trak is easier to use, less expensive, and most importantly it fits needs of the Seabees.

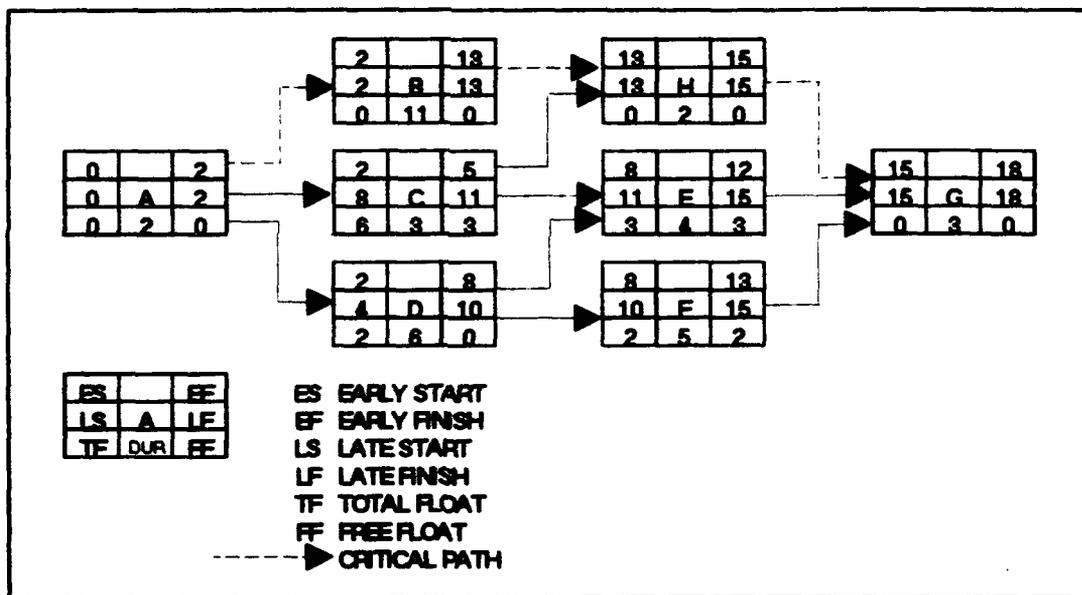
#### 2.6.4 Activity Float

Once the CPM is calculated the amount of total and free float will be known. It is important to recognize what float is and how it can be used or misused. Float can be used to absorb delays caused by weather, material, or re-work. However, care must be taken to track the amount of float used. Once all of an activity's float is consumed the activity becomes critical. In addition, the type of float used will determine if other activities will be impacted. There are three types of float: total float, free float, and interfering float [4].

The total float is the amount of time an activity can be delayed with out delaying project completion. To calculate total float simply subtract the sum of the activity's early start and duration from its late finish. It is important to note that several activities may share the same total float. Using up total float on one activity may also reduce total the float of another activity. This is important as a noncritical activity may become critical due to a delay in an activity it shares float with.

Free float is the amount of time an activity may be delayed without effecting other activities. The amount of free float of an activity is calculated by subtracting the

the activity's late finish from the early start of the activity with the lowest early start directly following it on the logic path. From figure 2-1, the free float for activity C was calculated by subtracting the early start of activity E (day 8) from the late finish of activity C (day 11). Activities E, F, and H directly follow C on the logic path, however, activity E's early start was chosen because it is the soonest early start of the three activities. As can be seen in Figure 2-1, activity F also has an early start on day 8 and could have been used to calculate the free float for activity C. Interfering float is the difference between the total float and free float of an activity.



**Figure 2-1. CPM displaying total and free float.**  
 Source: Dr. Z. Herbsman, Construction Planning and Scheduling, University of Florida

All too often the crew leader does not understand the differences in float types and believes noncritical activities may be delayed without affecting other activities.

If this happens multiply critical paths may develop and the crew leader may unknowingly delay a critical activity and thus delay project completion.

#### 2.6.5 Line of Balance Scheduling Technique

Line of Balance Scheduling or Linear Project Scheduling is currently not used by the Seabees. However, I believe it could be very useful in scheduling horizontal construction projects and therefore should be implemented. The line of balance schedule is a combination of CPM and bar chart. It shows both the activity dependencies and the time scale. See Appendix G for an example of line of balance scheduling. As can be seen from Appendix G, the Y-axis is a distance measure and the X-axis is the time scale.

The advantage to using this type of scheduling for horizontal projects is that it is easier to monitor construction progress. The rate of construction for each activity is estimated in distance per time unit (e.g., .5 miles/day or 2.5 miles/week). The Y-axis, distance, is divided into sections (e.g., 1 section = 1 mile). Within a section, an activity must be completed before the next activity may begin. Horizontal lines show delays, intentional or otherwise and vertical lines show skipped sections.

### 2.6.6 Resource Leveling

The goal of resource leveling is to maximize the labor and equipment resources of the battalion. It is unlikely any project will require the same number of personnel or same type and quantity of equipment on site throughout construction. By leveling resources you can more efficiently use what you have. In some cases you will be able to lower the project duration without increasing crew size or maintain the original schedule with a smaller crew. The crew leader will level the available resources as part of the planning effort.

This will be done by shifting the start and finish dates of noncritical activities. To level resources, noncritical activities may be started between their early and late start dates and completed between their early and late finish dates. Durations may be extended or shortened as required to level crew size or equipment requirements. Some noncritical activities may be completed with a smaller crew but at a longer duration. The increase in activity duration should not exceed the available float.

As mentioned earlier, the crew leader must take care not to inadvertently use up total float. The effect of delaying an activity on the rest of the project must be considered. Equipment use should also be leveled to avoid excessive transport of equipment to and from job sites. Resource leveling can be very complicated and

require a great amount of time to do correctly. The amount of effort placed on resource leveling should not exceed the benefit to be gained [4].

## CHAPTER III

### PROJECT EXECUTION

#### 3.1 Starting Point

By the time the battalion arrives at the deployment site each project should already be planned and scheduled to be constructed during the seven month deployment. After turnover with the outgoing battalion the starting point or the amount of work in place for each project will be established. The Operations Officer will issue the battalion's Deployment Execution Plan containing the level I schedule for the mainbody and detail sites along with the level II schedules from each company. The Level I, and II schedules will have the starting and completion dates for each project. The crew leader should be ready to begin construction at the planned time. A good start will put you ahead of the game. Delays in starting projects, for what ever reason, seem to snowball. The goal for the project manager at the start of a deployment is to hit the ground running.

#### 3.2 Monitoring Tools

The Company Commander has several tools to aid in construction management. The level I and II schedules are excellent tools for tracking progress and the key to

their successful use is simply to use them. Much effort is put into developing the schedules during the homeport period but all too often the schedules end up in a closet and are not used. The crew leader will use the detailed level III schedule to control the project on site. Again the key is to ensure the schedule is being used. If the original schedule proves to be inaccurate then a new schedule must be developed. Construction projects are usually too complex to be effectively managed by the seat of your pants.

In addition to using the level III schedule the project supervisor will develop a two week projection or two week schedule, see Appendix H. This schedule should be based on the level III and list all construction activities to be worked along with the labor by trade, tools, material, and equipment required for the next two weeks. The two week projection is one of the most helpful tools as it forces the project supervisor to look at least two weeks ahead. The Operations Officer will normally require the Company Commander to submit a new two week projection each week. The company projects chief should review the two week projections and assist the project supervisor as needed to avoid conflicts such as double counting personnel (e.g. scheduling the same personal on separate projects at the same time).

### 3.3 Goal Setting

The importance of goal setting can not be over stated. As indicated in Chapter II, goal setting is a key element in strategic planning. Goals should be established for all phases of the project. Daily goals need to be established at the start of each work day, posted on the job site, and all members of the crew briefed on the goals. These goals should directly relate to the level III schedule. The two week projection serves as a listing of goals to be accomplished over the next two weeks. For the goals to serve their purpose they must be challenging and at the very least keep the project on schedule.

While on a deployment I inspected a project which had fallen behind schedule to find out what had gone wrong and what could be done to fix it. The activity causing the delay was block laying. When asked, the project supervisor told me his daily goal for block laying was to place 100 concrete block units (CMU). The masonry crew consisted of four masons with tenders. When questioned on the capability of each mason, the project supervisor stated each man could lay fifty blocks a day. That would have been a crew total of 200 blocks each day.

The project supervisor justified the low daily goal because he wanted to ensure the goal would be met. He was correct, each day the crew met the daily goal, however they did little more despite the fact they had the capability to place twice as

many blocks. They only laid the number of blocks the project supervisor asked for. On further investigation it was learned that block laying was a critical activity and to stay on schedule an average of 200 CMU per day was required (probably the reason four masons were scheduled). For every two days of block laying at 100 block per day, the project fell one day behind schedule.

The requirement for the daily goals to meet the project schedule is common sense but I have seen this problem repeated on several projects. Another problem is when the goals are vague, it's hard to tell whether or not they are reached. Goals need to be specific and well defined to be effective. Every member of the crew should know the daily goal for the project and what they need to do to ensure the goal is met.

#### 3.4 Monitoring Construction

Company Commanders need to closely monitor construction to ensure professional execution of the projects. The Company Commander needs to ensure all members of the organization are performing professionally. The project supervisor should update the project status on the level III schedule prior to the end of each work day. The project supervisor should report the status to the projects chief at the end of each day. If the project supervisor determines the daily goals were not met and the project will be slightly behind schedule at the end of the day, the crew should work

late to met the goal. The goal is to maintain the schedule. A lot of effort went into developing the project schedules therefore they should be followed.

The Company Commander should get an update to the level II schedule from the projects chief at the end of each week. It is ultimately the Company Commanders responsibility to keep the projects on track. If a project starts to fall behind schedule the Company Commander must determine the cause and take the appropriate corrective action. The battalion is required to report to the brigade any project which falls behind the schedule established by the Deployment Execution Plan. The battalion must advise the brigade on the corrective action to bring the project back on schedule and any impact to other projects. Table 3-1 list the allowable percent deviation from the scheduled work in place [5].

TOTAL PROJECT MAN DAY RANGE	ALLOWABLE % DEVIATION ACTUAL Vs. SCHEDULED WIP
0 - 1000 MD	10%
1000 - 2000 MD	5%
2000 MD AND ABOVE	2.5%

**Table 3-1.** Allowable deviation in WIP from the Deployment Execution Plan.

Weather is not normally considered a valid reason for project delays. The actual weather would have to have had more of an impact than expected. For example, if you are planning a project in Roosevelt Roads, Puerto Rico to be constructed during the month of July, the P-405 estimating handbook lists an average of twenty-one days of rain. The project schedule should reflect the impact, if any, on the project. If you expect to be excavating or forming for a concrete foundation slab you should expect delays due to the weather. However, if your schedule calls for interior work during July, the weather should not be a factor. For the weather to be an acceptable cause for delay it would have to rain in excess of the estimated amount. The Company Commander needs to keep this in mind as weather is a sometimes used as an excuse for delays.

Other possible problems that might cause delays include material problems, unforeseen site conditions, design changes, overestimating crew skill, and changes to the project design. The project supervisor should do as much as possible to avoid these problems but keep in mind some things are out of his control.

Getting ahead of schedule, though not a problem still requires action of the project manager. The Company Commander needs to work with the project chief and project supervisor to determine why the project is ahead of schedule. The crew could be more productive than planned or the weather may not have been as much a factor as expected. For whatever reason if the project gets too far ahead of schedule, in

excess of two weeks, the schedule should be revised to reflect a shorter project duration. This is necessary to keep the crew challenged and may also allow the battalion to take on more work.

### 3.5 Updating the Schedule

#### 3.5.1 Level III Update

As mentioned above, project schedules need to be updated to reflect the actual amount of construction completed to date. The project supervisor should indicate the actual completion of each activity on the level II and III schedules. A quick and dirty method is to hang a string line at the top of the schedule on the current date. All construction activities to the left of the string line should be completed. It is best to post the updated schedules where the entire crew will be able to view them.

The crew needs to be kept informed of project status. It helps them work if they can relate what they are doing to the schedule, giving them a view of the big picture. In addition, it allows them to see their personal role in the company's construction mission. The crew members are your best asset, you can't build anything without them therefore you should treat them as part of the team. Posting an updated schedule where the crew will see it serves as a score board of their performance. Anyone who has ever played team sports will agree that you tend to play harder

when you're behind. The converse is also true, thus the need to revise the schedule if you get too far ahead.

### 3.5.2 Level II Update

The Company Commander needs to stay abreast of construction progress. A very good tool for this is updating the project level II schedules. By keeping track of the work in place of each master activity along with the man day effort actually expended the Company Commander can judge crew performance, see Appendix I. Each week the project chief should submit to the Company Commander an updated level II schedule for each project. The Company Commander should review the updated level II's and compare actual versus planned WIP for each master activity along with planned and actual man day expenditures. Significant differences from the schedule need to be examined to determine the cause.

### 3.6 Situation Reports

Once each month the battalion is required to forward a situation report (SITREP) to the brigade. The situation report is required by the third workday of the month and reports the status of all construction projects assigned to the battalion as of the end of the previous month. Each Company Commander will submit monthly SITREP input to the operations officer. The operations officer will use the company

input to generate the battalion SITREP. If the Company Commander has been monitoring his/her projects as recommended by Section 3.5 above, the company's input will be easy to generate. The project chief will normally draft the SITREP input for the Company Commander's review. Appendix J contains a sample format for SITREP input.

### 3.7 Quality Control

The goal of the quality control program is to provide the customer with a product matching the requirements of the plans and specifications. Quality construction is second in priority only to safety. Production is a lower priority and therefore projects should not sacrifice quality for work in place. The project supervisor will develop a quality control plan as part of the planning effort. Items which require quality control inspection will be listed on the construction activity summary sheets (CASS) for each project.

The operations department will assign quality control (QC) inspectors to ensure the battalion provides professional construction. The QC inspectors will file a daily report of construction which the project supervisor will sign. The QC report will be routed to the Operations Officer via the appropriate Company Commander. Regardless of the quality control inspections the Company Commander is still ultimately responsible for professional construction quality.

In addition to the QC inspectors the local Resident Officer in Charge of Construction (ROICC) will assign construction inspectors to further ensure construction complies with the plans and specifications. The ROICC inspectors will treat the battalion the same as they would a civilian construction contractor.

### 3.8 Schedule Compression

For private contractors, schedule compression involves expediting critical activities in order to shorten the overall project duration. Additional resources such as labor and equipment are usually needed to shorten an activity's duration. The professional project manager will determine the cost associated to compress each critical activity. The cost is usually based on the effort to reduce duration by one day. The benefits of compression are incentives to be received by the contractor for completing the project in a shorter duration or avoiding disincentives (e.g., liquidated damages) by bringing the project back on schedule.

The project manager will optimize the cost of compressing activities with the expected benefits. By definition, compressing a critical activity will shorten its duration. In doing so a new critical path may be formed as the compressed activity becomes noncritical. Once the compressed activity is noncritical there is no advantage to compress it further, it will not decrease the overall project time. Software such as QSB+ , is available to assist in compression calculations. Once the cost per day to

compress each critical activity is determined, QSB+ will select the best activity to compress to optimize benefits and minimize cost.

The above procedure will assist a contractor or civilian project manager in compressing a schedule but it doesn't help a Seabee. Even though there will not be a monetary incentive to compress the schedule for military construction projects, compression is sometimes required because of operational commitments or to get a project back on schedule. Labor costs are not a factor for Seabee projects, therefore the Company Commander will need to be creative in determining the best critical activities to compress. The available resources need to be considered to find ways to compress activities. Personnel may be borrowed from noncritical activities or even from other projects. If this is done you will need to keep track of the impact, (i.e. don't put another project behind schedule unless priorities dictate).

### 3.9 Forty-Five Day Review

Approximately forty-five days into a deployment the battalion will have an opportunity to revise its construction goals. This allows the battalion to reflect actual site conditions encountered once on deployment and adjust for impacts such as unexpected turnover projects from the previous battalion, current material status, revised customer priorities, and design changes. Each project manager will revise the project schedules to reflect the actual on site conditions. As the Company Commander

and project manager you need to use this chance to accurately adjust your level II and III schedules. The objective of updating the schedules is to keep the plan realistic and challenging.

Once the project schedules are revised the battalion will forward a revised Deployment Execution Plan to the brigade. The revised plan is considered to be a contractual agreement between the battalion and the brigade. The brigade will use the battalion's revised construction goals to plan future projects and tasking for other battalions.

### 3.10 Project Completion and Turnover

Once a project is completed the ROICC and a customer representative will perform a beneficial occupancy inspection. The facility will be turned over to the customer when all punch list items have been corrected. The date of turnover to the customer is termed the beneficial occupancy date (BOD). A sample BOD inspection checklist is contained in Appendix K.

If the project is not completed by the end of your battalion's deployment it will be turned over to the next battalion. When this occurs the project managers from the respective battalions will inspect the project and agree to a work in place percentage based on the man days of effort remaining to complete the project. The outgoing

project manager needs to identify a clean break point or activity to stop work in order to prepare for turnover and provide the incoming battalion with a clean starting point. As with anything else of this nature you should turn the project over as you would like it turned over to you. If you have professionally managed construction throughout the deployment this will not be a problem and the customer shouldn't notice the change in battalions.

## CHAPTER IV

### MATERIAL MANAGEMENT

#### 4.1 Identifying Material Requirements

The project supervisor will review the plans and specifications to develop the estimate and identify all material required for the project. A material take off will be generated listing all of the material needed for the project. The homeport regiment will prepare a bill of materials (BM) listing the required material from their estimate. The regiment will forward the BM to the battalion along with the plans and specifications. The project supervisor will check the MTO against the BM for accuracy.

Bouncing the MTO against the BM is more than just a check of the estimate, the BM is also a list of materials that have been ordered for the project. If the MTO identifies additional material items or changes in quantities from the BM, you must take the appropriate action.

#### 4.2 Tracking Material Status

The Company Commander is responsible to track the material status for all

assigned projects. To assist in this, the battalion will assign a Material Liaison Officer (MLO). The MLO will receive all construction materials, segregate and store material by project, issue when needed, and coordinate tracking material for the mainbody. The brigade will issue material status reports to provide information on the material required for each project. The reports are titled Project Control Report (PCR) by the Third Naval Construction Brigade and Project Status Report (PSR) by the Second Naval Construction Brigade. The two reports are very similar, the type of report you receive depends on the location of your deployment site.

In addition to listing the required material, the project supervisor will identify any long lead time items. Long lead items need to be tracked during procurement to assist in planning and help prevent project delays. The PCR and PSR are of particular use for tracking long lead time material items.

Once the materials are received by the battalion the project supervisor will coordinate with the MLO to draw the materials for the project. It is up to the project supervisor to manage the material and request it from MLO when needed. The two week projections discussed in Chapter Three are very good tools for material management. Each week as the project supervisor generates the two week projection, he will examine the material requirements for the next two weeks and should also follow up on any outstanding long lead items.

## CHAPTER V

### CONCLUSION

To provide the best possible support to combat units it is important to practice professional construction management in the Naval Construction Force. Many of the construction management techniques used in the private sector apply to military projects. An officer assigned to a Naval Construction Battalion will need to quickly learn the basic concepts of construction management.

Construction projects can be broken down into two general phases, planning and execution. Professional management of these areas is essential for efficient construction. It is not enough to go with the flow, the project manager needs to drive the project. Company Commanders must take ownership of their projects to ensure they are providing the best construction support possible to the customer.

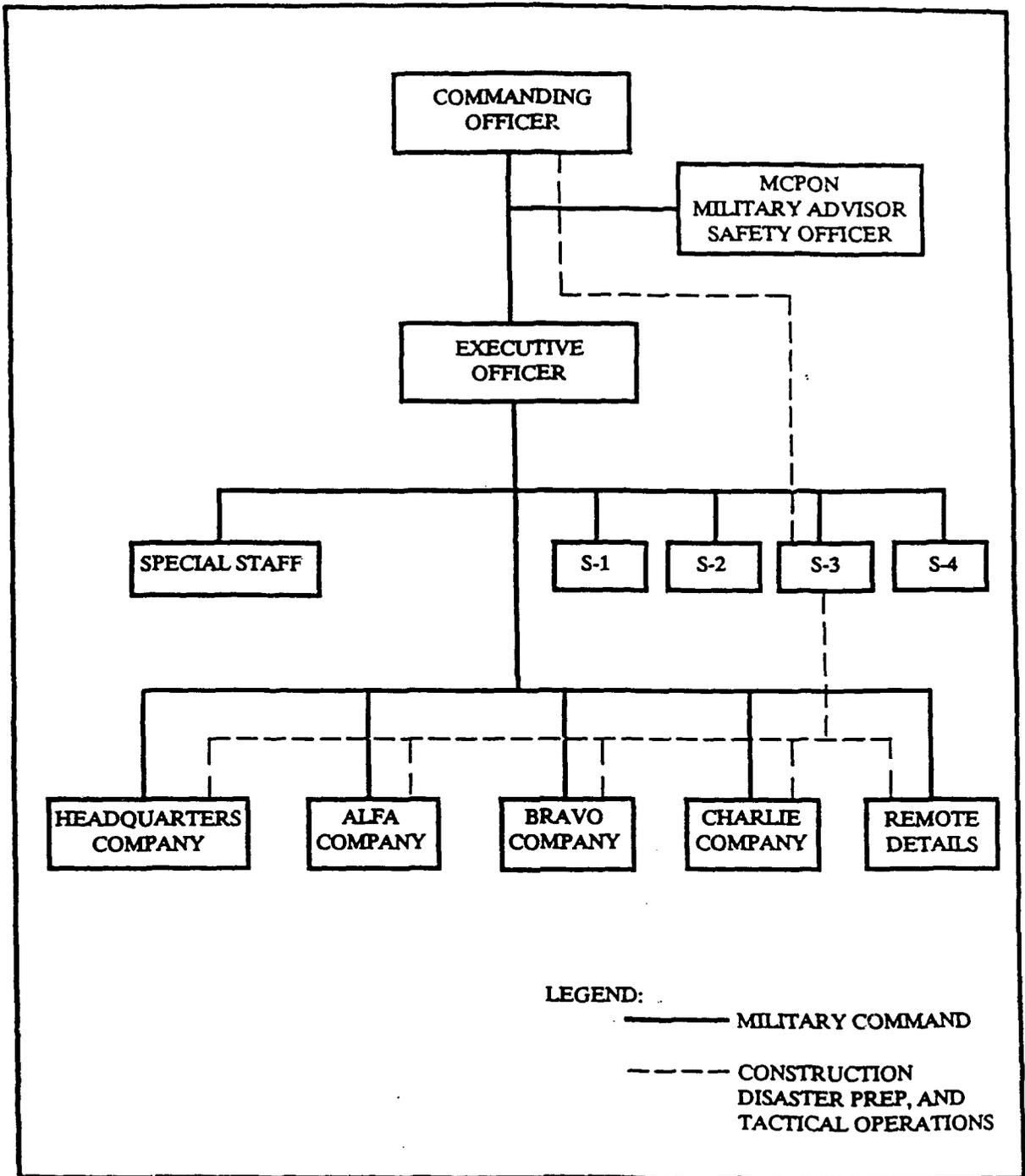
Project planning is the first step taken in any construction project. It must be performed well to avoid problems once construction has started. The Seabees currently use modern scheduling methods and computer applications in planning projects. Once a construction plan has been developed it should be used. Adjust the plan only if you get too far ahead or behind schedule. The goal is to meet you project tasking, (e.g., the work in place the brigade has assigned).

Goal setting is a key ingredient in project management. Challenging goals must be established to keep the crew focused on an objective. The intermediate goals such as those listed on the two week schedules serve as a short range target, a finish line the crew can see. Reaching the intermediate goals will be motivating to the crew. To help the crew stay on track they need to be kept informed of their progress throughout construction.

Breaking the two week goals into daily goals allows the project supervisor a method to monitor project status at all times. The project supervisor should know at the end of each work day if the project is ahead, behind, or on schedule. Losing track even for only a few days may lead to delaying completion. The project manager should know what goals the project supervisor has established and ensure they are challenging and relate to the project schedule.

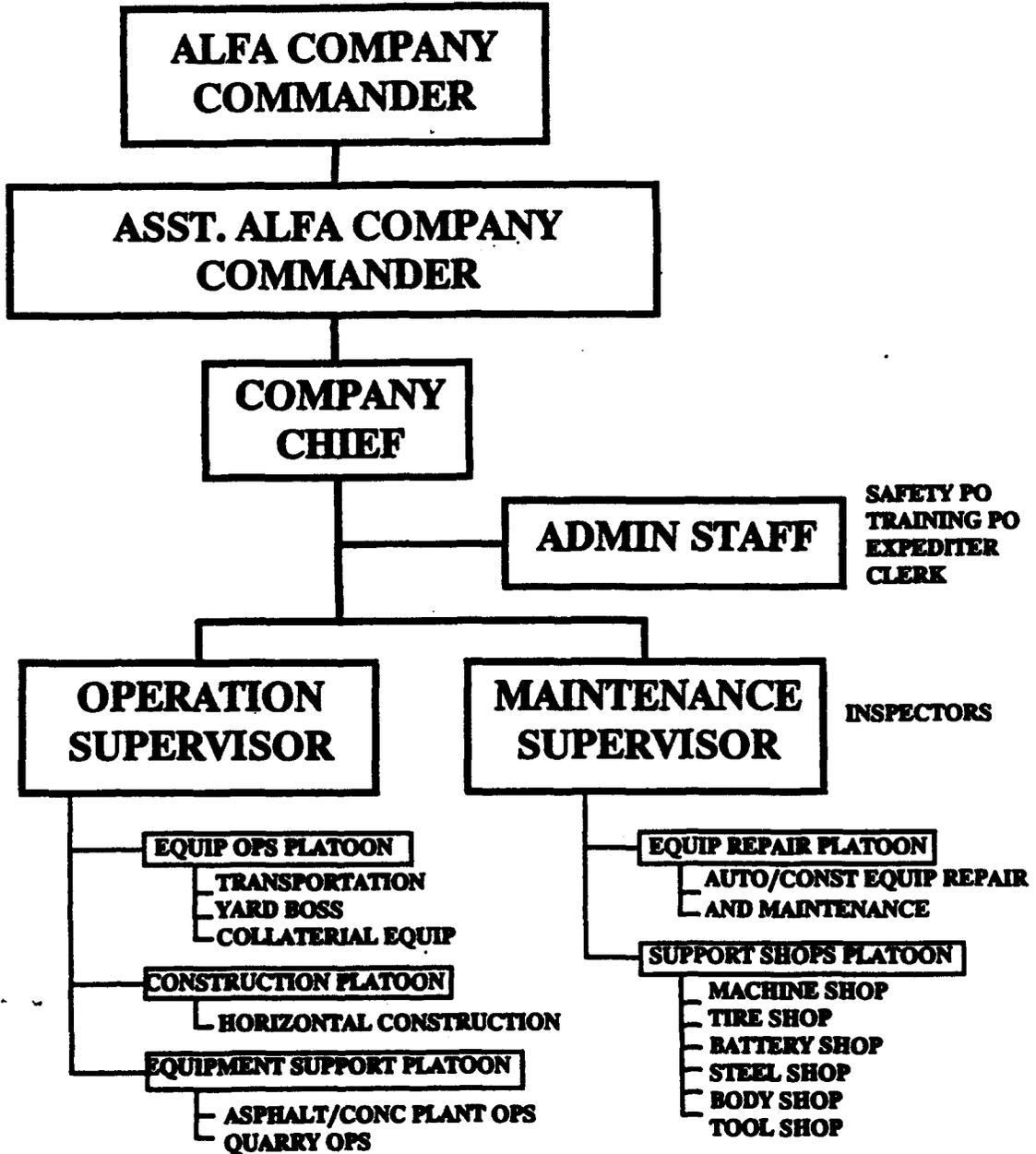
The Seabees are a fantastic group of constructors. What they lack in experience they make up in enthusiasm and hard work. They truly earned the "Can Do!" reputation during World War II. However, like any one else, they must be continually challenged and properly directed to be productive. Professional construction management is essential to allow the Seabees to perform at their potential.

**APPENDIX A**  
**NMCB ORGANIZATION**



Source: U. S. Navy, Operations Officer's Handbook

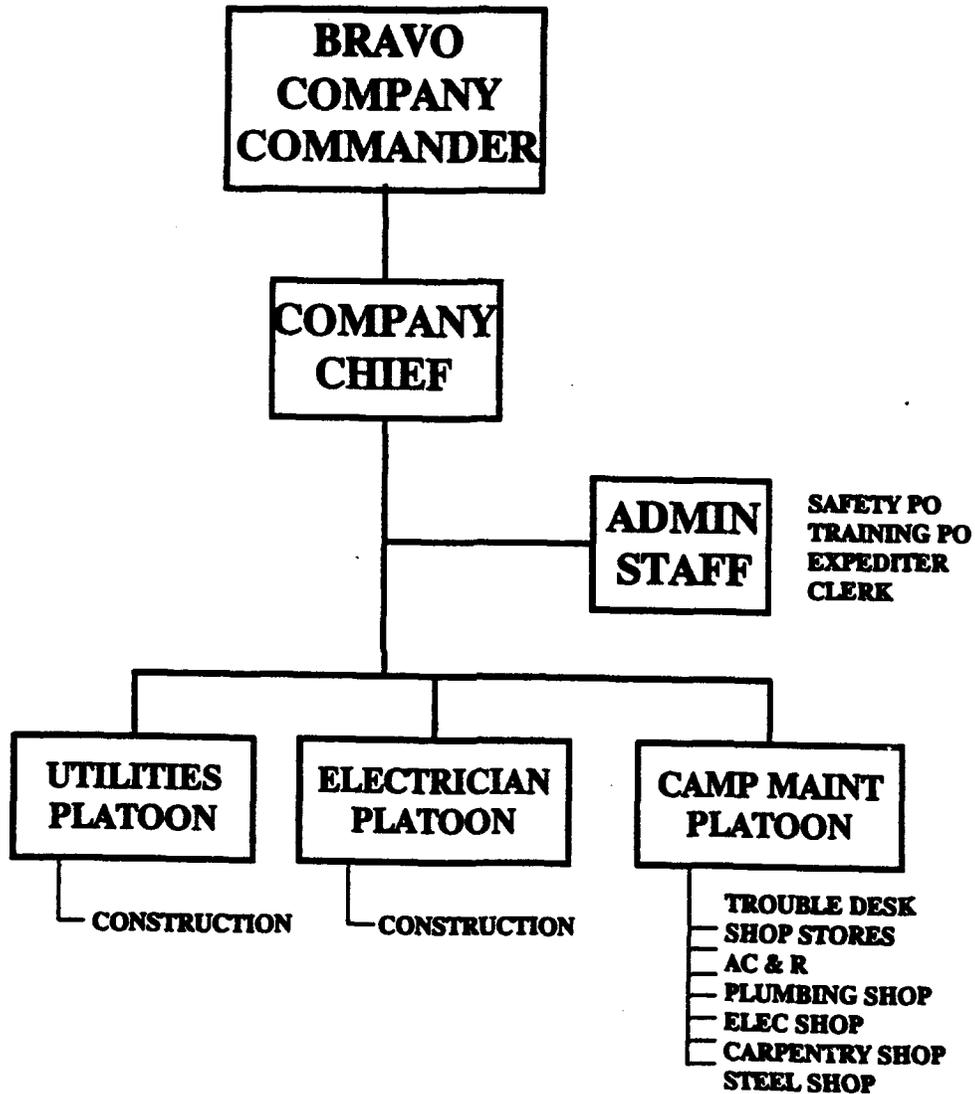
# ALFA COMPANY ORGANIZATION



NOTE: USE ONLY ONE ORGANIZATION FOR BOTH MILITARY AND CONSTRUCTION

Source: U. S. Navy, Operations Officer's Handbook

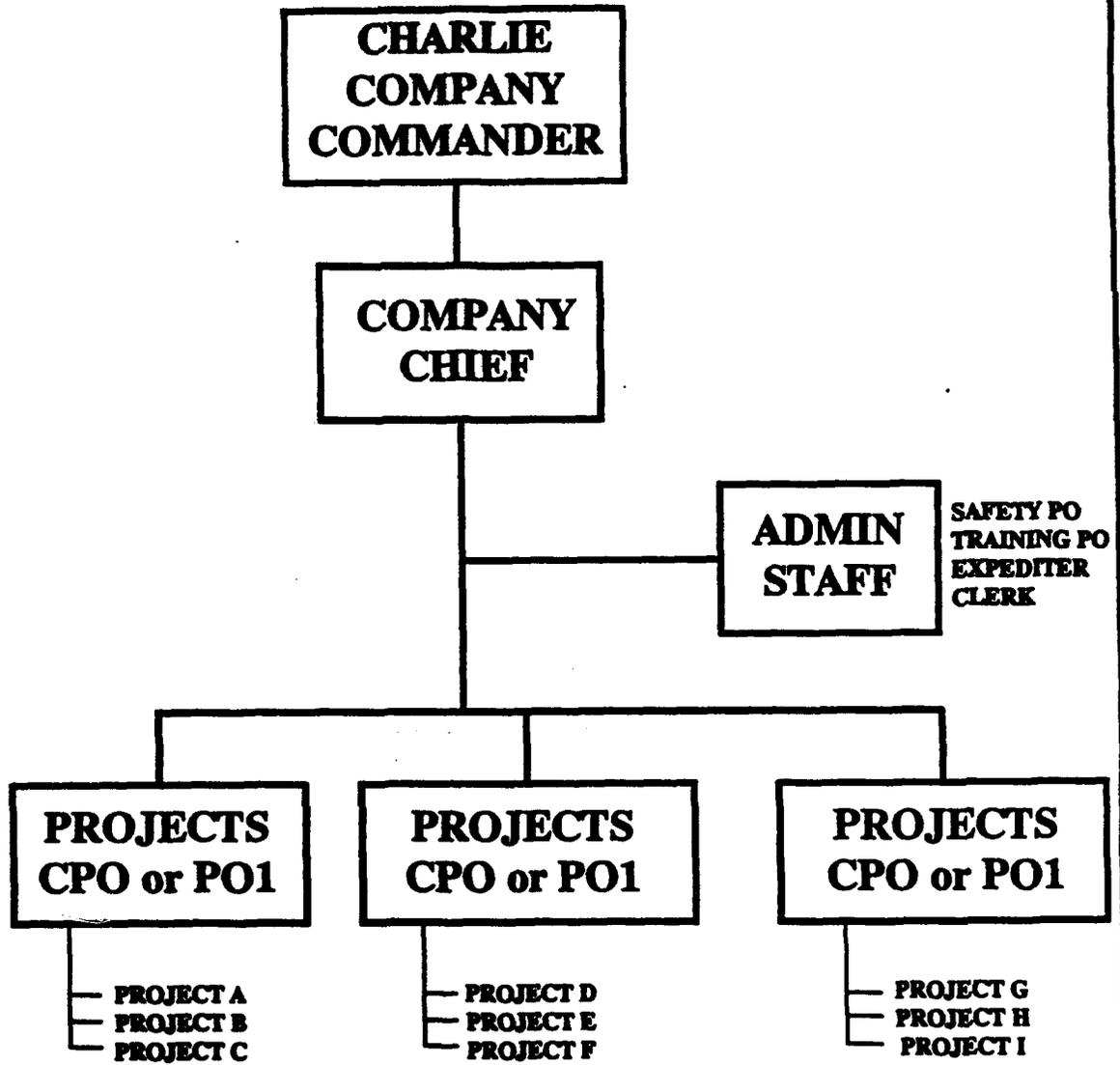
# BRAVO COMPANY ORGANIZATION



NOTE: USE ONLY ONE ORGANIZATION FOR BOTH MILITARY AND CONSTRUCTION

Source: U. S. Navy, Operations Officer's Handbook

# CHARLIE COMPANY ORGANIZATION



NOTE: USE ONLY ONE ORGANIZATION FOR BOTH MILITARY AND CONSTRUCTION

Source: U. S. Navy, Operations Officer's Handbook

**APPENDIX B**

**CONSTRUCTION ACTIVITY SUMMARY SHEET**

# CONSTRUCTION ACTIVITY SUMMARY SHEET

PROJECT TITLE: ADMIN BUILDING  
 B.M. CODE: EL8-930 PREPARED BY: \_\_\_\_\_ CHECKED BY: \_\_\_\_\_  
 START SCHEDULED: 22 MAY FINISH SCHEDULE: 23 MAY  
 ACTUAL: \_\_\_\_\_ ACTUAL: \_\_\_\_\_

ACT. NO. <u>1010</u>			GROUP CODE _____		
ACT. TITLE: <u>CLEAR AND GRUB</u>					
DESCRIPTION OF WORK METHOD: <u>REMOVE ALL VEGETATION AND 6" OF TOPSOIL</u>					
DURATION: ESTIMATED <u>2</u>			MANDAYS: ESTIMATED <u>4</u>		
ACTUAL _____			ACTUAL _____		
Production Efficiency Factor: <u>.65</u>			RESULTING DELAY FACTOR: <u>1.03</u>		
<b>LABOR RESOURCES:</b>					
NO.	DESCRIPTION	QTY.	NO.	DESCRIPTION	QTY.
<u>5500</u>	<u>EO</u>	<u>2</u>			
<b>EQUIPMENT RESOURCES:</b>					
NO.	DESCRIPTION	QTY.	NO.	DESCRIPTION	QTY.
	<u>GRADER</u>	<u>1</u>			
	<u>FRONT END LOADER</u>	<u>1</u>			

<b>MATERIAL RESOURCES:</b>					
NO.	DESCRIPTION	QTY.	NO.	DESCRIPTION	QTY.

ASSUMPTIONS: STOCK PILE TOPSOIL FOR LATER USE

**APPENDIX C**  
**PROJECT PLANNING STEPS [3]**

**I. Preliminary**

1. Obtain and review plans and specifications.
2. Write scope paragraph.
3. Develop master activities.

**Note: Between 10 - 15 activities keyed to major construction phases or like activities with no activity representing more than 10% of the project.**

4. Place master activities into logical construction sequence (logic network).
5. Rough man days per master activity (crew size x activity duration).
6. Select construction methods.
7. Identify long lead time materials.
8. Site visit (if practical).

**II. Detailed**

1. Break master activities into level III (construction) activities.
2. Develop construction activity subnets
3. Identify any training deficiencies.
4. Quantity estimate for detailed activities.
5. Complete Construction Activity Summary Sheet (CASS) for each activity.

6. Compare activity materials listed on MTO with BM.
7. Make/request shop drawings, coordinate with the Operations Department.
8. Revise planning based on site visit.
9. Develop safety and QC plans identifying major items for each activity.
10. Monitor message traffic (on site battalion's SITREP's) and correspondence.
11. Assign activity numbers.
12. Calculate the critical path.
13. Assign dates to schedule using the battalion's deployment calendar.
14. Level resources and reschedule.
15. Identify other information as necessary such as constraints on start finish times (e.g., utility connections, material delivery, etc.).
16. Supply required delivery dates for materials to the regiment.
17. Develop Level II schedule.
18. Develop milestones and load project into Micro-Trak.

**APPENDIX D**  
**LEVEL III SCHEDULE**







**APPENDIX E**  
**LEVEL II SCHEDULE**



APPENDIX F  
LEVEL I SCHEDULE

PROJECT: DETAIL DIEGO GARCIA  
 20-Nov-92

NMCS-133 "KANGEROOS"

NUMBER: SITE: DIEGO GARCIA

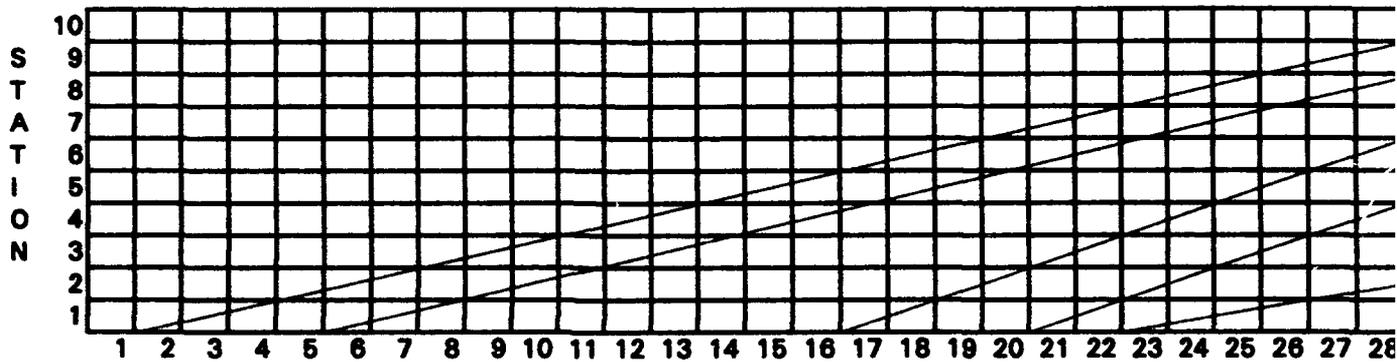
LEVEL I MANAGEMENT CHART

NO.	ACTIVITY	MDS	WT.	T/O	MAY	JUN	JUL	AUG	SEP	OCT	NOV	T/O	%
D68-802	REC SERV FACILITY	1572	39%	114					38	70	70	75	60
				7%					10%	14%	19%	23%	27%
D61-808	CONSTRUCT MMR BLDG	322	8%	0	38	53	66	73	47	45			
				0%	12%	28%	49%	71%	86%	100%			
D66-844	EMER PWR FUEL FARM	875	22%	0	32	70	69	66	26	63	54	53	59
				0%	4%	12%	20%	27%	30%	37%	43%	49%	56%
D69-801	MSC FACILITY	546	14%	302		61	73	61	49				
				55%		66%	80%	91%	100%				
D62-501	OIC DISCRETIONARY	100	3%	0	35	35	30						
				0%	35%	70%	100%						
D62-304	CAMP MAINTENANCE	50	1%	0	25	25							
				0%	50%	100%							
D62-819	WATER TANK PADS	300	8%	123	31				35	40	40	31	
					51%				63%	76%	89%	100%	
D62-XXX	SHMPS	220	6%					30	30	30	36		
								24%	48%	72%	100%		
				0%									
				0%									
				0%									

PLANNED	PERIOD	539	0	129	145	227	215	174	150	93	119	167	169	190	121	118	0
	CUM	539	0	129	274	501	716	890	1040	1133	1252	1419	1588	1778	1899	2017	2017
	%	T/O	0%	3%	7%	13%	18%	22%	26%	28%	31%	36%	40%	45%	48%	51%	51%
MONTHLY TOTALS		539		129	372		389		243		286		359		239		DEC
		T/O		MAY	JUN		JUL		AUG		SEP		OCT		NOV		DEC
RESOURCES		NO.	MDS	NO.	MDS	NO.	MDS	NO.	MDS	NO.	MDS	NO.	MDS	NO.	MDS	NO.	MDS
	BU	4	50	8	167	7	157	5	103	5	110	7	154	6	109		
	SM	2	21	3	70	3	58	2	44	3	63	3	62	2	38		
	UT	1	12	2	33	2	46	1	15	2	42	2	52	2	30		
	CE	2	28	2	51	3	76	2	32	1	20	2	41	2	35		
	ED	1	18	2	51	2	52	2	49	2	51	2	50	1	27		
	CREWSIZE	10		17		17		12		13		16		13			
			129		372		389		243		286		359		239		
TIMEKEEPING	ACTUAL MDS		29	73	70	57	113	94	86	121	171	82	129				
	% WIP		0%	3%	4%	7%	22%	24%	29%	33%	36%	40%	42%	45%	0%	0%	
	TOTAL MDS		0	29	102	172	229	342	436	522	643	814	896	1025	1025	1025	
	% MDS		0%	1%	3%	4%	6%	9%	11%	13%	16%	20%	22%	26%	26%	26%	
	WORK DAYS			15		24		25		23		23		24		21	
	TOTAL WORK DAYS			155													

Source: LT Jackson, OIC, NMCS 133 Detail Diego Garcia

**APPENDIX G**  
**LINE OF BALANCE SCHEDULE**

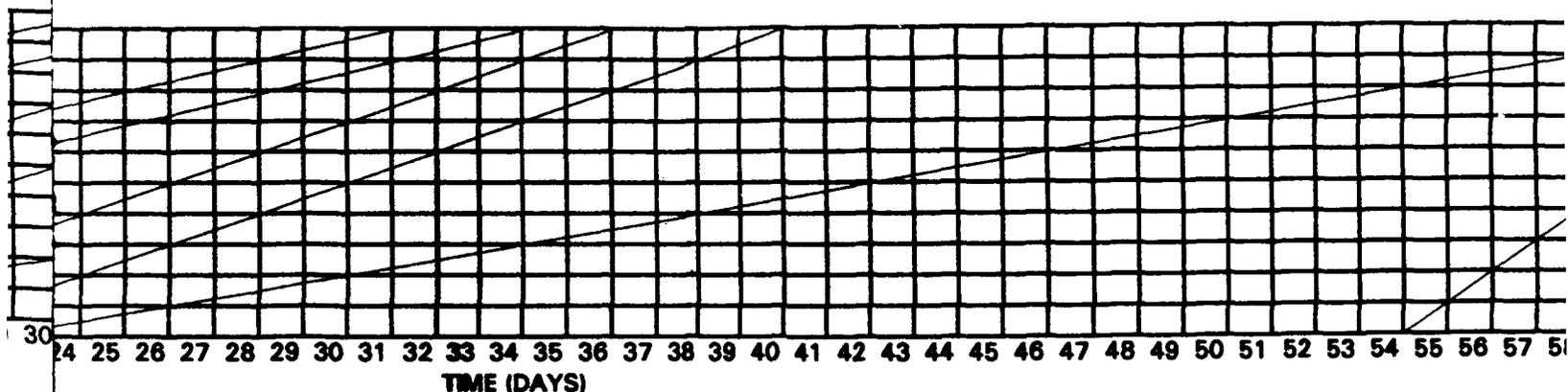


<u>ACTIVITY</u>	<u>K = RATE (DAYS /STATION)</u>	<u>DURATION (DAYS)</u>
MOVE IN	-	2
1 CLEAR&GRUB	3	30
2 CUT&FILL	3	30
3 GRADE	2	20
4 COMPACT	2	20
5 PRIME COAT	4	40
6 PAVE	1	10

STATION = 1 MILE

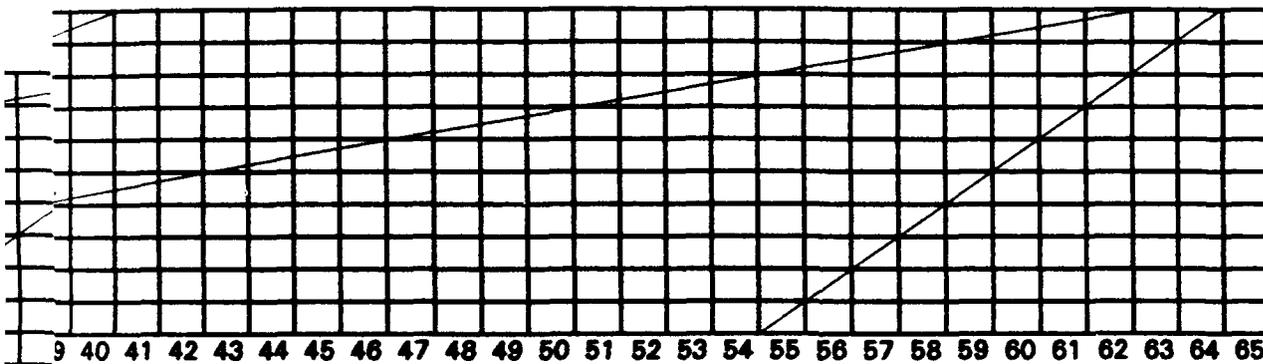
Source: Dr. Z. Herbeman, Construction Planning and Scheduling, University of Florida

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**Total Time**      $T_t = T_o + K_1 + K_2M + T_{w1} - K_3M + T_{w2} + K_4 + K_5 + T_{w3} +$   
 $= 2 + 3 + 3(10) + 2 - 2(10) + 4 + 2 + 4 + 27 + 1(10)$   
 $= 64 \text{ DAYS}$

- T<sub>t</sub> = TOTAL PROJECT TIME**
- T<sub>o</sub> = ORGANIZATION TIME (MOVE IN)**
- M = NUMBER OF SECTIONS**
- T<sub>w1</sub> = DELAY TIME BETWEEN ACTIVITIES 3 AND 4**
- T<sub>w2</sub> = DELAY TIME BETWEEN ACTIVITIES 5 AND 6 CAUSED BY THE SLOW RATE OF CONSTRUCTION OF ACTIVITY 5**



9 6(Time  
M

$$T_t = T_o + K_1 + K_2 M + T_{w1} - K_3 M + T_{w2} + K_4 + K_5 + T_{w3} + K_6 M$$

$$= 2 + 3 + 3(10) + 2 - 2(10) + 4 + 2 + 4 + 27 + 1(10)$$

$$= 64 \text{ DAYS}$$

**T<sub>t</sub> = TOTAL PROJECT TIME**

**T<sub>o</sub> = ORGANIZATION TIME (MOVE IN)**

**M = NUMBER OF SECTIONS**

**T<sub>w1</sub> = DELAY TIME BETWEEN ACTIVITIES 3 AND 4**

**T<sub>w2</sub> = DELAY TIME BETWEEN ACTIVITIES 5 AND 6 CAUSED BY THE SLOW RATE OF CONSTRUCTION OF ACTIVITY 5**

**APPENDIX H**  
**TWO WEEK PROJECTION**

TWO WEEK SCHEDULE

PROJECT NUMBER EL 0-830 PROJECT TITLE ADMIN BLDG WEEK ENDING 26-30 MAY

Construction Activity		Goal	Material, Tools and Equipment Required	Special Requirements	Remarks
Number	Description				
3020	PREFAB FORMS FOUNDATION SLAB	TO COMPLETE ALL PREFAB OF FORMS FOR FOUNDATION/SLAB			
3030	PREFAB 2 <sup>ND</sup> FOUNDATION SLAB	TO COMPLETE ALL PREFAB OF REBAR FOR FOUNDATION/SLAB			
1020	SUBGRADE FILL AND COMPACT	PLACE AND COMPACT SUBGRADE MATERIAL TO SPECS.	FRONT END LOADER DUMP TRUCK ROLLER	1 1/2" SELECT FILL 3/4" STONE	SCHED. FEB 26 MAY
4000	PREFAB LINTELS	PREFAB FORMS FOR ALL LINTELS	SCAFF SCAFF CABLE ASSY-40	7/8" DRILL 1/8" BUTTERFLY BIT	
1030	LAY OUT BUILDING AND BATTER BOARDS	LAYOUT BUILDING LINES AND BATTER BOARDS	SODIO		
1040	EXCAVATE FTRES/ UTILITIES	EXCAVATE ALL AREAS FOR FOOTERS AND UTILITY TO PROPER DIMENSIONS	FRONT END LOADER W/ BACKHOE		SCHED. 30 MAY
4000	PLACE LINTELS	PLACE CONCRETE IN ALL LINTEL FORMS	11.5 MIXER SCOFF SHOVELS WATERHOSE	ONE FOR CONCRETE 30 MAY	MIXER SCHED. 30 MAY

**APPENDIX I**  
**UPDATED LEVEL II SCHEDULE**

PROJECT: EMERG POWER FUEL FARM

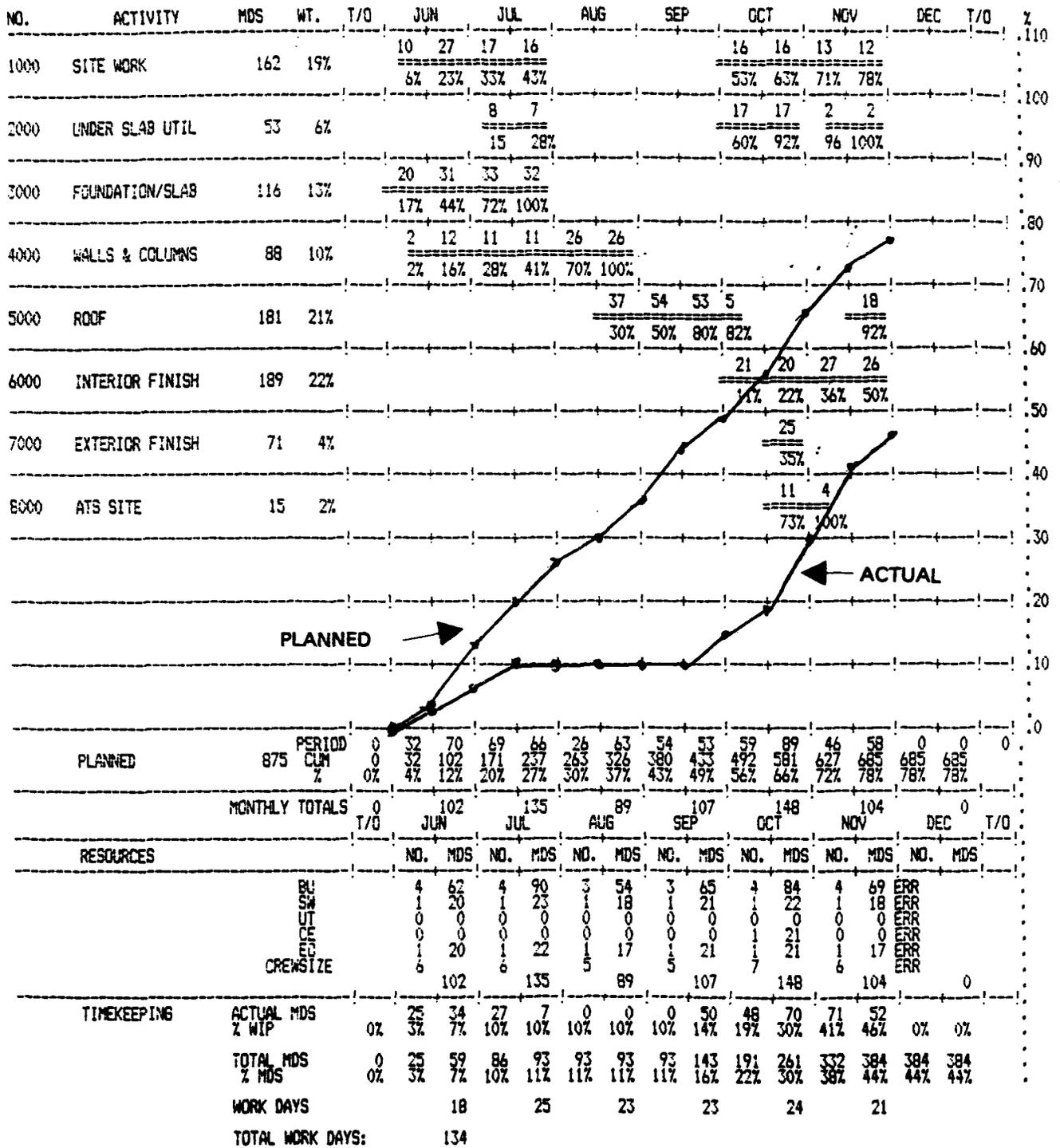
NMCB-133 "KANGROOS"

NUMBER: D66-844

28-Nov-92

SITE: DIEGO GARCIA

LEVEL II MANAGEMENT CHART



Source: LT Jackson, OIC, NMCB 133 Detail Diego Garcia

**APPENDIX J**  
**SITUATION REPORT FEEDER**



**APPENDIX K**  
**BOD CHECKLIST**

## PRE-BOD INSPECTION REQUEST

Project No:	Crewleader:	Date:
<p>This inspection is conducted prior to the final acceptance (BOD) inspection. This 'Pre-BOD' inspection is conducted jointly with battalion and ROICC representatives and is intended to identify any corrective steps necessary prior to customer occupancy.</p>		
Requested Date:	Time:	Requested by: (name/rate)
<p>The following checklist shall be completed by the crewleader and forwarded to QC two working days prior to the requested date of the inspection. The crewleader should use the following checklist as a guide but the Pre-BOD inspection will not be limited to these items.</p>		
<b>SITWORK</b>		crewleader init.
Final Grading (Grassing)		
Disposal of all Trash		
Sidewalks		
Curbs & Paving		
Lights		
<b>MECHANICAL</b>		
Installation of Piping, Fixtures and Equipment		
Application of Insulation and Hangers		
Sterilization (Water System)		
Shop Drawings		
Water Supply Test		
Gas & Oil Piping		
Heating and Cooling Units		
Duct Work		
Thermostat Controls		
Registers		
Exhaust Fans and Hoods		
Manufacturers' Catalogs		
Working Test (Boilers)		
<b>ELECTRICAL</b>		
Manufacturers' Catalog		
Test All Lights		
Test Fire Alarms		
Telephone Hook-up		
Main Panel Box (All Breakers Labelled)		
<b>CONCRETE &amp; MASONRY</b>		
Joints		
Cracks		
<b>STRUCTURAL STEEL</b>		
Touch-up Paint		

Source: U. S. Navy, Seabee Construction Management II, Student Guide

<b>HARDWARE</b>		crewleader init.
Closet Hardware		
Bathroom Accessories		
Door Hardware		
Gate Hardware		
Miscellaneous Hardware		
<b>DOORS &amp; WINDOWS</b>		
Clean		
Fit		
<b>FINISHES</b>		
Acoustic Tile		
Ceramic & Quarry Tile		
Floor Covering		
Painting		
Plastering		
<b>FURNISHINGS</b>		
Fabrication		
Installation		
<b>GENERAL</b>		
Project Package Up to Date		
As- Builts Completed		
Site Clean		
Excess Material Turned-in		
<b>REMARKS</b>		
Crewleader		QC Inspector

## APPENDIX L

### REFERENCES

1. Dr. Ellis, R.D., Civil Engineering Practice II, class notes July 7, 1994.
2. U. S. Navy, Naval Mobile Construction Battalion Crew leader's Handbook, September 1992, p. 2-5.
3. U. S. Navy, NAVFAC P-405. Seabee Planner's and Estimator's Handbook, October 1983, p. 5-2.
4. Willis, Edward M., Scheduling Construction Projects, Prentice Hall, Englewood Cliffs, NJ.,1986, p. 116.
5. U. S. Navy, COMCBPAC/COMCBLANT Instruction 5200.2A, NMCB Operations Officer's Handbook, March 1988, p. I-15.