

U.S. NAVY
U.S. ARMY
U.S. AIR FORCE
U.S. MARINE CORPS

NTRP 4-04.2.5
TM 3-34.42
AFPAM 32-1020
MCRP 3-17.7F

CONSTRUCTION PROJECT MANAGEMENT NTRP 4-04.2.5

EDITION DECEMBER 2012

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS,
HEADQUARTERS, DEPARTMENT OF THE ARMY,
SECRETARY OF THE AIR FORCE, AND
HEADQUARTERS, U.S. MARINE CORPS

DISTRIBUTION RESTRICTION:
APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION IS UNLIMITED.

PRIMARY REVIEW AUTHORITY:
COMMANDER, FIRST NAVAL
CONSTRUCTION DIVISION

URGENT CHANGE/ERRATUM RECORD		
NUMBER	DATE	ENTERED BY

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
HEADQUARTERS, U.S. MARINE CORPS



0411LP1130698

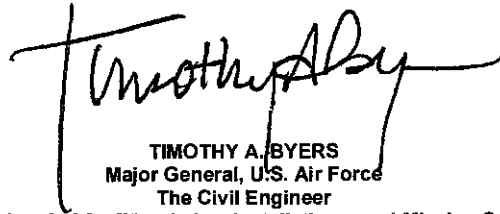
INTENTIONALLY BLANK

FOREWORD

This publication has been prepared under our direction for use
by our respective commands and other commands as appropriate.



PETER A. DELUCA
Brigadier General, U.S. Army
Commandant



TIMOTHY A. BYERS
Major General, U.S. Air Force
The Civil Engineer
Deputy Chief of Staff/Logistics, Installations, and Mission Support

BY DIRECTION OF THE COMMANDANT OF THE MARINE CORPS



RICHARD P. MILLS
Lieutenant General, U.S. Marine Corps
Deputy Commandant for Combat Development and Integration



T. B. KRAFT
Rear Admiral, U.S. Navy
Commander, Navy Warfare Development Command

This publication is available on the Navy Doctrine Library System (<https://ndls.nwdc.navy.mil/Default.aspx>); through the United States Army at Army Knowledge Online (AKO) (www.us.army.mil) and at the General Dennis J. Reimer Training and Doctrine Digital Library (www.train.army.mil) Web site; through the United States Air Force at the Air Force Publishing Web site (www.e-publishing.af.mil); and through the United States Marine Corps Doctrine Home Page at (<https://www.doctrine.usmc.mil/main.asp>).

INTENTIONALLY BLANK

December 2012

PUBLICATION NOTICE

ROUTING

1. NTRP 4-04.2.5/TM 3-34.42/AFPAM 32-1020/MCRP 3-17.7F (DEC 2012), CONSTRUCTION PROJECT MANAGEMENT, is available in the Navy Warfare Library. It is effective upon receipt.
2. This publication is a multiservice publication that provides uniform guidance to describe common methods, procedures, and formats for all aspects of construction project management at the operational unit level required to successfully plan, schedule, and execute a construction project by military engineer units.

Navy Warfare Library Custodian

Navy Warfare Library publications must be made readily available to all users and other interested personnel within the U.S. Navy.

Note to Navy Warfare Library Custodian

This notice should be duplicated for routing to cognizant personnel to keep them informed of changes to this publication.

INTENTIONALLY BLANK

CONTENTS

*Page
No.*

CHAPTER 1—INTRODUCTION TO CONSTRUCTION PROJECT MANAGEMENT

1.1	INTRODUCTION.....	1-1
1.1.1	Purpose	1-1
1.1.2	Scope	1-1
1.1.3	Applicability	1-2
1.1.4	Implementation Plan.....	1-2
1.1.5	Terminology	1-2
1.1.6	Forms.....	1-2
1.1.7	Use of Software Programs.....	1-3
1.2	PROJECT MODEL.....	1-3
1.3	PROJECT MANAGEMENT	1-4
1.3.1	Project Management Process Overview	1-4
1.3.2	Basic Functions of Project Management.....	1-5
1.4	CONSTRUCTION ORGANIZATION AND ROLES.....	1-5
1.4.1	Project Manager	1-6
1.4.2	Project Supervisor	1-6
1.4.3	Crew Leader	1-7
1.4.4	Crew	1-7
1.4.5	Subject Matter Experts in the Engineering Unit.....	1-7
1.4.6	The Construction Team	1-8

CHAPTER 2—PRELIMINARY CONSTRUCTION PLANNING

2.1	INTRODUCTION.....	2-1
2.1.1	Military Planning Process	2-2
2.1.2	Project Package	2-2
2.1.3	Sources for Man-day Estimates.....	2-2
2.2	INPUTS.....	2-2
2.3	PROCESS.....	2-2
2.3.1	Determine Task Organization	2-2
2.3.2	Determine Project Tasking.....	2-3
2.3.3	Determine Key Personnel Assignments	2-3
2.3.4	Determine Project Planning Timeline	2-3
2.3.5	Preplanning Conference	2-11
2.3.6	Review Plans and Specifications.....	2-11
2.3.7	Review Bill of Materials	2-11
2.3.8	Identify Special Training Requirements.....	2-11
2.3.9	Identify Long Lead Items	2-11
2.3.10	Determine Master Activities	2-11

2.3.11	Develop a Draft Level II Gantt Chart.....	2-18
2.3.12	Determine Initial Construction Activities	2-20
2.3.13	Construction Work Elements	2-28
2.4	OUTPUTS	2-28

CHAPTER 3—MANAGEMENT AND SCHEDULING TOOLS

3.1	INTRODUCTION.....	3-1
3.2	GANTT CHARTS.....	3-1
3.3	MAN-DAY ESTIMATING AND DURATIONS.....	3-2
3.3.1	Man-day Defined.....	3-2
3.3.2	Man-day Quantity Computation.....	3-3
3.3.3	Man-day Capability Computation	3-3
3.3.4	Other Computations	3-4
3.3.5	Production Consideration Computations.....	3-5
3.4	CRITICAL-PATH METHOD.....	3-5
3.4.1	Uses of the Critical-path Method	3-5
3.4.2	Limitations/Advantages of the Critical-path Method	3-6
3.5	LOGIC NETWORK.....	3-6
3.6	PRECEDENCE DIAGRAM	3-7
3.6.1	Activity Durations and Resources	3-7
3.6.2	The Activity Block	3-7
3.6.3	Calculation Procedure	3-8
3.6.4	Different Logic Types	3-11
3.7	LEVEL III GANTT CHART	3-12
3.8	RESOURCE LEVELING	3-14
3.8.1	Sample Level III Gantt Chart Ready for Resource Leveling	3-14
3.8.2	Resource Leveling Example Problem	3-19
3.9	LEVEL II GANTT CHART.....	3-22
3.9.1	Step 1	3-22
3.9.2	Step 2.....	3-25
3.9.3	Step 3	3-25
3.9.4	Step 4.....	3-25
3.9.5	Step 5.....	3-25
3.9.6	Step 6.....	3-26
3.9.7	Step 7.....	3-26
3.10	LEVEL I GANTT CHART/SYNCHRONIZATION MATRIX.....	3-27

CHAPTER 4—DETAILED PROJECT PLANNING

4.1	INTRODUCTION.....	4-1
-----	-------------------	-----

	<i>Page No.</i>
4.2	INPUTS 4-2
4.3	PROCESS 4-2
4.3.1	Conduct a Site Visit 4-2
4.3.2	Develop a Construction Estimate 4-4
4.3.3	Develop a Bill of Materials 4-4
4.3.4	Develop a Logic Network 4-4
4.3.5	Develop a Precedence Diagram 4-9
4.3.6	Develop a Level III Gantt Chart 4-9
4.3.7	Determine 30/60/90-day Material Requirements 4-9
4.3.8	Prepare Submittals 4-9
4.3.9	Prepare Construction Activity Summary Sheets 4-9
4.3.10	Determine Quality Control, Safety, and Environmental Protection Plans Requirements 4-13
4.3.11	Consolidate Resource Requirements and Set Baseline Schedule 4-16
4.4	OUTPUTS 4-16

CHAPTER 5—FINAL PLANNING AND PROJECT TURNOVER

5.1	INTRODUCTION 5-1
5.2	INPUTS 5-2
5.3	PROCESS 5-2
5.3.1	Compile Project Package 5-2
5.3.2	Review and Resource-level Unit Requirements 5-2
5.3.3	Complete Preparations for Deployment/Project Mobilization 5-3
5.3.4	Confirmation of Material Procurement Status 5-3
5.3.5	Project Confirmation Brief 5-3
5.3.6	Project Turnover 5-3
5.3.7	New Start Project—Preconstruction Conference 5-14
5.4	OUTPUTS 5-14

CHAPTER 6—PROJECT EXECUTION

6.1	INTRODUCTION 6-1
6.2	JOBSITE ORGANIZATION 6-1
6.2.1	Initial Jobsite Setup Considerations 6-1
6.2.2	Jobsite Appearance 6-6
6.2.3	Field Office 6-6
6.2.4	Standard Project Sign 6-6
6.3	PROJECT EXECUTION MANAGEMENT 6-7
6.3.1	Jobsite Information Board 6-9
6.3.2	Crew Member Briefings 6-10
6.3.3	Quality Control Plan Implementation 6-10
6.3.4	Safety and Environmental Protection Plan Implementation 6-12
6.3.5	Project Logbook 6-14
6.3.6	Construction Activity Summary Sheet 6-14
6.3.7	Level III Gantt Chart 6-16

	<i>Page No.</i>
6.3.8 Two-week Schedule	6-18
6.4 MATERIAL MANAGEMENT CONSIDERATIONS	6-28
6.4.1 Financial Awareness.....	6-28
6.4.2 Material Tracking.....	6-29
6.4.3 Authorization for Approval and Receipt of Material	6-29
6.4.4 Project Material Issue and Jobsite Delivery	6-29
6.4.5 Material Borrow/Transfer.....	6-30
6.4.6 Excess Material	6-33
6.4.7 Returning Project Material	6-33
6.4.8 Add-on/Reorder Materials.....	6-33
6.4.9 Concrete, Asphalt, Sand, or Aggregate Request	6-33
6.4.10 Long Lead Item Follow-up.....	6-33
6.4.11 Hazardous Materials.....	6-35
6.5 TOOL MANAGEMENT CONSIDERATIONS.....	6-35
6.5.1 Authorization for Approval and Receipt of Tools.....	6-35
6.5.2 Jobsite Responsibilities	6-35
6.6 EQUIPMENT MANAGEMENT CONSIDERATIONS.....	6-36
6.6.1 Equipment Considerations	6-36
6.6.2 Jobsite Responsibilities	6-37
6.7 VISITOR CONSIDERATIONS.....	6-37
6.7.1 Visitors	6-37
6.7.2 Visitors Briefing.....	6-38

CHAPTER 7—PROJECT MONITORING

7.1 INTRODUCTION.....	7-1
7.2 UNIT SITUATION REPORTS.....	7-1
7.2.1 Meeting the Scheduled Project Completion Date	7-1
7.2.2 Photographic Coverage	7-1
7.3 LABOR REPORTING	7-1
7.3.1 Labor Accounting Codes.....	7-2
7.3.2 Timecards	7-2
7.4 PROJECT SITUATION REPORT INPUT	7-3
7.4.1 Work-in-Place Method	7-3
7.4.2 Man-days Earned Method	7-9
7.5 CONTROLLING PROCEDURES AND CORRECTIVE ACTIONS TO KEEP THE SCHEDULE	7-10
7.5.1 Level II Gantt Chart—Actual Progress	7-13
7.5.2 Regaining the Schedule	7-13
7.6 LEVEL I GANTT CHART—ACTUAL PROGRESS.....	7-16

CHAPTER 8—FINAL PROJECT TRANSFER AND CLOSEOUT

8.1	INTRODUCTION	8-1
8.2	PROJECT TRANSFER AND CLOSEOUT STEPS	8-1
8.3	PROJECT SUPERVISOR RESPONSIBILITIES	8-5
8.3.1	Tools, Equipment, and Material Turn-in	8-5
8.3.2	As-built Drawings	8-5
8.3.3	Project Package	8-5
8.4	TRANSFER AND ACCEPTANCE DOCUMENTATION OF REAL PROPERTY	8-5

CHAPTER 9—QUALITY CONTROL PLAN

9.1	INTRODUCTION	9-1
9.2	QUALITY CONTROL	9-1
9.3	THE QUALITY CONTROL PLAN	9-1
9.4	DEVELOPMENT OF THE PROJECT QUALITY CONTROL PLAN	9-3
9.4.1	Project Scope Sheet	9-3
9.4.2	Quality Control Requirements	9-3
9.4.3	Definable Features of Work	9-5
9.4.4	Identify Required Skills, Training, and Equipment	9-5
9.4.5	Special License(s) Required	9-5
9.4.6	Activity Hazard Analysis	9-5
9.4.7	Quality Control Plan Summary	9-7
9.4.8	Quality Control Testing Plan and Log	9-7
9.4.9	Testing Equipment Requirement	9-7
9.4.10	Personal Protective Equipment Required for Testing	9-9
9.4.11	Submittals and Submittal Status Log	9-9
9.4.12	Request for Information and Status Log	9-9
9.4.13	Field Adjustment Request and Status Log	9-9
9.4.14	Design Change Directive File	9-14
9.5	EXECUTION OF THE PROJECT QUALITY CONTROL PLAN	9-14
9.5.1	Preparatory Phase	9-14
9.5.2	Initial Phase	9-14
9.5.3	Follow-up Phase and Daily Quality Control Inspection Report	9-17
9.5.4	Rework Items Procedure	9-17
9.5.5	Completion/Turnover Inspection Roles and Procedures	9-20
9.6	CONTRACTING OFFICE INTERFACE	9-20
9.7	AS-BUILT RECORD DRAWINGS	9-21
9.8	AS-BUILT RECORD OF MATERIALS USED	9-21

CHAPTER 10—SAFETY PLAN

10.1	INTRODUCTION	10-1
10.2	SAFETY PROGRAM AND OPERATIONAL RISK MANAGEMENT	10-1
10.3	THE SAFETY PLAN	10-1
10.4	DEVELOPMENT OF THE PROJECT SAFETY PLAN	10-1
10.4.1	Project Organization Sheet	10-1
10.4.2	Project Scope Sheet	10-3
10.4.3	Definable Features of Work	10-3
10.4.4	Activity Hazard Analysis	10-3
10.4.5	Identify Required Skills and Training	10-5
10.4.6	Special License and Permit Required	10-5
10.4.7	Safety Inspection Plan Summary (Engineering Controls)	10-5
10.4.8	Administrative Controls	10-5
10.4.9	Safety Equipment Required	10-5
10.4.10	Personal Protective Equipment Required for Safety	10-5
10.4.11	Special Safety Plans	10-8
10.5	EXECUTION OF THE PROJECT SAFETY PLAN	10-8
10.5.1	Emergency Mishap Response Plan	10-8
10.5.2	Daily Safety Lecture Log	10-8
10.5.3	Daily Safety Inspection	10-8
10.5.4	Safety Hazard/Deficiency	10-9
10.5.5	Report of Unsafe or Unhealthy Working Conditions	10-9
10.5.6	Completion/Turnover Inspection Roles and Procedures	10-9

CHAPTER 11—ENVIRONMENTAL PROTECTION PLAN

11.1	INTRODUCTION	11-1
11.2	ENVIRONMENTAL PROTECTION	11-1
11.3	THE ENVIRONMENTAL PROTECTION PLAN	11-1
11.4	DEVELOPMENT OF THE ENVIRONMENTAL PROTECTION PLAN	11-3
11.4.1	Project Organization Sheet	11-3
11.4.2	Project Scope Sheet	11-3
11.4.3	Definable Features of Work	11-3
11.4.4	Activity Hazard Analysis	11-3
11.4.5	Identify Required Skills and Training	11-3
11.4.6	Special License(s) and Permits Required	11-3
11.4.7	Environmental Protection Plan Summary (Engineering Controls)	11-4
11.4.8	Administrative Controls	11-4
11.4.9	Environmental Equipment Required	11-4
11.4.10	Personal Protective Equipment Required for Safety	11-4
11.5	EXECUTION OF THE PROJECT ENVIRONMENTAL PLAN	11-7
11.5.1	Hazardous Material/Hazardous Waste Management	11-7
11.5.2	Authorized User List	11-7

11.5.3	Material Safety Data Sheet.....	11-7
11.5.4	Project Environmental Inspection Checklists.....	11-8
11.5.5	Spill Response Plan.....	11-8
11.5.6	Completion/Turnover Inspection Roles and Procedures.....	11-8
11.6	ASBESTOS.....	11-8
11.7	FUGITIVE DUST.....	11-8
11.8	STORM WATER.....	11-10
11.9	WASTE DISPOSAL AND RECYCLING.....	11-10
11.10	WETLANDS.....	11-10

APPENDIX A—CONSTRUCTION PROJECT PACKAGE

A.1	INTRODUCTION.....	A-1
A.2	FORMS.....	A-1

APPENDIX B—UNITED STATES AIR FORCE CONSTRUCTION PROJECT PACKAGE

B.1	INTRODUCTION.....	B-1
B.2	UNITED STATES AIR FORCE UNIQUE PROJECT GUIDANCE.....	B-1
B.3	PROJECT PACKAGE SECTION LISTING.....	B-2

APPENDIX C—ALTERNATE CRITICAL-PATH METHOD PROCEDURES

C.1	INTRODUCTION.....	C-1
C.2	LOGIC DIAGRAM.....	C-1
C.2.1	Determine Activity Relationships.....	C-2
C.2.2	Logic Network Symbols.....	C-3
C.2.3	Logic Diagram Example.....	C-4
C.2.4	Activity Node Numbering.....	C-4
C.3	ACTIVITY DURATION AND RESOURCES.....	C-5
C.4	ACTIVITY START AND FINISH TIMES.....	C-5
C.4.1	Early Start/Early Finish.....	C-6
C.4.2	Late Finish/Late Start.....	C-8
C.5	CRITICAL ACTIVITIES, THE CRITICAL PATH, AND FLOAT.....	C-9
C.6	EARLY START SCHEDULE.....	C-10
C.7	REDUCTION OF THE PROJECT.....	C-12
C.7.1	Materials.....	C-13
C.7.2	Cost.....	C-13

C.7.3	Redefined Logic	C-13
-------	-----------------------	------

APPENDIX D—ALTERNATE SCHEDULING RESOURCE-CONSTRAINING PROCEDURES

D.1	INTRODUCTION	D-1
D.2	RESOURCE-CONSTRAIN THE EARLY START SCHEDULE	D-1
D.2.1	Step 1—Find the Resource Requirement Excess	D-1
D.2.2	Step 2—Choose an Activity to Delay	D-1
D.2.3	Step 3—Follow the Delay	D-2
D.2.4	Step 4—Sum the Resources	D-2
D.2.5	Step 5—Proceed to the Next Time Period	D-2
D.2.6	Step 6—Identify the Cause of the Delay	D-2
D.2.7	Step 7—Draw the Resource Flow Arrows	D-3
D.3	UPDATE THE LOGIC NETWORK	D-4
D.3.1	Step 8—Draw the Resource Dummy Arrow	D-4
D.3.2	Step 9—Conduct a New Time Analysis	D-4
D.4	UPDATE THE EARLY START SCHEDULE	D-4
D.4.1	Step 10—List Activities	D-4
D.4.2	Step 11—Mark Timeframes	D-4
D.4.3	Step 12—Identify Float	D-4
D.5	SAMPLE PROBLEM	D-5
D.5.1	Resource Constraining Example—Part 1	D-5
D.5.2	Resource Constraining Example—Part 2	D-5
D.5.3	Resource Constraining Example—Part 3	D-8

APPENDIX E—PROJECT CONFIRMATION BRIEF

E.1	INTRODUCTION	E-1
E.2	SAMPLE PROJECT CONFIRMATION BRIEF	E-1

APPENDIX F—LABOR ACCOUNTING SYSTEM

F.1	INTRODUCTION	F-1
F.2	DIRECT LABOR	F-1
F.3	INDIRECT LABOR	F-1
F.4	READINESS AND TRAINING	F-3

REFERENCES

GLOSSARY

LIST OF ACRONYMS AND ABBREVIATIONS

LIST OF ILLUSTRATIONS

*Page
No.*

CHAPTER 1—INTRODUCTION TO CONSTRUCTION PROJECT MANAGEMENT

Figure 1-1.	Construction Project Phasing Model.....	1-3
Figure 1-2.	Project Management Process	1-5
Figure 1-3.	Contracting Office and Public Works/Base Operations Support Tasks.....	1-9

CHAPTER 2—PRELIMINARY CONSTRUCTION PLANNING

Figure 2-1.	Project Phase 1 Outputs	2-1
Figure 2-2.	Sample Project Tasking Letter	2-4
Figure 2-3.	Table of Organization Form.....	2-5
Figure 2-4.	Sample Appointment Letter	2-6
Figure 2-5.	Project Planning Steps Checklist	2-7
Figure 2-6.	Project Planning Milestones Form	2-9
Figure 2-7.	Unit Level Project Planning Flow Chart.....	2-10
Figure 2-8.	Project Scope Sheet Form	2-12
Figure 2-9.	Project Training Requirements Plan Form.....	2-14
Figure 2-10.	Long Lead Items Examples.....	2-15
Figure 2-11.	Long Lead Items Form.....	2-16
Figure 2-12.	Master Activities List Form	2-17
Figure 2-13.	Master Activities	2-18
Figure 2-14.	Level II Gantt Chart Form	2-19
Figure 2-15.	Construction Activities List Form.....	2-20
Figure 2-16.	Construction Activity Number.....	2-22
Figure 2-17.	Construction Activities	2-23

CHAPTER 3—MANAGEMENT AND SCHEDULING TOOLS

Figure 3-1.	Gantt Chart Pyramid	3-2
Figure 3-2.	Logic Network: Sequence of Work.....	3-7
Figure 3-3.	Typical Activity Block.....	3-8
Figure 3-4.	Precedence Diagram Example	3-9
Figure 3-5.	Logic Relationship Examples	3-11
Figure 3-6.	Activity Bar Example.....	3-13
Figure 3-7.	Legend for Level III Gantt Chart	3-13
Figure 3-8.	Level III Gantt Chart Example 1.....	3-15
Figure 3-9.	Level III Gantt Chart Example 2.....	3-17
Figure 3-10.	Level III Gantt Chart Example 3.....	3-20
Figure 3-11.	Level III Gantt Chart Example 4.....	3-23
Figure 3-12.	Level II Gantt Chart Example	3-24
Figure 3-13.	Level I Gantt Chart—Unconstrained Example	3-28
Figure 3-14.	Level I Gantt Chart—Resource-leveling Attempt 1 Example	3-29
Figure 3-15.	Level I Gantt Chart—Resource-leveling Attempt 2 Example	3-30

CHAPTER 4—DETAILED PROJECT PLANNING

Figure 4-1.	Project Phase 2 Outputs	4-1
Figure 4-2.	Project Site Visit Summary Form	4-3
Figure 4-3.	Bill of Materials Form.....	4-5
Figure 4-4.	Bill of Materials/Material Takeoff Comparison Worksheet Form.....	4-6
Figure 4-5.	Add-On/Reorder Justification Form	4-7
Figure 4-6.	Bill of Materials Add-On/Reorder Form.....	4-8
Figure 4-7.	30/60/90-Day Material List Form	4-10
Figure 4-8.	Construction Activity Summary Sheet Form—Front	4-11
Figure 4-9.	Tool Requirement Summary Form	4-14
Figure 4-10.	Equipment Requirement Summary Form	4-15
Figure 4-11.	Master Activity Summary Sheet Form	4-17

CHAPTER 5—FINAL PLANNING AND PROJECT TURNOVER

Figure 5-1.	Project Phase 3 Outputs	5-1
Figure 5-2.	Readiness to Deploy Evaluation/Management Assist Visit Checklist Form	5-4
Figure 5-3.	Project Status at Turnover Situation Report Message Form	5-7
Figure 5-4.	Project Turnover Questions Checklist Form.....	5-8
Figure 5-5.	Turnover Memorandum Worksheet Form	5-9
Figure 5-6.	Typical Attendees at a Preconstruction Conference	5-15
Figure 5-7.	Unit Preparation for Preconstruction Conference Checklist	5-16
Figure 5-8.	Preconstruction Conference Summary Form	5-17

CHAPTER 6—PROJECT EXECUTION

Figure 6-1.	Jobsite Layout Objectives Checklist Form	6-2
Figure 6-2.	Jobsite Organization Checklist Form	6-2
Figure 6-3.	Standard Project Sign Example.....	6-7
Figure 6-4.	Jobsite Management Checklist.....	6-8
Figure 6-5.	Jobsite Information Board Example.....	6-9
Figure 6-6.	Emergency Phone Numbers Form	6-10
Figure 6-7.	Daily Safety Lecture Log Form	6-11
Figure 6-8.	Jobsite Required Safety Items Checklist Form	6-12
Figure 6-9.	Project Supervisor's Jobsite Safety Checklist Form	6-13
Figure 6-10.	Project Logbook Sample Page	6-15
Figure 6-11.	Level III Gantt Chart Example 5.....	6-17
Figure 6-12.	Two-week Schedule Example.....	6-20
Figure 6-13.	Engineering Services Request Form	6-22
Figure 6-14.	Excavation Request Form	6-23
Figure 6-15.	Road Closure Request Form	6-24
Figure 6-16.	Utility Disruption Request Form.....	6-25
Figure 6-17.	Concrete Placement Clearance Form	6-26
Figure 6-18.	Asphalt Placement Clearance Form	6-27
Figure 6-19.	Project Cost Worksheet.....	6-28
Figure 6-20.	Material Borrow/Transfer Request Form	6-31
Figure 6-21.	Borrow/Transfer Log Form.....	6-32
Figure 6-22.	Concrete, Asphalt, Sand, or Aggregate Request Form	6-34

CHAPTER 7—PROJECT MONITORING

Figure 7-1.	Indirect Labor Codes.....	7-2
Figure 7-2.	Lead Element/Support Element Timecard Example.....	7-4
Figure 7-3.	Two-week Labor Summary Example	7-5
Figure 7-4.	Project Situation Report Feeder Example	7-6
Figure 7-5.	Master Activity Percent Complete Worksheet Example.....	7-8
Figure 7-6.	Master Activity Percent Complete Worksheet: Man-days Earned Method	7-11
Figure 7-7.	Project Percent Complete Worksheet: Man-days Earned Method.....	7-12
Figure 7-8.	Level II Gantt Chart—Actual Progress Example.....	7-14
Figure 7-9.	Level I Gantt Chart—In Progress Example	7-17

CHAPTER 8—FINAL PROJECT TRANSFER AND CLOSEOUT

Figure 8-1.	Pre-final Inspection Request and Checklist Form.....	8-3
-------------	--	-----

CHAPTER 9—QUALITY CONTROL PLAN

Figure 9-1.	Project Quality Control Plan Cover Sheet and Table of Contents	9-2
Figure 9-2.	Quality Control Summary/Plan Form	9-4
Figure 9-3.	Definable Features of Work Submittal Form.....	9-6
Figure 9-4.	Quality Control Testing Plan and Log Form.....	9-8
Figure 9-5.	Request for Information Form	9-10
Figure 9-6.	Request for Information Log.....	9-11
Figure 9-7.	Field Adjustment Request Form	9-12
Figure 9-8.	Field Adjustment Request Log	9-13
Figure 9-9.	Preparatory Phase Checklist Form	9-15
Figure 9-10.	Initial Phase Checklist Form	9-18
Figure 9-11.	Rework Items List Form	9-19

CHAPTER 10—SAFETY PLAN

Figure 10-1.	Project Safety Plan Cover Sheet and Table of Contents	10-2
Figure 10-2.	Activity Hazard Analysis Form	10-4
Figure 10-3.	Safety Inspection Summary Plan Form.....	10-6
Figure 10-4.	Safety Equipment List/Personal Protective Equipment List Form	10-7
Figure 10-5.	Safety Hazard and Deficiency List Form.....	10-10

CHAPTER 11—ENVIRONMENTAL PROTECTION PLAN

Figure 11-1.	Environmental Protection Plan Cover Sheet and Table of Contents	11-2
Figure 11-2.	Environmental Protection Plan Summary Form	11-5
Figure 11-3.	Environmental Protection Plan Equipment List Form	11-6
Figure 11-4.	Project Environmental Inspection Checklist Form	11-9

APPENDIX A—CONSTRUCTION PROJECT PACKAGE

Figure A-1.	Project Package	A-2
-------------	-----------------------	-----

APPENDIX B—UNITED STATES AIR FORCE CONSTRUCTION PROJECT PACKAGE

Figure B-1.	United States Air Force Project Package	B-2
-------------	---	-----

APPENDIX C—ALTERNATE CRITICAL-PATH METHOD PROCEDURES

Figure C-1.	Activities List.....	C-3
Figure C-2.	Typical Activity Block (USA/USMC).....	C-4
Figure C-3.	Logic Diagram (USA/USMC)	C-5
Figure C-4.	Activities List with Resources	C-6
Figure C-5.	Advancing the Largest Early Finish Time	C-7
Figure C-6.	Critical-path Method Diagram Showing Project Duration	C-7
Figure C-7.	Retrieving the Smallest Late Start Time	C-8
Figure C-8.	Bracketing the Time Span.....	C-10
Figure C-9.	Scheduling Resources	C-11
Figure C-10.	Early Start Schedule Showing Float	C-11
Figure C-11.	Multiple-resources Schedule.....	C-12
Figure C-12.	Lag Factor	C-14

APPENDIX D—ALTERNATE SCHEDULING RESOURCE-CONSTRAINING PROCEDURES

Figure D-1.	Resource Flow Arrow Example 1	D-3
Figure D-2.	Resource Flow Arrow Example 2	D-3
Figure D-3.	Resource Dummy Arrows.....	D-4
Figure D-4.	Sample Problem—Logic Network.....	D-6
Figure D-5.	Sample Problem—Early Start Schedule	D-6
Figure D-6.	Sample Problem—Resource-constrained Early Start Schedule.....	D-7
Figure D-7.	Sample Problem—Updated Logic Network	D-7
Figure D-8.	Sample Problem—Updated Early Start Schedule	D-8

PREFACE

NTRP 4-04.2.5/TM 3-34.42/AFPAM 32-1020/MCRP 3-17.7F (DEC 2012), Construction Project Management, is a reference providing all aspects of construction project management at the operational unit level required to successfully plan, schedule, and execute a construction project by military engineer units. Throughout this publication, references to other publications imply the effective edition. Unless otherwise stated, masculine nouns and pronouns do not refer exclusively to men.

Report administrative discrepancies by letter, message, or e-mail to:

COMMANDER
NAVY WARFARE DEVELOPMENT COMMAND
ATTN: DOCTRINE
1528 PIERSEY STREET BLDG O-27
NORFOLK VA 23511-2723

NWDC_NRFK_FLEETPUBS@NAVY.MIL

ORDERING DATA

Order printed copies of a publication using the print-on-demand (POD) system. A command may requisition a publication using the standard military standard requisitioning and issue procedure (MILSTRIP) processes or the Naval Supply Systems Command Web site called the Naval Logistics Library (<https://nll1.ahf.nmci.navy.mil>). An approved requisition is forwarded to the specific Defense Logistics Agency (DLA) site at which the publication's electronic file is officially stored. Currently, two copies are printed at no cost to the requester.

CHANGE RECOMMENDATIONS

Procedures for recommending changes are provided below.

WEB-BASED CHANGE RECOMMENDATIONS

Recommended changes to this publication may be submitted to the Navy Doctrine Library System, accessible through the Navy Warfare Development Command (NWDC) Web site at: <http://ndls.nwdc.navy.smil.mil> or <https://ndls.nwdc.navy.mil>.

URGENT CHANGE RECOMMENDATIONS

When items for changes are considered urgent, send this information by message to the primary review authority, info NWDC. Clearly identify and justify both the proposed change and its urgency. Information addressees should comment as appropriate. See the sample for urgent change recommendation format on page 24.

ROUTINE CHANGE RECOMMENDATIONS

Submit routine recommended changes to this publication at any time by using the routine change recommendation letter format on page 25. Mail it to the address below or post the recommendation on the Navy Doctrine Library System site.

United States Navy organizations and service points of contact submit recommendations to the PRA:

COMMANDER
NAVAL CONSTRUCTION FORCES COMMAND
PLANS, POLICY & DOCTRINE DEPARTMENT (N5)
1310 8TH STREET, SUITE 100
NORFOLK, VA 23521

DSN 253-3909 COMM (757) 462-3909

In addition, forward two copies of all recommendations to:

COMMANDER
NAVY WARFARE DEVELOPMENT COMMAND
ATTN: DOCTRINE
1528 PIERSEY STREET, BLDG O-27
NORFOLK, VA 23511

United States Army organizations submit recommendations to:

COMMANDANT
U.S. ARMY ENGINEER SCHOOL
ATTN: ATZT-CDC
320 MANSCEN LOOP, SUITE 270
FORT LEONARD WOOD, MISSOURI 65473-8929

Submit an electronic Department of the Army (DA) Form 2028 or comments and recommendations in the DA Form 2028 format by e-mail to (leon.cdiddcoddengdoc@conus.army.mil).

United States Air Force organizations submit recommendations to:

COMMANDER
AIR FORCE CIVIL ENGINEER SUPPORT AGENCY
READINESS SUPPORT DIVISION (CEX)
139 BARNES DRIVE, SUITE 1
TYNDALL AIR FORCE BASE, FL 32403

DSN 523-6995 COMM (888) 232-3721

United States Marine Corps organizations submit suggestions and changes through the Universal Need Statement (UNS) process. The UNS submission process is delineated in Marine Corps Order 3900.15A, Marine Corps Expeditionary Force Development System, which can be obtained from the Marine Corps Publications Electronic Library Online at: <http://www.marines.mil/news/Pages/OrdersAndDirectivesSearch.aspx>. The UNS recommendation should include the following information:

1. Location of change
 - a. Publication number and title
 - b. Current page number
 - c. Paragraph number (if applicable)

- d. Line number
 - e. Figure number (if applicable).
2. Nature of change
- a. Addition/deletion of text
 - b. Proposed new text.

CHANGE BARS

Revised text is indicated by a black vertical line in the outside margin of the page, like the one printed next to this paragraph. The change bar indicates added or restated information. A change bar in the margin adjacent to the chapter number and title indicates a new or completely revised chapter.

WARNINGS, CAUTIONS, AND NOTES

The following definitions apply to warnings, cautions, and notes used in this manual:



An operating procedure, practice, or condition that may result in injury or death if not carefully observed or followed.



An operating procedure, practice, or condition that may result in damage to equipment if not carefully observed or followed.

Note

An operating procedure, practice, or condition that requires emphasis.

WORDING

Word usage and intended meaning throughout this publication are as follows:

“Shall” indicates the application of a procedure is mandatory.

“Should” indicates the application of a procedure is recommended.

“May” and “need not” indicate the application of a procedure is optional.

“Will” indicates future time. It never indicates any degree of requirement for application of a procedure.

FM ORIGINATOR

TO *(Primary Review Authority)*//JJJ//

INFO COMNAVWARDEVCOM NORFOLK VA//

COMUSFLTFORCOM NORFOLK VA//JJJ//

COMUSPACFLT PEARL HARBOR HI//JJJ//

(Additional Commands as Appropriate)//JJJ//

BT

CLASSIFICATION//N03510//

MSGID/GENADMIN/*(Organization ID)*//

SUBJ/URGENT CHANGE RECOMMENDATION FOR *(Publication Short Title)*//

REF/A/DOC/NTTP 1-01//

POC/*(Command Representative)*//

RMKS/ 1. IAW REF A URGENT CHANGE IS RECOMMENDED FOR *(Publication Short Title)*

2. PAGE _____ ART/PARA NO _____ LINE NO _____ FIG NO _____

3. PROPOSED NEW TEXT *(Include classification)*

4. JUSTIFICATION.

BT

Ensure that actual message conforms to MTF requirements.

Urgent Change Recommendation Message Format



DEPARTMENT OF THE NAVY

NAME OF ACTIVITY
STREET ADDRESS
CITY, STATE XXXXX-XXXX

5219
Code/Serial
Date

FROM: (Name, Grade or Title, Activity, Location)
TO: (Primary Review Authority)

SUBJECT: ROUTINE CHANGE RECOMMENDATION TO (Publication Short Title, Revision/Edition, Change Number, Publication Long Title)

ENCL: (List Attached Tables, Figures, etc.)

1. The following changes are recommended for NTTP X-XX, Rev. X, Change X:

a. CHANGE: (Page 1-1, Paragraph 1.1.1, Line 1)
Replace "...the ~~National Command Authority~~ President and Secretary of Defense establishes procedures for the..."
REASON: SECNAVINST ####, dated ####, instructing the term "National Command Authority" be replaced with "President and Secretary of Defense."

b. ADD: (Page 2-1, Paragraph 2.2, Line 4)
Add sentence at end of paragraph "See Figure 2-1."
REASON: Sentence will refer reader to enclosed illustration.
Add Figure 2-1 (see enclosure) where appropriate.
REASON: Enclosed figure helps clarify text in Paragraph 2.2.

c. DELETE: (Page 4-2, Paragraph 4.2.2, Line 3)
Remove "Navy Tactical Support Activity."
"...~~Navy Tactical Support Activity~~, and the Navy Warfare Development Command ~~are~~ is responsible for..."
REASON: Activity has been deactivated.

2. Point of contact for this action is (name, grade or title, telephone, e-mail address).

(SIGNATURE)
NAME

Copy to:
COMUSFLTFORCOM
COMUSPACFLT
COMNAVWARDEVCOM

Routine Change Recommendation Letter Format

INTENTIONALLY BLANK

CHAPTER 1

Introduction to Construction Project Management

1.1 INTRODUCTION

Navy Tactical Reference Publication (NTRP) 4-04.2.5/Technical Manual (TM) 3-34.42/Air Force Pamphlet (AFPAM) 32-1020/Marine Corps Reference Publication (MCRP) 3-17.7F, Construction Project Management, describes construction project planning, scheduling, and execution by military engineers.

In today's operational environment, engineers are increasingly employed as joint forces with multiple military service engineers under a single commander. This necessitates standardized construction project management for military engineers across the operational forces. Although the methods and procedures used in this publication are consistent with construction industry practices, military engineers face distinct challenges when operating in contingency operations. The fundamental principles in this publication apply to most construction projects, however, military engineers may adapt these principles to specific contingency situations.

1.1.1 Purpose

This multiservice publication provides comprehensive uniform guidance to military engineers responsible for construction project planning, scheduling, and execution.

1.1.2 Scope

This unclassified publication provides common methods, procedures, and formats for construction project management at the operational unit level required by military engineers to successfully plan, schedule, and execute general engineering and contingency construction projects. It provides information on the following:

1. Construction activity summary (CAS) sheets
2. Critical-path method (CPM) scheduling products
3. Field adjustment request (FAR)
4. Materials plan
5. Production and management of a project package
6. Project logbook
7. Project scheduling support tools
8. Quality control (QC), safety, and environmental protection plans
9. Request for information (RFI)
10. Situation report (SITREP) feeder
11. Timecards
12. Two-week schedule.

This publication is not a guide for construction estimating. Refer to NTRP 4-04.2.3/TM 3-34.41/AFPAM 32-1000/MCRP 3-17.7M, Construction Estimating, for information and data on estimating construction projects built by military engineering units.

1.1.3 Applicability

This publication is intended for use by military engineer project managers and project supervisors, but is applicable to staff-level engineers serving as liaison officers as well as training and educational institutions. It applies to engineers—both active and reserve, military and civilian—from the United States Army (USA), United States Air Force (USAF), United States Marine Corps (USMC), and United States Navy (USN).

Commonality across the military services for construction project management is based on guidance from the Federal Acquisition Regulation, Unified Facilities Criteria (UFC), and Unified Facilities Guide Specifications (UFGS). The UFGS documents are a multiservice effort of the United States Army Corps of Engineers, the Naval Facilities Engineering Command, and the United States Air Force Civil Engineer Support Agency.

1.1.4 Implementation Plan

The following commands have primary responsibility for each respective military service and will review this publication, validate the information, and incorporate it into military service manuals and curricula:

1. The USA will incorporate these procedures into Army training and doctrine publications as directed by the United States Army Training and Doctrine Command.
2. The USAF will incorporate these procedures as directed by the Civil Engineer, Deputy Chief of Staff/Logistics, Installations, and Mission Support.
3. The USMC will incorporate these procedures into Marine Corps training and doctrine publications by direction of the Commandant of the Marine Corps, Deputy Commandant for Combat Development and Integration.
4. The USN will incorporate these procedures into Navy training and doctrine publications as directed by the Commander, Navy Warfare Development Command.

1.1.5 Terminology

Terminology in this publication, as much as possible, is consistent with definitions found in Joint Publication 1-02, Department of Defense Dictionary of Military and Associated Terms; NTRP 1-02, Navy Supplement to the Department of Defense (DOD) Dictionary of Military and Associated Terms; Air Force Doctrine Document (AFDD) 1-2, Air Force Glossary; Field Manual (FM) 1-02/MCRP 5-12A, Operational Terms and Graphics; and MCRP 5-12C, Marine Corps Supplement to the Department of Defense Dictionary of Military and Associated Terms. However, this publication uses some key terms with industry standard definitions which apply specifically to construction, that are not consistent with joint and military service dictionary definitions. These terms are defined within the text.

1.1.6 Forms

Forms in this publication are examples and illustrate the information required to accomplish management tasks. Use of these forms is not mandatory. Forms vary by military service and software program. Managers use forms as directed by the supported command or unit standard operating procedure (SOP). Refer to appendixes A and B for further information about forms used in a construction project package.

1.1.7 Use of Software Programs

Each military service has unique requirements and applications for software programs. This publication provides the fundamental information for the process of planning, scheduling, and monitoring construction projects. Refer to the appropriate user manual for guidance on software input procedures.

1.2 PROJECT MODEL

Military construction projects follow a six-phase model, as illustrated in figure 1-1. The duration and amount of effort for each phase depends upon mission variables such as the scope and complexity of the project involved, the time available for planning, and the operational environment. This publication is organized according to the construction project phasing model.

A brief description of each project phase is provided below:

1. Project Phase 0, Initial Project Planning. This phase begins when a sponsoring entity originates, sponsors, and funds a construction project. The Department of Defense Form (DD)1391, Military Construction Project Data, is a programming tool used to request and justify a user need. The DD Form 1391 format enables the preparing official to systematically provide all of the important data required for design and/or proper review and validation of the project. Refer to Air Force Instruction (AFI) 32-1021, Planning and Programming Military Construction (MILCON) Projects; Army Regulation (AR) 420-1, Army Facilities Management; Chief of Naval Operations instruction (OPNAVINST) 11010.20G, Facilities Project Instruction; and UFC 1-300-09N, Design Procedures, for information on preparing the DD Form 1391 and project programming development. This phase is a military service-specific process for project identification/call for work process, force deployment planning, and the design period. This phase is beyond the scope of this publication.

This phase may also begin with receipt of a construction directive in the form of an operation order (OPORD), fragmentary order (FRAGORD), or a warning order (WARNORD) for an engineering unit designated as the construction agent for a design-build project. United States Air Force Rapid Engineer Deployable Heavy Operational Repair Squadron Engineer (RED HORSE) units normally use a design-build process during their training cycle. Refer to RED HORSE Project Management Manual, A Comprehensive Guide for Project OICs (officers in charge) and Project NCOICs (noncommissioned officers in charge), for their unique specific mission guidance.

2. Project Phase 1, Preliminary Construction Planning. This phase begins with receipt of construction directive in the form of an OPORD, FRAGORD, or WARNORD for projects that have already been designed. Preliminary project planning gives the engineering unit commander a quick overview of the assigned task, allows for assessment of the unit's capacity, and provides time to develop the commander's intent. It serves as a guide to the detailed planning that follows and includes task assignment of primary personnel as well as acquisition of plans and specifications. Refer to chapters 2 and 3 for further information.

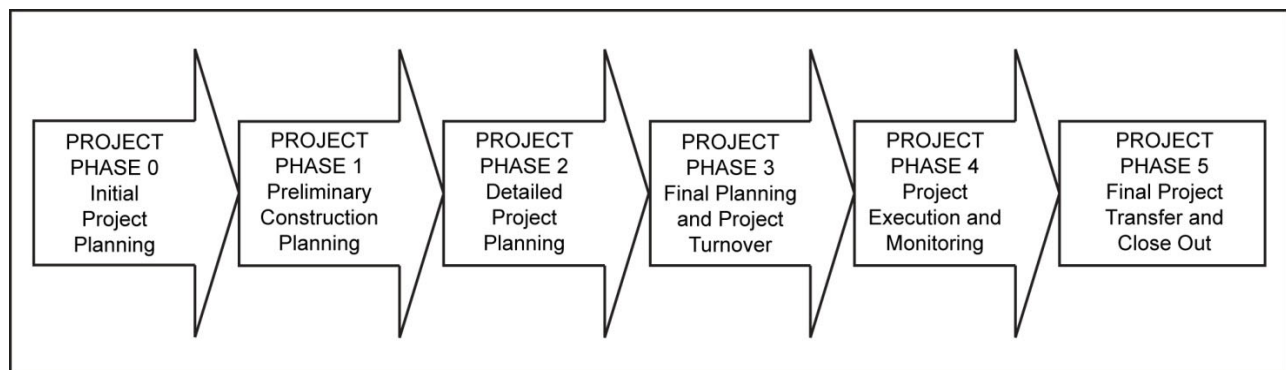


Figure 1-1. Construction Project Phasing Model

3. Project Phase 2, Detailed Project Planning. This phase provides a schedule for the entire construction project and develops an accurate estimate of the tools, equipment, materials, and personnel required for each construction activity. It includes the creation or validation of a bill of materials (BOM); the completion of product and resource-leveling schedules; and preparation and distribution of QC, safety, and environmental protection plans through the chain of command for review. This phase ends when managers generate CAS sheets. Refer to chapter 4 for further information.
4. Project Phase 3, Final Planning and Project Turnover. This phase includes project confirmation briefings, deployment/mobilization preparations, and confirmation of initial material requirements availability. This phase ends at project turnover or when mobilization is complete for a new start project. Refer to chapter 5 for further information.
5. Project Phase 4, Project Execution and Monitoring. This phase includes directing, monitoring, and taking corrective actions. This phase ends upon project completion or turnover. Refer to chapters 6 and 7 for further information.
6. Project Phase 5, Final Project Transfer and Closeout. This phase includes turn-in of all tools and materials, clearance of the jobsite, provision of as-built records and operation and maintenance manuals, and the construction agent's receipt of final acceptance of the project. It may include submission of DD Form 1354, Transfer and Acceptance of DOD Real Property. This phase ends with completion of after action reports and redeployment of the construction agent from the project site. Refer to chapter 8 for further information.

1.3 PROJECT MANAGEMENT

Project management is vital to achieving a quality project constructed on time and within budget. Good project management requires an investment of time and interest on the part of managers. No management system provides all the answers or totally eliminates risk, but by using the planning and management tools discussed in this publication, a manager will gain confidence in directing crews, managing resources, and reducing risk.

The functions of the military construction project manager are universal, although they may differ in details from one level to another. The managerial functions are: planning, scheduling, and monitoring/controlling. Each of these functions is aimed toward accomplishing the objective of the unit and is discussed throughout this publication. To implement these functions, the manager must understand the objectives, plans, and policies of superiors.

1.3.1 Project Management Process Overview

This publication is laid out in the chronological order of a project, from planning through building completion. The project management system described here provides tools for the process of coordinating the skill and labor of personnel using tools, equipment, and materials to accomplish a construction project.

Figure 1-2 illustrates an overview of the project management process required to move a project from initial tasking through planning phases and project execution.

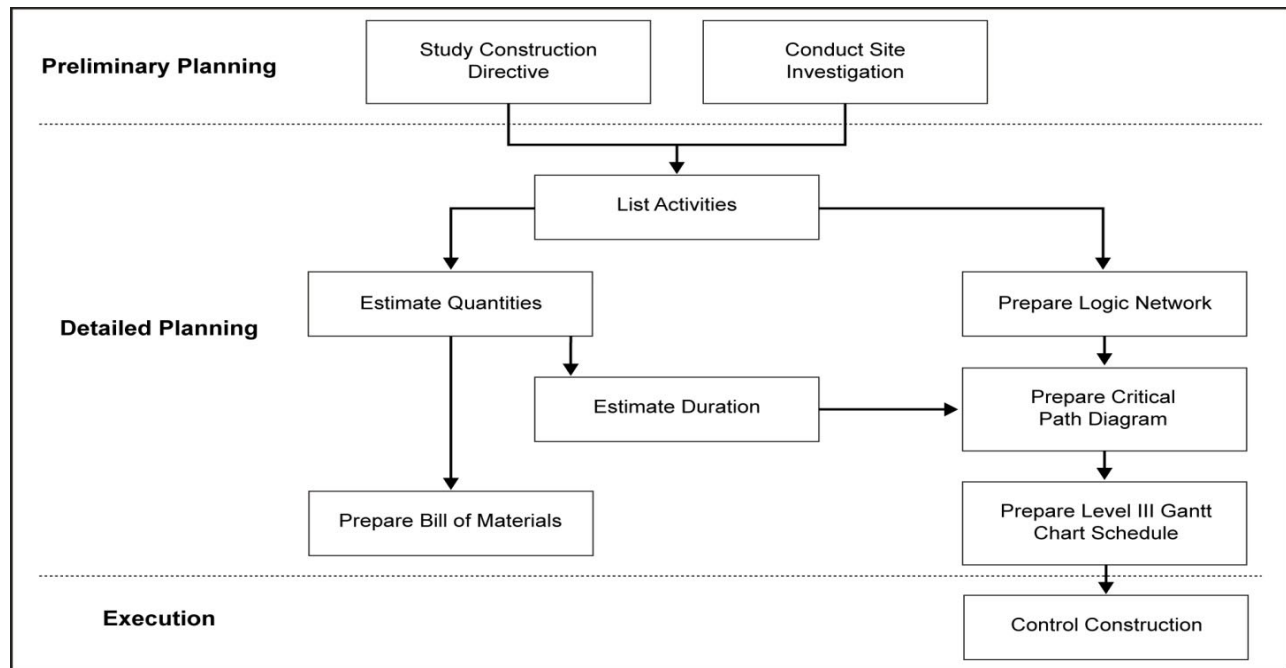


Figure 1-2. Project Management Process

1.3.2 Basic Functions of Project Management

Engineers manage engineering tasks from garrison construction projects to survivability positions in a theater of combat operations. How well the engineer accomplishes a task depends in large part on an ability to plan, schedule, and monitor/control resources within a constrained environment, described as follows:

1. The planning function includes organizing and staffing. In this function, the manager breaks down the project into workable subtasks, known as construction activities, and determines the order in which to perform them. The product of this step is a logic diagram, or network, which is an initial graphic representation of a plan's tasks and order of accomplishment.
2. The scheduling function adds a time element to the logic network as the manager first determines individual construction activity durations and then calculates the entire project's duration. The product of this step is a CPM diagram, typically presented as a project schedule or Gantt chart.
3. The monitoring and controlling function requires the manager to direct the project, measure the progress of the project, compare the actual progress against the initial schedule, and take corrective action if the actual progress deviates significantly from the schedule.

1.4 CONSTRUCTION ORGANIZATION AND ROLES

A construction organization's primary positions and its roles are described in subsequent paragraphs. The actual billet titles of personnel filling these roles differ between the military services based on the mission, organization, scope, and complexity of the projects involved. However, the fundamental roles as described are relatively consistent for each military service. This publication uses the term "construction agent" for the engineering unit

with primary responsibility for constructing a project. This publication uses the term “manager” when the task or information can apply to the various roles of leaders; otherwise, it refers to the following specific roles:

1.4.1 Project Manager

The project manager is a formal role assigned by the construction agent. Responsible for overall project supervision and oversight of one or more projects assigned as the lead element, the project manager ensures projects are completed on time and within budget.

Project managers set priorities of work and individual project goals. They establish the management process to ensure material, equipment, and manpower resource distribution is commensurate with the construction plan. They use the management process to make decisions on resource allocation to deconflict construction schedules and competing requirements.

A project manager manages all construction projects assigned to a unit or subordinate organization; tasking may include multiple construction projects or a large, complex project involving multiple facilities. The project manager accomplishes project supervision and oversight through a cadre of subordinate project supervisors.

Note

The terms “prime contractor” and “subcontractor” have been replaced with “lead element” and “support element,” respectively. This aligns terms with common USA and USMC nomenclature and lessens the confusion when referring to actual civilian contractors.

1.4.2 Project Supervisor

The project supervisor is a formal role assigned by the lead element project manager. Project supervisors are responsible for the quality and timely completion of their assigned projects. They are typically assigned to a single project/facility, but may be assigned multiple projects based on project scope and manpower resources.

During project execution, the project supervisor provides the following actions:

1. Full-time, on-site supervision of subordinates
2. Work coordination between trades
3. Efficient use of resources
4. Employment of personnel
5. Maintenance of production schedule
6. Inspection of work-in-place (WIP)
7. Adherence to quality, safety, and environmental guidelines.

Project supervisors are responsible for the development of construction estimates for labor, equipment and material, and the subsequent BOM; CAS sheets; QC, safety and environmental protection plans; and the project’s construction schedule. They initiate resource requirements for a tasked project.

Project supervisors review project documentation in order to identify potential issues or impediments affecting the construction schedule and balance the demands of competing requirements. They monitor and provide input for material status reports and track project expenditures. They validate requests for resource requirements and monitor delivery of resources to the project site.

Note

The role of project supervisor is referred to as “superintendent” by civilian construction companies and contractors. Unified Facilities Guide Specifications also reference the title of superintendent.

1.4.3 Crew Leader

The crew leader (also known as craft lead) is a formal role assigned by the project manager. Crew leaders are responsible for a crew of two or more persons, generally of the same trade, who are responsible for completing a phase or work element of a construction project. A crew leader may work for the lead or support element.

Crew leaders may also assist with project planning, including development of CAS sheets, QC; safety and environmental protection plans, the project’s construction schedule, and validation of the construction estimate and subsequent BOM. They keep the project supervisor updated on progress, potential delays or problem areas, required tests, and all changes.

Note

Naval construction force (NCF) units may assign a lead element crew leader of a small single-facility project to a dual role as the project supervisor.

1.4.4 Crew

The term “crew” is used to designate a group of personnel, usually of the same trade, assigned to a construction project. A construction project may have several crews from various support elements tasked for the time they are required to work on the project, or crews may be temporarily assigned to the project on a semipermanent basis throughout the duration of the project. Collectively, they are known as the project crew.

A crew normally consists of personnel having the same skill sets (i.e., builders, electricians), but could consist of personnel from various skills. Because of the nature of construction projects, a construction crew may not always align with fire team, squad, or platoon organizations, therefore, unit integrity may not be maintained.

1.4.5 Subject Matter Experts in the Engineering Unit

The following functions are performed by members of the engineering unit. Seek out subject matter experts (SMEs) who have been assigned these functions to assist with project planning.

1. **Quality Control Management.** Implements and advises on the construction QC program. Coordinates efforts with project supervisors and their assigned crew leaders to develop individual project QC plans and the unit’s overall QC plan. Refer to chapter 9 for information on the QC program.
2. **Safety Management.** Implements and advises on the Occupational Safety and Health Administration (OSHA) program. The unit safety officer has authority over all safety-related items during the construction process. Each project supervisor designates a crew member as a safety representative who works with the unit safety officer to coordinate individual project safety plans and the unit’s overall safety plan. Refer to chapter 10 for information on the safety program.
3. **Environmental Management.** Implements the environmental protection program and advises on all environmental, hazardous material (HM), and hazardous waste (HW) program issues. The unit environmental manager supports the planning effort. Refer to chapter 11 for information on environmental protection program considerations.

4. Material Liaison Office (MLO). Manages and advises on construction material procurement, tracking, and storage. Manages project financial records. Refer to paragraph 6.4 for information on resource management and logistics considerations.

1.4.6 The Construction Team

Construction projects are team efforts. They involve people from many organizations. A basic understanding of roles, responsibilities, and authorities assigned to the various team members is critical to effective communication among the team. The key players of a construction project also include:

1. Client. The client is the organization or group that benefits from the construction project.
2. Contracting Office. The contracting office is the primary delivery point for construction contracting at the station level. It is responsible for proper management and execution of construction contracts and responsible to individual clients for compliance with project plans and specifications. It supports projects by providing quality assurance (QA) oversight, client liaison, change and design management, and some public works (PW)/base operations support (BOS) coordination. The contracting office is ultimately responsible for a correctly built project turned over to the user when complete. This function is provided for the USN and USMC by the facilities engineering and acquisition division/resident officer in charge of construction (ROICC), for the USA by the resident engineer, and for the USAF by the base civil engineer (BCE).
3. Public Works/Base Operations Support. In many cases, the PW/BOS organization will remain engaged in the entire project process, from the beginning when a client documents a need through construction, turnover, and maintenance of the completed facility. Since it may be responsible for the facilities, utilities, and real estate, the PW/BOS organization will provide input, approval, and assistance for many issues that arise during a construction project.
4. Architect/Engineer. Professionally liable for the functionality and safety of the design, the architect/engineer is interested in ensuring the project is correctly built. The contracting office or PW/BOS organization manages the architect/engineer, a valuable project team asset in the event of design changes or problems. The architect/engineer produces a set of plans and specifications based on the concepts and requirements that define the client's needs. After this part of the task is complete, the architect/engineer may stand by to provide design and engineering assistance and oversight during project construction.
5. Other Organizations. Other groups on board an activity/base have project roles clearly defined by their functions. Managers must consider their issues and concerns when planning and executing a project. These include the activity/base safety, fire, security, and environmental departments.

Figure 1-3 illustrates key subject areas where the contracting office and PW/BOS may assist an engineering unit with construction projects.

LINE ITEM	TASK DESCRIPTION
1.	Final acceptance and project completion
2.	Material submittals for MLO-contracted support
3.	Materials and workmanship in accordance with plans and specifications
4.	Military engineer and client request changes to design
5.	Official visitors
6.	Project schedules up to Level II
7.	Proposed or required material substitutions
8.	Quality assurance/QC
9.	Technical system assistance (e.g., fire alarms, HM)
10.	Testing plans developed and executed per plans and specifications
11.	Turnover and preconstruction meetings
12.	Utility outages and communication cutover

Figure 1-3. Contracting Office and Public Works/Base Operations Support Tasks

INTENTIONALLY BLANK

CHAPTER 2

Preliminary Construction Planning

2.1 INTRODUCTION

The project management process normally begins at the unit level with receipt of the construction directive. This directive provides the who, what, when, where, and why of a particular project and may be in the form of an OPORD, FRAGORD, or a WARNORD.

The unit operations officer initiates preliminary construction planning actions, which include mission analysis and review of project tasking, in order to provide the necessary assignments and guidance to subordinates. The project manager, project supervisor, and crew leaders participate in the planning process upon assignment. Refer to figure 2-1 for an illustration of Project Phase 1 inputs, process, and outputs. Paragraphs 2.2 thru 2.4 discuss inputs, process, and outputs for Project Phase 1.

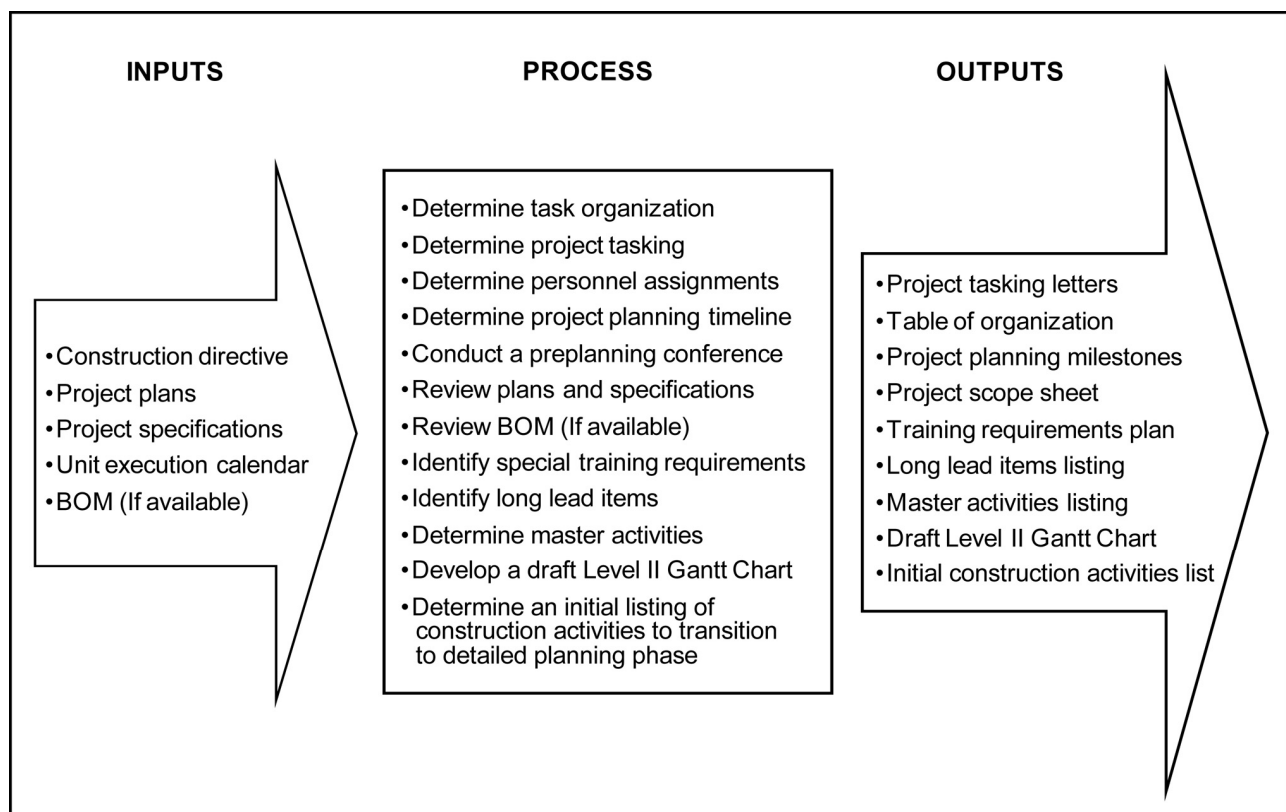


Figure 2-1. Project Phase 1 Outputs

2.1.1 Military Planning Process

Military engineers use the six-phase construction project model discussed in paragraph 1.2 to standardize project management efforts for tasked construction projects. Project management does not replace the use of the military planning process used by each military service for contingency and crisis action planning or troop-leading procedures at the tactical level for conducting unit operations.

2.1.2 Project Package

The project package, also referred to as a project folder, is a critical part of project management. It is the permanent record of everything that occurs on the project from start to closeout. Operations is responsible for maintaining the official copy of the project package. The project supervisor is responsible for creating and maintaining an on-site project package for the entire duration of the project. This on-site project package is turned over to operations for incorporation into the official copy upon completion of construction. Refer to appendix A for further information on the project package used by the USN, USA, and USMC. Refer to appendix B for further information on the project package used by the USAF.

2.1.3 Sources for Man-day Estimates

Military engineers use NTRP 4-04.2.3/TM 3-34.41/AFPAM 32-1000/MCRP 3-17.7M, and the Army's Theater Construction Management System (TCMS), as sources for man-day (MD) estimates. Theater Construction Management System supports engineer planners with facilities design information for outside the continental United States (OCONUS)/theater operation mission requirements. Discussion of TCMS is beyond the scope of this publication. Refer to the United States Army Corps of Engineers Web portal at <http://www.hnd.usace.army.mil/missions.aspx> for further information on TCMS.

2.2 INPUTS

Each phase in the project management process begins with inputs. Inputs may come from higher headquarters (HHQ), the commander or staff, or outputs from previous steps. Preliminary project planning requires the following essential items before Project Phase 1 planning can begin:

1. Construction directive
2. Project plans
3. Project specifications.

Other value-added planning inputs include:

1. Unit execution calendar
2. Bill of materials (if available).

2.3 PROCESS

The operations officer must understand the construction directive and the commander's initial guidance in order to initiate unit project planning. Paragraphs 2.3.1 thru 2.3.13 discuss actions that accomplish Project Phase 1 preliminary construction planning and transition to the detailed planning phase.

2.3.1 Determine Task Organization

Upon receipt of the construction directive, the operations officer conducts mission analysis and begins task organization and table of organization (T/O) assignment. Refer to NTRP 4-04.2.1, Doctrinal Reference for the

Naval Construction Force; AFDD 2, Operations and Organization; MCRP 5-12D, Organization of Marine Corps Forces; or FM 3-34, Engineer Operations, for further information on task organization and T/O.

2.3.2 Determine Project Tasking

As the unit's task organization is solidified, the operations officer assigns project tasking to the organizational elements. As part of project tasking, the operations officer designates lead and support elements with the following duties:

1. Lead element is responsible for the quality, safety, and timeliness of the construction effort and directs support elements accordingly.
2. Support element is responsible for schedule coordination and resource assignment in sufficient quantity and quality to accomplish the assigned project.

Refer to figure 2-2 for a sample project tasking letter.

2.3.3 Determine Key Personnel Assignments

Personnel assignments may vary from military service to military service, but it is imperative that key personnel are identified for the project to be successful. Project managers are designated in writing. Designated project managers, through coordination with the chain of command, name project supervisors and crew leaders. Refer to figure 2-3 for a sample T/O form.

The project manager designates the project supervisor and assigned crew leaders in writing. An appointment letter outlines the duties and responsibilities for each position. Refer to figure 2-4 for a sample appointment letter. Refer to paragraph 1.4 for information on the roles and function of each of these positions.

Project managers assign planning and estimating staff to assist project supervisors and their assigned crew leaders. Planning and estimating staff should include members of both the lead and support element crews.

2.3.4 Determine Project Planning Timeline

Project supervisors and crew leaders use the project planning steps checklist as the primary tool to determine the project planning timeline and to monitor the project planning process. Project supervisors and crew leaders assign dates to these steps to designate project planning milestones. A milestone represents a decision point, a major accomplishment, or a deliverable. The milestones form is routed through the project manager to the operations officer for approval of milestone dates. Refer to figure 2-5 for a project planning steps checklist. Refer to figure 2-6 for a project planning milestones form.

The unit-level project planning flow chart is used in conjunction with the project planning steps checklist and shows the sequence of planning steps inclusive of Project Phases 1 thru 3. Refer to figure 2-7 for an illustration of the project planning flow chart. The reference numbers shown on the flow chart correspond to the line item numbers in figure 2-5.

1300																									
S3																									
dd mmm yyyy																									
From:	Operations Officer, U.S. Naval Mobile Construction Battalion ##																								
To:	Xxxxxxx Company Commander, U.S. Naval Mobile Construction Battalion ##																								
Subj:	PROJECT TASKING ASSIGNMENT: EUROPEAN DEPLOYMENT 2012																								
Ref:	(a) S3 Memorandum of dd mmm yyyy																								
1.	Project XX##-###, Enlisted Club Addition, is assigned to XXXXXXX Company as lead element for construction. XXXX and XXXXX Companies are assigned as support elements.																								
2.	The project scope includes clearing, grubbing, demolition, new fill and grading, asphalt paving, curbs and sidewalks, interior and exterior finishes, electrical, mechanical, plumbing, fire alarm and protection systems, and other related incidental work. This will be a turnover project. The tasked start-stop percent is approximately 25–100 percent.																								
3.	The initial man-day estimate for NMCB ## tasking is 3,000 man-days. A complete project package is due to operations per reference (a).																								
4.	BU1 Seabee is assigned as the project QC specialist. Construction Electrician First Class Sparkey shall assist the QC effort as required.																								
5.	Operations is ready to assist you. Keep us informed of your progress and any problems as they arise.																								
Name LCDR CEC USN																									
Copy to: CO S3 codes Support company commanders MLO																									
Legend: <table style="width: 100%; border: none;"> <tr> <td style="width: 15%;">BU</td> <td style="width: 35%;">builder (USN rating)</td> <td style="width: 15%;">CO</td> <td style="width: 35%;">commanding officer</td> </tr> <tr> <td>BU1</td> <td>builder first class (USN rating)</td> <td>LCDR</td> <td>lieutenant commander</td> </tr> <tr> <td>BUC</td> <td>builder chief petty officer</td> <td>NMCB</td> <td>naval mobile construction battalion</td> </tr> <tr> <td>CE</td> <td>construction electrician (USN rating)</td> <td>S3</td> <td>battalion or brigade operations staff officer (USA, USMC battalion or regiment)</td> </tr> <tr> <td>CE1</td> <td>construction electrician first class (USN rating)</td> <td>U.S.</td> <td>United States</td> </tr> <tr> <td>CEC</td> <td>civil engineer corps</td> <td></td> <td></td> </tr> </table>		BU	builder (USN rating)	CO	commanding officer	BU1	builder first class (USN rating)	LCDR	lieutenant commander	BUC	builder chief petty officer	NMCB	naval mobile construction battalion	CE	construction electrician (USN rating)	S3	battalion or brigade operations staff officer (USA, USMC battalion or regiment)	CE1	construction electrician first class (USN rating)	U.S.	United States	CEC	civil engineer corps		
BU	builder (USN rating)	CO	commanding officer																						
BU1	builder first class (USN rating)	LCDR	lieutenant commander																						
BUC	builder chief petty officer	NMCB	naval mobile construction battalion																						
CE	construction electrician (USN rating)	S3	battalion or brigade operations staff officer (USA, USMC battalion or regiment)																						
CE1	construction electrician first class (USN rating)	U.S.	United States																						
CEC	civil engineer corps																								

Figure 2-2. Sample Project Tasking Letter

PROJECT ORGANIZATION
Project Manager/Company Commander: _____
Company Operations Chief: _____
Project Supervisor: _____
Lead Element Crew Leader: _____
Support Element Crew Leader: _____
Support Element Crew Leader: _____
Safety Supervisor: _____
HM/HW Representative: _____
QC Manager: _____
QC Specialist: _____
Safety Officer: _____
Environmental Program Manager: _____

Figure 2-3. Table of Organization Form

1306 Code dd mmm yyyy	
From:	Commanding Officer, U.S. Naval Mobile Construction Battalion ##
To:	BU1(SCW) I. M. Enlisted, USN, NNN-NN-NNNN
Subj:	DESIGNATION AS PROJECT SUPERVISOR FOR PROJECT (Number)
Ref:	(a) NTRP 4-04.2.5/TM 3-34.42/AFPAM 32-1020/MCRP 3-17.7F Construction Project Management
1.	You are hereby designated as the Naval Mobile Construction Battalion or Detachment (Number) project supervisor for project (Number). You are responsible for all matters of production, quality, and safe construction.
2.	You will familiarize yourself with provisions of reference (a) in the performance of your duties.
3.	This designation is effective immediately and expires upon the completion and acceptance of the project or when the project is transferred at turnover.
Name LCDR CEC USN	
Copy to:	CO S3 Lead company commander Support company commanders
SCW Seabee combat warfare	

Figure 2-4. Sample Appointment Letter

LINE ITEM	TASK DESCRIPTION	PRIMARY RESPONSIBILITY
01	Make project assignments.	Operations officer
02	Designate crew leaders and planning and estimating staff.	Project manager and project supervisor
03	Hold preplanning conference.	Project manager
04	Obtain plans and specifications.	Project manager
05	Receive BOM.	Project manager
06	Review plans and specifications.	Project supervisor and assigned crew leaders
07	Create milestones list.	Project manager and project supervisor
08	Write scope sheet (basic scope of work initially provided in the tasking letter).	Project supervisor
09	Identify required skills, training, and SME shortfalls.	Project supervisor
10	Develop master activity listing. Place master activities into logical construction sequence (logic network).	Project supervisor
11	Identify long lead items.	Project supervisor and assigned crew leaders
12	Draft Level II Gantt chart. Use rough man-day estimates and durations.	Project supervisor and assigned crew leaders
13	Generate construction activities list.	Project supervisor and assigned crew leaders
14	Complete an independent MTO to develop a construction estimate.	Project supervisor and assigned crew leaders
15	Compare BOM/MTO.	Project supervisor and assigned crew leaders
16	Develop add-on/reorder BOM.	Project supervisor and assigned crew leaders
17	Develop logic network.	Project supervisor and assigned crew leaders
18	Create precedence diagram. Identify any restraints on start/finish.	Project supervisor and assigned crew leaders
19	Generate Level III Gantt chart.	Project supervisor and assigned crew leaders
20	Deliver 30/60/90-day material list to unit MLO.	Project supervisor and assigned crew leaders

Figure 2-5. Project Planning Steps Checklist (Sheet 1 of 2)

LINE ITEM	TASK DESCRIPTION	PRIMARY RESPONSIBILITY
21	Deliver 30/60/90-day material list to HHQ.	Project manager and project supervisor
22	Develop CAS sheets.	Project supervisor and assigned crew leaders
23	Complete tool summary sheets.	Project supervisor and assigned crew leaders
24	Complete equipment summary sheets.	Project supervisor and assigned crew leaders
25	Complete shop drawings (e.g., slab layouts, rebar bending schedule).	Project supervisor and assigned crew leaders
26	Complete master activity summary sheets.	Project supervisor and assigned crew leaders
27	Smooth Level II Gantt chart from precedence diagram and Level III Gantt chart.	Project supervisor and assigned crew leaders
28	Compare and reconcile project QC plan with unit QC plan. Submit to operations officer for approval.	Quality control representative, project supervisor, and assigned crew leaders
29	Compare and reconcile project safety plan with unit safety plan. Submit to safety officer for approval.	Safety officer, project supervisor, and assigned crew leaders
30	Compare and reconcile project environmental protection plan with unit environmental protection plan.	Environmental officer, project supervisor, and assigned crew leaders
31	Finalize project packages (reviewed by lead element).	Project managers and project supervisors
32	Resource level. Identify constraints and resolve.	Project managers and project supervisors
33	Confirm material onsite.	Project supervisor and assigned crew leaders
34	Hold project briefing at unit level (reviewed by operations officer).	Project manager, project supervisor, and assigned crew leaders
35	Deliver project brief to HHQ.	Project manager, project supervisor, and assigned crew leaders
36	Finalize deployment execution plan.	Operations officer
Legend: MTO material takeoff		

Figure 2-5. Project Planning Steps Checklist (Sheet 2 of 2)

PROJECT PLANNING MILESTONES		
Project Number: _____		
Project Title: _____		
MILESTONE	DATE REQUIRED	DATE COMPLETED
Designate project supervisor, crew leaders, and planning and estimating staff.		
Hold preplanning conference.		
Review plans and specifications.		
Identify long lead items.		
Identify required skills and training.		
Complete project scope sheet.		
Complete master activity listing.		
Develop rough Level II Gantt chart.		
Develop Level II logic network.		
Generate construction activity listing.		
Develop independent MTO.		
Develop BOM/MTO discrepancy list.		
Complete CAS sheets.		
Develop Level III logic network.		
Input project to computer.		
Resource-leveling project.		
Develop Level III Gantt chart.		
Complete master activity summary sheets.		
Develop Level II Gantt chart.		
Consolidate tool requirements.		
Consolidate equipment requirements.		
Consolidate QC plan.		
Consolidate safety plan.		
Consolidate environmental protection plan.		
Prepare project brief.		

Figure 2-6. Project Planning Milestones Form

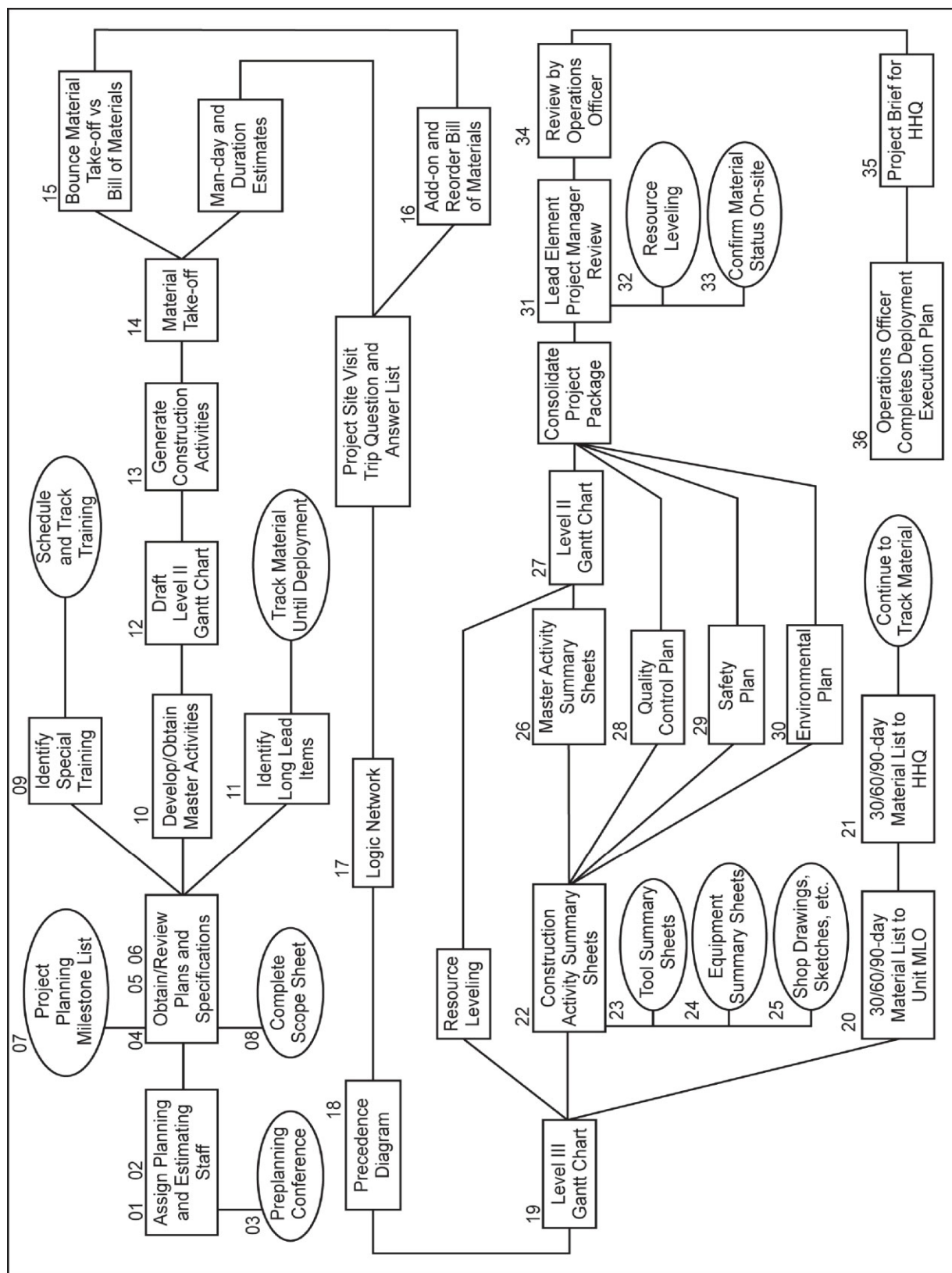


Figure 2-7. Unit Level Project Planning Flow Chart

2.3.5 Preplanning Conference

After reviewing the construction directive, the project manager conducts a preplanning conference with the project team to set goals for accomplishing the planning tasks leading to start of construction. This preplanning conference should set the following goals:

1. Provide overall job approach and construction methods to estimating staff.
2. Identify assumptions and limitations.
3. Determine feasibility of a preconstruction project site visit.
4. Begin monitoring message traffic, SITREPs, and correspondence for assigned projects.
5. Obtain deployment calendar or project execution calendar.

2.3.6 Review Plans and Specifications

The project supervisor and assigned crew leaders thoroughly review plans and specifications in conjunction with the drawings. They carefully read all notes and references, and examine all detail and reference drawings.

The project supervisor and assigned crew leaders next prepare a standard project package scope sheet and forward it to the operations officer for approval. Once the scope sheet is approved, the project supervisor works with the assigned estimating staff to create a detailed construction estimate. Refer to figure 2-8 for a sample project scope sheet form. Refer to chapter 4 for information on construction estimating.

In the absence of approved plans and specifications, HHQ, the tasking authority, or supported unit establishes and promulgates a definitive project scope, enforceable standards, and accepted construction practices to define the project.

2.3.7 Review Bill of Materials

If HHQ issues the BOM, the project manager holds it until completion of an MTO and construction estimate. Refer to paragraph 4.3.3 for further information regarding BOM/MTO comparison and additional requirements justification.

2.3.8 Identify Special Training Requirements

The project supervisor and assigned crew leaders identify the special training and skills required to accomplish assigned tasking. They submit these requirements via the project manager to the unit's training officer. Figure 2-9 illustrates a sample project training requirements plan form.

2.3.9 Identify Long Lead Items

The project supervisor identifies LL items, completes the standard project package form, and submits the form to the operations officer for review and approval. The operations officer forwards a copy of the approved form to MLO, who sends the appropriate message to the supported HHQ. Refer to figure 2-10 for a list of LL items. Refer to figure 2-11 for a sample long lead items form.

2.3.10 Determine Master Activities

The project manager and project supervisor determine the MA list for the project if it is not previously determined by HHQ or the design agency. The project supervisor completes and submits a standard project package form to the operations officer for review and approval. Refer to figure 2-12 for the sample master activities list form.

PROJECT SCOPE SHEET			
Project Title: _____			
Project Number: _____		Customer: _____	
Design Agent/Architect/Engineer Firm: _____			
Lead Element: _____		Project Supervisor: _____	
Man-day Estimate for Project: _____		Unit: _____	
BOM Generated By: _____		Network Duration: _____	
Date Onsite: _____			
Project Status: _____		New Start: _____	
Turnover: _____			
Brief Description of Project: _____			

Construction Schedule:			
Start		Complete	
Planned: _____		_____	
Actual: _____		_____	
Project Plans: Drawing Numbers: _____ Through: _____			
Project Specifications: Number: _____ Dated: _____			
Permits Required: _____			

Points of Contact:			
Organization:		Name:	
Contracting Office		Telephone:	
Public Works/Base		Email:	
Operations Support		_____	
Other		_____	
Management Plan Organization/Responsibilities:			

Figure 2-8. Project Scope Sheet Form (Sheet 1 of 2)

[illegible]

Figure 2-8. Project Scope Sheet Form (Sheet 2 of 2)

2-14

Figure 2-9. Project Training Requirements Plan Form

LONG LEAD ITEMS			
01	Air Conditioning Systems	24	Louvers
02	Bolted Steel Tanks	25	Lumber, Plywood (large orders)
03	Cabinets (wood and metal)	26	Marine Hardware
04	Carpet	27	Marine Piles
05	Cathodic Protection Systems	28	Partitions
06	Chain Link Fence Fabric	29	Power Panels
07	Circuit Breakers	30	Pre-engineered Buildings
08	Control/Feedback Systems	31	Prefab Joists
09	Doors	32	Roof Systems
10	Enunciator Panels	33	Rubber Fender System
11	Epoxy Mortars/Grouts	34	Screens
12	Explosion Proof Systems	35	Silver Solder
13	Fire Alarm Systems	36	Specialty Coatings
14	Fire Protection System	37	Specialty Electrical Items
15	Fire Pumps	38	Structural Pipe
16	Galvanized Metal Products	39	Structural Steel Members
17	Hardware/Locks/Cipher Locks	40	Switch Stations
18	High-intensity Discharge Light Fixtures/Lamps	41	Telephone Poles
19	High-voltage Specialty Switchgear	42	Timber (especially large sizes)
20	HVAC Components	43	Transformers
21	Intrusion Alarm Systems	44	Treated Wood Products
22	Large Quantities/Odd Sizes of Pipe/Fittings	45	Water Heaters
23	Large Quantity or Specialty Cable	46	Windows
Notes: 1. Finish items such as decorative brick, clay tiles, and unusual carpeting may require time to locate. 2. Large purchases of any item (more than \$10,000 or \$25,000 depending on local purchase authority) require time to competitively bid. 3. Electrical items tend to be unique to each installation and require additional time.			
Legend: HVAC heating, ventilation, and air conditioning PREFAB prefabricate			

Figure 2-10. Long Lead Items Examples

LONG LEAD ITEMS						
Project Number: _____				Date:_____		
Project Title: _____						
BOM NUMBER	LINE ITEM	DESCRIPTION	INTENDED USE	QTY	ROS	EOS

Legend:

EOS date estimated onsite
ROS date required onsite

QTY quantity

[illegible]

Figure 2-12. Master Activities List Form

Master activities represent large, functional parts of a project and are based on divisions of the MasterFormat standard, effective 2004, as established by the Construction Specifications Institute. This is a universal standard used throughout the private construction industry and the DOD. Refer to figure 2-13 for the standard MA list used by military engineers. The initial project planning unit/organization assigns MAs that remain with the project until completion. Master activities are used to develop construction management Level II Gantt charts (refer to paragraph 2.3.11).

The project supervisor must obtain an MA listing and a narrative description of the project scope before starting a detailed estimate. Master activity numbers form the basis for both estimating and scheduling format numbering.

2.3.11 Develop a Draft Level II Gantt Chart

The project supervisor determines rough MD estimates and durations for each MA, places them into a logical construction sequence, develops a draft Level II Gantt chart from the information, and forwards the chart to the unit operations officer via the project manager for approval. The draft Level II Gantt chart aids planning coordination. Refer to figure 2-14 for a sample Level II Gantt chart form. Refer to paragraph 3.2 for further information on Gantt charts used for project management.

MASTER ACTIVITY	DESCRIPTION	MASTER ACTIVITY	DESCRIPTION
00	Procurement and Contracting	23	HVAC
01	General Requirements	25	Integrated Automation
02	Existing Conditions	26	Electrical
03	Concrete	27	Communications
04	Masonry	28	Electronic Safety and Security
05	Metals	31	Earthwork
06	Wood, Plastics, and Composites	32	Exterior Improvements
07	Thermal and Moisture Protection	33	Utilities
08	Openings	34	Transportation
09	Finishes	35	Waterway and Marine Construction
10	Specialties	40	Process Integration
11	Equipment	41	Material Processing and Handling Equipment
12	Furnishings	42	Process Heating, Cooling, and Drying Equipment
13	Special Construction	43	Process Gas and Liquid Handling, Purification and Storage Equipment
14	Conveying Systems	44	Pollution Control Equipment
21	Fire Suppression	45	Industry-specific Manufacturing Equipment
22	Plumbing	48	Electrical Power Generation

Figure 2-13. Master Activities

PROJECT LEVEL II						
PROJECT # _____ TITLE _____				TOTAL MAN-DAY ESTIMATE _____	TASKED MAN-DAYS _____	
MA #	MASTER ACTIVITY TITLE	MA MDS	WT %			
						100%
						90%
						80%
						70%
						60%
						50%
						40%
						30%
						20%
						10%
						0%
TOTALS						
Man-days Scheduled This Period						
Cumulative Man-days Scheduled						
% Complete Scheduled (Plot)						
Man-days Actual This Period						
Cumulative Man-days Actual						
Man-days Earned This Period						
Cumulative Man-days Earned						
% WORK-IN-PLACE (PLOT)						

Figure 2-14. Level II Gantt Chart Form

2.3.12 Determine Initial Construction Activities

The project supervisor and assigned crew leaders develop an initial construction activities list from the MA list. Construction activities are subsets of the MAs that identify specific functional parts of the project. A typical military engineer project has between 15–50 construction activities. Determining these construction activities readies the project supervisor for the detailed estimating phase. Construction activities serve the following purposes:

1. They break down a project into logical definable parts, also known as definable features of work. Refer to paragraph 9.4.3 for information on definable features of work. Each of these smaller parts is individually estimated for materials, equipment, and labor. Estimators use the construction activity estimates to organize and format project construction estimates. Refer to NTRP 4-04.2.3/TM 3-34.41/AFPAM 32-1000/MCRP 3-17.7M, for information on estimating construction projects.
2. They allow organizers to track and manage the job for scheduling purposes. Refer to chapter 3 for information on scheduling.

Refer to figure 2-15 for a sample construction activities list form. The initial list uses columns A and B only. Refer to paragraph 3.5 for information on logic networks.

CONSTRUCTION ACTIVITY LIST					
Project Number: _____		Date Prepared: _____			
Project Title: _____					
Project Crew Leader: _____		Project Supervisor: _____			
CONSTRUCTION ACTIVITY NUMBER	CONSTRUCTION ACTIVITY TITLE	CREW SIZE	TOTAL FLOAT	BASELINE DURATION	ESTIMATED MAN-DAYS

Figure 2-15. Construction Activities List Form

2.3.12.1 Construction Activity Naming Convention

Military engineers consistently describe construction activities using the following naming convention:

1. An action taken
2. The building element involved in this action
3. A location identifier for the building element.

Some examples of construction activity names using this convention are the following:

1. PREFAB FORMS—FOUNDATION WALL/EAST SIDE
2. PREFAB REINFORCING STEEL—FOUNDATION/SOUTH SIDE
3. PLACE CONCRETE—FOUNDATION WALL/SOUTH SIDE
4. ERECT MASONRY WALL—EAST SIDE
5. INSTALL METAL STUDS—FIRST FLOOR.

2.3.12.2 Construction Activity Numbering System

The first pair of digits (Master Format Division—Level 1) represents the MA number, 00–48, as listed in figure 2-13.

The second pair of digits (Master Format Division—Level 2) represents a construction activity subcategory number, 01–99. Refer to Construction Specification Institute, MasterFormat 2010 Update Numbers & Titles, available at <http://csinet.org/Home-Page-Category/Formats/MasterFormat.aspx>, for more detail.

The third pair of digits is a sequence number, 00–99, and provides the ability to assign a unique number to each repeated construction activity with the same subcategory number. The user assigns these numbers as required and usually by groups of 10.

For example:

1. 03 10 10 PREFAB FORMS—FOUNDATION WALL/SOUTH SIDE
2. 03 10 20 PREFAB FORMS—FOUNDATION WALL/EAST SIDE
3. 03 20 10 PREFAB REINFORCING STEEL—FOUNDATION WALL/SOUTH SIDE
4. 03 20 20 PREFAB REINFORCING STEEL—FOUNDATION WALL/EAST SIDE
5. 03 20 30 SET REINFORCING STEEL—FOUNDATION WALL/SOUTH SIDE
6. 03 30 10 PLACE CONCRETE—FOUNDATION WALL/SOUTH SIDE

The subcategory number for each construction activity identifies a logical functional area that is a component of the related MA.

Figure 2-16 illustrates the 6-digit construction activity number's components.

Construction activity numbers can change for turnover projects, but the first two digits will remain the same; only the sequence numeral may change. Each construction activity is documented using a CAS sheet. To minimize changes, the project manager assigns construction activity numbers after completion of the logic network. Refer to figure 2-17 for a list of the standard construction activities and subcategories used by military engineers. Refer to paragraph 4.3.9 for further information on CAS sheets. Refer to paragraph 3.5 for information on logic networks.

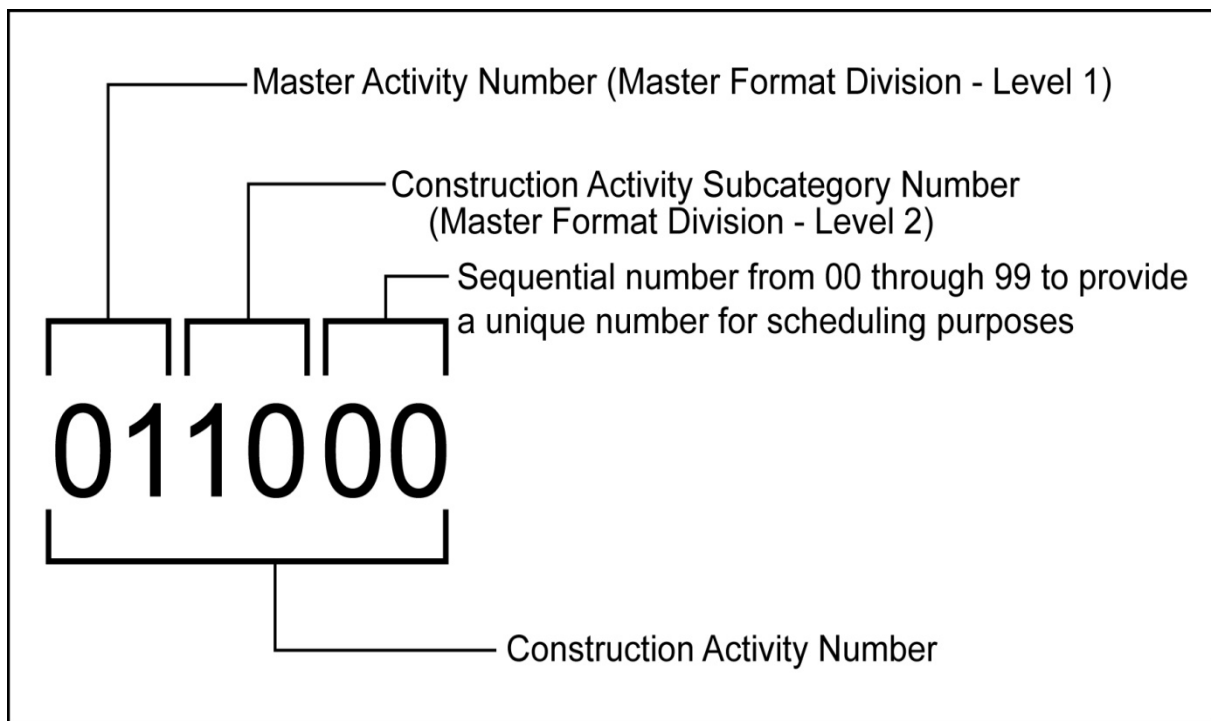


Figure 2-16. Construction Activity Number

CONSTRUCTION ACTIVITY	DESCRIPTION	CONSTRUCTION ACTIVITY	DESCRIPTION
01	General Requirements		
01 30 00	Administrative Requirements	01 60 00	Product Requirements
01 40 00	Quality Requirements	01 70 00	Execution and Closeout Requirement (includes move-in and move-out)
01 50 00	Temporary Facilities and Controls (includes environmental controls)		
02	Existing Conditions		
02 01 00	Maintenance of Existing Conditions	02 30 00	Subsurface Investigation
02 05 00	Common Work Results Existing Conditions	02 40 00	Demolition and Structure Moving
03	Concrete		
03 01 00	Maintenance of Concrete	03 40 00	Precast Concrete
03 10 00	Concrete Forming and Accessories	03 50 00	Cast Decks and Underlayment
03 20 00	Concrete Reinforcing	03 60 00	Grouting
03 30 00	Cast-in-place Concrete		
04	Masonry		
04 01 00	Maintenance of Masonry	04 40 00	Stone Assemblies
04 20 00	Unit Masonry	04 50 00	Refractory Masonry
05	Metals		
05 01 00	Maintenance of Metals	05 30 00	Metal Decking
05 10 00	Structural Metal Framing	05 50 00	Metal Fabrications
05 20 00	Metal Joists	05 70 00	Decorative Metal
06	Wood, Plastics, and Composites		
06 01 00	Maintenance of Wood, Plastics, and Composites	06 20 00	Finish Carpentry
06 10 00	Rough Carpentry	06 40 00	Architectural Woodwork
07	Thermal and Moisture Protection		
07 01 00	Operation and Maintenance of Thermal and Moisture Protection	07 50 00	Membrane Roofing
07 10 00	Dampproofing and Waterproofing	07 60 00	Flashing and Sheet Metal
07 20 00	Thermal Protection	07 70 00	Roof and Wall Specialties and Accessories
07 30 00	Steep Slope Roofing	07 80 00	Fire and Smoke Protection
07 40 00	Roofing and Siding Panels	07 90 00	Joint Protection

Figure 2-17. Construction Activities (Sheet 1 of 5)

CONSTRUCTION ACTIVITY	DESCRIPTION	CONSTRUCTION ACTIVITY	DESCRIPTION
08	Openings		
08 01 00	Operation and Maintenance of Openings	08 60 00	Roof Windows and Skylights
08 10 00	Doors and Frames	08 70 00	Hardware
08 30 00	Specialty Doors and Frames	08 80 00	Glazing
08 40 00	Entrances, Storefronts, and Curtain Walls	08 90 00	Louvers and Vents
08 50 00	Windows		
09	Finishes		
09 01 00	Maintenance of Finishes	09 60 00	Flooring
09 20 00	Plaster and Gypsum Board	09 70 00	Wall Finishes
09 30 00	Tiling	09 80 00	Acoustic Treatment
09 50 00	Ceilings	09 90 00	Painting and Coating
10	Specialties		
10 01 00	Operation and Maintenance of Specialties	10 40 00	Safety Specialties
10 10 00	Information Specialties	10 50 00	Storage Specialties
10 20 00	Interior Specialties	10 70 00	Exterior Specialties
10 30 00	Fireplaces and Stoves	10 80 00	Other Specialties
11	Equipment		
11 01 00	Operation and Maintenance of Equipment	11 50 00	Educational and Scientific Equipment
11 10 00	Vehicle and Pedestrian Equipment	11 60 00	Entertainment Equipment
11 20 00	Commercial Equipment	11 70 00	Healthcare Equipment
11 30 00	Residential Equipment	11 80 00	Collection and Disposal Equipment
12	Furnishings		
12 01 00	Operation and Maintenance of Furnishings	12 50 00	Furniture
12 20 00	Window Treatments	12 60 00	Multiple Seating
12 30 00	Casework	12 90 00	Other Furnishings
12 40 00	Furnishings and Accessories		
13	Special Construction		
13 01 00	Operation and Maintenance of Special Construction	13 30 00	Special Structures
13 10 00	Special Facility Components	13 40 00	Integrated Construction
13 20 00	Special Purpose Rooms	13 50 00	Special Instrumentation

Figure 2-17. Construction Activities (Sheet 2 of 5)

CONSTRUCTION ACTIVITY	DESCRIPTION	CONSTRUCTION ACTIVITY	DESCRIPTION
14	Conveying Systems		
14 01 00	Operation and Maintenance of Conveying Equipment	14 40 00	Lifts
14 10 00	Dumbwaiters	14 70 00	Turntables
14 20 00	Elevators	14 80 00	Scaffolding
14 30 00	Escalators and Moving Walks	14 90 00	Other Conveying Equipment
21	Fire Suppression		
21 01 00	Operation and Maintenance of Fire Suppression		
22	Plumbing		
22 01 00	Operation and Maintenance of Plumbing	22 30 00	Plumbing Equipment
22 07 00	Plumbing Insulation	22 40 00	Plumbing Fixtures
22 09 00	Instrumentation and Control for Plumbing	22 50 00	Pool and Fountain Plumbing Systems
22 10 00	Plumbing Piping and Pumps		
23	Heating, Ventilation, and Air Conditioning		
23 01 00	Operation and Maintenance of HVAC Systems	23 40 00	HVAC Air Cleaning Devices
23 07 00	HVAC Insulation	23 50 00	Central Heating Equipment
23 09 00	Instrumentation and Control for HVAC	23 60 00	Central Cooling Equipment
23 10 00	Facility Fuel Systems	23 70 00	Central HVAC Equipment
23 20 00	HVAC Piping and Pumps	23 80 00	Decentralized HVAC Equipment
23 30 00	HVAC Air Distribution		
25	Integrated Automation		
25 01 00	Operation and Maintenance of Integrated Automation		
26	Electrical		
26 01 00	Operation and Maintenance of Electrical Systems	26 30 00	Facility Electrical Power Generating and Storing Equipment
26 09 00	Instrumentation and Control for Electrical Systems	26 40 00	Electrical and Cathodic Protection
26 10 00	Medium-voltage Electrical Distribution	26 50 00	Lighting
26 20 00	Low-voltage Electrical Transmission		

Figure 2-17. Construction Activities (Sheet 3 of 5)

CONSTRUCTION ACTIVITY	DESCRIPTION	CONSTRUCTION ACTIVITY	DESCRIPTION
27	Communications		
27 01 00	Operation and Maintenance of Communications Systems	27 30 00	Voice Communications
27 10 00	Structured Cabling	27 40 00	Audio-video Communications
27 20 00	Data Communications	27 50 00	Distributed Communications and Monitoring Systems
28	Electronic Safety and Security		
28 01 00	Operation and Maintenance of Electronic Safety and Security	28 30 00	Electronic Detection and Alarm
28 10 00	Electronic Access Control and Intrusion Detection	28 40 00	Electronic Monitoring and Control
28 20 00	Electronic Surveillance		
31	Earthwork		
31 01 00	Maintenance of Earthwork	31 40 00	Shoring and Underpinning
31 10 00	Site Clearing	31 50 00	Excavation Support and Protection
31 20 00	Earth Moving	31 60 00	Special Foundations and Load-bearing Elements
31 30 00	Earthwork Methods	31 70 00	Tunneling and Mining
32	Exterior Improvements		
32 01 00	Operation and Maintenance of Exterior Improvements	32 70 00	Wetlands
32 10 00	Bases, Ballasts, and Paving (includes road construction)	32 80 00	Irrigation
32 30 00	Site Improvements	32 90 00	Planting
33	Utilities		
33 01 00	Operation and Maintenance of Utilities	33 40 00	Storm Drainage Utilities
33 09 00	Instrumentation and Control for Utilities	33 50 00	Fuel Distribution Utilities
33 10 00	Water Utilities	33 60 00	Hydronic and Steam Energy Utilities
33 20 00	Wells	33 70 00	Electrical Utilities
33 30 00	Sanitary Sewerage Utilities	33 80 00	Communications Utilities
34	Transportation		
34 01 00	Operation and Maintenance of Transportation	34 40 00	Transportation Signaling and Control Equipment (includes airfields)
34 05 00	Common Works Results for Transportation	34 70 00	Transportation Construction and Equipment (includes airfields)
34 10 00	Guideways/Railways	34 80 00	Bridges

Figure 2-17. Construction Activities (Sheet 4 of 5)

CONSTRUCTION ACTIVITY	DESCRIPTION	CONSTRUCTION ACTIVITY	DESCRIPTION
35	Waterway and Marine Construction		
35 01 00	Operation and Maintenance of Waterway and Marine Construction	35 30 00	Coastal Construction
35 05 00	Common Works Results for Waterway and Marine Construction	35 40 00	Waterway Construction and Equipment
35 10 00	Waterway and Marine Signaling and Control Equipment	35 50 00	Marine Construction and Equipment
35 20 00	Waterway and Marine Construction and Equipment	35 70 00	Dam Construction and Equipment
40	Process Integration		
40 01 00	Operation and Maintenance of Process Integration		
41	Material Processing and Handling Equipment		
41 01 00	Operation and Maintenance of Material Processing and Handling Equipment	41 20 00	Piece Material Handling Equipment
41 10 00	Bulk Material Processing Equipment	41 60 00	Mobile Plant Equipment
42	Process Heating, Cooling, and Drying Equipment		
42 01 00	Operation and Maintenance of Process Heating, Cooling, and Drying Equipment		
43	Process Gas and Liquid Handling, Purification, and Storage Equipment		
43 01 00	Operation and Maintenance of Process Gas and Liquid Handling, Purification, and Storage Equipment		
44	Pollution Control Equipment		
44 01 00	Operation and Maintenance of Pollution Control Equipment	44 40 00	Water Treatment Equipment
44 10 00	Air Pollution Control	44 50 00	Solid Waste Control
44 20 00	Noise Pollution Control		
45	Industry-Specific Manufacturing Equipment		
48	Electrical Power Generation		
48 01 00	Operation and Maintenance of Electrical Power Generation	48 10 00	Electrical Power Generation Equipment
48 09 00	Instrumentation and Control for Electrical Power Generation	48 70 00	Electrical Power Generation Testing

Figure 2-17. Construction Activities (Sheet 5 of 5)

2.3.13 Construction Work Elements

When more detail is required for accuracy and completeness, a construction activity breaks down into smaller tasks, known as construction work elements or work items. A specific construction activity may have one or several construction work elements. A work element, typically consisting of a single trade or skill, is expressed by a work rate. A work rate is a quantity of time per unit of measure. Selection of construction work elements should be taken from the data figures provided in NTRP 4-04.2.3/TM 3-34.41/AFPAM 32-1000/MCRP 3-17.7M.

Note

Placing a concrete grade beam, direct from chute, where the work rate is 0.480 man-hours per cubic yard of concrete is an example of a construction work element.

Refer to chapter 5 of NTRP 4-04.2.3/TM 3-34.41/AFPAM 32-1000/MCRP 3-17.7M, for more examples of work elements.

Construction work elements are not assigned a number for scheduling purposes, but they fall under an associated construction activity and are documented on the associated CAS sheet. Refer to paragraph 4.3.9 for further information on CAS sheets.

2.4 OUTPUTS

Senior staff initially performs this phase of preliminary planning, which provides the personnel tasking and basis for further planning. The following required outputs produced in this phase are vital inputs to the next steps in planning a construction project:

1. Project tasking letters. Refer to paragraph 2.3.2.
2. Table of organization assignments. Refer to paragraph 2.3.3.
3. Project planning milestones. Refer to paragraph 2.3.4.
4. Project scope sheet. Refer to paragraph 2.3.6.
5. Training requirements. Refer to paragraph 2.3.8.
6. Long lead items list. Refer to paragraph 2.3.9.
7. Master activities list. Refer to paragraph 2.3.10.
8. Draft Level II Gantt chart. Refer to paragraph 2.3.11.
9. Initial construction activities list. Refer to paragraph 2.3.12.

All output products should be retained and refined as necessary throughout the project planning process.

CHAPTER 3

Management and Scheduling Tools

3.1 INTRODUCTION

Managers implement management and scheduling tools to facilitate mission accomplishment. Scheduling is essential in order to track project activities and manage project timelines. Before continuing to other project planning phases, managers must understand the fundamental planning and management tools. Managers employ several systems to facilitate project task management:

1. Gantt charts
2. Man-day estimating calculations
3. Critical-path Method
 - a. Logic networks
 - b. Precedence diagrams.
4. Resource leveling.

3.2 GANTT CHARTS

Managers use Gantt charts for both planning and monitoring project progress. The charts indicate if the project is ahead of, behind, or on schedule; provide resource management; and track actual WIP against planned work. A Gantt chart, similar to a synchronization matrix, is a graphic representation of task duration against time. Work activities listed vertically on the left relate to a predetermined time scale shown horizontally across the top. A bar representing each activity illustrates the start and finish time, while the length of the bar shows the activity's duration.

Gantt charts are developed throughout the planning phases and updated throughout the execution phase. They are used in conjunction with a CPM diagram in order to determine the relationships between activities, whether or not activities are part of the critical path, and the effects of an incomplete activity within a scheduled timeframe. Refer to paragraph 3.4 for information on the CPM.

Military engineers use three levels of Gantt charts, as shown in figure 3-1. The primary difference between each Gantt chart level is the amount of detail included, described as follows:

1. Level III. Military engineers use the Level III Gantt chart to plan, schedule, and monitor/control the day-to-day operations of the project. A Level III chart is maintained for each project. The Level III is similar to the Level II in format, but goes into greater detail. The horizontal timeline specifies days; the vertical line items are construction activities for the project. The Level III provides a plan for project supervisors to accomplish project tasking. Project supervisors update the Level III Gantt chart daily. At the end of each two-week period, project supervisors plot the actual percent completed on the Level II Gantt chart. Refer to paragraph 3.7 for information on the project supervisor's input for a Level III Gantt chart.

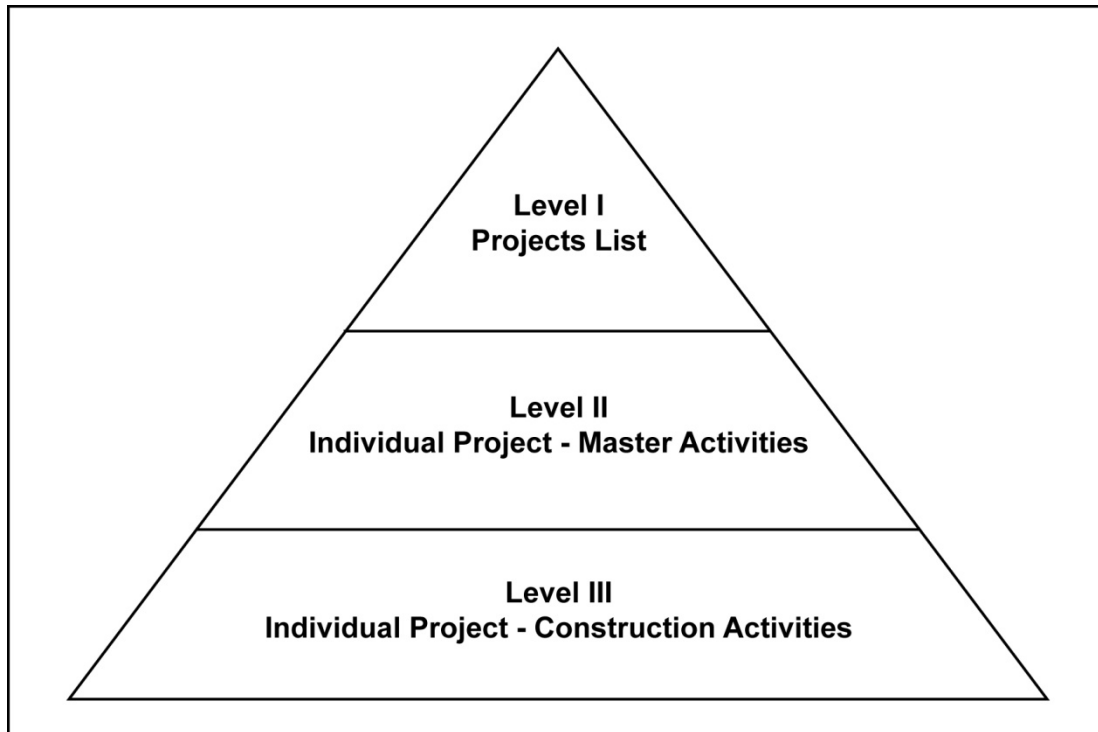


Figure 3-1. Gantt Chart Pyramid

2. Level II. Military engineers use the Level II Gantt chart for an individual project plan as well as to control and evaluate progress. The horizontal timeline specifies weeks for the entire duration of the project; the vertical line items are master activities for individual projects and reflect allocated manpower resources. Refer to paragraph 3.9 for information on the project supervisor's input for a Level II Gantt chart.
3. Level I. Military engineers use the Level I Gantt chart as the primary management tool to integrate efforts and manage overall unit tasking. The horizontal timeline for a Level I specifies months; the vertical line items are individual projects and reflect total MDs planned and/or expended. Refer to paragraph 3.10 for information on how the project manager creates the Level I Gantt chart.

3.3 MAN-DAY ESTIMATING AND DURATIONS

Critical to project management, accurate labor requirement estimates and priority schedules necessitate attention to detail and flexibility in both planning and execution. Planning mechanisms include MD defined, MD quantity computation, MD capability computation, and other computations. The application of these planning mechanisms enables managers to better employ personnel at critical times in support of construction activities.

3.3.1 Man-day Defined

An MD is a unit of work performed by one person in 8 hours. It is critically important for the military engineer to understand this definition. The MD is a set standard and does not change. Man-day hours are not the same as workday hours. The number of hours for an assigned workday may change, but an MD is always 8 hours.

Based upon direct labor (DL), MD and man-hour labor estimates do not include allowances for indirect or overhead labor. A project's schedule reflects only DL MDs. Refer to NTRP 4-04.2.3/TM 3-34.41/AFPAM 32-1000/MCRP 3-17.7M, for information on labor types.

3.3.2 Man-day Quantity Computation

Military engineers use a formula to determine the number of MDs needed for a given task or work element based on the quantity of material required. The quantity of work (determined by the MTO) is divided by the unit size, multiplied by the man-hours required to complete one unit, and then divided by 8 man-hours per MD. The equation follows:

$$\text{MDs} = \text{Quantity of Work/Unit Size} \times \text{Man-hours Required per Unit Size/8 Man-hours per Day}$$

Refer to NTRP 4-04.2.3/TM 3-34.41/AFPAM 32-1000/MCRP 3-17.7M, for information on construction estimating and production rate data.

3.3.3 Man-day Capability Computation

In order to calculate construction activity durations, the project supervisor must understand the MD capability computation. The MD capability (total capability) formula is as follows:

$$\text{MC} = \text{DL} \times \text{WD} \times \text{ME} \times \text{AF}$$

where:

1. MC is the total MD capability.
2. DL is the number of direct labor personnel assigned to a project or unit.
3. WD is the number of available workdays (not calendar days).
4. ME is the man-day equivalent (the number of MDs expended in a typical workday). In other words, it is the actual man-hours worked swinging hammers on the jobsite during a workday. Higher headquarters typically directs ME in the construction directive. To calculate the man-day equivalent, divide the length of the workday (minus lunch, breaks, and travel time to and from the jobsite, including lunch) by 8 (the number of hours in an MD).
5. AF is the availability factor, the amount of time a military engineer is actually on the job. The AF takes into account that troops assigned as DL are not available 100 percent of the time. A job loses about 20 percent of the DL personnel's time to leave and liberty; paydays; inspections; quarters; medical and dental; haircuts; military drills; watches and collateral duties. Higher headquarters provides AFs for planning purposes. They vary between 60–90 percent, depending on the situation. Typical percentages are 75 percent for main body sites and 80 percent for detachment sites. The typical percentage for contingency construction and theater engagement detachments is 90 percent. The availability factor will be adjusted by HHQ when accurate timekeeping demonstrates the need.

Military engineers also use this equation to determine the DL manning for a project/unit/detachment, with tasked MDs substituted for MD capability and the availability factor, the MD equivalent, and the number of available workdays plugged into the formula.

3.3.4 Other Computations

The MD capability computation also determines the duration (DUR), crew size (CS), AF, or MD equivalent for a given construction activity with the following substitutions and subsequent equations, where:

1. MD (man-day estimate) substitutes for MC (man-day capability).
2. DUR substitutes for WD (workdays, not calendar days).
3. CS substitutes for DL (direct labor).

The equation then becomes:

$$MD = CS \times DUR \times ME \times AF.$$

To solve for duration:

$$\begin{aligned} DUR &= MD / (CS \times ME \times AF) \\ \text{or} \\ DUR &= MD / CS / ME / AF. \end{aligned}$$

To solve for crew size:

$$\begin{aligned} CS &= MD / (DUR \times ME \times AF) \\ \text{or} \\ CS &= MD / DUR / ME / AF. \end{aligned}$$

To solve for availability factor:

$$\begin{aligned} AF &= MD / (CS \times DUR \times ME) \\ \text{or} \\ AF &= MD / CS / DUR / ME. \end{aligned}$$

To solve for MD equivalent:

$$\begin{aligned} ME &= MD / (CS \times DUR \times AF) \\ \text{or} \\ ME &= MD / CS / DUR / AF. \end{aligned}$$

The activity duration increases with the AF included to account for time lost from the project site. The actual crew on an average day is the assigned crew multiplied by the AF. The activity duration increases or decreases based on changes made to the following:

1. Availability factor (included to account for time lost from the project site)
2. Crew size (average crew assigned)
3. Man-day equivalent (hours worked on the job swinging hammers).

When making necessary adjustments to activity durations to resource level a plan, the project supervisor must keep in mind who controls each factor and which factors require approval by HHQ. For example, a project supervisor may be able to increase the crew size to shorten duration, but not increase the length of the working hours without first getting approval from HHQ.

3.3.5 Production Consideration Computations

Military engineers use a multiplier/delay factor based on taking production considerations into account and applying it to the MD computation formula to adjust their original MD estimate for a given task or work element. Refer to NTRP 4-04.2.3/TM 3-34.41/AFPAM 32-1000/MCRP 3-17.7M, for information on production considerations (eight elements) and how they affect labor production/work rate. A multiplier/delay factor of 1.0 does not change the MD calculation.

If the multiplier/delay factor is greater than 1.0, it will increase the number of MDs required to accomplish the work element. For example, a multiplier of 1.33 might need to be applied if using other civilian estimate guides to adjust estimates to more accurately reflect MDs required for military engineers to do the same skilled labor. The equation follows:

$$\text{MDs} = \text{Quantity of Work/Unit Size} \times \text{Man-hours Required per Unit Size/8 Man-hours per Day} \times \text{Multiplier} (\times 1.33)$$

If the multiplier/delay factor is less than 1.0, it will decrease the number of MDs required to accomplish the work element. For example, multiplier of 0.90 might need to be applied if adjusting an estimate that was based on construction in inclement weather. Since the timeframe has changed and the weather is going to be more favorable, it is estimated that a 10 percent efficiency will be gained. The equation follows:

$$\text{MDs} = \text{Quantity of Work/Unit Size} \times \text{Man-hours Required per Unit Size/8 Man-hours per Day} \times \text{Multiplier} (\times 0.90)$$

3.4 CRITICAL-PATH METHOD

The critical-path method is a planning and control technique that overcomes the disadvantages of using only a Gantt chart and provides an accurate, timely, and easily understood picture of the project. The CPM is comprised of two products: a logic network and a precedence diagram. With this additional information, the manager plans, schedules, and controls the project more easily. Used together, the Gantt chart and the CPM provide the manager with all the critical information necessary to accomplish the task. Development of a CPM schedule involves continual refinement as the manager makes decisions and incorporates changes during the plan of action development. Refer to paragraph 3.5 for additional information on a logic network and to paragraph 3.6 for a precedence diagram.

3.4.1 Uses of the Critical-path Method

The CPM requires a formal, detailed investigation into all identifiable tasks that constitute a project. This means that the manager must envision the project from start to finish as well as estimate time and resource requirements for each task. Refer to paragraph 4.3.2 for estimating information.

The CPM can be used to accomplish construction and combat tasks at any level of management from the engineer squad to the engineer brigade/regiment. A squad leader needs to have a basic knowledge of CPM for two primary reasons:

1. **Engineer Tasks.** As a member of a larger work element, the squad leader is responsible for assigned tasks within the CPM network. A leader's knowledge of CPM results in a better understanding of the critical nature of the tasks in relation to the total project, which better prepares the squad to accomplish these tasks.
2. **Combat Tasks.** A squad may be attached to a maneuver element if required by the tactical situation. Therefore, the squad leader becomes an independent manager of personnel, material, and equipment and must now plan, schedule, and control these assets. Normally, the squad leader does not require a formal portrayal of the CPM, but the basis for CPM becomes a valuable tool for the squad leader to accomplish combat tasks.

3.4.2 Limitations/Advantages of the Critical-path Method

The CPM is not a cure-all for engineer problems. It does not make decisions for the manager, nor can it contribute anything tangible to the actual construction. However, the CPM assists the manager in planning, scheduling, and controlling the project. Use of the CPM provides the following advantages:

1. It reduces the risk of overlooking essential tasks and provides a blueprint for long-range planning and coordination of the project.
2. It depicts the logical relationships between activities in a project, which is especially helpful if a new manager takes over the project.
3. It draws the manager's attention to the identified critical tasks.
4. It generates project information that the manager uses to make rational and timely decisions should complications develop.
5. It enables the manager to easily determine the necessary resources for project completion and the resource availability timeline.
6. It allows the manager to quickly determine what additional resources are necessary for project completion earlier than originally planned.
7. It provides feedback on a finished project, which allows the manager to improve techniques and assure the best use of resources on future projects.

Although military services use the CPM similarly, different procedures embedded in the culture of each military service occur throughout each training curriculum. For this reason, appendixes C and D present alternate CPM procedures.

3.5 LOGIC NETWORK

The project supervisor and assigned crew leaders construct a logic network that graphically illustrates the construction activity sequence from start to finish as well as the interdependencies among activities. Creation of the logic network during the project breakdown into construction activities ensures that no work items are overlooked. The project supervisor uses the initial list of construction activities as a starting point for the network. Refer to paragraph 2.3.12 for initial construction activities. Refer to paragraphs C.2 thru C.2.4 for alternate logic network procedures.

At this point, construction activity durations or crew sizes are immaterial. The pertinent concerns are identification of all required activities, sequence of work, and the relationships between activities. Although any basic diagramming technique can be used to develop the logic network, the recommended technique is to label pieces of paper with each activity name, place the labels in the sequence of construction on a roll of paper, tape the labels in place, and draw dependencies as required. The project supervisor creates the network, assigns activity numbers (refer to paragraph 2.3.12.2), and produces the initial construction activities list document (refer to figure 2-15).

Figure 3-2 illustrates a logic network in which each activity is represented by a rectangle (also known as a node), and the relationship between two or more activities is shown by a connecting arrow. Each activity is placed into a time segment of no specific duration. Activities Prefab (prefabricate) Forms and Set Rebar (reinforcing bar) cannot start until completion of activity Move-in, activity Set Forms cannot start until completion of activity Prefab Forms, and activity Place Concrete cannot start until completion of activities Set Rebar and Set Forms. This logic network example is simplified for clarity.

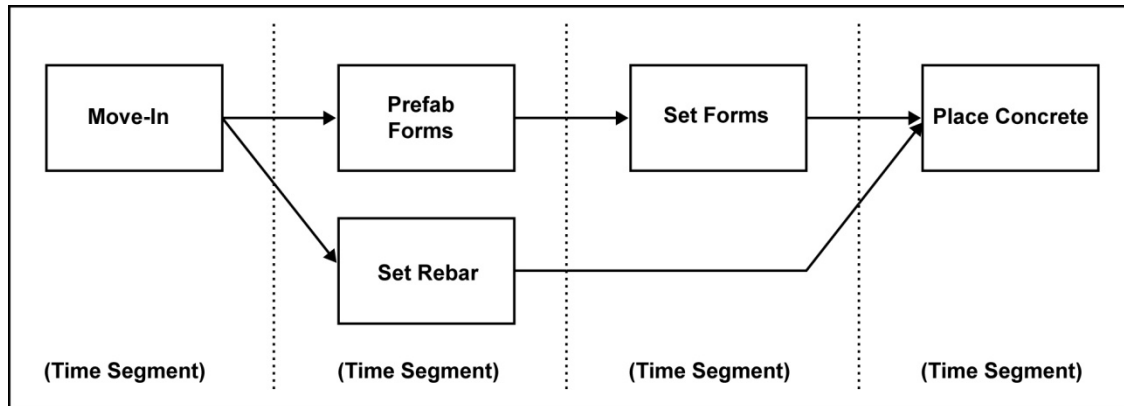


Figure 3-2. Logic Network: Sequence of Work

3.6 PRECEDENCE DIAGRAM

The precedence diagram's primary purpose is to show overall project duration and to identify the critical path. The critical path represents the group of construction activities that must be started on time and completed within the duration in order to finish the project by the scheduled completion date. Paragraphs 3.6.1 thru 3.6.4 discuss the CPM precedence diagram procedures. Refer to paragraphs C.3 thru C.5 for alternate CPM procedures.

3.6.1 Activity Durations and Resources

The logic network is constructed without regard to duration of activities or availability of required resources. However, precedence diagram development depends upon an accurate estimate of time and resources. The manager determines these times and resources for each construction activity using the estimating procedure discussed in chapter 4. Estimating data of durations and crew sizes forms the basis for calculating early and late event times, determining critical activities, tabulating activity times, and scheduling. Thus, CPM time analysis output depends upon estimating input. If an estimate changes because of new information or experience, the estimator uses the new data to update the time analysis. A time analysis based on outdated estimates is useless. Inputs necessary to the precedence diagram include the following:

1. Numbered activity list
2. Logic network diagram
3. Summary of activity durations.

3.6.2 The Activity Block

Each node of the logic network takes the form of an activity block during precedence diagram development. The activity block includes information as illustrated in figure 3-3. Appendices C and D present the USA/USMC version of the activity block and the USA/USMC methodology for conducting CPM and scheduling procedures. The CAS sheets completed during the estimating process provide the required resource information and activity duration times. Refer to chapter 4 for additional information on estimating and CAS sheets. The event-time numbers shown in the activity blocks represent the end of the time period. Thus, a start or finish time of day 5 indicates the end of the fifth day or the beginning of the sixth day. The manager uses activity block information to calculate the critical path through the forward pass and backward pass methods.

Activity Number		Activity Duration	
Early Start	Activity Description		Early Finish
Late Start	Total Float	Free Float	Late Finish

Figure 3-3. Typical Activity Block

3.6.3 Calculation Procedure

After establishing the initial precedence diagram, the manager calculates the earliest and latest times at which activities occur without violating the network logic or increasing the project's overall duration. This calculation provides the manager with a timeframe for each activity. Inability to complete each activity within its timeframe causes activity, task, or project delay. From this process, the manager easily identifies which tasks must be critically managed to ensure a minimized project duration. The process to determine early times, late times, and floats consists of three essential, sequential steps:

1. Forward pass
2. Backward pass
3. Total float (TF), free float (FF), and critical path.

Military engineers primarily use finish-to-start logic to calculate project duration. Refer to paragraph 3.6.4 for additional information on logic. Figure 3-4 provides an example for paragraphs 3.6.3.1 thru 3.6.3.5.

3.6.3.1 Forward Pass

The first step, the forward pass, determines the early start (ES) and early finish (EF). The manager begins with the first activity and plugs in a zero for its ES day (project workday). By adding the duration of that activity to the ES day, the manager computes the EF day. The EF day for an activity plus lag, if any, becomes the ES day for the next activity. Figure 3-4 shows that activity 03 10 10 has 2 preceding (predecessor) activities (03 10 00 and 31 20 20); the larger of the EF times (11 vice 10) plus lag determines the ES of the follow-on activity. There is zero lag.

Lag times are mandatory wait times between activities. A common example is concrete cure time where the lag is several days to several weeks after placing concrete before the crew can strip the forms. The following equations compute the EF and ES in the precedence diagram:

(Within the activity)

$$ES + DUR = EF$$

(Between activities)

$$* EF + \text{Lag (if any)} = ES \text{ (next activity)}$$

(With two or more predecessors, use the larger of the EF plus lag.)

Note

Equations marked with an asterisk (*) change for other types of logic.

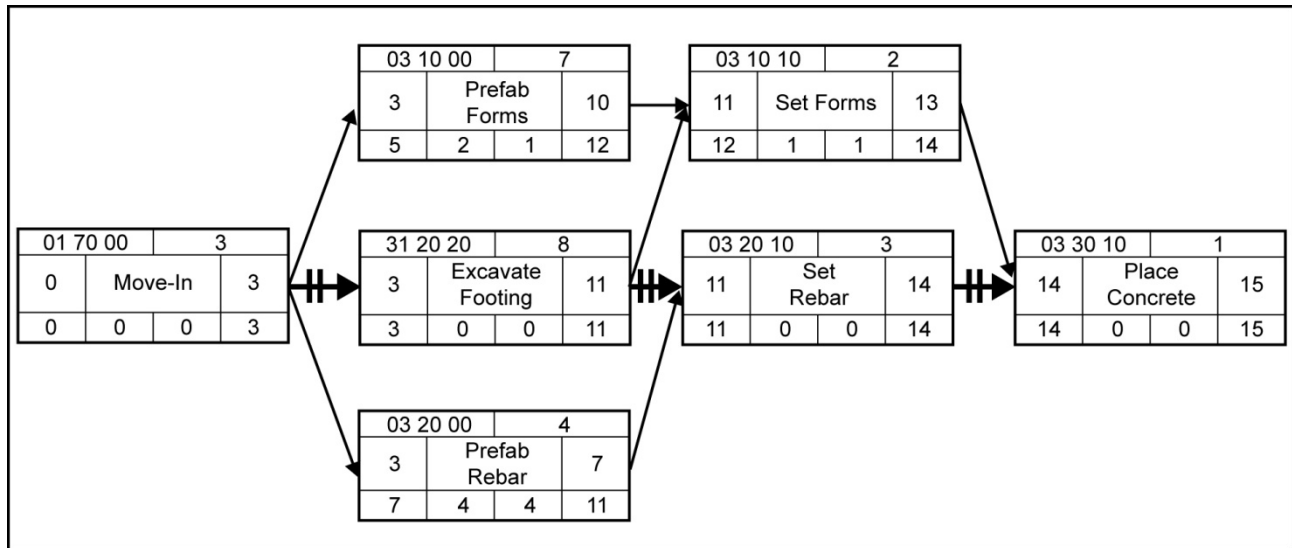


Figure 3-4. Precedence Diagram Example

The forward pass demonstrates that the early start and finish days for any activity depend upon the number and duration of the activities which must be completed prior to that activity starting.

3.6.3.2 Backward Pass

In the second step, the backward pass determines the late start (LS) times. The manager begins with the last activity and makes the late finish (LF) day the same day as the EF day. By subtracting the duration from the LF day, the manager computes the LS day. The LS day minus lag, if any, becomes the LF day for the preceding activity. Figure 3-4 shows that activity 31 20 20 has 2 follow-on (successor) activities (03 10 10 and 03 20 10); the smaller of the LS (11 vice 12) minus lag determines the LF for the preceding activity. The two equations below compute the LS and LF in the precedence diagram:

(Within the activity)

$$LF - DUR = LS$$

(Between activities)

$$* LS - \text{Lag (if any)} = LF \text{ (preceding activity).}$$

(With two or more successors, use the smaller of the late start minus lag.)

Note

Numbers are rounded up. Be aware that not all computer software programs round off, which may create different outcomes.

3.6.3.3 Critical Activities and the Critical Path

A critical activity, if delayed by any amount of time, delays the entire project's completion by the same amount of time. Critical activities, when linked together, always form a critical path along arrows from the start activity to the finish activity. The critical path focuses management attention on those activities which must not slip. The critical path as illustrated in figure 3-4 is 01 70 00, 31 20 20, 03 20 10, and 03 30 10.

The precedence diagram identifies a critical activity through application of the following rules:

1. The ES time for a particular activity is the same as the LS time.

2. The EF time for a particular activity is the same as the LF time.
3. The ES or LS added to the duration of the activity results in the EF or LF.

Managers use double slash lines, bold lines, or highlighted color to indicate the critical path on the precedence diagram. Any activity node not on the critical path will contain some float. Float is extra time available to complete an activity beyond the activity's actual duration such as having 6 days available to do 4 days of work. It is the scheduling leeway. No activities on the critical path have float.

The critical path may branch out or come back together at any point. A precedence diagram always has at least one critical path. All critical paths are continuous; any critical path that does not begin at the start node and end at the finish node indicates a logic mistake.

3.6.3.4 Total Float

Total float is the number of days an activity can be delayed without delaying the project completion date. In the example, activity 03 10 00 could finish as early as day 10 or as late as day 12. The 2 days of leeway in completing activity 03 10 00 anytime between day 10 and day 12 is called total float. Therefore, activity 03 10 00 has 2 days of TF. Managers compute TF by subtracting the EF day from the LF day (or the ES day from the LS day). Both calculations should be done in order to check for mathematical errors. Calculate TF on a forward pass. The following equation computes the TF in the precedence diagram:

$$TF = LS - ES \text{ or } LF - EF.$$

3.6.3.5 Free Float

Free float is the number of days an activity can be delayed without reducing float from the follow-on activity by delaying its ES date. Managers calculate the FF for an activity by subtracting its lag and EF from the ES for the next activity (successor). Free float calculation always uses the early days and occurs on a backward pass.

In the example, computation of the FF for activity 03 10 00 requires subtracting any lag between 03 10 00 and 03 10 10 (zero) and the EF for activity 03 10 00 (10) from the ES for activity 03 10 10 (11):

$$(11 - 0 - 10 = 1).$$

Free float for activity 03 10 00 is 1 day. Delaying activity 03 10 00 by 1 day will not delay activity 03 10 10 from its ES date. Delaying activity 03 10 00 by 2 days will delay the start of activity 03 10 10 until day 12 and will reduce the float for activity 03 10 00 by 1 day (to zero, in this case). Delaying activity 03 10 00 by more than 2 days will delay the project completion date, as 03 10 00 has only 2 days of TF. The following equation computes the FF throughout the precedence diagram illustrated in figure 3-4.

$$* FF = ES (\text{next activity}) - \text{Lag (if any)} - EF.$$

(With two or more successors, use the smaller of the $ES - \text{lag} - EF$.)

3.6.4 Different Logic Types

Finish-to-start logic is the most common logic type used by military engineers. It calculates the longest total project duration based on the logic that an activity has to finish before the following activity can start. The following three types of logic relationships are also used by military engineers:

1. Start-to-Start Logic. The start of the second activity depends upon the start of the first activity.
2. Finish-to-Finish Logic. The finish of the second activity depends upon the finish of the first activity.
3. Start-to-Finish Logic. The second activity cannot be completed until the first one starts. For example, engineers cannot cut off temporary power until they turn on a permanent electrical system.

Figure 3-5 illustrates the four logic types. Managers use the start-to-start and finish-to-finish logic to compress (shorten) the schedule. This compression occurs in the execution phase of the project to catch up if the project falls behind schedule. A repetitive project, such as roadway or pipeline construction, also benefits from this compression. Refer to paragraph C.7.3 for additional information on redefined logic.

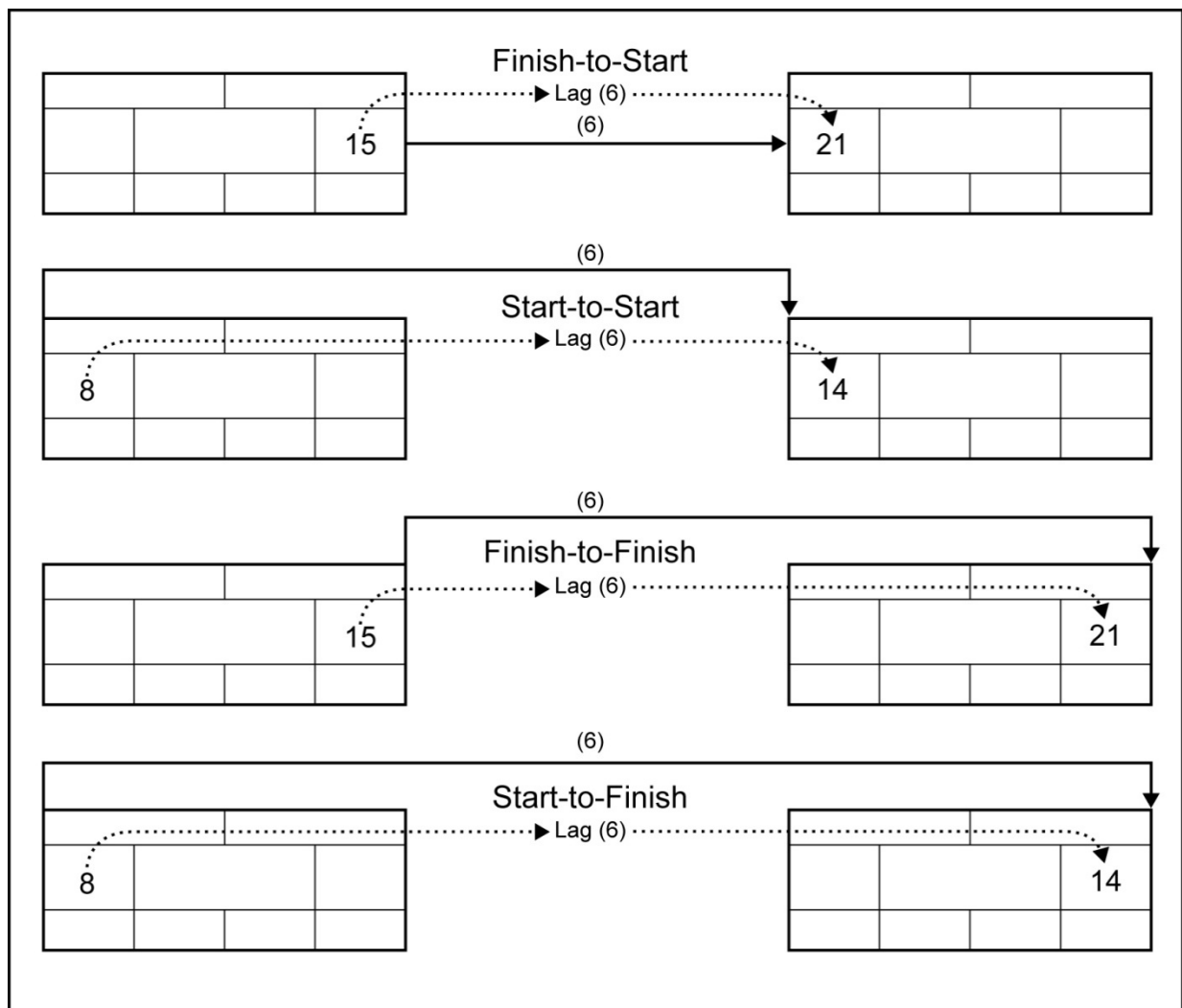


Figure 3-5. Logic Relationship Examples

3.6.4.1 Start-to-Start Logic Equations

Start-to-start logic equations follow:

Forward Pass

$$ES + DUR = EF$$

$$ES + Lag = ES \text{ (next activity)}$$

Backward Pass

$$LF - DUR = LS$$

$$LS - Lag = LS \text{ (preceding activity)}$$

Total Float

$$TF = LS - ES \text{ or } LF - EF$$

Free Float

$$FF = ES \text{ (next activity)} - Lag - ES.$$

3.6.4.2 Finish-to-Finish Logic Equations

Finish-to-finish logic equations follow:

Forward Pass

$$ES + DUR = EF$$

$$EF + Lag = EF \text{ (next activity)}$$

Backward Pass

$$LF - DUR = LS$$

$$LF - Lag = LF \text{ (preceding activity)}$$

Total Float

$$TF = LS - ES \text{ or } LF - EF$$

Free Float

$$FF = EF \text{ (next activity)} - Lag - EF.$$

3.7 LEVEL III GANTT CHART

The manager next constructs an activity schedule, taking information from the precedence diagram to create a Level III Gantt chart. A tool to manage resources and schedule activities, the Level III Gantt chart may be drawn manually or computer software-generated. Refer to paragraph C.6 for an alternate activity scheduling procedure known as the ES schedule.

The two steps used to create a Level III Gantt chart follow:

1. List each construction activity in order by its ES date.
2. Mark on the schedule each activity's timeframe. Scheduling each activity on the earliest possible day yields the early start Level III Gantt chart.

The time scale stretches from the first workday of the project to the last workday, as discussed in paragraph 3.2.

A bar represents the start date, finish date, and duration of each construction activity, as illustrated in figure 3-6. Managers establish the baseline start and finish dates prior to the start of the activity; a "piston" inside of the bar represents the actual start and forecast finish dates. If the activity starts on its ES date, the actual start and the baseline start remain in place. If the activity starts earlier or later than scheduled, the piston slides to the actual start date. As the activity progresses, the manager shades in the piston to represent percent complete or WIP. The series of dots shown after the bar represents TF.

Figure 3-7 illustrates a legend of common symbols used to create a Level III Gantt chart.

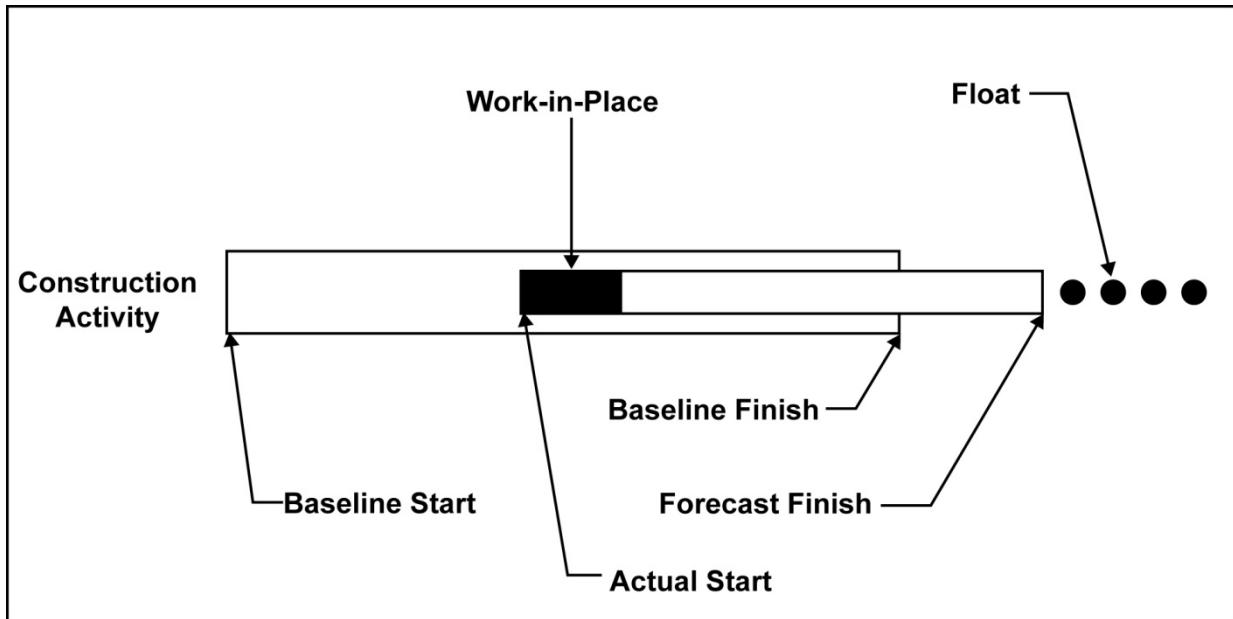


Figure 3-6. Activity Bar Example

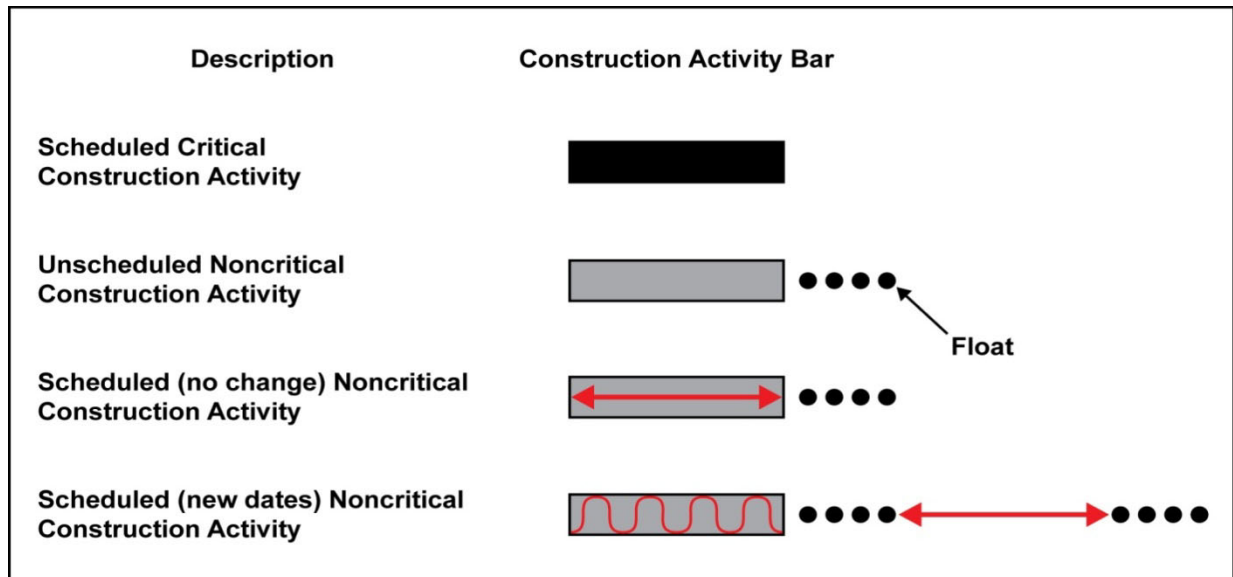


Figure 3-7. Legend for Level III Gantt Chart

A histogram may be manually added to the bottom of the Level III Gantt chart, as illustrated in figure 3-8. Some computer software programs also create the histogram. A histogram is used to show required resources as assigned by the user. Line items represent labor categories, equipment, and any other constrained item. Managers list the required resource totals for each day by column, each resource computed separately.

In the example shown in figure 3-8, scheduled labor requirement totals for each day contrast to available resources (crew size is seven). Requirements often exceed available resources for a given day, so managers must delay (reschedule using float time) selected activities to spread the requirements across the project timeframe and within the available resources.

3.8 RESOURCE LEVELING

Project supervisors have two primary goals:

1. Keep assigned troops gainfully employed every day.
2. Keep the work on schedule.

When daily equipment and personnel requirements exceed availability, the manager must resource-level requirements. Resource leveling involves shifting construction activity schedules to spread requirements across the timeframe of the project, while at the same time avoiding overall project duration delay. Rescheduling activities may result in additional critical activities and less available float for some activities within the schedule. Refer to appendix D for an alternative method for resource-constraining procedures.

3.8.1 Sample Level III Gantt Chart Ready for Resource Leveling

The primary objective of resource leveling is to schedule the noncritical work to coincide with personnel or equipment availability. Figure 3-8 illustrates a Level III Gantt chart used as a resource leveling sample problem, with application of the following information:

1. A portion of the first 2 months of a project's Level III Gantt chart is illustrated in figure 3-8.
2. Construction activities are sorted by ES date.
3. A crew of seven troops is available for the project duration.

The labor requirements summarized in the histogram are the total requirements needed if each activity starts on its ES date. The labor requirement as scheduled frequently exceeds or falls short of the available labor.

Information for the resource-leveling process draws from the precedence diagram, CAS sheets, and an activity summary sheet sorted by construction activity number. The activity summary sheet should contain the following information for each activity: CS, TF, baseline duration, and estimated MDs.

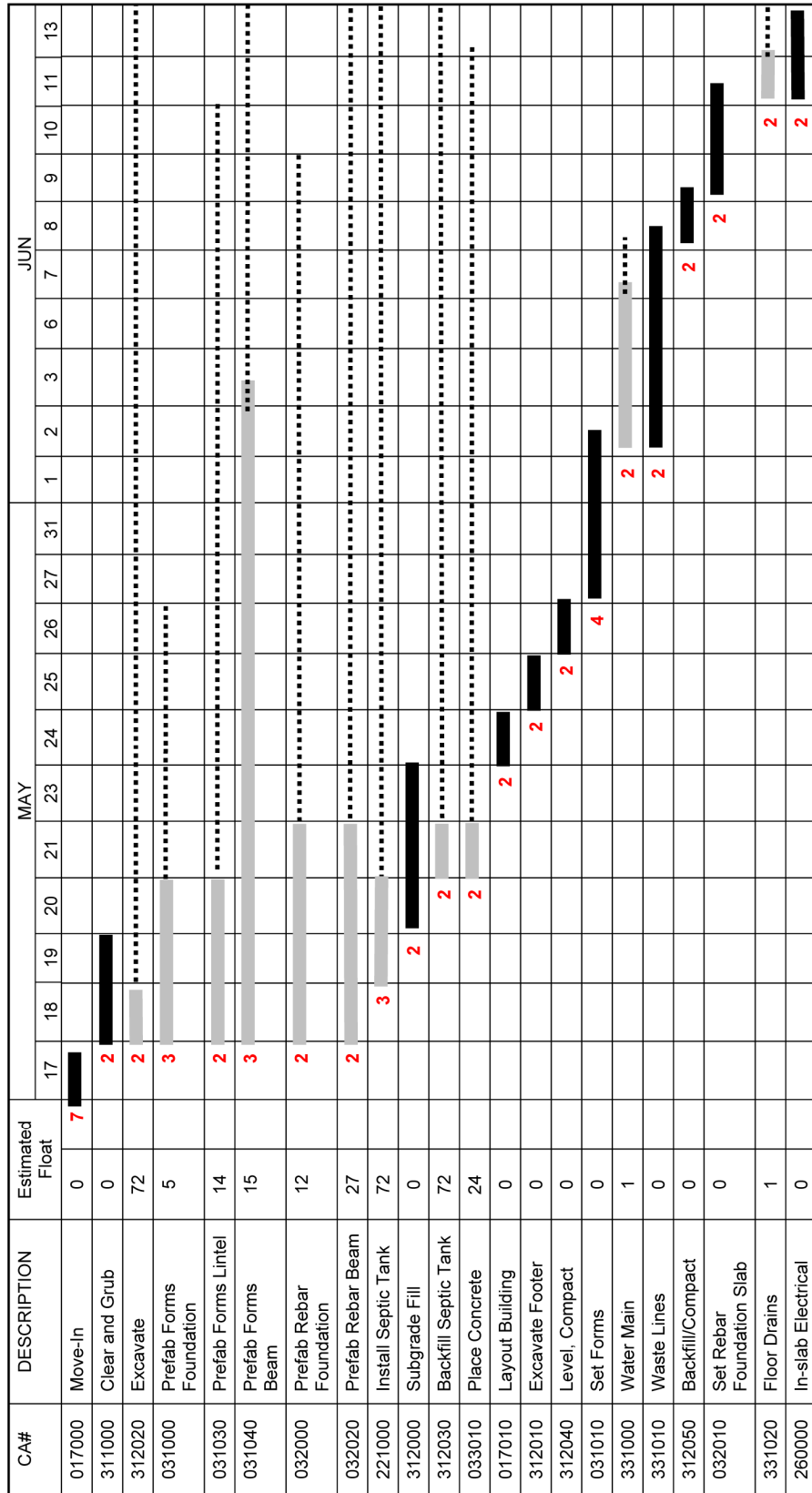


Figure 3-8. Level III Gantt Chart Example 1 (Sheet 1 of 2)

LABOR	17	18	19	20	21	23	24	25	26	27	31	1	2	3	6	7	8	9	10	11	13
	MAY											JUN									
Builder	6	8	8	8	5	3	5	3	3	7	7	7	3								
Electrician																				2	2
Engineering Services																					
Equipment Operator (EO)	1	4	3	3	4	2		2	1												
Steelworker (SW)			2	2					1									2	2		
Utilitiesman (UT)													4	4	4	2				2	
Other Crew Members	4	4	4	4	4												2				
TOTAL LABOR RESOURCES	7	16	17	17	13	5	5	5	5	7	7	7	7	4	4	2	2	2	2	4	2

Figure 3-8. Level III Gantt Chart Example 1 (Sheet 2 of 2)

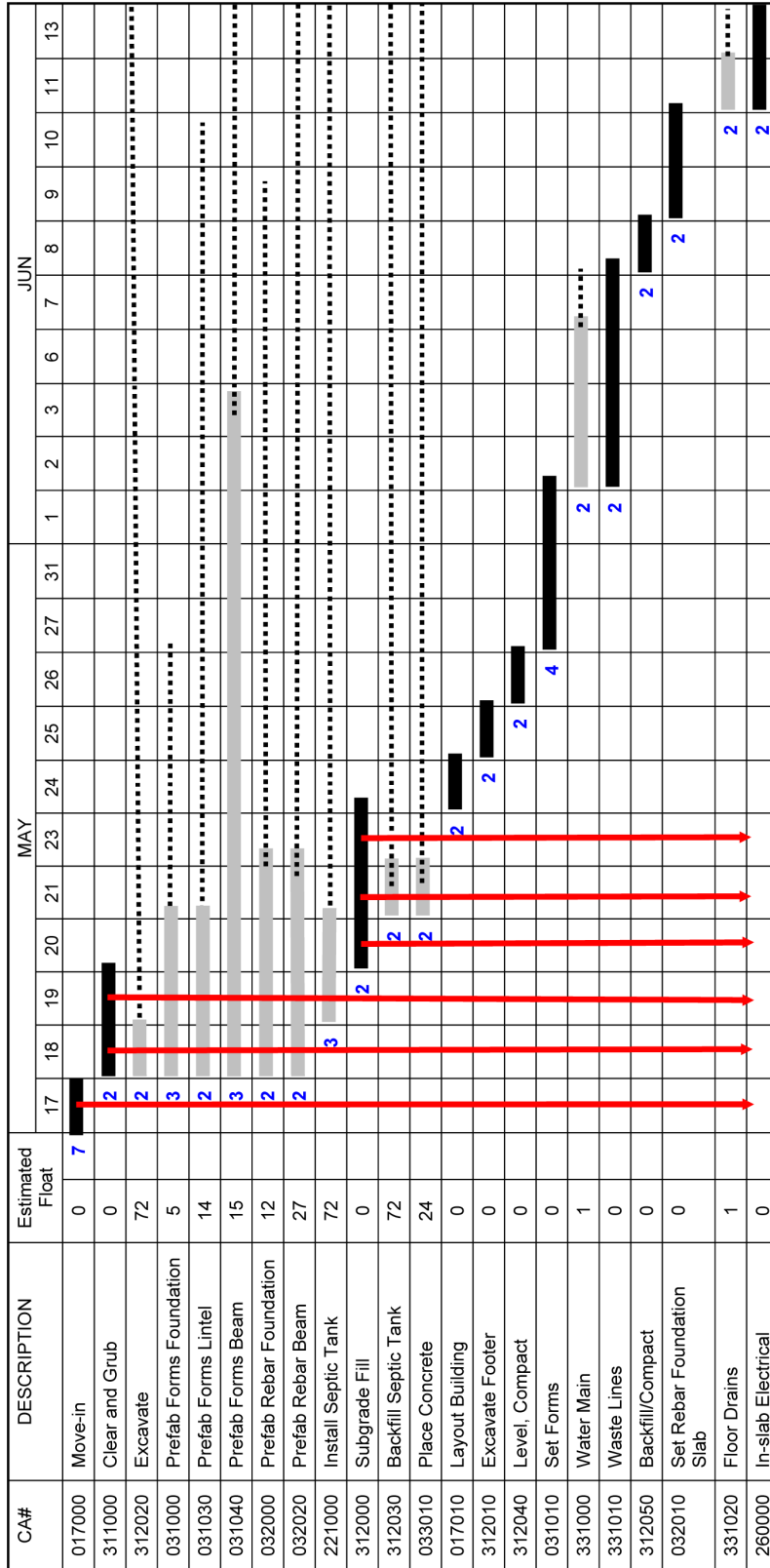


Figure 3-9. Level III Gantt Chart Example 2 (Sheet 1 of 2)

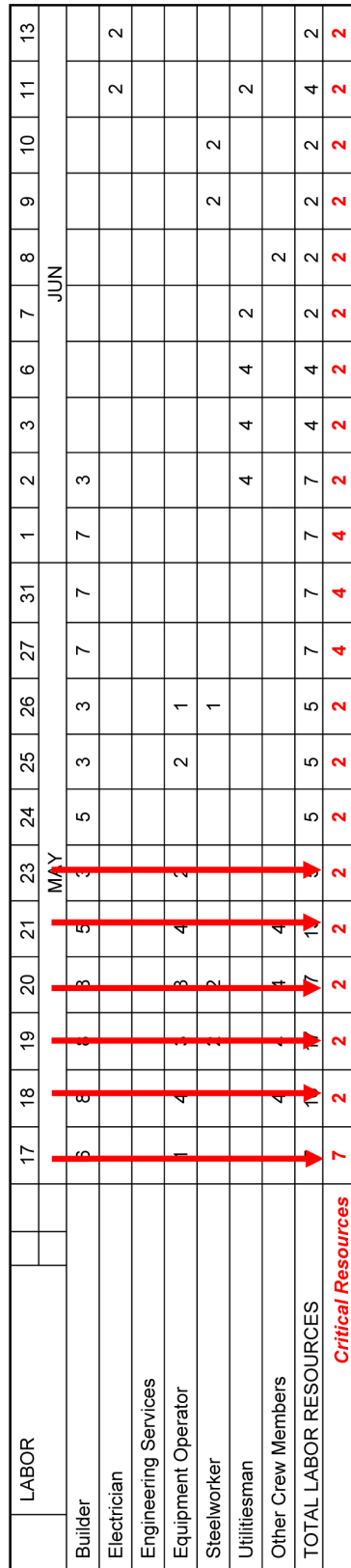


Figure 3-9. Level III Gantt Chart Example 2 (Sheet 2 of 2)

3.8.2 Resource Leveling Example Problem

The sample problem requires labor resource leveling in order to put seven people to work each day. Rates do not matter at this point. Resource leveling by rate follows the same process.

The first step is identification of daily critical-path labor requirements, listed in the critical resources row at the bottom of the histogram illustrated in figure 3-9. As shown, the critical path alone will not keep the entire crew busy. The start of noncritical activities shown on their ES dates needs to be delayed until availability of sufficient numbers of workers. The manager should always schedule the start of any delayed noncritical activities to coincide with available personnel (days where total resource required at the bottom of the page is less than seven).

The Level III Gantt chart is manually resource-leveled. Working from the top to the bottom, the manager uses the following four steps to schedule activities:

1. Find the activity with the least amount of TF.
2. Find the first available dates with available resources.
3. Mark the dates to schedule the activity.
4. Update the resources on the histogram at the bottom of the page.

Refer to the Level III Gantt chart in figure 3-10 for the resource leveling example below.

On the left side of the page, activity 33 10 00 is the first activity with the least amount of TF (1 day). Its ES date is June 2 and its duration is 3 days. The number of scheduled personnel for critical activities on these dates is 2, scheduled to work on critical activity 33 10 10. Since available crew number 7, the project manager marks activity 33 10 10 to start on its ES date and updates the resources on the histogram to 4 total. An activity does not move unless it must. If activity 33 10 00 moves 1 day, it becomes critical because it has 1 day only of TF. If it moves more than 1 day, it extends the project completion date.

The next activity with the least amount of TF, activity 33 10 20, also has 1 day of TF. Because June 11 has only 2 people working a critical activity, the project manager schedules activity 33 10 20 on its ES date. This brings the total resources on the histogram to four. No other activities show 1 day only of float.

From the top of the page again, the next activity with the least amount of TF is activity 03 10 00 (5 days). The project manager schedules it on its ES date and repeats the process for activity 03 20 00. Now the first four project days are at the maximum crew size (seven). Activities 31 20 20, 03 10 30, 03 10 40, 03 20 20, and 22 10 00 have start days during this timeframe. This means that they cannot start on their ES dates and must be moved.

The project manager cannot move an activity without consulting the precedence network to see if any other activities must move with it. Activity 03 10 30 has the next least amount of TF. The precedence diagram shows that activity 03 30 10 is dependent on 03 10 30, so if activity 03 10 30 moves, activity 03 30 10 must move at least the same amount.

The first available days to schedule activity 03 10 30 are May 21 thru 24. The first available day to start activity 03 30 10 after activity 03 10 30 is the following day, May 25. The next activity moved is activity 03 10 40, now scheduled for May 23 thru June 8. This process continues through the rest of the project schedule.

Note

Do not move activities unless necessary.

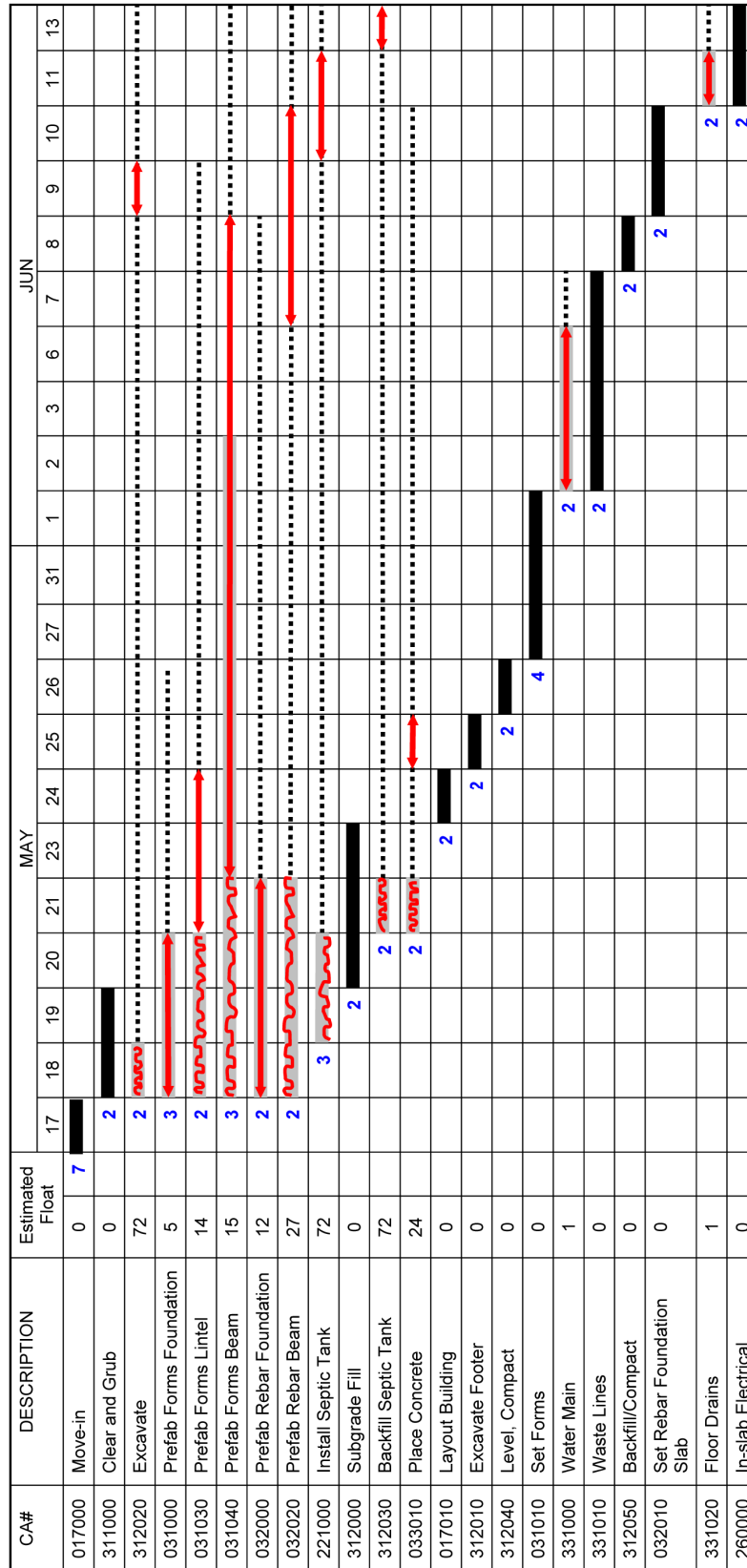


Figure 3-10. Level III Gantt Chart Example 3 (Sheet 1 of 2)

LABOR		17	18	19	20	21	23	24	25	26	27	31	1	2	3	6	7	8	9	10	11	13
		MAY											JUN									
Builder		6	8	8	8	5	3	5	3	3	7	7	7	3								
Electrician																					2	2
Engineering Services																						
Equipment Operator	1	4	3	3	4	2			2	1									2	2		
Steelworker				2	2					1												
Utilitiesman														4	4	4	2				2	
Other Crew Members		4	4	4	4												2					
TOTAL LABOR RESOURCES		7	16	17	17	13	5	5	5	5	7	7	7	7	4	4	2	2	2	2	4	2
		7	2	2	2	2	2	2	2	2	4	4	4	2	2	2	2	2	2	2	2	2
			5	5	5	4	4	4	4	5	7	7	7	4	4	4	5	5	4	4	4	4
			7	7	7	6	7	7	7					7	7	7	7	7	6	7	7	

Figure 3-10. Level III Gantt Chart Example 3 (Sheet 2 of 2)

At the end of the resource-leveling process, the total resources show the project manager where to adjust the project. On May 21, the project has 6 people scheduled. On May 26, the project has 5 people scheduled. Activity 31 20 20 (Excavate Septic Tank) could have been completed during this time, but activity 22 10 00 (Install Septic Tank) could not start until June 9. Since it is not practical to dig a hole and leave it empty for 2 weeks, activity 31 20 20 stays as scheduled.

The manager enters the new dates once all the activities are scheduled, creating a new Level III Gantt chart and then determines crew rate/trade makeup. Figure 3-10 shows that May 24 requires 7 builders. The activities during this timeframe, 03 10 30 (Prefab Lintel Forms), 03 10 40 (Prefab Forms Beams\Canopy), and 01 70 10 (Layout Building), require 3 skilled builders (1 on each activity), and the 4 other resources needed could be other crew not scheduled to work at this time.

Another option is to move activity 03 10 30 ahead a few days to take advantage of float. This brings the requirement down to two skilled builders. On May 25, the project needs 5 skilled builders. The activities during this timeframe, 03 10 40 and 03 20 10, require 2 skilled builders, and the 3 other resources could be other crew. The manager enters all crew makeup changes and final start dates into the computer software program and then prints out a new Level III Gantt chart.

3.9 LEVEL II GANTT CHART

The Level II Gantt chart is created using information derived from the Level III Gantt chart. After resource leveling, the manager prints a Level III Gantt chart with construction activities sorted by activity number rather than ES date, which makes the transfer of information to the Level II Gantt chart easier. The CAS sheets, or CAS report, provide the necessary MD estimate for each activity. Figure 3-11 illustrates a Level III Gantt chart after resource leveling. This figure represents only a portion of the complete Level III, but it provides clarity for Step 1 below. Paragraphs 3.9.1 thru 3.9.7 discuss the seven-step process to develop a Level II Gantt chart. Refer to figure 3-12 for clarity on Steps 2 thru 7.

3.9.1 Step 1

1. Calculate the estimated MDs per reporting period (normally 1 week) by MA from the project's Level III Gantt chart, then transfer that information to the project's Level II Gantt chart.
2. Draw in heavy horizontal lines to distinguish each MA and heavy vertical lines to distinguish each work week.
3. Next, write in the number of estimated MDs to the left or right side of the bar representing each activity. Where an activity is split between weeks, prorate the MDs between the weeks. Subtract any non-workdays in the week period for an accurate accounting of duration and then divide the total construction activity MDs by the number of days duration to produce the MDs per day for the activity. Multiply this number by the number of workdays in the week, and round up or down as needed to produce the activity MD total equal to the estimated MD total.

For example, activity 03 10 30 is estimated at 5 MDs (refer to figure 3-11). The date line shows that this activity spans 4 days of duration, but also that May 23 is a non-workday. This changes the duration from 4 days to 3 days. Dividing 5 MDs by 3 duration days produces 1.67. This number is then multiplied by the number of days in each week: 2 days to the left of the vertical week line equals 3.34 MDs, and 1 day to the right of the vertical week line equals 1.67. Rounding these numbers to 3 MDs and 2 MDs, respectively, equals a total of 5 MDs.

4. Finally, total the MDs per week for each MA, and total the estimated MDs for all construction activities in each MA. The circled numbers in figure 3-11 represent these totals.
5. Transfer the information from the Level III Gantt chart to the Level II Gantt chart, as illustrated in figure 3-12. This figure is an example for the remaining steps in this process. The Level II Gantt chart format lists MA numbers and titles in the left columns and the last workday of every two-week period of the entire project across the top for a timeline. The project's Level III Gantt chart provides these dates.

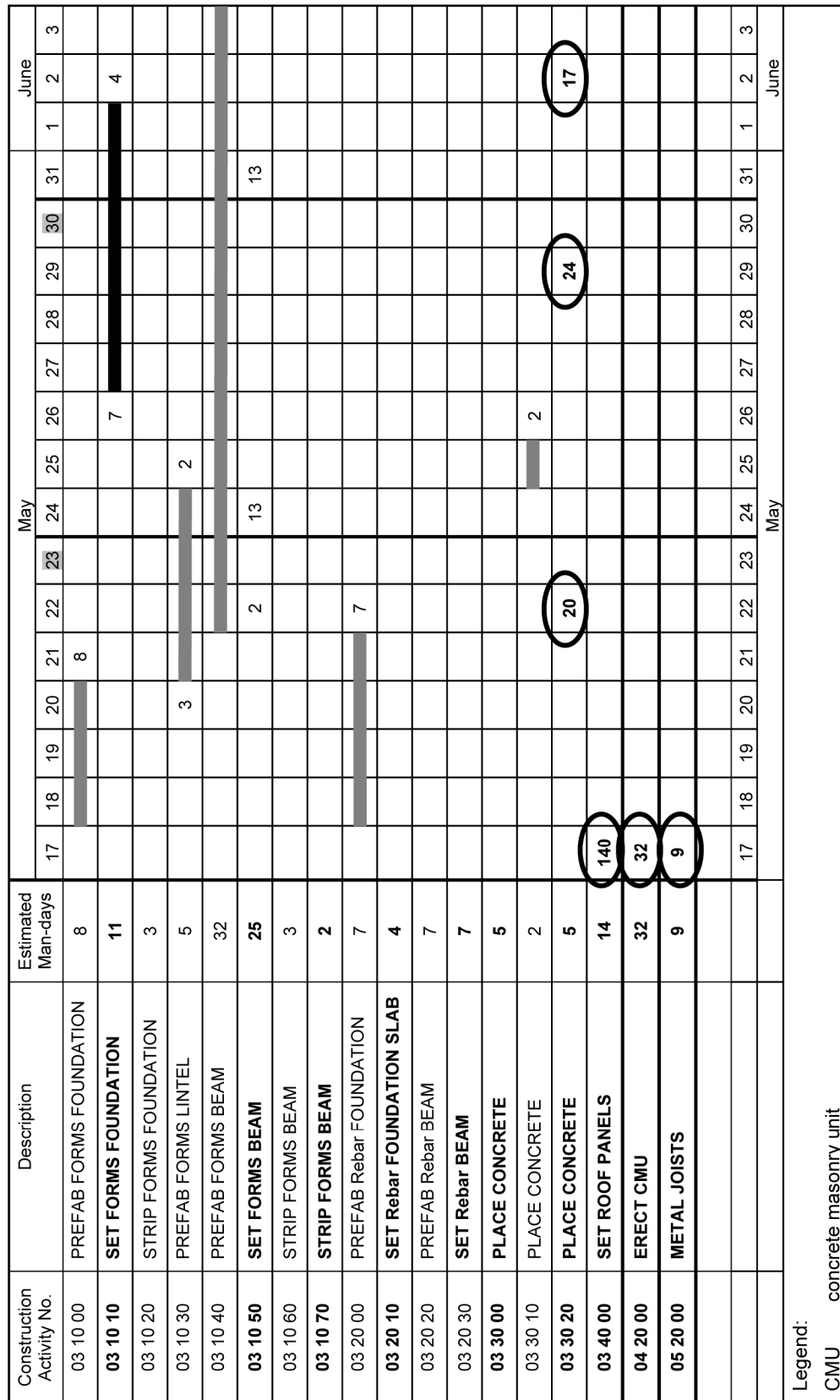


Figure 3-11. Level III Gantt Chart Example 4

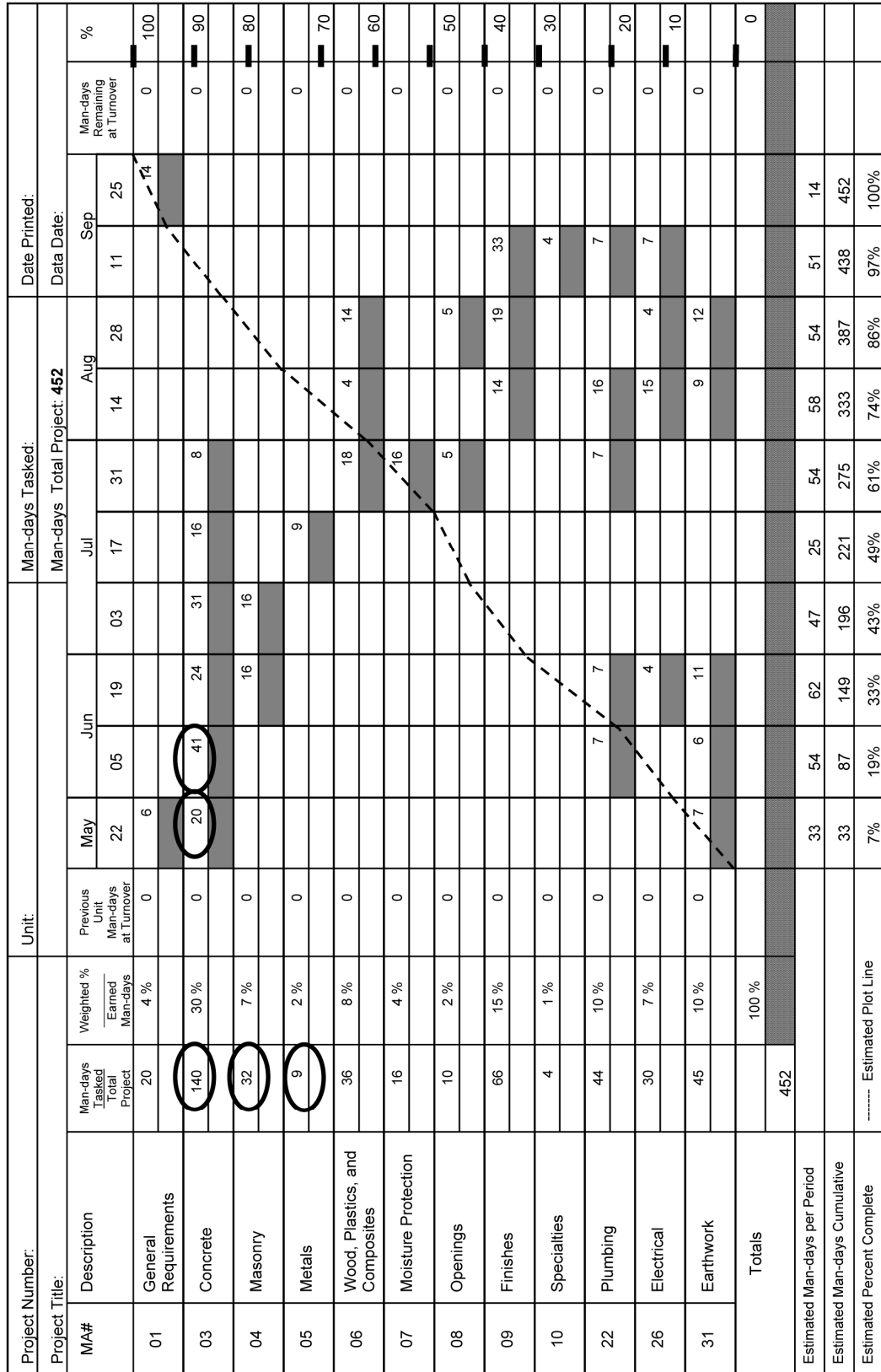


Figure 3-12. Level II Gantt Chart Example

3.9.2 Step 2

1. Transfer the MDs per time period for each MA from the Level III Gantt chart (refer to the circled numbers in figure 3-11) to the project's Level II Gantt chart.

For example, MA 03 has 20 MDs scheduled for the period ending May 22 and 24 + 17 MDs, totaling 41 MDs, scheduled for the period ending June 5. This process continues through the end of the Level III for all construction activities under MA 03. On the Level II, draw a horizontal bar or shade in each period that shows work (e.g., the periods ending on May 22 and June 5), and put the MDs scheduled for each period above the bar. Time periods with no scheduled work remain blank.

2. Repeat this process for each MA until the MDs per time period are all recorded on the Level II Gantt chart.

3.9.3 Step 3

1. Add the total MDs scheduled for each construction activity on the Level III to compute a total for that group's MA.
2. Place this number in the MDs Tasked column on the Level II Gantt chart. For example:
 - a. Master activity 03 (refer to figure 3-11) lists a total of 140 MDs (8 + 11 + 3 + 5 + 32 + 25 + 3 + 2 + 7 + 4 + 7 + 7 + 5 + 2 + 5 + 14).
 - b. Master activity 04 lists a total of 32 MDs. Repeat this process for each MA.

3.9.4 Step 4

1. Total the master activity MDs for the project by adding up the MDs Tasked column on the Level II Gantt chart. The total for this example is 452.
2. Place this number at the bottom of the MDs Tasked column and on the MD Total Project line at the top of the Level II Gantt chart.

3.9.5 Step 5

1. To determine the weighted percent by MA, divide the master activity MD estimate by the total project MD estimate, expressed as a percentage (multiplied by 100). For example:
 - a. Master activity 01 has 20 MDs total:

$$20/452 \times 100 = 4 \text{ percent}$$
 (round off to the nearest whole number).
 - b. Master activity 03 has 140 MDs total:

$$140/452 = 31 \text{ percent.}$$
2. Repeat this process for each MA.

3. Total the Weighted Percent column when each MA is done. This total must equal 100. If it does not, add to or subtract from the highest weighted percent to reach 100. For example:

The total of the Weighted Percent column, with MA 03 percent rounded up, totals 101.

$$140/452 \times 100 = 30.9.$$

Rounding down rather than up changes MA 03's weighted percent to 30 vice 31, so the column total equals 100.

3.9.6 Step 6

1. Calculate MDs scheduled for each two-week period.
2. Total the MDs scheduled for each two-week period at the bottom of each column in the Estimated MDs per Period row at the bottom of the Level II Gantt chart. For example:

For the period ending May 22,
 $6 + 20 + 7 = 33$ MDs.

3. Repeat this process for each work time period column.

The Estimated MDs Cumulative row equals the MDs scheduled for each two-week period added to all previous MDs scheduled. For example:

- a. The first two-week period is 33 MDs.
- b. The second two-week period is 87 MDs ($33 + 54$).
- c. The third two-week period is 149 MDs ($87 + 62$).

The last number in this row should equal the MDs Total Project estimate (452). If it does not, recalculate to find the math error.

3.9.7 Step 7

1. Calculate the scheduled percent complete curve. The Estimated Percent Complete row equals the cumulative MDs scheduled that period divided by the MDs Total Project, expressed as a percent (multiplied by 100). For example:
 - a. For the period ending May 22,
 $33/452 \times 100 = 7$ percent.
 - b. For the period ending June 5,
 $87/452 \times 100 = 19$ percent
(round off to the nearest whole number).
2. Plot the scheduled percent complete at the end of each two-week period against the percentage scale on the right of the Level II Gantt chart.
3. Find the percent scheduled for each two-week period and place a dot on the vertical line at the end of that two-week period.
4. Connect the dots to complete the scheduled percent complete curve.

3.10 LEVEL I GANTT CHART/SYNCHRONIZATION MATRIX

Military engineers use the Level I Gantt chart (also known as a synchronization matrix) as the primary management tool to integrate efforts and manage overall unit tasking. The horizontal timeline for a Level I specifies months; the vertical line items are individual projects and reflect total MDs planned and/or expended. The project manager creates the Level I Gantt chart in a process similar to the Level II Gantt chart, using information derived from Level II Gantt charts and project SITREPs.

Figure 3-13 illustrates an unconstrained example of a Level I Gantt chart. Figure 3-14 illustrates a Level I Gantt chart resource-leveling first attempt example. Figure 3-15 illustrates a Level I Gantt chart resource-leveling second attempt example.

Supported Command:				Unit:	Total Project MDs Estimated: 3639												Date Printed:						
Operation:				Location:	Total MDs Tasked: 3339												Data Date:						
Project ID Number	Description	MDs Estimate	MDs at Turnover Weighted %	WIP ~ Estimate Est ~ Tasked	Feb 00	Mar 00	Apr 00	May 00	Jun 00	Jul 00	Aug 00	Sep 00	MDs at Turnover ECD	ME 1,250									
01	Camp Maintenance	Total Project	Earned MDs	WIP ~ Tasked	12	26	11	25	8	22	6	20	3	17	1	15	29	12	26	9	Status	100	100%
		100	0	0%	32	35	33																
		100	3.0%	100%																			
		100	0	0%																			
02	OIC Discretionary	100	0	0%	33	33	34														100	90%	
		100	3.0%	100%																			
		100	0	0%																			
		100	0	0%																			
03	Direct Labor Training Allocation	239	0	0%	6	27	6	27	6	27	6	27	6	27	6	27	6	27	6	2	239	70%	
		239	7.2%	100%																			
		239	99	0%																			
		500	0	0%	45	37	64	37	64	37	64	37	64	37	64	37	14				500	60%	
04	Dog Kennel Renovation (6 DL)	500	15.0%	100%																		50%	
		500	242	0%																			
		400	0	0%	58	53	58	53	58	53	58	9									400	40%	
		400	12.0%	100%																			
05	Expand Red Label Area (5 DL)	400	0	0%																		30%	
		800	0	0%	105	96	105	96	105	96	105	92									800	20%	
		800	24.0%	100%																			
		800	0	0%																			
06	Upgrade Aircraft Wash (9 DL)	1500	0	0%	119	149	164	149	164	149	164	142									1200	10%	
		1200	35.9%	100%																			
		1500	0	0%																		0	
		3639	100.0%																		3339		
Total Project MDs Estimated				3339																		Availability Factor 85%	
EARNED MDs Per Period				Average																			
EARNED MDs Cumulative				-----																			
EARNED Percent Complete				Total																			
ESTIMATED MDs Per Period				Average	398	430	464	362	397	362	397	307	70	64	20	27	6	27	6	2	MD Capability 3363		
ESTIMATED MDs Cumulative				-----	2413	398	828	1292	1645	2051	2413	2810	3117	3187	3251	3271	3298	3304	3331	3339			
ESTIMATED Percent Complete				Total	72	12	25	39	50	61	72	84	93	95	97	98	99	99	100	100			
Work Days Available This Period				Average	10	8	10	11	10	11	10	11	10	11	10	11	10	11	10	11	MD Tasked 3339		
Direct Labor Available This Period				Average	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20			
MDs Available This Period				Average	210	170	213	234	213	234	213	234	213	234	213	234	213	234	213	234			
MDs Available Cumulative				Total	1832	170	383	617	830	1064	1277	1511	1724	1958	2171	2405	2618	2852	3065	3299	+ OVER/- UNDER -24		
+ OVER / - UNDER TASKED this period				Average	-2	228	217	230	149	163	149	163	94	-164	-149	-214	-186	-228	-186	-228			
EXPENDED MDs Per Period				Average																			Percent Tasked 99 %
EXPENDED MDs Cumulative				-----																			
EXPENDED As Percent of Tasking				Total																			Total Work Days: 158

Figure 3-13. Level I Gantt Chart—Unconstrained Example

Supported Command:										Unit:	Total Project MDs Estimated: 3639										Date Printed:												
Operation:					Location:					Total MDs Tasked:	Data Date:																						
Project ID Number	Description	MDs Estimate	MDs at Turnover Weighted %	MDs Tasked	WIP ~ Estimate Est ~ Tasked	Feb 00	Mar 00	Apr 00	May 00	Jun 00	Jul 00	Aug 00	Sep 00	MDs at Turnover ECD	ME 1250																		
01	Camp Maintenance	Total Project	Earned MDs	WIP ~ Tasked	WIP ~ Tasked	12	26	11	25	8	22	6	20	3	17	1	15	29	12	26	9	Status	100	100%									
		100	0	0%	0%	32	35	33																									
		100	3.0%	100%																													
		100	0	0%	0%																												
02	OIC Discretionary	100	0	0%	0%	33	33	34														100	90%										
		100	3.0%	100%																													
		100	0	0%	0%																												
		100	0	0%	0%																												
03	Direct Labor Training Allocation	239	0	0%	0%	6	27	6	27	6	27	6	27	6	27	6	27	6	27	6	2	239	70%										
		239	7.2%	100%																													
		239	0	0%	0%																												
		500	0	0%	0%	45	37	64	37	64	37	64	37	64	37	64	37	64	37	64	2	500	60%										
04	Dog Kennel Renovation (6 DL)	500	15.0%	100%																													
		500	0	0%	0%																												
		400	0	0%	0%																												
		400	12.0%	100%																													
05	Expand Red Label Area (5 DL)	400	0	0%	0%																												
		400	0	0%	0%																												
		800	0	0%	0%																												
		800	24.0%	100%																													
06	Upgrade Aircraft Wash (9 DL)	800	0	0%	0%																												
		800	0	0%	0%																												
		1500	0	0%	0%	119	149	164	149	164	149	164	142																				
		1200	35.9%	100%																													
07	Construct Covered Storage (14 DL) **TURN OVER**	1500	0	0%	0%																												
		1500	0	0%	0%																												
		3639	100.0%																														
		3339																															
EARNED MDs Per Period		Average																				Availability Factor 85%											
EARNED MDs Cumulative																																	
EARNED Percent Complete		Total																															
ESTIMATED MDs Per Period		Average		239		235		281		213		234		206		233		213		183		189		190		43		MD Capability 3363					
ESTIMATED MDs Cumulative				1477		235		516		817		1264		1477		1917		2363		2546		2735		3106		3339							
ESTIMATED Percent Complete		Total		44		7		15		24		31		38		44		51		64		71		82		87		93		99		100	
Work Days Available This Period		Average		10		8		10		11		10		11		10		11		10		11		10		11		3		MD Tasked 3339			
Direct Labor Available This Period		Average		20		20		20		20		20		20		20		20		20		20		20		20		20					
MDs Available This Period		Average		210		170		213		234		213		234		213		234		213		234		213		234		64					
MDs Available Cumulative		Total		1832		170		383		617		830		1064		1277		1511		1724		1958		2171		2405		2618		3363			
+ OVER / - UNDER TASKED this period		Average		-2		65		68		67		0		0		-7		-1		0		-51		-24		-44		-21		+ OVER /- UNDER -24			
EXPENDED MDs Per Period		Average																										Percent Tasked 99 %					
EXPENDED MDs Cumulative		Total																															
EXPENDED As Percent of Tasking																												Total Work Days: 158					

Figure 3-14. Level I Gantt Chart—Resource-leveling Attempt 1 Example

Supported Command:				Unit:		Total Project MDs Estimated: 3639												Date Printed:	
Operation:				Location:		Total MDs Tasked: 3339												Data Date:	
Project ID Number	Description	MDs Estimate	MDs at Turnover	WIP - Estimate	WIP - Tasked	Feb 00	Mar 00	Apr 00	May 00	Jun 00	Jul 00	Aug 00	Sep 00	MDs at Turnover	ME				
		MDs Tasked	Weighted %	Est ~ Tasked	WIP ~ Tasked	12	11	8	6	3	1	26	9	ECD	1250				
01	Camp Maintenance	Total Project	Earned MDs																
		100	0	0%															
		100	3.0%	100%												100			
		100	0	0%															
02	OIC Discretionary	100	0	0%															
		100	3.0%	100%															
		100	0	0%															
		100	0	0%															
03	Direct Labor Training Allocation	239	0	0%															
		239	7.2%	100%															
		239	0	0%															
		500	0	0%															
04	Dog Kennel Renovation (6 DL)	500	15.0%	100%															
		500	0	0%															
		500	0	0%															
		400	0	0%															
05	Expand Red Label Area (5 DL)	400	12.0%	100%															
		400	0	0%															
		800	0	0%															
		800	24.0%	100%															
06	Upgrade Aircraft Wash (9 DL)	800	0	0%															
		800	0	0%															
		800	0	0%															
		1500	0	0%															
07	Construct Covered Storage (14 DL) **TURN OVER**	1200	35.9%	100%															
		1500	0	0%															
		3639	100.0%																
		3339																	
Total MDs Tasked																			
EARNED MDs Per Period		Average														Availability Factor 85%			
EARNED MDs Cumulative		Total																	
EARNED Percent Complete																			
ESTIMATED MDs Per Period		Average														MD Capability 3363			
ESTIMATED MDs Cumulative		Total																	
ESTIMATED Percent Complete																			
Work Days Available This Period		Average														MD Tasked 3339			
Direct Labor Available This Period		Average																	
MDs Available This Period		Average																	
MDs Available Cumulative		Total														+ OVER / - UNDER			
+ OVER / - UNDER TASKED this period		Average															-24		
EXPENDED MDs Per Period		Average															Percent Tasked 99 %		
EXPENDED MDs Cumulative		Total														Total Work Days: 158			

Figure 3-15. Level I Gantt Chart—Resource-leveling Attempt 2 Example

CHAPTER 4

Detailed Project Planning

4.1 INTRODUCTION

Effective project planning is essential to successful project execution. Project Phase 2 is designed for managers to develop the construction plan. This plan consists of an accurate construction estimate comprising the tools, equipment, materials, and personnel required for each construction activity. It includes a schedule for the entire construction project and a plan for monitoring and controlling construction.

Planning actions include the creation or validation of a BOM; the completion of product and resource-leveling schedules; CAS sheet development; and the preparation and distribution of QC, safety, and environmental protection plans through the chain of command for review. This phase ends upon project package consolidation and readiness for the approval process.

Figure 4-1 illustrates Project Phase 2 inputs, process, and outputs.

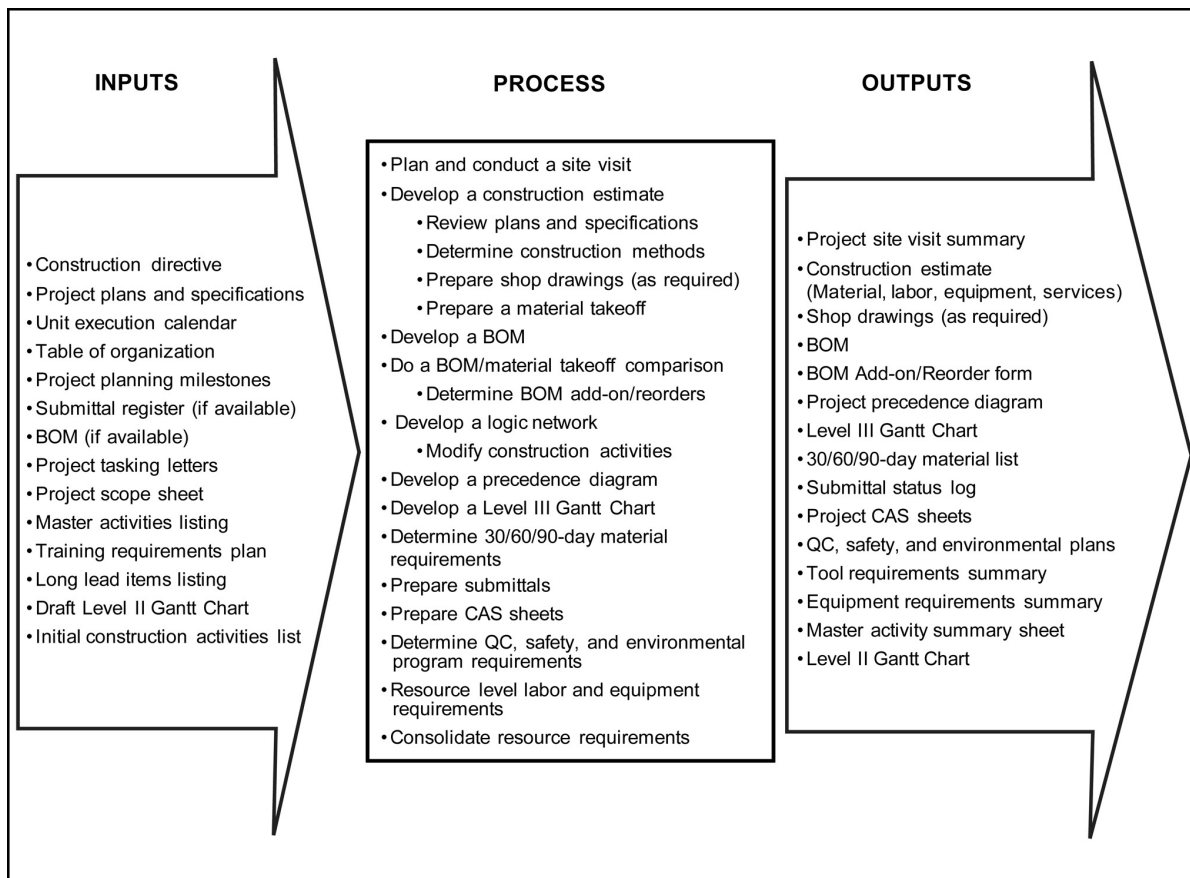


Figure 4-1. Project Phase 2 Outputs

4.2 INPUTS

Detailed planning and estimating requires the following essential items before development can begin:

1. Construction directive (includes the commander's intent)
2. Project plans
3. Project specifications
4. Unit execution calendar
5. Table of organization
6. Project planning milestones
7. Submittal register.

Other value-added planning inputs include:

1. Bill of materials (if available)
2. Project tasking letters
3. Project scope sheet
4. Master activities listing
5. Training requirements plan
6. Long lead items listing
7. Draft Level II Gantt chart
8. Initial construction activities list.

4.3 PROCESS

Managers develop the construction plan using, at a minimum, the required essential inputs. Managers consider two fundamental questions:

1. How to accomplish the project tasking?
2. What is needed to accomplish project tasking?

The answers to these questions form the foundation of construction plan development.

4.3.1 Conduct a Site Visit

A project site visit verifies existing conditions as represented on construction site plans. Since detailed planning yields a significant number of questions that are typically resolved during a preconstruction site visit, it is important for the project supervisor to document the information requirements and assumptions in a checklist format so the site visitor can address specific concerns. A project manager from the unit or HHQ often conducts the site visit. If the situation allows and if time and resources are available, it can be beneficial to include project supervisors and sometimes crew leaders in the site visit. Figure 4-2 illustrates a sample project site visit summary form.

PROJECT SITE VISIT SUMMARY			
Project Title: _____		Number: _____	
Site Visit Conducted by: _____		Date: _____	
Status of Project:	NEW START	TURNOVER	MULTIPLE TURNOVER
If a turnover project:			
List any differences between observed and reported status: _____			

	YES	NO	
Obtained copy of onsite battalion's project package?			
Obtained copies of management tools now in use?			
Obtained status of required project submittals?			
Is project to be worked during turnover?			
Will all project material be returned to MLO for turnover?			
Which items will not be returned? _____			

Obtained copies of the following missing documents:	NOT MISSING		
Project Plans			
Project Specifications			
Project BOM			
Obtained copies of local forms, instructions, and required procedures?			
Are the following permits required for construction?			
Excavation Permit			
Utility Outage Permit			
Burning Permit			
Hauling Permit			
Other Permits _____			
	CONUS	LOCAL	
Percentage of materials on hand:			
Estimated percentage at turnover:			
What special skills are required? _____			
Legend: CONUS continental United States			

Figure 4-2. Project Site Visit Summary Form

Should it not be feasible to conduct a preconstruction site visit, managers must use available resources to obtain as much information as possible about the physical location of the project. Following through on RFIs, conducting map searches, and contacting on-site personnel are all actions that help mitigate the unknown and reduce risk. Jobsite layout is a primary consideration for a preconstruction site visit. Prepare a sketch of the site and compare it to the site plan provided in the plans. Consider orientation and space availability for the layout of construction materials, equipment, and other needs of the construction effort beyond the actual siting of the facility to be built. Refer to paragraph 6.2 for jobsite layout objectives and checklist.

4.3.2 Develop a Construction Estimate

Managers use project construction estimates to support construction project planning. Project supervisors and assigned crew leaders break down a project into logical, sequenced construction activities. Estimators create detailed material, equipment, and labor estimates for each individual construction activity and then summarize them into an overall project estimate. Estimators also create shop drawings as required. The estimating worksheets generated during this process become part of the project package and provide the material, equipment, and labor information used by project supervisors to develop CAS sheets that provide the basis for project schedule management.

The project supervisor and assigned crew leaders determine the construction methods used or they create and document a set of assumptions in order to accurately identify the resources required to complete each construction activity. The choice of construction method will affect the amount of materials, types of equipment and tools, safety gear, and labor requirements. Discussion of construction estimating is beyond the scope of this publication. Refer to NTRP 4-04.2.3/TM 3-34.41/AFPAM 32-1000/MCRP 3-17.7M, for further information on components of a project estimate and MTO procedures.

4.3.3 Develop a Bill of Materials

The BOM is the official record of the project material requirements. The project supervisor is responsible to ensure that all required costs for project completion are included on the BOM. Bill of materials items include construction materials, equipment rental or purchase of special tools and safety items not organic to an engineering unit's table of allowance (TOA)/table of equipment, and subcontractors or contracted technical assistance for work such as balancing an HVAC system or certifying a fire alarm system. It is vital to verify that a BOM received from HHQ or another source has everything required and in the correct quantities, as identified in the construction estimate during the MTO process, for project construction. Refer to figure 4-3 for a typical BOM form. Refer to the unit's logistic SOP for an explanation of acronyms on this form. The project supervisor follows three steps to ensure identification and inclusion of all items on the project's BOM:

1. The project supervisor compares the original BOM to the MTO from the construction estimate using the BOM/MTO comparison worksheet form illustrated in figure 4-4.
2. The project supervisor documents and justifies any additional items to be added to the BOM using the add-on/reorder justification form illustrated in figure 4-5. This form is routed to the operations officer for approval per engineering unit SOP.
3. The operations officer approves the add-on/reorder items and submits them to the logistics organization using the BOM add-on/reorder form. Refer to figure 4-6 for a typical BOM add-on/reorder form.

4.3.4 Develop a Logic Network

The project supervisor develops a logic network using the initial list of construction activities developed in paragraph 2.3.12 as a starting point. The logic network, especially in a large, complicated project, ensures the identification of all construction activities for estimating as well as the interdependencies among activities. The project supervisor must identify the interdependencies of activities before creating a precedence diagram. Refer to paragraph 3.5 for information on how to develop a logic network.

BILL OF MATERIALS																
PROJECT NO		PROJECT TITLE				AUTHORITY/ORIGINATOR					BOM NO.		SECTION			
RID	M&S	SERV & REQNR	DEM	SERV & SUPP ADD	SIG	FUND	DIS	PRJ	PRI	JON	ROS	ACCOUNTING DATA				
4-6	7	30-35	44	45-50	51	52-53	54	57-59	60-61	62-64	72-77					
DOC I.D.	COG	NSN		UNIT OF ISSUE	QTY	DOCUMENT NUMBER	ADV	L/I	DESCRIPTION/VENDOR SOURCE INTENDED USE			UNIT PRICE	TOTAL COST			
1-3	55-56	8-20		23-24	25-29	36-43	65-66									
BOM SUBMITTED BY/DATE		BOM APPROVED BY/DATE				TARGET APPROVED/DATE			PAGE TOTAL \$		BOM TOTAL \$		PAGE OF _			

Figure 4-3. Bill of Materials Form

[illegible]

Figure 4-4. Bill of Materials/Material Takeoff Comparison Worksheet Form

ADD-ON/REORDER JUSTIFICATION				
Date: _____				
Attached is an add-on/reorder BOM for: _____ (circle one)				
Justification: _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____				
For reorder BOM only: BOM line item number: _____ Document number: _____ Requested by: _____ (Name, Rank, Company)				
Routing: Lead Company Projects Chief: _____ Date: _____ QC Specialist: _____ Date: _____				
MLO:		Yes	No	
	Available in Excess?			
	Funds Available?			
MLO Officer/Chief: _____				Date: _____
QC Manager: _____				Date: _____
Approved/Disapproved _____ (circle one) (Operations Officer)				Date: _____

Figure 4-5. Add-On/Reorder Justification Form

[illegible]

Figure 4-6. Bill of Materials Add-On/Reorder Form

4.3.5 Develop a Precedence Diagram

The project supervisor develops a precedence diagram using the logic network and data from the labor estimate developed for each construction activity. The project supervisor determines duration and crew size based on the labor estimate using the calculations discussed in paragraph 3.3.4. Refer to paragraph 3.6 for information on how to develop a precedence diagram.

4.3.6 Develop a Level III Gantt Chart

The project supervisor develops an activity schedule known as a Level III Gantt chart as illustrated in figure 3-8. At this stage, the Level III functions as a planning support tool. Later, during project execution, the Level III becomes the project supervisor's primary scheduling tool to track the project's daily progress and to schedule and manage resources (e.g., labor, equipment use, inspection requirements, material deliveries). Refer to paragraph 6.3 for information on how to use the Level III Gantt chart as a scheduling tool.

During the detailed project planning phase, the project supervisor uses the Level III to resource-level requirements to match constrained resources, to compress the schedule to match a desired completion date, or to justify additional resources. Refer to paragraph 3.7 for information on how to develop a Level III Gantt chart and to paragraph 3.8 for information on how to resource level using a Level III Gantt chart.

4.3.7 Determine 30/60/90-day Material Requirements

The project supervisor identifies materials (by BOM line item number) that will be required during the first 30, 60, and 90 days of the project. To identify scheduled activities and their material requirements, the project supervisor uses the Level III Gantt chart and the corresponding CAS sheets and estimating worksheets as planning support tools. A list of required materials is typically submitted through the chain of command to the operations officer for review no later than 2 ½ months prior to the project start date. Operations forwards the 30/60/90-day material requirements list to the supporting logistics organization and copies the HHQ project support office no later than 2 months prior to the project start date. Figure 4-7 illustrates a typical 30/60/90-day material list form.

4.3.8 Prepare Submittals

The project supervisor provides submittals as directed by the project manager and the QC manager. A submittal includes the manufacturer's information, shop drawings, samples, other descriptive literature, information for required materials, and construction methods and plans used in the project execution. Refer to paragraph 9.4.11 for further information on submittal guidance and procedures.

4.3.9 Prepare Construction Activity Summary Sheets

The project supervisor and assigned crew leaders create and maintain CAS sheets throughout the duration of the project. A project supervisor is responsible to ensure the identification of all required resources for each activity and to list them on the activity's corresponding CAS sheet. Construction activity summary sheets are a primary planning support and scheduling tool for the project supervisor. Refer to paragraph 6.3 for information on how to use CAS sheets as a scheduling tool to drive project execution.

During the detailed planning phase, the project supervisor develops CAS sheets as the central depository of information for each construction activity after the unit's approving authority approves the list of construction activities for a project. Refer to figure 4-8 for a CAS sheet form. The CAS sheet titles and numbers parallel the corresponding construction activity names and numbers.

Figure 4-7. 30/60/90-Day Material List Form

CONSTRUCTION ACTIVITY SUMMARY (CAS) SHEET						
Project Number: _____		Project Title: _____				
Master Activity Number: _____						
CAS Sheet Title: _____			CAS Sheet Number: _____			
Baseline Start: _____		Baseline Finish: _____				
Actual Start: _____		Actual Finish: _____				
Duration Estimated: _____		Duration Actual: _____				
Man-day Estimated: _____		Man-day Actual: _____				
Availability Factor: _____		Man-day Equivalent: _____				
Description of Work: _____						
Method of Construction/Assumptions: _____						
Prepared by: _____ Checked by: _____						
Work Elements:						
Reference Table/Code	Description	Unit of Measure	Quantity of Work	Delay Factor/Multiplier		
Labor Resources:						
Rate	Skill/Remarks	QTY		Rate	Skill/Remarks	QTY
Tool/Equipment Resources:						
Number	Description	QTY		Number	Description	QTY

Figure 4-8. Construction Activity Summary Sheet Form—Front (Sheet 1 of 2)

CONSTRUCTION ACTIVITY SUMMARY (CAS) SHEET (continued)				
CAS Sheet Title: _____ CAS Sheet Number: _____				
Material Resources:				
BOM Line Item	Description	Unit of Issue	QTY	LL (Yes/No)
Quality Control Plan:				
QC Requirement	Specification Reference	Control Measure		
Safety Plan:				
Safety Hazard	Reference/Page Number	RAC	Control Measure	
Environmental Protection Plan:				
Environmental Hazard	Reference/Page Number	Action Required		
Comments Continued: _____				

Legend:				
LL	long lead item			
RAC	risk assessment code			

Figure 4-8. Construction Activity Summary Sheet Form—Back (Sheet 2 of 2)

The project supervisor and assigned crew leaders must accurately document everything relevant to an activity (e.g., assumptions; calculations pertaining to MDs, durations, tools, and equipment; plan formation; notes; significant events). Attach additional documents to the back of the CAS sheet, if necessary. The Level III Gantt chart provides each activity's scheduled start and finish dates, which the project supervisor adds to the CAS sheet. This ties the resources to the schedule and allows the project supervisor to monitor any actions required to track or request resources on the CAS sheets. The following information is documented on CAS sheets:

1. **Work Elements.** Managers determine work elements during the project estimating process. Refer to paragraph 2.3.13 for further information on construction work elements.
2. **Labor Resources.** Managers initially identify the labor resources for each project during the project estimating process. The project supervisor refines crew and skill requirements on a histogram (also known as a resource use chart as illustrated in figure 3-8) through the scheduling and resource-leveling process as part of Level III Gantt chart development. Labor histograms are forwarded to unit operations via the lead element's project manager for unit-wide resource leveling. Refer to paragraph 3.8 for further information on resource leveling. Refer to chapter 5 for further information on the unit resource-leveling process.
3. **Tool and Equipment Resources.** Managers determine tool and equipment resources during the project estimating process. They schedule tool and equipment requirements on a histogram after project resource-leveling completion similarly to labor skill requirements. The project supervisor consolidates tool and equipment requirements on a tool requirement summary form as illustrated in figure 4-9 and an equipment requirement summary form as illustrated in figure 4-10. These forms are forwarded to unit operations via the lead element's project manager for unit-wide resource leveling. When the tools and equipment organic to the unit are not available, managers rent from commercial vendors if sufficient project funds are available. Any expenditure must be listed on the BOM.
4. **Material Resources.** Managers determine material resources for each construction activity during the project estimating process. After conducting an MTO/BOM bounce and updating the BOM, the project supervisor identifies the material resources by BOM line item number on the CAS sheet.
5. **Quality Control Plan.** Refer to chapter 9.
6. **Safety Plan.** Refer to chapter 10.
7. **Environmental Protection Plan.** Refer to chapter 11.

4.3.10 Determine Quality Control, Safety, and Environmental Protection Plans Requirements

The project supervisor and assigned crew leaders develop QC, safety, and environmental protection plans for the assigned project during the planning and estimating process, which includes identification of hazards, requirements, and corrective actions as well as annotation of the applicable CAS sheet. The project supervisor consolidates individual summary plans for QC, safety, and environmental subject areas from the CAS sheets upon planning completion. The unit QC manager/QC Specialist SMEs prepare an independent QC plan for each project for comparison with the project supervisor's QC plan; they identify and resolve differences between the plans. The unit SMEs for safety and environmental protection review these plans prior to approval by the project manager. Refer to chapters 9, 10, and 11 for additional information and summary plan forms on QC, safety, and environmental protection.

4-14

Figure 4-9. Tool Requirement Summary Form

[illegible]

Figure 4-10. Equipment Requirement Summary Form

4.3.11 Consolidate Resource Requirements and Set Baseline Schedule

Project supervisors and assigned supervisors perform the following tasks to prepare their project package for review by the project manager and the operations officer.

1. Master Activity Summary Sheets, illustrated in figure 4-11, result from consolidating CAS sheets of like master activities after Level III Gantt chart and CAS sheets finalization. Project supervisors and project managers use MA summaries to manage resources at the company and unit level by providing a roll-up of resource requirements under each MA. Software programs facilitate creation of these reports from previous data input for the CAS sheets.
2. A Level II Gantt chart, derived from the resource-leveled Level III Gantt chart, establishes a scheduled progress curve and sets the baseline for measuring progress (refer to figure 3-12). Refer to paragraph 3.9 for information on Level II Gantt chart development. Refer to chapter 7 for procedures to update a Level II Gantt chart for project monitoring of actual progress.

4.4 OUTPUTS

The project supervisor and assigned crew leaders perform the detailed planning. They coordinate their effort with the project manager and unit operations officer for decision and approval points. The required outputs follow:

1. Project site visit summary. Refer to paragraph 4.3.1.
2. Construction estimate. Refer to paragraph 4.3.2.
3. Shop drawings (as required). Refer to paragraph 4.3.2.
4. Bill of materials. Refer to paragraph 4.3.3.
5. Bill of materials add-on/reorder. Refer to paragraph 4.3.3.
6. Project precedence diagram. Refer to paragraph 4.3.4 and 4.3.5.
7. Level III Gantt chart. Refer to paragraph 4.3.6.
8. 30/60/90-day material list. Refer to paragraph 4.3.7.
9. Submittals and submittal status log. Refer to paragraph 9.4.11.
10. Project CAS sheets. Refer to paragraph 4.3.9.
11. Project QC plan. Refer to chapter 9.
12. Project safety plan. Refer to chapter 10.
13. Project environmental protection plan. Refer to chapter 11.
14. Tool requirement summary. Refer to paragraph 4.3.9.
15. Equipment requirement summary. Refer to paragraph 4.3.9.
16. Master Activity Summary Sheet. Refer to paragraph 4.3.11.
17. Level II Gantt chart. Refer to paragraph 4.3.11.

Throughout the project planning process, managers should retain and refine as necessary all output products.

MASTER ACTIVITY SUMMARY SHEET				
Project Number: _____ Title: _____				
BOM Code: _____ Prepared by: _____ Checked by: _____				
Start Scheduled: _____ Finish Scheduled: _____				
Actual: _____ Actual: _____				
Master Activity Number: _____ Title: _____				
CONSTRUCTION ACTIVITIES NUMBER	TITLE	CREW SIZE	DURATION	MAN-DAYS
Total Duration: Estimated: _____ Actual: _____ Total Man-days: Estimated: _____ Actual: _____				
Labor Resources:			Equipment Resources:	
Number	Description	QTY	Number	Description
Assumptions: _____				

Figure 4-11. Master Activity Summary Sheet Form

INTENTIONALLY BLANK

CHAPTER 5

Final Planning and Project Turnover

5.1 INTRODUCTION

Project Phase 3, Final Planning and Project Turnover, assists managers in accomplishing the following actions:

1. Complete the project package approval process.
2. Complete deployment or project mobilization preparations.
3. Confirm availability of initial material requirements.
4. Develop project confirmation briefs.
5. Conduct a project turnover.

This phase ends upon completion of project turnover or mobilization for a new start project. Refer to figure 5-1 for an illustration of Project Phase 3 inputs, process, and outputs.

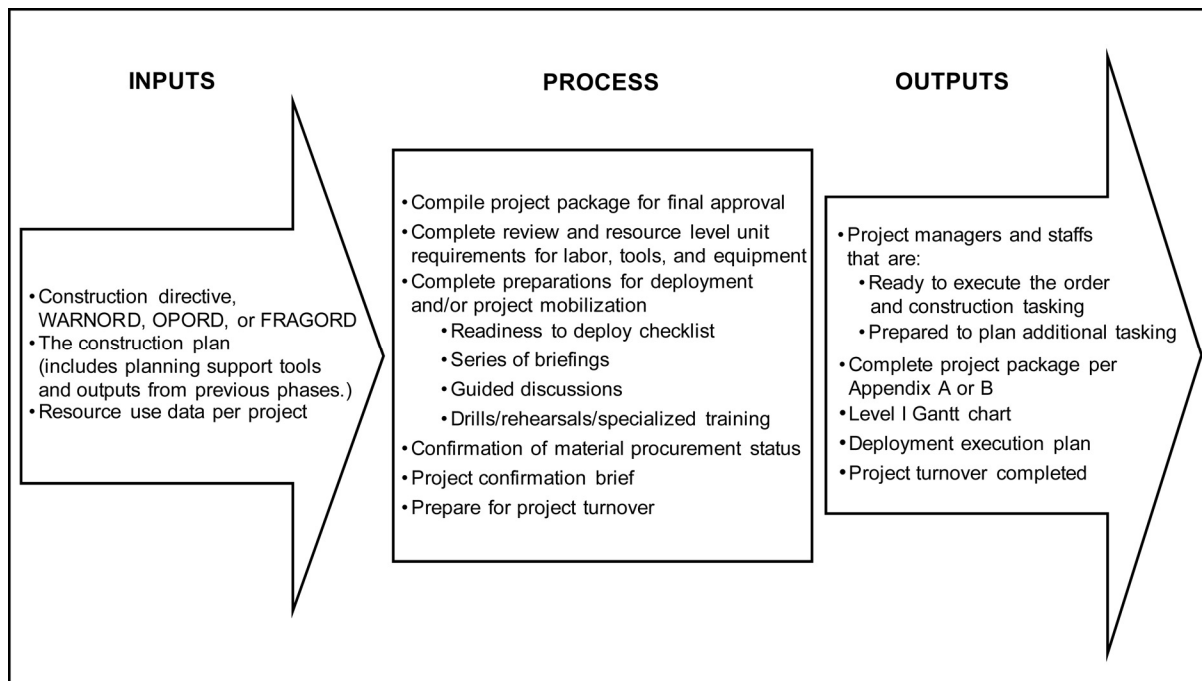


Figure 5-1. Project Phase 3 Outputs

5.2 INPUTS

Final planning requires the following essential items before development can begin:

1. Construction directive (includes the commander's intent)
2. The construction plan (includes planning support tools and outputs from previous phases)
3. Resource use data per project.

5.3 PROCESS

Managers complete preparations for construction using the process discussed in paragraphs 5.3.1 thru 5.3.5 to transition to the project execution phase.

5.3.1 Compile Project Package

The project supervisor consolidates and checks the project package for completeness before sending via the chain of command to the unit's operations officer for approval. Each project package includes a cover sheet to document approval signatures. The final project package sign-off sheet consists of the following information:

1. Header containing the title Project Package Sign-off Sheet, project number, and project title.
2. Three columns with the following titles: Reviewed By (Title), Name (Signature), and Date.
3. A minimum of the following reviewers listed under the Reviewed By column:
 - a. Support element crew leader(s)
 - b. Project supervisor
 - c. Company operations chief
 - d. Project manager
 - e. Quality control approving authority
 - f. Safety program approving authority
 - g. Environmental program project approving authority
 - h. Unit operations officer.

5.3.2 Review and Resource-level Unit Requirements

Project managers consolidate resource requirements data per project (e.g., tools, equipment, labor) and for all assigned projects using computer spreadsheets or software applications per unit SOP. These consolidated requirements are resource-leveled. Project managers then identify shortfalls, and determine whether to request additional resources or to prioritize available assets to projects, and adjust the plan to fit available assets. Refer to paragraph 3.8 for information on resource leveling.

5.3.3 Complete Preparations for Deployment/Project Mobilization

The project supervisor is responsible to complete preparations for deployment/project mobilization. Refer to figure 5-2 for a readiness to deploy evaluation/management assist visit checklist form, which provides guidance for the project supervisor. This checklist may also be used by project supervisors to prepare for readiness to deploy evaluations and management assist visits.

5.3.4 Confirmation of Material Procurement Status

The project supervisor is responsible for material management and accountability. Upon completion of the material estimate and the BOM/MTO comparison, the project supervisor's attention turns to material procurement status. The project supervisor is responsible to know the required materials for critical-path activities and when they are needed. Project supervisors submit material requisitions and the 30/60/90-day material list to initiate the project procurement cycle.

It is the on-site unit's responsibility to procure project material for both new-start and turnover projects tasked to the relieving unit. Failure of the on-site unit to procure adequate material for the relieving unit may cause project delays. The on-site unit procures 100 percent of the first 30- and 60-day material requirements, 80 percent of the 90-day material requirements, and 80 percent of all remaining materials on hand prior to the arrival of the relieving unit's advance party. Refer to paragraph 6.4 for information on project material management and tracking.

5.3.5 Project Confirmation Brief

Project supervisors deliver a project confirmation brief on two significant occasions:

1. **Preconstruction Confirmation Brief.** In this brief, the project supervisor and the assigned crew leaders demonstrate to the unit commanding officer's representative and/or HHQ's representative their understanding of commander's intent, their specific tasks and purpose, and the relationship between their tasking and the operational environment. The confirmation brief allows the commander's/HHQ's representative to identify gaps in the project plan, identify discrepancies between requirements and resources, and learn how the project supervisor and assigned crew leaders intend to accomplish their mission.
2. **In-process Review by HHQ.** A project brief, given by the project supervisor and/or assigned crew leaders, focuses on progress to date in comparison with the planned construction estimate and schedule. This is the unit's opportunity to show justification for any man-day tasking changes.

Refer to unit SOP for guidance on preparation and format of a project confirmation brief. As a general rule, managers modify the standard five-paragraph order (situation, mission, execution, administration and logistics, command and signal) format to fit specific guidance or situations. Refer to appendix E for a sample project confirmation brief.

5.3.6 Project Turnover

The project supervisor plans and conducts a project turnover. The project supervisor must be aware of the unit's policy on personnel behavior, schedules, and expectations for the turnover as determined by each engineering unit's operations officers. Project supervisors must set the example for professionalism and demand it from their troops.

Units make impressions, good or bad, based on how they conduct themselves at turnover. Persons outside of the engineer community see engineers, not separate units. It is unprofessional to criticize another unit. The outgoing unit's primary concern is to set up the incoming unit for a successful start. The relieving unit must protect the reputation of the outgoing unit after it is gone. If a problem with quality or timeliness of construction is blamed on a previous unit, customers form the impression that engineers, as a whole, are less than professional.

READINESS TO DEPLOY EVALUATION/MANAGEMENT ASSIST VISIT CHECKLIST			
1. Project Package Review:			
____ Construction logic (precedence diagram)			
____ Complete five-section package			
____ CAS sheets match Level III GANTT chart			
____ Level III GANTT chart matches Level II GANTT chart			
____ QC and safety plans match back of CAS sheets			
____ Crew size matches Level III GANTT chart			
____ Level II GANTT chart lines up with deployment schedule			
____ MTO compared with BOM and add-ons prepared			
____ 30/60/90-day material message sent and lines up with Level II GANTT chart			
____ Special tools and equipment requirements identified			
____ Need for contract support identified and communicated			
____ Project funding status known			
____ All safety items complete (e.g., safety/environmental plan, safety equipment/material)			
____ Documented contact with on-site engineering unit concerning safety items			
____ Lockout/tagout and temporary power personnel identified in writing.			
2. Deployment Execution Plan:			
____ Organization and manning			
____ Manning summary			
____ Level I GANTT chart matches Level II GANTT chart			
____ Direct labor capability versus plan			
____ Level I GANTT chart matches deployment calendar.			
3. Project Site Visits Checklist:			
a. Project Files:	Yes	No	N/A
(1) Project sign current?			
(2) Active CAS sheets posted?			
(3) Level II GANTT chart posted and updated?			
(4) Level III GANTT chart posted and updated?			
(5) Two-week schedule posted?			
(6) QC reports available?			
Consecutive (or gaps explained)?			
All noted problems corrected?			
(7) Safety reports available?			
(8) Jobsite material receipt file current?			

Figure 5-2. Readiness to Deploy Evaluation/Management Assist Visit Checklist Form (Sheet 1 of 2)

READINESS TO DEPLOY EVALUATION/MANAGEMENT ASSIST VISIT CHECKLIST (continued)			
	Yes	No	N/A
a. Project Files (continued)			
(9) Plans and specifications available?			
All changes approved and annotated?			
(10) MSDS available?			
(11) HM inventory available?			
b. Project Supervisor/Crew Leader:			
(1) Working planned activities?			
(2) Knows material delays and status?			
(3) Knows subcontractor's schedule?			
(4) Knows QC report problems and fixes?			
(5) Knows pending or submitted FAR or DCD?			
(6) Actual crew size in line with schedule?			
c. Safety:			
(1) Power tools/extension cords checked?			
(2) Temporary power certified?			
(3) Generators grounded?			
(4) Safety items available?			
Eyewash?			
Clean water jugs?			
First aid kits?			
Fire extinguishers?			
Rebar caps?			
PPE being used?			
d. Equipment:			
(1) Equipment inspected daily?			
(2) Prestart inspections being conducted?			
(3) Operating checks being completed?			
(4) Equipment clean?			
(5) Operator's maintenance being completed?			
Legend: DCD design change directive PPE personal protective equipment MSDS material safety data sheet			

Figure 5-2. Readiness to Deploy Evaluation/Management Assist Visit Checklist Form (Sheet 2 of 2)

5.3.6.1 Project Status at Turnover

The project supervisor needs to know exactly what portion of a project remains at turnover. The primary source of this information comes from the Project Status at Turnover SITREP Message. The on-site unit is responsible for providing turnover information to the contracting office and relieving unit. Sixty days prior to redeployment, in preparation for project turnover, the on-site unit provides HHQ and the relieving unit with a Project Status at Turnover SITREP Message, illustrated in figure 5-3. Figure 5-3 shows the minimum required information for a project status at turnover SITREP. The exact format may differ. Refer to the unit's communications SOP for standard message formats and an explanation of acronyms on this form.

The purpose of the SITREP message is to report the status of each of the deployed unit's tasked projects through to the deployment completion/turnover date for the relieving unit. Refer to figure 5-4 for a sample project turnover questions checklist form to assist preparation.

5.3.6.2 Material Status at Turnover

Material status is a major concern at turnover. The project supervisor is responsible for all material turned over on the project site and makes arrangements with MLO staff to inspect project materials held at MLO. Although MLO counts project material, the project supervisor needs to check the quantity, quality, type, and condition of the materials.

The on-site unit is responsible for procuring and providing adequate materials available at turnover to avoid material delays for the relieving unit. For turnover projects and new-start repair/alteration projects, the on-site unit must procure and provide 100 percent of the local purchase materials available. For new-start construction projects, the on-site unit must have on hand 50 percent of local purchase materials. The on-site unit submits a monthly local material procurement status SITREP that provides the procurement status of all locally procured project material.

Planners for the relieving unit monitor the monthly local material procurement status SITREP and project material status report to confirm material availability onsite. Each military service has different variations on these reports (refer to unit SOP for specific information). Refer to paragraph 6.4 for further information.

5.3.6.3 Project Turnover Execution

During turnover, the relieving unit operations officer ensures that all project files are current before accepting the project from the outgoing unit. Refer to figure 5-5 for a sample turnover memorandum worksheet form, the primary tool for monitoring the status of a project's turnover. It is the responsibility of each of the relieving unit's project lead elements to use this memorandum to document conditions and decisions reached at turnover. All participants receive a copy in addition to the project file.

5.3.6.4 Project Percent Complete at Turnover

Paragraph 6 of the turnover memorandum worksheet includes the procedure for determining percent complete at turnover. The focus is on MDs of work remaining. The two units and the contracting office examine the project estimates by activity until they agree on the estimate of total MDs remaining. If the units cannot agree whether or not part of the WIP conforms to the plans and specifications, the units should consult the contracting office for a determination. Any rework estimated to require more than 50 MDs or \$500 in materials requires approval of HHQ.

5.3.6.5 Continuity of Work-in-Place Curve

The project WIP curve must be continuous throughout the project unless HHQ issues an approved scope change. Should the unit wish to revise a previously reported WIP on a project, the unit submits a request for the change with justification by message to HHQ. This also applies to any downward adjustment in WIP during turnover negotiations. Any downward adjustments in WIP in the turnover SITREP must be explained. After turnover, the relieving unit cannot reduce the previously reported WIP without justification to HHQ.

FM <DEPLOYED UNIT>
 TO COM TWO TWO NCR//R33//OR
 COM TWO FIVE NCR//R33//OR
 COM THREE ZERO NCR//R33//
 <RELIEVING UNIT>//S3//
 INFO
 TWO ZERO SEABEE READINESS GROUP GULFPORT MS//R3//OR
 THREE ONE SRG SEABEE READINESS GROUP PORT HUENEME CA//R3//
 BT
 UNCLAS//<NXXXXX>//
 MSGID/GENADMIN/<DEPLOYED UNIT>//
 SUBJ/PROJECT STATUS AT TURNOVER//
 REF/A/DOC/(cite Service-specific guidance)//RMKS//
 1. IAW REF A, THE FOLLOWING IS THE PROJECT STATUS OF UNIT <DEPLOYED UNIT> TASKED
 PROJECTS TO THE DEPLOYMENT COMPLETION DATE OF <_____>//
 2. MAIN BODY (OR DETACHMENT SITE)
 A. PROJECT STATUS (READ IN FOUR COLUMNS). (List all projects and their status.)

PROJECT #	TITLE	PROJECTED WIP AT TURNOVER (PERCENT)	MAN-DAYS REMAINING (HORIZONTAL/VERTICAL)

B. PROJECT SUMMARY. (List each project.)

PROJECT #, TITLE

COMMENTS: (Enter concise summary comments on anticipated project status at turnover, provide projected WIP at turnover for each master activity, list material problems which exist at turnover, and any other significant factors.)

MASTER ACTIVITY SECTION	MASTER ACTIVITY WIP COMPLETION (PERCENT)

//BT//

Figure 5-3. Project Status at Turnover Situation Report Message Form

PROJECT TURNOVER CHECKLIST		
ITEM	YES	NO
1. Is an annotated project schedule indicating current status available?		
2. Are activity scope sheets for remaining activities available?		
3. Has the contracting office approved all WIP?		
4. Are complete project file and project planning package available?		
As-built drawings		
QC plan		
Safety plan		
QC reports		
Vendor submittals for approval		
Operations and maintenance manuals		
Change order records		
Record of manpower expended		
All project correspondence		
Fabrication drawings		
Project specifications		
Job photographs.		
5. Is the following information on project materials available?		
Complete MTO and addendum		
BOM worksheets and sketches		
Annotated MTO indicating in-place, on-site, in-warehouse, excess, or on-order status		
Material status reports		
Requisition follow-up status		
Listing of shelf-life materials and expiration dates		
Listing of HM.		
6. What is the current status of assigned, expended, obligated, and committed funds held by the unit?		
7. What construction tools were provided with project funds, and what are their conditions?		
8. Are progress-monitoring tools available?		
9. Is a lessons learned summary prepared?		
10. What recommended method improvements were submitted?		
11. Are all incomplete electrical systems tagged and identified?		
12. Are all circuits, conduits, and piping labeled?		
13. What percent complete is the project?		

Figure 5-4. Project Turnover Questions Checklist Form

TURNOVER MEMORANDUM WORKSHEET	
Date _____	
Relieved Unit: _____	
Relieving Unit: _____	
1. The status at turnover for the subject project is as follows: Project Number: _____ Project Title: _____ Client Contact: _____ Phone: _____ Contracting Office Contact: _____ Phone: _____ COTR Contact: _____ Phone: _____	
2. Project scope of work: (list from project scope sheet)	
3. Work completed to date: (list WIP by master activity based on physical observations)	
4. Rework required: (list WIP that does not conform to plans and specifications)	
5. Work remaining: (list work remaining by master activity based on WIP)	
Unit (summary of work remaining by master activity)	
Subcontract (summary of work remaining by subcontract)	
Title: _____ Cost: _____ Date request for contractor proposal submitted: _____ Date contract awarded: _____ Start: _____ Completion: _____ Status: _____	
Legend: COTR contracting office's technical representative	

Figure 5-5. Turnover Memorandum Worksheet Form (Sheet 1 of 5)

TURNOVER MEMORANDUM WORKSHEET (CONTINUED)

6. Labor statistics:

Man-day estimate established at 30-day review by unit: _____

Man-days expended (actual) by previous unit: _____

Man-days expended (actual) by outgoing unit: _____

Unit estimate of remaining man-days by rate: (negotiated between unit project supervisors)

LABOR CATEGORY/ DESCRIPTION							OTHER	TOTAL
Rework								
Remaining Work								
Total Estimate of Remaining Man-days								

Unit estimate of remaining man-days by master activity: (negotiated by project supervisors)

(1)	(2)	(3)	(4)
MASTER ACTIVITY	ESTIMATE OF TOTAL MAN- DAYS	ESTIMATE OF REMAINING MAN-DAYS	PERCENT COMPLETE (BASED ON WIP)
TOTALS			

New man-day completion estimates (6b + 6c + 6d): _____

Man-days expended total (6b + 6c): _____

Actual percent complete (total of column e4): _____

Projected beneficial occupancy date: _____.

Figure 5-5. Turnover Memorandum Worksheet Form (Sheet 2 of 5)

TURNOVER MEMORANDUM WORKSHEET (continued)			
7. Project files: (inventory by both project supervisors)			
DESCRIPTION	CIRCLE ONE		
a. Correspondence	Y	N	N/A
b. Messages	Y	N	N/A
c. Job specifications	Y	N	N/A
d. QC reports	Y	N	N/A
e. Test results	Y	N	N/A
f. FARs, DCDs, and RFIs	Y	N	N/A
g. Manufacturer's specifications	Y	N	N/A
h. Operation and maintenance manuals	Y	N	N/A
i. BOM/MTO worksheets	Y	N	N/A
j. QC plan	Y	N	N/A
k. Safety plan	Y	N	N/A
l. Activity sheets	Y	N	N/A
m. Discrepancies/explanation:	Y	N	N/A
8. Engineering: (inventory by engineering and QC staffs)			
DESCRIPTION	CIRCLE ONE		
a. As-built drawings	Y	N	N/A
b. Digging permits	Y	N	N/A
c. Other permits	Y	N	N/A
d. Pending FARs	Y	N	N/A
e. Discrepancies/explanation:	Y	N	N/A
9. Construction company: (inspection by project supervisors)			
DESCRIPTION	CIRCLE ONE		
a. Project network	Y	N	N/A
b. Electrical systems tagged	Y	N	N/A
c. Piping labeled/capped/clear	Y	N	N/A
d. Material on jobsite tagged	Y	N	N/A
e. Discrepancies/explanation:	Y	N	N/A

Figure 5-5. Turnover Memorandum Worksheet Form (Sheet 3 of 5)

TURNOVER MEMORANDUM WORKSHEET (continued)			
10. Project material status: (inventory by project supervisors)			
DESCRIPTION	CIRCLE ONE		
a. Project status report	Y	N	N/A
b. List of shelf life material/expiration	Y	N	N/A
c. List of HM/location	Y	N	N/A
d. Complete BOM and worksheets	Y	N	N/A
e. Payback items identified	Y	N	N/A
f. Review outstanding requisitions	Y	N	N/A
g. Inventory conducted	Y	N	N/A
h. BOM status	Y	N	N/A
Total line items	Y	N	N/A
Line items received	Y	N	N/A
Line items on order, but not received	Y	N	N/A
Line items not ordered.	Y	N	N/A
i. Discrepancies/explanation:	Y	N	N/A
11. Funding status: Funds provided: _____ Actual expenditure cost: _____ Pipeline costs: _____ Future funding requirements: _____ Total costs (11b + 11c + 11d): _____ Funding contingency ((11c + 11d) × 10 percent): _____ Estimate at completion (11e + 11f): _____ Additional funds requested (list the date-time-group of the message for each request): _____ Discrepancies/explanation: _____ _____			

Figure 5-5. Turnover Memorandum Worksheet Form (Sheet 4 of 5)

5.3.6.6 Turnover Conference

A turnover conference is held for each turnover project. The outgoing unit schedules the project turnover conference and invites the appropriate personnel. Attendees should be the same as those attending the preconstruction conference. Minutes of the turnover conference, including decisions reached therein, are prepared by the contracting office, signed by the appropriate engineering unit representatives and the COTR, and made part of the project file. The minutes of the preconstruction conference indicate the contracting office's approval of the QC and safety plans with any proposed changes.

While the meeting format may vary between contracting organizations, such as a facilities engineering and acquisitions division at a Navy PW/BOS department, an OIC of construction established for temporary construction programs, an ROICC onboard a non-Navy installation, or another military service contracting organization during a contingency, certain elements remain common between them.

The relationship between the contracting organization and the on-site unit is crucial to the unit's success. Operations officers must provide guidance to subordinates on their expectations of how unit personnel interact with the contracting office, COTR, local personnel, and contractors. Weekly meetings between the operations officer and the contracting office or COTR usually eliminate potential problems and provide necessary communications.

5.3.7 New Start Project—Preconstruction Conference

Prior to commencement of work for a new-start project or resumption of a hold project, the unit must hold a preconstruction conference. During this conference, the unit presents its methods for accomplishing the project in accordance with plans, specifications, and QC procedures to the contracting office. This conference is a key event in the QC procedures to mark the project's formal start. Figure 5-6 lists the key personnel who typically attend the preconstruction conference.

Refer to figure 5-7 for a list of key questions the engineering unit needs to consider in advance of the preconstruction conference. This checklist is also a valuable tool to help a unit prepare for a project turnover.

At the completion of the conference, if the unit convinces the contracting office that it is adequately prepared to perform the construction in accordance with the schedule, the contracting office issues a notice to proceed. The notice to proceed indicates approval of the QC and safety plans with any proposed changes, but this notice to proceed may be canceled if the project is not executed in accordance with the plans presented.

It is the responsibility of the project's lead element to take meeting minutes and document any decisions reached using the preconstruction conference summary form, illustrated in figure 5-8. All attendees receive a copy of these minutes, and a copy is placed in the project file.

5.4 OUTPUTS

The outputs of a successful project turnover or a new start project enable project supervisors to execute the project and adapt to situations in the operational environment. The required outputs follow:

1. Complete project package. Refer to appendix A or B.
2. Unit's Level I Gantt chart. Refer to paragraph 3.10.
3. Unit's deployment execution plan per unit SOP completed.
4. Project turnover completed (project status at turnover SITREP message and project turnover memorandum). Refer to paragraph 5.3.6.
5. Mobilization completed (preconstruction conference summary). Refer to paragraph 5.3.7.

PRECONSTRUCTION CONFERENCE ATTENDEES	
1.	Contracting Office
2.	COTR
3.	Operations Officer, Assistant Operations Officer, and Operations Chief
4.	Company Commander(s)/Detachment OIC
5.	Subcontractor Representatives
6.	Project Supervisors and Assigned Crew Leader(s)
7.	Project QC Representative
8.	Project Safety Representative
9.	Customer Representative(s)
Legend:	
OIC	officer in charge

Figure 5-6. Typical Attendees at a Preconstruction Conference

PRECONSTRUCTION CONFERENCE UNIT PREPARATION CHECKLIST	
1.	What questions regarding plans and specifications are unanswered?
2.	Have field conditions been verified?
3.	What operation and maintenance manuals are to be provided?
4.	Have required vendor submittals been requested and/or approved?
5.	What materials, by line item, for each construction activity are required?
6.	Are additional MTOs required? Have they been forwarded?
7.	What is the current status of all project materials?
8.	Does the schedule adequately consider all time delays and unit efficiency?
9.	Are the general safety and QC plans approved?
10.	Has a project QC plan been prepared for approval?
11.	Has a project safety plan been prepared for approval?
12.	What equipment and tools are required for each activity?
13.	Has a network schedule with milestones been prepared?
14.	Is any nonorganic technical assistance required?
15.	What is the priority of this project?
16.	How will other projects and missions affect the priority?
17.	Are excavation permits required? What is the request process? Have they been submitted/approved?
18.	What is the schedule for required utility outages?
19.	Who will connect new utilities into existing systems?
20.	What provisions have been made for temporary utilities?
21.	Who is the project manager? Project supervisor? What are their authority limits?
22.	What will the normal working hours be?
23.	Who is the POC should an after-hours problem arise?
24.	Has base security been advised of the construction plans? If not, who is responsible for advising them?
25.	Has security advised managers of any unusual requirements?
26.	What off-site prefabrication is anticipated? Where will it be done?
27.	Have projected curves for manpower expenditures and percent completed been prepared? Do they match the project schedule?
28.	What are the project reporting requirements?
29.	Are there any environmental hazards/protection requirements? What plans are required?
30.	Have the command's safety instruction requirements been met?
31.	What are the project's subcontract requirements and schedules?
32.	What are the procedures for resolving problems relating to plans, specifications, FARs, etc.?
33.	What are the procedures for continuing the project in the event the NCF unit is called away?
Legend:	
NCF	naval construction force
POC	point of contact

Figure 5-7. Unit Preparation for Preconstruction Conference Checklist

PRECONSTRUCTION CONFERENCE SUMMARY	
Project Number: _____ Date: _____	
Project Title: _____	
1. Contracting office project manager: Contracting office inspector:	
2. PW/BOS representative: Customer representative:	
3. Engineering unit POC: Engineering unit lead element: Engineering unit project supervisor: Engineering unit crew leader: Engineering unit QC manager/QC specialist:	
4. POC after normal working hours: Client: Contracting office: Engineering unit:	
5. POC during working hours: Client: Contracting office: Engineering unit:	
6. Planned start/completion dates: Known interruptions:	
7. Outstanding questions regarding plans and specifications or execution of work:	
8. Client-initiated changes to the scope of work are to be directed to the contracting office. Client-initiated changes must be via DCDs and approved by the contracting office prior to execution. Approved FARs and DCDs are the only authorized means of creating changes to the plans and/or specifications. Engineering is responsible for updating plans and/or specifications upon receipt of approved FARs and DCDs.	

Figure 5-8. Preconstruction Conference Summary Form (Sheet 1 of 3)

PRECONSTRUCTION CONFERENCE SUMMARY (continued)			
	Yes	No	N/A
9. Have field conditions been verified?			
Any unusual conditions?			
10. Have all permits been acquired?			
a. Site approval?			
b. Excavation permit?			
c. Tree removal?			
11. What operation and maintenance manuals have been or are to be provided to the customer?			
12. What are the project submittal/report requirements?			
13. QC plan to contracting office:	Provided	To be provided	
Special QC concerns:			
14. Safety plan to contracting office:	Provided	To be provided	
Special safety concerns:			
15. Materials to be supplied by client:			
16. Project tools and equipment to be provided to the client upon project completion:			
17. Is nonorganic technical assistance required? If so, what arrangements exist?			

Figure 5-8. Preconstruction Conference Summary Form (Sheet 2 of 3)

PRECONSTRUCTION CONFERENCE SUMMARY (continued)	
18. Will this project be affected by priorities of other projects/functions?	
19. What is the schedule for required utility outages?	
20. What arrangements exist for connection of new utilities to existing service?	
21. What provisions exist for temporary utilities service?	
22. What security clearances, if any, are required for the construction site?	
23. What off-site prefabrication is scheduled, and where is the prefabrication yard located?	
24. What environmental protection is required?	
25. Other comments/remarks:	
Contracting Office Representative/Date	Engineering Unit Operations Officer/Date

Figure 5-8. Preconstruction Conference Summary (Sheet 3 of 3)

INTENTIONALLY BLANK

CHAPTER 6

Project Execution

6.1 INTRODUCTION

Project Phase 4 is designed for managers to implement actions to execute and monitor progress of a construction project. These actions include jobsite organization, project execution scheduling and management tools, and jobsite resource management. This phase ends when the unit completes its tasking and is ready for a unit turnover or project transfer and closeout. Refer to chapter 7 for project monitoring information.

6.2 JOBSITE ORGANIZATION

Proper jobsite organization and layout are essential to smooth operations and optimum use of resources. A well-organized jobsite makes a great initial impression on visitors and indicates the project supervisor is an effective organizer and leader. In addition, it results in a safe work environment, creates less friction, and minimizes waste of material and manpower. Ultimately, an organized jobsite saves time and money. Project supervisors are responsible for jobsite organization, including jobsite setup, jobsite appearance, field office, and project sign. Jobsite organization and move-in are discussion topics for the preconstruction or project turnover meeting.

6.2.1 Initial Jobsite Setup Considerations

Effective jobsite organization accomplishes the following results:

1. Rise in productivity
2. Reduction of loss, pilferage, damage, and deterioration of staged materials
3. Safer work environment
4. Minimization of project supervisor's time spent daily on minor production decisions with maximization of time for more significant tasks.

Project supervisors submit jobsite requirements via the chain of command to the contracting office. A project supervisor prepares a layout sketch of the area limits, showing all information regarding potential impact to buildings, sites, and personnel adjacent to the construction and lay-down areas.

Figure 6-1 illustrates a jobsite layout objectives checklist. Project supervisors use these objectives as planning considerations for the initial site setup.

Figure 6-2 illustrates a jobsite organization checklist. Project supervisors use this checklist as both a guide on the ground when establishing the jobsite layout and a planning support tool.

JOBSITE LAYOUT OBJECTIVES CHECKLIST		
ITEM	YES	NO
1. Unimpeded work flow		
2. Shortest, simplest transport paths		
3. Safeguard of project resources		
4. Efficient receiving, inventorying, and staging of materials, parts, and equipment		
5. Optimization of project supervisor's ability to monitor and control operations:		
a. Visibility of work and staging areas		
b. Ease of access to work and materials		
c. Ease of inspection of work and materials (task checks, verifying WIP)		
6. Maintenance of operational flexibility as the character of work progresses from rough and heavy trades to finishing trades		
7. Adjustment to site constraints:		
a. Weather: dust, temperature, wind, sun, rain, humidity		
b. Terrain: surface and sub-surface conditions		
c. Scope and class of work		
d. Other interferences and operations		

Figure 6-1. Jobsite Layout Objectives Checklist Form

JOBSITE ORGANIZATION CHECKLIST		
ITEM	YES	NO
1. Job work and traffic flows (congestion):		
a. Exterior access to site		
b. Interior traffic and cross traffic		
c. Material bottlenecks		
d. Work access bottlenecks		
e. Trades and processes working through other trades		
f. Analysis of work sequences		
g. Movements of both temporary and installed materials from staging area and delivery yards to installation points		
h. Methods used by each trade for:		
(1) Delivery of materials		
(2) Erection of materials		

Figure 6-2. Jobsite Organization Checklist Form (Sheet 1 of 4)

JOBSITE ORGANIZATION CHECKLIST (continued)		
ITEM	YES	NO
1. Job work and traffic flows (congestion) (continued):		
(3) Use of scaffolds, hoists, elevators		
(4) Work areas required for proper usage of mobile equipment		
i. Benefit or hindrance caused by growing mass of installed work		
j. Continuous flows with priority (shorter) paths over occasional flows		
k. Heavier, bulkier, or more delicate components with closer location priority than lighter, less bulky, less delicate items		
l. Equipment with access to all working points and adequate room to maneuver		
2. Yard spaces and areas for prefabrication of components:		
a. Temporary structures and assemblies:		
(1) Concrete forms		
(2) Scaffolds		
(3) Hoists		
(4) Lagging, shoring, braces		
(5) Saw tables and jigs		
(6) Pine fabrication tables and jigs		
b. Installed assemblies:		
(1) Rebar		
(2) Embedded items		
(3) Piping and plumbing		
(4) Lumber framing		
(5) Steel framing		
(6) Sheet framing and miscellaneous metals		
(7) Electrical duct, panels, and wire harnesses		
(8) Masonry		
(9) Tile		
(10) Cabinetry and finish carpentry		
(11) Pile driving		
(12) Dewatering		
(13) Instrumentation		
(14) Precast framing, lintels, walls, and slabs		
3. Materials staging and storage:		
a. Must be planned concurrently with job traffic and work flow analysis and location of yard work plants and spaces		
b. Delivery points for inspection, receiving, and counting		

Figure 6-2. Jobsite Organization Checklist Form (Sheet 2 of 4)

JOBSITE ORGANIZATION CHECKLIST (continued)		
ITEM	YES	NO
3. Materials staging and storage (continued)		
c. Store by trade in separate areas		
d. Stockpiling arrangements:		
(1) First used, last used material locations		
(2) Palletized, stacked, sheltered, and raised off ground		
(3) Drainage		
(4) Unpacking and assembly space		
(5) Aisle and loader access		
(6) Storage space (particularly for pipe, steel, rebar, joists, electric duct, poles, and standards)		
(7) Space for phased delivery of perishable or long lead time materials		
e. Protection against:		
(1) Environmental deterioration		
(2) Handling and transporting		
(3) Theft, losses, and shrinkages		
f. Box trailers for small and valuable parts		
g. Ground treatment, platforms, and mats, etc., for heavy loads on soft ground		
h. Aggregate stockpiles		
4. Equipment and field maintenance site location:		
a. Parking.		
b. Maintenance pads, shops, and shelters.		
c. Petroleum, oils, and lubricants storage.		
d. Fueling stations.		
e. Parts van and box trailers.		
f. Tires.		
g. Attachments.		
h. Low boys.		
i. Loading/unloading ramps.		
j. Dust control.		
k. Batch and mix plants		
(1) Compressed air		
(2) Cooling or heating aggregates		
(3) Foundations		
(4) Loading, scalping, screening, crushing, conveying, washing, stockpiling, reloading, and hauling		

Figure 6-2. Jobsite Organization Checklist Form (Sheet 3 of 4)

JOBSITE ORGANIZATION CHECKLIST (continued)		
ITEM	YES/	NO
4. Equipment and field maintenance site location (continued):		
(5) Method of delivery		
(6) Method of placing		
(7) Power		
(8) Proximity to aggregate sources		
(9) Proximity to jobsite		
(10) Stockpiles, surge piles		
(11) Water.		
5. Haul roads and pits (haul economy):		
a. Elevation (minimum climb, level)		
b. Length (minimum haul time)		
c. Grades (minimum downshifts)		
d. Surface (rolling resistance)		
e. Temporary drainage		
f. Haul road maintenance.		
6. Temporary utilities:		
a. Electrical power distribution points and lighting		
b. Water points and water storage		
c. Potable water		
d. Sanitary toilets		
e. Temporary storm drainage		
f. Fire lines		
g. Fuel		
h. Office space		
i. Employee bulletin boards		
j. Survey benchmarks and reference points		
k. Watchman's shack		
l. Borrow and material pits.		
7. Security and safety:		
a. Gates, fences, and locked storage		
b. Barricades and safety lights		
c. Watchman		
(1) Shack		
(2) Telephone		
(3) Security lighting.		

Figure 6-2. Jobsite Organization Checklist Form (Sheet 4 of 4)

6.2.2 Jobsite Appearance

Project supervisors are responsible for jobsite cleanliness. The jobsite is the first thing one sees when visiting a project. If the jobsite appears disorganized, visitors might not notice high-quality work. A clean jobsite is a safe jobsite. Like a sharp uniform, a clean jobsite reflects pride in one's work.

The following precautions ensure a safe and clean jobsite:

1. Direct the crew members to pick up after themselves during the workday, and perform a final cleanup at the end of each day. Place trash in garbage cans or similar receptacles.
2. Store materials neatly out of the way of the construction area. Watch for items that need to be out of the weather. Dispose of unusable materials as soon as possible. Damaged materials add to the clutter and give the impression of a disorganized site.
3. Erect a professional-looking project sign (watch for misspelled names) and site office. A carefully constructed project sign and an organized field office inspire confidence in a project supervisor's ability to provide a safe construction site and a quality construction project.
4. Ensure safety precautions are in place at all times. Visitors form good or bad impressions of a construction site upon quick observations of safety issues such as open excavations, fall protection, vehicle traffic, hygiene, and electrical setups.

6.2.3 Field Office

The field office may be an equipment shelter or appropriate structure separate from tool and material storage. Never use project materials to construct a field office or build anything in the field office unless the project funds stipulate material purchase for that purpose.

The project supervisor is responsible for a great deal of documentation throughout a project's life cycle. Just as a jobsite must be organized, the field office must be properly organized to facilitate jobsite administration.

6.2.4 Standard Project Sign

Each project uses a standard project sign constructed by the project crew. Signs are constructed per unit SOP. Ensure the sign is presentable and displays names of current project supervisor and safety supervisor as the sign sets a first impression for visitors to the project site. Figure 6-3 illustrates a standard project sign.

Unit Seal	PROJECT TITLE ENGINEER FORCE i.e., “<i>SEABEES</i>” or “<i>RED HORSE</i>” PROJECT SUPERVISOR RANK/NAME SAFETY SUPERVISOR RANK/NAME SAFETY IS OUR FIRST PRIORITY	Safety Decal
--	---	---

Figure 6-3. Standard Project Sign Example

6.3 PROJECT EXECUTION MANAGEMENT

Satisfactory execution of construction tasking requires that many various resources come together at a specific time and place. The project supervisor is responsible for coordinating and scheduling requirements so that the right materials, tools, equipment, and personnel are available at the right time. Project supervisors are responsible for the daily tasks and routines during construction, and use the jobsite management checklist form illustrated in figure 6-4 as a reminder to update information daily. To execute their responsibilities, project supervisors also use the following scheduling and management tools:

1. Jobsite information board
2. Crew member briefings
3. Quality control and safety plans implementation
4. Environmental protection plan implementation
5. Project logbook
6. Construction activity summary sheet
7. Level III Gantt chart
8. Two-week schedule.

JOBSITE MANAGEMENT CHECKLIST			
ITEM	YES	NO	N/A
JOBSITE HOUSEKEEPING			
1. Construction containers, jobsite offices, and tool kits neat and orderly.			
2. Excess material removed from the jobsite.			
3. Jobsite as clean as possible (e.g., lumber free of protruding nails, scrap metal).			
4. Professional project sign with current information.			
5. Vehicles clean and prestarted.			
CREW MEMBERS			
1. Assistant project supervisor designated.			
2. If current project finishes before end of deployment, crew members know where they are going.			
3. Know the information on the CAS sheets for the next several activities.			
4. Must know timekeeping procedures.			
5. Must know who the QC inspector is.			
6. Must know who the project safety supervisor is.			
7. Must wear hard hats and steel-toed boots at all times.			
8. Strict adherence to daily routine.			
9. Unit integrity maintained to the maximum extent possible.			
JOBSITE PROJECT MANAGEMENT			
1. As-built (redline) drawings current and on-project.			
2. Project specifications annotated with notes and highlighted to reflect as-built use.			
3. BOM reflects accurate material status.			
4. Kit inventories current and inventories maintained on the jobsite.			
5. Project logbook is current.			
6. Jobsite information board current.			
7. Crew member briefings conducted and documented.			
8. QC plan current.			
9. Safety plan current.			
10. Environmental protection plan current.			
11. Gantt charts Level III and Level II reflect actual status.			
12. CAS sheets reflect Level III Gantt chart progress; actual start and finish dates; and BOM, tools, and equipment status.			
13. Two-week schedule reflects actual status.			
14. Project package complete and in use by the project supervisor.			
15. Two-week labor summary up to date.			

Figure 6-4. Jobsite Management Checklist

6.3.1 Jobsite Information Board

The project supervisor is responsible for the jobsite information board. This board displays the typical essential information required on a jobsite. These information boards should be the same throughout the unit. Content may vary from unit to unit per the individual unit or HHQ SOP.

The jobsite information board is a tool for communicating project information to the crew and visitors. Every member of the crew is informed as to the board's content and how the project supervisor uses it for project execution.

Some essential items on the board may be too large to display, such as the Level III Gantt chart or a large binder of MSDSs. For an item too large to display properly, in its place note the location of the item in the field office. The jobsite information board is the focal point of the project package information maintained by the project supervisor. All this information must be protected and kept organized until project completion, when the project package is finalized and turned in to the unit QC office.

Figure 6-5 illustrates the essential items on the jobsite information board. The project supervisor daily updates all of the information. Figure 6-6 lists the minimum essential emergency phone numbers.

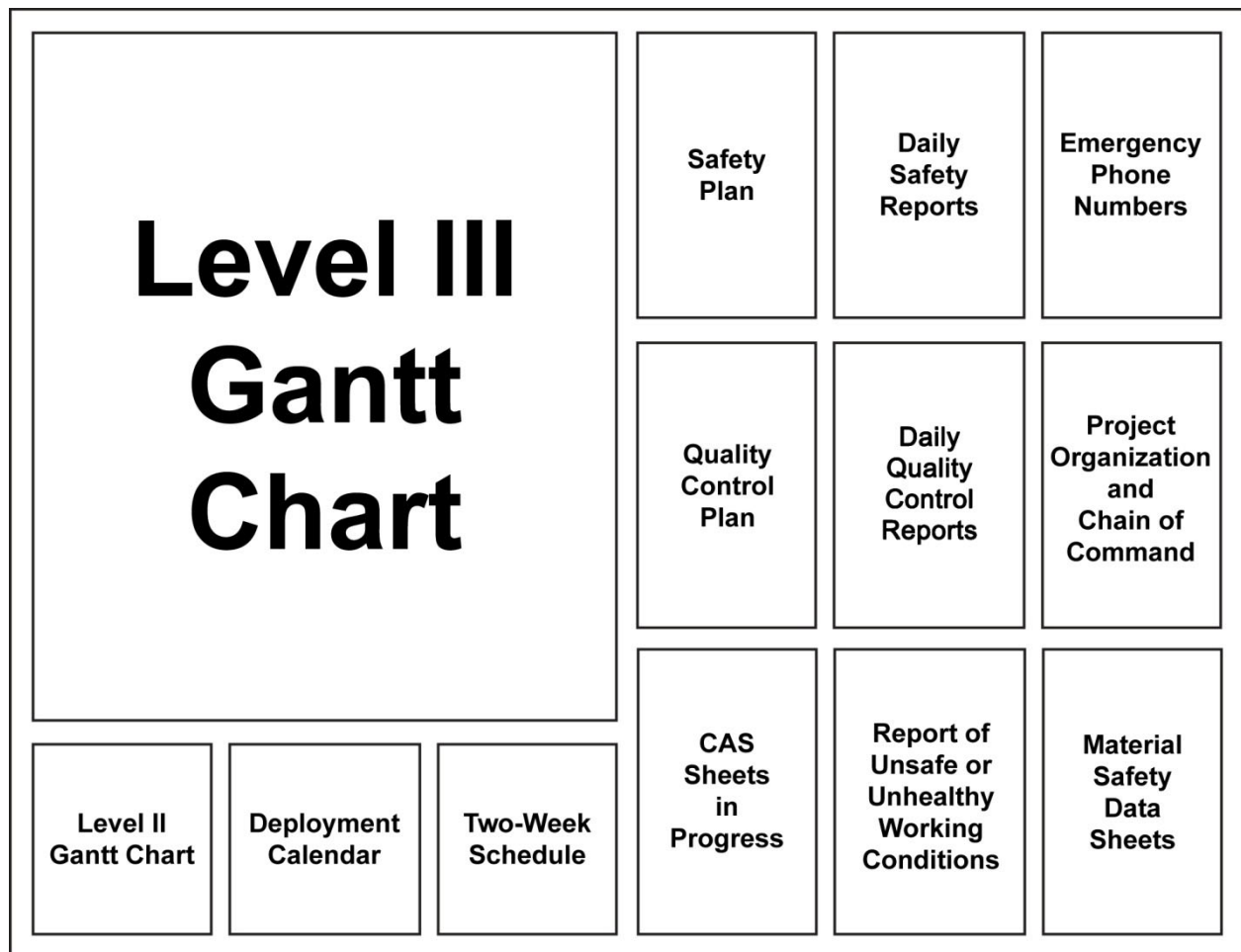


Figure 6-5. Jobsite Information Board Example

EMERGENCY PHONE NUMBERS	
MEDICAL/AMBULANCE:	_____
TO BE POSTED ON ALL PROJECT SITES	
FIRE DEPARTMENT:	_____
HOSPITAL:	_____
BASE SECURITY:	_____
EXPLOSIVE ORDNANCE DISPOSAL:	_____
OPERATIONS:	_____
SAFETY OFFICER:	_____
MISHAP INVESTIGATOR:	_____
QUARTERDECK:	_____
BUILDING NUMBER/PROJECT SITE:	_____
LOCATION OF NEAREST TELEPHONE:	_____
ENVIRONMENTAL MANAGER:	_____
SPILL RESPONSE EMERGENCY NOTIFICATION:	_____

Figure 6-6. Emergency Phone Numbers Form

6.3.2 Crew Member Briefings

Project supervisors are responsible to conduct the following daily crew briefings:

1. Daily Production Briefing. During this briefing, the project supervisor informs personnel what activity they will perform, how they will perform it, how much time is scheduled for the activity, and how an activity delay will impact the overall schedule.
2. Quality Control Measures. During this briefing, the project supervisor informs personnel regarding the activity's QC measures that day and the expected quality level.
3. Stand-up Safety Lectures. During this briefing, the project supervisor informs personnel regarding the activity's safety hazards and preventive measures that day. Refer to the preparatory phase and initial phase checklists discussed in paragraphs 9.5.1 and 9.5.2 for topics. Figure 6-7 illustrates the daily safety lecture log form.

6.3.3 Quality Control Plan Implementation

Project supervisors are responsible for implementation of the QC plan for the assigned construction project. Refer to chapter 9 for information on QC planning and execution actions.

[illegible]

Figure 6-7. Daily Safety Lecture Log Form

6.3.4 Safety and Environmental Protection Plan Implementation

Project supervisors are responsible for implementation of safety and environmental protection plans. Execution of these plans are coordinated by the project supervisor, project safety supervisor, project HM/HW representative, safety officer, and the environmental manager for the assigned construction project. Figure 6-8 lists safety items required on construction jobsites. Refer to chapter 10 for information on safety program planning and execution actions. Refer to chapter 11 for information on environmental protection planning and execution actions.

Project supervisors use the checklist shown in figure 6-9 for periodic project site checks to eliminate safety violations.

JOBSITE REQUIRED SAFETY ITEMS CHECKLIST		
ITEM	YES	NO
1. Communication/Transportation—Required for rapid response in case of a mishap.		
2. Drinking Water—Water must be provided from an approved source, labeled for drinking only, and not used for other purposes. Common cups are not allowed.		
3. Emergency Plans—Each jobsite must post the location of the nearest phone along with the telephone numbers and reporting instructions for ambulance, hospital, physician, police, and fire department personnel.		
4. Eyewash—Required where personnel are exposed to or handling poisons, acids, caustics, or toxic chemicals.		
5. Fire Extinguishers—One for every 3,000 square feet (or major fraction thereof) of building space. Travel distance from any point to the nearest extinguisher will not exceed 100 feet.		
6. First Aid Kits—First aid kits must be readily available and checked weekly for consumed items.		
7. First Aid-qualified Personnel—If a medical facility is not readily accessible (due to time or distance), a crew member must be first aid-qualified and available on the jobsite.		
8. Hazardous Material Inventory Sheet—For any hazardous material on the jobsite.		
9. Material Safety Data Sheets—For any hazardous material on the jobsite.		
10. Safety and Health Manuals—The 29 CFR 1926, Safety and Health Regulations for Construction; EM 385-1-1, Safety and Health Requirements Manual; or other safety documents required on the jobsite as directed by the supported HHQ SOP.		
11. Temporary Fencing/Barricades—Required for jobsites in actively used public areas.		
12. Toilet Facilities—Portable facilities must be provided if toilet facilities are not available.		
13. Warning Signs—Red for immediate hazards, yellow for potential hazards.		
Legend: CFR Code of Federal Regulations EM engineer manual		

Figure 6-8. Jobsite Required Safety Items Checklist Form

JOBSITE SAFETY CHECKLIST			
ITEM	YES	NO	N/A
Safety			
1. All floor openings or trenches properly barricaded or covered.			
2. All rebar ends properly covered.			
3. All required vehicles have wheels chocked.			
4. Clean drinking water with plenty of cups.			
5. Crew members know location of closest medical facility.			
6. Daily safety lecture given.			
7. Emergency response plan—Crew members aware of plan, required assets available, plan rehearsal conducted by crew.			
8. Fire extinguisher dedicated to support the performance of hot work (e.g., welding, cutting, soldering).			
9. Fire extinguishers staged and checked within the last month.			
10. Flag person used where vehicle traffic poses a danger/back-up guides used.			
11. Ground fault current interceptors/spider boxes in use for all temporary power.			
12. Loose materials secured against high winds.			
13. Overhead utilities secured before erection of scaffolds, and work on or near power lines begin.			
14. Personnel engaged in operations constituting an eye hazard use proper eye/face protection.			
15. Personnel have proper hearing protection and other PPE.			
16. Personnel performing hot work wearing protective clothing and other PPE.			
17. Power sources tagged reflecting recertification every 2 weeks.			
18. Power tools and extension cords visually inspected before use.			
19. Project site roped off.			
20. Scaffolding handrails, toe boards, and bracing.			
21. Underground utilities marked by dig safe authority, secured, and hand-located before machine excavation begins.			
22. Vehicle available to transport injured personnel to medical facility.			
23. Warning signs posted (e.g., hard hat area).			
24. Welders or light plants not used as power source.			

Figure 6-9. Project Supervisor's Jobsite Safety Checklist Form

6.3.5 Project Logbook

The project supervisor maintains a logbook documenting events and daily actions on the jobsite in order to have an accurate record and a basis for an assessment of the project status. Events and actions must be written down before they are forgotten. It is not always practical to fill out or update the appropriate management documents when events happen, so project supervisors use the logbook to capture the information and record it for later use. Figure 6-10 shows a project logbook sample page illustrating typical information recorded. Key information to record follows:

1. Date, weather, and timeline of daily events.
2. End of day progress of WIP for construction activities in-progress. Refer to paragraph 7.4.1 for further information on calculating WIP.
3. Material received.
4. Equipment on the jobsite.
5. Timecard notes. Refer to paragraph 7.3 for information on labor accounting codes and timecards.

6.3.6 Construction Activity Summary Sheet

The project supervisor uses CAS sheets in conjunction with the project logbook to track and document events and actions. A CAS sheet becomes active when used to develop the next two-week schedule. Refer to paragraph 6.3.8 for information on developing a two-week schedule. Construction activity summary sheets perform two primary functions:

1. Resource management support for linking resources (e.g., support plan actions, labor, tools, equipment, material) as determined in the detailed planning phase to the project schedule
2. Official documentation of actual project execution statistics as part of the project package.

Proper use of CAS sheets greatly reduces the chance of construction slowdown or stoppage due to a lack of resources or uncoordinated support plan action (i.e., safety approval, QC inspection, materials testing requirement). The majority of the resource requirements identified on the CAS sheet necessitate some action by the project supervisor, typically initiated during development of the two-week schedule. The project supervisor tracks these actions on the CAS sheets by highlighting the action required and also annotates whether it is a requisition for submission or an equipment request to turn in. For example, if a concrete request scheduled for Sept. 31 requires a lead time of 2 weeks, the project supervisor notes on the CAS sheet to turn in a single line item requisition by Sept. 16.

Upon completion of a construction activity, the project supervisor updates the CAS sheet with actual start and finish dates, actual duration, and actual MDs expended using information from the project logbook and SITREP input. This update information includes hours of direct labor under a construction activity, excluding hours under the X codes. Refer to paragraph 7.3 for information on labor reporting. A CAS sheet is closed out after it is updated, signed, and dated by the project's QC inspector and the project supervisor. A diagonal line drawn from corner to corner on the front of the CAS sheet indicates the closeout.

SATURDAY 21 MAY

Weather: Sunny and clear with temps in the 70s

0655 Arrive at jobsite
 0700 CA 03 10 00, 2 BUs
 CA 03 20 00, 1 SW, 1 CE
 CA 31 20 00, 1 EO, 1 UT
 * BUCN, UA
 1000 QC/Safety arrive, expressed concerns of worn-out ground fault current interrupter; change out for new ones from CTR tonight
 1025 QC/Safety depart
 1100 BUC arrives with BUCN; put him to work on CA 03 10 00
 1115 BUC departs with EO3; he is sick and will go to medical
 1200 Depart for lunch
 1245 Return from lunch
 1300 BU1 on CA 03 20 00
 1430 Operations officer arrives
 1500 Operations officer departs
 1700 Jobsite secured

End of Day Progress

Construction Activity	Total Work	Work Complete	Percent WIP
03 10 00	1248 SF	1073 SF	86
03 20 00	1120 pieces	1120 pieces	100
31 20 00	2700 SF	1800 SF	67

Material Received

03 10 00	Form release	5 gallons
03 30 10	Cement type 1	3 bags
	Sand, washed	6 cubic feet
	Aggregate 3/8 inch minus	12 cubic feet

Equipment on-site

31 20 00	Front-end loader	1 EA
03 30 10	11S Mixer	1 EA

Timecard Notes

Crew	031000	032000	312000	XO3	XO8	XO9
BU1		3		6		
BU2	9					
BU3	9					
BUCN	4					5
CE3		9				
SW3		9				
EO3			4		5	
UT2		8	1			
Total	22	29	5	6	5	5
Man-hours						

Figure 6-10. Project Logbook Sample Page (Sheet 1 of 2)

Legend:			
BU2	builder second class (USN rating)	EO	equipment operator (USN rating)
BU3	builder third class (USN rating)	SF	square feet
BUCN	builder constructionman	SW	steelworker (USN rating)
CA	construction activity	UA	unauthorized absence
CTR	central tool room	UT	utilitiesman (USN rating)
EA	each		

Figure 6-10. Project Logbook Sample Page (Sheet 2 of 2)

6.3.7 Level III Gantt Chart

The Level III Gantt chart is the primary visual scheduling tool a project supervisor uses to schedule and monitor progress of a project's construction activities. A Level III Gantt chart is printed by ES date for a specified time period and posted on the jobsite information board. The actual progress of the project impacts many management decisions. Any significant changes to construction progress, even on a single project, may significantly impact future schedule coordination, create resource availability conflicts, and disrupt company- or unit-level operations.

Using information from the project logbook and the CAS sheets, the project supervisor daily annotates the actual progress for each construction activity in progress on the Level III Gantt chart to reflect current project status and to avoid falling behind schedule. The daily annotation aids the project supervisor's early recognition of a construction activity falling behind schedule so that appropriate action can bring the project back on schedule. Refer to paragraph 7.5.2 for information on regaining the schedule.

The following techniques, illustrated in figure 6-11, apply to annotating the project's Level III Gantt chart with actual progress status:

1. Update the Level III Gantt chart by coloring in with black the center piston to indicate activity start, progress, and finish. If the activity starts early or finishes late, the center piston will be outside the baseline box. If an activity starts and finishes as scheduled, the center piston will be within the baseline box. The critical path is colored red and then shaded in with black to show progress. Refer to paragraph 3.7 for further information on Level III Gantt chart symbols.
2. A solid vertical line represents the end of a SITREP reporting period. In this publication, SITREPs are at two-week intervals, due the 15th and last day of the month. Managers adjust reporting requirements as directed by their unit or HHQ SOP. A vertical string line, not shown in figure 6-11, moves each day to reflect the current date on the Level III Gantt chart as the project progresses. A dashed vertical line represents interim snapshots of project status on the Level III. A string line pinned in place may also serve this purpose.
3. Actual WIP per construction activity is reflected on the Level III Gantt chart by a solid or dashed vertical line as discussed above. The vertical line, representing a specific date, deflects left or right (an arrow) for each construction activity to indicate its current progress. An arrow to the left indicates a construction activity behind schedule; an arrow to the right indicates a construction activity ahead of schedule. The numerical percent complete for each construction activity follows the construction activity bar. This data should match SITREP reporting data.
4. In the example, a vertical dashed line indicates project status at the close of business on May 20. Construction activities 017000 and 311000 are 100 percent complete. Construction activity 031000 is 80 percent complete and 1 day ahead of schedule. Construction activity 032000 is 100 percent complete and 1 day ahead of schedule. Construction activity 312000, a critical-path activity, is 1 day behind schedule. If this activity is not completed on time, it will impact other construction activities on the critical path. The project supervisor must take immediate action to correct the situation on construction activity 312000 or risk failing to complete the project on time. This example shows the value of using the Level III Gantt chart to see the big picture of a project.



Figure 6-11. Level III Gantt Chart Example 5

6.3.8 Two-week Schedule

The two-week schedule, also referred to as weekly goals, is the primary management support tool the project supervisor uses to manage near and far horizon coordination and planning. Successful project supervisors manage their projects from the following three perspectives:

1. Work in Progress. The project supervisor or an assistant is always on the jobsite to directly supervise the construction effort underway.
2. Near Horizon. The list of construction activities scheduled for the next 2 weeks ensures an uninterrupted flow of resources to the project. Project supervisors:
 - a. Coordinate support element and civilian subcontractor work.
 - b. Ensure material requests (i.e., single line item requisitions) are turned in and deliveries are scheduled.
 - c. Ensure equipment requests are turned in, confirmed, and approved.
 - d. Ensure QC tests, excavations permits, and other support requests are submitted and approved.
 - e. Take action on FARs and design change directives (DCDs).
3. Far Horizon. A list of construction activities scheduled for 3 weeks out to 3 months controls any LL items which, if not tracked, could eventually cause a work stoppage or delay. Project supervisors:
 - a. Follow up on outstanding 30/60/90-day material requirements plan and LL items.
 - b. Plan coordination of support element and civilian subcontractor's work.
 - c. Track funding status.
 - d. Plan equipment and tool rental requirements.

6.3.8.1 Significance of Setting Goals

Project supervisors set goals and use the two-week schedule to achieve three functions:

1. Plan. The two-week schedule determines the specific actions and resources required to achieve the stated goals of completing specified construction activities in the established time period.
2. Communicate. The two-week schedule provides a means to communicate intentions and requirements up, down, and across the organization. It provides awareness of what needs to be done for mission accomplishment.
3. Accomplish. The two-week schedule provides a means for the project supervisor to set priorities, and direct the crew's focus on specific tasks to accomplish the stated goals of the mission. It provides the means to create unity of effort and instill a sense of urgency for not only the project crew, but across the entire organization.

6.3.8.2 How to Use the Two-week Schedule

Project supervisors develop a two-week schedule using CAS sheets, Level III Gantt chart, BOM, and 30/60/90-day material requests. They typically cover a two-week period, are revised weekly, and are submitted to the project manager via the project supervisor. The project manager presents the two-week schedule at the weekly operations meeting and distributes material, equipment, and support action requests. Specific procedures for frequency and

presentation process may vary between engineer organizations (refer to unit or HHQ SOP requirements). The two-week schedules, used in the crew member briefings described in paragraph 6.3.2, provide ongoing project status updates to the chain of command, MLO, and other support elements.

The two-week schedule consists of the following three parts:

1. Part 1 includes the work scheduled for a 14-day period. The items of work listed on the two-week schedule must satisfy the following requirements:
 - a. Be clear and measurable.
 - b. Be included on the Level III Gantt chart for that period.
 - c. Reflect when a project is behind schedule, why it is behind schedule, and how it is going to get back on schedule.
2. Part 2 lists the tool and equipment requirements for the two-week period.
3. Part 3 lists the material requirements for the two-week period.

This management support tool is used primarily by the project supervisor to ensure that all tools, equipment, and materials are either on the jobsite or requested with sufficient lead time to ensure availability. The two-week schedule also helps management of support actions and events (e.g., engineering services, excavation/digging permits, road closures, utility interruption requests). Any deviation from the schedule of even a day or two can have far-reaching impacts (e.g., affecting the concrete supplier's delivery availability, the hired crane operator availability, additional costs, support elements actions) that the project supervisor and the chain of command must mitigate. Figure 6-12 illustrates an example of a two-week schedule.

The project supervisor uses the following forms to request and schedule services and events:

1. Figure 6-13. Engineering Services Request Form
2. Figure 6-14. Excavation Request Form
3. Figure 6-15. Road Closure Request Form
4. Figure 6-16. Utility Interruption Request Form
5. Figure 6-17. Concrete Placement Clearance Form
6. Figure 6-18. Asphalt Placement Clearance Form.

TWO-WEEK SCHEDULE (PART 1)																											
Project Title: <u>ADMINISTRATION BUILDING</u>														Codes:													
Project Number: <u>EL08-830</u>														S Start C Complete													
Company/Detachment: <u>CHARLIE</u> Period Covered: <u>16 MAY</u> to <u>29 MAY</u>														P In Progress O Off													
Date: <u>12 MAY</u> Page: <u>1</u> of <u>1</u>														TR Training SC Start/Complete in 1 day													
Construction Activity		DATES																Crew		Remarks							
Number	Title	16	17	18	19	20	21	22	23	24	25	26	27	28	29	Size											
017000	Move-in		SC					O						TR	O	7	Equipment confirmed										
311000	Clear and Grub			S	C			O						TR	O	2	ESR for boundary survey scheduled for 16 May										
031000	Prefab Forms Foundation			S	P	P	P	O	C					TR	O	3											
032000	Prefab Rebar Foundation			S	P	P	C	O						TR	O	2											
312000	Subgrade Fill & Corn					S	P	O	C					TR	O	2											
031040	Prefab Forms Beam							O	S	P	P	P	P	TR	O	3	Ends June 8										
017010	Layout Building							O		SC				TR	O	2	Submit ESR for EA support										
031030	Prefab Forms Lintels							O		S	P	C		TR	O	2											
312010	Excavate Footer/Utilities							O			SC			TR	O	2	Submit excavation request and equipment request										
312040	Level, Compact Util							O				SC		TR	O	2											
031010	Set Forms Found							O					S	TR	O	4											
033010	Place Concrete Lint							O					SC	TR	O	2	Submit ESR for material testing support										
																	Submit hard card to QC and concrete request										
Assumptions:																											
<u>1.</u> Material and equipment requests for 17 - 21 May work have been confirmed. _____ <u>2.</u> Material, equipment, and support action requests for period 23 - 27 May are submitted with this schedule. _____																											

Figure 6-12. Two-week Schedule Example (Sheet 1 of 2)

TWO-WEEK SCHEDULE (PART 2)									
Activity Number	Tool Requirements	Equipment Requirements	Remarks						
017000	Kit 80019	Lowboy							
		Rough Terrain Forklift	Required 09 May						
312040		Back Hoe	Required 25 May						
312040	Mechanical Compactor		Will contact for pick-up date						
033010	Concrete Kit		Will contact for pick-up date						
(Part 3)									
Activity Number	BOM Line Item Number	Description	Unit of Issue	BOM QTY	On-Hand QTY	Needed QTY	Date Required	Remarks	
017000	01	Lumber 2 X 4 inch	BF	40	40	40	16 May	Project sign	
	02	Plywood 3/4 inch, 4 x 8 foot	SH	01	01	01	16 May	Project sign	
033010	30	Concrete, 3000 PSI Ready Mix	CD	03	NA	03	27 May	QC approval required	

Figure 6-12. Two-week Schedule Example (Sheet 2 of 2)

ENGINEERING SERVICE REQUEST	
PART I (To be completed by requester)	
From: _____	Phone: _____ Date: _____
To: Engineering Division	
Subject: ENGINEERING SERVICE REQUEST	
01.	It is requested that the following service(s) be provided: ☐ surveying ☐ drafting ☐ reproduction ☐ other
02.	Date needed: _____
03.	Description of work: (include sketch, location, size, project number, etc.)

Requester's Signature	
Part II (To be completed by Engineering Division)	
Date request received: _____	Priority assigned: _____
Approved/disapproved: _____	Completed by: _____
Date work started: _____	Man-hours expended: _____
Date work completed: _____	
Original—File	
Copy—Requester upon completion of work	
Copy—Section performing work	Engineering Request Number: _____

Figure 6-13. Engineering Services Request Form

EXCAVATION REQUEST						
From: Engineering unit: _____ To: Public Works Department/Base Operations Support Subject: EXCAVATION REQUEST						Date: _____
Request clearance to excavate for the purpose of (describe excavation):						
Method of excavation:						
Planned start date:						
Planned completion date (including backfill, compaction, ground cover, paving repair, etc.):						
The excavation is for project _____ and is required to _____						
Point of contact: _____ Phone number: _____						
Sketch showing location of planned excavation is attached (mandatory).						
_____ Signature/printed name of requester						
INTERNAL PUBLIC WORKS ROUTING						
CODE	WORK CENTER	APPROVED/DISAPPROVED	SIGNATURE	DATE	PHONE	REMARKS
	Line Crew					
	Water Crew					
	Engineering					
PUBLIC WORKS DEPARTMENT ENDORSEMENT						
From: Public Works Department/Base Operations Support To: Engineering unit: _____						
Returned APPROVED/DISAPPROVED						
_____ Signature/printed name of approving official						

Figure 6-14. Excavation Request Form

ROAD CLOSURE REQUEST						
						Date: _____
From: Engineering unit: _____						
To: Public Works Department/Base Operations Support						
Subject: EXCAVATION REQUEST						
Request permission for closure/partial closure of: _____						
The excavation is for project _____ and is required to _____						
Planned closure date/time: _____						
Planned reopening date/time: _____						
Point of contact: _____ Phone number: _____						
_____ Signature/printed name of requester						
INTERNAL PUBLIC WORKS ROUTING						
CODE	WORK CENTER	APPROVED/DISAPPROVED	SIGNATURE	DATE	PHONE	REMARKS
PUBLIC WORKS DEPARTMENT ENDORSEMENT						
From: Public Works Department						
To: Engineering unit: _____						
Returned APPROVED/DISAPPROVED _____						
_____ Signature/printed name of approving official						

Figure 6-15. Road Closure Request Form

UTILITY DISRUPTION REQUEST						
From: Engineering unit: _____ To: Public Works Department/Base Operations Support Subject: UTILITY DISRUPTION REQUEST						Date: _____
Request authorization for a scheduled utility interruption involving the following utilities: _____ Electric _____ Water _____ Steam _____ Sewerage _____ Communication _____ Other						
Location: _____						
Planned start date/time: _____						
Planned completion date/time: _____						
The interruption is for project _____ and is required to _____						
Point of contact: _____ Phone number: _____						
_____ Signature/printed name of requester						
INTERNAL PUBLIC WORKS ROUTING						
CODE	WORK CENTER	APPROVED/ DISAPPROVED	SIGNATURE	DATE	PHONE	REMARKS
	Line Crew					
	Water Crew					
	Engineering					
PUBLIC WORKS DEPARTMENT ENDORSEMENT						
From: Public Works Department/Base Operations Support To: Engineering unit: _____						
Returned APPROVED/DISAPPROVED						
_____ Signature/printed name of approving official						

Figure 6-16. Utility Disruption Request Form

CONCRETE PLACEMENT CLEARANCE FORM							
PART I				Date: _____			
Project Number: _____		Title: _____		Location: _____			
Date/Time Desired: _____		QTY: _____		Strength (PSI): _____			
Slump (in.): _____		Max Aggregate Size: _____		Admixtures: _____			
Type of Placement		() Roof		() Slab		() Wall	
						() Other	
Finish Required (type):				Tolerance () +/- 1/4 inch () Other			
PART II		CONFORMS TO REQUIREMENTS				CONFORMS TO REQUIREMENTS	
ITEM	N/A	CREW LEADER	QC SPEC	ITEM	N/A	CREW LEADER	QC SPEC
Subgrade Prep				Electrical			
Elevation				Conduit Inst/Stubbed up			
Dimension				Sleeves (foundation)			
Compaction				Pull Cords			
Capillary Barrier (sand)				Mechanical			
Vapor Barrier				Sleeves (foundations)			
Misc. (insect, drain rack)				Subslab Piping			
Forms				Pressure Tested			
Elevation				Floor Drains (elevation and location)			
Dimensions				Floor Cleanouts (elevation and location)			
Alignment				Stubups (location, type)			
Bracing				Placing/Finishing Equipment			
Condition				Screed Boards Set			
Keyways				Screed Boards Checked			
Water Stop				Placing Tools Set			
Embedded Items				Placing Tools Checked			
Anchor Bolts				Finishing Tools Set			
Sleeves				Finishing Tools Checked			
Miscellaneous				Curing Materials			
Reinforcing				Testing Materials (cylinders, slump cone) arranged for onsite			
Size				Note: Photographs of forms, reinforcing steel, anchor bolts, etc., are to be taken prior to placement of concrete.			
Location and Spacing							
Chairs (meshups)							
Bracing							
Submitted: _____				_____			
Project Supervisor				Date			
Approved: _____				_____			
QC Specialist				Date			
Scheduled For: _____				Remarks: _____			

Figure 6-17. Concrete Placement Clearance Form

ASPHALT PLACEMENT CLEARANCE FORM			
Project Title:	N/A	Project Supervisor	QC Specialist
Part I Subgrade Prep			
Materials (specifications)			
Compaction			
Miscellaneous			
Part II Base Course			
Materials (specifications)			
Compaction			
Embedded Structures			
Blue Top Elevation			
Miscellaneous			
Part III Asphalt Prime			
Type (specifications)			
Rate of Application			
Application Temperature			
Cure			
Edge Preparation			
Other			
Part IV Asphalt Mix Requirements			
Design			
Extraction Tests			
Marshall Stability			
Placement Temperature			
Part V Equipment (onsite/good condition)			
Spreader			
Breakdown Roller			
Intermediate Roller			
Finish Roller			
Hand Tools (e.g., rakes, shovels)			
Cleanup Equipment			
Barricades or other Traffic Control			
Other (specify)			
Part VI Order			
Specification:	QTY:	Date of Delivery:	
Submitted By: _____		Approved By: _____	
Project Supervisor		QC Inspector	

Figure 6-18. Asphalt Placement Clearance Form

6.4 MATERIAL MANAGEMENT CONSIDERATIONS

Construction work cannot happen unless the necessary materials are delivered to the jobsite on time. Leaders at all levels of construction project management must familiarize themselves with the logistics procedures of the supporting organization, monitor project costs, and track material from order through receipt at the jobsite. The concept of MLO is not universal; in this publication MLO is modeled after the NCF. However, the principles of material management discussed in paragraphs 6.4.1 thru 6.4.11 apply to other military service engineering units.

6.4.1 Financial Awareness

Project managers are responsible for financial management of assigned projects. Project supervisors must be aware of material costs and their impact on the project's budget. Key questions to ask include:

1. What is the maximum funding amount allowed for the project?
2. How much available funding remains?
3. Is it enough to finish the project?

When a project comes on line, the client provides funding to complete the project as originally estimated to HHQ. The funding goes to the HHQ to purchase CONUS material and/or to the engineering unit and its detachments to buy materials locally. The amount of funding locally will depend on the amount of project material purchased in CONUS rather than the project location. Base/station fiscal departments typically hold the local purchase funding, which is tracked by MLO or an engineering unit's financial office. Figure 6-19 shows a project cost worksheet to assist managers with tracking project costs.

PROJECT COST WORKSHEET	
PROJECT NUMBER:	DATE:
PROJECT TITLE:	
ITEM	FUNDS (\$)
1. ORIGINAL ESTIMATE WITHIN SCOPE: Architect/engineer's estimate for the original BOM.	
2. FUNDS AUTHORIZED/PROVIDED: The amount of money HHQ provided to purchase materials locally.	
3. ACTUAL EXPENDITURE COST: Cost of materials MLO has received and paid for.	
4. PIPELINE COST: Cost of materials MLO has received or ordered, but has not paid for.	
5. FUTURE FUNDING REQUIREMENTS: Materials needed in the future, but not ordered.	
6. TOTAL MATERIAL AND SERVICES COST: Cost of all materials paid and unpaid, ordered and not ordered (= 03 + 04 + 05).	
7. FUNDING CONTINGENCY: Ten percent of the sum of pipeline plus future funding = 10% (04 + 05).	
8. ESTIMATE-AT-COMPLETION: The projected cost of the completed project (= 06 + 07).	

Figure 6-19. Project Cost Worksheet

Although MLO controls the project funds, the project supervisor is responsible to complete the project within the budgeted cost. Every time a BOM add-on/reorder item is submitted, the final project cost increases and the funding remaining to complete the project decreases. Information for status of project cost derives from financial reports published by MLO, base/station fiscal departments, or the project manager's own record. These reports vary across the military services, so refer to unit financial SOP for guidance.

6.4.2 Material Tracking

Project supervisors determine project material status through various reports published by the supported HHQ, the engineering unit MLO, or financial organization. These reports reference materials and services by BOM line item number. Quantities on these reports should match the quantities on the BOM; if they do not, investigate the discrepancy. Tracking reports typically provide a listing, by project and by BOM line item number, of all materials received, on order, issued, as well as material location in MLO. Refer to unit SOP for information on the specific reports used and frequency provided.

Material is ordered during the detailed planning phase using the BOM add-on/reorder request in conjunction with the LL items listing and 30/60/90-day material plan. Higher headquarters logistics organization and the engineering unit MLO order and track material status. Project managers receive reports from HHQ and MLO to track individual project material. Project supervisors use these reports in conjunction with the BOM and CAS sheets to track material receipts to MLO. Eventually, materials are requested from MLO using the two-week schedule and single line item consumption/requisition documents prepared for each item.

6.4.3 Authorization for Approval and Receipt of Material

All material transactions (receipt and return) with MLO are documented with a single line item consumption/requisition document. Material liaison office and other logistics organizations use established processes to ensure accountability for ordering and receiving materials. Project supervisors submit a memo to MLO via the chain of command listing the personnel authorized to requisition and receive material. The project supervisor must be authorized to requisition material. Material liaison office requires that one person cannot both requisition and receive a material item. Any person with signature authorization to approve or receive material may sign (red ink only) returns of unused materials. Refer to unit SOP for information on the specific routing and approval levels.

6.4.4 Project Material Issue and Jobsite Delivery

Project supervisors are responsible for material management at the jobsite. They submit single line item requisition documents in conjunction with the two-week schedule through the project manager to draw on-hand materials and specialty-ordered project tools from MLO. Refer to unit SOP for information on the specific procedures used by MLO.

The project supervisor initiates local purchase actions. In general, MLO procures no local purchase material until it is requested by the project supervisor. This request may be in the form of a 30/60/90-day material list or a single line item requisition turned in to MLO several weeks in advance.

Lead times for obtaining equipment and materials vary from several days for materials in the MLO yard to several weeks for equipment rented from a private contractor. If MLO needs a lead time of 2 weeks for a concrete request and the placement is scheduled for Sept. 30, make a note on the CAS sheet to turn in a single line item requisition by Sept. 8.

If MLO's turnaround times are unclear, ask for an explanation. Single line item requisitions can be filled out and retained in the project package weeks or months in advance. Dropping off single line item requisitions at MLO 3 days before the material is needed (for material in the yard) is better than short-fused, "I need it now" requests. The project supervisor should consider 3 days a minimum required lead time for requesting material from MLO. The Material liaison office can operate more effectively without short-fused requirements, which means they must drop what they are doing to get the material. If given more lead time, MLO can provide better service to all project sites.

Material receipt, storage, and use are important considerations for construction project execution. The client pays for all the materials on a construction project and expects engineers to protect project materials from theft, misuse, abuse, and damage by handling, weather, or vandalism. Once materials are on the jobsite, the project supervisor must protect them. Store materials indoors, if possible, or off the ground outdoors. Lock up easily pilfered, high-value items.

Project supervisors answer the following questions regarding project material considerations:

1. Is there easy access for material delivery and handling?
2. How much material is needed onsite?
3. How big an area is available to store material onsite?
4. Has a lay-down site been approved by the activity PW/BOS organization?
5. Can material be stored safely onsite? Can the material be secured?
6. Has the activity security organization been informed of the lay-down site?
7. Is material stored properly? Are materials exposed to the weather?
8. Are MSDSs available for materials that require one, and is it the appropriate material?

Refer to figure 6-2 for further information on jobsite material considerations.

Project supervisors may appoint a material custodian responsible for ensuring jobsite materials are accounted for, maintained, and used for their intended purpose. On a large project, project supervisor may assign a material custodian for each trade assigned to the project. Material management responsibilities include the following tasks:

1. Requisition, receipt, storage, and issue, as well as inventory and return of excess materials provided, to support the project per unit SOP; identification of discrepancies; and initiation of or follow-up on resolution actions
2. Provision of a secure storage area for materials
3. Documentation of daily receipt and use of project material on the jobsite in the following:
 - a. Project logbook
 - b. Construction activity summary sheet
 - c. Bill of materials.
4. Maintenance of a damaged materials record in the project logbook.

6.4.5 Material Borrow/Transfer

A project supervisor may borrow material from another ongoing job. If MLO has required material waiting for a project, but another job has the identical item onsite, the operations officer can authorize borrowing the on-site material if MLO can replace it before it is needed on the other project. Borrowing material is not recommended and must be carefully considered even for high-priority projects. The project supervisor submits a material borrow/transfer request, as shown in figure 6-20, and tracks items in a borrow/transfer log, as shown in figure 6-21. Refer to unit SOP for information on the specific procedures used by MLO.

Project materials on hand may be transferred to another project having identical materials currently requisitioned, which will resupply the borrowed materials.

MATERIAL BORROW/TRANSFER REQUEST	
From: _____ To: MLO Via: (1) QC (2) Planning and Estimating (3) Operations Officer 1. Request authorization to transfer the following material between the indicated projects: From: _____ Project: _____ BOM Line Item Number: _____ Description: _____ Quantity on Hand/Required: ____/____ To: _____ Project: _____ BOM Line Item Number: _____ Description: _____ Quantity on Hand/Required: ____/____ 2. Reason for request: _____ _____ Signature: _____	
OPERATIONS	
Quality Control:	Approved/Disapproved: _____ Date: _____ Signature: _____
Planning and Estimating:	Approved/Disapproved: _____ Date: _____ Signature: _____
Operations Officer:	Approved/Disapproved: _____ Date: _____ Signature: _____
Comments: _____	
MATERIAL LIAISON OFFICE	
1. The approved transfer has been completed, and the material is ready for issue. 2. The following action has been initiated to repay the loaning project: _____ The material has been ordered. Awaiting requisition number. _____ The material was already on order under requisition number _____, and upon receipt, it will be transferred to the loaning project as payback. _____ The material was reordered under requisition number _____, and upon receipt, it will be transferred to the loaning project as payback.	
_____ Material Liaison Officer	_____ Date

Figure 6-20. Material Borrow/Transfer Request Form

6-32

Figure 6-21. Borrow/Transfer Log Form

6.4.6 Excess Material

Excess material originates when completed or canceled project material is declined by the client and becomes available for other use. Transfer of excess materials to a specified project reduces cost or time.

Project supervisors are required to screen the excess list regularly published by MLO. If items on the list can be used on upcoming construction activities, the project supervisor submits a material borrow/transfer request through the project's chain of command. The project supervisor or assigned crew leaders are responsible for canceling the original BOM purchase order by a memo to MLO. Refer to unit SOP for information on the specific procedures and approval levels.

6.4.7 Returning Project Material

Project supervisors return to MLO any project materials issued and unused, specialty project tools, and/or equipment that is the property of the client. These items remain project materials until they are transferred to the client or the client cedes ownership in writing. Materials are returned using a single line item consumption/requisition document written in red ink.

6.4.8 Add-on/Reorder Materials

Project supervisors submit a BOM add-on request when additional material items to what is already on the BOM are required or a reorder request if a new material item not already on the BOM is required. Refer to paragraph 4.3.3 for information on a BOM add-on/reorder request and justification.

6.4.9 Concrete, Asphalt, Sand, or Aggregate Request

Project supervisors use a concrete, asphalt, sand, or aggregate request form, as shown in figure 6-22, to schedule the delivery of concrete, asphalt, and concrete components (cement, sand, aggregate) from local vendors and/or a military engineer plant. Supervisors submit one copy of the form with a single line item requisition for each BOM line item (i.e., concrete, sand, cement, aggregate, or asphalt) to MLO. Allow a minimum of 15 working days for routine scheduling. Prior to MLO ordering asphalt or concrete, QC completes an asphalt or concrete clearance form giving MLO clearance to order the product. The QC staff and MLO coordinate a final delivery schedule. Canceling a scheduled asphalt or concrete delivery requires a 24-hour-minimum notice to MLO. The vendor accommodates requests for rescheduling on a space/time availability basis; otherwise, the routine scheduling procedures is utilized.

6.4.10 Long Lead Item Follow-up

Project supervisors are responsible for the periodic review, update, and submittal of the project's LL items list to MLO. This form indicates which outstanding LL items still require status monitoring. Refer to paragraph 2.3.9 for information on developing an LL item list.

CONCRETE, ASPHALT, SAND, OR AGGREGATE REQUEST	
Date: _____ From: _____ To: MLO Via: (1) Quality Control Subject: CONCRETE, ASPHALT, SAND, OR AGGREGATE REQUEST	
01. Materials: Concrete, Asphalt, Sand, Aggregate (circle one) 02. Date Required: _____ 03. Time Required: _____ 04. Amount Required: _____ 05. Sequence of Delivery: _____ 06. Specifications/Comments: _____ _____ 07. Project Number: _____ Project Title: _____ Activity Number: _____ _____ Signature of requester	
QC ENDORSEMENT	
01. Request is forwarded APPROVED/DISAPPROVED. 02. Comments: _____ _____ _____ _____ Quality Control Signature/Date	
MLO ENDORSEMENT	
From: MLO To: _____ 01. Requisition Number: _____ 02. Any changes affecting delivery of materials requires IMMEDIATE notification of all concerned. _____ MLO Signature/Date	

Figure 6-22. Concrete, Asphalt, Sand, or Aggregate Request Form

6.4.11 Hazardous Materials

Project supervisors designate and train per their unit SOP a project crew member as an HM/HW representative. The project supervisor and HM/HW representative are responsible to ensure:

1. An inventory of HM for the project sites is submitted.
2. The MSDS logbook is kept on the project site.
3. Personnel are adequately trained for the HM in use, and follow safety measures listed on the MSDS.
4. Containers for temporary use are correctly labeled.
5. Spill kits are positioned at satellite HM storage areas.
6. Hazardous material is stored with compatible materials.
7. Hazardous waste is handled correctly per the unit SOP.

Project supervisors inspect the material at MLO to prepare for receipt and storage on the jobsite, paying particular attention to HM storage requirements. No more than 2 weeks of material is stored at the project site. Material liaison office ensures an MSDS is provided with HM and that the item is included on the unit's authorized user list. To return to MLO, HM must be in the original containers, in serviceable condition, and accompanied by the MSDS.

6.5 TOOL MANAGEMENT CONSIDERATIONS

Project supervisors are responsible for accountability, maintenance, and proper use of tools on the jobsite. Each military service has different procedures on how to manage tools, so it is important to read and use the unit or supported unit SOP.

6.5.1 Authorization for Approval and Receipt of Tools

Accountability starts with the authority to check-out tools. Submit signature authorization cards per unit SOP to the central tool room or supporting organization.

6.5.2 Jobsite Responsibilities

The project supervisor must have the right tools available and in proper working order for the crew to accomplish its work. The project supervisor must consider tool storage, access, and maintenance when organizing the jobsite. Supervisors may assign a tool custodian to assist with these responsibilities, which include the following tasks:

1. Performance of a thorough inventory of all tools provided to support the project per the unit SOP, usually on a biweekly basis.
2. Maintenance of tools, identification of discrepancies, and initiation of or follow up on resolution actions.
3. Provision of a secure storage area for tools.
4. Establishment of accountability procedures. Project supervisors authorize custody of tool kits to crew members (usually the senior individual in a trade) to ensure proper chain of custody and safekeeping. Check in and check out tools daily. Lost tools are charged to the individual who last had custody. Project tools bought with the project funds require special accountability since they are the property of the client and must be offered to the client at the end of the project.

5. Record management of lost and damaged tools to be replaced, per unit SOP. Submit required paperwork as quickly as possible, usually every 2 weeks during tool kit inventories, to have tools replaced.

6.6 EQUIPMENT MANAGEMENT CONSIDERATIONS

Project supervisors are responsible for accountability, maintenance, and proper use of equipment (also known as civil engineering support equipment (CESE)) on the jobsite. Project supervisors must take ownership of assigned equipment and instill that same sense of ownership in the crew members. This is a significant issue because of the dollar investment that equipment represents. For example, it does no good to complete ahead of schedule and under budget a \$45,000 project with quality construction if it includes \$35,800 worth of equipment repair and replacement cost due to negligent actions. Equipment is usually the most costly and most dangerous of all resources on a jobsite.

6.6.1 Equipment Considerations

Key equipment considerations include:

1. Jobsite Organization. Access, visitor parking, construction equipment staging, traffic flow, and environmental protection for vehicle petroleums, oils, and lubricants are key considerations. Refer to figure 6-2 for further information on jobsite equipment considerations.
2. Coordination of assigned equipment's preventive maintenance schedule and awareness of how it may impact the construction schedule. Coordinate with field maintenance crews rather than turning equipment back into the shop for maintenance. Remember to give oversight of rental equipment the same consideration and maintenance.
3. Equipment Operator Licensing and Training. Personnel are licensed operators for and trained on the equipment used for the assigned task(s).
4. Equipment Operator Accountability. If a piece of equipment assigned to a project comes with an equipment operator, that operator is accountable to the project supervisor for the duration of the equipment assignment.
5. Equipment Management Procedures:
 - a. Determine if equipment is to remain on the jobsite for an extended period of time.
 - b. Determine who is responsible for checking out and turning in daily trip tickets for each piece of equipment.
 - c. Refer to the unit SOP for specific equipment management procedures.
6. Equipment Accountability:
 - a. Assign someone to be directly accountable for each piece of equipment.
 - b. Ensure physical security and weekly inventory of equipment.
 - c. Ensure accountability of equipment and vehicle keys, fuel keys, and associated documents, including physical security of equipment, vehicles, and keys after duty hours.

6.6.2 Jobsite Responsibilities

Project supervisors are responsible to ensure crew members properly operate and maintain equipment on the jobsite. An equipment custodian may be assigned to assist with these responsibilities, which include the following tasks:

1. Operator Responsibilities:
 - a. Equipment used for intended purpose and not abused
 - b. Abuse and neglect reported and not overlooked
 - c. Documentation (including photographs) of any damage to equipment or vehicles prepared immediately.
2. Maintenance Responsibilities:
 - a. Prestart inspections and first echelon maintenance conducted by assigned operator daily
 - b. Equipment safe, clean, and maintained, including engine oil and coolant level checks, washing, and lubricating
 - c. Prompt documentation and report of any discrepancies.

6.7 VISITOR CONSIDERATIONS

6.7.1 Visitors

All visitors are important and should be treated with respect and professionalism. The two types of visitors are: unofficial visitors, with whom unit personnel deal on a regular basis in the execution of their duties; and official visitors, who interact with the unit's command in an official capacity. Create a visitor package that can be customized for types of visitors.

The project supervisor makes an important impression upon official visitors when presenting the job and should have military bearing and speak positively. A cluttered site raises questions of quality, safety, and construction ability. For a scheduled visit, ensure the crew is briefed, and the project site is in good order, as discussed in paragraph 6.2.2. Have safety items (e.g., hard hats, ear plugs, eye protection) on hand for visitors.

Meet and greet visitors as soon as they arrive on the project site. If involved in a critical evolution, the project supervisor should apologize to the visitors and return as soon as possible. While overlooking the project site, the project supervisor introduces leaders, project title, project number, and crew members. The project supervisor then guides the visitors around the jobsite. No one, not even unit personnel, should walk around unescorted. The exception is the QC or safety inspector who conducts daily inspections and has authority to walk around freely.

Point out key activities in progress. Take the time to answer questions by having crew members explain the activities. If a visitor approaches a working crew member, that worker should find a safe breaking point in the work and then address the visitor. Render the appropriate courtesies, but never at the expense of safely stopping the work.

Ask visitors if there is anything that they would like to see. End the visit by thanking them for their interest in the project. Allow the visitors to leave with an impression that the supervisor knows how to do the job. If unsure how to answer a question, a project supervisor should find the right answer before getting back to the visitors. Always get back to the visitors with an answer. Visitors will carry an impression, good or bad, back to HHQ.

The entire construction team, including the client, PW/BOS, and the contracting office should be notified by the unit prior to any visits by non-unit personnel E-8 and above.

6.7.2 Visitors Briefing

Project supervisors should escort visitors to the field office for a visitor's briefing. Use the briefing format as presented in paragraph 5.3.5 with the following content:

1. **Project Scope.** Paint a picture so that anyone unfamiliar with the project can visualize the goal. State the ultimate purpose of the project/facility. Stick to general descriptions, and avoid details unless asked specific questions. Explain the project schedule to the visitors using the Level III Gantt chart. If the project is behind schedule, explain how the crew will catch up.
 - a. **Activities.** State the progression of work in phases or master activities (i.e., "We plan to place 100 cubic meters of 200 cubic meters of concrete for the project, which will complete the first of two basketball courts").
 - b. **Time.** State the total number of MDs estimated and how much the crew is tasked to complete.
 - c. **Manpower.** State the crew size and how it may change as work progresses. State the support element requirements.
 - d. **Material.** State the general status of material, identify any critical material deficiencies, and describe what is being done to correct the deficiencies.
 - e. **Equipment.** State phases that require equipment and identify any availability issues that would affect them.
2. **Client.** Identify the client and the client's expectations.
3. **Budget.** State what the project funds are for the overall project.
4. **Civilian Subcontractors.** Give a brief description of the civilian subcontractors' part of the project.
5. **Project Management.** Highlight the top three QC and safety concerns and what measures will satisfy those concerns. Point out the project items of special interest:
 - a. **Quality Control.** State the major QC issues involved with the scope (e.g., concrete placement/preparation, mechanical/electrical material and code requirements, difficult or unique specifications) and know the specifications for each.
 - b. **Safety.** State the project's goal for a proactive safety posture. Name the project's safety representative. Outline the safety plan. Describe the morning's safety lecture.
 - c. **Hazards.** State the major hazards involved with the scope (e.g., trenching, scaffolding, electrical, confined spaces) and what actions are in place or being taken to mitigate the hazards.
 - d. **Concerns.** Describe concerns for the day's tasks and remedies.
 - e. **Delay Factors.** List major RFIs and design issues affecting progress (i.e., site work, structural questions, critical-path activities). Do not blame problems on the infamous "they." It is "our" project, and "we" control its destiny. If an issue is being worked at a higher level, then state that fact, but do not place blame on another unit.
6. **Photos.** Show photos displaying the project's progress and, comment on each.

CHAPTER 7

Project Monitoring

7.1 INTRODUCTION

Managers implement monitoring procedures to facilitate project execution and control. Monitoring is essential to evaluating the status of a project by comparing the scheduled progress to the actual progress. Managers employ several systems to facilitate project monitoring:

1. Situation reports
2. Labor reporting and timecards
3. Data computations for SITREP input
4. Controlling procedures and corrective actions to keep the schedule.

7.2 UNIT SITUATION REPORTS

Engineering units are required by the supported HHQ to provide construction project SITREPs. Refer to unit SOP for specific SITREP format and reporting requirements since each military service has unique requirements. Refer to paragraph 7.4 for information on SITREP input provided by the project supervisor.

7.2.1 Meeting the Scheduled Project Completion Date

Scheduled project completion dates and intermediate tasking milestones are commitments that must be kept and may have significant negative impact if not achieved. Higher headquarters conducts an in-process review of construction projects at or about the 30-day mark. At this point, the operations officer and project managers set a firm schedule with HHQ, committing the unit to meeting the scheduled project completion date.

Project supervisor informs the project manager as soon as the scheduled completion date is no longer achievable. Refer to paragraph 7.5.2 for information on regaining a project schedule. If the company leadership cannot regain the project schedule, they inform the operations officer. The clients rely upon the facility delivery on the scheduled date, and delays impact their plans. Delays may also impact the follow-on engineering unit schedule.

7.2.2 Photographic Coverage

Engineering units provide HHQ with digital pictures of each active project on a regular basis as part of unit SITREP reporting. Pictures indicate construction milestones and coordinate with SITREP comments. The point of reference for pictures provides the broadest coverage utilizing the same view over time to clearly show sequence of construction progress. Units also provide pictures of working crew members and major construction evolutions depicting engineers in action for historical and public affairs purposes. The project supervisor is responsible to ensure photos reflect professionalism, and do not show safety violations.

7.3 LABOR REPORTING

Project supervisors use timekeeping procedures to analyze how they use their assigned labor assets. Labor accounting provides data for construction management and statistics calculations.

7.3.1 Labor Accounting Codes

Labor accounting requires standardized codes for reporting. Project supervisors use the following labor accounting categories and codes on timecards. Refer to appendix F for further information on labor accounting codes.

1. Direct labor.
2. Indirect labor. Figure 7-1 lists indirect labor codes.
3. Readiness and training.

7.3.2 Timecards

Project supervisors prepare daily timecards reflecting actual man-hours expended by all personnel assigned to the project. Timecards are the most accurate way to record actual man-hours on a construction project. It is imperative that project supervisors and assigned crew leaders fill out timecards honestly and accurately. Timecards are used to:

1. Monitor the efficiency and accountability of assigned personnel
2. Provide data for SITREP input.

A support element crew leader uses the same timecard as the lead element crew leader (may also be the project supervisor) but indicates that it is for the support element crew only. The support element crew leader fills out the timecard in duplicate while on the project. This timecard reflects all support element labor and is signed by both the project supervisor and the support element crew leader. Each support element crew leader turns in a timecard to the chain of command. The project supervisor keeps a copy of each support element timecard and turns it in with the lead element timecard. This procedure allows the lead element project supervisor and project manager to monitor the effort expended by the support elements and the time charged against the project.

INDIRECT LABOR CODE	DESCRIPTION
XO1	Equipment, Repair, and Records
XO2	Project and Camp Maintenance Support
XO3	Project Management
XO4	Location Moving
XO5	Project Travel
XO6	Material Support
XO7	Tools
XO8	Administration and Personnel
XO9	Lost Time
XO10	Other

Figure 7-1. Indirect Labor Codes

Project supervisors record all timecard data daily on a two-week labor summary prior to submitting the timecards to the chain of command. This two-week labor summary provides the data used to develop SITREP feeders, track actual MDs per construction activity, and calculate crew availability. Labor is recorded to the nearest whole man-hour. If more than one labor category applies to a specific man-hour, the project supervisor uses the dominant category for reporting.

Figure 7-2 illustrates a sample lead element/support element timecard, and figure 7-3 illustrates a sample two-week labor summary. Refer to paragraph 3.3 for further information on converting man-hours to man-days.

7.4 PROJECT SITUATION REPORT INPUT

The SITREP feeder prepared by the project supervisor provides data for recording actual progress on the Level II Gantt chart and the unit SITREP required by HHQ. Military engineers use two primary methods to calculate actual progress of a construction project:

1. Work-in-place. The completed quantity of work divided by the total quantity of work yet to be performed, expressed as a percentage.
2. Man-days Earned. The portion of estimated or baseline MDs corresponding to the percentage of WIP.

7.4.1 Work-in-Place Method

The project SITREP feeder format uses the WIP method. Refer to figure 7-4 for a sample project SITREP feeder discussed in paragraphs 7.4.1.1 thru 7.4.1.6.

Information for the Percent Complete Estimated, Master Activity Number, Master Activity Description, and the Man-day Estimate columns come from the project's Level II Gantt chart. Refer to paragraph 3.9 for information on how to develop a Level II Gantt chart.

Weighted Percent (column b) is equal to the Man-day Estimate (column a) divided by the Total Project Man-day Estimate.

LEAD ELEMENT/SUPPORT ELEMENT TIME CARD													
Project Supervisor: BU1 BROWN		Signature:		Company: CHARLIE		Crew Size: 8		Transfers this date: NONE					
Project Number: EL08-830		Project Title: ADMINISTRATIVE BUILDING											
Crew Members Assigned	Direct Labor by Construction Activity Number				Indirect Labor				Training				
	031000	032000	312000						X03	X08	X09		Total
BU1 BROWN		3							6				9
BU2 SMITH	9												9
BU3 JONES	9												9
BUCN WHITE	4									5			9
CE3 GREEN		9											9
SW3 WILLIAMS		9											9
EO3 WILSON			4							5			9
UT2 JOHNSON		8	1										9
TOTAL MAN-HOURS	22	29	5						6	5	5		72

Figure 7-2. Lead Element/Support Element Timecard Example

TWO-WEEK LABOR SUMMARY																						
Project Supervisor: BU1 BROWN										Support Element Crew Leader: NONE										Page 1 of 1		
Project Number: EL08-830										Project Title: ADMINISTRATIVE BUILDING										Period Covered: From: 16 May To: 28 May		
Section A	Construction Activity Number (Man-hours)										Indirect Labor (Man-hours)										Training (Man-hours)	
Date	017000	311000	031000	032000	312000	031040	017010	031030	312010	312040	031010	033010	Total	XO3	XO8	XO9						Day Total
16 May Monday																						
17 May Tuesday	63												63	9								72
18 May Wednesday		18	27	18									63	9								72
19 May Thursday		9	27	18									54	7	11							72
20 May Friday			27	12	18								57	6	9							72
21 May Saturday			22	29	5								56	6	5	5						72
22 May Sunday																						
23 May Monday			27		22	18							67	5								72
24 May Tuesday						21	15	27					63	3	6							72
25 May Wednesday						27		27	13				67	5								72
26 May Thursday						27		22		18			67	5								72
27 May Friday						22					25	19	66	4	2							72
28 May Saturday														0						0		0
Total Section A	63	27	130	77	45	115	15	76	13	18	25	19	623	59	33	5						720
Section B																						
NONE																						
Total Section B													0									0
Grand Total: A + B	63	27	130	77	45	115	15	76	13	18	25	19	623	59	33	5						720
TOTAL MAN-DAYS	8	3	16	10	6	14	2	10	2	2	3	2	78	7	4	1						90

Figure 7-3. Two-week Labor Summary Example

PROJECT SITREP FEEDER								
Project Number: EL08-830					Date Printed: MAY 29			
Project Title: ADMINISTRATION BUILDING					Data Date: MAY 27			
Unit: NAMED UNIT					Work-in-Place:			
Company/Detachment: CHARLIE					% Complete Estimated:			
MASTER ACTIVITY (MA)		MAN-DAY ESTIMATE (TASKED BASELINE)	WEIGHTED PERCENT (%)	MA % COMPLETE (WIP)	PROJECT % COMPLETE	EARNED MAN-DAYS	MAN-DAYS REMAINING	MAN- DAYS ACTUAL
NUMBER (NO.)	DESCRIPTION	[a]	[b]	[c]	[d] = [b × c]	[e] = [a × c]	[f] = [a - e]	[g]
01	General	20	4	30	1.2	6	14	22
31	Earthwork	47	10	55	5.5	26	21	24
03	Concrete	140	30	69	20.7	97	43	105
04	Masonry	32	7	100	7.0	32	0	30
05	Metals	9	2	0	0	0	9	0
06	Woods	36	8	0	0	0	36	0
07	Moisture	16	4	0	0	0	16	0
08	Openings	10	2	0	0	0	10	0
09	Finishes	66	15	0	0	0	66	0
10	Specialties	4	1	0	0	0	4	0
22	Plumbing	44	10	32	3.2	14	30	16
26	Electrical	30	7	13	0.9	4	26	5
	TOTALS	454	100		38.5	179	275	202
Comments: _____								

Figure 7-4. Project Situation Report Feeder Example

7.4.1.1 Master Activity Percent Complete Column

Project supervisors complete a Master Activity Percent Complete worksheet for each MA in progress; this worksheet accounts for the status of each subcomponent construction activity. The Master Activity Percent Complete (column c), if other than 0 percent or 100 percent, comes from the Master Activity Percent Complete worksheet. Obviously, the WIP is 0 percent for MAs not started, and the WIP is 100 percent for completed MAs.

Master Activity Percent Complete is computed by multiplying the Construction Activity Percent Complete by the Weighted Percent. For master activities in progress, each individual construction activity must be evaluated. In MA 03, the following construction activities are complete: 031000, 031010, 031020, 031030, 031040, 032000, 032010, 032020, 033000, and 033010. These construction activities represent 60 percent of MA 03 ($6 + 8 + 2 + 4 + 22 + 5 + 3 + 5 + 4 + 1 = 60$). Refer to figure 7-5, the sample Master Activity Percent Complete worksheet, for the MA 03 Concrete data.

Construction activity 031050 (Set Forms Beam and Canopy), at 50 percent complete, is computed by measurement of actual WIP. In this case, measuring forms in place determined that one half of the forms are already set. Activity 031050 represents 18 percent of the master activity. Since it is half complete, it is credited for 9 percent of the total project. The 9 percent plus the previous 60 percent totals 69 percent complete for MA 03 when the Master Activity Percent Complete column is totaled.

Project supervisors complete the Master Activity Percent Complete worksheet using the following steps:

1. Construction Activity Number, Construction Activity Description, and Man-day Estimate columns data come from the CAS sheet or the Level II Gantt chart.
2. Weighted Percent (column b) is equal to the Man-day Estimate divided by the Total Master Activity Man-day Estimate.
3. Total Work (column c) is equal to the number of linear feet, square feet, cubic yards, etc., of work to be done.
4. Work Complete (column d) is equal to the number of linear feet, square feet, cubic yards, etc., of work actually completed.
5. Construction Activity Percent Complete (column e) is equal to the amount of Work Complete divided by the Total Work.
6. Master Activity Percent Complete (column f) is equal to the Weighted Percent multiplied by the Construction Activity Percent Complete.
7. Man-days Remaining (column g) is equal to the percentage of work remaining to be completed multiplied by the Man-day Estimate.
8. Man-days Actual (column h) comes from the timecards (two-week labor summary).
9. The Man-day Estimate, Weighted Percent, Master Activity Percent Complete, Man-days Remaining, and Man-days Actual columns are then totaled at the bottom of the page.

7.4.1.2 Project Percent Complete Column

Project Percent Complete represents the percentage that master activity work complete contributes to the overall project completion. The Project Percent Complete (column d) is equal to the Weighted Percent multiplied by the Master Activity Percent Complete (WIP).

For MA 31, Earthwork, the Weighted Percent of 10 multiplied by the Master Activity Percent Complete of 55 totals a Project Percent Complete of 5.5:

$$.10 \times 55 = 5.5.$$

MASTER ACTIVITY PERCENT COMPLETE WORKSHEET (WORK-IN-PLACE)										
Master Activity: 03 - CONCRETE		Date: 27 MAY								
Project Number: EL08-830		Title: ADMINISTRATION BUILDING								
Prepared by: BU3 HOLZMAN		Checked by: BU1 MICKELSON								
NO.	CONSTRUCTION ACTIVITY (CA)	MAN-DAY ESTIMATE (TASKED BASELINE)	WEIGHTED PERCENT (%)	TOTAL WORK	WORK COMPLETE	CA % COMPLETE (WIP)	MA % COMPLETE	MAN-DAYS REMAINING	MAN-DAYS ACTUAL	REMARKS
	DESCRIPTION	[a]	[b]	[c]	[d]	[e]	[f] = [b x e]	[g]	[h]	
031000	Prefab Forms Foundation	8	6			100	6	0	10	
031010	Set Forms Foundation	11	8			100	8	0	9	
031020	Strip Forms Foundation	3	2			100	2	0	3	
031030	Prefab Forms Lintel	5	4			100	4	0	5	
031040	Prefab Forms Beam	32	22			100	22	0	35	
031050	Set Forms Beam & Canopy	25	18	250LF	125LF	50	9	13	14	
031060	Strip Forms Beam Exterior	3	2			0	0	3	0	
031070	Strip Forms Beam Interior	2	1			0	0	2	0	
032000	Prefab Rebar Foundation	7	5			100	5	0	8	
032010	Set Rebar Foundation	4	3			100	3	0	5	
032020	Prefab Rebar Beam	7	5			100	5	0	7	
032030	Set Rebar Beam	7	5			0	0	7	0	
033000	Place Concrete Foundation	5	4			100	4	0	6	
033010	Place Concrete Lintels	2	1			100	1	0	3	
033020	Place Concrete Beam	5	4			0	0	5	0	
034000	Set Roof Panels	14	10			0	0	14	0	
TOTAL		140	100				69	44	105	

Figure 7-5. Master Activity Percent Complete Worksheet Example

7.4.1.3 Overall Project Percent Complete

Overall project percent complete for the project is the summation of the Project Percent Complete column as shown in figure 7-4. In this example, the overall project percent complete is 38.5 percent.

The project manager compares the actual WIP (Project Percent Complete) to the scheduled progress (Percent Complete Estimated) and determines its actual percent deviation. Higher headquarters sets the allowable percent deviation for a unit and its project. The Percent Complete Estimated—also termed the scheduled percent complete—appears at the top of the SITREP feeder. The scheduled percent complete comes from the project's Level II Gantt chart.

If the actual WIP falls behind the scheduled WIP by more than the allowable percent deviations, the unit must advise HHQ, include a plan to get the project back on schedule, and request approval for any required changes to the unit Level I Gantt chart or the project Level II Gantt chart for revised tasking numbers.

7.4.1.4 Man-days Remaining Column

The Man-days Remaining column data comes from the Master Activity Percent Complete worksheet. Man-days remaining data reflects how much work is yet to be done and has nothing to do with how many MDs have been expended.

For completed master activities, the MDs remaining is zero. For master activities not started, the MDs remaining equals the original MD estimate. For master activities under construction, the Master Activity Percent Complete worksheet evaluates the completion status of individual construction activities.

If a construction activity with an original estimate of 20 MDs is 25-percent complete, 15 MDs remain because 75 percent of the work is left to be done:

$$.75 \times 20 = 15.$$

7.4.1.5 Man-days Actual Column

The Man-days Actual column data comes from the Master Activity Percent Complete worksheet. Actual man-days have nothing to do with percent complete and are not included in the unit SITREP to HHQ.

The project supervisor includes the MDs actual number on the project SITREP feeder so the company staff and operations can see where MDs were expended. The information may provide insight on why a particular project is behind. The Level II Gantt chart also records the updated actual progress and MDs actual data.

7.4.1.6 Comments Line

The SITREP feeder includes a comment line for the project supervisor's draft input for the SITREP. In each SITREP brief, the battalion must include comments describing work performed since the last SITREP. If actual WIP is less than scheduled WIP, the SITREP must explain the delay, and include a plan for getting the project back on schedule.

7.4.2 Man-days Earned Method

Man-days earned is another method of calculating the actual project percent complete. A worksheet tabulates the data for each MA in progress.

For completed construction activities, the worksheet shows man-days earned for all of the original MD estimates, as in construction activity 031000, Prefab Forms Foundation.

For activities not started, the worksheet shows no credit for man-days earned, as in construction activity 031060, Strip Forms Beam Exterior.

For activities in progress, the worksheet shows earned MDs for the percentage complete. For example, construction activity 031050, Set Forms Beams/Canopy is 50 percent complete:

$$.50 \times 25 = 12.5 \text{ or } 13 \text{ MDs earned.}$$

The maximum MDs earned available for MA 03 is 140. To calculate the Master Activity Percent Complete, divide Total Man-days Earned by the Total Man-day Estimate:

$$97 \div 140 = .69 \text{ or } 69 \text{ percent.}$$

The same process calculates the MDs earned for the entire project.

Since MA 04 is complete, the worksheet shows credit for 32 earned MDs.

Master activities 05–10 have not started, so the worksheet shows no earned MDs.

Master activity 01 is 30 percent complete and shows 6 earned MDs:

$$.30 \times 20 = 6.$$

Master activity 31 is 55 percent complete and shows 26 earned MDs:

$$.55 \times 47 = 25.85.$$

Master activities 03, 15, and 16 are calculated in the same manner.

The project Total Actual Percent Complete is 39.4 percent:

$$179 \div 454 = .394 \text{ or } 39.4 \text{ percent.}$$

The project percent complete will vary slightly between the WIP and earned man-days methods of calculation by rounding to whole MDs. Either method is acceptable. Consult with the chain of command on which method to use.

Figure 7-6 illustrates the Master Activity Percent Complete worksheet: MDs earned method. Figure 7-7 illustrates the project percent complete worksheet: MDs earned method.

7.5 CONTROLLING PROCEDURES AND CORRECTIVE ACTIONS TO KEEP THE SCHEDULE

The project supervisor's goal is to stay as close to the scheduled progress curve as possible. Project leaders prefer challenging, realistic schedules to inflated estimates where a project finishes 2 months early in half the MDs estimated or where a project uses all the MDs estimated before it reaches 50 percent complete.

Managers use controlling procedures and corrective actions to maintain the scheduled progress curve. To avoid falling behind schedule, managers use a Level II Gantt chart to track actual progress against scheduled progress. If a project does fall behind schedule, managers employ various techniques and procedures to regain the schedule.

The contracting office and/or client representatives hold project progress meetings on a regular basis. This is the place to provide notice of any potential schedule problems, especially if the client can provide technical or coordination assistance that could minimize potential delay.

MASTER ACTIVITY <u>03</u> PERCENT COMPLETE WORKSHEET (MAN-DAYS EARNED)				
CONSTRUCTION ACTIVITY (CA)		MAN-DAY ESTIMATE (TASKED BASELINE)	CA % COMPLETE (WIP)	MAN-DAYS EARNED
NO.	DESCRIPTION			
		[a]	[b]	[c] = [a × b]
031000	Prefab Forms Foundation	8	100	8
031010	Set Forms Foundation	11	100	11
031020	Strip Forms Foundation	3	100	3
031030	Prefab Forms Lintel	5	100	5
031040	Prefab Forms Beam	32	100	32
031050	Set Forms Beam & Canopy	25	50	13
031060	Strip Forms Beam Exterior	3	0	0
031070	Strip Forms Beam Interior	2	0	0
032000	Prefab Rebar Foundation	7	100	7
032010	Set Rebar Foundation	4	100	4
032020	Prefab Rebar Beam	7	100	7
032030	Set Rebar Beam	7	0	0
033000	Place Concrete Foundation	5	100	5
033010	Place Concrete Lintels	2	100	2
033020	Place Concrete Beam	5	0	0
034000	Set Roof Panels	14	0	0
TOTALS		140		97
MASTER ACTIVITY PERCENT COMPLETE		Column [c] divided by [a] = 97 divided by 140 =		69 %

Figure 7-6. Master Activity Percent Complete Worksheet: Man-days Earned Method

PROJECT PERCENT COMPLETE WORKSHEET (MAN-DAYS EARNED)				
Date: _____				
Project Number: _____		Title: _____		
Prepared by: _____		Checked by: _____		
MASTER ACTIVITY (MA)		MAN-DAY ESTIMATE (TASKED BASELINE)	MA % COMPLETE	MAN-DAYS EARNED
NO.	DESCRIPTION			
		[a]	[b]	[c] = [a × b]
01	General Requirements	20	30	6
31	Site Work	47	55	26
03	Concrete	140	69	97
04	Masonry	32	100	32
05	Metals	9	0	0
06	Wood, Plastics, and Composites	8	0	0
07	Thermal and Moisture Protection	16	0	0
08	Openings	10	0	0
09	Finishes	66	0	0
10	Specialties	4	0	0
22	Plumbing	44	32	14
26	Electrical	30	13	4
TOTALS		454		179
PROJECT PERCENT COMPLETE		Column [c] divided by [a] = 179 divided by 454 =		39.4 %

Figure 7-7. Project Percent Complete Worksheet: Man-days Earned Method

7.5.1 Level II Gantt Chart–Actual Progress

The Level II Gantt chart develops during preconstruction planning. Refer to paragraph 3.9 for further information on development of a Level II Gantt chart. The Level II data remains the baseline measure of task progress until the HHQ in-process review. During the in-process review, managers negotiate MD tasking based on documented need for changing the original estimate. The new data then becomes the baseline.

The Level II Gantt chart is the primary management support tool showing actual construction progress as compared to scheduled progress. It is updated each unit SITREP reporting period as established by operations, typically a two-week period. It graphically shows if the project is ahead, behind, or on schedule, as illustrated in figure 7-8.

The Level II Gantt chart is updated using information derived from the project SITREP feeder discussed in paragraph 7.4. The percent complete is taken from the SITREP feeder and plotted against the percentages displayed on the Level II Gantt chart. There may be slight variation in the numbers between a Level II Gantt chart prepared by hand and one prepared by computer software because of rounding and use of significant figures. To make the actual progress curve, connect the plotline dots. If the actual progress curve is above the planned progress curve, the project is ahead of schedule; if below, the project is behind schedule.

A large variation indicates a problem. If the project is behind schedule, refer to paragraph 7.5.2 for methods and procedures to regain the schedule.

7.5.2 Regaining the Schedule

Avoid any delay that puts a project behind schedule. The project supervisor instills a sense of mission and urgency in crew members, especially when dealing with critical-path construction activities. By taking early and appropriate action, a project supervisor formulates a plan to avoid a catastrophic problem and regain the schedule.

Monitoring and reporting systems alert managers when a project is falling behind or in trouble, but do not provide the reasons for the problem. The project manager must get on the job, observe, and interact with the project supervisor and crew to help the project supervisor develop corrective actions. Project managers ensure the project execution is within its planning numbers (i.e., crew size, crew availability, length of workday).

7.5.2.1 Methods

If the project is behind schedule, the project supervisor reviews CAS sheets for upcoming activities that might conserve man-days by a change of method that increases production efficiency. For example, using different equipment may result in less time expended; renting a trencher rather than using the unit's backhoe on an underground pipe job will save man-days. Of course, funding availability impacts these choices. The project supervisor consults others to identify MD-saving alternatives to "work smarter, not harder."

7.5.2.2 Phasing of Activities

Project supervisors typically lay out a project logic diagram using finish-to-start logic relationships. This has the effect of stretching out project duration and reducing required crew size. It also leaves plenty of opportunity to compress the schedule by working several activities at the same time. The project supervisor may be able to squeeze a few days out of the schedule by splitting up the crew and having some of them work the next activity.

The project supervisor may also consider replanning the project using start-to-start or finish-to-finish logic relationships. Any real gains on the schedule probably require additional people, and if the project supervisor presents a plan for getting back on schedule to the chain of command, the project could be assigned additional temporary crew members.

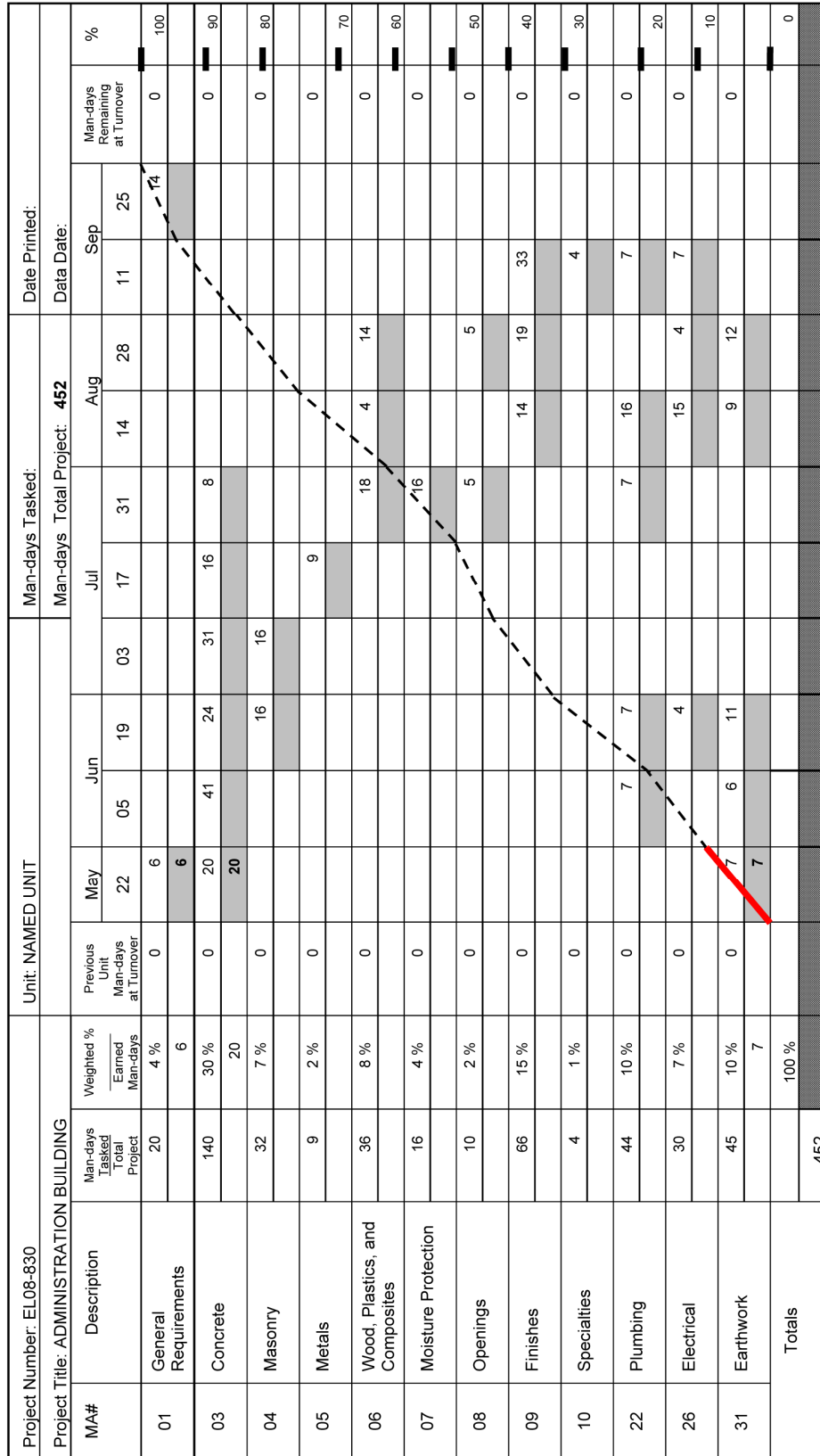


Figure 7-8. Level II Gantt Chart—Actual Progress Example (Sheet 1 of 2)

Project Number: EL08-830				Unit: NAMED UNIT				Man-days Tasked:				Date Printed:				
Project Title: ADMINISTRATION BUILDING				Man-days Total Project: 452												
MA#	Description	MAN-DAYS TASKED TOTAL PROJECT	WEIGHTED % EARNED MAN-DAYS 100 %	PREVIOUS UNIT MAN-DAYS AT TURNOVER	May 22	Jun 05	Jun 19	03	Jul 17	31	14	28	Sep 11	25	MAN-DAYS REMAINING AT TURNOVER	%
Totals		452	100 %													0
Estimated Man-days per Period					33	54	62	47	25	54	58	54	51	14		
Estimated Man-days Cumulative					33	87	149	196	221	275	333	387	438	452		
Estimated Percent Complete		■■■■■■■ Estimated Plot Line			7%	19%	33%	43%	49%	61%	74%	86%	97%	100%		
Earned Man-days per Period					33											
Earned Man-days Cumulative					33											
Earned WIP Percent Complete		■■■■■■■ WIP Plot Line			7%											
Actual Man-days per Period					33											
Actual Man-days Cumulative					33											
Actual Percent Complete					7%											

Figure 7-8. Level II Gantt Chart—Actual Progress Example (Sheet 2 of 2)

7.5.2.3 Apply More Resources

The most obvious manager response to project delays involves getting more people on the job, working longer hours, or additional equipment. Before taking these actions, the project supervisor considers getting more productive man-hours out of the same number of people by increasing the actual availability. For planning purposes, the project supervisor uses a site-specific availability factor between 0.75 and 0.85 (0.90 for contingencies). The actual availability factor for the project uses the following equation:

$$AF = MD \text{ Actual} / (CS \times WD \times ME)$$

To determine an actual AF (the amount of time a military engineer is actually on the job), the project supervisor needs to know the following, where:

1. CS is the number of crew members assigned.
2. MD Actual is the number of MDs actually expended.
3. WD is the number of available workdays (not calendar days) in the time period reported.
4. ME is the MD equivalent (the number of MDs expended in a typical workday), the number of hours worked each day on the job divided by 8 hours.

If the actual availability is low (below 0.75), consider permanent changes to the daily routine of the crew to increase availability (e.g., haircuts, leave, medical appointments, watch standing).

If the actual availability is average, increase it for a short time to get back on schedule. Work with the chain of command to coordinate dental/medical appointments and other administrative issues that take the crew away from the jobsite. Increasing availability by 10 percent has the same effect as adding another member to the crew.

7.6 LEVEL I GANTT CHART—ACTUAL PROGRESS

The Level I Gantt chart develops during preconstruction planning and continues to be updated through project execution. Refer to paragraph 3.10 for further information on development of a Level I Gantt chart. The Level I data remains the baseline measure of unit tasking progress until the HHQ in-process review. During the in-process review, Project managers negotiate MD tasking based on documented need for changing the original estimate. The new data then becomes the baseline. Refer to military service-specific implementation guidance for further information on use of the Level I Gantt chart.

The Level I Gantt chart is the primary management support tool showing actual construction progress in comparison with scheduled progress of unit tasking. It is updated each unit SITREP reporting period as established by operations, typically a two-week period. It graphically shows if the unit is ahead, behind, or on schedule, as illustrated in figure 7-9.

[illegible]

Figure 7-9. Level I Gantt Chart—In Progress Example

INTENTIONALLY BLANK

CHAPTER 8

Final Project Transfer and Closeout

8.1 INTRODUCTION

Project Phase 5 is designed for managers to implement actions to transfer and close out a completed construction project. These actions include operational and administrative steps to prepare for the final inspection. This phase ends when the unit departs the project site, completes the final inspection, and provides required documentation to the client's representative.

Managers do not schedule projects for transfer and closeout when significant work still remains. The relieving unit does not schedule a substantial amount of MDs for a project reported as complete. Refer to paragraph 5.3.6 for information pertaining to project turnover of an unfinished project to a relieving unit.

8.2 PROJECT TRANSFER AND CLOSEOUT STEPS

Project supervisors need to understand the process to transfer and close out a completed construction project in order to effectively accomplish their responsibilities. The transfer and final closeout of a construction project include the following steps:

1. The project supervisor initiates the request to schedule the pre-final inspection using the Pre-final Inspection Request and Checklist Form. The project supervisor uses this checklist as a guide to prepare for the pre-final inspection. When ready for the pre-final inspection, the project supervisor forwards the pre-final inspection request through the unit's QC staff to the contracting office.
2. Key representatives conduct the pre-final inspection to determine work items still to be completed—known as a punch list—by the engineering unit. The following personnel typically attend the pre-final or final inspection:
 - a. Unit project manager, project supervisor, and assigned crew leaders
 - b. Unit operations officer and/or QC staff member
 - c. Contracting office representative
 - d. Public works/BOS/BCE representative
 - e. Client/facility user representative.

The contracting office generates an official copy of the punch list. Following this inspection, the unit expeditiously completes punch list items. A unit corrects punch list items, with the possible exception of minor work—usually cosmetic in nature—prior to establishing a date for the final inspection. An excessive punch list indicates the project was not ready to transfer to the client. In most cases, the project will not transfer to the client until completion of all punch list items.

3. The project supervisor initiates the request for the final inspection upon completion of punch list items, following the same procedures used to schedule the pre-final inspection.

4. Key representatives conduct the final inspection in the same manner as the pre-final inspection. This final inspection results in one of the following possible outcomes:
 - a. No Discrepancies. The client accepts the facility at this final inspection, the representatives establish the beneficial occupancy date, and a one-year warranty period takes effect. The beneficial occupancy date is the date when a facility is ready to fulfill its intended purpose, available for occupancy, and accepted by the client.
 - b. Minor Discrepancies. The client accepts the facility at this final inspection, the representatives establish the beneficial occupancy date, and a one-year warranty period takes effect. The contracting office generates an official copy of punch list items. The unit expeditiously completes punch list items.
 - c. Discrepancies. The client does not accept the facility at this final inspection. The contracting office generates an official copy of punch list items. The unit expeditiously completes these punch list items and follows through per Step 2 above. This process is repeated until the client accepts the facility.
5. When the unit completes all remaining punch list items and the facility is accepted by the client, the unit operations staff prepares a transfer letter documenting the project is complete and provides the following items/information to the contracting office:
 - a. Two sets of as-built drawings
 - b. Operation and maintenance manuals, parts catalogs, and other technical service manuals
 - c. Statement of actual material cost, labor costs, and actual man-days used.
6. Following receipt of the transfer letter, the contracting office provides an acceptance letter to the engineering unit. The project files are then closed and retained onsite for 2 years.

Figure 8-1 illustrates a pre-final inspection request and checklist form.

PRE-FINAL INSPECTION REQUEST AND CHECKLIST		
Project Number:	Project Supervisor:	Date:
This pre-final inspection is conducted prior to the final inspection acceptance. It is conducted jointly with unit and contracting office representatives and is intended to identify any necessary corrective steps prior to client occupancy.		
Inspection Date:	Time:	Requested by: (name/rank)
The following checklist is completed by the project supervisor and forwarded to QC a minimum of 2 working days prior to the requested date of the inspection. The project supervisor uses this checklist as a guide, but the pre-final inspection is not limited to these items.		
SITework		Project Supervisor Initials
Final Grading (grassing)		
Disposal of all Trash		
Sidewalks		
Curbs and Paving		
Light		
MECHANICAL		
Installation of Piping, Fixtures, and Equipment		
Application of Insulation and Hangers		
Sterilization (water system)		
Shop Drawings		
Water Supply Test		
Gas and Oil Piping		
Heating and Cooling Units		
Duct Work		
Thermostat Controls		
Registers		
Exhaust Fans and Hoods		
Manufacturer Catalogs		
Working Test (boilers)		
ELECTRICAL		
Manufacturer Catalogs		
Test all Lights		
Test Fire Alarms		
Telephone Hook-up		
Main Panel Box (all breakers labeled)		
CONCRETE AND MASONRY		
Joints		
Cracks		
STRUCTURAL STEEL		
Touch-up Paint		

Figure 8-1. Pre-final Inspection Request and Checklist Form (Sheet 1 of 2)

PRE-FINAL INSPECTION REQUEST AND CHECKLIST (continued)	
HARDWARE	Project Supervisor Initials
Closet Hardware	
Bathroom Accessories	
Door Hardware	
Gate Hardware	
Miscellaneous Hardware	
DOORS AND WINDOWS	
Clean	
Fit	
FINISHES	
Acoustic Tile	
Ceramic and Quarry Tile	
Floor Covering	
Painting	
Plastering	
FURNISHINGS	
Fabrication	
Installation	
GENERAL	
Project Package Current	
As-builts Completed	
Site Clean	
Excess Material Turned In	
REMARKS	
Project Supervisor:	QC Manager/QC Specialist:

Figure 8-1. Pre-final Inspection Request and Checklist Form (Sheet 2 of 2)

8.3 PROJECT SUPERVISOR RESPONSIBILITIES

Project supervisors are responsible for the following actions to transfer and close out a completed construction project:

8.3.1 Tools, Equipment, and Material Turn-in

The project supervisor ensures all tools, excess material, and equipment are properly cleaned, inventoried, and returned to the proper outlet. Naval Supply Systems Command form 1250-1, Single Line Item Consumption/Requisition Document, filled out for missing or broken items must accompany all tools and tool kits returned to custodians. Line item requisition forms filled out in red ink with the appropriate BOM line item numbers must accompany all material turned in to MLO. Project supervisors must offer all material, tools, and equipment purchased with project funds to the customer prior to considering them excess.

8.3.2 As-built Drawings

The project supervisor keeps project drawings updated during construction to reflect as-built condition. At project closeout, the unit must turn in two sets of as-built (also known as red-line) drawings to the contracting office. These drawings reflect all DCDs and approved FARs.

8.3.3 Project Package

The project supervisor provides a current and complete project package, including any computer-generated data, and the final acceptance letter, which is forwarded to HHQ via the engineering unit's QC staff. Completed project files remain in the deployed location operations files for the designated warranty period.

8.4 TRANSFER AND ACCEPTANCE DOCUMENTATION OF REAL PROPERTY

Project managers may be required to submit DD Form 1354, Transfer and Acceptance of DOD Real Property, or provide the data necessary to complete DD Form 1354. The DD Form 1354 is the legally established method for transferring ownership of Government real property; it provides the host base real property office with the information needed to add the facility to the base real property records. It is required after constructing a new facility, adding to an existing one, or renovating/upgrading an existing system. Project managers follow their military service's guidance as applicable. Refer to UFC 1-300-08, Criteria for Transfer and Acceptance of DOD Real Property, for further information on DD Form 1354.

INTENTIONALLY BLANK

CHAPTER 9

Quality Control Plan

9.1 INTRODUCTION

All construction projects have QC considerations requiring an approved plan. Common guidance applicable to each military service is found in the Federal Acquisition Regulation and UFGS. Managers are responsible for initiating actions to develop a QC plan.

Leadership is imperative to integrating QC considerations into the planning process through the performance phases to achieve the desired outcomes. Military engineers must turn concern for quality into an institutional and personal ethic. For a successful project outcome, engineers incorporate these considerations proactively to identify, prevent, and mitigate situations that impact mission accomplishment rather than as a reaction to poor quality work.

9.2 QUALITY CONTROL

The Federal Acquisition Regulation requires military engineers to perform construction quality management when tasked with construction projects. Construction quality management consists of QA and QC activities instituted to achieve the quality levels established by project plans and specifications or as directed by HHQ. The QA component is the responsibility of the contracting office, comprising a system in place to monitor the QC efforts of the engineering unit. Project QA activities are beyond the scope of this publication and only referred to for the integration and transition points with project managers and project supervisors. The QC component is the responsibility of the engineering unit construction agent tasked with the construction project. Quality control is the engineering unit's system in place during execution to manage, control, and document the unit's activities in compliance with the project plans and specifications requirements. Refer to UFGS Section 01-45-00.00-10, Quality Control, for further information on the QC program. The QC component has two levels:

1. Project QC Plan. Project managers and project supervisors perform and direct activities to develop an individual project QC plan.
2. Unit QC Plan. The unit's QC manager and assigned QC specialists perform and direct activities to execute the unit-level QC program. These activities are beyond the scope of this publication, however, this publication discusses integration and transition points involving project managers and project supervisors with the unit QC program. An engineering unit's QC plan must be accepted by the contracting office prior to the start of construction.

Refer to Engineer Regulation (ER) 1180-1-6, Construction Quality Management, and Commander, First Naval Construction Division Instruction (COMFIRSTNCDINST) 4355.1, Construction Quality Program, for Service-specific guidance.

9.3 THE QUALITY CONTROL PLAN

The project supervisor tailors a QC plan to meet the specific project QC requirements approved by the unit QC manager. The requirements emerge from the project plans and specifications. Figure 9-1 illustrates a project QC plan cover sheet listing the components of a project QC plan. Items 1-14 are initiated in the planning phase; items 15-19 are initiated during the execution phase of construction.

PROJECT QUALITY CONTROL PLAN (COVER SHEET)		
Project Number: _____ Project Location: _____		
Project Title: _____		
Lead Element: _____ Support Element(s): _____		
TABLE OF CONTENTS	YES	NO
1. Project Scope Sheet.		
2. Quality Control Requirements List (by specification number).		
3. Definable Features of Work Submittal List.		
4. Identify Required Skills and Training.		
5. Special License(s) Required.		
6. Activity Hazard Analysis—feeds the Project Safety Plan.		
7. Quality Control Plan Summary/Quality Control Inspection Plan.		
8. Testing Plan and Log (e.g., soil, concrete).		
9. Testing Equipment Required (state how it will be used).		
10. Personal Protective Equipment Required for Testing.		
11. Submittal Procedures and Submittal Status Log.		
12. Request for Information (RFI) and Status Log.		
13. Field Adjustment Request (FAR) and Status Log.		
14. Design Change Directive (DCD) File.		
15. Preparatory Phase Checklist File.		
16. Initial Phase Checklist File.		
17. Daily Quality Control Inspection Reports (includes Follow-up Phase Checklist).		
18. Rework Items Procedure and Rework Items List.		
19. Completion/Turnover Inspection Roles and Procedures.		
Project Supervisor: _____ Date: _____		
Project Manager: _____		
QC Manager: _____		Approved/Disapproved
Reason for disapproval: _____		

Figure 9-1. Project Quality Control Plan Cover Sheet and Table of Contents

9.4 DEVELOPMENT OF THE PROJECT QUALITY CONTROL PLAN

Project supervisors and crew leaders develop a project QC plan as discussed in paragraphs 9.4.1 thru 9.4.14. The level of QC will be commensurate to the size, complexity, cost, and risk associated with the project. For example, a project with many different types of construction or materials would require a more aggressive QC plan than a simple project such as a sidewalk. The engineering unit's operations officer, in consultation with the assigned project manager and QC manager, directs the amount of QC effort that is put into a project.

9.4.1 Project Scope Sheet

Project supervisors create a project scope sheet for inclusion in the QC plan. Refer to paragraph 2.3.6 for information on project scope sheet development.

9.4.2 Quality Control Requirements

The project supervisor and assigned crew leaders annotate plans and specifications to establish the project's QC requirements concurrent with developing the construction estimate. The QC requirements list is a worksheet capturing the specification or drawing reference number, the QC requirement, and control measure/remarks from the annotated plans and specifications. The QC plan summary form, illustrated in figure 9-2, may be used for the QC requirements list worksheet.

The QC requirements must be:

1. Specific
2. Measurable or seen in the field
3. Listed in plain language on the CAS sheet.

Project QC requirements for reinforcing steel include the size, the placement, the anchoring, and the distance lapped. For example, reinforcing steel must be at least 1½ inches from inside of forming; reinforcing steel must be lapped 24 inches at splices.

Once specification sections are associated with a construction activity/work element, the project supervisor and crew leaders place them on the appropriate CAS sheet. Refer to paragraph 4.3.9 for information on CAS sheets. After CAS sheets are initially completed, QC requirements are summarized by activity number. This summary becomes the project's QC plan. Refer to paragraph 9.4.7 for information on the QC plan summary.

References cited on the QC plan summary must be considered valid for use by a military service organization. Refer to the Whole Building Design Guide Web site, <http://www.wbdg.org/ccb/ccb.php>, for access to valid reference documents or specific unit SOP guidance.

[illegible]

Figure 9-2. Quality Control Summary/Plan Form

9.4.3 Definable Features of Work

The project supervisor identifies definable features of work during the estimating and scheduling process. United Facilities Guide Specifications Section 01–45–00.00–10, defines a definable feature of work as a “task which is separate and distinct from other tasks, has separate control requirements, and may be identified by different trades or disciplines, or it may be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable feature of work, there are frequently more than one definable feature under a particular section.” The project supervisor follows four steps in the identification and use of definable features of work process.

1. Project supervisors and assigned crew leaders develop an initial list of definable features of work, using the form illustrated in figure 9-3, during the creation of construction activity/work element numbering. This initial list is validated by the QC manager/QC specialist during final development of the project’s initial Level III schedule.
2. Each definable feature of work is placed on the appropriate CAS sheet when associated with a construction activity or work element number. Then, all definable features of work QC requirements are analyzed for materials, skills, equipment, and control measure testing requirements.
3. The definable features of work submittal list becomes the scheduling support tool used by the project supervisor and QC manager to monitor execution of the preparatory and initial phase checklist controls conducted by the project supervisor, assigned crew leader, and QC specialist during the construction phase. Refer to paragraphs 9.5.1 thru 9.5.2 for further information on the preparatory and initial phase checklists.
4. The project supervisor monitors the definable features of work submittal list and flags the two-week schedule to notify required personnel (e.g., project manager, QA representative) of the preparatory and initial phase checklist meeting schedules.

9.4.4 Identify Required Skills, Training, and Equipment

Project supervisors and assigned crew leaders identify skills, training, and equipment required for accomplishment of QC actions. They also identify contractor, special equipment not in a unit’s TOA, or other special skill requirements for inclusion on the BOM for funding. The project supervisor ensures that the requested training satisfies the project’s QC requirements. If the available requested training does not meet the specification requirement, but provides an equivalent certification, the project supervisor submits a FAR to the contracting office to formally change the specification requirement to allow the equivalent certification. Refer to paragraph 2.3.8 for information on training requirements and to paragraph 4.3.3 for information on BOM development.

9.4.5 Special License(s) Required

Project supervisors and assigned crew leaders identify special license requirements. They submit these requirements via the project manager to the unit’s training officer. Refer to paragraph 2.3.8 for further information.

9.4.6 Activity Hazard Analysis

Project supervisors and assigned crew leaders conduct an activity hazard analysis of each definable feature of work. This review feeds the project safety plan. Refer to chapter 10 for further information.

[illegible]

Figure 9-3. Definable Features of Work Submittal Form

9.4.7 Quality Control Plan Summary

The project supervisor and assigned crew leaders create the project QC plan by consolidating a summary list of QC requirements by activity number from each CAS sheet. Refer to figure 9-2 for a project QC plan form. This form may also be used for the QC requirements list discussed in paragraph 9.4.2.

The QC specialist, using an independently developed QC inspection plan, validates the project supervisor's QC plan. The QC specialist's quality control inspection plan is what the QC specialist will use to verify that each QC element was correctly completed by the project crew. The reconciled QC plan provides data for the project supervisor to create the preparatory and initial phase checklists. It also provides data for the QC specialist's daily QC inspections incorporating the follow-up phase checklist.

9.4.8 Quality Control Testing Plan and Log

The project supervisor and assigned crew leaders identify on-site testing requirements (e.g., soil compaction, concrete) and engineering unit testing capabilities as they analyze QC requirements on each CAS sheet. They create the project's QC testing plan and log by consolidating a summary list of QC testing requirements by activity number from each CAS sheet. Figure 9-4 illustrates a project QC testing plan and log form.

The QC specialist, using an independently developed QC testing plan, validates the project supervisor's QC testing plan. The project supervisor monitors the reconciled plan and flags the two-week schedule to notify required personnel (e.g., project manager, QC manager, QA representative) of the testing schedule and to ensure testing service requests are submitted well in advance. Testing requirements are also annotated on the Level III Gantt chart schedule. The QC manager/QC specialist maintains the official QC testing log for each project.

Some engineering units have a sufficient number of trained personnel to conduct and coordinate required tests on concrete, asphalt, soils, and other materials, as well as to maintain equipment needed to perform these tests. If so, the engineer testing organization receives a copy of the unit projects testing plans so it can schedule its resources and requirements. If a required testing capability is not available within the unit, the QC manager contacts other agencies to coordinate the necessary testing services.

During construction, testing personnel conduct required tests in accordance with the testing plan. Refer to paragraph 9.5.3 for information on documenting the test results.

The project supervisor, QC specialist, and QA representative agree in advance on the exact requirements and how the various tests will be performed. For example, if the crew lays asphalt 2 inches thick, will test personnel measure it with a poker device or with a string line and tape measure? If the crew lays block required to be within 1/4-in plumb within 10 feet, will test personnel measure with a string line, level, or some other method?

9.4.9 Testing Equipment Requirement

Project supervisors and assigned crew leaders identify testing equipment requirements, and submit the requirements to the QC manager via the project manager using the tool requirement summary form (refer to figure 4-9). Project supervisors confirm equipment listed is on either the unit's TOA, and available, or the BOM. They also provide remarks on the testing equipment requirement list as to how each item of testing equipment will be used.

[illegible]

Figure 9-4. Quality Control Testing Plan and Log Form

9.4.10 Personal Protective Equipment Required for Testing

Project supervisors and assigned crew leaders identify PPE required for QC testing. They submit the requirements to the QC manager via the project manager using the equipment requirement summary form (refer to figure 4-10). Project supervisors confirm equipment listed is on either the unit's TOA, and available, or the BOM.

9.4.11 Submittals and Submittal Status Log

The design agent generates a submittal register, which lists the materials, equipment, and systems requiring submittals and identifies the approving authority. The construction agent receives the submittal register with the project plans via HHQ or by separate document from the design agent. In most cases, the project documents will include UFGS Section 01-33-00, Submittal Procedures, which state the proper procedures for handling submittals.

The project supervisor provides submittals as directed by the project manager and the QC manager. A submittal includes the manufacturer's information, shop drawings, samples, other descriptive literature, information for required materials, and construction methods and plans used in the project execution. The Government or authorized representative and the engineering unit QC manager are the only two approval authorities for submittals. The QC manager is responsible for maintaining a submittal status log at the engineering unit.

Submittal procedures outside of direct requirements provided by the project supervisor and project manager are beyond the scope of this publication. Refer to ER1180-1-6, or COMFIRSTNCDINST 4355.1, for Service-specific guidance on submittal procedures.

9.4.12 Request for Information and Status Log

An RFI is a convenient, formal procedure to record, track, and monitor questions concerning a construction project's plans and specifications. Project supervisors submit questions using the RFI form illustrated in figure 9-5. Project supervisors keep a log and track the status of RFIs using the RFI submittal log form illustrated in figure 9-6. Project managers ensure RFIs have been fully researched prior to forwarding to the QC manager for disposition. All returned RFIs become part of the project package. Requests for information may be submitted anytime from the planning phase through the construction phase.

An RFI should receive a written response within seven working days, but a complex question may require longer time. An RFI requiring a response in less than seven working days may be expedited through best available means. These should be managed by exception to ensure they are answered as quickly as possible.

An RFI response is not an authority to proceed with a changed condition. The contracting office requires a FAR if the project supervisor considers the RFI response a changed condition, in accordance with paragraph 9.4.13.

9.4.13 Field Adjustment Request and Status Log

The FAR is a formal procedure to record, track, and monitor requests by the engineering unit for an alteration to the original project plans or specifications because of changed conditions (e.g., site conditions differ from original plans, print/design defects). Project supervisors research and submit their requests using the form illustrated in figure 9-7. Project supervisors keep a log, and track the status of FARs using the form illustrated in figure 9-8.

Project managers ensure FARs have been fully researched and warrant approval prior to forwarding to the QC manager for disposition. The contracting officer, or authorized representative, is the only approval authority for FARs. All returned FARs, whether approved or disapproved, become part of the project package. Field adjustment requests may be submitted anytime from the planning phase through the construction phase. Refer to the engineering unit SOP for Service-specific guidance on approval authority restrictions for labor and material costs of changes.

REQUEST FOR INFORMATION (RFI)				
RFI Number:	Page ____ of ____	Route to:	Initial	Date
		Lead Element		
Project Number:	Project Title:	QC Manager		
		Engineering		
Submitted by:	Date:	Operations Officer		
		Contracting Office		
Description of and reason for request. Include drawing and sheet numbers. Attach drawings as necessary for description.				
Signature/printed name of requester Date				
Response from contracting office or design agent.				
Signature/printed name of approving official Date				

Figure 9-5. Request for Information Form

[illegible]

Figure 9-6. Request for Information Log

FIELD ADJUSTMENT REQUEST (FAR)				
FAR Number:		Page ____ of ____		
Project Number:		Project Title:		
Submitted by:		Date:		
Description of and reason for request. Include drawing and sheet numbers. Attach drawings as necessary for description.				
Route to:	Approved By: (Initial)	Disapproved By: (Initial)	Date:	Estimated Additional Cost:
Lead Element				
QC Manager				Estimated Additional Man-days:
Engineering				
Operations Officer				As-built: _____ Date: _____ (Initial)
Contracting Office				
Contracting Officer Signature: _____				
Notes: 1. Route original and three copies to contracting office. 2. Contracting office return original and two copies.				

Figure 9-7. Field Adjustment Request Form

[illegible]

Figure 9-8. Field Adjustment Request Log

9.4.14 Design Change Directive File

The design change directive is a formal procedure to record changes to the project plans or specifications approved by the contracting office as directed by the design agent, customer, or HHQ.

All received DCDs become part of the project package. Design change directives may be received anytime from the planning phase through the construction phase.

9.5 EXECUTION OF THE PROJECT QUALITY CONTROL PLAN

The project supervisor is the primary person responsible for the quality of work and production of the assigned project. Engineers control construction and inspect the work. Control is preventive; it is an ongoing and continual system of planning future activities to avoid discrepancies. The objectives of control are to ensure workers are adequately prepared to begin a phase of work, eliminate deficiencies, and accomplish the work in accordance with plans and specifications.

Inspection is the examination of ongoing and completed work. Inspection is after the fact. The objective is to ensure that the work has been accomplished in accordance with plans and specifications. Discrepancies identified by the QC specialist represent failures in execution of the project supervisor's QC plan.

Military engineers use three phases of control for each definable feature of work: the preparatory, initial, and follow-up phases. Each control phase provides the opportunity to prevent problems and to correct deficiencies. Paragraphs 9.5.1 thru 9.5.3 discuss the three phases of control.

9.5.1 Preparatory Phase

The project supervisor and crew leader responsible for the definable feature of work create the preparatory phase checklist, illustrated in figure 9-9, in advance of the preparatory phase meeting. All the items included on the preparatory phase checklist should correlate with the project's QC plan and must be accomplished during the preparatory phase for each definable feature of work. The project supervisor schedules the preparatory phase meeting and notifies attendees at least 3 workdays in advance. The project supervisor, designated crew leader, QC manager/QC specialist, and QA representative attend the meeting to document that the list items have been accomplished.

The preparatory phase, as it applies to definable features of work, starts with actions in advance of construction. These actions include approval of shop drawings, test reports, and mix designs; a physical check of material onsite against submittal approvals and contract requirements; and safety checks of equipment. This preparatory action helps locate conflicts between trade items in time to permit correction. Advance planning must be performed to determine that all preparatory actions required prior to construction have been accomplished.

9.5.2 Initial Phase

The initial phase comprises the following actions for each definable feature of work:

1. Establish the quality of workmanship required as listed in the QC plan and agreed upon during the preparatory phase meeting.
2. Resolve conflicts.
3. Ensure required testing is performed.
4. Check work procedures for compliance with the safety plan and the appropriate activity hazard analysis to ensure that applicable safety requirements are met.
5. Document initial phase checklists (lead and support element crew leaders) for the QC specialist to include with the daily QC inspection report.

UNIT _____ PREPARATORY PHASE CHECKLIST		Specification Section:		Date:	
(Continued on second page)					
Project No.		Definable Feature of Work:		Schedule Activity No.	
Index No.					
PERSONNEL PRESENT	NAME	POSITION		COMPANY	
SUBMITTALS	Review submittal and/or submittal register. Have all submittals been approved? YES NO				
	If no, what items have not been submitted?				
	Are all materials on hand? YES NO If no, what items are missing?				
	Check approved submittals against delivered material. (This should be done as material arrives.)				
	Comments:				
MATERIAL STORAGE	Do materials on hand meet contract drawings and specifications? YES NO				
	If no, what discrepancies are present?				
	Are materials stored properly? YES NO If no, what action is taken?				
TOOLS	Are necessary tools on hand to complete activity? YES NO If no, what action is taken?				
	Is working condition of tools adequate to complete activity? YES NO If no, what action is taken?				
SPECIFICATIONS	Review each paragraph of specifications.				
	Discuss procedure for accomplishing the work.				
	Clarify any differences.				
PRELIMINARY WORK AND PERMITS	Ensure preliminary work is correct and permits are on file. If not, what actions are taken?				
	N/A				

Figure 9-9. Preparatory Phase Checklist Form (Sheet 1 of 2)

UNIT _____ PREPARATORY PHASE CHECKLIST (Continued from first page)		Specification Section:	Date:
Contract No.	Definable Feature of Work:	Schedule Activity No.	Index No.
TESTING	Identify test to be performed, frequency, and by whom.		
	When required?		
	Where required?		
	Review testing plan.		
	Has test facility been approved?		
	SAFETY	Activity hazard analysis approved? YES NO	
Review applicable portion of EM 385-1-1.			
MEETING COMMENTS	Navy PWD/BOS/ROICC comments during meeting.		
OTHER ITEMS OR REMARKS	Other items or remarks:		
QC MANAGER DATE			

Figure 9-9. Preparatory Phase Checklist Form (Sheet 2 of 2)

The project supervisor and crew leaders responsible for the definable feature of work prepare the initial phase checklist illustrated in figure 9-10 in advance of the initial phase meeting. All the items included on the initial phase checklist must be accomplished during the initial phase for each definable feature of work. The project supervisor schedules the initial phase meeting when the construction crew is ready to start the work and notifies attendees at least 3 workdays in advance of the meeting. The project supervisor, designated crew leader, QC manager/QC specialist, and QA representative attend this meeting to document that the list items have been accomplished.

The QC manager/QC specialist and project supervisor observe the initial segment of the definable feature of work to ensure the work complies with the QC plan and to determine whether or not the crew thoroughly understands and is capable of accomplishing the work as specified. The QC manager/QC specialist and project supervisor also check for proper implementation of safety standards at this time, using the activity hazard analysis plan, and correct any discrepancies in workmanship immediately. The initial phase must be repeated for each new crew to work onsite or when construction work does not meet acceptable levels of specified quality.

This phase ends when the QC manager or QC specialist signs off on the initial phase checklist.

9.5.3 Follow-up Phase and Daily Quality Control Inspection Report

The QC manager/QC specialist is responsible for the daily QC inspection report and follow-up phase reporting. These procedures are beyond the scope of this publication. Refer to ER 1180-1-6, and NTRP 4-04.2.7, Construction Quality Control for Seabees, for Service-specific guidance on QC reporting requirements and formats.

The daily inspection report monitors the follow-up phase by documenting the following:

1. Required control measure checks, tests, and inspections are performed.
2. Work completed or in progress either is or is not in accordance with the QC plan and project specifications.
3. Actions on all three phases of control, as well as rework items.

Its primary intention is to document the follow-up phase controls of the ongoing work, and clearly tie the activities to the project's schedule.

The QC manager/QC specialist signs these reports, which include certification by the QC manager that the work is in compliance with the contract, except as noted in the report. The project supervisor also signs the report acknowledging its content. The project supervisor posts a copy of the daily QC inspection report on the jobsite information board. The follow-up phase begins at the completion of the initial phase meeting and ends when the QC manager or QC specialist signs off on the completed work for each specific defined feature of work.

Project supervisors and assigned crew leaders are also responsible for a daily inspection of subordinates' work, recording their findings in the project supervisor's logbook.

9.5.4 Rework Items Procedure

Project supervisors and assigned crew leaders work to avoid or correct deficiencies from the onset of construction. They require rework to correct any nonconforming work identified. If a deficiency is not corrected that same day, it must be noted on the daily QC inspection report and tracked on the rework items list. The list should indicate the date identified, description of each deficiency, contract requirement, action taken, resolution, and the date corrected, as illustrated in figure 9-11. The project supervisor maintains a rework items list at the jobsite; the QC specialist maintains an independent rework items list.

INITIAL PHASE CHECKLIST		Spec Section No.	Date: dd/mm/yyyy
Contract No.	Definable Feature of Work:	Activity No./Schedule Activity ID	Index No.
PERSONNEL PRESENT	Government rep notified _____ hours in advance? YES NO		
	NAME	POSITION	COMPANY/GOVERNMENT
PROCEDURE COMPLIANCE	Identify full compliance with procedures identified at preparatory; coordinate plans, specifications, and submittals. Comments:		
PRELIMINARY WORK	Ensure preliminary work is complete and correct. If not, what action is taken?		
WORKMANSHIP	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.)		
RESOLUTION	Resolve any differences. Comments:		
CHECK SAFETY	Review job conditions using EM 385-1-1 and job hazard analysis. Comments:		
OTHER	Other items or remarks:		
		QC MANAGER	DATE

Figure 9-10. Initial Phase Checklist Form

[illegible]

Figure 9-11. Rework Items List Form

The QC manager/QC specialist should not allow the adding to, building upon, or enclosing of nonconforming work. The QC manager has the authority to correct any deficiency, even though it might result in stopping work on a particular segment of the project, and must notify the project manager if a deficiency will significantly impact the construction schedule or cost. Any rework estimated to require more than 50 MDs or \$500 in materials requires approval of HHQ.

9.5.5 Completion/Turnover Inspection Roles and Procedures

The project manager, project supervisor, and QC staff play a significant role with project completion or turnover inspections. Refer to chapter 5 for information on roles and procedures for project turnover or chapter 8 for project completion information. All received documents concerning completion or turnover become part of the project package.

9.6 CONTRACTING OFFICE INTERFACE

The QA representative/contracting office is responsible for obtaining quality construction within the funds and time allotted by monitoring the engineering unit's QC system. The QA representative is the primary POC at the jobsite between the project manager, project supervisor, QC manager, client, user, and the contracting office. The QC manager is the primary POC for the QA representative on issues of quality, workmanship, or construction in general. However, this does not preclude the QA representative from dealing with the project manager and project supervisor on items that are normally their responsibility such as site safety, utility outages, the overall construction schedule, and site access.

Quality assurance representative do not fill the same role as the QC managers. A close, professional working relationship between the QA representative and the QC manager is important. Any communications affecting the execution of the work should always include the QA representative. The QA representative is responsible for the following tasks.

1. Attend the preconstruction conference and weekly or bi-weekly QC meetings.
2. Check certifications of materials and equipment delivered to the site.
3. Check status of as-built drawings.
4. Conduct pre-final and final inspections.
5. Conduct project site visits and QA inspections; spot-check workmanship.
6. Evaluate the engineering unit's QC system.
7. Observe enforcement of safety provisions during normal site visits.
8. Observe testing procedures.
9. Prepare noncompliance notices.
10. Review and approve the QC plan.
11. Review and comment on construction schedules.
12. Review submittal register, rework items list, testing plan, and log.
13. Review the daily QC inspection reports in a timely manner and take necessary action.
14. Schedule and coordinate required utility outages.
15. Verify and obtain decision on changed conditions (e.g., FARs, DCDs).

9.7 AS-BUILT RECORD DRAWINGS

The project supervisor is required to maintain a full-size set of as-built drawings, also known as red-lines, on the project site. They are updated on a daily basis, showing all deviations (i.e., approved FARs, DCDs) from the project drawings, including buried or enclosed utilities and conditions revealed during construction. The project manager and QC manager review these drawings every 2 weeks to ensure they are current. The QA representative checks the as-built drawings monthly.

The QC manager also maintains a full-size set of as-built drawings. The QC manager or assigned QC specialist must initial each revision. Upon completion of work, the QC manager will furnish a certificate attesting to the accuracy of the as-built drawings prior to submission to the contracting officer. Two sets of as-built drawings are submitted to the contracting office.

9.8 AS-BUILT RECORD OF MATERIALS USED

The project supervisor is required to maintain an accurate record of the materials incorporated into the project. The project manager is responsible to ensure this record is kept. The QC manager/QC specialist periodically inspects this record. Upon completion of construction, the records are submitted to the contracting office as part of the final completion package. Refer to chapter 8 for further information on project completion requirements.

INTENTIONALLY BLANK

CHAPTER 10

Safety Plan

10.1 INTRODUCTION

All construction projects have safety considerations requiring an approved plan. The military must also comply with construction and occupational safety and health regulations while accomplishing its mission. Common guidance applicable to each military service is found in the Federal Acquisition Regulation and UFGS. Managers are responsible for initiating actions to develop a safety plan.

Leadership is imperative to integrating safety considerations into the planning process through the performance phases to achieve the desired outcomes. Military engineers must turn concern for safety into an institutional and personal ethic. For a successful project outcome, engineers incorporate these considerations proactively to identify, prevent, and mitigate situations that impact mission accomplishment rather than as a reaction to accidents, poor safety practices, and regulations.

10.2 SAFETY PROGRAM AND OPERATIONAL RISK MANAGEMENT

Military engineers are required by military service instructions based on Department of Defense Instruction (DODI) 6055.1, DOD Safety and Occupational Health (SOH) Program, to comply with safety and occupational health laws and regulations. The safety organization in most engineering units consists of an appointed safety officer, assistant safety officer, and safety supervisor. Each subordinate component and project site assigns a safety supervisor as a collateral duty function. The project safety supervisor reports to the project supervisor. Each military engineer is responsible to learn the procedures for safe construction and is empowered to identify and stop an unsafe situation.

Each military service performs operational risk management (ORM) as part of a daily safety routine as directed by DODI 6055.1. Operational risk management is not a standalone element of the safety plan, but is an inherent part of its elements.

10.3 THE SAFETY PLAN

The project supervisor is required to have a tailored safety plan—also known as an accident prevention plan—that properly addresses safety and occupational health requirements and ensures execution throughout the cycle of a project. Figure 10-1 illustrates a project safety plan cover sheet listing the components of a project safety plan. Items 1–11 are initiated in the planning phase; items 12–17 are initiated during the execution phase of construction.

10.4 DEVELOPMENT OF THE PROJECT SAFETY PLAN

Project supervisors and crew leaders develop a project safety plan as discussed in paragraphs 10.4.1–10.4.11. The project safety plan must be approved before work at the project site can start.

10.4.1 Project Organization Sheet

Project supervisors create a project organization sheet for inclusion in the safety plan. Refer to paragraph 2.3.3 for information on T/O development.

PROJECT SAFETY PLAN/ ACCIDENT PREVENTION PLAN (COVER SHEET)		
Project Number: _____ Project Location: _____		
Project Title: _____		
Lead Element: _____ Support Element(s): _____		
TABLE OF CONTENTS	YES	NO
1. Project Organization Sheet.		
2. Project Scope Sheet.		
3. Definable Features of Work Submittal List.		
4. Activity Hazard Analysis Sheets.		
5. Identify Required Skills and Training.		
6. Special License(s) and Permits Required.		
7. Safety Inspection Plan Summary.		
8. Administrative Controls (e.g., general safety plan, policies, procedures, SOPs).		
9. Safety Equipment Required; Tools and Materials (state how it will be used).		
10. Personal Protective Equipment Required for Safety.		
11. Special Safety Plans (e.g., fall protection plan, scaffolding plans).		
12. Emergency Phone Number Form.		
13. Daily Safety Lecture Log.		
14. Daily Safety Inspection Reports.		
15. Safety Hazard/Deficiency List.		
16. Report of Unsafe or Unhealthy Working Conditions.		
17. Completion/Turnover Inspection Roles and Procedures.		
Project Supervisor: _____ Date: _____		
Project Manager: _____		
Safety Officer: _____ Approved/Disapproved		
Reason for disapproval: _____		

Figure 10-1. Project Safety Plan Cover Sheet and Table of Contents

10.4.2 Project Scope Sheet

Project supervisors create a project scope sheet for inclusion in the safety plan. Refer to paragraph 2.3.6 for information on project scope sheet development.

10.4.3 Definable Features of Work

A definable feature of work is the basis for an activity hazard analysis. Refer to paragraph 9.4.3 for information on the development of the definable features of work submittal list.

10.4.4 Activity Hazard Analysis

Project supervisors and assigned crew leaders conduct an activity hazard analysis on each definable feature of work to provide detailed identification of project-specific hazards and controls. Ideally, the workers involved with the activity should develop the activity hazard analysis, as they normally have the technical expertise to know the process and the hazards involved. It should be used as a training tool for all members involved in the activity and reviewed before work begins. Before beginning each work activity that presents hazards not experienced in previous project operations, or where a new work crew or support element crew is to perform the work, the crew performing that work activity prepares an activity hazard analysis, using the following procedures:

1. An activity hazard analysis defines the activity being performed and identifies the work sequences, specific anticipated hazards, site conditions, equipment, materials, as well as the control measures to be implemented to eliminate or reduce each hazard to an acceptable level of risk. Figure 10-2 illustrates the activity hazard analysis form.
2. Work does not begin until the activity hazard analysis for the work activity is accepted by the safety officer and discussed with all engaged in the activity, including the lead element, support element(s), and unit safety representatives at preparatory and initial control phase meetings.
3. The names of the competent/qualified person(s) required for a particular activity (e.g., excavations, scaffolding, fall protection, as specified by 29 CFR 1910, Occupational Safety and Health Standards; 29 CFR 1926, Safety and Health Regulations for Construction; and EM 385-1-1) are identified and included in the activity hazard analysis. Proof of competency/qualification is submitted to the safety office for acceptance prior to the start of that work activity.
 - a. A competent person is one who can identify existing and predictable hazards in the working environment or working conditions that are dangerous to personnel and who has authorization to take prompt corrective measures to eliminate them.
 - b. A qualified person is one who, by possession of a recognized degree, certificate, or professional standing or extensive knowledge, training, and experience, has successfully demonstrated the ability to solve problems related to the subject matter, the work, or the project.
4. The activity hazard analysis is reviewed and modified as necessary to address changing site conditions, operations, or competent/qualified person(s).
 - a. If more than one competent/qualified person is used on the activity, a list of names is submitted as an attachment to the activity hazard analysis. Those listed must be competent/qualified for the type of work involved in the activity hazard analysis and familiar with current site safety issues.
 - b. If a competent/qualified person not on the original list is added, the list is updated—an administrative action not requiring an updated activity hazard analysis. The new person shall acknowledge in writing that he or she has reviewed the activity hazard analysis and is familiar with current site safety issues.
5. An RAC is assigned to each activity using a risk assessment matrix and the ORM process. Refer to unit SOP for procedures based on DODI 6055.1.

ACTIVITY HAZARD ANALYSIS				
Project Number: _____		Project Title: _____		Date: _____
Activity Number: _____		Definable Feature of Work: _____		
Prepared By: _____		Project Supervisor: _____		
Safety Office (Approved/Disapproved) _____		Activity Risk Assessment Code (RAC): _____ (Use highest code)		
JOB STEPS Identify the principal steps and sequence of work activities.	HAZARDS Analyze each principal step for potential hazards.	CONTROLS Develop specific controls for potential hazards.	RAC Assign using Risk Assessment Matrix	
EQUIPMENT List equipment used in the work activity.	TRAINING List training requirements.	INSPECTIONS List inspection requirements.		
PERSONNEL INVOLVED: _____				
				SHEET ____ OF ____

Figure 10-2. Activity Hazard Analysis Form

10.4.5 Identify Required Skills and Training

Project supervisors and assigned crew leaders identify skills and training required for accomplishment of safety actions during each activity hazard analysis. For example, a safety supervisor is designated on each project crew. This person will have required minimum training for the safety supervisor duty pertaining to the occupational safety and health program. Contact the unit safety officer for an up-to-date list of safety supervisor training requirements. Refer to paragraph 2.3.8 for information on documenting training requirements. Also, if special training required for the project is not unit-funded, the requirement must be added to the project's BOM. Refer to paragraph 4.3.3 for information on BOM development.

10.4.6 Special License and Permit Required

Project supervisors and assigned crew leaders identify special license and permit requirements. They submit these requirements via the project manager to the unit training officer for licensing. Refer to paragraph 2.3.8 for further information on training requirements. Permit requests are coordinated with the unit QC manager. Refer to paragraph 6.3.8.2 for permit request scheduling and forms.

10.4.7 Safety Inspection Plan Summary (Engineering Controls)

The project supervisor and assigned crew leaders create the project safety inspection plan summary by consolidating a list of safety requirements by activity number from each CAS sheet and activity hazard analysis. Figure 10-3 illustrates a project safety inspection plan summary form. The unit safety officer reviews this plan before forwarding to the lead element project manager for resource leveling and approval.

10.4.8 Administrative Controls

Project supervisors and assigned crew leaders create administrative controls required to avoid or mitigate hazards identified during each activity hazard analysis. The unit safety officer is contacted for an up-to-date list of standard/general safety actions, policies, procedures, and SOPs prior to creating an independent list of administrative controls. The unit safety officer reviews this list before forwarding to the lead element project manager for approval.

10.4.9 Safety Equipment Required

Project supervisors and assigned crew leaders identify safety equipment requirements based on each activity hazard analysis. The unit safety officer is contacted for an up-to-date list of standard safety equipment, including safety consumable items commonly used on construction projects, prior to creating an independent list. Project supervisors confirm tools and materials listed are on either the unit's TOA and available or the BOM. The unit safety officer reviews these requirements before forwarding to the lead element project manager for resource leveling and approval. Figure 10-4 illustrates a safety equipment list form.

10.4.10 Personal Protective Equipment Required for Safety

Project supervisors and assigned crew leaders identify PPE requirements based on each activity hazard analysis. The unit safety officer is contacted for an up-to-date list of common PPE used on project sites prior to creating an independent list. Project supervisors confirm PPE listed is on either the unit's TOA, and available, or the BOM. The unit safety officer reviews these requirements before forwarding to the lead element project manager for resource leveling and approval. Refer to figure 10-4 for the PPE list form.

[illegible]

Figure 10-3. Safety Inspection Summary Plan Form

[illegible]

Figure 10-4. Safety Equipment List/Personal Protective Equipment List Form

10.4.11 Special Safety Plans

Specific safety plans are required for the following areas:

1. Fall protection
2. Scaffolding
3. Excavation
4. Demolition
5. Confined space
6. Traffic control.

Risk assessment from each activity hazard analysis and mandatory OSHA compliance programs may require additional plans. Refer to EM 385-1-1, and/or 29 CFR 1926, as a guide. Contact the unit safety officer for further information.

10.5 EXECUTION OF THE PROJECT SAFETY PLAN

The project supervisor is the primary person responsible for safety at the assigned project. The project manager ensures that the project supervisor executes the safety plan and integrates safety principles and procedures as a matter of routine into daily production tasks.

10.5.1 Emergency Mishap Response Plan

Project supervisors and assigned crew leaders tailor the unit's emergency response plan to the project location. Crew members must know the location of the nearest telephone or means of communication; have access to a map or know the location of the nearest medical facility; and know the proper procedure to report mishaps. Project supervisors hold rehearsal events, especially upon first arrival at a new location and when a new support element crew is onsite. The project supervisor submits the emergency response plan to the project manager for approval via the unit safety officer. Refer to paragraphs 6.2 and 6.3 for further information on jobsite setup.

10.5.2 Daily Safety Lecture Log

Project supervisors and assigned crew leaders conduct daily safety lectures, which are coordinated with the schedule, and focus on hazard awareness for the production tasks to be conducted that day. Personnel awareness is crucial to mishap prevention. In addition to anticipating the hazard and providing protective equipment, a crew leader must be trained and motivated to properly use the equipment. If the corrective action includes specific procedures or methods, the project supervisor must ensure the crew leader follows those procedures every time. Refer to paragraph 6.3.2 for further information on crew briefings.

10.5.3 Daily Safety Inspection

The safety officer/assistant safety officer is responsible for the daily safety report. These procedures are beyond the scope of this publication. Refer to individual unit safety SOP Service-specific guidance on safety inspection report requirements and formats.

The purpose of this report is to document that the required hazard control measures are in use and properly followed. The safety inspector signs these reports. The project supervisor and project safety supervisor also sign the report, acknowledging its contents. A copy of the daily safety report is provided to the project supervisor so it can be posted on the jobsite information board.

10.5.4 Safety Hazard/Deficiency

Project supervisors and assigned crew leaders work continually to avoid or correct deficiencies from the onset of construction. When a hazard or unsafe condition is recognized, the situation is immediately addressed. Safety hazards and deficiencies not immediately corrected are noted on the daily safety report and tracked on the rework items list. The list should indicate the date identified, description of each deficiency, contract requirement, action taken, resolution, and the date corrected. Figure 10-5 illustrates a project Safety Hazard and Deficiency List Form. The project supervisor maintains a safety hazard and deficiency list at the jobsite; the safety officer maintains an independent safety hazard and deficiency list.

The project supervisor must not allow unsafe work practices to continue. Each crew member has the authority to stop unsafe acts. The project manager must be notified of all mishaps and near mishaps according to unit safety SOP. The project manager closely monitors corrective action of safety hazards and deficiencies, ensuring proper resource allocation. Repeated hazards and deficiencies receive command attention if not corrected within several days.

10.5.5 Report of Unsafe or Unhealthy Working Conditions

Any person may submit a report of an unsafe or unhealthful working condition directly to the safety office. Project supervisors post the proper form for reporting unsafe or unhealthful working conditions on the jobsite information board and ensure crew members are briefed on its use. Contact the unit safety officer for information on the most up-to-date forms and procedures.

10.5.6 Completion/Turnover Inspection Roles and Procedures

The project manager, project supervisor, safety supervisor, and safety officer play a significant role with project completion or turnover inspections. Refer to chapter 5 for information on roles and procedures for project turnover or chapter 8 for project completion information. Refer to the unit safety officer's SOP for specific joint facilities and project site safety inspection criteria. All received documents concerning completion or turnover become part of the project package.

[illegible]

Figure 10-5. Safety Hazard and Deficiency List Form

CHAPTER 11

Environmental Protection Plan

11.1 INTRODUCTION

All construction projects have environmental considerations requiring an approved plan. The military must also comply with environmental legal requirements while accomplishing its mission. Common guidance applicable to each military service is found in the Federal Acquisition Regulation and UFGS. Managers are responsible for initiating actions to develop an environmental protection plan.

Leadership is imperative to integrating environmental considerations into the planning process through the performance phases to achieve the desired outcomes. Military engineers must turn concern for environmental considerations into an institutional and personal ethic. For a successful project outcome, engineers incorporate these considerations proactively to identify, prevent, and mitigate situations that impact mission accomplishment rather than as a reaction to laws and regulations.

11.2 ENVIRONMENTAL PROTECTION

Air Force Instruction (AFI) 91-301, Air Force Occupation and Environmental Safety, Fire Protection, and Health (AFOSH) Program Field Manual 3-34.5/MCRP 4-11B, Environmental Considerations; and Navy warfare publication (NWP) 4-11, Environmental Protection, provide guidance to military engineers on compliance with environmental laws and regulations. Environmental considerations comprise a broad range of issues that must be integrated into all phases of construction from design, planning, and estimating through execution.

The contracting office must accept an engineering unit environmental plan prior to the start of construction. Refer to UFGS Section 01-45-20.00-10, Environmental Protection, for further information on the unit environmental protection plan. The unit environmental program has two levels with regard to construction projects:

1. Project Environmental Protection Plan. Project managers and project supervisor perform and direct activities to develop an individual project environmental protection plan. These activities are discussed in paragraphs 11.3 thru 11.10.
2. Unit Environmental Protection Plan. The unit environmental manager implements the environmental program and advises the commanding officer on all environmental and HM/HW issues. The environmental program is executed through the chain of command. These activities are beyond the scope of this publication. However, this publication discusses integration and transition points involving project managers and project supervisors with the unit environmental program.

11.3 THE ENVIRONMENTAL PROTECTION PLAN

The project supervisor is required to have a tailored environmental protection plan specific to the assigned project that presents a comprehensive overview of known or potential environmental issues which the project supervisor must address during construction. Figure 11-1 illustrates a cover sheet listing the components of a project environmental protection plan. Items 1-10 are initiated in the planning phase; items 11-15 are initiated during the execution phase of construction. The project supervisor must keep the environmental protection plan current and onsite.

PROJECT ENVIRONMENTAL PROTECTION PLAN (COVER SHEET)		
Project Number: _____ Project Location: _____		
Project Title: _____		
Lead Element: _____ Support Element(s): _____		
TABLE OF CONTENTS	YES	NO
1. Project Organization Sheet.		
2. Project Scope Sheet.		
3. Definable Features of Work Submittal List.		
4. Activity Hazard Analysis Sheets.		
5. Identify Required Skills and Training.		
6. Special License(s) and Permits Required.		
7. Environmental Protection Plan Summary.		
8. Administrative Controls (e.g., HM/HW plan, policies, procedures, SOPs).		
9. Environmental Equipment Required; Tools and Materials (state how it will be used).		
10. Personal Protective Equipment Required for Environmental.		
11. Hazardous Material Inventory.		
12. Authorized User List.		
13. Material Safety Data Sheet File.		
14. Project Environmental Inspection Checklists.		
15. Spill Response Plan.		
16. Other Plans and Considerations.		
Project Supervisor: _____ Date: _____		
Project Manager: _____		
Environmental Manager: _____		Approved/Disapproved
Reason for disapproval: _____		

Figure 11-1. Environmental Protection Plan Cover Sheet and Table of Contents

Environmental protection is vital in construction. The project manager must be engaged in the planning process from the beginning. The project manager engages base public works at the project location as early as possible to identify and forestall potential problems. The project manager meets with the contracting officer prior to submittal of the environmental protection plan to discuss implementation of the initial plan, possible subsequent additions and revisions to the plan, and any reporting requirements.

11.4 DEVELOPMENT OF THE ENVIRONMENTAL PROTECTION PLAN

Project supervisors and crew leaders develop a project environmental protection plan as discussed in paragraphs 11.4.1 thru 11.4.10. For each topic, they address environmental issues at a level of detail commensurate with the scope of the environmental issue and the required construction task(s).

11.4.1 Project Organization Sheet

Project supervisors create a project organization sheet for inclusion in the environmental protection plan. Refer to paragraph 2.3.3 for information on T/O development.

11.4.2 Project Scope Sheet

Project supervisors create a project scope sheet including general site information, a preconstruction description of the site, and photos for inclusion in the environmental protection plan. Refer to paragraph 2.3.6 for information on project scope sheet development.

11.4.3 Definable Features of Work

A definable feature of work is the basis for an activity hazard analysis. Refer to paragraph 9.4.3 for information on the development of the definable features of work submittal list.

11.4.4 Activity Hazard Analysis

Project supervisors and assigned crew leaders conduct an activity hazard analysis of each definable feature of work to provide detailed identification of known or potential environmental issues and controls. Copies of applicable activity hazard analysis sheets become part of the environmental protection plan. Refer to paragraph 10.4.4 for further information on conducting an activity hazard analysis.

11.4.5 Identify Required Skills and Training

Project supervisors and assigned crew leaders identify skills and training required for accomplishment of environmental actions during each activity hazard analysis. For example, each project crew must have a designated HM/HW representative. This person will have required minimum training for the HM/HW representative duty pertaining to the unit environmental program. Contact the unit environmental manager for an up-to-date list of HM/HW representative training requirements. If the special training required is not unit-funded, the requirement must be added to the project's BOM. Refer to paragraph 4.3.3 for information on BOM development. Refer to paragraph 2.3.8 for information on training requirements documentation.

11.4.6 Special License(s) and Permits Required

Project supervisors and assigned crew leaders identify special license(s) and permit requirements. They submit these requirements via the project manager to the unit environmental manager. Permit requests are coordinated with the unit QC manager. Refer to paragraph 6.3.8.2 for permit request scheduling and forms. Refer to paragraph 2.3.8 for further information on training requirements.

11.4.7 Environmental Protection Plan Summary (Engineering Controls)

The project supervisor and assigned crew leaders create the project environmental protection plan summary by consolidating a list of environmental requirements by activity number from each CAS sheet and activity hazard analysis. Figure 11-2 illustrates a project Environmental Protection Plan Summary form. The unit environmental manager reviews this plan before it is forwarded to the lead element project manager for resource leveling and approval.

11.4.8 Administrative Controls

Project supervisors and assigned crew leaders create administrative controls required to avoid or mitigate hazards identified during each activity hazard analysis. Contact the unit environmental manager for an up-to-date list of standard/general environmental actions, policies, procedures, and SOPs prior to creating an independent list of administrative controls. The unit environmental manager reviews these administrative controls before forwarding to the lead element project manager for approval.

11.4.9 Environmental Equipment Required

Project supervisors and assigned crew leaders identify environmental equipment requirements based on each activity hazard analysis. Contact the unit environmental manager for an up-to-date list of standard environmental equipment, including consumable items, commonly used on construction projects prior to creating an independent list. Project supervisors confirm tools and materials listed are on either the unit's TOA, and available, or the BOM. The unit environmental manager reviews the requirements list before forwarding to the lead element project manager for resource leveling and approval. Figure 11-3 illustrates an Environmental Protection Plan Equipment List form.

11.4.10 Personal Protective Equipment Required for Safety

Project supervisors and assigned crew leaders identify PPE requirements based on each activity hazard analysis. Contact the unit environmental manager for an up-to-date list of common PPE used on project sites prior to creating an independent list. Project supervisors confirm PPE listed is on either the unit's TOA, and available, or the BOM. The unit environmental manager reviews these requirements before forwarding to the lead element project manager for resource leveling and approval. Refer to figure 11-3 for the Environmental Protection Plan Equipment List form.

[illegible]

Figure 11-2. Environmental Protection Plan Summary Form

11-6

11.5 EXECUTION OF THE PROJECT ENVIRONMENTAL PLAN

The project supervisor is the primary responsible person for environmental protection actions on the assigned project. The project manager is responsible to see that the project supervisor is executing the environmental protection plan and integrating environmental principles and procedures as a matter of routine into daily production tasks.

11.5.1 Hazardous Material/Hazardous Waste Management

The project supervisor and assigned crew leaders are responsible for the proper handling of HM. It is important to identify all HM on the project and understand the requirements for storage, usage, and disposal. The project supervisor ensures the HM/HW representative maintains an accurate inventory of HM at the project site. Refer to the unit SOP or the environmental manager for the hazardous material inventory format.

Refer to the unit SOP for HM/HW management and procedures. In support of HM/HW management, leaders should:

1. Ensure subordinates receive adequate training on the HM to which they are exposed.
2. Maintain an up-to-date list of all HM/HW present in the area.
3. Ensure that containers of hazardous chemicals are labeled, tagged, or otherwise marked to identify the material and to warn personnel of hazards.
4. Maintain an MSDS for every HM on the project site
5. Ensure that personnel are trained to recognize, understand, and use the MSDS and labels for the HM to which they are exposed.
6. Ensure that personnel use proper procedures when working with hazardous chemicals and wear PPE.

11.5.2 Authorized User List

The authorized user list is an established comprehensive list of HM authorized for use at the unit. If the HM item is not on this list, the unit cannot obtain it. Project supervisors identify HM during planning and estimating to ensure the item is on the unit's or project site location's authorized user list. Contact the environmental manager to add required HM items not identified on the authorized user list.

11.5.3 Material Safety Data Sheet

An MSDS is a summary of information on a given chemical that identifies the material, its health and physical hazards, its exposure limits, and the precautions involved. An MSDS also provides the following information:

1. How the material may be safely handled
2. Personal protective equipment required
3. Safety precautions required for use
4. Proper storage
5. First aid or medical treatment required for exposure.

An MSDS must be onsite for each HM used on the project site. The project supervisor is required by Federal law to inform crew members of the risks and all safety precautions associated with any HM present on the jobsite and

ensure the crew knows the MSDS location and use. The project supervisor may use the daily safety lecture to discuss this information. Material safety data sheets for HM in use are posted on the jobsite information board. The unit environmental manager is responsible for maintaining a reference library for each HM item. Contact the environmental manager for technical guidance on the use of MSDS.

11.5.4 Project Environmental Inspection Checklists

The Project Environmental Inspection Checklist documents that the required environmental protection measures are in use and proper procedures are being followed on the jobsite. The project supervisor, a crew leader, the project safety supervisor, or HM/HW representative is responsible to inspect the jobsite on a daily basis using the checklist illustrated in figure 11-4. Refer to individual unit environmental program SOP Service-specific guidance for inspection reporting requirements, frequency, and formats. The inspector signs these reports and, unless otherwise directed, files them in the jobsite project file.

11.5.5 Spill Response Plan

Emergency HM/HW spill response plans are required for all construction project sites. These plans address all aspects of spill response, to include site-specific response procedures and spill response equipment requirements for each major HM/HW operation.

The project manager is responsible to ensure a spill response plan is approved for the project. Project supervisors are responsible to execute the plan and ensure assigned crew members are trained on the plan. Contact the unit environmental manager for up-to-date information, checklists, and procedures for a site-specific plan. Refer to FM 3-34.5/MCRP 4-11B, for further information on spill response plans.

11.5.6 Completion/Turnover Inspection Roles and Procedures

The project manager, project supervisor, HM/HW representative, and environmental manager play a significant role with project completion or turnover inspections. Refer to the unit environmental manager's SOP for environmental program turnover/completion actions. All received documents concerning completion or turnover become part of the project package.

11.6 ASBESTOS

State environmental regulatory departments closely scrutinize the demolition projects of older structures on installations. Many of these structures contain asbestos and lead-based paint, both of which are known health hazards. Installations are required to notify the State before beginning demolition or renovation projects. Immediately stop work and contact the unit environmental manager if asbestos is suspected on a project. All asbestos-containing materials and lead-based paint must be removed by trained personnel.

11.7 FUGITIVE DUST

The project supervisor should attempt to minimize airborne dust resulting from construction activities and must address the following questions:

1. Is a dust permit required?
2. Does the project have the proper dust control permit for construction activities?
3. Does the project have a dust mitigation plan? Dust mitigation must occur 24 hours a day 7 days a week regardless of construction status.

PROJECT ENVIRONMENTAL INSPECTION CHECKLIST			
Project Number: _____ Date: _____			
Project Title: _____			
Inspected by: _____			
1. ADMINISTRATION	YES	NO	N/A
Oil and hazardous substance spill checklist posted in a high-visibility area?			
Are emergency phone numbers posted by field office phones?			
Does the project site have any ignitable (e.g., fuel storage areas) or reactive waste?			
If yes, are items separated and confined from all sources of ignition or reaction?			
Are smoking and open flames confined to a designated area?			
Are "NO SMOKING" signs posted?			
Are MSDS available for each hazardous material used?			
Do all workers know how to use MSDS and where they are located?			
NOTE: Do not accept materials without MSDS. MSDS need to travel with the material at all times.			
2. HAZARDOUS MATERIAL CONTAINERS/PALLETS/COVERS			
Are Department of Transportation-approved containers in use?			
Are environmental pallets/covers available and in use?			
Are drip pans/absorbent material placed under the containers?			
Are containers holding ignitable grounded; do they have a 6-in freeboard?			
Are containers properly sealed?			
Are containers leaking, damaged, or overfilled?			
Are containers 50 inches from the facility?			
Is there evidence of heat generation from incompatible waste being mixed?			
Are containers properly marked and labeled?			
Are any containers overdue; do any containers need to be turned in to HM or the base?			
Are all oily rags stored in containers marked "OILY RAGS ONLY"?			
3. SAFETY EQUIPMENT			
Are warning signs posted and in good condition?			
Are gloves, face shields, and protective aprons available and in good condition?			
4. EMERGENCY RESPONSE			
Is a properly stocked spill kit available?			
Have personnel been briefed on emergency response and clean-up procedures?			

Figure 11-4. Project Environmental Inspection Checklist Form (Sheet 1 of 2)

Have personnel been briefed on any environmental or health hazards associated with the project?			
Have personnel received HW management training (i.e., classroom, on-the-job training)?			
5. FUGITIVE DUST			
Is a visible plume of dust resulting from construction activities extending more than 50 yards from the point of origin?			
6. CLEANING PAVING EQUIPMENT			
If a solvent is being used (e.g., diesel fuel), is the runoff properly contained?			
7. CHLOROFLUOROCARBON USAGE			
Is recycling equipment being used to reclaim all Freon?			
Are operators certified to service air conditioners?			

Figure 11-4. Project Environmental Inspection Checklist Form (Sheet 2 of 2)

The project supervisor takes all reasonable precautions to abate fugitive dust from becoming airborne whenever a project site activity produces fugitive dust. Reasonable precautions include the following:

1. Conditions agreed upon in the project permit
2. Sprinkling
3. Compacting
4. Enclosure
5. Chemical or asphalt sealing
6. Cleaning up
7. Sweeping
8. Other measures the project manager may specify to accomplish satisfactory results.

11.8 STORM WATER

Many projects require a specific storm water plan and permit. Consult the host base environmental representative and inquire about specific permit requirements. Many bases have a template for the storm water permit and can assist in writing the permit. However, if the plan and permit are not required, the project should still follow best management practices to protect storm sewers and waterways.

11.9 WASTE DISPOSAL AND RECYCLING

Ensure waste is disposed of in accordance with base policy. Many bases have recycling/reuse programs that minimize waste stream. Additionally, it is always beneficial to identify ways to reduce the project waste stream.

11.10 WETLANDS

Wetlands present many problems for construction. If a project is in a wetlands area, start working early with the base environmental representative to address all possible issues.

APPENDIX A

Construction Project Package

A.1 INTRODUCTION

The planning, organization, and execution of a construction project can be demanding and complex. The construction project package is a tool to assist leaders in mission accomplishment.

Figure A-1 illustrates a table of contents for items contained in the project package. All project packages are in the project package format and use forms as shown in figure A-1. The contents of the individual sections are shown in alphabetical order for ease of locating what information goes into each section. Follow specific unit implementation guidance for the exact project package format.

In a contingency operation, some forms may be waived or vary in format based on guidance by command authority or HHQ.

A.2 FORMS

The First Naval Construction Division (1NCD) and NCRs validate the approved forms. Electronic copies of blank forms used for the construction project package are available at 1NCD's Web portal:
<https://www.portal.navy.mil/necc/1ncd/N3>.

Forms are also available at the Navy staff operations directorate (N3) operations page and/or NCR's R3 operations Web sites. Software guidance is available in the Seabee Construction Management Software User Guide.

Forms may be computer-generated, but must be the same content as shown. Users should periodically check the source documents referenced for changes to these forms.

PROJECT PACKAGE	
SECTION	CONTENTS
Section 1: General Information and Correspondence	
1A	Incoming Messages and Correspondence Outgoing Messages and Correspondence Tasking Letter/Correspondence
1B	Deployment Calendar Pre-beneficial Occupancy Date Inspection Request Preconstruction Conference Summary Predeployment Site Visit Summary Project Organization Project Package Sign-off Sheet Project Planning Milestones Project Scope Sheet Turnover Memorandum
Section 2: Activities and Network	
2A	Level II Gantt Chart Level III Precedence Diagram Master Activity Listing Master Activity Summary Sheets Two-week Schedules
2B	CAS Sheets (Recommend including filled-out material requisitions) CAS Sheets of Completed Activities Level III Gantt Chart Other Computer Printouts/Reports SITREP Feeders and Photo SITREPs Two-week Labor Summaries
Section 3: Resources	
3A	30/60/90-day Material List 30/60/90-day Material List Letter BOM Equipment Requirement Summary Submittal Status Log and Procedures Tool Requirement Summary
3B	Add-on/Reorder Justification Forms Add-on/Reorder BOM BOM/MTO Comparison Worksheets Borrow Log Long Lead Items List MTO Worksheets Material Transfer Requests

Figure A-1. Project Package (Sheet 1 of 3)

PROJECT PACKAGE	
SECTION	CONTENTS
Section 4: Plans	
4A	<u>QC Plan/QC Plan Cover Sheet</u> 29 Code of Federal Regulations 1926, Highlighted Completion/Turnover Inspection and Letters File Asphalt Placement Clearance Forms Concrete Placement Clearance Forms Daily QC Inspection Reports DCD File Definable Features of Work Submittal List Engineering Service Request Excavation Request FAR Submittal Log and FAR File Initial Phase Checklist File Mineral Products Request Other Quality Control and Production Forms Photos (i.e., preplacement photos for concrete placements) PPE Required for Testing List Preparatory Phase Checklist File QC Inspection Plan Summary QC Requirements List Rework Items List and Procedures RFI Submittal Log and RFI File Road Closure Request Skill and Training Requirements (Training for production and QC) Special License Requirements Testing Equipment Requirements List Testing Plan and Log Utility Interruption Request
4B	<u>Safety Plan/Safety Plan Cover Sheet</u> Accident/Near Mishap/Mishap Reports Activity Hazard Analysis Sheets Administrative Controls (i.e., General Safety Plan, policies, procedures, SOPs) Completion/Turnover Inspection and Letters File Daily Safety Inspection Reports Daily Safety Lecture Log Emergency Phone Numbers Employee Report of Unsafe or Unhealthful Working Conditions PPE Required for Safety List Safety Equipment Requirements List Safety Hazard/Deficiency List Safety Inspection Plan Summary Skill and Training Requirements (Training for Safety) Special License and Permit Requirements Special Safety Plans (i.e., Fall Protection Plan, Scaffolding Plan)

Figure A-1. Project Package (Sheet 2 of 3)

PROJECT PACKAGE	
SECTION	CONTENTS
Section 4: Plans (continued)	
4B	<u>Environmental Protection Plan and Environmental Protection Plan Cover Sheet</u> Administrative Controls (i.e., General HM/HW plan, policies, procedures, SOPs) Completion/Turnover Inspection and Letters File Environmental Protection Plan Summary Environmental Equipment Requirements List HM/HW Management File Authorized User List (Copy of pages showing project required items only) HM Inventory (Project Site) MSDS File Other Plans and Considerations (i.e., Asbestos-testing results, fugitive dust, storm water) PPE Required for Environmental Protection List Project Environmental Inspection Checklist Skill and Training Requirements (Training for Environmental) Special License and Permit Requirements Spill Response Plan
Section 5: Drawings and Specifications	
5A	Project Plans Specifications—Highlighted
5B	Detailed Slab Layout Drawings Forming Plans Other Sketches/Drawings Rebar Bending Schedule Shop Drawings Site Layout Technical Data

Figure A-1. Project Package (Sheet 3 of 3)

APPENDIX B

United States Air Force Construction Project Package

B.1 INTRODUCTION

The United States Air Force Construction Project Package facilitates the optimization of resources, to include personnel, equipment, and materials, through its approach to project management. Organized sequentially by section, this project package is the central depository for essential items documenting the history, progress, and associated costs of a construction project. Figure B-1 illustrates a table of contents for items contained in this project package.

The operations section is responsible for maintaining the official copy of the project folder, however, an on-site project folder must also be maintained throughout project duration and then turned over to operations section for incorporation into the official copy. The design engineer is responsible for creating the project folder and adding all programming, evaluation, and design information to it.

After design is complete, the project engineer/project manager maintains the project folder until completed close-out documentation is added. The folder is generally a six-part folder, but project size and stored information may require additional folders or binders.

B.2 UNITED STATES AIR FORCE UNIQUE PROJECT GUIDANCE

United States Air Force RED HORSE units normally use a “design-build” process during their training cycle. Refer to RED HORSE Project Management Manual, A Comprehensive Guide for Project OICs and Project NCOICs; and United States Air Force Project Managers’ Guide for Design and Construction, for their unique specific mission guidance.

B.3 PROJECT PACKAGE SECTION LISTING

SECTION	CONTENTS
Section 1: Approval Documentation	
	Approved DD Form 1391/1391c AF Form (AF) 332, Base Civil Engineer Work Request or AF 327, Base Civil Engineer Work Order AF 813, Request for Environmental Impact Analysis RED HORSE 1391c Cost Evaluation Customer Notification Letter
Section 2: Design Diary	
	Evaluation Visit and Design Visit Trip Report Point of Contact List Calculations/Specifications Minutes of Preconstruction Meetings and Correspondence
Section 3: Funding Documentation	
03	Funding Message Funding Request Correspondence AF 9, Request for Purchase, with Contract Documents Other Material Order or Funding Forms (AF 1445, Materials and Equipment List; AF 1469, Subsistence-in-Kind (SIK) Invalid Entitlements Log (LRA); AF 2005, Issue/Turn-in Request; DD Form 1348-6, DOD Single Line Item Requisition System Document, etc.) BOM Receipts and Record of Credit Card Purchases
Section 4: Temporary Duty/Weekly Reports	
	Project Operation Order Team Roster Temporary Duty Orders Weekly SITREPs/Cost Reports Paid Temporary Duty Vouchers
Section 5: Construction Diary	
	Construction Blue Book AF 103, Base Civil Engineer Work Clearance Request Reduced Size Copy of Complete Drawings Project Schedule Lab Results Problems/Special Site Adaptations Minutes of Meetings/General Correspondence
Section 6: Project Summary	
	Closeout Checklist DD Form 1354, Transfer and Acceptance of DOD Real Property After Action Report Photographs/Newspaper Articles
Legend:	
AF	Air Force (form)
RED HORSE	Rapid Engineer Deployable Heavy Operational Repair Squadron Engineer

Figure B-1. United States Air Force Project Package

APPENDIX C

Alternate Critical-path Method Procedures

C.1 INTRODUCTION

Critical-path method is essentially a practical guide to construction project scheduling. It is a step-by-step system for process planning and synchronization that identifies critical and noncritical activities with the objective of mitigating timeframe dilemmas and process bottlenecks. United States Army and USMC engineers utilize the following tools for the CPM of project scheduling:

1. Logic diagram
2. Activity duration and resources
3. Activity start and finish times
4. Critical activities, critical path, and float
5. Early start schedule
6. Reduction of the project.

Although the military services use the CPM similarly, different procedures embedded in the culture of each military service appear throughout each training curriculum. For this reason, this appendix discusses CPM procedures used by the USA and USMC. This content is taken from FM 5-412/MCRP 3-17.7F, Project Management. Refer to chapter 3 for further information on the CPM common to all military engineers.

Note

Field Manual 5-412/MCRP 3-17.7F will be canceled when NTRP 4-04.2.3/TM 3-34.41/AFPAM 32-1000/MCRP 3-17.7M, Construction Estimating, and this publication, NTRP 4-04.2.5/TM 3-34.42/AFPAM 32-1020/MCRP 3-17.7F, Construction Project Management, meet approval.

C.2 LOGIC DIAGRAM

One of the most important features of the CPM is the logic diagram. The logic diagram graphically portrays the relationships among a project's many activities. This benefits the manager by providing a tool to anticipate and eliminate problems that might occur during the construction phase of the project. Before the diagram can be drawn up, however, the project construction must first be mentally conceived and depicted on paper to determine the activity relationships. The manager does this by posing the following questions for each activity on the activity list:

1. Start. Can this activity start at the beginning of the project?
2. Precedence. Which activities must be finished before this one begins?
3. Concurrence. Which other activities may either start or finish at the same time as this one?

4. Succession. Which activities cannot begin until this one is finished?
5. Lag/Lead. Which activities may start when a portion of another activity is complete?

C.2.1 Determine Activity Relationships

One way to determine activity relationships is to add a column titled Preceded Immediately By to the right of the activities list, as illustrated in figure C-1. Under this column, for each activity, list all other activities (numbers, letters, or symbols) which must immediately precede the activity in question. If the activity can start at the very beginning of the entire project, enter “None.”

For example, the mission is to build a 40-ft by 40-ft by 8-in concrete pad, and construct a 12-ft wide, 1,000-yard long gravel roadway leading to it. From the mental and paper construction of the project, the manager lists the following activities for constructing the roadway:

1. Clear roadway.
2. Acquire gravel.
3. Prepare subgrade/subbase.
4. Lay gravel.

For the pad, the manager lists the following tasks:

1. Clear site.
2. Acquire gravel.
3. Prepare foundation.
4. Prepare forms.
5. Place forms.
6. Mix and pour concrete.
7. Cure concrete.
8. Remove forms.

An actual activities list is much more detailed. This is a simplified activities list to provide clarity.

If all resources are immediately available, except the gravel which must be acquired, four of the activities (A, B, C, G) can begin immediately and “None” will be noted in the Preceded Immediately By column for those activities. Preparation of the pad foundation (D) cannot begin until the pad site has been cleared (A), so activity D’s Preceded Immediately By column lists A. Since activities F and I both require gravel (activity F because gravel is a component of concrete), both F and I Preceded Immediately By columns list activity C.

ACTIVITY SYMBOL	CONSTRUCTION ACTIVITY NAME	PRECEDED IMMEDIATELY BY
A	Clear pad site.	None
B	Clear roadway.	None
C	Acquire gravel.	None
D	Prepare pad foundation.	A
E	Prepare subgrade/subbase.	B
F	Lay gravel surface.	C, E
G	Prepare forms.	None
H	Place forms.	D, G
I	Mix and place concrete.	C, H
J	Cure concrete.	I
K	Remove forms.	J

Figure C-1. Activities List

Note

Only those items that immediately precede the activity in question should be marked. For example, even though activity B precedes activity F, it does not immediately precede it; activity B immediately precedes activity E, which immediately precedes activity F.

C.2.2 Logic Network Symbols

After determining the activity relationships needed to develop the logic diagram, the manager must decide which logic diagram format to use. The current standard for both military and civilian managers is the activity-on-the-node format, or precedence diagramming, rather than the activity-on-the-arrow format. The two logic symbols on the precedence diagram are the node and the precedence arrow.

A node is simply a parallelogram that represents an activity, and each activity on the activities list is represented by a node on the logic diagram. The node contains all the necessary information for the activity in a standard shape and format. It represents a period of time equal to the activity duration. Each node includes the activity's number, duration, required resources, ES and LS times, and EF and LF times, as illustrated in figure C-2. Required resources information and activity duration times come from the CAS sheet completed during resource estimating. Refer to chapter 4 for further information on estimating and CAS sheets. Refer to paragraphs C.2.4 and C.4 for development of activity numbers and start/finish times.

Start and finish nodes, known as milestones, have no duration and are normally represented by a circle or oval. Milestones can also be used at other points in the network to represent a checkpoint, a major accomplishment, or a deliverable result.

The precedence arrow shows the order sequence and relationships between activities (e.g., what activities must precede and may follow another activity). The configuration of the diagram's nodes and arrows is the result of the Preceded Immediately By list (i.e., the answers to the five questions posed for each activity). The logic behind the diagram is that an activity cannot begin until completion of all activities that send arrows to it.

Early Start	Activity Number	Early Finish
	Duration	
Late Start	Resources	Late Finish

Figure C-2. Typical Activity Block (USA/USMC)

C.2.3 Logic Diagram Example

Using the example in paragraph C.2.1, figure C-3 illustrates a logic diagram to show the relationships among the project activities. First, all activities that begin at the start of the project (i.e., activities not reliant upon completion of any other activity before they begin) will come directly from the Start node (A, B, C, G).

Since activity D cannot begin until activity A is complete (activity D is preceded immediately by activity A), an arrow connects activity A to activity D. Since activity H cannot begin until both activities D and G are complete (activity H is preceded immediately by D and G), activity H must connect to both activities D and G. Since neither activity F nor activity I may begin until activity C is complete, an arrow connects activity C to both activities F and I. If two activities run concurrently (F and I), then they both receive an arrow from a preceding activity yet have no arrows connecting their own nodes. Finally, all activities that do not have a succeeding activity will go directly to the Finish node (F and K).

Actual diagrams often develop through trial and error. The manager forms a rough draft which satisfies some of the logic criteria and then modifies the diagram to meet the remaining criteria. The activities which have “None” under the Preceded Immediately By column stem directly from the Start node. Then the follow-on activities, which list the starting activities in the Preceded Immediately By column, connect by arrow to their starting activities. This same methodology continues until all activities are diagrammed. Finally, all the dangling activities connect to the Finish node. At this point, the manager checks and modifies the diagram to ensure the integrity of logic criteria.

C.2.4 Activity Node Numbering

Once the manager constructs the logic diagram, each activity, or node, needs a number for identification on the diagram. Two rules exist for activity node numbering:

1. Every activity node number must be different.
2. The activity node number at the head of the logic arrow must be greater than the number at the tail.

Otherwise, any number may represent the activity node number. Numbering the activities reduces confusion on a diagram and is very useful during resource scheduling. The activity node numbers sit in the upper middle sector of the node (refer to figure C-2) and normally increase incrementally by 5 or 10. This allows room for additional activity nodes to be inserted later, if necessary. Once numbered, the activities may be referred to by either names or numbers. United States Army engineers frequently designate activity names by letters (refer to figures C-1 and C-3), but the node receives a number once placed in a logic diagram. Refer to paragraph 2.3.12.2 for further information about construction activity numbering.

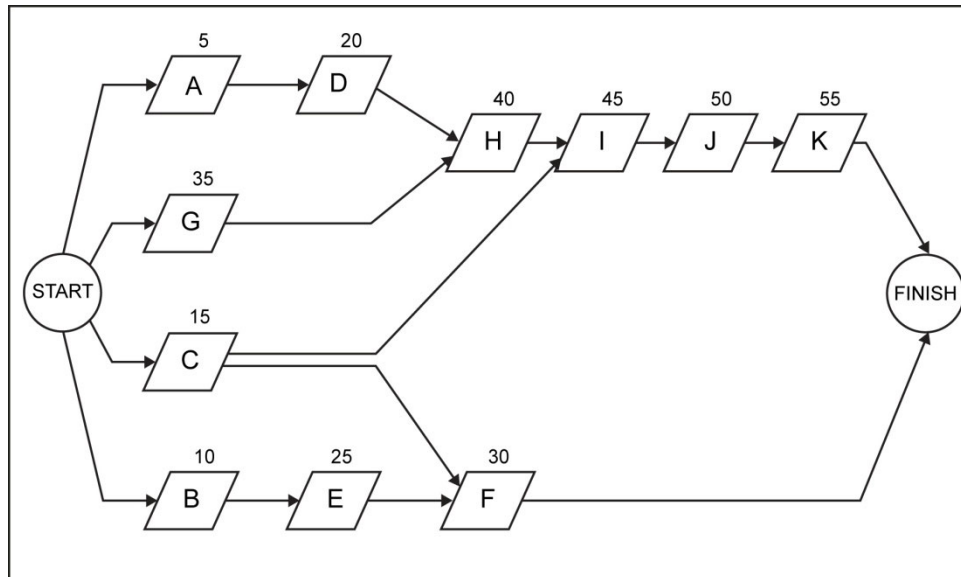


Figure C-3. Logic Diagram (USA/USMC)

C.3 ACTIVITY DURATION AND RESOURCES

The logic network is constructed without regard to how long an activity will last or whether or not all required resources are available. It simply displays the relationships between activities, provides project understanding, and improves communications.

After drawing the network and inserting the activity numbers, the manager places activity duration and resource requirements data into the center and lower middle sectors (refer to figure C-2) of each activity node. The manager determines these times and resources using the estimating procedure discussed in chapter 4. This recommended standard procedure is flexible and lends itself to full documentation. The manager uses a code to refer to the necessary resources if an activity has too many resources to list easily in the space provided in the node. Alternatively, a list of resources for each activity, as shown in figure C-4, provides an option.

Figure C-4 illustrates an activities list that shows not only the Preceded Immediately By column, but also the new node numbers (replacing activity letters), the duration of each activity in days, and the estimated resources.

Estimating is the lifeblood of the CPM time analysis. Estimating data, both activity duration and crew sizes, forms the basis for calculating early and late event times, as well as critical activities, tabulating activity times, and scheduling. Thus, output of CPM time analysis depends upon estimating input. If an estimate changes because of new information or experience, the estimator must use the new data to update the time analysis. A time analysis based on outdated estimates is useless.

C.4 ACTIVITY START AND FINISH TIMES

The next step in the CPM process is to calculate the earliest and latest times at which the activities can occur without violating the network logic or increasing the project's overall duration. This provides the manager with a timeframe for each activity. The activity must be completed within each timeframe to prevent the delay of other activities or the entire project.

From this exercise, the manager easily identifies which tasks must be critically managed to ensure minimization of project duration. Naturally, an event cannot begin until completion of all events previous to it (arrows leading to it in the logic diagram). The event-time numbers shown in the corners of activity nodes represent the end of the time period. Thus, a start or finish of day 5 means the end of the fifth day (or the beginning of the sixth day).

ACTIVITY SYMBOL	CONSTRUCTION ACTIVITY NAME	PRECEDED IMMEDIATELY BY	DURATION	RESOURCES
05	Clear pad site.	None	1	1 D7, 1 SQ
10	Clear roadway.	None	2	2 D7s, 2 SQs
15	Acquire gravel.	None	6	2 5Ts, 1 SL, 1 SQ
20	Prepare pad foundation.	05	2	2 SQs
25	Prepare subgrade/subbase.	10	3	1 D7, 1 SF
30	Lay gravel surface.	15, 25	2	1 D7, 2 5Ts
35	Prepare forms.	None	1	1 flatbed truck, 1 SL, 1 SQ
40	Place forms.	20, 35	1	2 SQs
45	Mix and place concrete.	15, 40	1	3 SQs
50	Cure concrete.	45	6	1 SQ
55	Remove forms.	50	1	1 SQ
Legend 5T 5-ton dump trucks SL Scoop loader D7 Dozers SQ Squads SF Sheepsfoot roller				

Figure C-4. Activities List with Resources

The manager now fills in the information for all three center squares of the activity nodes (refer to figure C-2). This includes the node numbers in increasing increments of 5 or 10; activity duration, defined in hours, days, or weeks; and resources needed.

C.4.1 Early Start/Early Finish

The ES, in the upper left corner of the activity node, is the earliest time the activity events may logically start. Since the beginning activities (activities 5, 10, 15, and 35 in the above example) are at the start of the project, the earliest time these events could start is zero (the end of day zero or the beginning of day 1).

By adding the duration of each activity (center of the node) to the ES, the manager computes the EF, positioned in the upper right corner of the activity node (refer to figure C-2). The EF is the earliest time the activity event may finish if the duration estimate is accurate. Computation of EF uses the following equation:

$$ES + DUR = EF.$$

The manager follows the precedence arrows within the logic diagram (refer to figure C-3) to continue the computation. The next activity's ES, at the head of the arrow, is the same as the previous activity's EF, at the tail of the arrow. The node's bottom left and bottom right corners do not matter at this time. The largest EF of all activities at the arrows' tails determines an activity's ES when more than one arrow leads into its node, as illustrated in figure C-5. Logically, an activity cannot begin until completion of all preceding activities.

The systematic process continues throughout the entire logic diagram, determining all ES and EF times. This computational movement through the logic diagram is the forward pass. At the finish node, the overall duration for the project will be the largest EF of all activity nodes leading into the finish node. Project duration of 14 days, as determined by the sequence of construction and the time duration on each activity, culminates in an EF at node 55 of 14 days, as illustrated in figure C-6. Refer to paragraph 3.6.3.1 for additional information on ES, EF, and forward pass. See figure 3-4 for an additional example of the forward pass.

For example, node 30 has 2 arrows leading into it, from nodes 15 and 25. The larger of the 2 EF times of node 15 (6) and node 25 (5) determines the ES time of node 30. In this case, day 6 is the appropriate ES for node 30 as illustrated in figure C-6.

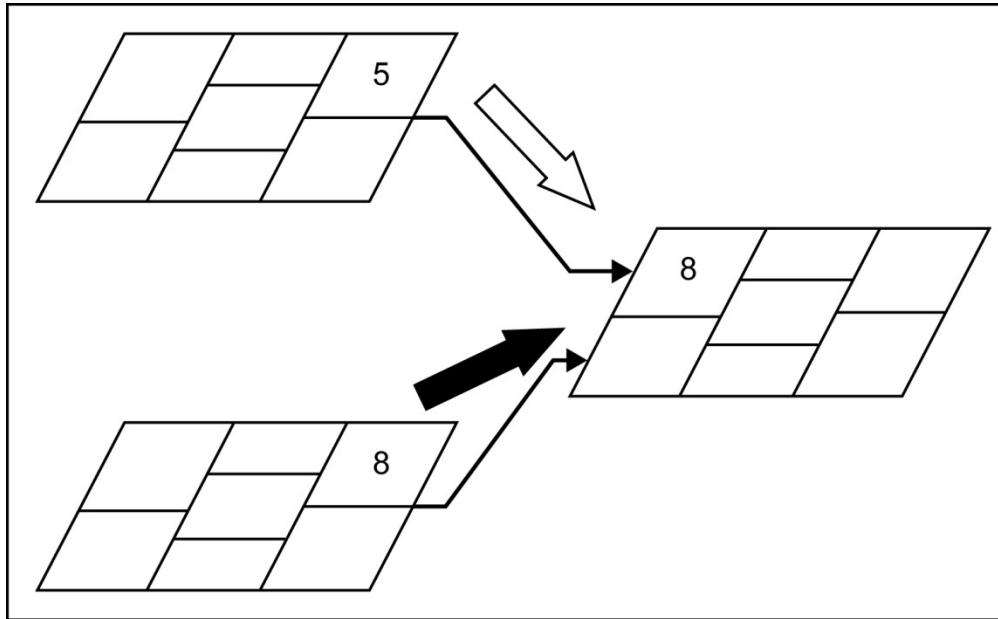


Figure C-5. Advancing the Largest Early Finish Time

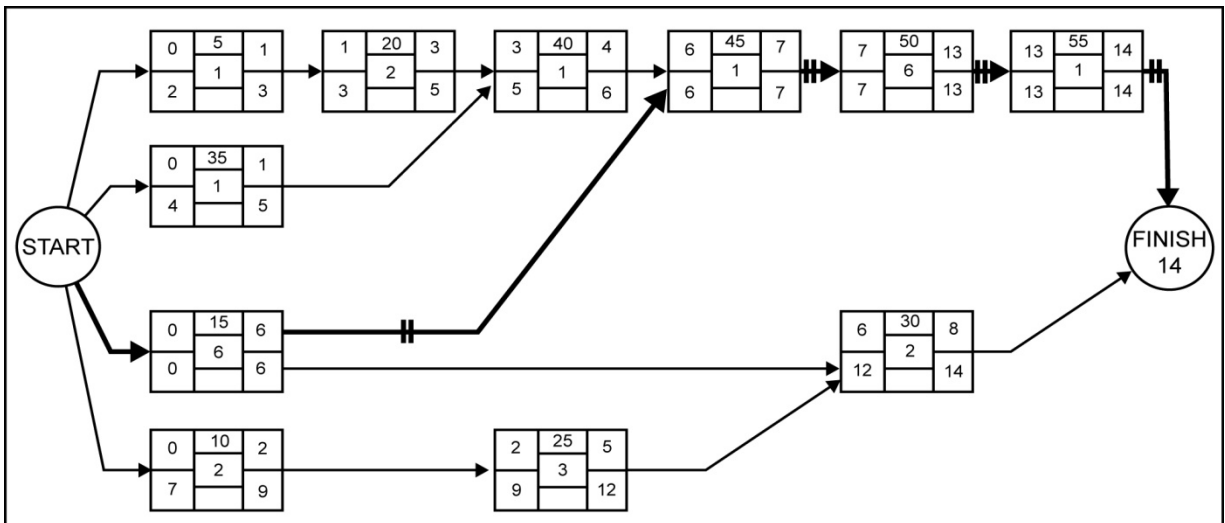


Figure C-6. Critical-path Method Diagram Showing Project Duration

C.4.2 Late Finish/Late Start

The LF, positioned in the lower right corner of the activity node, is the latest time the activity events may finish without delaying the entire project if the duration estimate is accurate. Since the last activities (activities 30 and 55 in the above example) are both at the end of the 14-day project, the latest time that both these events could finish is the project duration's finish, or the end of day 14. The number 14, then, occupies the lower right corner of both nodes.

The manager subtracts the duration of each activity from its LF time to compute the LS time, positioned in the lower left corner of the activity node. Computation for LS uses the following equation:

$$LF - DUR = LS.$$

The manager follows the precedence arrows backward within the logic diagram (right to left) to continue the computation. The previous activity's LF time, at the tail of the arrow, is the same as the next activity's LS time, at the head of the arrow. The ES and EF times within the nodes do not matter at this time. The smallest LS time of all activities at the arrows' heads determines an activity's LF time when more than one arrow tail leads away from its node, as illustrated in figure C-7. Logically, an activity must finish before all follow-on activities may begin.

The systematic process continues backward throughout the entire logic diagram (against the arrows), computing all LF and LS times. This computational movement through the logic diagram is the backward pass. At least one of the LS times of an activity coming from the start node must be zero. In the 14-day project, the LS of node 15 is day zero. Refer to paragraph 3.6.3.2 for additional information on LS, LF, and backward pass. See figure 3-4 for an additional example of the backward pass.

For example, node 15 connects to nodes 30 and 45. The smaller of the two LS times of node 30 (12) and node 45 (6) determines the LF of node 15. In this case, day 6 is the appropriate LF for node 15, as illustrated in figure C-6.

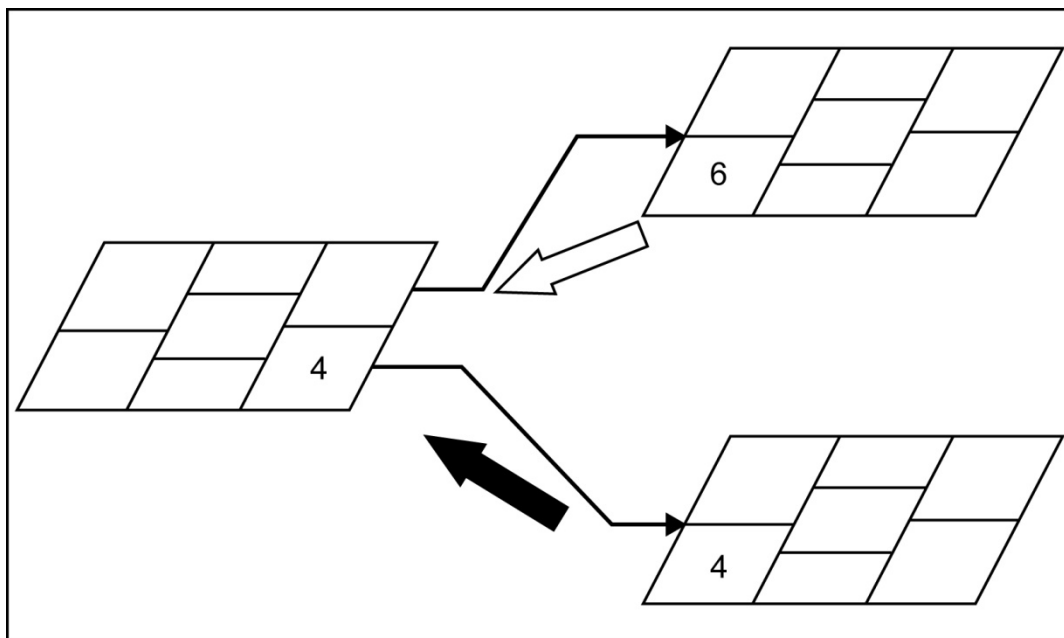


Figure C-7. Retrieving the Smallest Late Start Time

C.5 CRITICAL ACTIVITIES, THE CRITICAL PATH, AND FLOAT

The logic network illustrates a critical activity through application of the following rules:

1. The ES time for a particular activity is the same as the LS time.
2. The EF time for a particular activity is the same as the LF time.
3. The ES or LS added to the duration of the activity results in the EF or LF.

In the above example, nodes 15, 45, 50, and 55 meet the listed criteria, thus making them critical activities. A critical activity, if delayed by any amount of time, will delay the entire project's completion by the same amount of time. Critical activities, when linked by arrows, form a path from the start node to the finish node, called a critical path.

A logic arrow between two critical activities usually forms the critical path, but the path between two critical activities is critical only when the EF of a critical activity is equal to the ES of the following critical activity. If it is not, the critical path branches off to another critical activity before linking back up. The critical path may branch out or come back together at any point. A logic diagram will always have one or more critical paths. All critical paths must be continuous; any critical path that does not begin at the start node and end at the finish node indicates a logic mistake.

Managers indicate critical paths on the logic diagram by methods such as double lines, bold lines, or highlighted color (refer to figure C-6). Any activity node not on the critical path will contain some float. Float is extra time available to complete an activity beyond the activity's actual duration, such as having 6 days available to do 4 days worth of work. It is the scheduling leeway. No activities on the critical path will have float.

Total float is the entire amount of time that an activity may be delayed without delaying the project's estimated completion time. Computation for an activity's total float uses the following equation:

$$\begin{aligned} \text{TF} &= \text{LS} - \text{ES} \\ \text{or} \\ \text{TF} &= \text{LF} - \text{EF}. \end{aligned}$$

Both equations will yield the same answer if the manager has properly computed the LS, ES, LF, and EF. Total float consists of the sum of interfering float (IF) and free float:

$$\text{TF} = \text{IF} + \text{FF}.$$

Interfering float is time available to delay an activity without delaying the entire project's estimated completion time, but delaying an activity into IF delays the start of one or more other noncritical activities later in the project. In the logic network, if more than one activity logically follows the activity in question, choose the smallest ES for the activities that follow the activity in question. An activity's IF is determined by the equation:

$$\text{IF} = \text{LF} - (\text{ES of following activity}).$$

Free float is also time available to delay an activity without delaying the project's estimated completion time and without delaying the start of any other activity in the project. An activity's FF is determined by the equation:

$$\text{FF} = \text{TF} - \text{IF}.$$

As illustrated in figure C-6, activity 25 is not on the critical path, so it must have float. Total float is 7 days (LS – ES or LF – EF). Interfering float is 6 days (LF of node 25 – ES of node 30). Free float is 1 day (TF – IF).

C.6 EARLY START SCHEDULE

The manager now has the information to construct an activity schedule, known as an ES schedule. This schedule, when coupled with a logic diagram, graphically shows all necessary planning information for the manager.

The first step is to list all activities in numerical order. For each activity, all immediately dependent activities, or those activities connected by an arrow, follow parenthetically. For example, activities 30 and 45 cannot begin until activity 15 is complete, so activity 15 appears in the schedule as 15 (30, 45). If an activity leads into the finish node, the manager either places an “F” in the parentheses after the activity number or lists the activity number with no parenthetical.

The next step is to mark on the schedule the timeframe during which each activity may be performed without delaying the project or violating any of the diagram sequence relationships. For node 40 (refer to figure C-6), the ES shows that the earliest this activity can begin is the end of day 3 (or the beginning of day 4). Thus, the beginning of day 4 to the end of day 6 (as determined from the LF) is the available time span for completion of this activity. Because of the nature of the logic diagram, this activity cannot be scheduled earlier, since activity 20 must be completed first. It cannot be scheduled later, for that would delay the entire project. Placing “ES + 1” and “LF” in brackets, as illustrated in figure C-8, serves as a reminder to schedule the right bracket at the beginning (morning) of the following day.

With the brackets correctly placed, the next step is to make a trial schedule, scheduling each activity as soon as possible within the timeframe, or flush with the left bracket. To schedule a particular activity, the manager places the number of each type of resource inside each box along the activity line. The number sequence does not exceed the activity’s duration and stops at the end of the EF time day. The remaining boxes within the brackets are left blank for now and will become either FF or IF.

For example, activity 40 requires 2 squads for 1 day for maximum efficiency. To show this activity scheduled as soon as possible, the number 2 (number of squads) appears in the first box within the brackets (duration), as illustrated in figure C-9.

Scheduling all the activities as soon as possible yields the ES schedule, as illustrated in figure C-10. For clarity, the schedule shows only the squads necessary for each activity and all activities scheduled to begin at their ES times. An “X” in the bracketed activity denotes a day of IF. To figure these IF days, the manager uses the formulas given earlier to compute total, interfering, and free float. Once computed, each day of IF, beginning at the right bracket and working to the left, appears as an “X” in each box. For activities 25 and 35, IF is marked to a point, and the remaining blank boxes within the brackets are free float. Some activities have all FF (activity 40) and some have all IF (activity 10). All noncritical activities followed immediately by the finish node in the logic diagram will always have all FF (activity 30).

ACTIVITY NUMBER	DAY													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
40(45)				[		]								
	ES + 1							LF						

Figure C-8. Bracketing the Time Span

ACTIVITY NUMBER	DAY													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
40(45)				[2		]								

Figure C-9. Scheduling Resources

ACTIVITY NUMBER	DAY													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
5(20)	[1	X	X]											
10(25)	[2	2	X	X	X	X	X	X	X]					
15(30,45)	[1	1	1	1	1	1]								
20(40)		[2	2	X	X]									
25(30)			[1	1	1		X	X	X	X	X	X]		
30							[1	1						]
35(40)	[1			X	X]									
40(45)				[2		]								
45(50)							[3]							
50(55)								[1	1	1	1	1	1]	
55														[1]
Total Squads	5	5	4	4	2	1	4	2	1	1	1	1	1	1

Figure C-10. Early Start Schedule Showing Float

The numbers in parentheses after the activity numbers on the schedule ensure proper placement of the interfering float “Xs.” If a dependent (follow-on) activity is scheduled to begin before the end bracket of the activity in question, then that activity will have IF from the first day of the dependent activity’s start.

For example, activity 35(40) begins on day 1, and the following activity, activity 40(45), begins on day 4. Therefore, days 4 and 5 of activity 35(40) will be IF because a delay of activity 35(40) past day 3 will delay activity 40(45).

However, this will not yet delay the entire duration of the project because activity 40(45) can be delayed into FF for 2 days before it bumps into the right bracket and becomes critical. Hypothetically, a delay of activity 40(45) into IF also subsequently delays some or all of its follow-on activities throughout the schedule.

In cases where an activity requires multiple types of resources, such as activity 15, managers may choose to enter each resource on a separate row. For example, figure C-11 shows a 5-ton truck, a scoop loader, and a squad listed on descending rows. This is a multiple-resource schedule. In the summation of resources by time period across the bottom of the ES schedule, each type of resource has a separate sum.

The multiple-resource schedule indicates where summed resources exceed available amounts for a given day and where activities must be delayed (into float whenever possible) to spread the resources across the project. Refer to appendix D for the systematic procedure to constrain resources and for a sample problem.

ACTIVITY NUMBER	DAY													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
05(20)	[1 D7	X	X]											
	[1 SQ	X	X]											
10(25)	[2 D7	2 D7	X	X	X	X	X	X	X]					
	[2 SQ	2 SQ	X	X	X	X	X	X	X]					
15(30,45)	[2 5T	2 5T	2 5T	2 5T	2 5T	2 5T]								
	[1 SL	1 SL	1 SL	1 SL	1 SL	1 SL]								
	[1 SQ	1 SQ	1 SQ	1 SQ	1 SQ	1 SQ]								
20(40)	[2 SQ	2 SQ	X	X]										
25(30)		[2 D7	2 D7	2 D7	X	X	X	X	X	X	X]			
		[1 SF	1 SF	1 SF	X	X	X	X	X	X	X]			
		[1 SQ	1 SQ	1 SQ	X	X	X	X	X	X	X]			
30							[1 D7	1 D7	X	X	X	X	X	X]
							[2 5T	2 5T	X	X	X	X	X	X]
							[1 SL	1 SL	X	X	X	X	X	X]
							[1 SQ	1 SQ	X	X	X	X	X	X]
35(40)	[1 SQ			X	X]									
40(45)				[2 SQ		]								
45(50)							3 SQ							
50(55)								[1 SQ	1 SQ	1 SQ	1 SQ	1 SQ	1 SQ]	
55														1 SQ
Total Resources														
D7	3	2	2	2	2	0	1	1	0	0	0	0	0	0
5T	2	2	2	2	2	2	2	2	0	0	0	0	0	0
SL	1	1	1	1	1	1	1	1	0	0	0	0	0	0
SF	0	0	1	1	1	0	0	0	0	0	0	0	0	0
SQ	5	5	4	4	2	1	4	2	1	1	1	1	1	1

Figure C-11. Multiple-resources Schedule

C.7 REDUCTION OF THE PROJECT

If the CPM indicates that the project's duration exceeds the HHQ's completion date, the manager should examine the logic diagram's critical path to find activity durations which could be shortened. This is expediting, compressing, or crashing the project. However, to shorten the project duration, managers must focus on critical activities on the critical path.

Shortening a noncritical activity will not shorten the project duration. However, an increase in resource allocation to activities which fall on the critical path may reduce the duration of the project by committing additional equipment and personnel or using the same equipment and personnel for longer hours. Usually, a moderately extended workday is the most economical and productive solution. Managers may also choose to work double shifts or weekends. However, expediting activities may have consequences that can lead to safety concerns and loss of efficiency while working nights, weekends, or extended periods of continuous operations. Close attention should be given to the maintenance of equipment, due to the extended periods of use.

C.7.1 Materials

Committing additional materials may also reduce a project's duration. For example, using additional forms in constructing concrete slabs is faster than reusing forms, or a construction agency might expedite material deliveries by providing its own transportation. After a critical-path activity is reduced by one time unit, the manager must check the logic diagram to determine whether or not additional paths have become critical such as those activities that previously had only 1 day of float.

C.7.2 Cost

If the estimates used in the CPM network reflect the most efficient methods of construction, crashing the project to finish before the determined duration will always cost money. In order to reduce project duration, the estimator must first identify how much each activity can be reduced in time and how much this reduction will cost. Then, the manager chooses the successive reductions in the critical path(s) duration that expedite the project at the least additional cost.

C.7.3 Redefined Logic

The project manager should review all the activities on the critical path for a preferred logic relationship that is not absolutely necessary. Logic can be redefined in two ways:

1. Move activities within the logic diagram for two sequential activities that could actually be done concurrently. For example, if it will take another hour before the small emplacement excavator shows up to dig a fighting position, Soldiers with hand tools can actually start early, and let the excavator finish upon its arrival.
2. Introduce a lag factor for an activity that does not have to be entirely completed before a following activity can be started. For example, although a road must be compacted before it can be paved, all 10 kilometers of the road need not be compacted before the paving can begin on the areas already compacted. With a 25-percent lag factor, paving begins upon completion of 25 percent of the compacting.

Computation for node ES after the lag factor on the forward pass follows:

$$(\text{DUR of activity} \times \text{percent lag}) + \text{ES} = \text{ES of following activity.}$$

Computation for node LF before the lag factor on the backward pass follows:

$$[\text{DUR of previous activity} \times (1 - \text{percent lag})] + \text{LS} = \text{LF of previous activity.}$$

Figure C-12 illustrates how the addition of a 25-percent lag factor reduces the duration from 24–15 time periods.

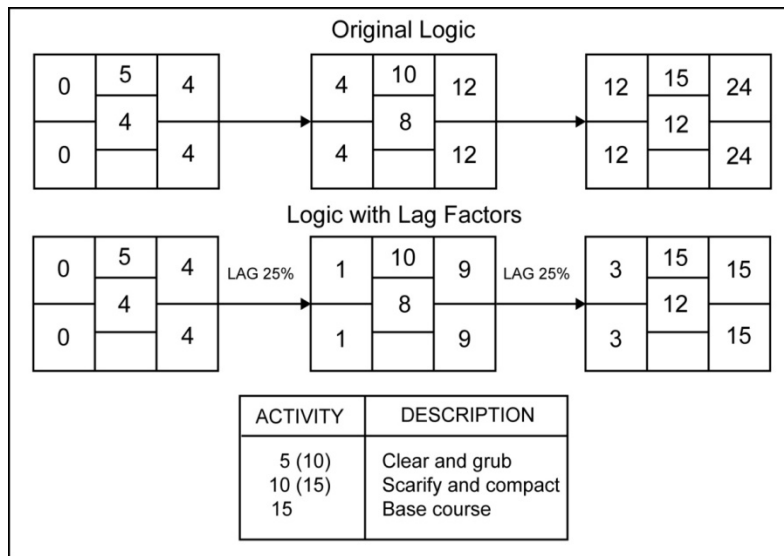


Figure C-12. Lag Factor

APPENDIX D

Alternate Scheduling Resource-constraining Procedures

D.1 INTRODUCTION

Construction project scheduling is intended to facilitate the alignment of resources, such as equipment, materials, and labor, with work activities over time. This synchronization of physical assets and workforce assets with project milestones also ensures the timely procurement of required building materials, optimizing the logistical chain. When daily equipment and personnel requirements exceed what is available, a manager must resource-constrain the project to affect project duration as little as possible. Often, a manager is able to reallocate resources to avoid delaying the overall project duration; however, such reallocation may result in a larger number of critical activities and less available float within the ES schedule. To resource-constrain a project, a manager completes the following three tasks:

1. Resource-constrain the ES schedule.
2. Update the logic network.
3. Update the ES schedule.

D.2 RESOURCE-CONSTRAIN THE EARLY START SCHEDULE

D.2.1 Step 1—Find the Resource Requirement Excess

The manager begins by finding the first time period where resource requirements exceed the resources allocated. Early start schedule resource manipulation must be chronological, working from left to right.

D.2.2 Step 2—Choose an Activity to Delay

Next, the manager solves the problem of too many scheduled resources on a given day by delaying an activity from being done and consuming resources on that day. The following five priorities help determine which activity to delay:

1. The first priority is an activity that starts on the time period in which resources exceed availability. The delay of an activity already started and ongoing leaves that job undone, necessitates pulling out the resources, and requires planning to finish it later. The choice of an activity scheduled to start saves start-up and shutdown time, as well as unnecessary transportation requirements and extra on-site material delivery coordination and security. If more than one activity has a scheduled start on the time period resources exceed availability, then the next priority offers more guidance.
2. The second priority is an activity that, when delayed, provides sufficient resources to solve the constraint problem. For example, if 15 trucks are scheduled for a particular day, but only 12 trucks are available for use, delaying an activity that uses 2 trucks does not solve the problem. The delay leaves 13 trucks scheduled, but the manager must constrain the schedule down to the 12 trucks (or fewer) available.

Delaying an activity using 5 trucks on that day brings the scheduled total down to 10 trucks, which solves the problem on that day. If no single activity provides sufficient resources to lower the amount to or below what is available, a combination of delayed activities often meets the constraint requirement. If, however, more than one activity provides sufficient resources to solve the problem, then the next priority offers more guidance.

3. The third priority is the activity with the most TF. This prevents the manager from selecting critical or nearly critical activities to delay, unless absolutely necessary. If more than one activity has the most TF (e.g., three activities each have 6 days total float), then the next priority offers more guidance.
4. The fourth priority is the activity with the most FF. Activities with more FF are less likely to impact follow-on activities in the schedule. If more than one activity has the most FF (e.g., two activities each have 4 days FF of the 6 days total float), then the next priority offers more guidance.
5. The fifth priority is the activity with the shortest activity duration. Shorter activity duration estimates are less likely to be incorrect and to extend the project's overall duration.

D.2.3 Step 3—Follow the Delay

The manager delays the chosen activity one time period and follows the delay through the schedule. If the delay moves into IF or past its right bracket (LF), the manager follows the results of the delay throughout the schedule. An activity delayed into IF will delay another activity, but will not delay the project duration.

The numbers of the follow-on activities, shown in parentheses behind the number of the delayed activity, identify all activities that logically follow the delayed activity. Follow-on activities cannot begin until the delayed, dependent activity is complete.

For example, activity 25 (40, 55) indicates that activities 40 and 55 logically follow activity 25 and they may or may not be affected by the delay of activity 25. The manager checks each of these follow-on activities to see if its ES time precedes the new EF time of the recently delayed activity. If so, the manager delays the follow-on activity's ES until the first time period after the EF of the delayed preceding activity. The check then moves to activities 40 and 55 and their follow-on activities. This pattern continues with all conflicting follow-on activities delayed into FF.

D.2.4 Step 4—Sum the Resources

After following the delay through the schedule, the manager determines the new total resource requirement for each time period.

D.2.5 Step 5—Proceed to the Next Time Period

The process moves to the next time period where required resources exceed the available resources and repeats Steps 2 thru 4 above until the entire schedule has been adjusted to meet the resource limitations.

D.2.6 Step 6—Identify the Cause of the Delay

An "R" to the right of an LF bracket (see figure D-1) indicates an activity delayed for resources at any time. An "L" to the right of an LF bracket indicates an activity delayed because of logic only (e.g., it logically follows a previously delayed activity). If an activity is delayed for both resources and logic (e.g., an activity logically delayed because of a resource-delayed activity and then further delayed because of resources), an "R" to the right of the LF bracket indicates that the resource delay takes precedence. Refer to paragraph D.5, Sample Problem, for additional examples on resource constraints due to logic (L) and resources (R).

D.2.7 Step 7—Draw the Resource Flow Arrows

A resource flow arrow extends from the end of the activity providing the resources to the beginning of the resource-delayed activity and indicates the flow of resources. Each resource-delayed activity follows an activity that uses the same resource and has an EF time that is one time period before the resource-delayed activity begins. This activity, when coupled with mothballed resources, will often provide sufficient resources to start the work in the next time period. Mothballed resources are resources not put to work in the previous time period (e.g., 2 trucks are mothballed the day that 12 trucks are available, and only 10 trucks are scheduled for work).

When two or more activities using the same resource are scheduled to finish (EF) during the preceding time period, the manager chooses the one which, when coupled with mothballed resources from the previous time period, avoids resource overkill. If no one activity provides sufficient resources, even when coupled with mothballed resources, the manager draws resource flow arrows from two or more ending activities to the start of the resource-delayed activity.

Figure D-1 illustrates a project resource-constrained down to 18 carpenters. Activity 15(50) is resource-delayed and will begin on day 5. Day 4 shows that both activities 5(60, 65) and 10(70) end at day 4 and use the same resource as activity 15(50), but only activity 10(70) provides sufficient resources for activity 15(50) to begin.

Therefore, activity 10(70) must be completed before activity 15(50) begins. A resource flow arrow issues from the scheduled end (EF) of activity 10(70) to the new beginning (ES) of activity 15(50).

An activity may require assets from two or more activities, or one activity may provide assets for two or more activities. Figure D-2 illustrates a project resource-constrained down to 14 SLs. Activities 25(35) and 30(55) are both necessary when coupled with 2 of the 3 unscheduled, mothballed resources not used in day 7 to provide sufficient resources for activity 40.

ACTIVITY NUMBER	DAY													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
05(60,65)	[2 C	2 C	2 C	2 C]										
10(70)	[4 C	4 C	4 C	4 C	X	X	X]							
15(50)				[	3 C	3 C		]	R					
20(65)				[6 C	6 C	6 C]								

Figure D-1. Resource Flow Arrow Example 1

ACTIVITY NUMBER	DAY													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
25(35)				[3 SL	3 SL	3 SL	3 SL]							
30(55)				[4 SL	4 SL	4 SL	4 SL]		X]					
35(50,55)								[2 SL	2 SL	2 SL]				
40						[		5 SL	5 SL			]	R	

Figure D-2. Resource Flow Arrow Example 2

D.3 UPDATE THE LOGIC NETWORK

D.3.1 Step 8—Draw the Resource Dummy Arrow

The manager adds a resource dummy arrow to the logic network for every resource flow arrow on the ES schedule. The resource dummy arrow proceeds from the activity that provides the resources to the activity that receives the resources. In figure D-3, activity 20 provides resources for activity 30. It is not necessary to maintain the activity numbering rules (lower to higher) when adding resource dummy arrows.

D.3.2 Step 9—Conduct a New Time Analysis

The added resource dummy arrow functions as a logic arrow and requires new forward and backward passes. The resource dummy arrow will change some of the early and late starts and finishes of the nodes in the network and it may cause a change or addition to the critical path(s).

D.4 UPDATE THE EARLY START SCHEDULE

D.4.1 Step 10—List Activities

This sequence of steps results in new follow-on activity numbers (in parentheses) for activities that provide resources.

D.4.2 Step 11—Mark Timeframes

The manager now checks the ES and LF times for all activities in the network and marks any changes in the left and right brackets accordingly.

D.4.3 Step 12—Identify Float

Each activity with new ES and LF times needs a recalculation of its IF and an update of the IF (“Xs”) on the ES schedule.

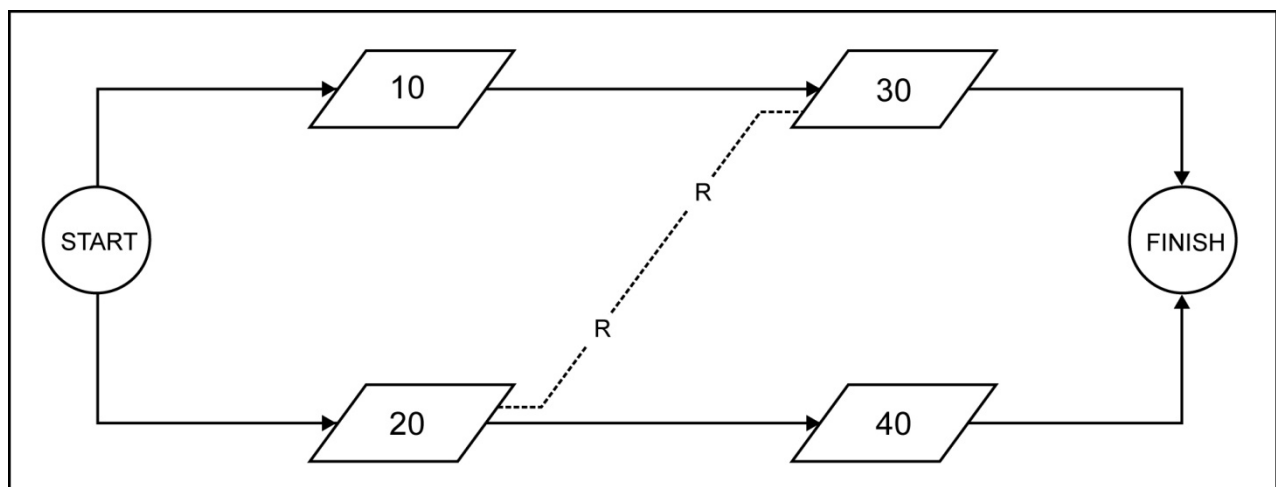


Figure D-3. Resource Dummy Arrows

This step-by-step procedure provides a solution to the problem of insufficient numbers of resources. When this technique results in unacceptable project delays, the manager uses variations to select activities for delay.

1. The first variation delays an activity that has already started by splitting the activity. This option requires making two activities out of one, redefining the logic network, and adding the new activity to the ES schedule.
2. The second variation delays an activity scheduled to begin before the time period in question. Although the delay procedure is the same as that defined in paragraph D.2, the activity delay is greater than one time period and, therefore, requires plenty of float. This variation often provides the better solution to the resource problem.
3. The third variation delays several activities rather than one critical or nearly critical activity. This is effective if a combination of activities provides sufficient resources to meet the constraint and each has plenty of float. This variation is a deviation from the second priority of Step 2 in the resource-constraining process.

A manager must fully understand the basic techniques of resource constraining to use these techniques. For any project with insufficient resources, the manager ultimately decides which activities to delay. An understanding of the intricate interaction between each activity enables the manager to make informed decisions and successfully complete the project.

D.5 SAMPLE PROBLEM

Paragraphs D.5.1 thru D.5.3 discuss an example of the three-part process to resource-constrain a project. The manager develops the logic diagram and ES schedule shown in figures D-4 and D-5. During initial planning, the number of available squads (14) is the only critical resource, but later tasking requires the provision of 3 squads to support post cleanup during the same time period. This reduces the number of available squads (11) for the project. The manager must resource-constrain the project to 11 squads by completing the following tasks:

1. Resource-constrain the ES schedule.
2. Update the logic network.
3. Update the ES schedule to determine if the reduced number of squads will affect the project duration.

D.5.1 Resource Constraining Example—Part 1

After constraining the ES schedule, the manager finds two resource delays (R) and one logic delay (L), as shown in figure D-6. Activity 15 cannot start until the resource from activity 20 becomes available. When delayed, activity 15 moves into IF. This causes a logic delay of 3 days for activities 35 and 40 (activity 45 is unaffected). When day 6 is constrained, activity 40 is resource-delayed 1 additional day. Although activity 40 is initially logic-delayed, it is now resource-delayed. The resource needed for activity 40 must come from activity 30.

D.5.2 Resource Constraining Example—Part 2

The two resource flow arrows, incorporated into the logic network by dashed arrows and a superimposed “R” as shown in figure D-7, establish two new paths in the network and change the time analysis. Whereas the old critical path consists of nodes 25 and 55, an additional critical path consists of nodes 20, 15, 35, and 55.

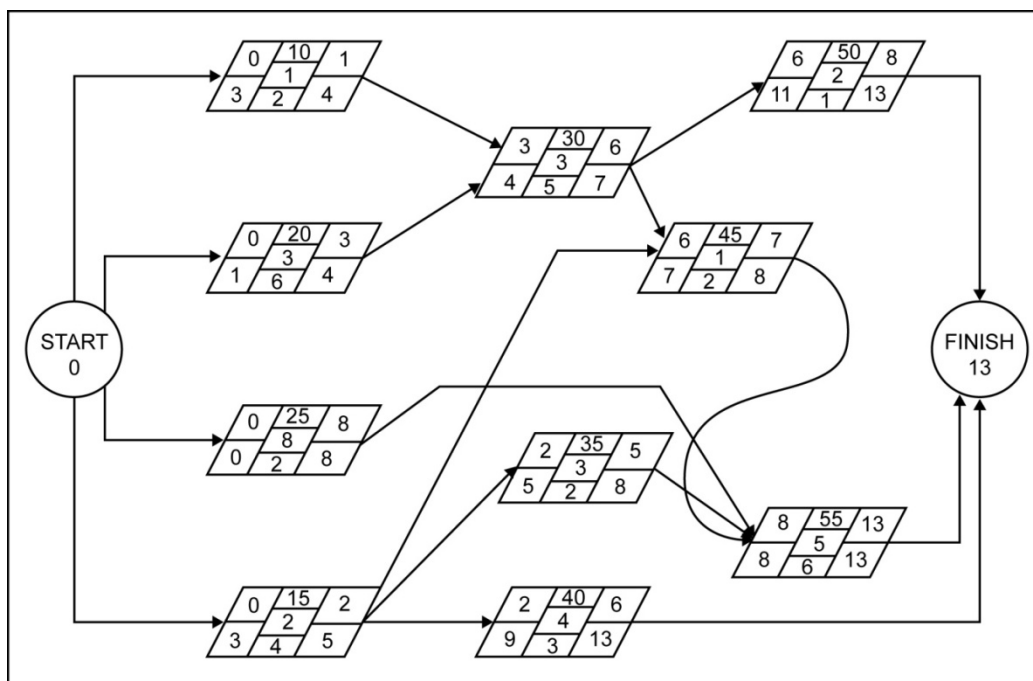


Figure D-4. Sample Problem—Logic Network

ACTIVITY NUMBER	DAY													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
10(30)	[2 SQ			X]										
15(35,40,45)	[4 SQ	4 SQ	X	X	X]									
20(30)	[6 SQ	6 SQ	6 SQ	X]										
25(55)	[2 SQ	2 SQ	2 SQ	2 SQ	2 SQ	2 SQ	2 SQ	2 SQ]						
30(45,50)				[5 SQ	5 SQ	5 SQ	X]							
35(55)			[2 SQ	2 SQ	2 SQ			]						
40			[3 SQ	3 SQ	3 SQ	3 SQ							]	
45(55)							[2 SQ	]						
50							[1 SQ	1 SQ					]	
55									[6 SQ	6 SQ	6 SQ	6 SQ	6 SQ]	
	14	12	13	12	12	10	5	3	6	6	6	6	6	

Figure D-5. Sample Problem—Early Start Schedule

ACTIVITY NUMBER	DAY													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
10(30)	[2 SQ			]										
15(35,40,45)	[			4 SQ	4 SQ]	R								
20(30)	[6 SQ	6 SQ	6 SQ	X]										
25(55)	[2 SQ	2 SQ	2 SQ	2 SQ	2 SQ	2 SQ	2 SQ	2 SQ]						
30(45,50)				[5 SQ	5 SQ	5 SQ	X]							
35(55)			[			2 SQ	2 SQ	2 SQ]	L					
40			[			3 SQ	3 SQ	3 SQ	3 SQ				]	R
45(55)							[2 SQ	]						
50							[1 SQ	1 SQ					]	
55									[6 SQ	6 SQ	6 SQ	6 SQ	6 SQ]	
SQ	44	42	43	42	42	40	5	3	6	6	6	6	6	
	10	8	8	11	11	9	10	8	9	9				

Figure D-6. Sample Problem—Resource-constrained Early Start Schedule

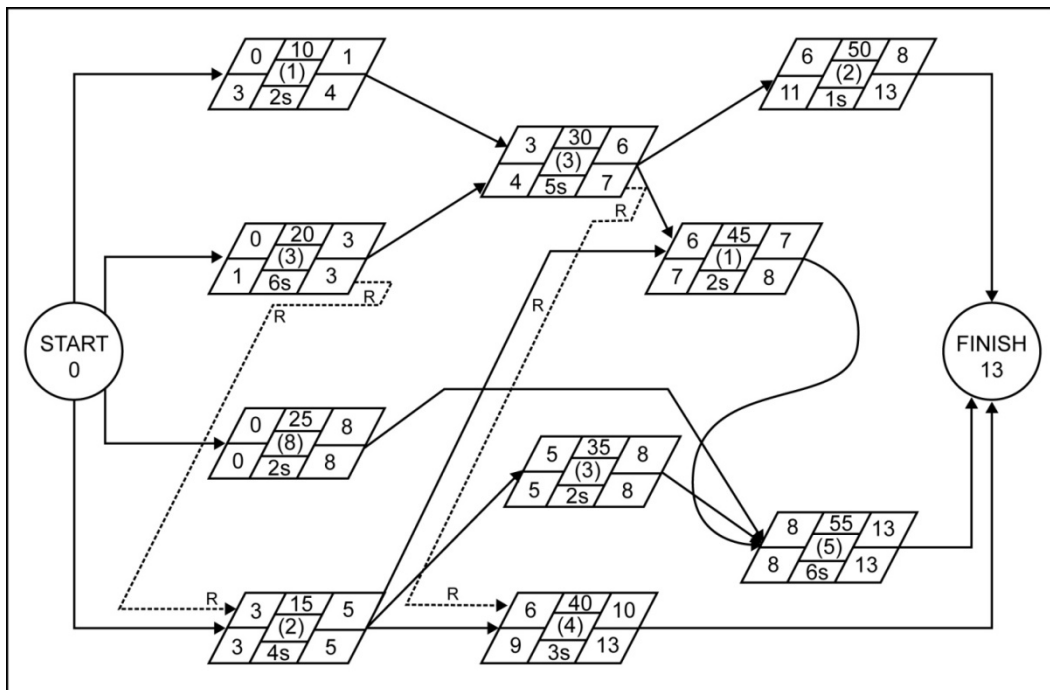


Figure D-7. Sample Problem—Updated Logic Network

D.5.3 Resource Constraining Example—Part 3

A new ES schedule must incorporate the changes made in the logic network. After updating the activity numbers (Step 10), timeframes (Step 11), and float calculations (Step 12), the manager prepares an ES schedule as shown in figure D-8.

Activities 20 and 30 change follow-on activities. Timeframes (ES and/or LF) change for activities 15, 20, 35, and 40. Interfering float calculations, however, do not change for the activities with float (activities 10, 30, 40, 45, and 55).

This project now has constrained resources. Three additional activities (15, 20, and 35) are critical. None of the changes results in an activity delayed beyond its LF (right bracket). Therefore, the project duration does not change.

ACTIVITY NUMBER	DAY													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
10(30)	[2 SQ			X]										
15(35,40,45)				[4 SQ	4 SQ]	R								
20(30)	[6 SQ	6 SQ	6 SQ]											
25(55)	[2 SQ	2 SQ	2 SQ	2 SQ	2 SQ	2 SQ	2 SQ	2 SQ]						
30(45,50)				[5 SQ	5 SQ	5 SQ	X]							
35(55)						[2 SQ	2 SQ	2 SQ]	L					
40							[3 SQ	3 SQ	3 SQ	3 SQ			]	R
45(55)							[2 SQ	]						
50							[1 SQ	1 SQ					]	
55									[6 SQ	6 SQ	6 SQ	6 SQ	6 SQ]	
SQ	44	42	43	42	42	40	5	3	6	6	6	6	6	
	10	8	8	11	11	9	10	8	9	9				

Figure D-8. Sample Problem—Updated Early Start Schedule

APPENDIX E

Project Confirmation Brief

E.1 INTRODUCTION

The project supervisor and assigned crew leaders present a confirmation brief to the unit commanding officer's representative and/or HHQ's representative. For the confirmation brief, project supervisors modify the standard five-paragraph order (situation, mission, execution, administration and logistics, and command and signal) format to fit specific guidance or situations. Refer to paragraph 5.3.5 for further information on project confirmation briefs.

E.2 SAMPLE PROJECT CONFIRMATION BRIEF

1. Situation:

- a. Identify managers' names, team members, and organization.
- b. Provide an overview of the supported operation and the basis for tasking.

2. Mission:

- a. State the title, project scope, project name, customer, and location.
- b. Identify the project confirmation brief's order of presentation:

"Good afternoon, Sir/Ma'am. I'm BU1 Seabee, and I am the project supervisor. With me are two of my crew leaders, SW2 Torch and UT2 Pipe.

"I am here to brief you about project GM10-811, Construct Entrance Guard House.

"This project is budgeted for \$425,000. It is scheduled to begin in August 2011 and be complete by December 2011. It is located at the main entrance to the magazine area on Guam.

"It will consist of a self-enclosed concrete masonry unit facility with power and water about 300 square feet in size. It will be built on a slab, have metal windows and doors, and have a cast-in-place concrete roof.

"I will start with an overview of the plans, talk to you about your crew makeup, walk you through the major parts of our Level II, talk to you about specific requirements and issues of the project (including those things that worry me), and then conclude with a summary of our plan of attack."

3. Execution:

- a. Plans. The attendees use the key drawing copies in front of them for orientation to the project supervisor's presentation.
- b. Crew. Identify the number, rate makeup, and experience of the permanently assigned crew. Also, clarify the surge plan for periods of increased activity. Will other companies subcontract on a request-by-request basis? Will they permanently assign personnel to the job, or will they arrange a combination of the two?
- c. Level II Gantt Chart/Precedence Network. Use these tools for a chronological walk-through. Do not talk to every activity and duration, but point out the high-interest and high-concern areas. Use the actual planning to address concerns in greater detail. Do not wing it or bluff. Does the MA list pass the sanity check?

4. Administration and Logistics:

- a. Construction Activity Summary Sheets. A well-prepared CAS sheet allows someone with basic construction experience to come on the job and start working. The actual activity must be explained in enough depth and basic construction language to allow this to happen. Specifically troubleshoot the following common mistakes:
 - (1) Do the variable planning factors actually vary?
 - (2) Are the QC items measurable and easily understood?
 - (3) Does the safety section include references and necessary specific equipment?
- b. Quality Control Plan. The QC plan should be more than just a cut-and-paste of all the CAS Sheet quality checks. Has the unit's QC SME reviewed it? Did managers develop it with the QC SME?
- c. Safety Plan. Has it been through the safety department? Has operational risk management been applied to every high-risk activity? Is the necessary equipment available? Has the contracting office approved it?
- d. Materials. Have LL time/unique items been identified? Are they tracked by the crew using MLO as a partner? What system is in place to inspect items as they arrive (to allow time for returns/reorders) rather than as needed?
- e. Equipment. What does the project need? Are CESE and tools available at the project site? If available, are they up and running? Do other crews need them that day? What are alternate plans B, C, and D?
- f. Training. Have managers identified any necessary additional crew training?
- g. Customer Issues. Are there specific issues with this project (historical, cultural, environmental, high-visibility, flag interest)?

5. Command and Signal. At a minimum, discuss reporting requirements.

The evaluators' reaction to the project confirmation brief should be a positive acknowledgement of the manager's preparedness and project ownership. To receive this response, the project supervisor/crew leaders must know the project, display ownership for its success, and appear confident rather than defensive or argumentative. If evaluators ask a hard question or hammer a point, it is almost always because they have firsthand knowledge of a problem area and are trying to prevent a mistake.

APPENDIX F

Labor Accounting System

F.1 INTRODUCTION

This appendix provides labor categories used by the NCF as promulgated by COMFIRSTNCDINST 5312.1A, Procedures for Naval Construction Force (NCF) Timekeeping. This system may be adopted by all military service engineers unless they are directed to another system by the supported HHQ or their unit SOP. Refer to paragraph 7.3 for further information on labor reporting and timekeeping. The three categories used by the NCF are:

1. Direct labor
2. Indirect labor
3. Readiness and training.

F.2 DIRECT LABOR

Direct labor includes all labor expended directly on assigned construction tasks, either in the field or in the shop, which contributes directly to completing 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. Included under direct labor, besides construction, are the following tasks:

1. Project and site surveying
2. Shop work that contributes directly to the completion of the project (e.g., prefabrication of components)
3. Camp maintenance when accomplished as part of the unit's direct labor tasking such as emergency service authorization requests, standing job orders, and specific job orders (e.g., work requests)
4. Mineral products operations for either a tasked project or as a specific tasked project
5. Construction equipment operation when assigned to a tasked project.

F.3 INDIRECT LABOR

Indirect labor includes all labor required to support construction, but does not usually produce an end product itself. Therefore, this time is not reported under a project number, but under an indirect labor code as follows:

1. Code XO1—Equipment, Repair, and Records. Work in this code includes:
 - a. Maintenance or repair of TOA, supplemental, or augment construction equipment or tools
 - b. All common and automotive spare parts functions
 - c. Recordkeeping supporting maintenance or repair of equipment and tools.

2. Code XO2—Project and Camp Maintenance Support. Work in this code includes:
 - a. Planning, estimating, and MTOs
 - b. Operation of the trouble desk
 - c. Project planning and scheduling.
3. Code XO3—Project Management. Work in this code includes labor expended by field and shop personnel supervising project and shop work. This category also includes typical project coordination and management functions such as the following:
 - a. Labor expended arranging for equipment and tools
 - b. Labor expended scheduling utility outages
 - c. Coordinating with other crews and planning company work
 - d. Inspections, meetings, and turnover functions.
4. Code XO4—Location Moving. Work in this code includes:
 - a. Mobilization/demobilization of equipment, tools, and field offices to and from project sites
 - b. Motor pool operations
 - c. Taxi drivers and road master.
5. Code XO5—Project Travel. This category includes all travel time to and from project sites.
6. Code XO6—Material Support. This category involves time expended by line company personnel. Work in this code includes:
 - a. Receipt, storage, inventory, issue, and delivery of materials
 - b. All material records and bookkeeping
 - c. Ordering and following up on ordered material.
7. Code XO7—Tools. Work in this code includes:
 - a. All tool maintenance and repair
 - b. Inventory control
 - c. Ordering replacement parts and rental equipment.
8. Code XO8—Administration and Personnel. Involves time expended by line company personnel in areas such as general administration and personnel; legal; drug and alcohol program advisor; career counselor; counseling with chaplain; driver's license examiner; education services; public affairs office; post office; medical and dental; special services; leave and liberty; personal affairs; supply and disbursing; security; temporary additional duty personnel not covered under productive labor; court witness; armed forces police; military sports competition; and timekeeping.

9. Code XO9—Lost Time. Work in this code includes lost time due to:
 - a. Inclement weather
 - b. Awaiting transportation
 - c. Shortage of tools or material
 - d. Unauthorized absence and confinement.
10. Code XO10—Other. Work in this code includes all indirect labor expended in areas not specifically addressed elsewhere in this category.

F.4 READINESS AND TRAINING

Readiness and training are comprised of 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 unit.

INTENTIONALLY BLANK

REFERENCES

GENERAL

29 CFR 1910, Occupational Safety and Health Standards
29 CFR 1926, Safety and Health Regulations for Construction
Federal Acquisition Regulation
UFC 1-300-09N, Design Procedures
Unified Facilities Guide Specifications

JOINT PUBLICATIONS

DD Form 1354, Transfer and Acceptance of DOD Real Property
DD Form 1391, Military Construction Project Data
DODI 6055.1, Department of Defense Safety and Occupational Health (SOH) Program
JP 1-02, Department of Defense Dictionary of Military and Associated Terms

MULTISERVICE PUBLICATIONS

FM 1-02/MCRP 5-12A, Operational Terms and Graphics
FM 3-34.5/MCRP 4-11B, Environmental Considerations
FM 5-412/MCRP 3-17.7F, Project Management
NTRP 4-04.2.3/TM 3-34.41/AFPAM 32-1000/MCRP 3-17.7M, Construction Estimating

NAVY PUBLICATIONS

COMFIRSTNCDINST 4355.1, Construction Quality Program
COMFIRSTNCDINST 5312.1A, Procedures for Naval Construction (NCF) Timekeeping
NTRP 1-02, Navy Supplement to the DOD Dictionary of Military and Associated Terms
NTRP 4-04.2.1, Doctrinal Reference for the Naval Construction Force
NTRP 4-04.2.7, Construction Quality Control for Seabees [Draft under development]
NWP 4-11, Environmental Protection

OPNAVINST 11010.20G, Facilities Project Instruction

Seabee Construction Management Software User Guide

OTHER SERVICE PUBLICATIONS

AIR FORCE

AFDD 1–2, Air Force Glossary

AFDD 2, Operations and Organization

AFI 32–1021, Planning and Programming Military Construction (MILCON) Projects

AFI 91–301, Air Force Occupation and Environmental Safety, Fire Protection, and Health (AFOSH) Program

RED HORSE Project Management Manual, A Comprehensive Guide for Project OICs and Project NCOICs

United States Air Force Project Managers' Guide for Design and Construction

ARMY

AR 420–1, Army Facilities Management

EM 385–1–1, Safety and Health Requirements Manual

Engineer Regulation 1180–1–6, Construction Quality Management

FM 3–34, Engineer Operations

MARINE CORPS

MCRP 5–12C, Marine Corps Supplement to the DOD Dictionary of Military and Associated Terms

MCRP 5–12D, Organization of Marine Corps Forces

WEB SITES

Construction Specifications Institute, MasterFormat™ 2010, Update Numbers and Titles,
<http://www.csinet.org/Home-Page-Category/Formats/MasterFormat.aspx>

<https://www.portal.navy.mil/necc/1ncd/N3>

United States Army Corps of Engineers Web portal: <http://www.hnd.usace.army.mil/missions.aspx>

Whole Building Design Guide: <http://www.wbdg.org/ccb/ccb.php>

RECOMMENDED READING

Engineer Pamphlet 415–1–261, Quality Assurance Representative Guide [useful checklists for planning and execution]

Vol 1, General Information and Sitework.

Vol 2, Pile Driving, Dams, Levees and Related Items

Vol 3, Architectural and Structural Features in Building Construction

Vol 4, Special Construction, Conveying Systems, Mechanical, and Electrical Features of Building Construction

Vol 5, Ground Water Extraction, Ground Water Treatment, Landfills, Soils Vapor Extraction, Slurry Walls and Solidification/Stabilization

INTENTIONALLY BLANK

GLOSSARY

activity (ACT). 1. A unit, organization, or installation performing a function or mission. 2. A function, mission, action, or collection of actions. (JP 1-02. Source: JP 3-0)

allocation. Distribution of limited forces and resources for employment among competing requirements. (JP 1-02. Source: JP 5-0)

base. 1. A locality from which operations are projected or supported. 2. An area or locality containing installations which provide logistic or other support. 3. Home airfield or home carrier. (JP 1-02. Source: JP 4-0)

billet. 1. Shelter for troops. 2. To quarter troops. 3. A personnel position or assignment that may be filled by one person. (NTRP 1-02. Source: N/A)

civil engineering. Those combat support and combat service support activities that identify, design, construct, lease, or provide facilities, and that operate, maintain, and perform war damage repair and other engineering functions in support of military operations. (NTRP 1-02. Source: N/A)

commander's intent. A clear and concise expression of the purpose of the operation and the desired military end state that supports mission command provides focus to the staff, and helps subordinate and supporting commanders act to achieve the commander's desired results without further orders, even when the operation does not unfold as planned. (JP 1-02. Source: JP 3-0)

construction. 1. Any planned physical change to the existing physical environment for a positive purpose. New construction, alterations, repairs, demolition, removal, replacement of component parts, excavation, dredging, and painting are all forms of construction. 2. The erection, installation, or assembly of a new facility; the addition, expansion, extension, alteration, conversion, or replacement of an existing facility; or the relocation of a facility from one installation to another. Construction includes equipment installed in and made a part of such facilities, and related site preparation, excavation, filling, and landscaping, or other land improvements. (NTRP 1-02. Source: N/A)

continental United States (CONUS). United States territory, including the adjacent territorial waters, located within North America between Canada and Mexico. (JP 1-02)

contingency. A situation requiring military operations in response to natural disasters, terrorists, subversives, or as otherwise directed by appropriate authority to protect US interests. (JP 1-02. Source: JP 5-0)

contingency operation. A military operation that is either designated by the Secretary of Defense as a contingency operation or becomes a contingency operation as a matter of law (Title 10, United States Code, Section 101[a][13]). It is a military operation that: a. is designated by the Secretary of Defense as an operation in which members of the Armed Forces are or may become involved in military actions, operations, or hostilities against an enemy of the United States or against an opposing force; or b. is created by definition of law. Under Title 10, United States Code, Section 101 (a)(13)(B), a contingency operation exists if a military operation results in the (1) call-up to (or retention on) active duty of members of the uniformed Services under certain enumerated statutes (Title 10, United States Code, Sections 688, 12301[a], 12302, 12304, 12305, 12406, or 331-335); and (2) the call-up to (or retention on) active duty of members of the uniformed Services under other (non-enumerated) statutes during war or national emergency declared by the President or Congress. (JP 1-02. Source: JP 1)

contracting officer. The Service member or Department of Defense civilian with the legal authority to enter into, administer, modify, and/or terminate contracts. (JP 1-02. Source: JP 4-10)

date-time group (DTG). The date and time, expressed as six digits followed by the time zone suffix at which the message was prepared for transmission. (first pair of digits denotes the date, second pair the hours, third pair the minutes, followed by a three-letter month abbreviation and two-digit year abbreviation.) (JP 1-02. Source: JP 5-0)

deployment. The relocation of forces and materiel to desired operational areas. Deployment encompasses all activities from origin or home station through destination, specifically including intra-continental United States, intertheater, and intratheater movement legs, staging, and holding areas. (JP 1-02. Source: JP 4-0)

environmental considerations. The spectrum of environmental media, resources, or programs that may impact affect the planning and execution of military operations. (JP 1-02. Source: JP 3-34)

exercise. A military maneuver or simulated wartime operation involving planning, preparation, and execution that is carried out for the purpose of training and evaluation. (JP 1-02. Source: JP 3-34)

facility. A real property entity consisting of one or more of the following: a building, a structure, a utility system, pavement, and underlying land. (JP 1-02. Source: 3-34)

fragmentary order (FRAGORD). An abbreviated form of an operation order issued as needed after an operation order to change or modify that order or to execute a branch or sequel to that order. (JP 1-02. Source: JP 5-0)

general engineering (GE). Those engineering capabilities and activities, other than combat engineering, that modify, maintain, or protect the physical environment. (JP 1-02. Source: JP 3-34)

hazardous material (HAZMAT). Any material that because of its quantity, concentration, or physical or chemical characteristics may pose a substantial hazard to human health or to the environment when released. (NTRP 1-02. Source: N/A)

hazardous waste (HW). 1. A solid waste or combination of solid wastes that because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause or significantly contribute to an increase in mortality or an increase in irreversible or incapacitating reversible illness or (b) pose a substantial present or potential hazard to human health or to the environment when improperly treated, stored, transported, disposed of, or otherwise managed. The term solid waste includes liquid, semisolid, or contained gaseous material. 2. Any waste that requires special precaution in its storage, collection, transportation, treatment, or disposal to prevent damage to persons or property, including explosive, flammable, volatile, radioactive, toxic, and pathological wastes. (NTRP 1-02. Source: N/A.)

joint force. A general term applied to a force composed of significant elements, assigned or attached, of two or more Military Departments operating under a single joint force commander. (JP 1-02. Source: JP 3-0)

liaison. That contact or intercommunication maintained between elements of military forces or other agencies to ensure mutual understanding and unity of purpose and action. (JP 1-02. Source: JP 3-08)

local purchase. The function of acquiring a decentralized item of supply from sources outside the Department of Defense. (JP 1-02)

logistics. Planning and executing the movement and support of forces. It includes those aspects of military operations that deal with: a. design and development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposition of materiel; b. movement, evacuation, and hospitalization of personnel; c. acquisition or construction, maintenance, operation, and disposition of facilities; and d. acquisition or furnishing of services. (JP 1-02. Source: JP 4-0)

materiel. All items (including ships, tanks, self-propelled weapons, aircraft, etc., and related spares, repair parts, and support equipment, but excluding real property, installations, and utilities) necessary to equip, operate, maintain, and support military activities without distinction as to its application for administrative or combat purposes. (JP 1-02. Source: JP 4-0)

military construction (MILCON). Any construction, alteration, development, conversion, or extension of any kind carried out with respect to a military installation. (JP 1-02. Source: JP 3-34)

mission. 1. The task, together with the purpose, that clearly indicates the action to be taken and the reason therefore. 2. In common usage, especially when applied to lower military units, a duty assigned to an individual or unit; a task. (JP 1-02. Source: JP 3-0)

mobilization (MOB). 1. The act of assembling and organizing national resources to support national objectives in time of war or other emergencies. 2. The process by which the Armed Forces or part of them are brought to a state of readiness for war or other national emergency. This includes activating all or part of the Reserve Component as well as assembling and organizing personnel, supplies, and materiel. Mobilization of the Armed Forces includes but is not limited to the following categories: a. **selective mobilization**—Expansion of the active Armed Forces resulting from action by Congress and/or the President to mobilize Reserve Component units, Individual Ready Reservists, and the resources needed for their support to meet the requirements of a domestic emergency that is not the result of an enemy attack. b. **partial mobilization**—Expansion of the active Armed Forces resulting from action by Congress (up to full mobilization) or by the President (not more than 1,000,000 for not more than 24 consecutive months) to mobilize Ready Reserve Component units, individual reservists, and the resources needed for their support to meet the requirements of a war or other national emergency involving an external threat to the national security. c. **full mobilization**—Expansion of the active Armed Forces resulting from action by Congress and the President to mobilize all Reserve Component units and individuals in the existing approved force structure, as well as all retired military personnel, and the resources needed for their support to meet the requirements of a war or other national emergency involving an external threat to the national security. Reserve personnel can be placed on active duty for the duration of the emergency plus six months. d. **total mobilization**—Expansion of the active Armed Forces resulting from action by Congress and the President to organize and/or generate additional units or personnel beyond the existing force structure, and the resources needed for their support, to meet the total requirements of a war or other national emergency involving an external threat to the national security. (JP 1-02. Source: JP 4-05)

naval construction force (NCF). The combined construction units of the Navy that are part of the operating forces and represent the Navy's capability for advanced base construction. (JP 1-02. Source: JP 3-34)

naval mobile construction battalion (NMCB). An established naval construction unit, trained and equipped for general construction of an advanced base, including buildings, airfields, roads, waterfront structures, utilities, and fuel installations. It is an integral unit in personnel, housing, subsistence, administration, and equipment and is infantry equipped for defensive warfare. (NTRP 1-02. Source: N/A)

operation. 1. A series of tactical actions with a common purpose or unifying theme. (JP 1-02. Source: JP 1)
2. A military action or the carrying out of a strategic, operational, tactical, service, training, or administrative military mission. (JP 1-02. Source: JP 3-0)

operation and maintenance (O&M). Maintenance and repair of real property, operation of utilities, and provision of other services such as refuse collection and disposal, entomology, snow removal, and ice alleviation. (JP 1-02. Source: JP 3-34)

operation order (OPORD). A directive issued by a commander to subordinate commanders for the purpose of effecting the coordinated execution of an operation. (JP 1-02. Source: JP 5-0)

operational environment (OE). A composite of the conditions, circumstances, and influences that affect the employment of capabilities and bear on the decisions of the commander. (JP 1-02. Source: JP 3-0)

personal protective equipment (PPE). The equipment provided to shield or isolate a person from the chemical, physical, and thermal hazards that can be encountered at a hazardous materials incident. Personal protective equipment includes both personal protective clothing and respiratory protection. (JP 1-02. Source: JP 3-11)

personnel. Those individuals required in either a military or civilian capacity to accomplish the assigned mission. (JP 1-02. Source: N/A)

petroleum, oils, and lubricants (POL). A broad term that includes all petroleum and associated products used by the Armed Forces. (JP 1-02. Source: JP 4-01.6)

potable. Water that is free from disease-producing organisms, poisonous substances, and chemical or biological agents and radioactive contaminants that make it unfit for human consumption and many other uses. (NTRP 1-02. Source: N/A)

quality assurance (QA). A planned and systematic pattern of all actions necessary to provide confidence that adequate technical requirements are established, that products and services conform to those requirements, and that satisfactory performance is achieved. (NTRP 1-02. Source: N/A)

Rapid Engineer Deployable Heavy Operational Repair Squadron Engineer (RED HORSE). Air Force units wartime-structured to provide a heavy engineer capability that are mobile, rapidly deployable, and largely self-sufficient for limited periods of time. (JP 1-02. Source: JP 3-34)

real property. Lands, buildings, structures, utilities systems, improvements, and appurtenances, thereto that includes equipment attached to and made part of buildings and structures, but not movable equipment. (JP 1-02. Source: JP 3-34)

redeployment. The transfer of forces and materiel to support another joint force commander's operational requirements, or to return personnel, equipment, and materiel to the home and/or demobilization stations for reintegration and/or out-processing. (JP 1-02. Source: JP 3-35)

request for information (RFI). 1. Any specific time-sensitive ad hoc requirement for intelligence information or products to support an ongoing crisis or operation not necessarily related to standing requirements or scheduled intelligence production. A request for information can be initiated to respond to operational requirements and will be validated in accordance with the combatant command's procedures. 2. The National Security Agency/Central Security Service uses this term to state ad hoc signals intelligence requirements. (JP 1-02. Source: JP 2-0)

resource management (RM). A financial management function that provides advice and guidance to the commander to develop command resource requirements. (JP 1-02. Source: JP 1-06)

resources. The forces, materiel, and other assets or capabilities apportioned or allocated to the commander of a unified or specified command. (JP 1-02)

risk management (RM). The process of identifying, assessing, and controlling risks arising from operational factors and making decisions that balance risk cost with mission benefits. (JP 1-02. Source: JP 3-0)

standard operating procedure (SOP). A set of instructions covering those features of operations which lend themselves to a definite or standardized procedure without loss of effectiveness. The procedure is applicable unless ordered otherwise. (JP 1-02. Source: N/A)

supported unit. As related to contracted support, a supported unit is the organization that is the recipient, but not necessarily the requester of, contractor-provided support. (JP 1-02. Source: JP 4-10)

survivability. All aspects of protecting personnel, weapons, and supplies while simultaneously deceiving the enemy. (JP 1-02. Source: JP 3-34)

synchronization. 1. The arrangement of military actions in time, space, and purpose to produce maximum relative combat power at a decisive place and time. 2. In the intelligence context, application of intelligence sources and methods in concert with the operation plan to ensure intelligence requirements are answered in time to influence the decisions they support. (JP 1-02. Source: JP 2-0)

table of allowance (TOA). An equipment allowance document that prescribes basic allowances of organizational equipment, and provides the control to develop, revise, or change equipment authorization inventory data. (JP 1-02. Source: JP 4-09)

unit of issue. In its special storage meaning, refers to the quantity of an item; as each number, dozen, gallon, pair, pound, ream, set, yard. Usually termed unit of issue to distinguish from “unit price.” (JP 1-02. Source: N/A)

United States (US). Includes the land area, internal waters, territorial sea, and airspace of the United States, including the following: a. US territories, possessions, and commonwealths; and b. Other areas over which the US Government has complete jurisdiction and control or has exclusive authority or defense responsibility. (JP 1-02. Source: N/A)

warning order (WARNORD). 1. A preliminary notice of an order or action that is to follow. 2. A planning directive that initiates the development and evaluation of military courses of action by a supported commander and requests that the supported commander submit a commander’s estimate 3. A planning directive that describes the situation, allocates forces and resources, establishes command relationships, provides other initial planning guidance, and initiates subordinate unit mission planning. (JP 1-02. Source: JP 5-0)

INTENTIONALLY BLANK

LIST OF ACRONYMS AND ABBREVIATIONS

1NCD	First Naval Construction Division
5T	5-ton truck
AF	availability factor; Air Force form
AFDD	Air Force doctrine document
AFI	Air Force instruction
AFOSH	Air Force Occupation and Environmental Safety, Fire Protection, and Health
AFPAM	Air Force pamphlet
BCE	base civil engineer
BOM	bill of materials
BOS	base operations support
BU1	builder first class (USN rating)
BUC	chief builder (USN rating)
BUCN	builder, constructionman (USN rating)
CA	construction activity
CAS	construction activity summary
CE	construction electrician
CEC	civil engineer corps
CESE	civil engineering support equipment
CFR	Code of Federal Regulations
CO	commanding officer
COMFIRSTNCDINST	Commander, First Naval Construction Division instruction
CONUS	continental United States
COTR	contracting officer's technical representative
CPM	critical-path method
CS	crew size

D7	dozers
DA	Department of the Army form
DCD	design change directive
DD	Department of Defense (form)
DL	direct labor
DOD	Department of Defense
DODI	Department of Defense instruction
DUR	duration
EA	each
ECD	estimated completion date
EM	engineer manual
EO3	equipment operator third class (USN rating)
EOS	estimated on-site
EF	early finish
ES	early start
FAR	field adjustment request
FF	free float
FM	field manual (USA)
FRAGORD	fragmentary order
ft	foot
HHQ	higher headquarters
HM	hazardous material
HVAC	heating, ventilation, and air conditioning
HW	hazardous waste
ID	identification
IF	interfering float
in	inch
L	logic delay

LCDR	lieutenant commander
LF	late finish
LL	long lead items
LS	late start
MC	man-day capability
MCRP	Marine Corps reference publication
MD	man-day
ME	man-day equivalent
MILCON	military construction
MLO	material liaison office
MSDS	material safety data sheet
MTO	material takeoff
N3	Navy staff operations directorate
NCF	naval construction force
NCOIC	noncommissioned officer in charge
NCR	naval construction regiment
NMCB	naval mobile construction battalion
No.	number
NTRP	Navy tactical reference publication
OIC	officer in charge
OPNAVINST	Chief of Naval Operations instruction
OPORD	operation order
ORM	operational risk management
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
PW	public works
QA	quality assurance
QC	quality control

QTY	quantity
R	resource delay
R3	operations
RAC	risk assessment code
RDD	required delivery date
Rebar	reinforcing bar
RED HORSE	Rapid Engineer Deployable Heavy Operational Repair Squadron Engineers
RFI	request for information
ROICC	resident officer in charge of construction
ROS	required on-site
SITREP	situation report
SF	sheepsfoot
SL	scoop loader
SME	subject matter expert
SOP	standard operating procedure
SQ	squad
T/O	table of organization
TOA	table of allowance
TCMS	Theater Construction Management System
TM	technical manual
TOA	table of allowance
UFC	Unified Facilities Criteria
UFGS	Unified Facilities Guide Specifications
UNS	Universal Need Statement
U.S.	United States
USA	United States Army
USAF	United States Air Force

USMC	United States Marine Corps
USN	United States Navy
UT2	utilitiesman second class (Navy rating)
WARNORD	warning order
WD	workday
WIP	work-in-place

INTENTIONALLY BLANK

LIST OF EFFECTIVE PAGES

Effective Pages	Page Numbers
DEC 2012	1 thru 24
DEC 2012	1-1 thru 1-10
DEC 2012	2-1 thru 2-28
DEC 2012	3-1 thru 3-30
DEC 2012	4-1 thru 4-18
DEC 2012	5-1 thru 5-20
DEC 2012	6-1 thru 6-38
DEC 2012	7-1 thru 7-18
DEC 2012	8-1 thru 8-6
DEC 2012	9-1 thru 9-22
DEC 2012	10-1 thru 10-10
DEC 2012	11-1 thru 11-10
DEC 2012	A-1 thru A-4
DEC 2012	B-1, B-2
DEC 2012	C-1 thru C-14
DEC 2012	D-1 thru D-8
DEC 2012	E-1, E-2
DEC 2012	F-1 thru F-4
DEC 2012	Reference-1 thru Reference-4
DEC 2012	Glossary-1 thru Glossary-6
DEC 2012	LOAA-1 thru LOAA-6
DEC 2012	LEP-1, LEP-2

INTENTIONALLY BLANK

TM 3-34.42
17 December 2021

By Order of the Secretary of the Army:

JAMES C. MCCONVILLE
General, United States Army
Chief of Staff

Official:



MARK F. AVERILL
Acting Administrative Assistant
to the Secretary of the Army

2135001

DISTRIBUTION:

Active Army, Army National Guard, and United States Army Reserve. Distributed in electronic media only(EMO).

**NTRP 4-04.2.5/
TM 3-34.42/
AFPAM 32-1020/
MCRP 3-17.7F
DEC 2012**