

Plant Project Engineering Guidebook

for Mechanical and Civil Engineers

CASTI Publishing Inc.
10566 - 114 Street
Edmonton, Alberta T5H 3J7 Canada
Tel:(780) 424-2552 Fax:(780) 421-1308

First Edition on CD-ROM™



Search

Subject Index

Table of Contents

E-Mail: casti@casti.ca
Internet Web Site: www.casti.ca

Plant Project Engineering Guidebook for Mechanical and Civil Engineers

Morley H. Selver, P. Eng.

Executive Editor
John E. Bringas, P.Eng.



CASTI Publishing Inc.
10566 - 114 Street
Edmonton, Alberta, T5H 3J7, Canada
Tel: (780) 424-2552 Fax: (780) 421-1308
E-mail: casti@casti.ca
Internet Web Site: <http://www.casti.ca>

ISBN 1-894038-52-5
Printed in Canada

National Library of Canada Cataloguing in Publication Data

Selver, Morley H.

Plant project engineering guidebook for mechanical and civil engineers

(CASTI guidebook series ; v. 5)

Includes index.

ISBN 1-894038-52-5 (bound). -- ISBN 1-895038-53-3 (CD-ROM)

1. Industrial project management. 2. Engineering--Management. I.

Title. II. Series.

T56.8.S44 2001

658.4'04

C2001-911015-4

Plant Project Engineering Guidebook

CASTI PUBLICATIONS

CASTI METALS DATA BOOK SERIES™

CASTI Metals Black Book™ - North American Ferrous Data

CASTI Metals Black Book™ - European Ferrous Data

CASTI Metals Red Book™ - Nonferrous Metals

CASTI Metals Blue Book™ - Welding Filler Metals

CASTI GUIDEBOOK SERIES™

Volume 1

CASTI Guidebook to ASME Section II, B31.1 & B31.3 - Materials Index

Volume 2

CASTI Guidebook to ASME Section IX - Welding Qualifications

Volume 3

CASTI Guidebook to ASME B31.3 - Process Piping

Volume 4

CASTI Guidebook to ASME Section VIII Div. 1 - Pressure Vessels

Volume 5

Plant Project Engineering Guidebook: for Mechanical and Civil Engineers

CASTI CORROSION SERIES™

Volume 1

Handbook of Cladding Technology

Volume 2

Handbook of Stainless Steels & Nickel Alloys

Volume 3

Handbook of Corrosion in Soils

Volume 4

Corrosion Control

FROM THE PUBLISHER

IMPORTANT NOTICE

The material presented herein has been prepared for the general information of the reader and should not be used or relied upon for specific applications without first securing competent technical advice. Nor should it be used as a replacement for current complete engineering standards. In fact, it is highly recommended that current engineering standards be reviewed in detail prior to any decision-making.

While the material in this book was compiled with great effort and is believed to be technically correct, *CASTI Publishing Inc.* and its staff do not represent or warrant its suitability for any general or specific use and assume no liability or responsibility of any kind in connection with the information herein.

Nothing in this book shall be construed as a defense against any alleged infringement of letters of patents, copyright, or trademark, or as defense against liability for such infringement.

First printing of First Edition, January 2002
ISBN 1-894038-52-5 Copyright © 2002

All rights reserved. No part of this book covered by the copyright hereon may be reproduced or used in any form or by any means - graphic, electronic, or mechanical, including photocopying, recording, taping, or information storage and retrieval systems without the written permission of the publisher.

Plant Project Engineering Guidebook

WE WOULD LIKE TO HEAR FROM YOU

Our mission at the *CASTI* Group of Companies is to provide the latest technical information to engineers, scientists, technologists, technicians, inspectors, and other technical hungry people. We strive to be your choice to find technical information in print, on CD-ROM, on the web and beyond. If you have any comments or suggestions we would like to hear from you:

CASTI Publishing Inc.
10566 - 114 Street
Edmonton, Alberta T5H 3J7
Canada
Tel: (780) 424-2552, Fax: (780) 421-1308
E-mail: casti@casti.ca

BROWSE THROUGH OUR BOOKS ONLINE ***www.casti.ca***

Through our electronic bookstore you can view the lite versions of all *CASTI* books, which contain the table of contents and selected pages from each chapter. You can find our home page at <http://www.casti.ca>.

MYCASTI.ENGINEERING WEB PORTAL ***www.casti.ca***

If you are looking for engineering information, then *my.CASTI*.Engineering Web Portal is the place to start. It contains thousands of engineering related web site links in a fast and powerful online database. These engineering links are also organized in 35 categories to make it even easier to find important technical information that you are looking for. Check it out at www.casti.ca.

PREFACE

This guidebook was written for new plant project engineers and for foreign engineers trying to understand how projects are managed in North America. New engineers joining the ranks of plant project engineering have to learn a lot of procedures, work methods, and absorb a lot of information for managing small plant projects. To the new engineer this can be a confusing learning process with a lot of trial and error. At the time of this writing, there are no books or guidebooks published to help the plant project engineer in the management of their small plant projects. There are numerous books written on project management, but these books assume that one knows the basics of project engineering, covers subjects that are not really relevant at the plant working level, do not cover material that is required, and are too theoretical for small projects.

For the thousands of foreign companies supplying services and equipment into the North American market, it is difficult and expensive to determine how plant projects are managed in North America. The companies, if able, will send engineers to North America for several years to learn the customs and management methods. However, this only trains a very small portion of the companies' workforce and there is still no reference or guidebook for the engineers back home.

I started working as a plant project engineer in a pulp mill then moved on to central engineering for a large industrial corporation. There we managed large projects in the 11 plants that we owned. I noticed that plant project engineers were not very well educated in the field of plant project engineering as there were no proper training programs available. It was this lack of training that made the company have a central engineering department to manage their projects.

As I moved around and my career progressed in the area of plant project engineering I had the opportunity to develop and use contract documents, set up plant engineering departments, and manage plants. All this gave me a good understanding of what basic knowledge a plant project engineer should have. I have written this book to give the new plant project engineer background knowledge of the project authorization process including budgets and estimating, information on how to control the office and drawing functions, a description of the bidding and procurement process, the basics of construction management, contracts, commissioning procedures, startup, and training. This book is not theory, as the information and forms can be taken from the book and actually used in your projects. Although this book is written in Canada, the information has been used in both Canada and the US. The information is common to the oil and gas, pulp and paper, board and recycling industries.

It is my hope that plant project engineers and foreign engineers will find this guidebook useful in understanding the issues and methods necessary to successfully manage their plant projects.

Morley H. Selver, P.Eng.

TABLE OF CONTENTS

Chapter 1

Introduction.....	1
Why This Book	1
General Guidelines	2

Chapter 2

Project Authorization.....	5
Plant Capital and Maintenance Budgets	5
Project Authorization and Scope Documentation	9
Project Authorization Document.....	17

Chapter 3

Engineering Control and Design.....	71
Introduction	71
Engineering Files	71
Drawings.....	77
External Drawing Issue.....	84
Drawing Revisions	86
Drawing Transmittals	89
Document Distribution	90
Drawing Certification	92

Chapter 4

Procurement.....	93
Request for Quotation - General	93
Request for Quotations - Types	95
Plant Conditions and Standard Component List.....	102
Plant Conditions and Services	103
Structural	107
Mechanical.....	108
Piping.....	111
Instrumentation	111
Electrical.....	114
Painting	117
Vendor Data Requirements	118

Chapter 4 (continued)

Vendor Information Requirements	128
Vendor Information Requirements Form	129
Contracts and Tender Documents	131

Chapter 5

Tender Form and Instructions to Bidders	137
Lump Sum Tender	147
Statement Regarding Outstanding Claims	157
Contractors Daily Manpower Report.....	161
Instructions to Bidders	165

Chapter 6

Scope of Work, Drawings, and Specifications.....	171
Scope 1 General Description	173
Scope 2 Definition of the Work.....	174
Scope 3 Included in the Work.....	175
Scope 4 Not Included in the Work.....	191
Contract Drawings	195
Specifications and Standards	197

Chapter 7

Agreement and General Conditions of Contract.....	198
Special Conditions for Site Contractors.....	201
List of Tools and Equipment	218
Plastic Control Guidelines.....	225
Schedule I, Part A	225

Chapter 8

Bid Meetings, Bid Evaluation, Purchase Orders, and Contracts	229
Bid Meetings.....	229
Bid Evaluation Checklist.....	238
Purchase Orders and Contracts	239

Chapter 9

Construction Management.....	245
Where Does it Start?	245
Construction Management	249
Contract Administration	253
Field Work Orders and Change Orders	254
Back Charges.....	260
Notice of Back Charge	261
Inspection	262
Daily Project Diary.....	268
Deficiency List.....	272
Equipment Record.....	274
Electrical Equipment Checkout Record.....	275
Instrument Checkout Record	276
Certificate of Substantial Completion	278
Certificate of Final Completion.....	280
Commissioning and Startup.....	281
Training	282

Chapter 10

Commissioning Procedures	289
Introduction	289
Administrative Procedures	291
Administrative Procedure AP-1	
Startup Program	292
AP-1, Attachment 2 - Form 100	
Construction Turnover for Commissioning and Startup.....	308
AP-1, Attachment 3.....	309
System Punch List	309
Administrative Procedure AP-2	
Lockout Procedure	310
Employee/Contractor Acknowledgement.....	316
Supervisor Acknowledgement.....	316
Quick Reference – Lock Out Procedure	317
Administrative Procedure AP-3	
System Turnover Boundary Identification Procedures	318
Administrative Procedure AP-4	
Commissioning Schedule.....	320

Chapter 11

Mechanical Commissioning Procedures	321
Mechanical Test Procedures.....	321
Mechanical Test Procedure MTP-1	
System Inspection Procedure	322
MTP-1, Attachment 1	
System Inspection and Checklist Guidelines	324
Mechanical Test Procedure MTP-2	
Initial Operation of Rotating Equipment	327
Mechanical Test Procedure MTP-3	
Piping System Cleaning Procedure	333
MTP-3, Attachment 1	
Acceptance Criteria and Approval	336
Mechanical Test Procedure MTP-4	
Air System Cleaning Procedure	337
MTP-4, Attachment 1 Approval Sheet.....	340
Mechanical Test Procedure MTP-5	
Pressure Testing Installed Piping	341

Chapter 12

Electrical Commissioning Procedures.....	355
Electrical Test Procedures.....	355
Electrical Test Procedure ETP-1	
Electrical Test Methods and Procedures	356
Electrical Test Procedure ETP-2	
AC Electrical Motors.....	366
Electrical Test Procedure ETP-3	
Control Circuitry Checkout	373
Electrical Test Procedure ETP-4	
Batteries and Chargers.....	378
Electrical Test Procedure ETP-5	
Equipment Grounding	383

Chapter 13

Instrumentation Commissioning Procedures.....	387
Instrument Test Procedures.....	387
Instrument Test Procedure ITP-1	
Instrument and Controls Calibration Methods	388
Instrument Test Procedure ITP-2	
Instrumentation and Controls Installation Checkout.....	390
Instrument Test Procedure ITP-3	
Instrumentation and Controls Calibration and Functional Checkout.....	393
Conclusion	396
Subject Index	397

Chapter

1

INTRODUCTION

Why This Book

Industrial plants are the training grounds for young project engineers, who are usually hired by the plants to fill an immediate need for help. On the first day, a coworker will give them a tour of the plant and office. They will be introduced to a lot of people they will need to know whose names will be forgotten in minutes and will be shown to their new desk. There they will find all the information required to perform their job. It is expected that they will “learn on the job” and they generally do. There is nothing wrong with this approach and it usually works quite well; however, there is a difference between learning and understanding. This book is intended to steer the project engineer toward an *understanding* of what they are trying to “learn on the job.”

This book is written from the perspective of a plant project engineer and is based on a typical plant engineering, procurement, and construction contract (EPC). However, the principles and methods discussed also apply to other engineering areas in all industries. All projects go through the same steps and require the same information to be implemented. For small projects handled in-house, this book will give the project engineer an understanding of why certain things are done, and for large projects where outside consultants are involved, it will give an understanding of what the consultants do and what the project engineer should be looking for. Most courses and books about project management deal with large projects and assume that the basics of project management and project control are understood. This is not necessarily the case. The majority of everyday

2 Introduction Chapter 1

projects encountered in a plant are fairly small (less than \$5 million), and using project management techniques designed for large projects can be cumbersome, time-consuming, and not necessarily cost effective. By understanding what is required for each project and why, a reasoned approach can be taken to employ the right techniques to get the job done without being burdened with questionable tasks developed specifically for large projects.

This book covers the basics of what a project engineer should look for when gathering information for the Project Approval Phase, pitfalls to avoid in the Design Phase, what to ask for in Request for Quotations, and problems which will be encountered during the Construction Management Phase. By using this book as a guide, the Project Engineer will get enough information to control and manage projects effectively. The aim is for the project engineer to have a clear understanding throughout the project life cycle of **WHAT** is to be done, **WHY** it is being done, **WHEN** it will be done, **HOW** it will be done, **WHERE** it will be done, and **WHO** will do it.

The information in this book comes from knowledge gathered during my 20 plus years of working for operating pulp and paper mills, in corporate central engineering, and as a consultant in the pulp, paper, and board industry. This book is intended to help project engineers perform their job in an efficient, professional manner by understanding and maintaining control throughout all phases of their projects.

General Guidelines

The following are some general guidelines to keep in mind when managing projects:

1. It is important to keep your supervisor informed to the fullest extent throughout the project. Just like you, your supervisor does not like surprises.

Chapter 2

PROJECT AUTHORIZATION

Plant Capital and Maintenance Budgets

Plants, in fact all companies, have long range plans and budgets. In industrial plants there are usually three budgets—a capital budget, a maintenance budget, and an overhead budget. The capital budget covers new equipment or improvements to the plant. The maintenance budget takes in repairs to existing plant equipment or structures. The overhead budget covers services provided to the plant such as accounting, stores, etc. In most jurisdictions, items on the capital budget are taxable, while maintenance budget items are a tax write-off against the plant operations. The maintenance budget costs and overhead budget costs are part of the plant operating costs. Therefore, the maintenance budget can have significant effect on the plant's profit and/or loss.

The budgets contain line items regarding new equipment or structures (capital budget), maintenance work required on equipment or plant structures (maintenance budget), the projected cost to supply service to the plant for the upcoming year (overhead budget).

The three budgets are developed and submitted to management for approval, usually once a year; however, they are worked on throughout the year. The budget line items will have a dollar value assigned that is a rough order of magnitude (ROM). The dollar amounts assigned to the line items could come from department managers, supervisors, engineers, or are sometimes amounts left over from previous budgets. Some ROM estimates are pure guesswork and others are determined by talking with vendors about equipment

6 Project Authorization Chapter 2

prices and getting estimates of installation costs. The time spent on the each estimate will vary and each estimate's accuracy will vary but should reflect actual anticipated costs as much as possible.

For a $\pm 10\%$ estimate, the backup information you use has to be detailed, current, and accurate. This requires a lot of up-front engineering work. In fact all the detailed engineering should be complete and current pricing obtained using detailed engineering drawings. The pricing would include material suppliers, vendors, and contractors. This type of estimate requires the company to spend money up-front to dedicate a person to the project, do the detailed design, obtain and evaluate proposals, and prepare the estimate. Although this is the preferred type of estimate, there are typically very few of these estimates.

At the midrange of $\pm 20\%$ to $\pm 30\%$ estimate, you would have a preliminary flowsheet and layout and a basic scope. You could be using past equipment pricing with a multiplier or a preliminary price from a vendor or contractor (with his own accuracy range). You have looked at the installation requirements and prepared a lump sum estimate based on them. You may get installation information from published directories. The less information you have, the more your estimate will lean toward $\pm 30\%$. Most budget items will be in this range.

At the end of the scale is $\pm 50\%$ estimate which is based on very little information and a lot of experience. This would take very little time to prepare. The less experience you have the more the estimate will be off and a range value higher than $\pm 50\%$ may have to be used. A lot of the budget items would be in this category.

Assuming the plant is one of many in a corporation, plant management will scrutinize, modify, remove, and prioritize budget items to get the budget within guidelines provided by the head office. One of these guidelines for capital budget items is *Rate of Return*. The benefits of installing the equipment or structure are looked at and a dollar value assigned to the benefits. Examples of benefits would be:

- Cost savings due to less manpower required to perform the function;
- Improved quality would allow selling product for a higher price;
- Speed improvement would allow more product to be sold;
- Savings in maintenance costs;
- Savings in cost of raw materials;
- Ease of use decreasing operator errors.

Each line item will have a benefits value associated with it and these will be evaluated further at the project approval phase.

The Rate of Return is calculated as follows:

$$(\text{Benefits} - \text{Cost} / \text{Cost}) \times 100$$

A Rate of Return of 10% is typical; however, a value as high as 20% has been used. Every plant is different and the current state of the plant business will determine the required Rate of Return. For some projects the benefits are fairly easy to determine and cost. For other projects the benefits are nebulous and have to be searched for. For these borderline projects there will be pressure to either lower the estimated project cost or to increase the benefits. Be very careful with your estimates when dealing with these types of budget items.

Once the plant is satisfied with their budget, they will then submit the total budget dollar estimates to the head office for approval. At the head office the budget is usually pared back, discussions held, and the budget reworked until an agreeable dollar value is reached and the budget line items are approved. Line item and budget approval usually depends on how the market is for the plant's product:

- If economic times and profits are good, then a lot of capital projects as well as maintenance items will get approved.
- If times are bad and profits mediocre, then less capital and more maintenance projects will get approved.

Even with the best advanced planning, however, changes will be needed. Items will be left out, someone will have a better way of doing the project, or future project owners will want something more expensive. If through proper documentation and estimating sufficient funds have been approved, there may be some spending leeway. Sufficient funding always makes the project easier to manage and run. There is nothing worse than an underfunded project.

By knowing exactly what is included in your estimate it is easier to determine the requirement for scope changes when someone wants something extra added to the project. At least you can say with honesty that it is an “extra” and you’ll have the backup to prove it. Management should approve any scope change requests before the work takes place. Don’t get caught up in trying to keep your fellow employees happy by adding unauthorized scope changes. The scope change may not seem like much at the start of the project but it could have a major effect on the final project cost and you will have no excuse for the scope addition. Letting management say yes or no to a scope change request takes the pressure off you of going against your fellow employees’ wishes.

A Project Authorization Form (Figure 2.1) is a brief summary of what is included in the project and lists the items that should be approved by management. The required items will vary from plant to plant, however, this form is a good basis to start from. The intent is to make the authorization form as complete as possible so management has all the information required to make an approval decision. Do not try to hide things management may not want to hear, as these will come back to haunt you once the project is approved. If management wants to take items out of the scope, it is their prerogative, but it is important they have all the information and backup required to make a decision. The Authorization Checklist (Figure 2.4) covers all items that should be looked at when making up the Project Authorization Form. As items are considered and completed the item can be checked off so that you know you have looked at it. You can use a Y (yes) or N (no) as applicable to have a list of what information or documentation is needed for project authorization.

This authorization documentation and accompanying estimate will be the basis for your project. Any changes to the project after approval will have to have a scope change approved by management. Therefore, it is vital that what is being approved, in the project authorization, is known in as much detail as time and available information allows. It is not only your fellow workers who may want changes, but management may also want to change something. A Scope Change document should apply to management change requests as well. You may have to watch your step so you do not upset your supervisor when you insist on acquiring the documentation; however, you will have the backup information outlining what was included.

Project Authorization Document

The following discussion explains each part of the Project Authorization form shown in Figure 2.1.

Date

This is the date you submit the form to management. Do not use any other date as this will show you how long the approval process takes. It will also give an indication of how long it took to prepare the approval document. This can be done by comparing this form date with the date on the engineering request. Both of these dates will be of interest to you for future reference so keep track of them.

PA Number

This is the Project Authorization number assigned by the accounting group and tying the project back to the budget line item. The number will be the same throughout the duration of the project. This number should be shown on all documents relating to the project as your accounting system, filing system, drawings, purchasing documents, etc. will use this number to collect information and define what project the document is for.

Project Title

The title you give the project should describe the project and have meaning to others in the plant. Titles are sometimes given that bear no resemblance to what the project is actually about. Poor project titles can be confusing and do nothing for the communication flow in the plant. For example, the project “Washer Vent Disengagement Section” would be less confusing if it was titled by its more common name of “Washer Vent Demister.” You can change the project title from what is shown in the budget line item. Just make sure that you reference the old title in your authorization document.

Prepared By

This is the name of the person who prepared the documentation, presumably you.

Department

This is the department in which the project will be carried out. If the project crosses several departments, use the department that handles the major portion of the project or the department that originated the request.

Area Specialist

In large plants there are usually process engineers and area engineers who are classed as specialists in their respective areas. They will usually have a detailed understanding of the process, the equipment, and what the problem is. This specialist should work with you to prepare the documentation. He will be able to describe the project objective in great detail and assist in the scope definition. This person may move on and may not necessarily be the specialist working with you on the project. Sometimes, years later, someone needs to know who worked on the project; therefore, this information should be added. If your plant does not have specialists and you filled the roll, then put your name for this item.

EWR Number

This is the Engineering Work Request number. To control what projects plant engineers are working on, engineering departments use a Work Request System. This Work Request System ensures that the plant engineers only work on approved work. All requests for engineering assistance are sent to management for approval. If the request is approved, then it is assigned the next sequential number from the Engineering Work Request list. This keeps plant engineers from working on frivolous items that do not reflect the objectives of the plant. Depending on your plant's accounting system, your time will be charged to this number. The master list will cross-reference this EWR number back to the PA number and eventually to the budget line item. The costs collected under this EWR number will be charged back to the project upon approval.

Work Order Numbers

People outside the engineering department usually work under a work order numbering system. For a person to work on a piece of equipment or to help you with your assignment requires the issuing of a work order number to track their time. This system allows the plant to track the personnel portion of its maintenance costs. The numbers you list are the ones used to collect the costs associated with the approval documentation. These costs are usually charged back to the project once it is approved.

Because these work order numbers are like blank cheques, it is very important to keep track of them and who is charging their time to them. Since some people are always looking for active work order numbers to charge to, make sure all your work orders are closed once the task is complete. In fact, issue and close work orders often so the work order numbers do not get out into the plant and unauthorized people start charging to the number. The longer the number is out there, the more likely there will be abuse. Keep in mind cost reports are usually issued about once a month and by the time you find out about unauthorized charges it may be too late. If you find unauthorized charges, go back to the accounting group and have

them removed. Because of the possibility of unauthorized charges, do not use blanket work order numbers. A blanket work order number is a number issued to collect the costs for an assortment of tasks over a long period of time.

1.1 Project Objective

This is the justification for doing the project. It should include a description of the project's purpose and what is expected to be achieved. It should outline what the existing situation is, what is to be accomplished by carrying out the project, and any special requirements or limitations that management should know about. If possible the project objective should be expressed in measurable, fixed, and identifiable terms, e.g., the project will increase production by 25 tons; the vendor's process guarantee; etc.

For example: This project will replace the non-reversing gear boxes on the Archimedes Screws at the effluent treatment plant. There are 3 screws with 2 running all the time on a 16-hour rotation. When the screw stops, the water does not drain back down to the pit, but stays in the screw. During the winter, this water freezes and puts the screw out of service until the maintenance crew can thaw the ice. These freeze-ups have occurred at least 4 times every year for the past two years at a cost of \$50,000 per occurrence.

By replacing the gear boxes with a reversing type, the screws will be allowed to rotate backwards, draining the water and preventing freeze-ups. This will allow the operating rotation of units to be maintained more efficiently and save \$200,000 per year in maintenance costs.

The plant's project sponsors or area specialist will usually help you with this section. It is important that this section be written in clear, concise terms. If, as the project progresses, there are attempts to add items to the project or change the project concept, this section can be referred to to see if the request is relevant and within the objective of the project. Because these issues will have to be dealt with, it is important to have this section clearly written.

1.2 **Schedule**

This should at least outline proposed milestone dates for the project. It should include: project approval time (this will be a guess), permit approval times, start of engineering, when major equipment has to be purchased by, delivery dates of major equipment, start of construction, shutdown dates and durations, startup date, and full production date. Larger projects will require more schedule information but the above would be sufficient for smaller projects. These do not have to be actual dates but can be indicated as number of days/weeks/months after project approval. That way it doesn't matter that the project receives management approval within a specified timeframe. However, if a fixed date (e.g., a shutdown) is driving the schedule, then the schedule should be within a specified timeframe with a "drop-dead" date for approval. Management approval is probably the hardest date to estimate. Do not be fooled into thinking approval will be immediate, no matter how important the project supposedly is. Protect yourself with a drop-dead date.

Preparing a schedule makes you think about how the project will go together and will help identify missing items. It also gets you talking to suppliers. This will give you a better feel for the viability of the project and if there are potential equipment delivery problems. You may even find there is another solution to the problem that could save money.

If you have a scheduling program, use it. It will make your document look more professional and present the information in a more readable format. But be careful with scheduling programs. Some are designed primarily for large projects and do not lend themselves well to small projects. Others are easy to use for small projects and produce Gantt charts (bar charts) quite readily. For approval schedules, milestone dates may be faster and just as adequate. The dates can be shown in Gantt chart form or simply listed depending on what format is desired by management.

Do not put too much information in the management schedule. This can be confusing and may end up in nitpicking questions and more

work for you. Stick to the relevant points. If management wants more information, they will ask for it.

The only way to keep proficient at computer programs is to use them all the time; therefore, it may be worthwhile to use the scheduling programs for all your projects no matter how small. Most programs will allow you to take a detailed schedule and roll it up into a milestone schedule if that is what you require.

Scheduling should not be taken lightly. It should be relevant and not put together haphazardly. Management will always remember any favorable dates you give them even if you tell them the dates are just a guess. For this reason, it is important to specify only those dates you are sure you can meet and to make clear any qualifications affecting those dates. Most projects will tie in with plant shutdowns and these dates should be known well in advance. On larger projects, plant shutdowns scheduled a year in advance may determine your schedule or, conversely, your project may determine the shutdown date and length. As you get more experience in managing projects, you will find that the end date never changes even when the front-end dates cannot be met because of late management approval or other problems. Your schedules will always be compressed and you will spend a lot of time protecting the dates. For every change to the project, you should look at the schedule impact, and if an extension is required it should be shown on the schedule.

1.3 Critical Assumptions

All assumptions used in developing the budget estimate should be listed. Because your assumptions affect the final estimated cost, it is important that you and your management understand how the estimate was derived. Someone with more experience may advise you that some of your assumptions should not be used or may add other assumptions. Management is usually looking at the big picture and does not look at the details. The assumptions will get management thinking about different aspects of the project and how it could affect other parts of the plant.

Once the project is approved, all your assumptions will be part of the project basis. Throughout the project, if changes occur such that any of the assumptions no longer apply, then the project budget estimates and schedule deadlines should be changed accordingly, e.g., additional funds should be allocated to compensate for the monetary change and the schedule should be extended to compensate for the time required to do the extra work. Management may and often does refuse the additional compensation for small items. For bigger items there may not be any additional compensation until the end of the project when all the costs are in. If there is a budget underrun, the funds would go to pay for the changes. If not, the additional funds would have to come out of the pool of project money. Keep records of what transpires to help explain any overruns at the end of the project. Assumptions can be as simple as:

- contractor or plant forces to do the work
- union or non-union contractors
- availability of special equipment or material
- suitability of existing foundations
- availability of permits
- sufficient quantity of utilities
- reuse of existing plant equipment

1.4 Drawings

List the drawings and sketches used to develop the estimate. The drawings could be original plant drawings. These drawings, in the end, may be obsolete but they at least show what the project approval was based on. All drawings should be numbered, dated, and uniquely identifiable in some way. There should be as a minimum a flowsheet (if applicable) showing how the project will tie in with the existing process. Submit this flowsheet with the approval package.

By going through the exercise of producing drawings or sketches, other things pertaining to the project will come to light. This could lead to further assumptions or additional items that have to be covered in the project. When doing field research for information to produce a drawing or to confirm information, the area in question

Authorization Checklist			
1.0	SCOPE	2.11.2.5	= Single Line Diagram
1.1	Project Objective	2.12	Electrical Equipment
1.2	Schedule	2.13	Electrical Installation
1.3	Critical Assumptions	2.14	Electrical Tie-ins
1.4	Drawings	2.15	Instrumentation
1.5	Standards & Specifications	2.15.1	= Control
1.6	Process Requirements	2.15.2	= Control Loops
1.7	Battery Limits	2.15.3	= Control Panels
1.8	Mechanical/Civil/Structural Requirements	2.15.4	= Control Room Equipment
1.9	Electrical Requirements	2.15.5	= Field Instruments
1.10	Instrument Requirements	2.15.6	= Instrument Installation
1.11	Safety	2.16	Air Purification
1.12	Startup & Commissioning	2.17	Environmental
1.13	Permits	2.17.1	= General
1.14	Environmental	2.17.2	= Regulations
2.0	ESTIMATING	2.17.3	= Permits
2.1	Site Work	2.17.4	= Working Conditions
2.1.1	= Demolition & Relocation	2.17.5	= Surrounding Community
2.1.2	= Surveying	2.18	Training
2.2	Site Grade	2.19	Startup
2.3	Site Improvements	2.20	Permits
2.4	Structures	2.21	Engineering
2.4.1	= New Structures	2.22	Construction
2.4.2	= Existing Structures	2.22.1	= Inspection
2.4.2.1	= Modifications	2.23	Process Simulation Trials
2.4.2.2	= Additions	2.24	Insurance
2.5	Special Access Requirements	2.25	Currency
2.6	Soils	2.26	Contingencies
2.7	Mechanical Equipment	2.27	Escalation
2.7.1	= Process Equipment	2.28	Freight
2.7.1	= Mobile Equipment	2.29	Restrictions
2.7.3	= Other Equipment	2.30	Work By Others
2.8	Piping Requirements	2.31	Services For Construction
2.8.1	= Pipe Testing & Inspection	2.32	Utilities For Construction
2.8.2	= Piping Tie-ins	2.33	Receiving & Storage
2.8.3	= Fire Protection	2.34	Safety
2.8.4	= Pipe Insulation	2.34.1	= Design Considerations
2.8.5	= Pipe Penetrations	2.34.2	= Plant Hazards To Contractors
2.9	Other Insulation	2.34.3	=Construction Hazards To Mill Employees
2.10	H & V	2.34.4	Safety Issues After Construction
2.11	Electrical	3.0	SCHEDULES
2.11.1	= Power Source	3.1	Spending Forecast
2.11.2	= Power Distribution	3.2	Overall Project Schedule
2.11.2.1	= General Distribution	3.2.1	= Engineering
2.11.2.2	= Item Distribution	3.2.2	= Procurement
2.11.2.3	= Wiring & Control	3.2.3	= Construction
2.11.2.4	= Grounding		

Figure 2.4 Authorization Checklist

2.1 Site Work

2.1.1 Demolition & Relocation

Does anything need to be demolished or relocated to prepare the site for the project? This includes structures, equipment, piping, electrical, underground utilities, instrumentation, etc. Be sure to indicate what will be done with any equipment that is removed; i.e., reinstalled in another project, stored for future use, scrapped, sold, or whatever. If money is to be recovered, this should appear in the estimate. Make sure you are not overly optimistic in its worth. Also, be sure to identify and cross reference any rework or modifications required as a result of demolition and relocation.

2.1.2 Surveying

Is any surveying required to lay out the site, establish benchmarks, carry out legal surveys, or make up plot plans and submit to local authorities? Are survey points readily available on site or does a surveyor have to find them? Equipment location and setting of equipment should be under Mechanical Installation. If you have survey points that are currently outside, they may have to be moved inside if a building goes up and obscures the points. You should make an effort to protect survey points for future use. The plant should hire a surveyor to bring the required survey points and bench marks into the construction area for the contractor's use. Do not depend on your contractor to do this. You will have to bring the surveyor back throughout the construction to check certain points to ensure that the contractor is in the right location.

2.2 Site Grade

Are there any special site requirements such as clearing, excavation, fill, special elevations, slopes, surcharging, etc.? How will waste material be disposed of? Is there a pollution problem with any of the areas to be graded? If there is a need for a soil engineering study, identify this and cross reference to the appropriate sections. Does a topographic survey have to be done? Will winter work be a problem?

2.3 Site Improvements

Are there any new requirements for, or modifications to, existing roadways, railways, area paving, area lighting, underground utilities, landscaping, parking lots, fencing or other security measures, etc.?

2.4 Structures

2.4.1 New Structures

Does the project require new structures such as a new equipment building, control room, electrical room, offices, etc.? Include any requirements for foundations, floors, walls, ceilings, roof, painting, linings, lighting, heating and ventilation, fire protection, etc. Be sure to identify items such as restrooms (male and female), locker rooms (male and female), laboratories, maintenance shops, offices, electrical rooms, etc. Are there requirements for new building structural steel, such as towers or pipe supports? (Platforms and equipment supports should be included under mechanical equipment.)

Allow for freight if needed and cross reference to the freight section.

2.4.2 Existing Structures

2.4.2.1 Modifications

Does the existing structure have to be reinforced, walls moved, painted, etc.?

2.4.2.2 Additions

Are there additions to be made to an existing structure? If you add an extension to a tower in this section, you will have to add the reinforcing of the tower in section 2.4.2.1 and cross reference.

2.5 Special Access Requirements

Most building codes now require special walkways for the handicapped as well as handicap accessible washrooms; in fact, no new addition or building should be constructed without considering handicap access. Depending on your jurisdiction, you may be required to install handicap washrooms in all areas but you do not necessarily have to provide handicap access to the washrooms. It is important to check this out. Requirements can affect how you approach the layout and the design. As an example, if you plan on a two-story building but have to put in an elevator for handicap reasons, it may be less expensive to go with a single story. This can be a costly item if not checked out properly at the estimating stage.

Are there any out of the ordinary ladders, platforms, doors, lighting, etc. required for access to facilities and instrumentation for their operation and maintenance? Can items be reached from manlifts or cranes, etc? One way or another everything in the plant should be accessible. If you plan on using existing plant equipment to access items, you should state that here, e.g., a manlift will be used to access valve handle.

2.6 Soils

Identify work to be done or work previously done to determine the soil conditions for the foundation design. Keep in mind it can be dangerous to try extrapolating existing soil information to cover an area that was not tested. You could run into major construction problems if you are wrong. For important items it is prudent to test, although testing is no guarantee either. Allow enough money to do a proper soils examination, i.e., do not use the local water well driller when a proper soils examination should be done.

If you are working inside a plant, check photos from the original construction or, if possible, talk to people who worked on the construction to get a feel for what is under the building. If need be dig test pits inside the building, but try to do something to make an educated guess as to what your foundation requirements will be.

Case History 6

For one project we were trying to determine the depth of rock in an area where a new building was going to be constructed. We knew there was rock at a shallow depth and that it sloped upwards across the site. We did borings every 2 ft. across the width of the site. The borings indicated rock at a depth of 15 ft. on the east side and at a depth of 2 ft. on the west side. The building foundation was designed accordingly. When we started excavation for the foundations we found that on the west side the rock dropped off 20 ft. We had stopped our borings 2 ft. from the drop off! Work had to be stopped while the foundations were redesigned. This affected the schedule and the project cost.

2.7 Mechanical Equipment**2.7.1 Process Equipment**

For each piece of equipment such as pumps, conveyors, agitators, etc., include the following information:

- Equipment specification (e.g., pump type and model, agitator model, etc.)
- Materials of construction (e.g., 316 SS, titanium, etc.)
- Drive requirements (e.g., adjustable speed drive, motor HP, gearbox model, etc.)
- Special requirements (e.g., mechanical seals, slide bases, etc.)
- Ancillary requirements (e.g., flushing water, seal water, etc.)
- Spare parts
- Freight allowance, FOB, DDU, duty, taxes, etc. Mention what it is and cross reference.

If you have a quote from a vendor, include the quote number and date. Identify any other documentation that supports the price, e.g., fax, record of discussion, minutes of meeting, etc. File these directly with your estimate documents.

Chapter

3

ENGINEERING CONTROL AND DESIGN

Introduction

This chapter looks at how to set up a filing system for your engineering office and discusses issues related to engineered drawings. The areas discussed are:

- Engineering files
- Drawings in an engineering office
- External drawing issues
- Drawing revisions
- Drawing transmittals
- Document distribution
- Drawing certification

Engineering Files

The plant should have a central file system already in place. In order to cut down on the amount of paper on your desk and in your personal files, you should get in the habit of using the central file for filing as much material as possible. Generally, it doesn't make sense to copy pages of information just to keep in your personal files that will never be looked at. There are some items that you may want in your own files, but you should be selective. Usually, copying is a waste of time and money.

The file system should be easy to follow and understand. If you have information you don't know where to file, add a new file number that makes sense. Make sure you add the number to the master file list as well. (The master file list is the numerical list that relates the file number to the file name). The filing system should be fluid with the ability to add numbers as required. It is your responsibility to put the appropriate file number on a document. Leaving this up to a secretary or file clerk can result in information getting lost.

Request For Quotations (RFQ's), Purchase Orders (PO's), and Contract Documents (CD's) are usually filed separately from the rest of the files, i.e., they do not follow the standard file numbering system from the master file list. Following is a generic description of the numbering and filing system for RFQ's, PO's, and CD's.

As discussed above, the accounting group gives a number to all projects submitted for approval. This number should appear on all documents sent to the central filing system. Different companies use different numbering systems, but typically each part of the number assigned has a specific meaning within the company. A typical project number might be PA-S112. The breakdown is as follows:

- PA = Project Authorization
- S = a project in the Stores Area. (Alternatively, a Major Area Number might be used instead of a letter, e.g., PA - 57-112, where 57 is the number for the Stores Area. This depends on how the plant is set up.)
- 112 = the project number assigned by the accounting group meaning project #112 of a running series of projects in the Stores Area.

Within the filing system there should be a separate file drawer for PA – S112 where the above RFQ's, PO's and CD's can be filed. Documents to be filed in the general file will have PA – S112 on it plus a file number off the master file list (i.e. PA – S112 / 6.8 could be an internal memo regarding project PA – S112). Once the project is

approved, the PA is dropped and a filing system for S112 is set up in the central file area. S112 becomes the project number.

The purchasing department will assign an RFQ number. When you give the RFQ to purchasing, they will assign a purchase order number to the RFQ. On large projects these purchase order numbers are determined well in advance and will show up on a purchasing schedule. These numbers will be the same from project to project, i.e. 1001 is structural steel, 1002 is civil construction, 1003 is mechanical installation, etc. The purchase order number/contract number has additional numbers (or letters) added to make it into a RFQ number. for example (using project S112):

- Purchase order number/contract number 1021 (assume this will be for painting) is going to be issued by purchasing. Before a purchase order / contract can be produced, one has to go out for bid using a RFQ.;
- The RFQ number is made up and may be of the form S112 - 100 - 1021; again, if your plant is set up with major areas, the RFQ number might become S112 - 100 - 57 - 1021 with 57 being the Stores Major Area. This way you can look at the RFQ number and know what area of the plant the RFQ applies to (you now have a RFQ for painting in the store's area).
- Upon contract award the 100 is dropped. The 100 is only used to signify that the document is out for bid;
- The purchase order number/contract number becomes S112 - 1021 or S112 - 57 - 1021 (you now have a purchase order number / contract number for painting in the stores area).

The additional numbers are added for control purposes. Do not issue PO numbers that are exactly the same as the RFQ numbers. The control numbers are added so that when discussing projects you know exactly what document you are talking about and what stage of the project it is in.

Prior to contract award all price inquiries, RFQ's, quotations, bid evaluations, data, and information from all vendors should be filed in the project authorization file. After contract award, all documents relating to the unsuccessful vendors should be transferred to a holding area in the files. Do not throw them out as you may have to refer to them. Filing will then be within the project by purchase order number if more than one purchase order is written. If only one purchase order is written, file by the project number.

Upon completion of the project the project files should be purged. Unsuccessful bidders information should be destroyed and successful bidder information transferred to the appropriate file according to the standard file system. Check with your accounting group to determine what information they have to retain for income tax purposes before destroying anything. The following are some examples of how various items are filed:

Examples:

- | | |
|------------------|---|
| PA S112/1.6.1 | A letter in S112 before project approval filed in 1.6.1. |
| S112/00335/1.6.3 | A fax under PO 00335 within Project S112 filed in 1.6.3 |
| S112/00442/1.6.1 | A letter under PO 00442 within Project S112 filed in 1.6.1. |

Vendor Equipment (Documents, Correspondence, & Drawings)

Vendor equipment information should be filed by purchase order within the project number and if possible double filed by the standard file system number.

Contracts

All contract information and documentation should be filed under the contract number within the project number.

Engineering Study File

A file should be kept of all completed engineering studies. Such studies would include borehole test reports and major engineering studies for productivity improvement, etc. These studies can be cataloged as follows:

	<u>Denotes:</u>	88	57	012
88	Engineering Study			
57	Major Area			
012	Serial Number			

An index is kept in the first file of this group of files. The title, consultant's company name, report number, author, and date are also recorded. The engineering secretary or other approved person assigns the index number.

Consultants File

A file of engineering consultants is usually maintained in alphabetical order. Each company resume is dated so that when superseding company resumes are received, the outdated resumes can be discarded. The following are some categories for consultant files:

Civil	Mechanical
Environmental	Structural
Electrical/Instrumentation	Other

Contractor File

A file of contractors is maintained in alphabetical order by category, not by company. Again each company resume is dated so when superseding resumes are received the outdated resume can be discarded. The following are some categories:

Civil	Piping
Electrical/Instrumentation	Structural
Mechanical	Other

Vendor File

A vendor brochure file is also kept in the engineering area. This information is filed by type of equipment and/or vendor service, not by vendor. You should date and put a file code on all literature deemed worthy of keeping for future reference. Following is a suggested list of vendor headings for an industrial plant:

- Agitators
- Air Compressors
- Air Conditioners
- Boilers
- Cleaners
- Coatings
- Conveyors
- Electrical Equipment
- Evaporators
- Fans
- Heat Exchangers
- Hydraulics
- Instrument Equipment
- Piping
- Pneumatics
- Presses
- Pumps
- Structural Components
- Tanks
- Vibrators

Plant Equipment Files

Documentation on all plant machinery should be kept in the plant equipment files located in the engineering area. The maintenance department also keeps a duplicate set. These files are indexed using the equipment number.

Drawing Revisions

Revisions are changes and/or additions to “technical” information on drawings. Each plant and consultant will have a specific procedure for drawing revisions. One method is to use issue letters until the drawing is “Certified For Construction” (CFC; or AFC–“Approved For Construction”). Once the drawing has been issued CFC, then revision numbers are used. The first issue of the CFC drawing is Revision 1 not 0. There is no Revision 0. You will go from the last issue letter to Revision 1.

Once a drawing has been issued you must make sure that any revision descriptions noted in the revision column are correct, dated and signed, and the correct revision number is shown in the revision block and in the box next to the drawing number. Make sure you check all this information before prints are made. A mistake with revision numbers or other drawing issue information can create problems after the drawing has been issued. So get it right before it gets printed!

There is no such thing as “General Revision.” All revisions should be clearly indicated on the drawing and described in the appropriate space. When a revised drawing is received on site or at the manufacturer, the revisions are noted and the work carries on. When you issue a drawing as a General Revision, someone has to spend the time to check every detail to see what has changed. This is poor engineering and laziness on the part of the engineer/draftsman. You can get backcharged by contractors if they have to spend too much time looking for revisions on “General Revision” drawings.

Method

A typical drawing revision procedure is as follows:

- The change will be described in the revision column with a clear and concise description of the revision.

- The revision will be identified correctly on the drawing (see “Identification of Revisions” below).
- A sequential numeric code is used. The first revision will be 1, the second 2, and so on.
- At the time of issue, you will determine that the drawing revision is properly closed off, i.e., the revisions have been checked and approved.

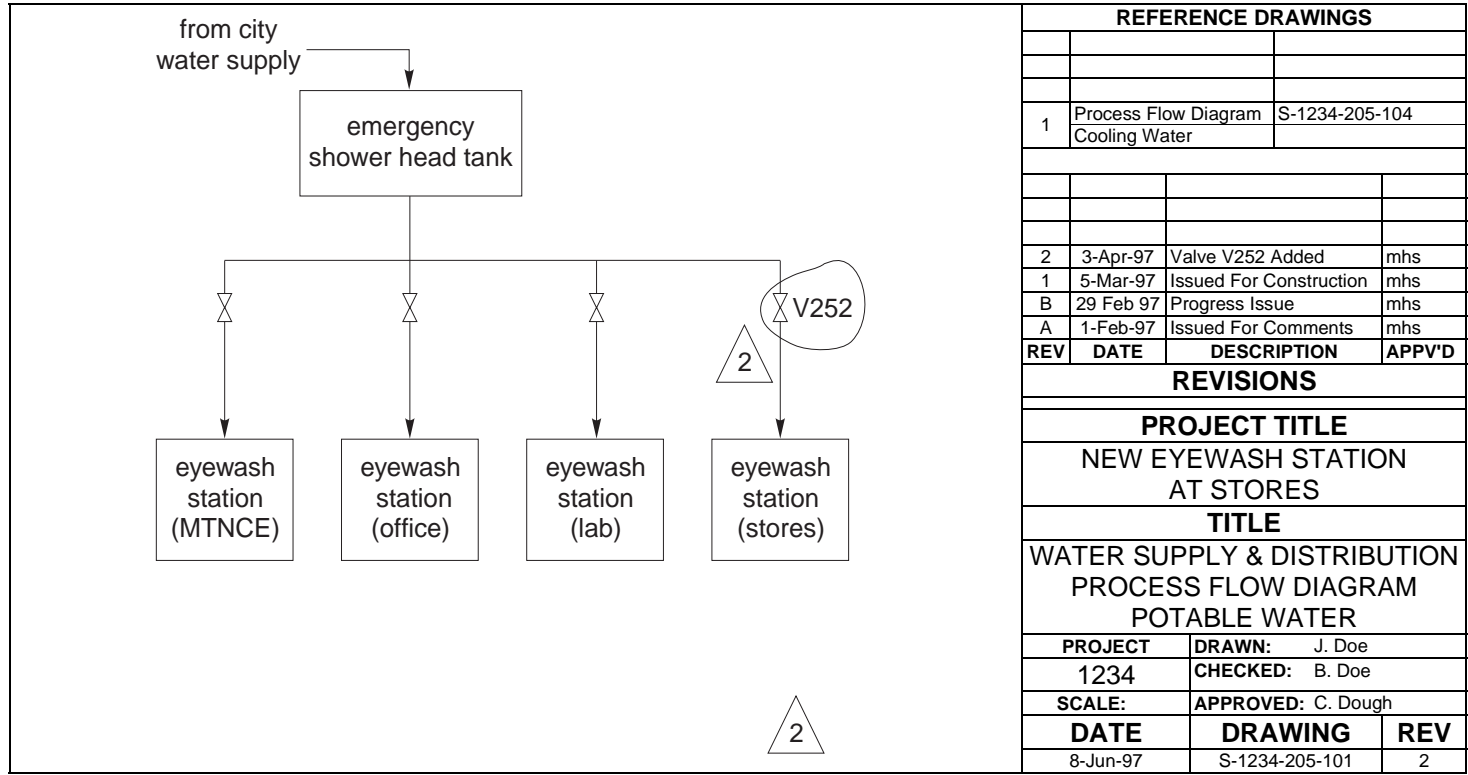
It is important that drawings be checked and approved and the initials put in the respective boxes on the drawings. You should not issue drawings “CFC” that have not been checked or approved.

Identification of Revisions

To cut down on the time and cost of locating drawing revisions, revisions are usually indicated with flags and by clouding (see Figure 3.1). This may seem like a trivial matter but on large piping drawings it becomes very important as the drawings can be cluttered and revisions difficult to find.

A typical revision procedure follows:

- Each change or addition should be clearly clouded and identified with a triangular flag containing the current revision number. The clouds are drawn on the back of the tracing with a soft pencil. Lines circling the previous revision should be removed. This is done with CADD drawings as well. On CADD drawings the revision is clouded on the computer file which shows up on the drawing.
- The flags are placed next to the spot where the change was made. To clearly indicate its location, additional flags are placed along either the right hand or lower outside border of the drawing. Aim the flag by pointing one corner of the triangle toward the change.



REFERENCE DRAWINGS			
1	Process Flow Diagram	S-1234-205-104	
	Cooling Water		
2	3-Apr-97	Valve V252 Added	mhs
1	5-Mar-97	Issued For Construction	mhs
B	29 Feb 97	Progress Issue	mhs
A	1-Feb-97	Issued For Comments	mhs
REV	DATE	DESCRIPTION	APPV'D
REVISIONS			
PROJECT TITLE			
NEW EYEWASH STATION AT STORES			
TITLE			
WATER SUPPLY & DISTRIBUTION PROCESS FLOW DIAGRAM POTABLE WATER			
PROJECT	1234	DRAWN:	J. Doe
		CHECKED:	B. Doe
SCALE:		APPROVED:	C. Dough
DATE	DRAWING	REV	
8-Jun-97	S-1234-205-101	2	

Figure 3.1 Drawing Revision Example.

Chapter

4

PROCUREMENT

Request for Quotation - General

Before anything can be purchased for the plant, you will have to get a price quote on the item or service from a vendor or contractor. The standard method of getting this price quote is to use a request for quotation (RFQ). As you will see later, the documentation you send out will have to define clearly what you require. The information is sent to the required number of vendors and if the process is followed correctly, all vendors receive the same information and are bidding on the same thing. When the required information comes back, make sure you are comparing “apples to apples.”

Case History 14

I was working for Central Engineering, and got involved in a project about half way through it. The plant had begun a major machine rebuild and were now in well over their heads. They had purchased a used plant in the UK and had entered into a contract with a demolition company. The RFQ scope was poorly written and the contractor had them over a barrel. At every major step in the removal of equipment the contractor demanded more money before he would proceed to the next phase. He destroyed part of the building getting some of the equipment out (he dropped a forklift through the roof to make an opening) and he destroyed some of the equipment to get it out. (He actually cut the trucks of a bridge crane in half to get them out, then crated them and put them on the boat.) The project was overrunning so bad that the scope was cut to what was affordable. I

sat in on one meeting where the plant project manager had to tell a senior VP that the overrun had increased by \$750,000.00 in one week! The equipment eventually came over on a boat (it was a pile of junk), was stored in various locations around the plant, and was never used. This was a case of not defining the project scope and signing a contract based on this poorly written scope.

Every year accountants audit your companies' books. They are making sure the business is run according to accepted business practices and operating within the law. By issuing the RFQs and using the bidding process, you are proving to them that the plant is following these standard accepted business practices. The RFQ is just one item of good business practice you should be following. You are also showing the company shareholders that the plant is getting the best value for the dollars spent.

The bidding process keeps you honest; that is, no one can accuse you of just giving work to your friends or showing favoritism to others. You should only give work to your friends if they have followed the bidding process and you can honestly justify using them over others. This aspect of the bidding process is more important if your plant is in a small town and the plant is the major employer. Keep your business relationships above board. In small communities, some business people do not understand the bidding processes and assume favoritism for others when they loose out on work.

You should keep the bidders list to a minimum. Usually three bids are required. Sometimes you will only find one or two qualified bidders and other times you will find too many qualified bidders. It makes no sense to get lots of bidders as it only makes more work for you and there may be no cost advantage. Deal only with bidders you are happy with and want to deal with. Government projects let anyone bid. There are no restrictions on the number of bidders, and the bidders have to pay for the bid documents. Privately owned businesses do not operate on the same principle and you can limit the number of bids and choose who you want on the bid list.

It costs money to prepare a bid and for large projects it can cost the bidder upwards of a \$100,000.00. It is not good business practice, nor fair, to ask a bidder to quote if you do not intend to use him. In the long run you can sour business relationships for a long time by doing this. With the increase in the number of EPC contracts being used, some companies are paying the bidders to prepare a quote. This way, the owner can get qualified bidders to bid, who may otherwise not bid because of the cost involved in putting a bid together.

Request for Quotations - Types

You will have to work with basically two types of RFQs. They are:

Type 1:

Those that are for equipment only with no manpower being supplied on site (other than start-up people), e.g., pumps, screens, heat exchangers, complete process package of several pieces of equipment, etc.

Type 2:

Those that are “supply and erect” or “erect only.” Supply and erect involves a contractor supplying equipment, material, and manpower to install the equipment. Erection only involves the contractor supplying the manpower only to install equipment and material supplied by others, e.g., piping system, boiler package, etc. These types will be discussed in greater detail under “Construction Management.”

RFQs should be sent out only by the purchasing department or by you under the direction of the purchasing department. This is important as the required purchasing forms and terms & conditions (T&Cs) have to go out with the documents.

The purchasing group will help ensure that any information that is going to affect the contractor's price is in the RFQ documents. The purchasing group will have a better understanding of the bonding and insurance requirements. If these items are required, this type of

information has to be given to bidders before contract award. If you provide this information after contract award, you could be charged for an addition to the scope or an “extra” to the contract. An extra is any additional work that is over and above the signed contract scope. If you agree that the work is an extra, the payment of the extra is handled with a Field Work Order (FWO)

To give bidders sufficient information to respond with a meaningful price and to make sure you have control of the project, the RFQs should contain the documentation listed below.

Type 1 RFQ

This RFQ should contain as a minimum the following documents:

- a) Purchasing's Request for Quotation form (if available) including plant terms and conditions
- b) A Scope of Work, schedule or milestone dates, any specifications, drawings, and standards
- c) Plant conditions and standard component list
- d) Vendor data requirements
- e) Vendor information requirements
- f) Equipment specifications
- g) Material specification
- h) Any other information relevant to the equipment/project.

Type 2 RFQ

This RFQ should contain as a minimum the following documents:

- a) Purchasing's Request For Quotation form including plant terms and conditions
- b) An RFQ form or a tender form that includes a Scope of Work, general conditions, special conditions, schedule or milestone dates, drawings, and standards
- c) Material specifications
- d) Equipment specifications
- e) Any other information relevant to the project.

For both Type 1 and Type 2 RFQs the following documentation will have to be generated:

An RFQ Title and Number

As discussed previously, many RFQ numbers eventually become the purchase order numbers. These numbers can refer to different plant areas and type of contract. It is important that a number and title be issued for a RFQ, as the number will be referred to throughout the life of the project. Titles help others who do not know how the numbering system works find and organize the project documentation. The title should be clear as to what the RFQ is for.

List of Bidders

You should put this together with input from the purchasing group as required. Keep the following points in mind when making up the lists:

If you don't want to do business with a specific vendor/contractor, don't put him on the bid list. It always turns out that the one you don't want to deal with has the lowest price and you then have to justify to management why you don't want to deal with him. Say no to the vendor/contractor up front.

Be leery of contractors recommended by upper management or those that are friends of management. If they are awarded the contract, you will have trouble controlling the job, as they will always try to bypass you and deal directly with your superior.

Be aware that sometimes management does not want certain vendors/contractors or people on site. Always check with your supervisor about who to put on (or keep off) the bid list.

If in doubt about a vendor/contractor check their references and don't be afraid to leave them off the bid list. The aggravation of

dealing with a bad vendor/contractor is not what you want to do nor have the time for.

If the job is large it may be advisable to do a credit check on the vendors/contractors or have them fill out a qualification form. Keep in mind that you cannot find out if the vendor/contractor owes back taxes to the government. You can check the contractor's references about the garnishment of payments for back taxes or ask the contractor directly about back taxes. He may not tell you but at least you tried. The issue of back taxes is not a common occurrence, but you may be involved with the issue at least once in your career.

If the contractor owes back taxes and the government finds out he is working, his payments will probably be garnisheed. As you can imagine, this is one headache you want to avoid at all costs. Unfortunately you can't do much about it until it happens. When it does happen you will have to get legal advice and will more than likely have to make arrangements to pay his subcontractors directly and bypass the contractor. What is left over from the subcontractors will go to the government. At least this way you can keep the project going.

Equipment Specification

You will have to prepare the equipment specification. The plant may have standard forms available, which should be used or followed. The form is important as it describes what you want and should address the following items:

- a) Scope of Work;
- b) What is included in the work?
- c) What is not included in the work?

- d) Design criteria and what the equipment will be used for. It is important that the supplier know what the end use is so your quote is based on a suitable item. Your specifications may be wrong and this is a chance to have an outsider more familiar with the products correct the specification. If you get the wrong item and have problems after installation, at least you have some recourse, as the supplier knew exactly what you were going to use the item for and he should have supplied something suitable.
- e) Material and component specifications should be as complete as possible with what you know at the time.
- f) Equipment tagging. This is a standard size stainless steel numberplate that is attached to all equipment in the plant. The plant should have a description of a standard equipment tag on file. Equipment tagging also describes how all the shipping crates or loose items should be marked for easy identification by the receiver.
- g) Proposal requirements. State how many copies of the proposal do you want so you don't have to do the copying. For large quotations it could cost you to get additional copies from the vendor.
- h) Performance guarantee. If the vendor does not have a guarantee you agree with, develop one that everyone agrees on. Do not sign a contract or issue a purchase order unless you have a performance guarantee that everyone agrees on.
- i) Warranty. If you want other than the standard warranty requirements, describe specifically what you want.
- j) Acceptance. How will everyone know when the piece of equipment is performing satisfactorily and the supplier's warranty starts?

Guideline 24

{Always give a paint specification. Give the contractor or vendor two or three choices of manufacturers, but spell out what type of paint material you want. If the contractor or vendor wants to use his own specification, review the specification and approve or disapprove it. If you do not spell out what you want, you will likely get colored water}.

Vendor Data Requirements

Guideline 25

{The information the vendor supplies to you will be used in the bid evaluation. The information requested has to do with the design. The information is used to see if the equipment is suitable and will it fit in the space assigned. If the equipment does not fit, what additional costs are required to make it fit?}

A. Information Required with Your Proposal

1. Components

In addition to describing fully the proposed equipment, the vendor shall also specify in full detail any of the following components, which may be purchased by him to constitute part of the proposal. These components should conform to the Plant Conditions and Standard Component List (*attached*) and vendor shall advise which components do not conform to the plant standard.

Pipe & Fittings:

- Dimensional specification, metallurgy, wall thickness, and method of manufacture.
- Valves - Manufacturer, model number, type, and metallurgy.

Electrical:

- Motors required for equipment operation (whether included in bid or not), recommended hp, speed, and characteristics.
- Other electrical components: manufacturer, model, type, and rating.
- Gear Reducers - Manufacturer, model number, type, service factor, and A.G.M.A. (American Gear Manufacturers Association) rating.

Guideline 26

{Most plants have purchasing agreements with motor manufacturers and get very good prices from them. The plant will usually purchase the motor separately and, if necessary, have it sent to the vendor for mounting with the equipment.}

2. Proposal Drawings

Drawings should fully illustrate:

- The physical dimensions of equipment specified.
- The necessary clearances around the equipment required for operation and maintenance.
- Special foundation requirements.

Guideline 27

{Requiring dimensions allows you to prepare a layout to see if the equipment will fit. If it won't fit, consider what would be required to make it fit and whether or not this is worth doing. Similarly you want to know about the foundation. A foundation out of the ordinary could result in a higher cost or affect operation of other equipment.}

7. Equipment Operational Services

The quantity and rating of all services required to operate the equipment, such as steam, compressed air, oil, gas, water, electricity, etc.

Guideline 32

{This information is required to determine if existing plant services are adequate}.

8. Metallurgy

Full metallurgical detail of the proposed equipment.

9. Erection and Startup Supervision

The daily charge-out rate, including subsistence cost, for qualified field engineering personnel deemed necessary by the manufacturer to supervise erection of their equipment.

The daily charge-out rate for an experienced operating engineer to assist startup and initial operation. State whether or not this service is necessary for guarantee purposes.

B. Performance Required by the Successful Bidder

The successful bidder will be required to perform to the following standards and/or conditions:

1. Codes

Local codes, standards, regulations, and labor agreements having jurisdiction over any part of the work covered in this bid shall be followed.

2. Structural

Fabricated steel components shall have sharp edges rounded and free of burrs, shall be welded in accordance with recognized good practice, and all weld spatter shall be removed.

Structural members composed of back-to-back angles shall not be used in the manufacture of structures or equipment.

Equipment anchor boltholes shall be $\frac{3}{4}$ " minimum anchor bolt diameter. Equipment bolted to frames and structures shall have the bolt heads on top of the connection components so that the bolts will not drop out of the holes whenever a nut works loose.

3. Mechanical

Baseplates shall conform to the following specifications:

- They shall be of rigid construction
- Adequate grout holes shall be provided on the top surface and vent holes in each corner.
- Equipment and drive setting blocks shall be welded to the baseplate and machined as an integral unit to assure the mounting surfaces are level with one another.
- The drive setting surfaces shall be a height that will allow $\frac{1}{8}$ " shims to be placed under the drive.
- Setting blocks welded to the baseplate shall have continuous seal welds (skip welding shall not be used).
- Baseplates shall be provided to suit the next larger motor frame size. Spacer blocks shall be welded.
- Equipment shall be fastened to the baseplate with cap screws.
- Bolts and nuts shall be American Standard Heavy N.C.2, electro-cadmium plated with hexagonal heads.
- Washers shall be installed under all nuts and under bolt heads that are placed in slotted holes or bear on cast metal or plastic materials.
- Beveled washers shall be used on tapered surfaces, such as structural steel flanges.

Guideline 33

{Your design drawing should specify a surface finish for the baseplate. Do not send out a baseplate drawing without a specified surface finish shown on it. You can purchase test coupons to compare surface finishes to ensure that you get what you asked for.}

The vendor shall supply bearing assemblies, couplings, sheaves, sprockets, V-belts, chains, baseplates, and equipment guards. He shall fit couplings, sheaves, and sprockets to his equipment as well as bore and key seat them to suit the shaft of the drives as required.

Guideline 34

{If you purchase the motor yourself, you may have to ship it to the vendor for fitting of drive components and testing of the equipment.}

4. Piping

- Carbon steel pipe, tube, and fittings for lubrication and hydraulic oil shall be pickled and passivated.
- Butt weld joints on lubrication or hydraulic oil piping shall have the inside of the joints ground to remove any slag.
- Threaded joints on lubrication or hydraulic oil piping shall have all cuttings and metal chips removed prior to assembly.
- Teflon tape shall not be used for threaded joints.
- Flange bolt hole drilling shall conform to ANSI Standard and shall straddle the centerlines.

Guideline 35

{If Teflon tape is not placed on the joint properly, small pieces can break off and plug up fine holes farther down the line.}

Contracts and Tender Documents

Normally, a plant will buy its own equipment and then hire a contractor to install it. When using this type of contractor service, a contract of some form should be entered into. A construction contract may take the following forms:

- A purchase order with the General Conditions For Site Contractors attached;
- A construction contract with a detailed tender document containing a Construction Agreement, General Conditions, and Special Conditions.

Your plant should have a standard tender document—ideally one where you can fill in the blanks with the required information. The document is prepared as part of a Request for Quotation and forms the backup to the construction contract upon the award of the work to the successful bidder. The next chapter will take you through a complete tender document.

When you use a construction contract with a tender document versus a purchase order with General Conditions is not a clear cut decision. Your decision should be based on your perception of how complex the work is, the level of risk to the plant of something going wrong, and the dollar amount of the work involved. As these factors increase, it is wise to consider the construction contract with a tender document as it provides more protection. As a guideline, the construction contract with a tender document should be considered for contracts over \$100,000 in value; however, using a purchase order with general conditions for contracts greater than \$100,000 but involving little complexity and low risk would be acceptable. On the other hand, for contracts less than \$100,000 but with increased risk, the construction contract with a tender document may be the better choice. In any situation involving on site labor, either one of these documents should be used.

One other way of getting around this issue is to add your new contract to an existing contract. If you have a contractor working on your site who is working under a construction contract with a tender document, you can issue a purchase order with general conditions stating that “all the conditions of Contract XYZ apply to this purchase order.”

The use of the purchase order with general conditions for small to medium sized design/build (EPC) and supply/erect contracts is suitable, as the tender document does not fit these applications very well. Major design/build and supply/erect contracts should be written specifically for the work involved.

Before preparing and sending the tender document, determine what type of contract you will be using. Examples of current types of construction contracts are:

1. **Lump Sum Contract or a Stipulated Price Contract.** In this type of contract the contractor will give you one price for all of the work. The contractor will have included money for his perceived risk. For you to get the best price, your scope has to be very well defined. If not, you will run into the problem of extras. In these types of contracts you do not have much say in how the work is to be carried out. If there are special construction requirements, they should be spelled out in the Scope of Work. If you try to change the requirements after contract award, it could result in an extra charge. Resist all attempts to make changes. Based on your scope, the contractor will determine how long he will be on site and include this in his costs accordingly. Any delays caused by the plant could result in an extra charge to the contract. Get unit prices to cover potential extras to the contract and you should get time and material rates for stoppages due to plant problems. Use this type of contract only when your scope is well defined. There is the potential for lawsuits with this type of contract. The Lump Sum Turnkey or Engineer, Procure, and Construct (EPC) contracts are of this form (see item 7).

Chapter 5

TENDER FORM AND INSTRUCTIONS TO BIDDERS

The tender document discussed here is for a Lump Sum contract and was developed for use in British Columbia, Canada. Treat it as a guide only and modify sections to suit your situation. As with all legal documents, you should get legal advice before using any of the wordings included here. With modifications, this document can also be used for all other types of contracts. You will have to review and change what does not apply to your particular contract. Your tender document should contain all the forms you want the contractor to submit and all the information you want him to track.

With word processing, it is simple to store this tender document once you have modified it for your plant. When you need to make up an RFQ, it is a matter of filling in the blanks. The footer should have the RFQ number in the bottom right hand corner to identify the documents. Make sure you change this number for each RFQ. Do not issue an RFQ with different numbers on the pages.

If you require more than one copy of the bid returned from the vendor/contractor, the tender document or RFQ should state how many copies are required to save you making copies later. It is easier to get the vendor to send the required number of copies with his bid. All bids should be sent to the Purchasing Department where the time of arrival and the bidder will be recorded. They will also follow up on bids not received by the specified deadline. Purchasing should open all quotes with or without your presence. Do not open bids yourself or

before the appointed time given in the tender document as this can lead to ethical questions.

All dealings with contractors should be above board and professional in every way. All correspondence during the bid period should be copied to the Purchasing Department. It is important that the Purchasing Department have a complete file of all correspondence as it all forms part of the contract or purchase order that will be written. Purchasing should be the one source of all information related to the bidding process, so keep them apprised.

With modern communications it is now normal for contractors/vendors to fax their bids by the closing date and send the original document by courier. Unless you have a secure fax machine, i.e., one that is not accessible to the general plant population, the faxes should be sent to the Purchasing Department. Normally faxes sent to engineering departments are left lying around the fax machine for everybody to read. This is not desirable as the bids are confidential information and should be treated as such. For the information you require, get a copy from the Purchasing Department leaving them the original.

The tender document is broken down into six sections. Section I is the Tender form, which the contractor is to complete and return to you. This is the document with his dollar value on it. The other five sections of the tender document are the backup material for the bid. The contractor keeps these sections as reference material.

Normally all technical questions are answered by you and questions regarding terms and conditions are answered by your Purchasing Department. All RFQs should state this, and it is important to include names, phone numbers, and fax numbers of the relevant contacts.

If, during the bidding process, a contractor has questions about the scope and how to do the work, you will have to decide if the other bidders should know the answer. If a contractor asks a question that will give him a competitive advantage, the answer should not go to all contractors. This situation usually comes about from the contractor

coming up with a less expensive way of installation and the other contractors should not benefit from his knowledge. Generally answers to questions regarding technical clarifications should be distributed to all bidders.

The progress payment forms are a standard format used throughout the construction industry. They were developed for use in Canada, so provincial sales tax (PST) and the goods & services tax (GST) is added on at the bottom of the form. You can use these numbers, change them, or delete them, depending on what the tax regulations are in your jurisdiction. The same applies to the holdback. You should prepare these documents in a spreadsheet format for automatic calculation.

The following numbered items correspond to the blanks in the tender document that have to be filled in.

1. Title of the project.
2. Project authorization number.
3. Request for Quotation number issued by purchasing. This number should also be put in the footer so it appears in the bottom right hand corner of every page.
4. Date bids are due
5. Name of the contractor to whom you are sending the Request for Quotation.
6. Contractor's full mailing address. This address may not be the mailing address later if he is the successful bidder, as he will set up on site. For legal issues, this should be the address where documents are to be sent.
7. The contractor enters his total value here. This value should be written out in words and a number value entered. Check to make sure they match. If they don't match, get the contractor to change it and resubmit the front sheet. Do not destroy the sheet that is incorrect, but file it with the RFQ.
8. The contractor fills this in. In Canada there is a goods & services tax. It may not apply in your jurisdiction. You can leave it out or put in the name of the tax that applies to you.

9. The contractor enters the total cost for his labor. If you subtract 8 and 9 from 7 you should get a rough idea of what the contractor's material and equipment costs are.

Item nos. 10 to 16 refer to the Statement Regarding Outstanding Claims. This form was developed to get around the problem of a contractor submitting a claim months after the work is finished and to allow you to keep track of extra charges. The contractor should be told before contract award that this form has to be submitted with his progress payments, and he can not submit a claim unless it has been identified on this form. This form is left blank in the tender document for the successful contractor's use after contract award. The contractor should fill in all the information:

10. Contract number
11. Contractor's company name
12. Contract title
13. Date contract was issued
14. Invoice date
15. Contractor's signature
16. Company position or title of the person signing the document
17. Witness to the signature
18. Area for the Additions (ADDS) and Deletions (DELETES) you want to apply to the contract. There are times when you will want to add extra work to your scope and other times when you will want to delete items from your scope. To keep control of your costs, you ask the contractor, at the bid stage, for unit prices to cover the items you may want to add (additions) or delete (deletions) at a later date. Examples would be earth works, concrete in foundations or walls, steel, valves, piping, pipe fittings, cable, terminations, etc. If you do not ask for these unit prices before contract award and have them written into the contract, you are at the mercy of the contractor to provide reasonable unit prices later. List all items for which you require a unit price. These are items you feel are not well defined in the scope. You should also make a list of Deletes. You will receive credit for deducting these

**MHS Engineering Services Inc.
P.O. Box 600
Anywhere, B.C.
L5R 3T9**

Lump Sum Tender

List of Tender Documents

Section	Title
I	Tender Form
II	Instructions to Bidders
III	Scope of Work
IV	Drawing List
V	Specifications and Standards
VI	Agreement & General Conditions of Contract

Section I
Lump Sum Price
Tender Form

MHS Engineering Services Inc.
P.O. Box 600
Anywhere, B.C.
L5R 3T9

Project Title:

P.A. No:

Inquiry No: **Closing Date:**

Name of Contractor:

Address of Contractor:

1.0 Having carefully examined the tender documents and drawings listed herein for the above titled project, we propose to furnish all materials, supervision, labor, plant, equipment, and tools required by and in accordance with the said documents for the entire work including all duties, municipal, and federal taxes, for the lump sum of:

\$	7
----	---

The amount of Goods and Services Tax included in the above Lump Sum Tender price is: \$

8

The Site labor content (including all labor, supervision, fringe benefits, payroll burdens, travel allowances, etc.) included in the above Lump Sum Tender price is: \$

9

1.1 Cost and Billing

1.1.1 Billing Procedure and Cost Breakdown

It is understood no advance payments will be made. Progress payments will be made as the work progresses on the basis of Monthly Progress Invoices submitted (see attached form) to the Project Engineer. The applicable holdback as required by law will be released upon acceptance of the work by the Owner.

The Lump Sum price quoted in Section 1.0 is broken down as specified on the attached Progress Invoice form. The breakdown of the total price is required to assist in comparison of bids and for accounting purposes only.

Contract Change Notifications and approved Field Work Orders will be submitted on separate forms provided by the Owner when required.

Chapter

6

SCOPE OF WORK, DRAWINGS, AND SPECIFICATIONS

All projects revolve around the management of scope, schedule, and budget. Chapter 5 laid out the information needed from the contractor for the management of schedule and budget. This chapter guides you through the information that you will have to provide to the contractor to create and manage the scope. This scope of work was developed for a greenfield plant where the owner was providing the utilities for the contractors. The plant was constructed in northern British Columbia and at the construction peak there was a work force of approximately 570 people.

The greenfield plant was on the edge of a small town and the building lot was a forest when the project started. Following is the scope of the services and utilities that the owner had to provide before construction started:

- A contractors parking lot had to be built and it had to be expandable. Plugins for the cars in winter were not provided even though -40 C temperatures were anticipated.
- Roads around the site had to be built so that machinery could get around any road blockage.
- The owner was going to supply the sanitary facilities so a new potable water line was run onto the site. This was a tie-in to the firewater line. This provided water to the washcar and office facilities.

- The owner was also providing construction power so a power line had to be run in to the new construction power transformer. Power cable then had to be run to various locations around the site for the contractor's power panels.
- Telephone lines had to be run onto the site and a central junction box installed. This allowed the contractors and new plant to have phone service.
- A washcar with sanitary facilities for both men and women was rented and installed in a central location. (You do not want people wasting time walking too far.) There was no sanitary sewer close to the site so septic tanks were used.
- As it was a clear site and would eventually have a large warehouse, the surveyor ran in three different survey points so there would be reference points that could be seen as the building was erected. Once the building got to a point where the reference points could not be seen, the surveyor came back and moved the points inside the building.
- A construction office had to be built using rental trailers. They were set up so that more trailers could be added should the need arise.
- As the owner was the general contractor they were responsible for the first aid room for the whole site (570 people). This first aid room was built inside the main office trailer. This was staffed by a safety officer hired by the owner.
- Areas for laydown of materials and contractors trailers had to be leveled and gravel put down.
- A security perimeter had to be fenced and a security gate set up. Security had to be arranged for nights and weekends. We visited the local fire department to let them know we were out there and had them come out for a visit to see what the site looked like.

Section III

Scope 3 **Included in the Work**

3.1 The following list of work to be performed by the Contractor is presented to complement or clarify the Construction Drawings, Specifications, and other Contract Documents, but shall not limit the “Definition of the Work” as described in Scope 2, nor shall it constitute a complete list of the work.

3.1.1 General

1. Providing the Owner with proof of insurance prior to commencing work.

Guideline 50

{Your plant requires this to ensure that the plant property is protected. Make sure you get this before the contractor starts work and if it expires during the contract period, make sure you get a copy of the new policy. Do not let a contractor work on your site without proper insurance coverage.}

2. Prior to commencing work and prior to receiving final payment, provide the Owner with evidence of compliance with the requirements of the workers compensation insurance including payments due thereunder.

- (a) At any time during the term of the Contract, when requested by the Owner, the Contractor shall provide such evidence for himself and his Subcontractors.

Guideline 51

{You need the original letter from the Compensation Board, not a copy. People have been known to change dates on copies and the contractor may be in arrears. In certain jurisdictions in Canada, if the contractor is in arrears and the

Compensation Board finds out he is working for you, you are automatically responsible for his back payments. You can ask for a proof of payment with every invoice if you so desire. Everyone on your site should be covered by workers compensation insurance. If you are using an individual consultant, he may not be able to get coverage because he is a one-person operation. In these cases you can add them to the plant coverage by advising the Compensation Board in writing. All injuries should be reported, as even seemingly minor injuries can sometimes have long term affects on a person. Making a claim at the time of the accident could help prove a compensation claim years later for a related illness.)

3. Performing general work items listed in the General Conditions and Special Conditions.
4. Accepting the Site in its existing condition at the time work commences.
5. Submitting to the Owner, prior to commencing the Work on the Site, a list of the names of known supervisory, administrative, and other employees required on the Site and reporting any changes to the Owner as they occur during the duration of the Contract.

Guideline 52

{This information is required for plant security purposes. In case of emergency, you want to know who is on site and where they are located on the site. Also, there may be people you do not want on site and you can tell the contractor to keep them away. It is better to know *before* they show up on the site.}

6. Maintaining complete records at all times during the progress of the Work, in a form and detail of presentation acceptable to the Owner.

7. Submitting to the Owner a list of temporary buildings and building sizes that the Contractor intends to bring onto the Site, before mobilization of the structures. The structures should be propane heated. Owner will provide and hook up 120 volt power for lighting purposes only. The Owner will advise the Contractor of the Site where the temporary buildings will be located.

Guideline 53

{On most sites space is at a premium; therefore, you want to know in advance what the contractors are bringing on site. You will have to assign a location for him along with the other contractors you have on site. You will control the location of all trailers, washcars, and storage containers. Normally, you try to locate the trailers close to the work site. When assigning a site, try to envision what the site will be like when the trailer has to be removed at the end of the job. Will it be boxed in? Will it be in the way of landscaping? You may have to move the trailers before the end of the job if they are in the way.}

8. Providing First Aid personnel, equipment, and supplies, pursuant to Special Conditions and complying with the Province/State of **55** Occupational Health and Safety Act First-Aid Regulations for the duration of the Contract.

Guideline 54

{The first aid requirements increase with the number of people on site and as the distance from a hospital increases. If you are using the plant first aid facilities, you can charge the cost back to the contractors prorated by the number of people they have. You will, however, get the complaint that “my crews are safer than theirs, therefore we should not have to pay as much.” This has to be an across-the-board decision, and it has to be sorted out before you start.

Chapter

7

AGREEMENT AND GENERAL CONDITIONS OF CONTRACT

Section VI

Guideline 101

{This section is used to specify what contract document will control the project. This book references Canadian Construction Document Committee (CCDC) contracts (see Chapter 4); however, if your plant has its own contract, reference that. Make sure the contractors bidding on the work are familiar with your contract. If not give them a copy of it before you award them a contract to do the work.

The CCDC contract contains the following articles:

- Articles of Agreement
- General Conditions
 - General Provisions
 - Administration of the Contract
 - Execution of the Work
 - Allowances
 - Payment
 - Changes to the Work
 - Default Notice
 - Dispute Resolution
 - Protection of Persons and Property

Governing Regulations
Insurance and Bonds
Indemnification-Waiver-Warranty

These articles are not covered in the Tender Document. You will have to change your Tender Document to make it compatible with the contract you intend to use. Following are some changes that can be made to the CCDC2 contract document to reflect the plant conditions:)

- 6.1 The terms and conditions as detailed in the Standard Construction Document CCDC No. 2 (Stipulated Price Contract), latest edition, including Supplementary General Conditions for use in The Province of British Columbia, shall apply to this contract (document not supplied).

Guideline 102

{This is where you reference the contract you want to use.}

- 6.2 In Standard Construction Document CCDC No. 2 the term Consultant may not apply and should be deleted on a project by project basis.
- 6.3 Standard Clause GC. 20 Insurance, of Standard Construction Document CCDC No. 2 shall be considered deleted and the revised section GC. 20 enclosed with this inquiry shall apply.

Guideline 103

{If you are using a plant contract, this clause is not required. If using a different contract, the insurance and bonds section should reflect what the plant requires.}

GC. 20 Insurance & Bonds

20.1 The Contractor will, if requested by the Owner, provide the Owner with either or both a Performance Bond or Labor and Materials Bond in respect of the contractor's obligations under the Contract. Such bonds shall be in the form and in such amounts as the Owner may reasonably require from surety companies authorized to carry on the surety business in British Columbia.

Guideline 104

{A bond is a contract between the bonding company, the contractor, and the plant; it is not an insurance policy. The bonding company agrees to guarantee that the contractor will perform as specified. The performance bond is a guarantee that the contractor will perform his contract obligations. A labor and material bond is a guarantee that the contractor's suppliers and labor will be paid.}

20.2 The Contractor shall maintain during the performance of the Work, in form and with carriers acceptable to the Owner:

- (a) Comprehensive General Liability Insurance, and
- (b) Insurance covering all motor vehicles or other craft utilized by the Contractor, and
- (c) Insurance covering its equipment used in connection with the Work.

Guideline 105

{Contractors' employees bringing their personal vehicles on the plant property must have liability insurance that meets the plant requirements. The contractor requires vehicle insurance, per the insurance document and the employee bringing his vehicle on site also requires the same vehicle insurance per company policy. If the employee's vehicle does not have the required level of insurance, the vehicle is not allowed on site. Insurance should be checked as you can run

into trouble if the employee damages plant property and disrupts plant operations.}

The limits of liability insurance described in (a) and (b) shall be \$2,000,000 per occurrence. The insurance referred to in (a) shall name the Owner, its directors, officers, and employees as named insureds, and shall include liability and completed operations coverage. The insurance referred to in (b) and (c) shall waive rights of subrogation against the Owner, its directors, officers, and employees.

Guideline 106

{The liability amount of \$2,000,000 should be checked as it may be too low.}

- 20.3 The Contractor shall provide the Owner with certificates evidencing all required insurance prior to starting the Work. All insurance shall provide that the Owner receives 15 days prior notice of any change or cancellation.

Guideline 107

{Check your company procedure regarding the requirement of bonds. Also check the limits and types of the insurance required. Make sure you have copies of these documents before the contractor commences work.}

Special Conditions for Site Contractors

1. Job Conditions

- a) The Contractor agrees that he is familiar with the premises, drawings, and specifications, accepts the conditions that will exist in performing the Work, and the price for this Contract was established with full consideration of such acceptance. The Contractor shall perform the work under the direction

and to the satisfaction of the "Owner's representative" designated in a written notice from Owner to Contractor. The Contractor shall cooperate with the Owner's representative and other contractors on the premises and shall carry on the work as not to hinder, delay, or interfere with the operations of the Plant or other Contractors.

Guideline 108

{Advise the contractor who has the authority to act on the plant's behalf in the normal management of the project. You may even outline that person's responsibility, e.g., can he issue field work orders? This can be done at a meeting and recorded in the minutes or you can advise in writing. There has to be one person in charge from the plant to prevent confusion.}

- b) The Contractor shall bring to the immediate attention of Owner's representative any discrepancies or errors found in the work performed by others.

Guideline 109

{The contractor should make sure, before he starts his work, when interfacing with someone else's work that the work he is interfacing with is correct.

Examples would be:

- A mechanical contractor placing a tank on a foundation done in error by a civil contractor.
- An electrical contractor attempting to hook up a motor supplied by others, with the connection box on the wrong side of the motor.}

2. Supervision

- a) Contractor shall keep on the project continuously during the progress of the Work a competent general superintendent and any necessary assistants, all to be satisfactory to the Owner's representative. The Superintendent shall not be removed from the project and another substituted for him except with the consent of the Owner's representative unless the Superintendent ceases to be in the Contractor's employ. The Superintendent shall represent Contractor in his absence and all directions given to the Superintendent shall be as binding as if given to the Contractor.

Guideline 115

{You do not want the contractor to take a good supervisor off your job and send him to another project. Keep on top of this, as contractors will hide a superintendent on a job site while waiting for his real assignment to start up on another project. If the superintendent is good, you do not want him removed to the detriment of your project.}

3. Temporary Services and Facilities

- a) Unless otherwise stipulated, the Contractor may use the following services at locations on the site as determined by the Owner's representative. All hoses or cables, etc. required to run from the service location to work site will be supplied by the Contractor.
 - i. Electrical power is 120V, single phase, AC and 600V, three phase, 60Hz. Contractors shall be notified by Owner's representative of any power outage, times, and dates. Contractor to provide their own construction power panels which will be hooked up by the Owner. Contractor to advise Owner of power requirements prior to contract award.

List of Tools and Equipment

Item	Item

Date of Entry: [] date tradesman brings tools on site AM/PM
 Contractor: [] name of contractor
 Contractor's Signature: [] signature of contractor
 Guard's Signature: [] signature of guard on duty
 Date of Exit: [] date tools are removed from the site AM/PM
 Contractor's Signature: [] signature of contractor
 Guard's Signature: [] signature of guard on duty

A Removal Permit must be obtained for all items being removed before completion of Contract.

Guideline 142

{The above form is only used when the tools and equipment first arrive on the site and at project completion when the contractor is demobilizing the site. For those times in between, the plant should have a Removal Permit system in place, and this Removal Permit should be used.}

- b) Owner's representative shall have the right to require Contractor to complete work of the Project or any part thereof before the date set forth in the construction schedule or to require Contractor to complete work of the project according to the construction schedule when his claim for delays has been ruled valid by Owner's representative. Contractor may submit a claim for reimbursement of any additional costs to him that can be shown to be the direct result of the exercise of such right by Owner's representative.

Plastic Control Guidelines

Schedule I, Part A

Guideline 153

{This is an example of the type of guidelines you can develop for your plant. In this case, plastic created a big problem if it got into the pulp process since it melted and fine particles did not come out in the process. If your plant has metal, plastic, paper, glue, or some other contaminant that has to be kept out of the final product, use the following to develop a guideline.}

Case History 16

In one pulp mill we were getting plastic contamination in the final product. There were already restrictions on plastic use in the plant. The cafeteria went to metal utensils. They changed the hearing protection to ear muffs and outlawed plastic combs. This cleaned up most of the problem; however, there was still plastic getting into the process but it was not consistent. As the plant used wood chips to produce the pulp, each load was sampled to determine payment. Someone noticed that one of the people doing the testing was eating his lunch on the chip piles and discarding his plastic sandwich wrappers into the pile. This was the source of plastic that was giving the problem. This points out that you have to look at every detail to keep contaminants out of the system.

Plastic type material can contaminate the pulp produced on this site; therefore, any synthetic material such as polyethylene, polypropylene, and Styrofoam must be managed very carefully by the Contractor to ensure that the material does not get into the pulp process.

As a Contractor working on site, you have the obligation and responsibility to minimize the quantity of harmful plastics entering the site and whenever these contaminants are used, careful usage and control must be exercised and proper disposal in suitable containers must occur.

The following are SOME guidelines involved in successful plastic control:

1. Roping off areas - Polypropylene rope (yellow in color) will not be used. Jute or hemp rope will be used.
2. Slings - Polypropylene slings are banned. Use steel cable, hemp, or nylon slings as alternatives.
3. Signs - If plastic signs are used, they must be securely fastened to ropes, walls, sign posts, etc. to prevent the wind from carrying them away and into the process.
4. Consumable items - These must be disposed of as soon as possible. Examples include oil and coolant containers for portable welders and compressors, welding rod packing, etc.
5. Packaging - The mill stores will remove as much plastic packing as practical.
6. Employee items - Combs, ball point pens, thermos bottles, lunch kits, and associated items are serious problems if they enter the system. Employees must be aware that saran wrap, baggies, etc. should be carefully discarded in garbage cans. Employees can also help by using pencils instead of ball point pens and by using "nylon" combs.

Chapter

8

BID MEETINGS, BID EVALUATION, PURCHASE ORDERS, AND CONTRACTS

Bid Meetings

For all contractors to have the same understanding of the extent of the work you should hold a bid meeting on site that includes a visit to the location of the work. On site bid meetings are normally held with equipment vendors. There is a section in the Tender Document for advising of the time and place of the meeting. You cannot force a contractor to attend but it is usually advised that they do. Unless you are pressed for time, allow at least two weeks between sending out the bid package and the bid meeting. This will give the contractors reasonable time to make arrangements to attend your meeting. If you are pressed for time and your contractors are local, you can have the meeting within a week after issuing the bid package. A few days before the meeting send a fax requesting a response from those who will be attending the meeting to get a feel for how many will be there.

Make sure you have a meeting room reserved and if there are any meeting location changes advise the contractors in writing before the time of the meeting. Advise your plant security of the location and whom you expect will attend. Give him the location of the meeting so he can give proper directions to the contractors; otherwise, they may end up wandering around your plant. If the contractors need their vehicles or special safety equipment for the site visit, advise the security guard.

Arrange for an assistant to take minutes at the meeting so you can concentrate on the discussion at hand. You also may need a second opinion in case something comes up later about the meeting. Have a sign-in sheet and ask everyone there to sign their name, print it out, and print the name of the company they are representing. Keep this list for future reference. Start the meeting on time, as it is not fair to those who are punctual to have to wait for those who are late.

Have an agenda for the meeting outlining what will be covered in the formal meeting and in the site visit. At the meeting start at the beginning of the Tender Document and go through every section. Review what you have asked for and what you expect to get back from the contractor. Ask if they understand what you want and if there are any questions. You do not have to have all the answers at the tip of your fingers. You can advise the contractors that you will get back to them, in writing, within the next few days.

Review the drawings, standards, and specifications at the meeting. If you have additional or revised drawings, issue them to the contractors at the meeting and review what the changes are. After the drawing review, go through the Special Conditions and make sure the contractors understand what services and utilities you will and will not provide. Any misunderstanding in this section can result in an unwanted surprise to the contractor, which you do not want.

Once you have covered all the written issues, drawings, and specifications and there are no more questions, it is time to take a site tour to see the work location. Take note of who is on the tour. On the tour make sure you point out the locations of the services such as water, air, power, washrooms, trailer area, and parking. If it is a greenfield site, explain what the set-up will be and where the above noted services will be located on the site. Take note of any questions answered and include them in the meeting minutes. Make sure all contractors understand the site conditions and any hazards the site could impose on them.

When the meeting has finished it is imperative that the minutes be written and issued within 24 hours. These minutes will form part of the contract documents. You can include clarifications in the minutes or send them out under separate cover as an addendum. If questions come up between the meeting and the bid due date, respond in writing to the pertinent people. These responses will form part of the contract. You will get requests to extend the bid due date. If all contractors are requesting an extension, you may not have allowed enough time for the bid to be prepared. You have two choices:

- If you are pressed for time with your schedule, you can refuse to extend the due date;
- You can extend the due date as you see fit.

If only one contractor wants an extension, you will probably have to deny the request.

The contractors' quotes and equipment vendors' quotes should be sent to the purchasing group where they will be collected. They are date stamped when received and collected until the time of the opening. If you receive any, you should give them to the purchasing group unopened. Make arrangements with the purchasing group to meet when all the quotes will be opened. Once opened, they have to be compared to determine the successful bidder. This comparison is called the bid evaluation.

Bid Evaluation

The bid evaluation process is used for both contractors and equipment vendors and involves comparing all the quotes in a systematic and organized fashion. The bid evaluation is the lead-up to a pre-award meeting which:

- will be your last chance to make changes, request exactly what you require, and have this included in the price.
- is the opportunity to ask questions and clarify your understanding of what is included,
- allows you to negotiate quoted prices you may not agree with.

The evaluation should be done in a spreadsheet format where items can be compared across all bidders. It is important to do this comparison on a spreadsheet as it:

- makes the differences between bidders easy to see;
- allows those who require specific information to get what they require very easily.

Because most of the information in the bid evaluation will appear on the purchase order, be as organized as possible so you only have to sort out the information once and then copy it to the purchase order. The bid evaluations should be considered confidential information and treated as such. Do not make them a general distribution document.

The following items should be included in the bid evaluation. (Their order is not important.) The items apply to both equipment vendors and contractors. This exercise may seem trivial for some small bids; however, no matter the size of the bid, the same amount of work has to be done. Only by doing this for the small projects do you get the experience required for the bigger projects.

Price Inquiry Number

This allows you to reference the correct bid package.

Price Inquiry Name

This lets others not familiar with the numbering system know what bid you are evaluating.

Date Evaluation Done

For reference purposes only. If you do not record this, you will forget when you did the evaluation.

Bid Evaluation Checklist

1. Price Inquiry No. Shown <input type="checkbox"/>	8. Delivery <input type="checkbox"/>
2. Price Inquiry Name <input type="checkbox"/>	Date of Shipment <input type="checkbox"/>
3. Date Evaluation Done <input type="checkbox"/>	After Approval Drawings <input type="checkbox"/>
4. Vendor Information <input type="checkbox"/>	What Will Be Supplied <input type="checkbox"/>
complete address <input type="checkbox"/>	How Many <input type="checkbox"/>
name of contact person <input type="checkbox"/>	What Type <input type="checkbox"/>
phone number <input type="checkbox"/>	What Size <input type="checkbox"/>
fax number <input type="checkbox"/>	Match Vendor Date Req'd <input type="checkbox"/>
quote number <input type="checkbox"/>	9. Shipping <input type="checkbox"/>
5. Technical Evaluation <input type="checkbox"/>	How Shipped <input type="checkbox"/>
Mechanical <input type="checkbox"/>	Shipping Weight <input type="checkbox"/>
Piping <input type="checkbox"/>	Shipping Dimensions <input type="checkbox"/>
Civil <input type="checkbox"/>	Humidity/Temp. Restrictions <input type="checkbox"/>
HVAC <input type="checkbox"/>	Suitable for Outside Storage <input type="checkbox"/>
Electrical <input type="checkbox"/>	10. Warranty <input type="checkbox"/>
Instrumentation <input type="checkbox"/>	Warranty or Performance <input type="checkbox"/>
Codes and Standards <input type="checkbox"/>	11. Startup Services <input type="checkbox"/>
Highlight Differences in Bids <input type="checkbox"/>	Number of Days Included <input type="checkbox"/>
6. Price <input type="checkbox"/>	Includes Travel and <input type="checkbox"/>
US or Canadian Funds <input type="checkbox"/>	Expenses at Cost <input type="checkbox"/>
Firm or Subject to Escalation <input type="checkbox"/>	Rate for Additional Days <input type="checkbox"/>
Exchange Rate <input type="checkbox"/>	Training Provided <input type="checkbox"/>
Unit Prices for Add & Deletes <input type="checkbox"/>	How <input type="checkbox"/>
Taxes Included <input type="checkbox"/>	Freight Allowed <input type="checkbox"/>
(break out if included) <input type="checkbox"/>	12. Union Affiliation <input type="checkbox"/>
FOB Point <input type="checkbox"/>	Contract Expire Date <input type="checkbox"/>
Duty and Brokerage Included <input type="checkbox"/>	13. Certificates Provided <input type="checkbox"/>
7. Terms <input type="checkbox"/>	14. Spares Included <input type="checkbox"/>
Progress Payments <input type="checkbox"/>	Price of Spares <input type="checkbox"/>
Milestone Payments <input type="checkbox"/>	15 Vendor References <input type="checkbox"/>
Subject to Holdback <input type="checkbox"/>	16. Local Content <input type="checkbox"/>
	17. Area Representation <input type="checkbox"/>
	Closest Warehouse <input type="checkbox"/>

Chapter

9

CONSTRUCTION MANAGEMENT

Where Does it Start?

When the concept of construction management is mentioned, most people think of it as directing contractors on and around a plant or construction site. They believe that once the purchasing group has awarded the contract, a construction manager is appointed to oversee the administration of the contract. In many cases this is true; however, construction management generally involves more than this.

Construction management starts in the project design phase and runs throughout the project to its final acceptance. As the construction manager you should be involved in the design, procurement, and construction phases, i.e., throughout the project life cycle.

If it has not already happened to you, there will come a time when you will have to work on a project where someone else has done all the up-front work and you have been left to pick up the pieces and make a success of the project. Not being involved in all phases of the project is one reason for project failures. So, for a reasonable chance at project success, you should be involved in all of the up-front work. You should be looking at the following:

- Does the layout allow the equipment to be installed at the least expense? Working in existing plants limits the available room for new equipment installation, so the location of the equipment can have an affect on the cost of the project. If you are working in the middle of a building, a helicopter may be needed to install equipment; however, relocating the equipment to an outer part of the building may allow a crane to be used. Sometimes moving a piece of equipment 10 feet will change the type of equipment required for installation.
- Is the design constructable? To play it safe, assume that the designer has limited knowledge about construction or what happens on a construction site. You may get lucky and get a designer who understands the field issues; otherwise, the designs produced will look good on paper but will not take into account others working in the area, existing items that may be in the way, or the sequence of installation. Sometimes if the designer does not know what to do, he will just leave the item out. (When in doubt, leave it out?) It then becomes a field problem. If the designer is lucky, he will be on another project before the field realize there is a problem. On large projects there can be many bombshells from this lack of field knowledge. The problems will come at you from all directions and at the least opportune time. Make yourself available for design reviews, as it will save you a lot of trouble in the long run.
- Does the design take construction safety into account? You will get a lot of designs where there has been no thought given as to how to install the equipment. Review what is being proposed and see if the installation can proceed safely. Using a helicopter for moving material, etc. sounds like fun, but in an operating plant it can become a problem to organize it so that the procedure is carried out safely.
- Is there room to maneuver around the equipment? Sometimes layouts are made so tight that installation and maintenance can be difficult. Always be prepared to maintain the

Construction Management

The size of the project and the experience of the plant personnel will determine how the construction management will be handled. For large projects, where the plant personnel have little experience at managing, a consultant can be hired to do all the management (project and construction). This is an extension of the design process and can be a separate contract; i.e., have one contract for the design and another contract for the construction management. The construction management can go to another consultant if he proves to be more experienced. This is quite common today. With this set-up the design consultant would design the plant and write/issue purchase orders on his own letterhead and the construction management consultant would organize and manage the site. The plant would have a person to keep track of the project and to work as liaison between the design consultant, the construction management consultant, and the plant to make sure the project runs smoothly.

If the project is small and the plant personnel have the experience, the plant can handle the project and construction management. Get a consultant to do the design and have him write and issue all purchase orders on plant letterhead. For plant personnel construction management can be a very time-consuming exercise and this creates a potential for problems, as there never seems to be enough time for adequate contractor supervision.

General Contractor

The above distinctions are important in determining who is the general contractor—the plant or a consultant. If a consultant hires the contractors on his purchase orders and is supervising the site, then he is the general contractor. If the plant issues the purchase order to the contractor, then the plant is the general contractor even though an outside consultant is hired to supervise the contractor. You have to be aware of who the general contractor is, as the general contractor is liable for the project. This means he is responsible for site safety, first aid, security, and directing all contractors on site who are associated with the project. Generally, on small projects plants do

not have a problem with the risk and are prepared to assume it. On larger projects it is too much risk for the plant to assume.

The biggest problem with being the general contractor is site safety. This includes responsibility for ensuring that there is a safety program in place and that the appropriate safety measures are being followed. This responsibility cannot be delegated to the site contractors doing the work. The contractor has to have his own safety program but it is specific to his trade. The plant must have a safety program specific to the plant. To protect the plant in case of a serious accident, you will have to show that you, as the general contractor, performed due diligence by being proactive with the safety measures. To protect yourself, notify the contractor in writing of any infractions, and point out to the contractor's personnel any time they are performing an unsafe act, etc. All conversations and actions taken regarding safety issues should be in writing and filed for future reference. Your best protection is to hire a safety consultant, trained in construction safety, to handle this issue for you.

This issue of safety is a big responsibility especially on a plant construction site. What is safe or unsafe depends on your perspective. If you do a tour with a construction safety professional, you will see that he looks at work practices differently than you do. He will pick out the infractions that you will miss because you are not trained to look for them or you are not familiar with the rules. You have to be vigilant and if you are not sure, question the act being performed. Do not turn your back on safety infractions and hope for the best. If there is ever a problem, you want to be able to prove to the authorities you were proactive and did what you could to make the contractor aware of safety issues, infractions, and errors in implementing his and your safety program. Always have the health and safety of those under your direction in mind when they are performing their job and discussing ways of doing jobs. You do not want a serious accident on your job site with the authorities holding you responsible because you were not diligent.

Contract Signing

Once all the bids are in and have been evaluated, it is time to make a decision. The short list contractors are selected and individual meetings arranged to discuss the final price. At this meeting you should review everything in the scope to satisfy yourself that the contractor has included all items called for in the tender document and that you both have the same understanding of all the items. This is your last chance to have items and prices changed without the penalty of an extra. Get a copy of the contractor's Health & Safety Policy and the Quality Control Procedures before contract award. If you are meeting with several contractors, at the end of each meeting tell the each contractor you will get back to him and go on to the next contractor meeting. If the contractor is the only one on the short list, you can, based on your company policy, award the contract at the meeting. At any of these contractor pre-award and award meetings, a purchasing representative should be present. Once the decision to award is made the following has to be done, but not necessarily in the following order:

- Give the contractor written confirmation of the purchase order number. Copy the construction manager.
- Advise, in writing, the unsuccessful contractors.
- Determine who the contact people are for communication on the project.
- With the successful contractor, sign off the drawings, standards, and specifications that make up the quoted price.
- Make sure the progress payment forms are correct and issue them to the contractor and to your accounting group.
- Issue all relevant forms to the contractor.
- Advise others in the plant what has transpired and when you expect the contractor on site.
- Write the purchase order/contract.

Written confirmation of the purchase order number can be by a fax sent to the appropriate contact person or by written letter. It is important that the contractor have this information in writing, as

some contractors will not make a move unless they have received written confirmation.

Sending letters to the unsuccessful contractors is the professional thing to do. If not done, the contractors will be phoning you for the results. The purchasing group usually sends out a standard form letter and it is a recommended practice.

The final set of bid documents have to be signed off to establish the base from which extras will evolve. Sepias of the drawings (if available) or two or more sets of prints are initialed by both parties and dated. The contractor gets a set for his files and you get a set for your files. The site construction manager, if you have one, will require one set. All signed off documents should be kept in a separate file and not mixed in with all the other drawings, etc. These are important documents and you will have to refer to them throughout the project.

When the bid documents come in, the contractor will have given a breakdown of his price based on the breakdown you requested. As the quotes are finalized and prices are changed, this breakdown may not get updated. After award get the contractor to redo his breakdown to reflect any price changes he has made or that resulted from discussions held. Advise him that he will not get paid until the changes have been made, as accounting will only pay based on this progress payment document. Once you get the breakdown, prepare an official progress payment form and issue it to the contractor plus others in your group who should get it. This is proprietary information and should not be widely distributed nor left lying around.

All forms mentioned in the tender document should be issued to the contractor. Make up a transmittal so you know the forms have been sent and received. This way there are no excuses for not using the forms.

Once a contract is awarded, inform the required people in the plant. Advise them as to who will be on site, when they will start, and where they will be located and working. The rest of the plant should be aware that there will be strangers in the plant and extra precautions

Because a FWO is an extra to the main contract or purchase order, make sure funds are available to cover their cost. The funds in your budget have to be allocated to the purchase order that covers the FWO. This means you will have to revise your purchase order to allocate additional funds to cover the extra work and may have to revise it again if the allocation is exceeded. If the job is small, you can record the extra costs on your Project Cost Report and make one revision when the job is complete, provided you know what all your costs are. In all cases you should have an up-to-date record of your extra costs and the dollar value even if approximate. The above mentioned method of collecting 10 FWOs and issuing a CO to cover them does not take away from the fact that you have to make sure you have money available to cover the FWO. Each FWO has to have funds allocated to it as it is written. As part of the cost reporting system, throughout the project you will have to estimate what you feel the extra costs will be to complete each purchase order.

Back Charges

One of the hardest project costs to control is back charges to vendors and/or contractors. They are usually a source of conflict, especially if the vendor is having trouble and losing money. For this reason they have to be well documented. The Notice of Back Charge form shown in Figure 9.3 helps provide the required information.

The vendor should be contacted before any work takes place to see how he wants to handle the repairs and subsequent back charge. All details of the discussion should be filled into the form. This should be done in ink, not pencil. You should have an hourly rate for all the plant staff whose work will be backcharged to the vendor. Sometimes the vendor will deal directly with the contractor to have the repairs done and you do not get involved, which is okay. If the vendor is from out of your jurisdiction, your local contractors may not want to deal directly with the vendor and you will then have to be the go-between.

Notice of Back Charge

Purchase Order No. or Contract No.: _____

Company Name: _____

Description of Problem: _____

Name of Individual Contacted: _____

Date and Time Contacted: _____ a.m./p.m.

Contact Made By: _____

Phone _____ Phone Number: _____

Fax _____ Fax Number: _____

Attach copy of telephone record or fax.

Remedy to Problem: _____

Estimated Cost: \$_____ Back Charge FWO No.: _____

Does Vendor Accept Back Charge: Yes No

Originator & Date Vendor Acceptance & Date

_____ signature _____ signature

_____ print name _____ print name

Distribution:

Vendor / Contractor / Project Manager / Accounting / Purchasing

Figure 9.3 Notice of Back Charge Form

A field work order is issued to your contractor to cover the vendor's work and a back charge issued to the vendor to cover the cost of the work. These two documents have to be cross referenced for easy retrieval and control by the accounting group. The back charge amount is deducted from the vendor's invoice. You have to make sure that all the vendor's money is not paid out at the end of the job if there are back charges outstanding. If you have a back charge, accounting has to keep track of the back charge amounts so that the vendor is not overpaid. If you are aware of back charges you should start deducting the money as soon as possible.

If you have back charges, make sure the accounting group is aware of them and that they have a method of tracking them.

Inspection

On small jobs you or your designate will inspect the contractor's work, whereas on larger jobs an inspection company or consultant will be hired. Specialized inspection such as concrete sampling and testing, soil compaction, x-raying, NDT, welding, etc. should be contracted out unless you are trained in it. Some plants have people on staff who are trained in some of these areas and they can be used if desired.

Make daily inspection rounds at different times of the day so the contractor does not know when you will be around. Talk to the people on the tools and listen to what the problems are. You will find out that there are rumors every day as well as people complaining about all kinds of things. Before you challenge the contractor about any issues, make sure you have the facts and the story correct, otherwise you will make a fool of yourself and will lose creditability with the contractor.

In the field, your role as an inspector is a fine line that should not be crossed. You have to remember that the role is inspection and you must not direct the contractor on how to do the work. You can tell him what he can not do if it affects the mill operations, but the

Photos

If necessary, progress photographs should be taken at set intervals to document progress. Additional photos should be taken, as required, of anything that will be buried or covered up, the inside of equipment that has been opened for inspection, heavy lifts that are out of the ordinary, etc.

With site pictures, you will find out two things:

1. The picture will come in handy for the oddest reason and you will be glad it was taken;
2. The picture will only contain part of what you are interested in. However, part of a picture is better than no picture at all.

The pictures should be labeled and filed away for safekeeping. Control who borrows them and where the pictures are taken to when removed from the office.

Case History 17

During the construction phase of one project we were looking for a very large wood crate full of parts required for installation. We searched the plant site but could not find anything matching the description. We were going to challenge the vendor about not delivering it when someone produced a photo taken during the offloading of equipment and to one side was the crate in question. It was not the main subject of the picture, but fortunately it was in the picture. The crate was about 10' W x 10' L x 20' H and had a big X on it, so it should have been easy to find. We searched the site again but never found it. To keep the job moving, we had to reorder all the parts that were in the crate. I worked in the plant for a year after startup and never saw the crate or its contents around the plant.

Do not let others take pictures around your plant site. Your plant should have a policy about photography and you should enforce it. This would apply to union business agents, vendors, contractors, and the media. You do not want pictures taken and then showing up in

vendors' advertising for all your competitors to see. Let management decide what picture they want to allow.

Correspondence

Any correspondence from the contractor should be acted upon and responded to as soon as possible. It has to be done in a timely fashion and failure to respond implies that you agree with what the contractor has written. This could be detrimental if a legal claim is made against the project. Do not procrastinate about responding to matters you do not feel comfortable about. If you need time to gather information, send back a note stating that is what you are doing and that you take exception to what was written. When you get correspondence of this nature you will be thankful you kept such good notes in your diary.

Always make every effort to get the contractor all the information and material he needs to complete the work. The late delivery of drawings and/or material can lead to claims by the contractor for extras. This is why you have to keep track of all correspondence that goes out of your office. Drawings should be listed on a transmittal with the revision number and issue number. All documents, including drawings, that you receive should have a "RECEIVED" date stamped on it. You will find the contractor will also date stamp the drawings when he receives them just for the purpose of tracking drawings and claims.

If the contractor files a claim stating that late delivery of material or drawings held up certain work, you will have to go over his schedule and manpower to see if he was really held up or if he could have been doing something else. The contractor may not have any choice with small jobs, but on large jobs with many functions the contractor can usually move his manpower around.

Deficiency List

Throughout the construction phase you should keep a running deficiency list (sometimes referred to a "punch list") of the deficiencies known to you at that particular point. The items should

be brought to the contractor's attention if the deficiency item affects the current work. It is important to bring up the items you feel are deficiencies as it may be a difference in the interpretation of the contract that has led to the deficiency. This allows the problem to be solved now and not at a later date. The deficiency list will be updated throughout the construction and will become part of the contract documents at the end of the job. As the work nears completion, an official deficiency list can be prepared (see Figure 9.5). Do not give any deficiency list to a contractor containing items that are not part of his scope, or items that are part of the normal construction process and will get completed as the work finishes.

At the point of substantial completion, a deficiency list of items is given to the contractor and final completion is not achieved until the deficiencies are satisfactorily addressed. You will have to sign off the deficiency list for the final completion to be reached and the final money paid out.

Substantial Completion and Final Completion

There are two points that define the completion of the construction work—substantial completion and final completion. Your plant should have a policy on when these two points are reached.

In general, *substantial completion* is reached when the work has been completed to a point that the work can be used for its intended purpose. The work does not have to be complete, but you have to be able to use what has been installed in a safe manner that will not damage the plant or equipment. At this point, you have to have a deficiency list that you and the contractor agree upon. The deficiency list has a cost assigned to it reflecting what it will cost to complete the work. If you agree to substantial completion, a legal document is filled out giving the date substantial completion was achieved (see Figure 9.9). These Certificates of Substantial Completion are standard forms for each jurisdiction and can be purchased at your local stationary store. The contractor can now apply for partial release of his holdback. If you have been following procedures, you have been holding back 10 – 15% from every invoice the contractor has submitted. Partial holdback will be the holdback minus twice the value of the work left to complete on the deficiency list. Before you can pay out partial holdback, the contractor has to prove to you that all his subcontractors and workers have been paid, there are no claims against the job, and his worker's compensation is up to date.

Certificate of Substantial Completion

Contract No.: _____ Date of Inspection: _____
Contractor: _____
Contract Title: _____

This certificate refers and relates to the contractual agreement dated _____ between MHS Engineering Services Inc. (hereinafter referred to as the owner) and the contractor.

In accordance with the contract between the owner and the contractor, the owner hereby certifies that on the basis of an inspection jointly carried out, the work is at this date, namely _____ (hereinafter referred to as the "Agreed Date of Substantial Completion"), suitable for the purpose for which it was designed.

The agreed date of Substantial Completion shall be regarded as the date of Substantial Completion for all purposes whatsoever and, without restricting the generality of the foregoing, for determining the rights, duties and obligations of the owner and the contractor under the agreement between them, as well as for all purposes under the Builder's Lien Act.

A Deficiency List of items to be completed or corrected is attached hereto. The contractor undertakes to complete or correct the work listed as quickly as possible in accordance with the terms and conditions of contract taking into consideration the availability of materials and labor. The estimated date for completion of deficiencies is _____

Value of deficiencies as shown on attached list is \$ _____

The holdback against the contractor is to be released in accordance with the contract document, less an amount equal to twice the agreed value of the deficiencies, which amount is to be released seven (7) days after all the deficiencies are completed.

The guarantee of the contractor with regard to accepted portions of the work is to commence on the agreed date of Substantial Completion.

Except as in this Certificate expressly provided, this Certificate does not affect any rights, duties, or obligations between the owner and the contractor.

MHS Engineering Services Inc. Contractor
Signed By _____ Signed By _____
Title: _____ Title: _____
Date: _____ Date: _____

Figure 9.9 Certificate of Substantial Completion

Chapter 10

COMMISSIONING PROCEDURES

Introduction

Commissioning procedures are not very common in most plants. Those that are available are probably from the original plant startup and can be too cumbersome for small plant projects. The following commissioning procedure has been modified so you can use it for your small plant projects. It is written based on the assumption that you have hired an outside consultant to do the engineering and construction management. You can modify and use individual sections of this procedure as they suit your situation. The mechanical, electrical, and instrumentation sections are detailed in what commissioning is and how it is to be done. If you assemble Chapters 10, 11, 12, and 13 into one document, you will have a complete commissioning procedure. Even if you are not commissioning equipment, the information presented is something you should know for future use.

For this commissioning procedure the overall flowsheet is broken into different groupings based on what equipment can be run without interfering with the other equipment down the line. The groupings were color coded and numbered on the master flowsheet. A list is made up with the numbers of all the equipment in each group. From this flowsheet and equipment number list everyone involved in the startup will know exactly what the commissioning sequence will be and what equipment has to be completed in order to commission a group.

The Turnover Sequence Chart, under item 9, shows the different phases involved in the commissioning and startup. When you look at the phases you will see they are clearly defined as to what takes place during each phase. It also shows when mechanical completion, substantial completion, and final completion occur. This document should be discussed with the contractor at the pre-award meetings so there is no misunderstanding of the phases and when they end. At this meeting, you should get a feel for the manpower requirements and length of time needed to carry out the phases. This should help in your project estimating at the front end of the project.

The following administrative, mechanical, electrical, and instrumentation procedures are used for the commissioning (engineering checkout and system testing) activities for the plant equipment and systems. Manufacturers' representative's information and manufacturers' technical manual instructions supplied with the equipment are used throughout the commissioning and supplement these procedures.

Engineering checkout is performed during and after construction is complete to verify that the equipment and systems are capable of functioning in accordance with design and manufacturers' specifications. When all equipment checkouts and tests are satisfactorily completed, the checkout activities continue in logical stages until individual systems are commissioned. Once commissioned the entire process is placed in operation and raw material is run through the normal flow paths using the Human Machine Interface (HMI) to monitor and control the operating functions. Commissioning is complete when all equipment and systems have been verified as satisfactory and documented using the following procedures and supplemental procedures, as applicable, contained in manufacturers' technical manuals. Mechanical completion is certified when checkout is complete. This is also substantial completion.

After mechanical completion, the system testing phase begins with the water trials, which is the running of all the equipment in automatic mode with water instead of process liquids or raw material.

Representatives from the major equipment suppliers will participate in the startup phase to ensure that their equipment operates properly. Part way through the system testing, final completion will be reached. This occurs after the deficiency list from substantial completion is completed.

Operations personnel will be integrated and involved in the systems testing phase. The classroom portion of the training will include in-mill periods to review layout and other details of the equipment, but the majority of hands-on training will be accomplished during systems testing. Maintenance training will also be part of the systems testing phase.

In order for commissioning and startup to be carried out smoothly and safely the events have to be well organized and responsibilities clearly defined. As you will be running equipment that may not have it's guards in place it is imperative that people are aware of what is going on and when. The following administrative procedure outlines definitions, the groups involved, responsibilities of all the people involved, activities involved in the phases, and how the different systems are turned over to the next group. The procedure will also describe the lock out and tagout of equipment, and commissioning schedule issues.

Administrative Procedures

- AP-1 Startup Program Administrative Procedure
- AP-2 Lockout/Tagout Procedure
(Control of Hazardous Energy)
- AP-3 System Boundary Identification Procedure
- AP-4 Schedule

Administrative Procedure AP-1 Startup Program

1.0 Purpose and Scope

- 1.1 To define the phases of the commissioning (Engineering Checkout and System Testing) and assign responsibilities.
- 1.2 To provide a method to ensure that all equipment and/or systems have been proved operational before the system is turned over to the Plant.

2.0 Definitions

2.1 Construction Inspections and Checks

Those inspections and checks performed by Construction to ensure that the required construction activities are completed prior to commissioning and startup.

2.2 Phases of the Commissioning and Startup Program

The Plant Startup Sequence is divided into three phases listed below and shown graphically in AP-1, Attachment 1:

- Construction Completion Phase
- Commissioning
 - Engineering Checkout
 - System Testing Phase
- Startup Phase

2.3 Commissioning

Commissioning is defined as the performance of those inspections, system tests, and trials, required to ensure that a portion of the plant is ready for first time start-up and continuous operation. It is the dry running of the equipment systems, without introducing any raw materials, to verify the

proper functioning of the equipment system and its associated control system. Test materials may be used.

2.4 Startup

Startup is the running of all the equipment in automatic mode with feedstock in order to produce product. for the purpose of commencing commercial operations.

2.5 Mechanical Completion

Mechanical completion will occur when all construction work is complete and the work is ready for system testing, although some work may still be needed. The work left to be done, however, will allow the Plant (or system) to be operated without damage to the Plant (or system).

2.6 Deficiency List (Punch List)

There are two Deficiency Lists that you will have to prepare.

1. Construction Deficiency List
2. Commissioning Deficiency List

The Construction Deficiency List defines the work that remains to be done for the contractor to complete the construction. The project engineer prepares this list.

The Commissioning Deficiency List is prepared by the project engineer but with input from the operations group. This list addresses design issues that affect the operation of the plant.

2.7 Functional Circuit Check

A verification of the integrity of control circuits by simulation or manipulation of every contact and/or device within the control circuit with control power applied.

294 Commissioning Procedures Chapter 10

2.8 Instrument Calibration

Individual adjustment of instruments and control devices utilizing predetermined values and verifying acceptable quantitative accuracy obtained.

2.9 Functional Loop Check

A set of tests performed to verify the functional integrity of an instrumentation control loop. These loop checks are performed with all loop components installed, electronic loop energized, and/or pneumatic loop pressurized. This includes a loop check from the primary device to the HMI screen and from the HMI screen back to the final device.

3.0 Participating Groups

3.1 Plant

Plant representatives located at the job site.

3.2 MHS Engineering Services Inc. (MHS)

MHS Project Manager located at the job site.

3.3 Contractor

A subcontractor to MHS involved in the construction of the Plant.

4.0 Responsibilities

4.1 The Plant

The Plant is responsible for the following activities:

- 4.1.1 Participation in the system turnover procedure as outlined in this Administrative Procedure.
- 4.1.2 Operation of all permanent plant equipment to support the commissioning schedule under the direction of the MHS representative.

4.2 MHS Engineering Services Inc.

MHS shall be responsible for the following:

- 4.2.1 Furnishing all of the engineering documents and information necessary for the completion of construction.
- 4.2.2 Furnishing the engineering documents required to complete the commissioning and startup phases.
- 4.2.3 Furnishing engineers on site during the commissioning and startup phases to provide an interface on design and engineering problems, as required.
- 4.2.4 Providing the technical training of operators.
- 4.2.5 Completion of all the systems to support the commissioning and startup schedule.
- 4.2.6 Participation in the system turnover procedures as outlined in this Administrative Procedure.
- 4.2.7 Inspection activities performed by the construction supervisors and engineers in accordance with the erection and installation specification(s).
- 4.2.8 The Construction Manager shall be aware of the startup priorities and how construction interfaces with the commissioning and startup schedule.

**AP-1, Attachment 1
MHS Engineering Services Inc. - Turnover Sequence**

Installation Phase	Commissioning		Startup
Construction Completion	Checkout	System Testing	Integrated Operation
Equipment installed.	Bump & run motors.	Demonstration of system electrical control functions.	Demonstration of furnish addition and production of final product.
Grouting complete.	Set limit switches.	Demonstration of system equipment functions.	Functional demonstration of individual equipment's efficiency and operating parameters.
Mechanical alignment.	Flush & clean equipment using installed equipment.	Operator on-the-job training.	Functional testing and adjustments to major equipment.
Hangers & restraints installed.	Steam blow.	Check pipe hangers/supports for acceptable restraint when at design temperatures.	Optimization of chemicals to produce the required quantity and quality of product.
Hydrostatic testing complete.	Final alignment.	Dry run systems without material.	Final optimization prior to performance test.
Initial equipment lubrication.	Verify relay & overload settings.	Continue to tune instrument loops.	Performance test.
Pipe clean & inspected.	Functional checkout of components & circuits.		
Equipment cleaned & inspected.	Thermal oil hydrostatic test & boilout.		
Mechanical "as built" drawings provided.	Stroke valves.		Start of warranty
Electrical cable installation checks.	Check vibration of rotating equipment.		Normal operation
Wiring & termination checks.			
Continuity tests completed.			
MCCs installed/meggered.			
Electrical "as-built" drawings provided.			
Construction Completion	Substantial Completion & Mechanical Completion	Contract Deficiencies	Final Completion

Administrative Procedure AP-2 Lockout Procedure

1.0 Purpose

- 1.0 To assign responsibilities to ensure a safe lock out.
- 2.0 To provide a method so equipment and machinery are locked out in a safe manner.

2.0 Definitions

Lock out	means the application of a lock, or several locks, to the control devices providing the primary source of energy to the machinery or equipment. The source of energy may be electrical, air, gas, or hydraulic. In electrical systems, control devices means disconnect switches on MCC's or local disconnects. They do NOT include control buttons or control circuits.
Lock Out Tag	a standard red and white DO NOT OPERATE tag with a blank space for writing the required information on it. Plastic laminate tags are preferred.
Lock Out Log	a hard covered notebook kept at the lock out board. The log book is to record the date, lock number, equipment placed on, time, name of person placing the lock, and the reason for the lock placement.
Lock Out Board	a yellow board with black lettering that holds locks, keys, hasps, and the Lock Out Log

3.0 Application

Employees, contractors, and/or staff working on or in close proximity to equipment, which has the potential for unexpected operation, movement, release of energy or release of hazardous materials, must have the source of that energy tagged and whenever possible locked to prevent the release of that energy.

A part of a machine, piece of equipment, device or thing shall be cleaned, oiled, adjusted, repaired, or have maintenance work performed on it only when,

- a) motion that may endanger a worker has stopped, and
- b) any part that has been stopped and that may subsequently move and endanger a worker has been blocked to prevent its movement.

Where the starting of a machine, piece of equipment, device or thing may endanger the safety of a worker,

- a) control switches or other control mechanisms shall be locked out, and
- b) the effective precautions necessary to prevent such starting shall be taken.

This procedure deals primarily with locking out electrical energy sources, but shall also be applied to other equipment that fits the above criteria such as; dryer hydraulic drive.

4.0 Lock Out Boards

Lock out boards will be located in the following areas:

- a) adjacent to and on the north side of the press
- b) on column W13 beside the sanders
- c) inside door 15 on the east side

Chapter

11

MECHANICAL COMMISSIONING PROCEDURES

This section of the commissioning procedure presents the methods to be used to carry out the checkout and startup of mechanical equipment. Review your drawings and standards, then revise this section to reflect what you are trying to accomplish. Also, make sure these procedures match your plant procedures and the codes you are using.

Mechanical Test Procedures

MTP-1 System Inspection Procedure

MTP-2 Initial Operation of Rotating Equipment

MTP-3 Piping System Cleaning Procedure

MTP-4 Air System Cleaning Procedure

MTP-5 Pressure Testing Installed Piping Procedure

Mechanical Test Procedure MTP-1 System Inspection Procedure

1.0 Purpose and Scope

- 1.1 To establish a procedure to inspect a system or a portion of a system prior to checkout and system testing.
- 1.2 To establish a method which MHS Construction and MHS Startup Engineers will use to inspect systems and report any deficient items found so appropriate corrective action may be taken.

2.0 Prerequisite

- 2.1 The MHS Construction Manager (CM) and MHS Startup Manager (SM) will schedule the inspection (walkdown) based on the startup schedule and discussions during startup meetings.

3.0 Procedure

3.1 Inspection

- 3.1.1 The CM and SM will inspect each system and associated equipment that is to be turned over.
- 3.1.2 Inspection will include a walkdown of the system and the listing of items not complete at the time of turnover. Attachment 1 will be used as a guideline during system walkdown and inspection. Form 100A, will be used to record all punch list items.
- 3.1.3 If the CM and SM find the system satisfactory, that is, either complete in all aspects or only deficient in items, which will not prevent system testing in a safe manner, the SM will sign the Turnover Form and take care and custody of the equipment/system. If the equipment/system is found unsatisfactory, the Construction Turnover Sheet and the System Punch List will be returned to the CM for corrective action.

3.2 System Punch List

- 3.2.1 A System Punch List, Form 100A will be prepared for each system.
- 3.2.2 The Master System Punch List and the resolution of the items will be kept current by the CM.
- 3.2.3 The CM will monitor and update the System Punch List as often as necessary to ensure completion of items.

4.0 Start-Up Forms

The forms attached to this section shall be used to record mechanical startup inspection data. After the forms have been completed, they will be included in the System Turnover Package in accordance with AP-1.

5.0 Attachments

5.1.1 System Inspection and Checklist

**MTP-1, Attachment 1
System Inspection and Checklist Guidelines**

The following list should be used as a guideline to inspect systems and equipment within a turnover boundary:

A. Mechanical Inspection and Checks

1. Piping installed according to flow diagrams _____
2. Pipe supports installed (slippers installed and lubricated) _____
3. Pipe hangers installed in locations shown on drawings _____
4. Spring hangers cold set _____
5. Pipe restraints installed _____
6. Pipe snubbers installed and adjusted _____
7. Thermal insulation installed (if applicable) _____
8. Heat tracing installed according to flow diagrams _____
9. Personnel protection installed for hot pipes (not designed for thermal insulation) _____
10. Equipment properly grouted _____
11. Equipment properly mounted (equipment to base plate, base plate to concrete) _____
12. Equipment and area clean _____
13. Equipment properly lubricated: lube sheet available and completed _____
14. Air Operated Valves (AOV) and Motor Operated Valves (MOV) that have special shipping packing have been repacked with proper packing _____
15. All grease connections of valve stem yoke bushings, equipment bearings, glands, plug valves, etc. have been lubricated _____
16. Temporary piping installed, if required, for initial operations _____
17. Temporary strainers screens installed with applicable Differential Pressure gages, if required, for initial operations _____
18. Local vents and drains with pipe caps as appropriate are installed. There may be valves added due to layout consideration that may not be included on the flow diagram _____
19. Valve locking devices provided according to flow diagram _____

Mechanical Test Procedure MTP-2 Initial Operation of Rotating Equipment

1.0 Purpose

- 1.1 The purpose of this procedure is to establish the methods for:
 - 1.1.1 Initial operation of rotating equipment.
 - 1.2.2 Documentation of initial operating characteristics of the equipment.

2.0 Prerequisites

- 2.1 The following prerequisites must be completed before initially attempting to operate a piece of equipment.
 - 2.1.1 Personnel involved shall be thoroughly familiar with the applicable vendor manual and drawings, placing special emphasis on:
 - 2.1.1.1 Installation requirements such as: mounting, lubrication, and alignment.
 - 2.1.1.2 Design limitations
 - 2.1.1.3 Pump sealing configurations and requirements including packing adjustment and seal venting.
 - 2.1.1.4 Run-in requirements.
 - 2.1.1.5 Restart limitations for large motors.
 - 2.1.2 Nameplate data information.
 - 2.1.3 Electrical controls have been checked out and tested in accordance with the applicable Electrical Test Procedure (ETP) and documented on the proper form.
 - 2.1.4 Personnel shall be thoroughly familiar with the system and equipment files associated with the piece of equipment to be tested to assure they are cognizant of all available information.
 - 2.1.5 Personnel shall be thoroughly familiar with P&IDs and actual as-built configurations of the equipment and systems.

- 2.1.6 Lubrication has been verified and completed lubrication data sheet is on file.
- 2.1.7 Final alignment data has been verified and the alignment data sheet is on file.
- 2.1.8 Instrumentation has been calibrated and loop checked to monitor performance of the equipment, or enough calibrated test equipment installed to verify expected parameters.
- 2.1.9 The uncoupled and coupled run of all motors will be the responsibility of the appropriate startup engineer.

3.0 Precautions

- 3.1 The following precautions must be followed as a minimum to ensure protection of personnel:
 - 3.1.1 Lockout/Tagout shall be established in accordance with MHS procedures to provide adequate flow boundaries and electrical protection.
 - 3.1.2 If the startup engineer deems it necessary, the area around the equipment to be operated initially will be roped off and only authorized personnel will be permitted in this area.
 - 3.1.3 Equipment and flow path have been visually inspected immediately prior to initial operation to verify system boundaries and integrity.
 - 3.1.4 All prerequisites must be complete and personnel cognizant of required and expected parameters such as minimum suction head, discharge shut-off head, expected operating discharge pressure and flow, no load and full load motor current and direction of proper rotation.

4.0 Procedure for Initial Uncoupled Motor Run

- 4.1 Megger readings have been completed prior to initial run.
- 4.2 All prerequisites pertaining to motor run have been completed.

Mechanical Test Procedure MTP-5 Pressure Testing Installed Piping

1.0 Purpose and Scope

1.0 This procedure defines the technical and administrative requirements for pressure testing installed piping systems or portions of a system in accordance with the applicable design code. Any conflicts between this procedure and the specification or other controlling document shall be referred to the MHS Startup Manager for resolution.

2.0 General Test Method

2.1 General

2.1.1 ANSI B31.1 and Others

Piping designed, fabricated, and erected under this code shall receive a hydrostatic or pneumatic test prior to initial operation. Systems not specified to receive these tests will receive an Initial Service Leak Test (ISLT).

2.1.2 National Fire Code (NFC)

All piping classified as Fire Protection System Piping shall be hydrostatically tested in accordance with applicable NFPA codes.

2.1.3 The pressure test shall include the instrument lines up to the last isolation valve before the instrument. If the instrument lines are not installed at the time of test, an ISLT is acceptable.

2.1.4 The pressure test shall include all sample lines up to the last isolation valve at the sample rack. If sample lines are not installed, the test shall be up to the sample line connection root valve and an ISLT shall be performed on the sample lines when installed.

2.1.5 The contractor is to provide the testing forms that collect the required information to meet the noted standards.

2.2 Test Pressures

Test pressures for system piping will be in accordance with the code requirements for the boiler and fire protection system. All other systems will be subject to an ISLT at initial operation.

2.3 Definitions

2.3.1 Piping System:

A configuration of material and components which, when installed, provides a flow path for a fluid.

2.3.2 As-Built:

The documentation used to describe what was actually installed.

2.3.3 Inspection:

The physical examination of a process or product to determine its adherence to applicable requirements.

2.3.4 Lay-up:

The protection of piping or equipment after it has been pressure tested to prevent corrosion of interior surfaces prior to subsequent operation.

2.3.5 Pressure Test Supervisor:

Contractor's supervisor responsible for pressure test.

2.4 Test Media

- 2.4.1 Hydrostatic Testing - If the system cleanliness has been established prior to hydrostatic testing, water of a purity equal to or greater than that specified in the system operating procedure shall be used. If hydrostatic testing is performed prior to establishing the final pre-operational cleanliness class, filtered water or water meeting normal system water quality may be used. At no time shall the test media decrease the system cleanliness established at the time of the test.
- 2.4.2 Pneumatic Testing - Pneumatic leak tests shall normally be performed with clean, oil-free dry instrument air. Clean, dry nitrogen is also permissible. In no case shall other than a non-flammable gas be used for a pneumatic test.

Note: A test medium other than those specified above may be permitted when specifically allowed by an approved procedure.

Guideline 158

{You have to make sure the test media will not contaminate the final product. An example is thermal oil. If the intended final product is thermal oil, the lines must be tested using thermal oil as water will rust the interior of the pipes and contaminate the oil. The system is also flushed using oil and by the use of in-line strainers the pipes are cleaned during the boil out. For these instances of special test materials you have to be prepared for the possibility of failing the test. If you have a leak at a weld, what do you do with all the test material? Make sure you have enough tank storage capacity to handle the volume.

If using a test medium other than water, it is prudent for the contractor to pretest the piping with air at a low pressure.

This will determine any leaks before putting the actual test medium in the piping.}

2.5 Schedule

2.5.1 Before any testing can take place, the contractor will submit, for review and approval, a schedule outlining the date, time, and duration of each test.

Guideline 159

{When pressure testing vessels, try to schedule the tests so that you fill and test the largest vessel first, then transfer that water to the next largest, and so forth down the line. This saves time, energy, and water by only getting a large volume of water once.}

3.0 References

3.1 AP-1, Administrative Procedure for the Performance of the Test and Startup Program.

4.0 Special Test Equipment

4.1 Test Pressure Source - The hydrostatic or pneumatic test procedure source shall be capable of producing and maintaining the required test pressures. There shall be provisions for relieving pressure located in the immediate reach of the pressure source operator.

4.2 Test Gauges

4.2.1 Only calibrated test gauges shall be used for pressure testing.

4.2.2 The pressure gauges used for pressure testing shall preferably have a dial graduated over a range approximately double the intended maximum test

pressure. In no case shall the gauge range be less than 1 ½ nor more than 4 times the maximum pressure.

5.0 Prerequisites

- 5.1 Verify from the latest applicable Pressure Test Diagram the hydrostatic test pressure for piping to be tested.

Guideline 160

{The pressure test diagram is a drawing produced by the design engineer showing the test pressures required for the different lines according to the code the line was designed under.}

- 5.2 A copy of the latest system flow diagram marked up to “as-built” conditions, showing the applicable test boundaries, shall be part of each system pressure test. These flow diagrams shall be marked up and submitted along with the test schedule as required in Section 2.5.1.
- 5.3 Prior to testing a system, an inspection shall be made to ensure that any drain plugs installed on diaphragm valves are removed to allow checking for leaking diaphragms.
- 5.4 Prior to testing a heat exchanger, vents and drains on the side not under test shall be opened to allow checks for internal tube leakage.

6.0 Initial Conditions

- 6.1 Test pressure source, gauges, and overpressure protection are installed and communications established.
- 6.2 All joints, including welds, branch connections, and regions of high stress, such as regions around openings (weldolets, sockolets, elbowlets, etc.; thickness transitions, reducers,

Chapter

12

ELECTRICAL COMMISSIONING PROCEDURES

Guideline 167

This section of the commissioning procedure presents the methods to be used to carry out the checkout and startup of electrical equipment. You should review your drawings and standards, then revise this section to reflect what you are trying to accomplish. Also, make sure these procedures match your plant procedures and the codes you are using.

Electrical Test Procedures

ETP-1 Electrical Test Methods and Procedures

ETP-2 AC Electric Motors

ETP-3 Control Circuitry

ETP-4 Batteries and Chargers

ETP-5 Equipment Grounding

Electrical Test Procedure ETP-1 Electrical Test Methods and Procedures

1.0 Purpose and Scope

- 1.1 To establish a list of electrical checks and tests performed by electrical startup personnel or a qualified electrical test contractor.
- 1.2 To define the recommended minimum field test program.

2.0 General Test Method

- 2.1 The International Electrical Testing Association (NETA) Acceptance Testing Specifications, IEEE, and ANSI shall be used as guidelines for all electrical tests. These three will be used as guidelines for all electrical tests. These three will be referred to in the procedures as “NETA.” The contractor is to provide the testing forms to collect the required information to meet the noted standards.

Guideline 168

{Before contract award discuss the issue of providing the required forms, as it may cost the contractor money to find or develop them. Unless you have them readily at hand, it is easier to let the contractor supply them.}

- 2.2 The pretest checks listed herein are performed by test personnel or verified that they have already been completed by construction or contracted testing company personnel.

3.0 Equipment Tests and Checks

3.1 Transformer - Liquid Filled

3.1.1 Visual and Mechanical Inspection

- 3.1.1.1 Compare equipment nameplate data with single line diagram and report discrepancies.
- 3.1.1.2 Inspect for physical damage. Inspect impact recorder prior to unloading transformer, if applicable.
- 3.1.1.3 Verify removal of any shipping bracing after final placement.
- 3.1.1.4 Verify proper auxiliary device operation.
- 3.1.1.5 Check tightness of accessible bolted electrical connections in accordance with manufacturer or NETA specifications.
- 3.1.1.6 Verify proper liquid level in tank and bushings.
- 3.1.1.7 Perform other specific inspection and mechanical tests as recommended by the equipment manufacturer.
- 3.1.1.8 Verify proper equipment grounding

3.1.2 Electrical Tests

- 3.1.2.1 Perform insulation resistance tests, winding-to-winding, and winding-to-ground, using a megohm meter with test voltage output as shown in NETA specifications. Test duration shall be 10 minutes with resistances tabulated at 1 minute intervals to calculate a polarization index.
- 3.1.2.2 Perform a turns-ratio test between windings at all tap positions.

- 3.1.2.3 Perform insulation resistance testing on bushings and lightning arrestor in accordance with NETA specifications.
 - 3.1.2.4 Perform individual excitation current tests on each phase.
 - 3.1.2.5 Perform tests and adjustments on the fan, pump controls, and alarm functions, where applicable.
 - 3.1.2.6 Verify proper core grounding if accessible.
 - 3.1.2.7 Sample insulating liquid in accordance with ASTM. Samples shall be tested for:
 - Dielectric breakdown voltage
 - Acid neutralization number
 - Specific gravity
 - Interfacial tension
 - Color
 - Visual condition
 - Water content (required on 25 kV or higher voltages and on all silicone-filled units)
 - Dissolved gas - Perform dissolved gas analysis (DGA) in accordance with ANSI/IEEE or ASTM
 - Combustible gas - Measure total combustible gas (TCG) content in accordance with ANSI/IEEE or ASTM
 - Oxygen content - Perform percent oxygen test
- 3.2 Transformer - Dry Type larger than 100 kVA single-phase or 300 kVA three-phase
- 3.2.1 Visual and Mechanical Inspection
 - 3.2.1.1 Compare equipment nameplate data with single line diagram and report discrepancies.
 - 3.2.1.2 Inspect for physical damage, cracked insulators, tightness of connections, defective wiring, and general mechanical and electrical conditions.

- 3.2.1.3 Verify proper auxiliary device operation.
- 3.2.1.4 Check tightness of accessible bolted electrical connections in accordance with manufacturer or NETA specifications.
- 3.2.1.5 Perform other specific inspection and mechanical tests as recommended by the equipment manufacturer.
- 3.2.1.6 Make a close examination for shipping brackets or fixtures that may not have been removed during installation. Ensure that resilient mounts are free.
- 3.2.1.7 Verify proper core grounding.
- 3.2.1.8 Verify proper equipment grounding.
- 3.2.1.9 Thoroughly clean unit prior to testing.

3.2.2 Electrical Tests

- 3.2.2.1 Perform insulation resistance tests, winding-to-winding, and winding-to-ground, using a megohm meter with test voltage output as shown in NETA specifications. Test duration shall be 10 minutes with resistances tabulated at 1 minute intervals to calculate a polarization index.
- 3.2.2.2 Perform power-factor or dissipation-factor tests in accordance with the manufacturer's instructions.
- 3.2.2.3 Perform a turns-ratio test between windings at all tap positions.
- 3.2.2.4 Perform winding-resistance tests for each winding at nominal tap setting.
- 3.2.2.5 Perform individual excitation current tests on each phase.
- 3.2.2.6 Perform AC overpotential tests on all high- and low-voltage windings-to ground. Use test potentials specified to NETA specifications.
- 3.2.2.7 Perform tests and adjustments for fans, controls, and alarm functions.

Electrical Test Procedure ETP-2 AC Electrical Motors

1.0 Purpose

- 1.1 To determine, by functional testing, that all components operate as designed.
- 1.2 To verify that the motor is suitable for the service intended and installed properly.
- 1.3 To provide baseline data for future evaluation of AC motors tested during routine maintenance.

2.0 General

AC motors are generally tested uncoupled, where possible, and then coupled. Coupled testing should be with the system conditions as near to normal or design as possible. When circumstances are such that normal operating conditions cannot be attained, the highest load possible shall be placed on the motor so that meaningful test data may be obtained and evaluated and a reasonable evaluation of the motor's adequacy for the intended service may be made.

3.0 Prerequisites and Initial Conditions

- 3.1 Prior to performing this test, verify that all circuit breakers, fuses, and overload devices have been properly sized, installed, and tested, as required.
- 3.2 A functional test of the motor control circuit has been completed.
- 3.3 For coupled operation, system alignment should be checked to prevent fluid or air flow into undesirable locations.

3.4 Communications shall be established between control and monitoring areas during the performance of this test.

4.0 Precautions and Limitations

4.1 Do not “megger” equipment with solid state components.

4.2 Applicable lockout/tagout procedures shall be followed when performing test.

4.3 Coupling guards shall be installed as soon as practical. All jumpers and lifted leads shall be strictly controlled.

4.5 Do not exceed manufacturer’s starting limitations.

5.0 Test Equipment

5.1 Clamp-on ammeter

5.2 Insulation resistance tester

5.3 Multimeter

5.4 Phase-rotation meter

5.5 Stopwatch

5.6 Temperature measuring device. Where automatic measuring equipment is installed for the bearings and/or the windings, it should be used.

5.7 Vibration analyzer

6.0 Uncoupled Motor Test Procedure

6.1 Inspect the foundation and ensure that the motor is properly secured.

Electrical Test Procedure ETP-5 Equipment Grounding

1.0 Purpose and Scope

- 1.1 To verify the grounding of electrical equipment according to specified requirements.

2.0 General Test Method

- 2.1 All electrical equipment will be either inspected visually or by record to verify proper grounding.

3.0 References

- 3.1 National Electric Code 1994, Article 250.
- 3.2 Engineer's specified design criteria.

4.0 Special Test Equipment

- 4.1 Ground megger tester

5.0 Prerequisites

- 5.1 The associated system file shall be available and the assigned startup personnel shall be familiar with that portion of its contents relative to the grounding system in question.
- 5.2 Startup engineers must have made a preliminary inspection of the system of equipment and accepted it from construction.

6.0 Precautions and Limitations

- 6.1 Before any item of equipment is energized, verification must be made that the grounding requirements are complete (i.e., case, structure, etc.).

7.0 Procedure

- 7.1 The facility and switchyard ground grids may be installed before startup personnel are active at the site. They will be buried in the earth and thus inaccessible for inspection. Their integrity will be based upon construction inspection records and test results.
- 7.2 In the Plant, verify that structures and equipment are grounded in accordance with design requirements. The NEC grounding requirements are summarized below.
- 7.2.1 All Plant electrical equipment shall be grounded. The main process building and all auxiliary building structural steel shall also be grounded.
- 7.2.2 Power transformers shall be connected to the ground grid in at least two places with 350 MCM copper cable. Where surge arrestors are provided, the surge arrestor ground connection must be made either to the transformer or directly to the ground grid with electrical conductors provided specifically for ground purposes (not support bolts). If a discharge counter is supplied, manufacturer's instructions should be followed. The transformer neutral requires one additional 350 MCM tap to the ground grid usually from a ground bus to which the neutral bushing is connected.
- 7.2.3 In general, the conduit containing the control conductors constitutes the primary ground conductor. When conduit is not used, a ground conductor shall be used.

Chapter

13

INSTRUMENTATION COMMISSIONING PROCEDURES

Instrument Test Procedures

ITP-1 Instrumentation and Controls Calibration Methods

ITP-2 Instrumentation and Controls Installation Checkout

ITP-3 Instrumentation and Controls Calibration and Functional
Checkout

Instrument Test Procedure ITP-1 Instrument and Controls Calibration Methods

1.0 Purpose

- 1.1 Establish the method of the instrument and controls calibration.
- 1.2 Establish procedures for performance of instrumentation and controls calibration and test procedures.

2.0 Scope

- 2.1 All instrument and controls calibration and checkout will be performed by the startup group using certified calibration instruments and applicable vendor instrument test procedures and Instrument Test Procedure ITP-2 Installation Checkout and ITP-3 Calibration and Functional Checkout Procedures.
- 2.2 All instrument and controls calibration and checkout will be performed by qualified technicians.

3.0 Responsibilities

- 3.1 **Engineers:**
The startup manager is responsible for supervising the I&C calibration and test program. He shall supervise the calibration personnel to ensure that all instruments and instrument loops are checked out in a timely and professional manner and that they are properly documented. He shall coordinate the I&C program activities with the requirements of the overall startup program.
- 3.2 **Calibration Personnel:**
The technicians will conduct device calibration and loop checkout activities as directed by the SM.

Instrument Test Procedure ITP-3 Instrumentation and Controls Calibration and Functional Checkout

1.0 Purpose and Scope

- 1.1 To verify all instruments are calibrated in accordance with approved procedures.
- 1.2 To determine, by functional testing, that an instrument loop is complete and that satisfactory response of the equipment is obtained.
- 1.3 To provide baseline data for the evaluation of future testing of the instrumentation.

2.0 General Test Method

- 2.1 Individual instruments will be calibrated by an authorized calibration contractor.
- 2.2 Instrument loops will be checked functionally to verify proper response of equipment.

3.0 References

- 3.1 Applicable instrument technical data sheet
- 3.2 Applicable manufacturers' instruction manuals
- 3.3 ITP-2, Instrumentation and Controls Installation Checkout Procedure

4.0 Special Test Equipment

- 4.1 Test and calibration equipment as required by applicable instrument calibration procedures and manufacturer's instructions.

4.2 All test equipment and devices shall be calibrated prior to starting the calibration program.

5.0 Prerequisites

5.1 ITP-2, Instrumentation and Controls Installation Checkout, shall have been satisfactorily completed, where applicable.

5.2 All required tools, instruments, and other devices, properly calibrated, shall be available prior to the start of a specific instrument loop checkout.

6.0 Precautions and Limitations

6.1 AP-2, Lockout/Tagout Procedure, shall be followed while conducting tests.

6.2 Assure that operation of equipment during testing will not create plant disturbances or personnel hazards.

7.0 Procedures

7.1 Device Calibration

7.1.1 Using the vendor's instrument calibration procedures and/or manufacturer's instructions, calibrate all instruments.

Note: On pressure instruments, make head corrections as necessary and record on the Instrument Calibration Data Sheet.

7.1.2 All instrument calibration set-points and ranges shall be obtained from the engineer's Instrument Calibration Data Sheet when available or from the manufacturer's instruction manual.

Subject Index

A

Abbreviations, 3, 84,100
Accounting, 33-34, 58, 72-74
 Billing Procedure and Cost Breakdown, 149
 Purchase Orders, 239-243
 Contracts and Tender Documents, 131-132
 Control Loops, 248
 Engineering Files, 72-73
 Materials and Facilities, 53
 Receiving, 64
 Request for Quotation (RFQ), 97
 Vendor Equipement, 74
Air Purification, 35, 50
Approvals, 43, 50, 55, 150-151, 256
Arrow, 79-80
Authorization
 Additions, 37
 Drawing Revisions, 86
 Pricing, Bid Meetings 233
 Tender Documents, 140-141
 Unit Prices, 158
 Critical Assumptions, 22-23, 60, 65
Award of Contract, 164, 167-168

B

Back Charge, 56, 260-262
Bid Evaluation, 231-239
Bids, 94, 137-139, 236-237, 239
Billing Procedure, 149
Bonds, 200, 201, 202

398 Subject Index

Budget

- Accuracy, 6
- Capital, 6-8
- Maintenance, 5, 8-9
- Overhead, 5
- Training, 52-53

C

- Computer Aided Design and Drafting (CADD), 79, 81, 87, 92, 125, 247
- Change Orders, 156-157, 254
- Changes to Work, 17, 176, 199
 - Tender Form, 158-159
- Claims
 - Lawsuits, 265-267
 - Outstanding, 140, 156-157
 - Tracking, 270
- Codes, 24-25, 122
 - Building, 38, 55
 - Contract Administration, 253
 - Drawing, 78
 - Piping, 188, 353
 - Technical Evaluation, 233
- Commissioning
 - Procedures
 - Administrative, 291-320
 - Electrical, 355-386
 - Instrumentation, 387-396
 - Mechanical, 321-354
 - Schedule, 320
- Construction
 - Administration, 248, 253
 - Canadian Construction Document Committee (CCDC), 135, 158, 199-200, 224
 - Contract, 131-135
 - Costs, 57-58
 - Drawings and Documents, 84-88, 224

- Construction (Continued)
 - Hazards, 36, 66
 - Management, 245-287
 - Schedule, 69
 - Services for, 63
 - Turnover, 308
 - Utilities for, 63
- Consultants, 52, 56
 - Cost of, 56
 - Drawings Done by, 83
 - File, 75
 - Hiring, 52
- Contingency,
 - Budget, 9, 32
 - Costs, 59-60
 - Field Work Order (FWO), 258
- Contractor
 - see General Contractor
- Contracts
 - Cost plus Lump Sum Fee, 134
 - Cost plus Lump Sum Fee plus Bonus, 134
 - Guaranteed Maximum Price plus Bonus, 134
 - Lump Sum Contract, 132
 - Lump Sum Turnkey or EPC, 134
 - Stipulated Price Contract, 132
 - Time and Material, 54, 133, 254
 - Unit Price Contract, 133, 254
- Control Loops, 35, 48
- Control Panels, 35, 49
- Control Room Equipment, 35, 49
- Correspondence, 3, 74, 270
 - Bid Period, 138
- Cost Code, 33-34, 242
- Cross Referencing, 33, 82
- Currency, 35, 59, 233
- Cyclical Markets, 8

D

- Daily Manpower Report, 161, 223
- Deficiency List
 - Commissioning, 291, 293
 - Construction, 270-271, 272, 277, 279, 293
- Demolition, 35-36, 93
- Design Considerations, 35, 65
- Design Phase, 2, 245, 247, 253
- Diary, 3, 263, 266-268, 270
- Document Distribution, 71, 90-91
- Drawings
 - As-Built, 210
 - Certification, 71, 92
 - Matchlines, 83
 - Numbers, 82, 84, 255

E

- Electrical
 - Commissioning
 - see Commissioning, Procedures, Electrical
 - Equipment, 47, 275, 333, 355, 383
 - Installation, 35, 47, 184
 - Tie-Ins, 35, 48
- Engineering
 - Consultants, 56
 - Control and Design
 - Drawings, 77-84
 - Certification, 91
 - Distribution, 90
 - External Issue, 84-85
 - Revisions, 86-88
 - Transmittals, 89
 - Engineering Work Request, 19
 - Files, 71-77
 - Schedule, 67

- Environment, 49, 52
 - Permits, 29-30, 51-52, 54-56
 - Regulations, 50-51
- Equipment
 - Checkout, 273, 275, 296
 - Tags, 273
- Escalation, 35, 60, 233, 238
- Estimates
 - Accuracy of, 30-32
 - Electrical
 - Equipment, 47
 - Building Modification Considerations, 47
 - Installation, 47
 - Tie-Ins, 48
 - Power Distribution, 45-47
 - Power Source, 45
 - Power Supply Requirements, 45
 - Transformers, 45
 - Forms, 32
 - Heating and Ventilation, 45
 - Items to Include, 33-34
 - Items to Exclude, 33-34
 - Laboratory Equipment, 40
 - Maintenance Equipment, 40
 - Mechanical Equipment
 - Process Equipment
 - Installation of, 40
 - Specifications and Requirements of, 39
 - Vendor Quote Documentation, Gathering, 39
 - Mobile Equipment
 - Additional Cost Allowances, 40
 - Industry Requirements, 40
 - Spare Parts, 40
 - Used Equipment, Purchase of, 40
 - Vendor Quotation Data, 40
- Plant Project Accounting Cost Code system, 33
- Site Work, 36

402 Subject Index

Estimates (Continued)

Site Grade

Special Requirements and Considerations, 36

Site Improvements

New Requirements and Modifications, 37

Soils

Soil Examinations, 38-39

Special Access Requirements

Handicap Access, 38

Structures

Existing Structures, 37

New Structures, 37

Office Equipment, 40

Piping

Drawings, 41

Fitting Allowances, 41

Fire Protection, 42

Addition of Equipment, 43

Approval, 43

Insurance, 42-43

Risk Considerations, 42-43

Insulation, 44

Special Requirements, 41

Specification Requirements, 41

Structural Considerations, 41

Supports, 41

Testing and Inspection 41-42

Tie-Ins, 42

Valve Specifications, 41

Ethics, 4, 138

Exclusions, 34, 259

Execution of Contract, 164

External Issue

see Engineering, Consultants, Drawings

F

- Field Instruments, 49-50
- Field Work Order (FWO), 96, 254-255, 258, 262
- Files
 - Engineering, 71-77
 - Tickler, 4
- Filing System, 71-92
- Final Completion, 277, 279
 - Certificate, 280
 - Deficiencies, 271
 - Testing, 291
- Fire Protection,
 - see estimates, piping
- First Aid, 57, 63-65, 172, 177-178, 192, 208, 264
- Freight, 46, 60-61, 233

G

- Gantt Chart, 21
- General Contractor, 172, 178, 249-250
- General Distribution, 35, 46, 232
- Grounding, 46, 383-386

H

- Heating and Ventilation
 - see estimates

I

- Inspection, 262-263
 - Certificates, 187
 - Costs, 58, 168, 204
 - Instrumentation, 326

404 Subject Index

- Inspection (Continued)
 - Notification, 184
 - Piping, 41-42
 - Quality Control, 188
 - Site Examination, 166-167
 - Testing, 127
- Instructions to Bidders, 137, 147, 165
- Instrument Commissioning
 - see Commissioning, Procedures, Instrumentation
- Instrumentation, 48-50
 - Calibration, 393-396
 - Inspection
 - see Inspection, Instrumentation
 - Installation, 35, 50, 390-392
 - Procurement, 111-114
 - Requirements, 28, 38, 125, 298
 - Tags, 273
- Insulation, 44, 65, 114, 193
 - see also Electrical, Insulation
 - see also Piping, Insulation
- Insurance, 43, 59, 95, 175-176, 200-202, 235
- Item Distribution, 46

K

- Key Plans, 83

L

- Labor Charge-Out Rates, 159

M

Mechanical Commissioning
 see Commissioning, Procedures, Mechanical
Mechanical Completion, 281, 293
Metric, 79-81, 104, 110
Minutes of Meeting, 39, 240
Mobile Equipment, 40

N

North Arrow, 79-80,
Non-Destructive Testing (NDT)
 see Estimates, Piping, Testing and Inspection
Notebook, 3, 310

P

Permits, 29, 51, 54, 62, 168, 204, 219
 Building, 30, 54, 168
 Environmental, 30, 50, 54
Photographs, 167, 269
Pipe Insulation, 44
Pipe Penetrations, 44
Piping, 41, 111, 188, 333, 341
 Construction Completion Phase, 298
 Pressure, 42
Piping Requirements, 41
Piping Tie-Ins, 42
Plant Hazards, 65
Plant Capital Budget
 see Budget, Capital
Plant Maintenance Budget
 see Budget, Maintenance
Plant Overhead Budget
 see Budget, Overhead

406 Subject Index

Plastics, 221, 226, 227
Power Distribution, 45-46
Power Source, 45
Process
 Equipment, 39, 41
 Requirements, 25-26
 Simulation, 58
Project Approval, 10, 66
Project Authorization, 5, 10
 Checklist, 16, 35
 Form, 11, 16, 17
Project Engineer, 1-2, 11, 34, 287
Project Objective, 20
Project Scope, 94
Purchase Orders, 53, 72, 91, 229, 239, 241, 249

R

Rate of Return, 7-8
Relocation, 36
Request for Quotation, 72, 95
 Documents, 72, 96, 131
 Drawings, 77
 Plant Conditions, 96, 101-103
 Schedule, 96, 101
 Scope, 96, 98
 Specification, 98, 100
 Vendor Data, 98, 101
Vendor Information, 102, 128, 129, 233
 Civil, 76, 203
 Mechanical, 76, 194, 203
 Electrical, 76, 203
 Instrumentation, 76
 Safety, 62, 64

S

Safety, 28, 58, 63, 64, 82, 214, 219, 228, 246, 250, 264, 347
Schedules, 21-22, 23, 51, 55, 66-69, 101, 160, 164
 Commissioning, 320
 Employee, 285
Scope, 10, 12, 18, 132, 134, 171
 Change, 17, 59
 Training, 52-53
 Work, 10, 96, 100, 132, 134, 144, 146, 173
Security, 63, 172, 176, 187, 217
Services For Construction, 63
Single Line Diagram, 47, 357,358
Site
 Grade, 36
 Improvements, 37
 Supervision, 163
Soil Testing, 58
Special Access, 38
Special Conditions, 96, 135, 202, 230
Spending Forecast, 66-68
Standard Components, 101
Standards, 24, 77, 78, 79, 81, 122, 197
Startup, 29, 30, 51, 52, 53-54, 122, 235, 281, 282, 308
Stick file, 77, 85
Storing, 64, 183
Stress, 41, 297, 329, 345
Structures, 5, 37, 133, 177, 217, 384
Subcontractors, 98, 162, 178, 185, 253
Substantial Completion, 271, 277-278, 291
Supervision, 122, 163, 174, 206, 249
Supervisor, 2, 10, 97
Surveying, 36, 40, 184

T

Tender Form, 96, 137-138, 148, 165
Tender Information Required, 163
Tenders, 163, 165, 167-168
Tickler file, 4
Time On Machines, 53
Title, 18, 75, 78, 84
 Project, 18
 RFQ, 97
Training, 1, 29, 52, 66, 282, 283, 285, 291, 396
 Personnel, 53
Transmittals,
 Drawing, 89

U

Utilities for Construction, 63

V

Vendor, 5, 31, 32, 53, 54, 67, 81, 98, 99, 127, 240, 243, 260, 281
 Contracts, 67
 Control loop drawings, 48
 Drawings, 77, 79, 80, 82, 377
 Equipment, 52, 67, 74, 101, 229, 231, 232, 236
 European, 235
 File, 76
 Machine, 79
 Quote, 39, 40, 53, 54, 60, 231
Vendor Data Requirements, 96, 101, 118
Vendor Information Requirements, 96, 101, 102, 128, 233
 Form, 129

W

- Wiring and Control, 46
- Work Breakdown Structure (WBS), 13
 - Form, 14,15
- Work By Others, 62
- Work Order Numbers, 19-20
- Workers Compensation, 175-176, 182

ABOUT THE AUTHOR



Morley H. Selver, P. Eng. earned his Bachelor of Science degree in Civil Engineering in 1973 from the University of Manitoba. He has over 25 years of experience in industrial plant project engineering. He has worked in industry, with and for consultants, and has had his own consulting business. His industrial experience includes operations and maintenance, research and development, management of small to medium size plant projects, construction management of large industrial projects, mechanical installation of heavy industrial equipment, commissioning and startup of industrial plants, and plant management.

He has worked in operating pulp and paper mills, oil refineries, on North Slope oil projects, board plants, and the recycling industry in various locations across Canada and the USA. He is currently working in the consulting business.