POWER PLANT CONSTRUCTION MANAGEMENT

A Survival Guide

PETER G. HESSLER

Before you build, read this!

Planning, siting and building a power plant is more complex than ever. World-renowned construction expert Peter Hessler gives the definitive guide in his new book, *Power Plant Construction Management - A Survival Guide.*

In today's era of strict economic accountability, managing a construction operation as complex as an electric power plant requires focus, detailed planning, and the incorporation of modern techniques like just-in-time deliveries. Senior managers and investors expect these facilities to be brought online, on time and within budget.

Construction managers and foremen will obtain obvious benefits from this informative book. In addition, subcontractors, maintenance supervisors and utility managers will garner key information through Hessler's important guide. Senior managers will also find this survivor's guide a critical tool.

About the author

A member of the American Society of Mechanical Engineers, Peter Hessler is president of Construction Business Associates. With more than 30 years of international construction management experience, Mr. Hessler's expertise is highly sought as a consultant, lecturer, and teacher on a variety of projects, in the electrical, energy, and petrochemical industries.

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Preface

This book, *Power Plant Construction Management: A Survival Guide,* has been written to provide economic guidance and support to those involved in the management of power plant construction activities, whether these activities are the building of new plant or the rebuilding or modification of existing components. This book is not intended to be a technical "how to" manual on performing construction work, on selecting the mechanical tools for executing the construction activities, or on directing the day-to-day activities of the work. Instead, this book is intended to provide a stimulus to perform these tasks in a cost effective manner—to think outside of the box—to think about the financial stakeholders of the projects at hand. In other words, this book will not help the reader to select the right crane for a particular lifting task, but it will offer the reader support in deciding whether using a crane in the first place is the most economic thing to do.

Although the book title and its supporting examples are specifically power plant oriented, the fundamental theories and practices discussed within are applicable to any construction endeavor, from power plants to road building, to refinery construction, and to commercial and municipal projects. The underlying premise is that the construction activities being undertaken are being performed for the ultimate benefit of the owner/stakeholder and this owner/stakeholder expects a return for investing in this endeavor. Too many projects, within and outside the power plant industry, do not meet the expectations of their stakeholders, from an economic perspective. The projects do generally reach conclusion, but often with cost overruns, schedule delays, and even unmet specification requirements.

As pointed out by many of the contributors to the text of this book, maintaining awareness of the finances of the site construction activities is extremely important, but being able to predict—and correspondingly impact—the outcome, early during the project, is even more crucial. As one contributor, John Long from Constellation Energy put it, "Surprises are not acceptable." In other words, the outcome may be inevitable, but it is crucial to be able to predict this early in the game; the owner/stakeholder must be afforded the opportunity to mitigate. Mitigation may take the form of shifting budgets from a contingency pool to the project, it may take the form of revising current budgets or deferring other projects in support of the project in question, or the owner/stakeholder may decide to cut the losses and stop all work. The importance is that he needs to be able to make these decisions in time for them to be effective!

This book was written to provide support for several different circles. First, it is a treatise on managing the economics of power plant construction intended to be useful for the site superintendent to get from today to tomorrow. Second, it is intended for the site general manager to direct his staff in performing their duties, in a coordinated and focused approach. But third, it is also written to provide the management of all these site personnel a primer on what to expect from them and how to offer them ideas and support. The book provides detailed formats for accomplishing many of the tasks of performing construction management and it offers examples of how to use these formats in various settings. This makes the book especially useful in teaching environments, whether in academic or industrial settings.

The thoughts and processes discussed in this book have been employed over many years by a few individuals. The hope is that many more construction personnel will now pick and choose topics within this manuscript to supplement their management practices for the good of their projects and the gain of their owners and shareholders. As technology evolves, there will be better, faster and more effective tools to accomplish these tasks, but the underlying principles won't change. Hopefully, if enough advances come to the forefront in the next few years, we'll rewrite this book and you'll have the same quality support with the newer techniques.

As the introductory chapter points out, the twenty-first century has begun with a new set of rules taking over the power generation industry—the rules of economics. The owners of today place more emphasis on return on their investment than these owners did in the past. Their former protected guarantee of returns has gone the way of the industrial giants of yesteryear. Today, their returns must be managed because they are no longer guaranteed. Today's manager of the construction process must go beyond the traditional "get the job done at any cost" mantra and afford the owner and stakeholder the opportunity to participate in the decision process. This book provides the reader a skeletal format with which to manage the power plant construction process while also satisfying the needs of the owners and shareholders.

As the author, I hope you, the reader, benefit from the contents of this book but as importantly, I hope you will be willing to share your thoughts on its content, on its usefulness and on your ideas on how to improve its next edition. I thank you for making this book a part of your palette of business tools and the publisher and I hope that its contents contribute to the success of your future projects.

Peter G. Hessler
July, 2005

Acknowledgments

This book would not be possible without the support and input from many people. A topic as broad as one on managing the construction activities of power plant work is made up of many parts and no one person can be an expert on all of them. Seldom is the expert on putting together the project process also an expert on safety or quality control. Seldom is the expert on contract structuring and commercial framing also an expert on site staff management and managing the site activities. So the preparation of this book depended heavily on many persons who graciously donated their time, providing expert material and reviewing many pages of the author's manuscript.

In many instances throughout the book, recognition has been given directly to the contributor of expert quotes, graphs, or figures. But there are also many instances where support was provided on a broader basis, and it is this support that the author also wishes to identify and recognize.

First, the basic premise of the book itself could not have materialized without the active participation of the publisher's staff; their guidance and support made this book possible. Second, the author's concept of focusing on the cost elements of the construction process was strongly influenced by two individuals with whom he has worked collectively for almost 50 years, John Bona and Gary (Red) Wilcoxon. Their willingness to take time from their respective, very busy schedules to review manuscript content and offer many suggestions was invaluable.

Then, there were other individuals who provided support for very specific subject areas such as risk management, suretyship, the quality process, and safety; these subject areas would have floundered without their guidance. Risk management is a cornerstone of this book and is referenced directly or indirectly many times; this would have been very difficult without the collaboration of one of the author's closest business associates, Bob Tichacek. The author also depended on the support of Surety Information Office's Marla McIntyre. She explained the importance of the site staff understanding how the surety and insurance process works and that often decisions made (or not made) by this staff can have economic consequences directly related to this subject.

The author also gratefully acknowledges the support of a former business associate, Jim Pillow, for the guidance and clarifications provided during the development of the chapter on controlling quality. Since the cost impact of quality is often an inexact measurement, this subject would also have appeared imprecise without this help. Another former associate, Dick Peterson, was instrumental in helping the author clarify the impact various safety practices have on the cost of the site work. Too often, safety is only respected due to regulatory pressures; but with this guidance, the author was able to present safety as a cost control device as well.

Finally, the author very gratefully thanks his wife, Teresa, for her wholehearted support during the long period of preparing the manuscript. The many days and nights of "being absent" from the normal routine of life were often frustrations that she endured with love and compassion. Without her support, this book would not have met any of the deadlines that seemed to arrive all too often.

There were many, many others whom the author would also like to thank, but in the interest of time and space, they will remain unnamed, although not unremembered. Thank you one and all for your help and support!

Peter Hessler
July, 2005

Acronyms

AACEi	American Association of Cost Engineers international
ADA	Americans with Disabilities Act
A/E	architect/engineer
ASME	American Society of Mechanical Engineers
BAR	builders' all risk
BOT	build-operate-transfer
BOO	build-own-operate
BOOT	build-own-operate-transfer
B2B	business-to-business
CPM	Critical Path Method
D&B	Dunn & Bradstreet
D&E	delivered and erected
DBOM	design-build-operate-maintain
E&C	engineer and construct
EPC	engineer-procure-construct
EPA	Environmental Protection Agency
EEOC	Equal Employment Opportunity Commission
EMR	experience modification rate
FW	Feed Water
GC	general contractor
IPP	independent power producer
LDs	liquidated damages
LTSA	long term service agreement
MW	megawatt
MOST program	Mobilization, Optimization, Stabilization and Training

NACBE	National Association of Construction Boilermaker Employers
NLRB	National Labor Relations Board
NDE	Non Destructive Examination
NCR	non-conformance report
OSHA	Occupational Safety and Health Administration
OEM	original equipment manufacturer
OT	overtime
OCIP	owner-controlled insurance program
PDAs	personal digital assistants
PPE	personal protective equipment
PERT	Program Evaluation Review Technique
PLA	project labor agreement
RFI	requests for information
RH	Reheat
WBS	work breakdown structures

Introduction

Today it's all About the Money

As we entered the 21st century, a new set of rules began taking over the power generation industry—the rules of economics. The power generation industry of today has owners that place more emphasis on the return on their investment than owners did in the past. The industry has changed. Protection through regulation is quickly becoming a questionable practice. The *protected* guarantee of blue-chip stock returns from the major utilities has gone the way of the industrial giants of yesteryear. Today to stay in business, a company must provide a return to its shareholders that exceeds what they could earn elsewhere. In essence, any business today is only as viable as the edge its return on investment has over other options those investors may care to explore. Most power companies are now viewed as expendable by their shareholders. The power plant business of today is about much more than just generating megawatt hours; it is about generating profits for the investor.

What is important today is that *times have changed*. Managing the construction activities of a power plant project in this century requires a different focus. Equipment, technology, and operational skills have evolved. Sophistication is more in demand than ever before. Not only are *just-in-time* deliveries important to facilitate smaller footprints and lay down needs, they're important for the cost of inventory control and storage fees. Not only are pretrained craftsmen important for being able to hit the ground running, they're important for the cost savings in on-the-job training avoidance that translates into saved man-hours and a reduction in schedule. Not only is an emphasis on safety morally correct and an often-demanded requirement to work on many of the sites, but now it is also a major factor of the bottom-line labor costs. The list goes on and on.

The management of the construction phase of a power project will impact the total costs of that project, whether it's building a new plant or rehabilitating the old. Although the construction phase occurs at the end of the project process, it is really the tail that wags the dog. The project process may start in operations, it may start in maintenance, or it may start in engineering. But then it moves into budgeting and from there to project management. Once, twice, or three times, it is reviewed then engineered, parts and equipment are procured, and finally it goes to the field. By then, however, the cost of change, the cost of inefficiency and the cost of cancellation can be devastating. The trick is to link all of the phases upfront and then manage them collectively, towards a successful conclusion.

The investors expect nothing less. They want to be assured that processes are in place to ensure predictability. They want confirmation that costs are controlled and that schedules are met. They want reliability. As John Long, senior vice president of generation for Constellation Energy, one of today's largest power generators, explains:

> *The ability to accurately track project financial commitments as well as physical completion is critical in today's world. Surprises are not acceptable! The successful power generators are those who can consistently meet and beat their forecasted earnings. Excellence in project management and project controls are vital competencies to achieve those goals.*

But what does this mean in real dollars and cents? Or put another way, what is the economic impact of construction management in the power plant construction industry today? Let's look at some numbers. Just in the United States, there are around 15,000 power generators with an installed nameplate capacity of approximately one million megawatts generating almost four billion megawatt hours annually, and more is planned.[1] During the past 10 years, this has provided approximately $3.2 billion of put-in-place construction work annually.[2] So if it's major maintenance or the rehabilitation of an existing plant or if it's the construction of new plants that will be built in the foreseeable future, there's a very large base to provide a huge opportunity for impacting the investors' bottom line.

The Economics of a Managed Process

The economic impact of good construction management to the power plant and to its owner/shareholder is dependent upon the type of project undertaken. In the event of a new plant project, both the time value of the money borrowed to build the plant and the time required to get the plant built, commissioned, and ready to generate revenues, is of prime concern. In the event of a rehabilitation project to an existing plant, the loss of revenue while the plant is offline is paramount.

For the new plant scenario, plant owners/shareholders have minimal control over the project so they protect themselves through stiff penalties on the construction contractors for not meeting the end date and warrantees—at times to the tune of $500,000 per day or more. For the refurbishment project, owners are more involved and can directly impact the end date by their actions, or inactions. Thus, they cannot demand the same magnitude of penalties, but their loss of revenue, while the unit is offline, can easily approach $600,000 per day during peak demand (fig. I–1). At these levels of penalties or lost earnings, a well-managed project is essential.

One 500 MW Unit = 500,000 KW

Selling power for $0.05 [1.] per KWHr = $ 25,000 of revenues per hour

Operating for 24 hours in one day = $600,000 of Revenues Per Day

1. Based on an average selling price of $0.05 per kilowatt-hour, often noted as "Generation Service Charge" on the homeowner's electric bill (Connecticut in 2003).

Fig. I–1 Cost of (lost) generation in revenue.

Management of the project, and especially the construction phase, comes in many forms and may be performed by different parties. Some utilities handle their own construction management, others contract it out, and others mitigate their risks by sharing the duties and the risks with their contractors and service providers. Whichever way, the goals of prudent management and good cost control remain the same: to deliver on the promises and reduce the uncertainties.

What's not wanted is chaos. The discovery of unplanned obstructions on a construction site, like the realization that the turbine internals are in much worse state than originally predicted or the realization that the labor resources required to perform the work are not available can all lead to chaos. So once again, good construction management and its attendant cost control practices are paramount to maintaining shareholder interest in the plant.

But even the best of intentions does not guarantee that the project will succeed. The service providers, those responsible for managing the many stages of the process that makes up the total project, must also be capable of delivering. They must be knowledgeable in their field of expertise and they must have internal depth to ensure they can deliver on their commitments, even when the unexpected occurs. They must be willing to work as part of a team, pulling together with all of the other participants in the project. In addition, they must have a cost control process in place that ensures their ability to handle the complexities of managing projects in today's construction world where safety, cash flow, change orders, and quick turnaround are important parameters for success. Scott Budoff, a partner in Saw Mill Capital, an equity investment firm specializing in service providers to the power plant industry, succinctly explains the investment community's views:

> *We only invest in companies that add value to overall plant performance. Our service companies have common attributes: they work with the client to manage risks of performance, they seek solutions to issues, and they consistently deliver. We seek management that takes ownership over their contribution to the overall construction process.*
>
> *The responsibility that Saw Mill Capital has to its investors is to ensure that our power plant service providers have the processes in place to manage the business, especially project safety, costs, and schedules. Contractors, as well as other service providers, that add value to the construction project are companies that are managing the risks within their scope of work and areas of core competence. Our commitment to our investors is to make sure that management has the processes in place to manage project risks. At the end of the day, there are no silver bullets to success.*

This book covers the management process of both power plant new construction and power plant outage work. Although there are differences between managing new construction and outage work, the cost management processes are essentially the same, with the major difference being the time available to make and implement decisions. Therefore, examples throughout the book are drawn from both. There are discussions about the commercial and contractual necessities that must be addressed, and there are discussions about claims avoidance methods with examples of what can go wrong if prudent contracting is not practiced. Following the contractual makeup, the jobsite setup requirements are reviewed as well as a look into how to resource personnel—both to do the work and to manage the process. There are chapters on quality control and safety and the impact these can have on the bottom line, either positively or negatively.

However, the central theme of this book is devoted to managing the finances of the site work activities. Examples are provided of how and how not to do this. Tools are offered to make the process easier. There are checklists, guidelines, photos, and examples that can be useful for setting up a jobsite, for managing the activities and for reporting the results. Communication methods are discussed and the pros and cons of how to present to upper management are addressed.

Finally, a chapter on the differences of doing this overseas is included for the reader whose business (or just his curiosity) takes him beyond the confines of his borders, beyond the comfort zone of our contractual law and cultures. Examples of what to do—and more importantly, what *not* to do—are provided to highlight the points made in the discussions. The circle is closed by demonstrating that even though the world outside is different, the basic principles of good construction management and cost control apply universally.

It is the author's hope that the reader will find the topics herein to be of use in his or her own daily practice. As Richard Ott states in his book, *Creating Demand,* this survival guide can only be published now because:

> *I've taken all the body of knowledge that I've come across over the years, combined that with the observations of how things seem to really work out on the street, and the result of that is what I've come up with in my book.* [3]

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[2] Tuchman, Janice L., ed. "Annual Value of Construction Put-in-Place from 1993–2002," *Engineering News-Record,* The McGraw-Hill Companies, January 5, 2004.

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1

PLANNING THE PROCESS

The power plant construction world in the 21st century is very different from that of the century before. Financial dictates now rule. Time is of the essence. The investor is only interested in one thing—the money. Generating megawatt hours (MWhrs) is only a means to an end, the end being the making of the money. While a new plant is being constructed or while an existing one is being revamped, the investor is not making money. He can only hope the plant gets (back) online as soon as possible so his cash flow can start again.

But what does this mean? It means that while the unit is not generating power, its downtime must be diligently managed. To diligently manage the process means it must be planned. The complete project, from inception through start-up, requires a detailed, scheduled plan, along with personnel selected and responsibilities assigned. It requires a sponsor, it requires a committed team, and it requires a clear definition of success. Once the project phase moves to the field (and in the case of an existing plant, once the unit is taken offline) everyone must hit on the ground running. It's too late to start the planning process then.

The Project Delivery Structure

One of the first decisions to be made is how the project will be structured—under what type of contractual obligations will it be executed? During most of the 20th century, the design-bid-build delivery mode was used almost exclusively. Utilities would develop (design) the specifications and solicit bids for the work. After evaluation of the bids, the most cost-effective contractor would be awarded the job and the utility's construction group would manage the contractors. This was a costly approach, but it gave the utility total control of the process—something many felt was required since their management mandate was to focus on reliable power generation more than on profitability. Thanks to the regulatory process, profitability for the utilities' investors was already guaranteed.

However, as utility regulatory groups started focusing on the *price* of power *in addition to reliability*, utility management began to look for more cost-effective ways to manage construction projects. This led directly to contracting with architect/engineer (A/E) firms for the development of the specifications, the solicitation of the contractor bids and many times, for the management of the field construction activities. Since many of the A/E firms were often involved in multiple power projects at any one time, their personnel developed economies of scale that resulted in lower design and construction management costs than if the utility self-performed.

As the 20th century entered its last quarter, changes in regulations governing the generation and sale of electricity encouraged more and more cost control. This led to the creation of a new kind of power generator, the independent power producer (IPP). These IPPs were focused solely on selling electricity at a profit, with their selling prices reflecting the supply and demand of the electric power industry. Therefore, they were very focused on controlling costs and schedule, especially when building new plants, and this led to more innovative project delivery methods. Terms such as build-operate-transfer (BOT), build-own-operate (BOO), build-own-operate-transfer (BOOT), and design-build-operate-maintain

(DBOM) became popular. Investors were forcing owners and contractors to become extremely cost conscious and take responsibility for not only the building of the plant but also for its output efficiency.

This, in turn, led to a major shift in the basic type of plant delivered; it led to a shift from large steam-driven turbines to smaller gas-fired turbines that could handle rapid load shifts at higher machine efficiencies. These plants could be delivered, installed, and commissioned much sooner than their predecessors. However, many of these new machines were designed at the cutting edge of technology. With no historical operational basis for the owner/IPP and investor to feel secure that these machines would operate within the parameters that they were sold, a new kind of warranty emerged—the long-term service agreement (LTSA).

These new agreements were actually *after-market* engineer-procure-construct (EPC) contracts that required the original equipment manufacturer (OEM) to inspect, repair/replace, and sometimes upgrade these cutting-edge gas turbines over a period of 10–15 years, hence the phrase *long-term*. But these agreements were beneficial to all parties concerned. As discussed during one of the roundtable discussions at the Power-Gen Europe 2003 conference held in Düsseldorf, Germany in May 2003, with financiers (Credit Lyonnais), owners (RWE Power), insurers (AIG), and OEMs (Alstom and Mitsubishi), all saw benefits to this new arrangement.

The financiers' benefits:

- Certainty of margins (revenues and costs)
- Builds shareholder confidence knowing OEM is contractually bound to support the technology long term for the life of the asset = security value

The owners' benefits:

- Long-term support for purchased technology
- Technical expertise and spare parts readily available
- Long-term cash flow management = predictability
- Plant reliability and efficiency

- Consistency of performance
- Builds shareholder confidence knowing OEM is contractually bound to support the technology long term
- Security in obtaining spares
- Price of replacement parts defined
- Owner is up-to-date with latest service bulletins

The insurers' benefits:

- Comfort through shared risk = reduced exposure

The OEMs' benefits:

- An operating machine to use for validation of technologies
- An opportunity for long-term relationship building with the owner

So after a very long period of "business as usual" in the regulated power industry, a shift from focusing solely on reliability to focusing on profitability forced a shift in the delivery of power plant construction projects. Not any one of the methods of delivering a power plant construction project is better than the other *all* of the time. A risk analysis needs to be performed before a final decision can be made as to which delivery system is the best for a particular project, and it is beyond the scope of this book to delve into that. However, some method—either one of the ones stated previously or some variation on them—will have to be chosen before the planning process for the actual construction work can begin.

Sourcing the Resources

It is important to start on the right foot. At the very beginning, once the project has been identified, and once it has been approved, budgeted, time-lined, and the delivery method determined, it must be resourced. Careful attention to planning and locating the resources required during the various stages of the project will help support a smooth flow of the project schedule.

The construction management team

The first priority will be to establish the construction management team. Where does it come from and who provides it? Does it come from within the plant or owner organization? Does it come from the major equipment supplier? Or is it contracted to a third party? Some of these decisions will depend on the type of project delivery mode selected.

The individuals selected for the construction management team must have the right level of expertise and skills to do their job. If the job is long term, periodic training and recertification may be necessary. A plan should be in place to address changing staff requirements as the work proceeds through its various stages. For example, the initial site setup will require personnel with good administrative skills. As the job progresses, a heavier emphasis may be on rigging skills, welding expertise, and craft labor management. Then, as the start-up phase approaches, the expertise required will shift from the installation and labor management skills to commissioning expertise.

In addition to finding the required people with the necessary skills, at the time they are needed, a plan should be in place to handle unexpected turnover. Especially on new plant projects, which are usually long term, individuals may leave for personal reasons, they may be replaced for performance reasons, or they may be rotated for company convenience. A temporary fix to handle these situations is to cross-train key personnel. Assume, for example, that on a large new plant project, one with an 18 months on-site program, the welding specialist is suddenly not available. By having cross-trained one of the other superintendents beforehand, there would be a backup with enough welding skills to keep the job going until a replacement is found. Without such contingent planning, there could be a halt in the production welding which then translates directly to schedule delays; or it creates a massive backup of inspections required by the replacement person who ends up expending lots of overtime (OT) when he arrives.

The craft labor work force

Second only to the selection of the management team is the selection of the craft labor. This may come from many sources such as:

- Contracted to:
  - OEM
  - Third party
- Direct hire from:
  - Union halls
  - Nonunion sources
- Use of in-house personnel

But from wherever the labor is sourced, there should be some basic criteria. For example, certain skill levels should be required. A minimum number of craftsmen should be planned and there should be a predetermined work schedule with shifts and hours that accommodate the activities of the entire jobsite as well as ongoing operations in the existing plant, if applicable.

One of the first investigations to be made when planning the project should be the origin of the craft labor. If this labor comes from the local area, as opposed to being imported and requiring housing, a survey needs to be conducted of other ongoing or planned projects that will overlap the project schedule. There's nothing worse than expecting labor to be available for a project and then finding out that it is not available because there's another major project being built two miles away. Or maybe there's a *fast-track* project two states away, starting at the same time, but they're paying premium wages and lots of OT; the labor is also only in it for the money and they will go there instead. So it is crucial that coordination takes place to minimize parallel projects (more on this later). Next, some potential labor suppliers.

Contracted OEM. What are the advantages of using the OEM? The strongest advantage of going with the OEM is to obtain follow-on guarantees. Most major manufacturers are willing to provide an all-inclusive performance guarantee if they also install the equipment they have supplied. If others install it, and even if the OEM has a representative on site, they won't accept responsibility if the equipment fails to perform as a result of wrong installation or poor workmanship.

Additional advantages of awarding an OEM installation contract can be a relief from bearing the responsibility of equipment delivery to meet the construction schedule and a shifting of responsibilities for repair to equipment that either arrived with damages or that was damaged during installation. In both of these cases of damage to the equipment, the OEM contractor will normally replace or repair the equipment, at his expense, and mitigate any schedule impacts that result; third-party contractors will look to the owner or general contractor (GC) to fix the problems.

Finally, working with an OEM contractor most often results in a team of site specialists, both supervision and labor, that are highly experienced in installing the particular pieces of equipment being supplied. They know the *industry secrets* that often seem to mystify the less initiated. However, by awarding a turnkey contract to the OEM and asking for an all-inclusive guarantee, the costs may be higher since more risk is assumed by the OEM.

Contracted third party. But what about using third-party contractors? They may have been working in the area, or even the plant, for many years. They may be very familiar with the local labor. They may have special arrangements with the local tool and equipment suppliers. They may even have other projects in the area, going on simultaneously, from which they could draw labor, supervision, and equipment if the going gets tough. Plus, they may have seen ways of installing the equipment that the particular OEM has never experienced.

Many of today's OEMs have downsized. They have shed their construction arm—or if they still have a construction group, they have reduced its in-house support. Most likely, the construction engineering has been dramatically reduced, the welding specialists have been scaled back, and their closeness of working with the original designers of the equipment is no longer a given.

On the other hand, the third-party contractors are often pure constructors. They usually have no manufacturing arm and often no allegiance to any one supplier. To stay in the lead, these constructors will support their site teams with an in-house engineering staff, they will have their own welding specialists, and they may even have ongoing training programs that all of their field staff supervisors are required to attend on a regular basis.

As Al Brousseau, former vice president of power operations for Lockwood Grenne, who has worked for both OEM and third-party constructors in the power plant industry, explains: improvise.

> *In today's market environment, mitigating one's risk is the name of the game from the Owner to the OEM to the EPC contractor.... As such, the need to address the risk factors in any project is very important; both the external environmental risk—contract language, LDs and schedule, and internal risk—lack of qualified field labor, labor productivity and skill sets of the craft superintendents. As OEMs and EPC contractors move forward in time, the average age of their experienced workforce increases dramatically*

and as many choose to retire, the experience they have gained over their career is not transferred to the "new" work force. As a consequence, many of us have had to re-invent the process for making projects successful and safe to maintain a risk profile for the company that is prudent.

With the OEMs downsizing and risk shedding, establishing an integrated E&C (Engineer & Construct) business model and taking experience from a number of OEMs worldwide in developing an experience base is important. The key is to have the ability to take lessons learned in this environment and apply that knowledge to each project, not just from a construction aspect but also from an engineering and manufacturing quality assurance perspective. This is where an integrated E&C company bridges the ever expanding gap between an aging experienced workforce and the risk shedding strategy of Owners and OEMs. Formalizing theses internal procedures and processes and implementing them successfully are a key to everyone's success in the future.

Direct-hire labor. Regardless of who is responsible for performing the actual site work, they have to arrange for the craftsmen. How they do this is dependent upon whether the job will be union or nonunion. Sometimes it is a non-issue since the plant owner may dictate one or the other. At other times, it is also a non-issue since the contractor is already signatory to the union and therefore has no choice but to use unionized labor. However, the issue can become complex if there is a mix of union and nonunion contractors working on the same site or if there is a shortage of union labor.

First, the case of using unionized labor: Usually, the contractor has a signed agreement with the various unions involved in the work such as the electricians, the boilermakers, the laborers, etc. This essentially fixes the cost for the labor element of the project for the duration of the agreement, including fringe benefits such as training, health and welfare, pension, and vacation. Therefore, the contractor has one less element of his price subject to fluctuation during the execution of the project, *i.e.*, mitigating some uncertainties.

Another benefit of using union labor is that the union is a third party between the contractor and the craftsmen. It is responsible for the craftsmen's training in areas such as Occupational Safety and Health Administration (OSHA) requirements, craft-specific skills such as welding certification or pipefitting and other safety training like personal protection equipment (PPE), confined space, fall protection, and scaffold erection. For example, the boilermaker's union, working with the National Association of Construction Boilermaker Employers (NACBE) has a program to:

- Maintain a highly skilled work force
- Provide boilermaker work force in areas of need
- Train new skills and technology
- Instruct and teach safe work habits

This program, commonly referred to as the Mobilization, Optimization, Stabilization and Training program (MOST), includes the following:

- Boilermaker National Reserve Center
- Boilermaker National Joint Apprenticeship Program
- Common Arc
- Safety training
- Drug testing
- Respirator fit and training
- Eye protection program
- Safety internship program

As a result of these types of programs that are used by the more progressive union organizations, contractors can save many labor man-hours at the jobsite. Just one of these programs, the Common Arc program, has saved the boilermaker industry millions of dollars through its welder certification program (fig. 1-1).

Common Arc – A Power Plant Industry Cost Reduction Program

Until the late 1980's, welders hired by a contractor working on a boilermaker job were required to take an individual welding proficiency test, for each contractor for whom they worked, to ensure that they were qualified to weld for that specific contractor. Every time the welder moved to a different contractor, he was required to test again, for the new contractor. Sometimes, they even re-tested for the same contractor. Calculations by the industry at that time put these testing costs at around $500 per weld test.

In those days, as is still common today, when a large outage started, it was not uncommon to need 100 ASME Code-certified welders at the peak of the work. With test passing often hovering in the 50% range, this meant 200 welders would need to be tested before 100 were certified to work. In the 1980's, that added up to an enormous $100,000 per job, all of which took up time and was non-productive. But even more so, when multiplied by two outage seasons per year and by the number of plants that were having regular outages, it was calculated that the industry was spending over $55 million each year for all of this testing! So the boilermaker union and it's contractors got together to see if they could devise a way to reduce these costs for their clients – the plant owners of the day.

In 1988, they established the Common Arc Corporation, a not-for profit organization chartered to reduce the cost of providing certified welders for member contractors and owners. Working with the ASME Code committee, Common Arc devised a simultaneous testing system whereby many welders could be tested and witnessed by many contractors, all at the same time. They designed this to be done at off-site locations, during slow work periods, so as not to interrupt the outage seasons, and they called it "Simultaneous Testing".

Through the use of this new program, today's cost of testing and having available a certified union welder has come from what would cost $1,000 to under $30 per man. Total industry costs now run under $2 million per year and there is a pool of approximately 11,000 certified welders that are available, ***instantaneously and without additional expenditures,*** for any outage work a Common Arc member may require. That's a cost saving measure that can only come from forward-thinking team work.

Fig. 1–1 Common Arc initiative.
Adapted from a presentation by John Erickson at the 2004 Boilermakers' National Tripartite Alliance Conference, with permission.

Finally, the owner or power plant management may negotiate a project labor agreement (PLA) directly with the applicable unions for a specific project. This is usually done to lock in the wages and other working rules to be used by everyone at the project so there will be fewer chances of unexpected cost variations and job disruptions. All contractors will then be required to abide by the PLA regardless of the agreements they may already have with the unions.

Next, using nonunion labor. Unlike the case of using unionized labor, there is no third-party organization with which the contractor signs long-term agreements that fix wages, fringe benefits, and other rules of engagement. This allows the contractor to pay whatever the labor market will bear and allows for the flexibility to be innovative with the benefits package—sign-up and completion bonuses can be used, productivity incentives are easier to implement, shift and working hour rules can be more flexible and hiring/firing/layoff requirements are less stringent, *e.g.,* often no *last in–first out* requirement for layoffs.

However, having more flexibility in the administration of the labor also creates more uncertainty in the final cost of these resources. Instead of being required to use a pre-agreed-upon wage scale, the contractor's staff frequently resorts to manipulating the pay scale process to maximize workers' productivity. This results in wage costs different from those that were used to budget the job, *i.e.,* eliminating an opportunity to mitigate some of the job's uncertainties. But then, there must be an offset, and there is. It is the opportunity to have lower labor costs since the union wage rates include more than just workers' wages and benefits, they also include the cost of the union infrastructure—its management personnel costs, their travel and living costs, the union office buildings, etc.

Another difference encountered when using nonunion labor is the training of the crafts. In the union environment, the training is standardized so each craftsman has learned his skill in approximately the same manner. In the nonunion world, workers often learn *on the job* and since they are learning on many different jobs run by many different contractors, there is little consistency. When they go from one contractor to the next, they may have to relearn their skills to satisfy the new employer. For example, one contractor may require that all small-bore pressure part tubing be welded using only heli-arc while another may require that only the root pass be heli-arced and the remaining passes be completed using shielded metal arc. The welder, especially if he has only worked for the first contractor, may now have to learn and qualify on a new procedure before he can weld for the second contractor. This is not the case for the union employee.

There are now more and more instances of nonunion contractors taking the initiative to set up training classes for their workers, either before the work begins or on the job, in the hope that they can get consistent results from them. The downside is that the workers may opt to work elsewhere the next time they are needed, or they may even leave the job before it's over, and the training costs will have been lost. Union workers, on the other hand, usually stay with the project to the end and since they are all similarly trained, if one must be replaced, the replacement will not have to be retrained. But again, the trade-off is lower labor costs for the nonunion worker balanced against more uncertainty of consistent skills.

Finally, there is one other source of labor that may be union or nonunion, and that is from a labor supplier, commonly known as a *body shop*. These organizations act similar to a union labor hall, signing a contract with the contractor for the supply of labor at a fixed rate but for a given project only. Usually, these suppliers do not train the labor nor does the labor have any special relationship with them. They just keep a database of resumes that is consulted when an order comes for a certain number of people with a certain set of skills. These body shops may agree to pay the cost of replacing a worker if the worker does not fulfill his obligations of being able to perform the work or remaining on the job until its end. But the labor has no loyalty to either the body shop or the contractor.

Although using labor suppliers seems like a last-ditch effort to source craftsmen for a job, there are distinct advantages to using them. First, there is the cost avoidance of having permanent staff and its attendant costs of benefits, supervision, training, and support overheads. Second, there is the flexibility of being able to ramp up and ramp down the number of personnel without regard to availability or nonavailability. Third, there is the ability to remove any or all of the people without reason (but not indiscriminately). In many cases, using these third-party labor brokers is very cost-effective for a particular project, but if there are always projects in the pipeline, using this source of labor is best left for filling the unexpected peak needs, only.

In-house labor. Some construction projects are performed with craftsmen sourced from the utility's in-house labor pool. This may be when the utility self performs the work or it may be a contractual requirement that their contractors use the utility's craftsmen to do the work, in essence managing the utility's labor force. Some utilities feel that by using craftsmen from within their own labor ranks, they maximize efficiency since the labor is already familiar with the plants and the working requirements of the utility and the workers have a loyalty to the utility.

As with any of the other sources of labor, however, there are also trade-offs with using in-house labor. Generally, the contractors managing the in-house labor will not accept responsibility for productivity, they will not accept responsibility for absenteeism nor will they accept responsibility for lack of available skills. This often translates into the utility not being able to penalize contractors for delay or workmanship issues, which means that, if these issues arise, the utility pays for any extra costs.

Subcontracting

There are many reasons to consider subcontracting parts of the work, whether it is for the supply of the labor, provisioning of small tools and consumables or for the supply of the heavy equipment. The reason can be the previous affiliation with a particular subcontractor. It can be to keep the work within the corporate family of contractors or it can be as simple as the economics of who can do that scope of the work for the lowest cost. But when initially laying out the workflow plan, subcontracting can be a viable way to shift the responsibility of resourcing while simultaneously mitigating risk.

It is not uncommon for the owner or the EPC contractor to subcontract specialty tasks such as civil, electrical, and insulation work. Also, specialty machining and even specialty welding is often subcontracted since the skills required by these disciplines are seldom available within the labor ranks of the owner or EPC contractor. But actually locating and contracting for these services can be a daunting challenge. Issues such as union vs. nonunion, differing pay scales, distance from the jobsite, and the per diem for travelers all enter into the decision-making process.

Subcontracting also brings with it a whole host of issues that are nonexistent when self-performing. Similar to the effect that multiple projects in the area have on the supply of labor, subcontractors can also get stretched too thin. Some will accept the work and then not be able to perform while others will accept the work, do an unsatisfactory job, and ultimately cost the project more time and money than if the work were self performed.

It is also very important to plan the administration and management of the subcontractors at the very beginning of the work. Since misunderstandings usually occur due to poorly planned processes, issues such as claims can be greatly minimized if properly addressed before the work begins (this is discussed further in chapter 4).

Small tools and consumables

When a tool or a consumable such as a special welding rod is not available, the craftsman may have to stop working. As part of the planning process, it becomes crucial to know where to find the small tools and consumables that the craftsmen will use, how to get them to the site in a timely manner and how to control them once they are there.

Imagine a scenario where the superheater elements are being replaced in a large utility boiler. Envision them all hung out, tacked in place, and ready for final welding. Then assume there are five pairs of welders, on each 10-hour shift, with 1400 high-alloy steel welds to complete. This is a two-week, two-shift welding operation and will require approximately half a ton of welding rod. But suppose that halfway through the job, the welding supervisor finds out the last 500 lbs of rod is not high-alloy, it's plain 6010 carbon steel. The work has to stop, someone has to scramble to locate more rod, and two 10-man welding crews are standing around, getting paid to do nothing. That's expensive. But what's worse is when the missing rod does finally arrive, more OT may be required to avoid completion penalties or, in spite of the extra OT, there may still be penalties—up to $500,000 per day! (More on managing small tools and consumables in chapter 11.) The point here is to realize the impact a lack of planning can have even for such mundane items as small tools and consumables.

Heavy equipment vs. the alternatives

Unlike the planning required for resourcing small tools and consumables, deciding how and from where to obtain large construction equipment requires a multidisciplinary effort. Large construction equipment, such as cranes, bulldozers, heavy haul trucks, etc. are expensive. Usually, the constructing entity does not have this type of equipment, whether this is the owner, a GC or a subcontractor; this type of equipment is generally the purvey of a specialty company. Arrangements can be complex for having this equipment available when called for in the construction schedule. There may be other projects that already have contracted for it, or there may be issues of adequate sizing, such as needing extra boom or longer jibs for a crane. It's because of the uniqueness of heavy construction equipment that other avenues of approaching the task to be done should be explored.

Maybe, instead of using heavy-haul trailers to move large components within the project perimeter, such as bringing the steam drum into the boiler cavity, consideration should be given to laying a railroad spur into the location. Maybe, instead of using two large cranes to lift the boiler drum into position, consideration should be given to using special jacks that *pull* the drum up by the cables attached to it (fig. 1–2). The economics, including impact on schedule, must be closely reviewed along with a risk analysis and back up plan in the event things go awry.

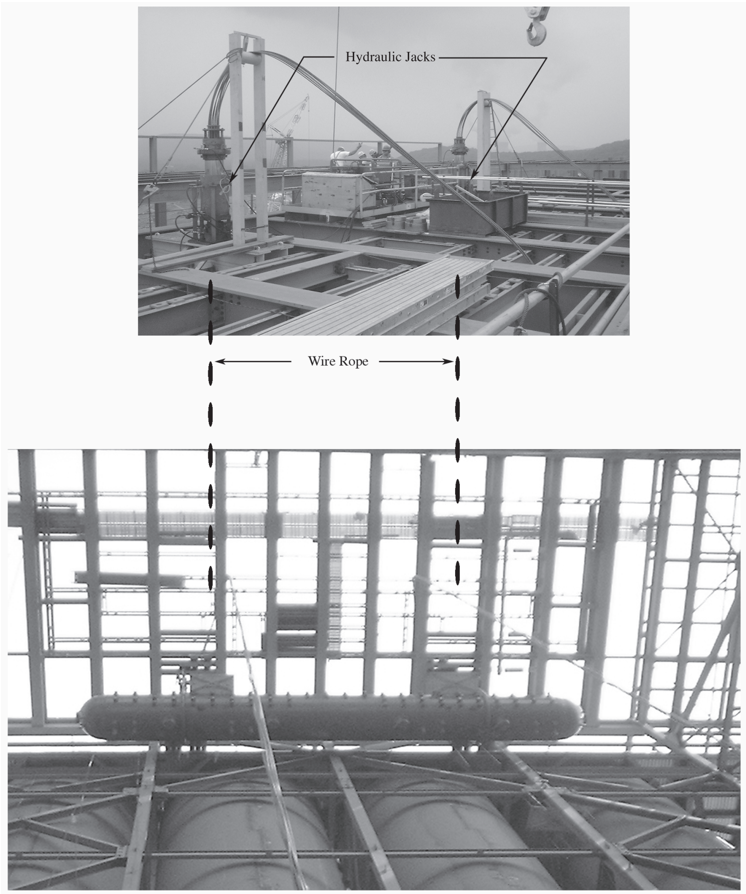

Fig. 1–2 Drum raising with hydraulic jacks.
Courtesy of Barnhart Crane & Rigging Co.

This is why it is important to use a multidisciplinary approach. Equipment and rigging specialists should be consulted for developing the most expeditious methods of moving large components such as steam drums, superheater modules, turbines, generator stators, etc. They should review the availability of the largest equipment available to do the job; they should design the *lifts* that will be required, and then determine if this will satisfy the schedule requirements, based on the availability of the equipment specified.

Another team of construction engineers should simultaneously review alternate approaches to performing the same task. They should look into the laying of railroad tracks for movement of components. They should look into using less sophisticated equipment such as jacking or winching components in lieu of using large cranes. At the same time, a third team (preferably the original component designers) should investigate redesigning some of the components or the external support structures in an attempt to modify the components into smaller pieces or reshape them for easier access if time still permits.

Finally, the costs and schedule impacts of all of these various approaches must be evaluated and the most cost-effective one selected. If the most cost-effective approach is to use heavy equipment, then plans must be made to ensure its availability and cost for the point in time required. Also, the terms of use must be clearly established and issues such as operator, maintenance, and repair have to be established. If the job is in a remote location, plans must be made for the eventuality of a long-term breakdown of the equipment and in any case, thought must be given to the method of transport, demurrage, assembly, and disassembly, etc.

Contingency Plans

Once the project delivery mode is chosen, whether it is BOT, BOO, BOOT, or some other variation, the risk parameters will have been set and the schedule can therefore be developed in keeping with these parameters. Then the next challenge will be to ensure the supply of the resources will be available per the needs of the schedule. Having established from where the management and labor forces will be sourced and having determined the supply source of the tools, equipment, and consumables, the issue to be resolved is what to do in the event of changes.

Project delays

All too often, the project may not start when originally planned. This may be due to any number of causes from difficulty in obtaining permits to problems with bonding issues to changes in funding and many more. Management personnel that were originally scheduled for the project may now no longer be available; they may be on another project. Labor can be in short supply when the project finally does start due to the same reasons, and this also happens with some of the resources such as heavy equipment. So what can be done?

First, let's see how the supervisory pool can be kept available when the start date keeps slipping. Since not every position on the management team is *mission critical*, there are really only three or four that require specific *must-have* skill sets that may be lost without careful preplanning. The remaining positions can generally be filled with personnel from a variety of sources such as labor brokers, union halls, borrowing from other projects, or hiring through newspaper ads.

But for the three or four mission critical positions, a plan should be in place. Usually, since delays are only on the order of 3–6 months, there is not enough time for squeezing in another assignment. Therefore, it's a matter of finding productive work for them that usually does not add much to the bottom line of the organization. However, the downtime cost of four workers for a period of six months—when these are *the* supervisors needed to ensure the success of the job—is often less than the overruns, penalties, or other unplanned costs that would be incurred if they were not available when the job finally does start. Let's look at some numbers: assuming six months of delay, four supervisors at a cost to the company of $100/hour will run just under $400,000. Compared to a project with liquidated damages (LDs) of $500,000 per calendar day, this is less than one day of overrun—a small price to pay for ensuring the right people are on the job when they are needed!

But, what about the labor? Here, there are a lot more people to deal with. The complexity of this issue is impacted by the planned source of the labor—is it union, nonunion, subcontracted, in-house, etc.? The key is to stay in close communication with the source or supplier of these resources. As soon as it is evident that there *may* be a delay, this needs to be discussed and contingency plans developed. If the delay is for only a few weeks, one possibility is to encourage the craftsmen to take vacation. If the delay is of longer duration, there are other options such as: paying a bonus to those who make themselves available when needed, importing craftsmen from outside the area and paying them a per diem for food and lodging, or changing the planned source of labor from direct hiring to subcontracting or vice versa.

Finally, if the original plan included the use of equipment such as large excavating machines or heavy lift cranes, their availability must also be reaffirmed. In these cases, it is sometimes possible to pay a *supply guarantee* fee in return for assurance that this machinery will be where it's needed, when it's needed. If this is not possible and if importing it from other locations is not feasible, the process of the work sometimes can be revised. Following the same procedures used when first deciding how to best perform the work, utilizing the engineering, rigging, and designer staffs, the work process may be able to be redesigned to eliminate the need for this heavy equipment.

However, all of these contingency efforts usually have costs associated with them. These costs may be recoverable but even if they are not, when carefully developed, they may still be less than penalties for late completion. So just because there is a delay in the start of the project, it does not mean the project is hopelessly out of control. Delays can and should be mitigated.

Parallel projects

Another common drain on the availability of planned resources is the unexpected emergence of other projects to be executed at the same time and intending to use the same resources as the project that's been planned. For example, another utility may schedule a major outage or a neighboring refinery may plan a capital expansion project for the same time period that the power plant outage in question is scheduled. Since all too often, there is little or no communication between the various industries in the locale, coordination of resource use seldom occurs.

In this case, the effect on the availability of the supervisory staff is different than in the previous case of project delays. Previously, the issue was how to keep key staff members available until the project actually started while knowing that the remaining staff could be sourced from somewhere when the time came. In the case of two or more projects executing at the same time, the key staff issue does not exist. Rather, the availability of the remaining staff becomes the issue.

Usually, the project that starts first is the one that gets this *remaining* staff. This is not to say that they are less important than the key staff; it's just that they are selected for their specific skills instead of their intimate involvement with the project. If the personnel with these requisite skills have already signed up for one of the parallel projects when the job in question starts, it does not mean others won't be available. It's just that they may have to be brought in from other locations, paid a higher wage to entice them to leave home, and also paid a per diem for housing, meals and transportation—costs that may not be in the original budget.

However, as before, the critical issue is the source of the craft labor. There is a fixed pool of labor in any given area. Depending on the skills required, this may be an issue or it may not. But assuming that the other projects in the area have locked up the local labor, there may be a serious issue in executing the job at hand. If the job is manpower intensive, importing labor from outside of the local area can become prohibitively expensive. Sometimes it is just more economical to either postpone the start of the job until the local labor is once again available. In the event of outage work, it may be more cost-effective to cancel the outage and plan to increase the scope of the next outage to include the scope from this one.

Also as with the issue of project delays, heavy equipment availability can be a problem when multiple projects are scheduled to execute in the same time frame. Similar to the supervision issue, the project that starts first usually gets the equipment first. In this case, there are several options. First, the sequence of activities may be able to be rearranged to accommodate the equipment's availability schedule. Second, as in the case of project delays, the work process may be redesigned to exclude the need for the heavy cranes, excavators, etc. But there is a third option.

Arrangements can often be made with the management of the other projects to share the equipment. In other words, there may be a week or two when the refinery expansion will not need the large crane. If the project schedule can be rearranged to use that equipment during this time, the refinery management is usually happy to sublet the equipment temporarily as a way to reduce their rental costs for that period.

As before, all of these contingency efforts will have costs associated with them. These costs are generally not recoverable; but when carefully developed, they may still be less than penalties for late completion. So just because there are other unexpected projects that impact the availability of resources, it does not mean the project is hopelessly unmanageable. These issues can and should be mitigated.

As a final suggestion, communication within the industry will avoid many of these issues. For unionized contracting work, maintaining a close tie to the union management by both the labor-using contractors and the owners and plant staff can lead to contingency planning that will help mitigate the problems of delays or parallel projects. Similarly, keeping in close contact with other contractors in the area and sharing information on the projects planned and contracted is good intelligence that can be used for contingency planning. Lastly, never underestimate the information available to the equipment suppliers. They make many regular visits to the plant owners and contractors to learn exactly what the work will be today, tomorrow, and after tomorrow. They know that regardless of who will be performing the work, they will be supplying the equipment. To stay in business, they must be prepared, so talk to them. Knowledge is key and communicating it is survival.

Contingency dollars

However, no matter how much planning, questioning, and intelligence gathering is done beforehand, there will always be surprises. It is very common for estimators, schedulers, planners, and management to add contingency money to a bid. The most common method is to add an arbitrary percentage to the bottom line in the belief that the money will be needed somewhere, sometime during the project's execution. Seldom is the *contingency* a calculated value based on specific risk analysis. This common approach was discussed and redirected in the paper "Contingency Misuse and other Risk Mitigation Pitfalls."[1]

> *Contingency is established to mitigate the adverse impacts of the unforeseen or under-predicted events. As such, contingency should be utilized and managed exclusively within the framework for which it is established. While a project budget document might contain several different "Fund" accounts as opposed to "Line" allocations, contingency is very different in that it is a reserve and "hedge" against risk.*
>
> *The manner in which Contingency Funding is developed dictates the guidelines of how it should be effectively managed. As contingency is risk-based, it should be sufficient to manage the realization of risks. The manner in which risk affects a project is a combination of constants and key variables. These will change relative to each other and to the Project itself at different points throughout the project.*

The contingency adder should be specifically calculated as opposed to using a standard percentage. For example, if there is the possibility of working through a holiday period, a contingency should be calculated for the additional OT instead of using a percentage adder. Or if the labor productivity is questionable due to potential disruptions from other contractors, a specific number of additional labor hours should be calculated and included as a contingency. If a contingency to cover potential schedule LDs is prudent, it should be calculated using a fixed number of people for a specified time frame.

> *Just adding an ad hoc 10–15% of the total budget for contingency poses two problems. The first problem is whether the line item contingency is adequate for the risks that are associated with the project. The second problem lies in determining when the contingency should be used. Holding contingency funds throughout the project and then looking for ways to spend the funds at the end*

of the project is not the most efficient use of project funds. This is especially the case where funds are limited and unused contingency funds could be used to fund other projects.[2]

Summary

In summary, a well-planned project must have a delivery structure designed to provide an acceptable rate of return to the financier of the project while meeting the owner's needs of long-term reliability of plant, technology and replacement parts. For this to happen, the resources required to carry out the site work must be diligently procured. The construction management team members must be complementary, and the team structure must be adaptable to the changes required as the project moves from inception through the various construction phases and into and through the commissioning stage.

Selection of the craft labor is second only to the selection of the management team. Decisions need to be made regarding the use of OEM's, third-party constructors, or in-house sources. Also, the use of union vs. nonunion labor must be addressed as well as whether to subcontract or direct hire.

Once the contracting and personnel issues are settled, there still remains the sourcing of small tools, consumables, and heavy equipment. A thorough analysis should be made to determine the cost effectiveness of using tools and equipment in place of labor-intensive tasks. This also requires a review of future availability, reliability, and serviceability.

Finally, no matter how thorough the planning, no matter how carefully and thoughtfully the plan was developed, certain things will not happen as planned. There may be strikes or bad weather. There may be bankruptcies. There most likely will be unanticipated additional costs or scope creep. There may be many other unforeseen changes, all of which must be accommodated in some fashion. Therefore, contingency planning must form a part of the overall planning process. The two most disruptive issues are usually project delays and parallel projects that were not foreseen. Some type of contingency funding must be developed to address these and any other potential disruptions, and then it must be managed.

References

[1] Noor, Dr. Iqbal and Robert Tichacek, "Contingency Misuse and other Risk Mitigation Pitfalls," presented at American Association of Cost Engineers international (AACEi) annual meeting, Washington, D.C: June 13–16, 2004.

[2] Ibid.

2

UNDERSTANDING THE CONTRACTUAL COMMITMENTS

At the heart of every construction project is a signed commitment. This is the document or contract that describes the work to be done, the results expected, and the payment to be made. It is intended to capture the desires of the parties and the rules of how the project will be performed, *i.e.,* who does what, and it also includes the penalties for not complying with these rules. It is the lack of understanding the importance of complying with these rules where most people get into trouble (see chapter 3).

The Bidding Review Process

Before discussing the contractual commitments and how they affect the owner and contractor, it is important to spend some time on the development of the bid that leads to the contract. This will not be a comprehensive litany on how to solicit and bid for the work nor will it be a detailed examination of the process to be used for structuring the contract. But, based on a Competitive Power College course presentation,[1] it will be a synopsis for promoting an understanding that the greater the effort put forth in structuring the contract, the greater the rewards and the less the chances of failure.

When first developing a project and before signing the contract, the project scope and rules must be reviewed. This usually starts with a review of the needs that led to the project and then the development of a specification. Next, the owner or his designated A/E will solicit bids to perform the work, based on the previously developed specifications. This is what is generally called the bidding process, and it is the start of most of the problems encountered during the project's execution. To avoid these potential problems, a properly managed bidding process, followed by diligent project management, will usually ensure a successful outcome whereas a *wing-it* or *seat-of-the-pants* type of approach will almost always end up in disaster. The trick to starting out right is to design and manage a workable bidding process.

But what is a properly managed bidding process? It is a series of steps, preplanned, that must be followed to ensure an ultimate *win-win* contract. It follows a sequence similar to that described in the next few paragraphs.

The specifications

The first step in the bidding process is the preparation or review of the specifications. Owners, A/Es, or GCs will prepare a set of specifications describing their wants. The better these specs are written, the less likelihood of misinterpretations, missed items, and disagreements during the contractual stage. For the bidding contractor, a detailed review is a must. Whether preparing or reviewing the specifications, the types of questions to be asked are:

- Is the scope clearly defined?
- Are the equipment and materials specified in detail?
- Are the schedule limitations understood?
- Are the LDs understood?
- Have bonuses or penalties been considered?

The resources

As a part of the decision-making process and before starting to prepare the bid, it is extremely important to ensure that the proper type and amount of resources are available to prepare the bid in a timely and effective manner. It is important to view the bid in perspective of the overall demands on the business at hand, both today as well as when the project eventually executes. Some of the questions to be asked before committing to prepare the bid are:

- Is there adequate time to prepare the bid?
- Are there adequate resources to prepare the estimate?
- Is there a process in place to track the bid effort?

The spec review

Once the decision has been made to move forward with the bidding process, a thorough review must be performed of the specifications, drawings, and all other information available. If it is a complex project, the specification should be separated into a logical grouping of disciplines and reviewed by experts in each field. One typical grouping would look like the following:

- Quality assurance and Non-Destructive Examination (NDE)
- Commercial/legal
- Construction engineering
- Welding engineering
- Labor relations
- Safety
- Accounting (cash flow, taxes, Dunn & Bradstreet (D&B), etc.)

During the review of the various sections of the specifications, it is advisable that the reviewers look at the requirements from two perspectives: 1) the specification's author and 2) the reviewer's company risks. The author of the specification is usually looking for a proposal that is all-inclusive and with a minimum of exceptions, transferring to the bidder as much risk as possible. On the other hand, the bidder will be trying to minimize risk by taking prudent exceptions where risks are high or placing a monetary or time value on those risks that can be mitigated accordingly. The ultimate objective is to submit an offer that is a win-win solution for both the owner and the bidder.

The site visit

Before starting the task of preparing the estimate, a thorough understanding of the jobsite conditions should be developed. Information on items such as access to the site, parking, and storage area will be important for the preparation of the estimate. Contractor facilities such as subassembly areas, field offices, tool room availability, sanitary facilities, change rooms, and first aid must be investigated. Sources of utilities such as power, lights, water, and compressed air need to be identified. Finally, the local working conditions should be seen firsthand. Appendix A is a typical checklist for gathering site-specific information that can be modified for use on any specific project.

The rest of the process

The rest of the process is fairly straightforward. With the bidding process in place and with the parameters of the project defined, the estimate can be prepared. Any assumptions made during the preparation of the estimate need to be documented and made part of the submittal, including a list of contract responsibilities such as those in appendix B. The project cash flow has to be prepared, and care must be taken that the cost of money being spent before it is received is built into the job. With all of these completed, the estimate is then mostly a matter of take-offs and arithmetic.

Once the bid is completed, submitted, and negotiated, the contract can be prepared. The principal elements of this document are:

- Scope
- Schedule
- Price
- Payment terms
- Taxes
- Penalties/bonuses
- Terms & Conditions

Scope

Scope is the product or service offered by the seller and accepted in writing by the buyer. Because scope often goes through many changes prior to contract award, it is important to confirm the final scope in any contract. After contract award, scope can be increased or decreased through written change orders. But for the management staff in the field, scope must be clearly understood. On large, lengthy, and complex jobs, it is often very unclear where one contractor's scope ends and another's begins. Take the case of installing the feedwater line to the boiler economizer. Contractor A is responsible for the installation of the feedwater line to the boiler. Contractor B is responsible for the boiler itself. The question that frequently comes up is: who is responsible for the final weld between the feedwater check valve and the boiler economizer inlet header? Drawings usually show a line at this point with two arrows pointing in opposite directions and a note that says responsibility of Contractor A to the left and that of Contractor B to the right (fig. 2–1). It does not usually indicate who has the responsibility for the junction weld itself.

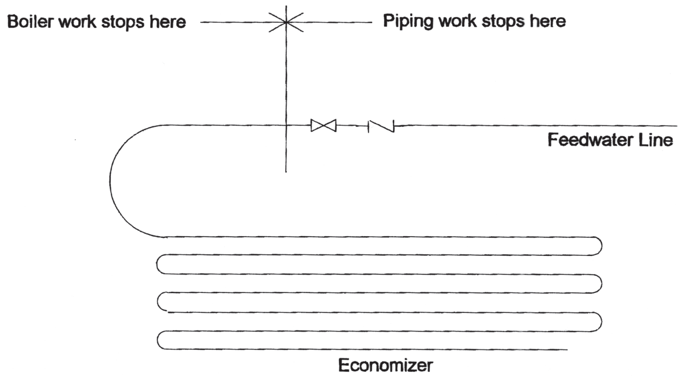

Fig. 2–1 Sketch of interface between feedwater (FW) line and economizer.

Scope issues are not related just to the materials to be removed or installed. They also relate to support issues such as trash removal, road maintenance, the supply of construction power, water, etc. (see appendix B). If not clearly defined, or agreed upon shortly after moving onsite, costs can be incurred that may be difficult to recover later. For instance, it may be clear that the owner is responsible for the supply of construction power. However, at the site, the contractor may automatically assume responsibility for the step-down transformers and connections, although somewhere in the obscure paperwork or in earlier meeting minutes, the owner may have agreed to provide power all the way to the distribution board. Later, the contractor may realize the responsibility was the owner's, and may then look to the owner for reimbursement but the reimbursement may be refused. Had the contract documentation been clearer up-front, this issue could have been avoided.

Another scope item that is often misunderstood is touch-up painting. Let's assume that Contractor A is installing the boiler feedwater line. As part of this scope, included is the responsibility for the hanger support system. But to install this system, the contractor must erect some steel structures and platforms, and this requires welding and bolting to the existing boiler support structure. In the course of this work, however, some of the paint of this existing steel will be damaged. The question arises, who will repaint or touch-up, these areas? Who should provide the paint and who should provide the labor? Be clear with the scope.

Schedule and Constraints

In addition to being clear on scope, the contract also must be clear on the agreed-upon schedule and any potential constraints. Generally, the schedule is the date of delivery or the dates of the mobilization, project activities, and demobilization. It may have one activity with a delivery date, it may have two activities (start and stop) with a performance span, or it may be a complex program with 5,000 activities, many of which are interdependent. Whichever form the schedule takes, there will almost certainly be financial ramifications if the activities performed do not meet the dates as scheduled.

It is imperative that all parties are in agreement on the form of the schedule, *i.e.,* bar chart, Program Evaluation Review Technique (PERT), Critical Path Method (CPM), etc. The software used to produce the schedule is not as important as the format, but if agreement can be reached that all parties use the same process, then updating and exchanging data will be greatly simplified.

Far too often, there end up being several schedules onsite. The owner may have a schedule, which gets updated, based on input from the contractors and an analysis by the staff. The GC usually has a schedule that many times is not linked to the owner's, and the various sub-tier contractors often also have their own, independent schedules that are not linked to each other nor to the GCs. This is a recipe for disaster.

When different parties, contractually bound to work towards the same end goal do not use one consistent *master schedule,* deviations from the critical path will develop. There will be differences in the stages of completion of the various activities from contractor to contractor, and there will not be identical paths to get from the current state to the completed state.

This happens all the time because each party does not want to divulge to the other everything known about the job. Sometimes this is due to potential or ongoing claims and litigation. At other times, it has to do with payment that may be adversely affected. The ultimate risk is that everybody loses efficiency because they're not pulling together.

In the best interests of the project,—which is to say that for the best interests of the client/owner—it is important for all parties to work together using a single master plan. It is important that all parties understand the constraints they place on the other parties by not meeting their expected commitment. To illustrate this, let's look at the following example: Say that during a new plant construction project the electrical contractor saw an opportunity to start installing cable trays into the boiler steel structure four weeks early. The workers proceed to install the trays, even pulling some cables, and then they remove their scaffolding and cranes and the contractor reports the activity as complete—maybe even getting paid a substantial sum for activity completion. One week later, the boiler contractor moves in to start installing the reheat elements and cannot get the elements into the boiler cavity because the cable trays are blocking the access (fig. 2–2). Obviously, the cable has to be pulled back and the trays removed. Who reimburses the electrical contractor for the removal and reinstallation? Who reimburses the boiler contractor for the delay while waiting for access to install the reheat elements?

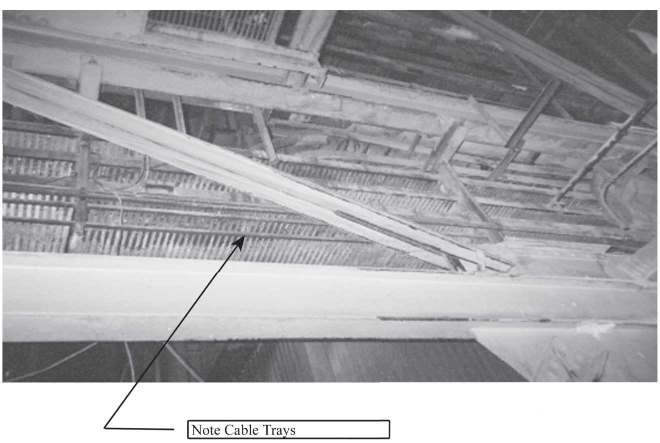

Fig. 2–2 Cable trays blocking reheat elements.

Unless the *constraints* to the schedule are as understood as the basic schedule itself, problems will occur. As just seen, extra work will be done by the electrical contractor with little chance of financial recovery. Delays will be incurred by others, which never needed to have occurred. To alleviate these potential problems, regular (daily?) progress updates must occur, and the updates must be to a single, master project schedule to which all participants have full access and a clear understanding of its logic and reasons therefore.

To illustrate how the lack of using one project master schedule can hurt the owner, go back to the beginning of the book, where a day's lost revenue can easily equal $600,000 (see fig. I–1). Assume a major plant overhaul outage with some work (like the boiler) being contracted and other work (like balance of plant) being kept for in-house labor. Then, as too often happens, the contractor is working to a detailed, sophisticated schedule but the plant personnel are not. Plant personnel are moved on an almost daily basis, from task to task, sometimes not completing one task before being *temporarily* moved to another to accommodate other plant issues. Subsequently, envision a delay to the start of the boiler hydrostatic test, because the feedwater pump was still disassembled. The plant personnel, who had been working on this pump, had been reassigned elsewhere. Although the overall project logic would say that the hydro test should not be scheduled to start until after the feedwater pump was ready for service, here is a case where the boiler work schedule and the balance of plant work program were not coordinated. No formal link was ever established between the balance of plant work and that which was contracted to third parties. At up to $600,000 per day, this should not be acceptable, yet unfortunately, it continues to happen!

Price and Price Changes

So how are these issues addressed when they do occur? Obviously, someone is out a lot of money when scheduling problems arise. The same goes for scope misunderstandings. Therefore, one of the contract document's main purposes is to address these issues *because they will occur*. But first, let's look at price. The contract price is the amount of money to be paid by the buyer to the seller for the product or service being sold. Each proposal should include a price directly related to the scope and schedule, and every acceptance of the offer should acknowledge that price. If extra work is anticipated, rates and/or unit prices for such work should be included, and standby rates may be appropriate. Then, there may also be a need for addressing special circumstances and any assumptions made when developing the price.

For example, the contract could have qualifiers that spell out what is expected to avoid potential problems from the delays incurred in the previous feedwater pump example. An example could be the following:

> *The Seller will meet the schedule guarantees provided the Buyer grants unobstructed access to the site, with the equipment prepared, ready for use, on the date agreed in the contract schedule.*

Another qualifier often missing in contracts could be the following:

> *The Seller will meet the schedule guarantees provided the Buyer provides all materials to the site, prepared ready for installation, in accordance with the installation sequence.*

To illustrate the importance of the second case, let's look at the problems an insulation contractor can encounter. Like most projects, assume that this one has an immovable date of completion. Assume that the contract does not have the clauses referenced above, but that it does have heavy penalties for not meeting the completion dates, and no other "changes" clause that addresses relief of schedule. The main contractor now schedules a set of work release dates for the insulation contractor to get access to the work areas. The insulation material arrives ahead of schedule but as the work area release dates arrive, the mechanical contractor has not completed the mechanical work sufficiently for the insulation contractor to move in. This obviously prevents the insulation contractor from starting per the agreed upon plan.

Finally, the mechanical contractor does complete, the insulation contractor does get access, but what was originally scheduled to take 10 months to complete on a fairly level manpower loaded program now requires more insulators because the time frame for completion is now compressed; and these additional workers are not readily available in the area. In fact, as can be seen in figure 2–3, 50% of the area was not released until the seventh month. Without extra compensation for importing manpower and working additional overtime, the insulation contractor completes some months behind schedule. The main contractor however, claims delays for failing to meet original progress dates and imposes LDs. The insulation contractor sues for extra time and money since the workers were required to stay mobilized longer than originally scheduled, because of the late releases. They go to court to fight it out when this could have been avoided with just the simple clauses above.

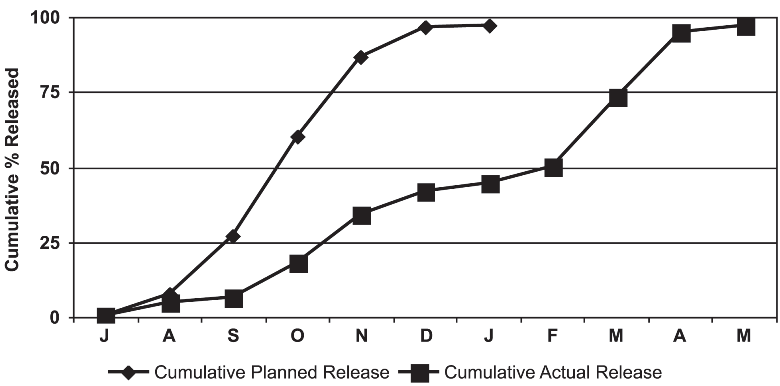

Fig. 2–3 Impact of late releases.

But what happens when the issue is not directly related to schedule dates and instead it is related to *scope creep*. Staying with the same insulation/mechanical/main contractors, as in the previous example, let's look at this. Suppose the insulation material was provided directly by the main contractor to the insulator, free of charge. When the insulating contractor prepared the material installation price, he was given the square area to be insulated and the quantities of material that were to be installed and then prepared the price accordingly. However, time passed and as the design progressed, the size of the unit to be insulated grew. No mention of this was made to the contractor until well into the job when he realized that there was significantly greater amount of material to install than originally bid.

Unfortunately, the contract did not address scope creep. The main contractor took the position that the insulator should have reaffirmed the quantities before starting work since the contract did clearly state that it was the insulator's responsibility to complete the whole job without additional compensation. The insulator stated that the insulation installation quotation clearly spelled out the quantities to be installed. Short of arguing the points of law in this case, both parties felt strongly about their positions and court was the only option.

Here again is a classic case of not understanding the contractual commitments, especially by the insulating contractor. Depending on the severity of the changes in these two cases and depending on the honesty of the parties involved, the court may find for either party—something that would not have been necessary if more thought went into the development of the contract document. Changes go beyond just schedule and scope. They also can include weather conditions, strikes, acts of war, lost shipments of materials, and a host of other things. One cannot overemphasize the necessity of addressing the mechanisms to be employed in the event of changes.

Every construction contract must clearly state how to address changes, whether they are intentional or not. It can avoid endless squabbling and it can certainly reduce the likelihood of going to court. But most importantly of all, it will foster better relations at the site since the *rules of the game* are then available and clear to all.

Finally, when drafting a formula for handling extra work, it is very important to establish an extra work pricing structure that is easy to implement. Many contracts have extremely difficult, complicated formulas that are not easy to administrate. The site staff is usually too busy to spend a lot of time trying to figure out all of this, so keeping the extra work rates simple to administer is the best policy.

As an example, some extra work rate structures require the contractor to provide time sheets signed by the client's representative, certified payroll records showing exactly what each worker was paid for this work, the structure used to add the statutory, and, if applicable, union fringes and also the contractor markups for insurance, overhead, and profit. They then go further to have the contractor add a specific percentage for the use of small tools and consumables, by craft. This kind of detail requires input by and coordination of a lot of people who could be more productive doing other things.

Instead of forcing such detail on the contractor and instead of subjecting the internal accountants to verify the accuracy of all of these numbers for every extra work invoice, a simplified system of rates will save a lot of time and effort. For example, there could be a breakdown of crafts by broad category such as certified welders, mechanical craftsmen, electrical craftsmen, insulators, and laborers. Fixed straight time and overtime rates could be agreed for these five categories that would also include all adders whether they be statutory, union, insurance, overhead, or profit.

Using the rate structure from the second example does afford the contractor the opportunity to earn additional money since there will be insistence on rates that cover the upper limits of the wage brackets while some of the men may be paid less. However, a solid contract limits the percentage of extra work that can be performed under the extra work rates, thereby minimizing the impact of this.

A typical example of this is a clause that states if the extra work exceeds 15% of the base contract value, then the contract price shall be subject to renegotiation. This is done to protect both parties. On one side, if the work significantly increases, the contractor may have to provide site facilities to support this extra work but there may not be any recourse to be reimbursed for these extra costs. On the other hand, if the scope is reduced significantly, the client may be paying the contractor for establishment costs originally anticipated but now not needed.

Payment Requirements

The name of the game in the construction business is almost always *cash flow*. Cash is King and without an adequate flow of it, the labor can't be paid, the suppliers shut off their credit lines, and the job comes to a halt. The first line of defense against this scenario is at the jobsite itself. As with understanding contractual commitments such as scope, schedule, and how to handle changes, it is extremely important that the site staff also understand the contractual requirements to get paid for the work performed.

There are any number of systems of payment releases triggered by just as many different events. A typical contract may have the owner providing an upfront down payment of say 10% of the anticipated contract value. Then, the next 80% may be tied to either percent progress or to milestones reached or sometimes a combination of both. The last 10% will usually be held in abeyance until the unit meets certain operational criteria such as a successful 100-hour run. But it is often the personnel at site who *pull the trigger* for the payment process to start or not start, based on their actions or inactions.

Normally, the contract will spell out exactly what events must happen to claim for a payment. It also generally spells out the procedure to follow to process the claim. For example, the contract may call for a 10% mobilization fee upon successful completion of establishing the site offices, tool room, and changing facilities. It may further spell out that the next 20% will be paid upon completion of the inspection of the turbine internals. This is a total of 30%. Then, there may be a progress payment sequence for the next 50% of the project, starting with the repair of components and their subsequent replacement. Finally, the following 10% may be triggered when the unit is handed back to the plant for synchronization and the last 10% may be held until six months or some number of hours of successful operation (fig. 2–4).

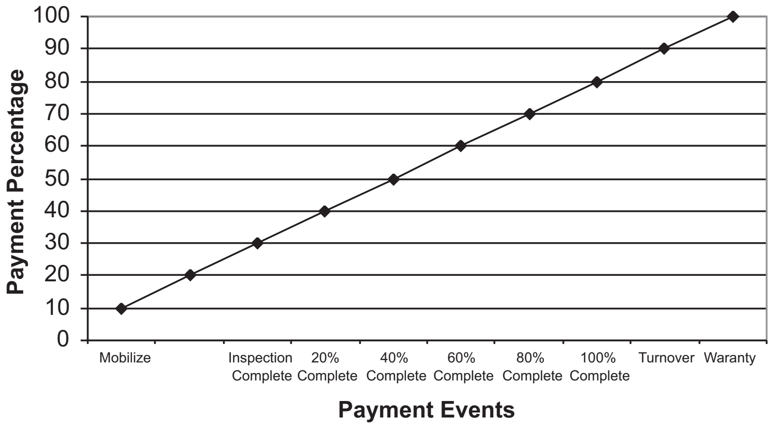

Fig. 2–4 Payment schedule.

What's important to realize is that only the site staff knows when the payment milestones have been reached. Therefore, it will be up to them to initiate the process that generates an invoice. Since cash flow is so extremely important, someone at the site (the administrator, the site manager, or another appointed person) should be intimately familiar with the payment sections of the contract. That person should also clearly understand the internal process of invoicing and needs to know how the client processes the invoices and makes the payment. Then, that person should be accountable for ensuring that the payments actually occur.

Here's what this entails.

- They must know the actual process of notifications, paperwork, and approvals at the site level.
- They must be in touch with the appropriate personnel who can decide if a milestone has been reached, and they must know who is responsible for approving this.
- They must be on guard for the absence of these key people and determine who will be the stand-in when they are not available.

Then there's the whole paperwork flow. What forms are to be used? How many copies are required? What backup is required—time sheets, vendor invoices, repair estimates, etc. Then, who needs to sign off first, second, third, and so forth? Once it's all approved at the site level, where does it go next? Should it be sent by express mail? Should an electronic copy precede it? Afterwards, it needs to be expedited. If it first goes to the home office for formal invoice preparation, who there handles it and what roadblocks do they encounter? Do they then send it back to the site or does it go elsewhere for processing by the client?

At some point, the client gets the invoice for payment. What is the client's internal process? Who handles the actual paperwork and who authorizes the release of the funds? What is their timetable? Is it only once a week and if that day is missed, it's another seven days until the funds are released? Not being on top of all the steps of this process can add days, and sometimes weeks, to the time until the funds are received.

Sometimes there are also bank issues such as letters of credit that have very specific requirements that must be met before funds are transferred. Maybe partial lien waivers are required, waiving the contractor's rights for all work performed through the date of the invoice. Small, mundane issues such as not including the correct purchase order reference number can cause the invoice to be rejected. Of course, there must be communications with the receiving bank to verify that the funds have actually been received and are available for use.

If the contractor has been diligent in the preparation of the contract, there will be a time limit within which the client is required to pay. However, it is up to the contractor to enforce this provision. Assuming that the time limit is 30 days, then the contractor, with intimate knowledge of all of the processes involved, should start expediting the payment process long before the end date (say at 20 days into the cycle). Also important to remember are banking holidays that can delay the transfer of funds. Again, it's all about cash flow, and the prudent contractor will leave no stone unturned to ensure that the payment process works flawlessly.

Taxes

The subject of taxes is very complex. There are people who do nothing but work with tax issues to do the following:

1) be sure that no laws are broken
2) be sure to comply in a timely manner to avoid penalties (which can be very large)
3) be sure that full advantage is taken of all benefits provided by the taxing structure

Record keeping is very important. Frequently, the taxing authorities ask for verification that their requirements have been met. They may perform audits to ensure compliance. They may require the business entity to prove that third-party audits have shown the process to be in compliance. Therefore, many companies automatically perform internal business reviews before they are subjected to external audits.

On construction projects, there are a host of tax issues that can directly affect the bottom line of the job. The first and most important are the payroll taxes. Every jurisdiction, whether local, county, state, or federal (and even beyond our borders) have requirements to ensure that the workers and their employers pay the prescribed amount of taxes on a regular basis. They will also require that the payer provide verification of wages paid and taxes withheld from the employee, and this must be done by a certain date—usually by issuing a W-2 form if the work involves U.S. citizens or residents. Most all contracts between the owner and the contractor or between the contractor and subcontractors require that all statutory requirements be met, especially in the area of taxation. This is done to protect the contracting party from the taxing authority coming in and attaching the site or site assets for future sale because someone did not pay the taxes. So once again, good record keeping, in addition to judicious practice of withholding from employees and paying to the taxing authority is of paramount importance.

Other taxes that are unique to construction sites are for the purchase of gasoline and materials that will form a permanent part of the structure being built. Although not all jurisdictions follow the same rules, generally the taxes on gasoline are exempt if the gas is being used in vehicles that remain onsite. For a two- or three-year major power plant construction project, this can be significant. Materials that will form a permanent part of the final structure are also often exempt from local and state sales taxes. If the project is large, and if shop assembly is not, then there may be major dollars at stake.

The prudent site administrator will research the statutory rules that govern these situations and then structure the site accordingly. For example, if large quantities of gasoline or diesel fuel are expected to be consumed solely onsite, the installation of a fueling station may be a very cost-effective move. Other taxes such as taxes on profits and taxes on imported goods and services are usually best left for disposition by the home office.

Penalties/Bonuses

Penalties are a way of life in the contracting business. The majority of the contracting entities are still working from the days where compliance with contract requirements was thought to be best enforced through the imposition of penalties for noncompliance. Although this usually has the intended effect, it is not necessarily the most cost-effective approach to contractual satisfaction. Often, the contracting party will impose some type of financial *deduct* against the payments for the work if certain milestones or performances are not met. Sometimes these penalties are calculated based on perceived damages to the client. But more often than not, they are just an assigned value that the client takes right to the bottom line, if imposed. The term used for this is LDs, which essentially means that in lieu of calculating the damages incurred, this assigned value will cover whatever the cost may be, and both parties will accept this imposition.

Since these LDs are generally imposed on a calendar day basis, they could add up to very large sums if not properly managed. Therefore, contractors usually insist on a maximum, upper limit that they are willing to commit. This limit, or cap, is then included in the contract language either as a specific monetary value or as a percentage of the contract value.

As pointed out in the introduction of this book, a 500 MW unit offline can prevent the owner from realizing revenues of up to $600,000 per day. Certainly, owners want to recoup any of this unrealized revenue in the event the unit does not come back online as scheduled, or in the event it does not perform as promised when it does come back, so they insist on some form of damage recovery. However, there are several issues with this.

First, the contractor being penalized may not have a direct effect on the availability of the unit. Although the contractor may be late in completing the contracted portion of the work, others may actually be the cause for the unit not being available. In this case, the owner could potentially collect LDs from several contractors, simultaneously, although collectively suffering less than the total of the damages collected. To minimize this eventuality, the prudent contractor will insist on a *no harm, no foul* stipulation in the contract. This essentially says that if the delayed work by the contractor did not impact the loss of revenue of the client, then even though the LDs suggest payment, there will not be any since there was no harm to the client due to the contractor's actions or inactions.

The second issue concerns contractor pricing, which eventually affects the overall project cost and then rolls to the investor's bottom line rate of return. When contractors are required to accept large LDs, they will usually add additional monies to their bid to cover the unforeseen eventuality that they will have to pay some of these damages. If the project is to build a new power plant, the construction contract for this work could have a value of $25 million or more with LDs of $25,000 per day. Although these LDs may then be capped at 20% of the contract value, the contractor is still exposed to as much as $5 million worth of penalties, which is a lot of cash. To mitigate the risk of losing this much money, the contractor will usually add contingency monies to offset some of these potential losses. To determine the amount to be added, one approach that is used is as follows in figure 2–5.

- Determine the number of days overrun to reach the LD cap
- Determine the number of days of overrun that *could* happen
- Calculate the percentage the *could overrun* is of the *capped overrun*
- Take this percentage of the capped value as the contingency

Contract Value	$	25,000,000
Liquidated Damages Capped At		20%
Maximum Penalty Exposure	**$**	**5,000,000**
Daily Liquidated Damages	$	25,000
Maximum Days Exposure		**200**
Realistic Days of Overrun		30
Realistic Days ÷ Maximum Days		**15%**
Contingency = 15% of $5,000,000	**$**	**750,000**

Fig. 2–5 LDs contingency calculation.

In this example, the contractor would add $750,000 to the bid, as a contingency to pay penalties for not completing on time. Per the calculations in figure 2–5, this equates to a 30-day overrun. Although this is only 3% of the total contract price, it is still three quarters of a million dollars, the price differential by which many contracts are won and lost. If one assumes that the contractor will not incur the penalty, and if the job is fixed price, this money will go to the contractor's bottom line, at the expense of the client.

A more palatable approach to this issue is to move away from the punitive. Contracts that are structured with a win-win mentality will approach the LDs somewhat differently. The first, and most straightforward approach, is to include a payment of bonuses for early completion, assuming early completion has value, which is often the case for plant shutdown work. With new construction, there are often too many contractor interfaces for early completion by any one contractor to have value. However, when early completion does have value, offering a bonus may help offset the contractor's contingency. In the previous example, one might look at the possibility of an early completion of 15 days and offset that against the potential 30-day overrun and now only add $375,000 to the bid, half of the contingency originally calculated.

But there are also ways of structuring incentives to meet the end date that encourages both parties to the contract to work together to avoid delays. One such method is for the client to hold the LD contingency in escrow instead of paying it to the contractor as part of the base contract price. Then, if the contractor foresees a need for this money, maybe to pay overtime to make up for schedule slippage, the client would release the money. The specific conditions under which this would be triggered would need to be spelled out in the contract.

The importance of the site personnel being keenly cognizant of penalties, as well as bonus opportunities, is made clear just by looking at the numbers. Being charged $25,000 for every calendar day of noncompletion adds up very quickly. In addition, there are the ongoing site overhead costs for each and every day the site is still active. Recognizing that the site management personnel are the front-line observers of the day-to-day activities, it is important that they know what may impact the completion date in time to take corrective action.

Summary

Not understanding the contract requirements, the commitments that both parties have agreed to abide by, can be disastrous. Hopefully, those that were responsible for developing the original specifications, bids and proposals followed a business approach towards developing the final contract documents. The intent should be to structure a user-friendly, win-win document. Items such as the scope and the schedule—which in reality are the intent of the contract—should be thoroughly prepared. The architects of the contract should ensure that these two items clearly reflect the intent of the buyer while at the same time reflecting the capabilities of the seller. When either the sellers or the buyers feel they are not performing or receiving services in keeping with their expectations, the contracts are the documents that will be used to mediate the issues.

The contract is the document that will be used to implement changes to scope and/or schedule. Therefore, it must be clear and concise so it can be used to manage these changes without disruption to the project. During its development, the contract authors should be looking for ways to structure the document that will allow its implementation to fit within the normal business practices of each party's organization.

The same holds true of the structure for the flow of the payments. Since for the contractor, cash is king, the document must be clearly written with regard to how the payment process is started, how it is implemented, and how the monies are actually transferred. It is incumbent on both the buyer and the seller to accept only conditions of payment that provide a timely transfer of funds, representative of the services performed.

Taxes are an area that can confound the most astute site management team. It is always prudent to seek expert advice from local sources regarding the requirements and obligations of the tax systems applicable to the project at hand. Sometimes significant sums are required to be paid up-front to obtain permission to even start work at site. Then there will be periodic payments that *must* be made in a timely manner. The cost of noncompliance with the requirements of the taxing authorities can be quite high, including the requirement to cease operations until the misunderstandings are resolved.

Finally, serious thought should be given before the imposition of penalties and/or bonuses. These can create ill will if not structured fairly and if not administered with care. A contractor who is approaching the possibility of being penalized will be focusing attention on ways to avoid this at the expense of focusing on the job at hand. Similarly, a client nearing a decision to impose LDs on a contractor will find their relations starting to sour, and that is never conducive to successfully completing the project. The best approach is to find some middle road where both parties have an incentive to work towards a goal of timely completion.

The intent of the framers of the contract document must be to structure a workable process. The obligation of the users of the document must be to clearly understand what it says and how to use it to carry out the everyday activities of the project. In the event that differences occur, they must also know how to use it to resolve those differences. Notwithstanding all of the foregoing, the fervent hope of most parties is to avoid having to delve into the contract language to resolve disputes in the first place. So being thoroughly familiar with the documents and understanding the contractual commitments that are in place, dramatically increases the possibilities of having a successful project.

In chapter 6, there is a discussion of the first steps to be taken in this regard. The basic idea is for the salient points of the contract to be abstracted and made required reading for all of the staff. Using this approach, the management of the work then becomes easier to perform.

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3

THE COMMERCIAL SIDE

In the previous chapter, understanding the contract was emphasized. Specific contract conditions were reviewed and examples given of the pitfalls that lay ahead for those who do not take the time to study these documents. This chapter delves into the additional contractual issues that are often referred to as the legalese of the contract. They are the clauses referred to by the site management when contentious issues are first raised. They are also the clauses referred to by the adjudicating management and lawyers when the issues go beyond the ability of the site staff to resolve.

The Legal Framework

A typical power plant construction contract will consist of a host of clauses put in place at the insistence of the legal advisors to the parties to the contract for their mutual protection in the event things don't go as planned. No one, neither the client nor the contractor, want to risk the total assets of the company on any one project. They want to be able to assure their shareholders that the commitments they are making have a downside limit with regard to bankrupting the organization. So they negotiate a series of conditions that spell out what the rights and obligations are of each party and where their limits are.

For many smaller contracts, such as routine maintenance outages, the contracting parties may already have a pre-agreed document that spells out the conditions to be used in administering the contract. This is a great time saver since it allows the parties to focus solely on the technical aspects of the work, and it eliminates the time delay of negotiating commercial conditions before being able to start the work. It also takes off the table the temptation for either party to play lawyer and change conditions.

But for the majority of major contracts, say above $1 million, the pre-agreed contract documents are generally inadequate. As an example, a routine outage labor contract may be valued at $250,000. Since the terms of the pre-agreed contract frequently state that the limitations of liability, the maximum exposure the contractor can incur, are capped at the value of the contract, the exposure the contractor incurs is limited to $250,000. But if this language is used for larger projects, say for a $5 million job, the average contractor will not be willing to risk being liable for this total value. Therefore, additional protections are commonly found in the larger contracts.

Terms and Conditions

The commercial rules that govern the implementation of the contract are collectively called the terms and conditions of the contract. These rules are put in place by all of the parties to the contract to protect themselves in the event of disputes. During the contract negotiations, each party jockeys for position, looking to secure the most favorable terms they can for themselves.

A typical contract's terms and conditions will address, at a minimum, the following, also called *contract features*:

- Consequential damages
- Limits of liability
- Warranties—expressed and non-expressed
- Remedies that deal with conflicts of contract provisions
- Third-party claims
- Force majeure delays
- Dispute resolution
- Proprietary and commercial property protection
- Performance guarantees

Consequential damages

Damages that are not quantifiable, and therefore normally not insurable, are considered *consequential*. For example, a contractor's crane boom falls and takes down the power lines between the main transformer and the switchyard. The direct damage to the client is the damage sustained by the power line. The consequential damage could be the loss of profits or revenues due to business interruption since the plant will not be able to dispatch power from the unit until the power line is replaced. Normal contracting practice excludes these damages from the contractor's liability.

Limits of liability

Prudent contracting includes placing limits on the total exposure to the overall liability that can be incurred. Adding to the earlier examples of limiting the contractor's exposure to some portion of the contract value due to schedule overruns, often contractors go beyond just protecting themselves from these penalties to also limiting their total exposure from any and all items to an aggregate monetary amount. This is usually highlighted by a separate Limitation of Liability clause that essentially states the contractor's overall liability from all causes is limited to some specified value.

Warranties—expressed and non-expressed

Warranties can be directly expressed in a contract, or they can be implied. Expressed warranties are exactly that: they are expressed or stated directly in the contract document, *e.g.*, the contractor *warrants* that the area will be returned to its preexisting condition upon completion of the work. A non-expressed (or implied) warranty, on the other hand, is not an intended warranty by the contractor. For example, there may be remedies available to the client based on legal precedence. Unless specifically addressed in the contract, they are implied and the prudent contractor will include a statement specifically excluding them.

Remedies that deal with conflicts of contract provisions

With large contracts, there are often large documents. Even though both parties are careful to avoid conflicting clauses within these many documents, it is often almost impossible to check for every possible conflict. Therefore, the contract should address what is to happen in the event conflicting provisions arise. For example, in the standard terms and conditions section of the contract, it may state that the contractor has three days for notification of events likely to create a delay, such as encountering asbestos insulation on some part of the plant. In another section, maybe a section called Special Provisions, it may state that the contractor has 24 hours for notification of events that may create extra compensable work. Since delays and extra work often go hand in hand, the contractor that waits three days to claim for a compensable delay may have trouble getting agreement on timely notification unless there is a statement somewhere else that states the terms and conditions section of the contract rule in the event of any conflicting statements.

Third-party claims

A third-party claim is a claim by anyone other than the signatories to the contract. It might be another contractor on-site, or it may be the family of an employee who was injured on-site. The contract should address what happens in the event of a third-party claim. It is not unusual for a client to ask contractors to provide indemnification from all claims, including claims from third parties. The prudent course of action in this case is for the contract to limit the contractor's indemnification to claims arising only from the contractor's own negligence during the performance of the work and only while on-site.

Force majeure delays

Force majeure delays are delays that are beyond the control of the buyer or seller. Such things as lightening strikes, hurricanes, earthquakes, etc., commonly called *acts of God*, are classic cases where no one has control. In such cases, the contract will usually stipulate that the contractor will be allowed a reasonable extension of time. However, since neither party had any control over the event, it is seldom compensable. Other items, outside acts of God, may also be included such as labor strikes, war, sabotage, and whatever additional items the parties deem to be included. What's important to remember is that if it is in doubt, the item should be written into the contract as an exclusionary item.

As an example, let's assume that the contract has included labor strikes as a force majeure item. Then, let's assume the contractor's personnel go on strike for higher wages. The contractor will claim for force majeure delay but the client may refuse, saying the intent of this clause was for causes outside of the control of the parties, and the wage issue is not outside of the contractor's control; the workers could have been given more money. Obviously, more clarification was required.

Dispute resolution

Unfortunately, large, long-term contracts often end with the parties in conflict over some item or issue. This may be because the language of the contract document is not clear, or it may be because the language was never included in the first place. Issues can range from scope, schedule, extra work rates, payments and delays to access, site maintenance, damages, and labor troubles. Whatever the issue, its resolution will be much easier if the framers of the contract document agreed on the rules for resolving disputes and then clearly spelled them out in the document (more on dispute resolution in chapter 4).

Proprietary and commercial property protection

Most parties to the contract will own some kind of documents or other items that they wish to keep others from duplicating and/or using for commercial gain, without reciprocal compensation. These items may be shop or other detail drawings and designs. They may be specially developed software products or a host of other patented or copyrighted materials or processes. The contract should clearly spell out that the use of these items, outside of the confines of the contract work, is prohibited. A typical case is the use of confidential drawings, especially drawings from an OEM.

Often, a plant hires the OEM to install or replace/repair equipment and components because of the OEM's access to the *confidential* drawings and designs. This ensures that the work will be done to the specifications the OEM intended when the part or equipment was designed and that it will perform accordingly. However, this usually comes at a price—the OEM may charge a higher price than a third-party contractor because the OEM has invested considerable time and money into developing and proving the part or equipment and now is guaranteeing its performance. Since third-party contractors do not have these upfront costs to recover, they may be able to provide the same work for a lower cost if they have access to the same drawings. So, often the OEM will ask that the contract prohibit the owner from using these drawings or designs without the OEM's explicit approval. In other words, the OEM does not want competitors to have access to proprietary information and then be the lower bidder on the next job.

Performance guarantees

In addition to guaranteeing project completion by a certain date, many larger power plant construction projects also include certain performance obligations. These obligations are usually related to equipment provided by the contractor that forms part of the final plant operation such as valves, motors, pumps, and instruments. To avoid disputes, a win-win contract document will clearly spell out the parameters associated with guaranteeing performance. First, guarantee points should be clearly stated. Then, the methods and means for the testing itself should be written. Third, it should be clarified whether the testing is to be performed by the contractor, the owner, or a third party.

Not only should the guarantee points and performance methods be spelled out, but also the existing conditions on which the guarantee points are dependent must be included. Finally, specific remedies should be included in the event the performance guarantees are not met. These remedies may be as simple as replacing the item, say the controls of a feedwater control valve. But in the event of an inaccessible part (say some boiler bank tubes in the center of the generating bank, between the upper and lower steam drums), the replacement may not be feasible and payment may have to be adjusted to compensate for reduced throughput.

However, the manner in which all of these terms and conditions are addressed differs significantly, depending on who is trying to protect whom. A plant owner will be looking for as much shifting of risk to the GC as possible. On the other hand, the GC will be looking to shed as much risk back to the owner as possible, and when negotiating with subcontractors, the GC will be looking to shift risk down to them as well. Meanwhile, the subcontractor will be looking to shed risk by shifting it to back to the GC. The next two figures compare some of the more salient terms and conditions from the viewpoints of these different parties. Figure 3–1 shows the owner/GC relationship, and figure 3–2 shows the relationship between the GC and the subcontractor.

TERMS AND CONDITIONS

OWNER – GENERAL CONTRACTOR CONTRACT

OWNER'S VIEW

INCLUDE	EXCLUDE
Indemnification clauses	Limited or qualified indemnification
A/E's decision as final and binding	Limited A/E's decision clauses
Limiting extra work clauses	Open-ended extra work clauses
No damages for delay or disruption	Clauses permitting delay claims
Liquidated damages clauses for delayed completion	Attempts to qualify or limit liquidated damages
Payment clauses requiring release of liens and claims	
Termination for cause clause limiting exposure to claims	
Termination for convenience clauses limiting exposure to claims	

GENERAL CONTRACTOR'S VIEW

INCLUDE	EXCLUDE
Limited indemnity only for negligence	Payment contingent on events other than performance of the work
Concealed conditions clause	A/E decision being final
Recovery for extra work	Detailed and complex extra work clauses
Recovery of delay related damages	No damages for delay clauses
Recovery of overhead and profit in the event of termination	Liquidated damages clauses

Fig. 3–1 Owner/GC contract clauses.

TERMS AND CONDITIONS

GENERAL CONTRACTOR - SUBCONTRACTOR CONTRACT

GENERAL CONTRACTOR'S VIEW

INCLUDE	EXCLUDE
Incorporate by reference all contract documents	Clauses that bind subcontractor only to technical specifications
Pay when paid clauses	Limited indemnity clauses
No damages for delay clauses	Clauses allowing for recovery of damages or termination in the event of delays
Clauses allowing for recovery of overhead and profit on deductive change orders	
Termination for convenience with payment of only actual loss of work supplied	
Termination for cause upon two days written notice	

SUBCONTRACTOR'S VIEW

INCLUDE	EXCLUDE
Clause limiting scope only to plans and technical specifications	Incorporation by reference clauses
Unconditional payment clauses	Pay when paid clauses
Basic extra work clauses	Complex extra work clauses
Clauses entitling subcontractor to delay damages	No damages for delay clauses
Clauses permitting termination for nonpayment	

Fig. 3–2 GC/subcontractor contract clauses.

First, let's look at figure 3–1, a comparison of the contract clauses *wish list* from the owner's point of view as opposed to the GC's point of view. The owner wants broad indemnifications. The owner will want to include protection against third-party claims, but the contractor will want to limit these protections to self-negligence. The owner will want to give the A/E the latitude to ensure the work meets the intent of the specifications without granting additional compensation or time to the contractor. The owner will want to minimize extra work while the contractor will want to be paid for anything even resembling out of scope efforts. The contractor will also want to be paid for disruptions due to concealed conditions, such as finding underground piping, or electrical cables, of which there was no prior advice. The owner will want to shift the cost of damages due to delays to the contractor by increasing the LDs while the contractor will want the exact opposite. The contractor will want to reduce exposure to LDs and will want to qualify specifically how they are triggered.

In the event the owner terminates the contract, the contractor will want recovery of the overhead and profit planned for the total project while the owner will want to limit this to only that portion directly associated with the work performed.

Figure 3–2 shows a similar comparison of contract clauses, but this time it is a comparison between what the GC wants vs. what the subcontractor wants. Specifically, the GC is looking to shift all scope risk to the sub by trying to incorporate any and all documents related to the project into the contract between them. The GC is also looking to stay cash neutral by asking for a "pay when paid" clause where the sub does not get paid until the GC has been paid. This can have very serious consequences for the sub since, as already seen, in the construction world cash is king. Therefore, the subcontractor should ask for a clause permitting termination of the contract for nonpayment.

Although subcontractors are once removed from the owner and usually not in a position to make contractual contact, they still must be cognizant of issues that may be created by the owner, that flow through the GC, and that then affect them directly. *Pay when paid* is one such issue. But so are delays. The delays may not be the fault of the GC. They may be the fault of the owner or even another contractor on-site. So subcontractors will want the contract language to protect them in the event there are costs due to delays by others beyond the GC.

Summary

As we now see, the commercial side of the contract should be the least used part of the contract document. In a perfect world, there would be no delays, no scope changes and therefore no disputes; and on the smaller, faster jobs, that's often the case. However, in the real world, when projects are large and complex, it is impractical to expect perfection. So the terms and conditions of the contract do have their place.

But to be of help in resolving the issues that do arise, they have to be practical. They should not be one-sided; they should be clear, and they should outline a resolution process that is acceptable to all parties. They have to be legally sound and usable in the jurisdiction where the issues will be resolved.

All parties to the contract must understand that they have different levels of responsibilities to each other. The owner has responsibility to the investors of the plant, and responsibilities to the A/E or GC who in turn is pulled between the owner and the subcontractors. The subcontractor may be impacted by others against whom there is no recourse yet there remains a responsibility to the GC. The win-win contract will take into consideration the needs of all these parties and strive to protect each one.

4

RISK MANAGEMENT

If you've read through chapters 1, 2, and 3, you'll see that we've now structured a contract. We've structured a contract that meets the needs of the owner, it meets the needs of the contractor, and most importantly, it meets the needs of the investor. We've researched the types of contract structures that could be used and saw that depending on previously determined needs, there are a variety of structures available.

We've looked at all of the available resources for ultimately executing the work, starting with the makeup of the construction management team. We investigated the different sources of labor and the various conditions under which they would or would not be suitable for the work. We checked into the availability and sourcing of small tools, consumables, and we looked at alternatives for the use of heavy construction equipment.

But then, we also realized that "the best laid plans of mice and men often go astray." We knew that reality will set in, and no matter how carefully and thoughtfully we developed our plan and no matter how craftily we structured our contracts, certain things *will not happen as planned*. So we also looked at contingency plans.

Contingency planning is simply one prudent tool in the business of contracting. It can take the form of calculating a monetary cushion. It can take the form of adding days or weeks to the schedule. It can take the form of invoking or not invoking certain contractual clauses. But whatever form it takes, contingencies must be managed and managing contingencies is managing risk.

This chapter will introduce the reader to the subjects of claims avoidance and insurance management. Both of these are part of the risk management process and therefore must be understood by those preparing the construction contracts as well as by the site management team that follows. Numerous books have been written about each subject as well as risk management itself. This chapter does not cover these subjects in detail; it only addresses them from the view of the site management team; the intent is to familiarize the team with the steps they must take to protect their position when risk issues arise.

Claims Avoidance

One of the objectives of a risk management program is to achieve the project's goals while avoiding the risk of claims resulting from disputes. These disputes could arise from any number of issues, the most common being scope, schedule, cost, and quality. One thing is clear, however; projects do not spontaneously fail. In every case, there is a trail that leads back to an unrealized, misunderstood, or unmanaged risk. Unfortunately, the end result of these failures is often a claim leading to arbitration, mediation, or litigation with lots of time and money spent by all parties.

In the early days of power plant construction, during the days of regulated utilities, claims avoidance and its parallel risk management process were not at the forefront. The emphasis was on project completion and reliability of the plant. Today, with the emphasis on economics, this has changed. With the tighter economic environment, many contractors, A/E firms, and owners are experiencing, profits are being squeezed and the participants in the projects fight harder for every dollar they believe is theirs. This leads to tougher negotiations, tighter contract terms, and stricter enforcement of contract language, especially on larger projects (>$100 million).[1]

For these reasons, it is important today that power plant construction projects are structured to minimize claims, and that they are structured to expedite disputes. This is not easy. Managing risk has become increasingly complex. Technological innovation, globalization, and increased accountability at the senior management level of the corporate world have changed how risk must be managed today. Add that to the shortage of personnel skilled in managing power plant projects, and we have a situation that requires careful planning, contracting, and site execution—from the outset of the project—to avoid claims.

There are many steps that owners, designers, and contractors can take toward ensuring that their projects are completed on time, within budget, and without claims and litigation. First, learn all you can about your partner. Risk-shifting by owners, A/Es, and GCs has become the norm. Large firms often create special corporations to build a project, all with the specific intent of limiting their liabilities. Their purpose is to shelter the parent company from legal problems and financial obligations in the event of issues down the road. It may appear that corporate money is paying for the project, but the special corporation is often financed by parties with no connections to the corporate firm. To make matters worse, these financiers often have no money available for cost overruns, which means that the contractor, if he gets into trouble through no fault of his own, has no one to turn to.

After vetting the partners in the transaction and knowing their financial strengths and weaknesses, good contracting must be enacted. The terms and conditions of the contract are often bigger risks than timely or efficient contract performance. For example, force majeure used to be a protection for the contractor. In the event of forces beyond his control, the contractor was allowed compensatory time and sometimes was even paid for costs incurred. Today many owners are denying this protection and forcing acceleration without compensation. The contractor used to expect protection when encountering site conditions different from what was expected; today, this risk is frequently shifted back to the contractor. For reasons such as these, it becomes increasingly important for all parties to the contract to clearly understand their obligations to each other and to third parties as well.

In chapter 5, there is a suggested outline of specific contractual clauses that should be understood by all site management personnel. Some of these clauses impose specific obligations on the parties that, if not met, may cause the offended party to lose its right of redress. For example, most delay and force majeure clauses require notification within a certain time after the occurrence of the event. Suppose a hurricane shuts down the job for a few days. If the contract requires the owner to be notified within three days of the event but if the contractor waits until the end of the job to claim for time, the owner may have the right to deny the claim, even though everyone knew there was a hurricane. Therefore, it is necessary for the parties to understand their obligations in order to preserve their rights of future redress.

Next, in today's litigious world, a strong step toward claims avoidance can be to have a mandatory process of review and negotiations to be followed before any legal actions are started. The first such step would be a systematic process of reviewing potential claims. Large new construction projects, and overhauls with potential unknown scopes could require the participants to hold weekly meetings to review any items of possible contention. (For example, what work will be required once the turbine has been opened and inspected?) The idea is that if these items are brought to the attention of the parties at their earliest stages of discovery, often there is time for work-arounds that will lessen or eliminate problems down the road. Even if the contract documents are silent on this issue, site management teams still can implement their own review procedures to facilitate the avoidance of claims.

The next requirement may be to have a mechanism in the contract that encourages both sides to meet and discuss problematic items at varying levels of management. This kind of provision can greatly enhance the resolution of claims by negotiation among senior managers of both parties, eliminating the need for a legal resolution.

As can be seen, most of the foregoing can be summed up in one word, *communication.* Communication is the key to many of the issues that lead to claims. Figure 4–1 shows a classic case of the lack of communication during a construction project. Unfortunately, the owner doesn't always get what was wanted, and the contractor doesn't always build what was designed. Construction requires very extensive communication efforts by all parties. Site visits, models, renderings, and computer simulations can help explain what is intended more clearly than just a set of plans and specifications.[2]

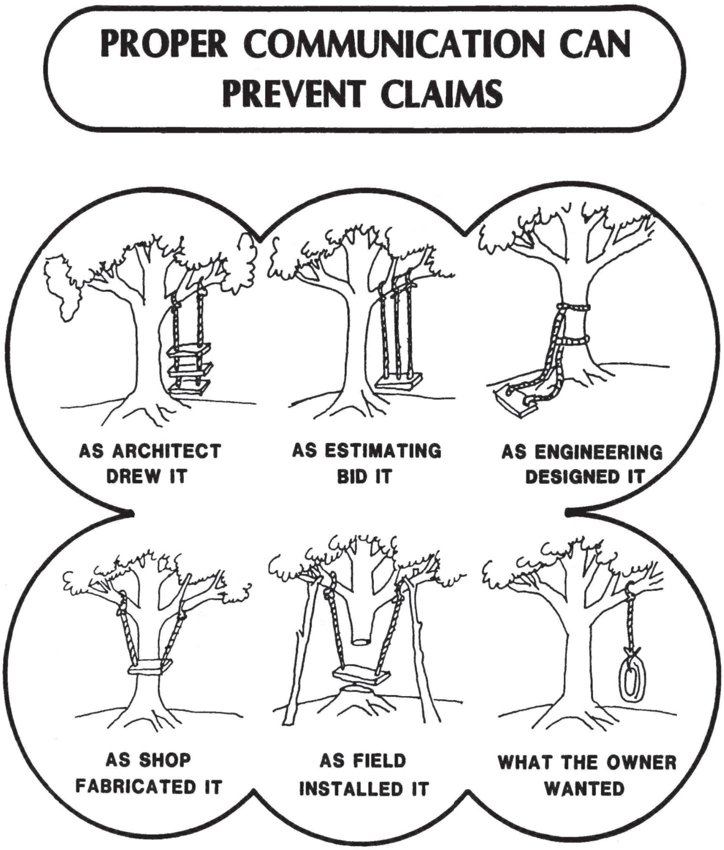

Fig. 4–1 Proper communication can prevent claims.
Courtesy of Wilson Management Associates, Inc.

On complex new construction projects (and even for major retrofits where piping or other equipment must be shoehorned into position), computer simulations can greatly enhance the understanding of the task at hand. This can happen both in the office during the design and afterward in the field before the installation work proceeds. Some years ago, this type of modeling was very expensive and only the largest of contractors could afford the investment. Today this is no longer the case. Therefore, using this kind of simulation can quickly highlight problem areas to be encountered in time to either develop alternate approaches or to build a clear case for a contract adjustment. No longer can designers and contractors use the excuse of "unforeseen obstructions or interferences" as effectively as they could in the past. The tools now exist to mitigate many of these issues and avoid contentious claims.

Being prepared

A major step toward claims avoidance is to be prepared in the first place. Being prepared forces one to be cognizant of the potential for claims, whether being in the position of the claimer or being the claimed. The first step is maintaining all documentation. It is not sufficient to only keep the *latest* version of a document. For the resolution of most claims, a trail of evidence, a *history*, must be available. This suggests that all versions/revisions of pertinent documentation must be available and must be able to be linked to each other and to the latest version, at least up to the date of the claim. Otherwise, the opposing party may reconstruct the evidence and surely their version will not be your version. The most obvious of documents to which this applies is the construction schedule.

For example, let's assume the GC is the author and keeper of the overall construction schedule (as it should be!). Weekly, the revised schedule is issued, based on input from all of the sub-tier contractors. Now suppose the project is nearing completion and the electrical contractor has not yet set the motor control center nor pulled the power cables to the boiler feedwater pumps, although the original schedule showed this being complete by now. In actuality however, as the weeks of the project progressed, the work in this area continued to be delayed due to lack of access and problems in constructing the motor control center enclosure, none of which were under the contractor's control. Now comes the time for filling the boiler with water for the hydrotest, and the feedwater pumps are not operational. The boiler contractor claims for an extension of time and related delay charges to the GC who in turn claims against the electrical contractor. If the electrical contractor did not keep the entire series of schedules as they were developed and issued and especially if there was no other documentation contesting the delays, he will have a difficult time proving that others delayed him. It's extremely important to keep *everything*!

In addition to keeping all versions of the schedule, it is also important to keep the original estimate and all of its variations. This can be very useful when arguing against a claim or when making a claim to show that the item in dispute was or was not different when originally bid. The same goes for documentation of the site visit and any information provided by the owner and GC at that time (see Appendix A). It is important to file and have readily available *all* documents until the project is completed and all of the paperwork, changes, and disputes have been resolved, sometimes several years beyond completion of the site work. In fact, many companies have specific retention requirements for all documentation and they make it a part of their quality control program.

The claims process

At the outset of the job, the potential for claims must be considered, whether from the viewpoint of being the claimer or the claimant. The modern power plant has yet to be built where there either were no claims or where there was not at least a thought given to the making of a claim. That does not mean to imply that claims have to be contentious. Many times, claims are clearly legitimate, even encouraged by the claimant, and readily accepted. The following is not intended to be a comprehensive treatise on claims processing. Rather, it is intended to be a primer on what creates claims and what steps are required to be in a position to manage a claim in the event one is made. Hopefully, by being knowledgeable about these steps, contentious claims can be avoided in the first place.

There are several steps required to successfully formulate and present a claim for additional costs. First, it must be recognized that something on the job is going wrong. This is not a guarantee that anyone is due more money, but it may be an indication that compensation is warranted. Second, it must be determined what is outside of the contract scope and the cost of it. Third, one party must convince the other on the merits of the case and the associated costs.

Figure 4–2 is a typical example of a claims matrix, showing the relationship between the cause, the effect, the impact or remedy, and the cost elements associated with each. Clearly, there are a multitude of causes. These can be due to the actions or inactions of any party on the project. However, the effect is usually either scope related or schedule related. The impacts, here shown as schedule related, do not mean there will be a delay. They just mean that a delay is possible if nothing is done to mitigate the causes, and as the claims matrix shows, that mitigation usually manifests itself in the guise of cost elements.

So how does one provide the proof of cost impact or defend against it? Very simply, set up cost codes at the outset of the job and then diligently input the data on a regular basis. At the time there is even a hint of a potential claim, each party should compare the related costs to actual input data and verify that they are representative of the potential claim. That, in itself, does not constitute acceptance of the claim nor does it constitute agreement that the costs are exact and final, but it does set up the basis from which to negotiate any resulting claim.

Schedule data can be equally important. As shown in the earlier example of the unavailability of the boiler feedwater pump, the contractor's schedule should clearly demonstrate how the work was intended to be completed—the "as-sold" schedule. The work sequence and time durations should be actual intended ones and not simply something to satisfy the contract requirements or use up all available time. It should be sufficiently detailed to clearly show the use of major equipment, movement of materials, number of crews (manpower loaded), and possibly cost loaded (expected cash flow in/out). The schedule should be updated on a regular basis throughout the life of the project, with distribution to all parties. You don't want to find yourself in the scenario as shown in figure 4–3 and then try to defend a claim.[3]

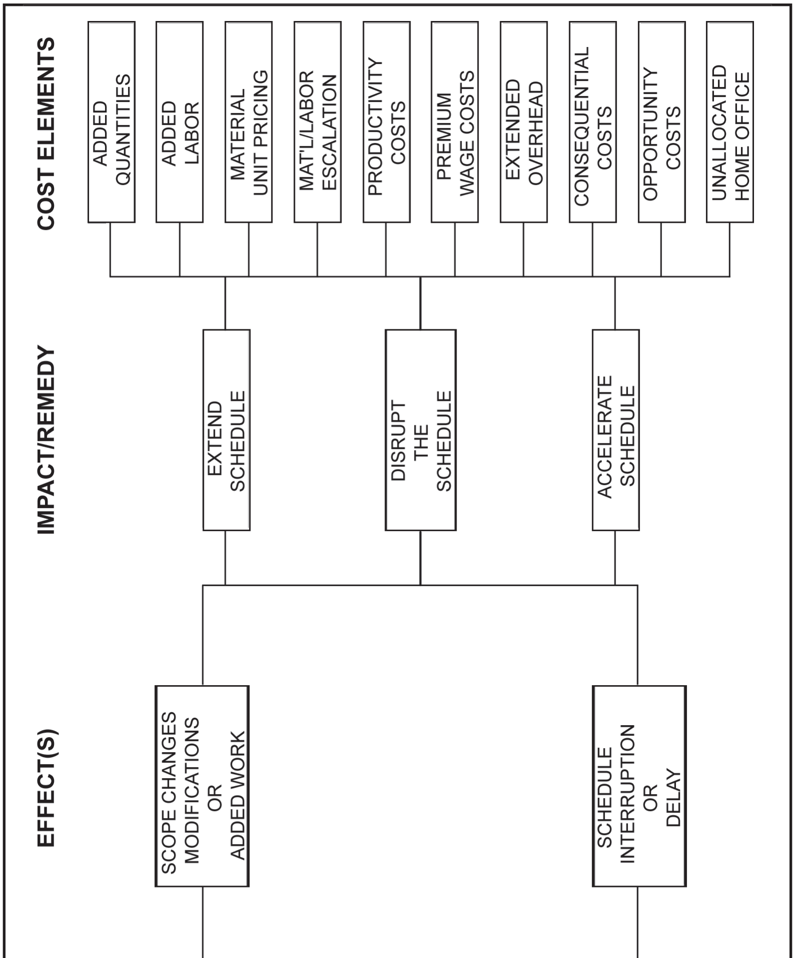

Fig. 4–2 Construction claims matrix.
Courtesy of Saybrook Associates, Inc.

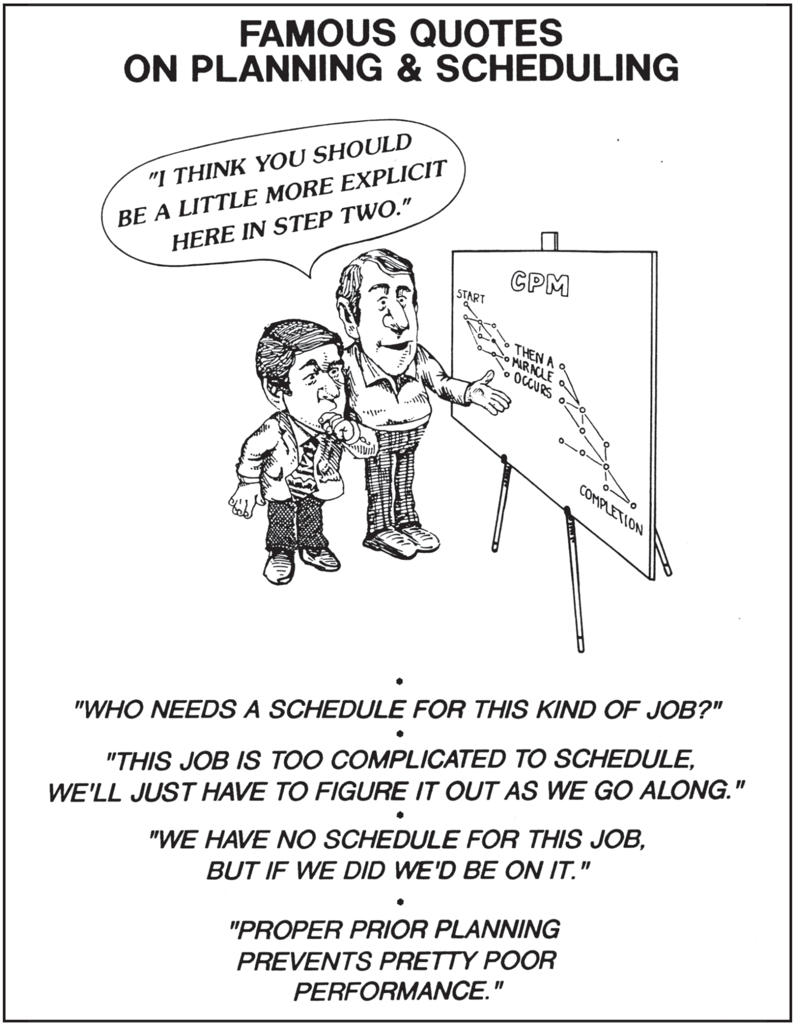

Fig. 4–3 Famous quotes on planning and scheduling.
Courtesy of Wilson Management Associates, Inc.

Next, all claims must be documented and that requires a good record-keeping system. It is therefore very important that each party to the contract takes a hard look at his record-keeping system, runs some tests on it, and sees how well it performs. If it does not meet expectations, then it needs to be modified to accomplish its goals.[4]

Let's take the case of a major plant overhaul, one that's been planned and scheduled for three or four years. The scope is all-encompassing, from turbine re-blading to boiler tube replacement to pump and valve replacement/repacking and more. The job is awarded to a major contractor who breaks it into smaller packages for subcontracting. The turbine work runs into delays, which then extend the outage, allowing the pump/valve mechanical contractor time for additional work. He, in turn, discusses with the GC the need for certain valves to be replaced, instead of just repaired/repacked, especially since now there's time to order, receive, and install them. He gets the OK and proceeds.

At the end of the job, he submits an invoice to the GC for the extra costs in procuring and changing out the valves, and the GC, in turn, bills the owner. The owner asks for documentation that 1) proves the necessity of replacing the valves and 2) shows acceptance of having the work performed. A good record-keeping system would enable the GC to access all correspondence necessary to satisfy the owner by keying into his correspondence database a word or phrase such as "valve repair," which would immediately point to all documentation involved with this aspect of the work. The same goes for the mechanical contractor who pointed out the need for the work in the first place. There are many electronic systems available today that are designed specifically for this type of record retrieval, and the excuse for not being able to find the proper documentation is no longer acceptable.

Records that should be kept for several years, and readily accessible, are ones such as the following (more on these in chapter 6):

- As-sold estimate
- All schedule revisions
- Daily progress report
- Transmittal letters
- Document status logs
- Clarification memos and requests for information (RFI)
- Most correspondence, including e-mails

- Minutes of meetings
- Weekly and monthly status reports
- Photographs

It is critical to remember that *all written and retained records* are "discoverable" and not confidential. This means that once it's been written and recorded, any party to a future claim will have legal rights to see and use it. Note that the use of individual (personal) diaries is often questionable since they may not be admissible in court, so the best policy is to avoid using them. Sometimes they contain comments of a personal nature, not very professionally written, that could result in some embarrassing statements being made public.

Finally, as part of the claims avoidance process, the prudent site management team should be aware of The Deadly Dozen,[5] 12 causes of troubled projects that frequently lead to claims.

1. **Delayed completion**

   When a construction project is completed late, the owner, contractor, and even the designer may experience financial damages. Unraveling delayed project completion is difficult and requires careful comparison between the originally planned schedule and the as-built version. Being able to plot some of the variables, such as manpower, percent complete, etc., on the same time scale as the planned and as-built schedules will be helpful in seeing the cause of the delay. Therefore, this historic data should always be retained.

2. **Accelerated schedule**

   Acceleration of a project often comes about because of earlier delays that are being overcome. These efforts may result in increased cost to the party performing the work. More resources may be assigned, additional shifts may be implemented and overtime may be required. Usually, the incremental cost for accelerating must be established and the acceleration approved before extra payment will be made. This requires that cost records be available for verification.

3. **Starting or ending date change**

   For most power plant construction work, starting and ending dates are carefully selected due to seasonal power needs and climatic variations. Therefore, the starting and ending dates of the project, as well as certain activities within the project, should be carefully spelled out. When changes are made in the time frames for the work—like shifting the work into the hard winter or the very rainy season—additional costs could be incurred. These incremental costs must be established before extra payment will be made. This requires that records be available for verification.

4. **Work sequence changes**

   The sequence of the work can be mandated by the contract documents or it can be implied by the nature of the work. If there will be restrictions on the sequence of the work, the party preparing the contract documents must spell this out. Once established, changes in the work sequence can be expensive and time-consuming. However, good documentation must be available to show that there was a required sequence, and if it was unilaterally changed, that there were incremental costs.

5. **Excessive management**

   Every project has some type of management structure. An organizational chart should be prepared and distributed showing the names of the companies and the individuals within who are to be the point of contact. Never skip these lines of communications, and more importantly, *never* give directions to your contractor's subcontractor. Also, never direct a party on how to accomplish the tasks required by the contract, only direct him that the task should be accomplished. Doing any of these can lead to claims of increased costs due to excessive interference.

6. **Lack of management by the owner or GC**

   The owner and/or GC has an obligation to coordinate the work of the contractors and subcontractors, and this obligation must be fulfilled. Lack of decisions in a timely manner will lead to confusion, interferences, and ultimately increased costs for which claims will be made.

7. **Quantity variations**

   When contractors bid and contract to do work on a unit price basis, they have to make some assumptions as to the quantity of work they expect to have available so they can properly charge for fixed costs like overhead and equipment. When there is a significant change from the estimated quantity of the work, there must be, by necessity, a method to change the unit price. In the case of unit price contracts, it is important to remain aware of the total quantities so proper adjustments can be made.

8. **Quality of work**

   One of the most difficult things to define in a contract is quality. Quality is often determined by comparing the work on one project to similar work on another. In order to minimize disputes, the contract should invoke established codes wherever practical. If possible, sketch out or construct a physical sample of the work desired and advise everyone that this is the quality required.

9. **Access restriction**s

   Any access restrictions to the work area must be clearly spelled out in the contract documents. In many cases, especially when working in an operating plant, the bidders should be required to visit the area during operations to familiarize themselves with the restrictions so that there won't be any surprises during the performance of the work. If conditions change, there may be a claim for changed work sequence.

10. **Failure of project to perform**

    A contract should be for *performance* or for *put in place*, not both. If it has some of both, confusion will result and the parties will end up with claims against each other. As an example, if the electrical contractor is required to wire the drives of some equipment, say large feedwater pump motors, in accordance with industry standards, then he cannot also be told what size of cabling to use. However, if he is told only what size cabling to use, and this cable is too small, resulting in a fire, he then cannot be held accountable for the damage.

11. **Additional costs because of the actions of others**

    Similar to Item 4, "Work sequence changes," a contractor can be impacted by the actions or inactions of others. This may be as simple as one contractor excavating across the access road to lay underground pipe, which then impedes the access to the work for everyone else. But it may also be as serious as the owner's employees blocking contractor access to the site, as part of a labor action. Incidences such as these may cause contractors to incur additional costs.

12. **Ambiguous contract documents**

    There are very few contracts that do not contain some ambiguity. Words like timely, prompt, and workmanlike, should be redefined early in the project. Since one of the legal principles of construction contracting is that an ambiguous clause will be interpreted against the person who prepared the contract, it behooves this party to review the contract wording and clarify all ambiguities.

In summary, with the availability of all of the foregoing records, data and other information, the parties on-site should be able to formulate claims, defend from claims, and ultimately resolve claim issues amicably. Hopefully, the claims can be settled at site between the parties. But when they cannot, another process must be started because the people at site do not have the time to process contentious claims and still get their job done. So claims are often sent on to others for processing.

Once a claim leaves the site, it should be treated as a project. It needs to be worked by a team with a leader. Like any project, it should be defined, scheduled, budgeted, and managed. But it should also be treated in three phases. Phase one would be to evaluate the claim by reviewing selected project documentation and identifying the issues in dispute. Then a risk analysis would be made, with the result being a decision whether to go forward or not, based on the potential of success vs. the cost of pursuing it. Phase two would then be a full-fledged analysis of the claim with solid positions supported by credible documentation and knowledgeable personnel. The third phase, then, would be the resolution procedure itself, something that can take many forms.

Depending on the perception each party has of the strength of the other's position, claims may be resolved through party-to-party negotiations. When that does not work, arbitration can be used. Often, mediation is selected as a cost-effective way to resolve claims. Then, if all else fails, there is still the court system—litigation. However, all of these efforts are costly and they often create ill will. The preferred way to handle this is to avoid claims from the outset. Understand the contract, clear up its ambiguities, make timely notification of issues, and then discuss them, but always document, document, document.

A final word needs to be said about contentious claims and the need to avoid them whenever possible. Just because a contract is worded in a specific way, it may not be enforced that way if allowed to go to litigation. Here are a couple of examples:

- **Inordinate delays**

  If the contractor is forced to perform under more difficult and costly conditions due to delays outside of his control, he may be allowed recovery for the excess costs, even though the contract clearly stated that he would not be allowed recovery for *any* cost overruns. An example would be that a power plant located in the far north did not shut down during the fall season, as the contract said it would, rather it shifted its outage to the winter, with the accompanying severe weather and holidays. Many, although not all, courts will use a sense of fairness when adjudicating a claim for recovery of the extra costs incurred due to this *inordinate* type of delay. One never knows who the presiding judge will be!

- **Unit rates**

  Many contracts have a provision for using fixed unit rates to adjust the price in the event of additions or deletions. However, if the change is of such a nature that the unit rate is no longer representative of the work required, the court may not uphold the contractual rate. For example, if the unit prices for the erection of a ton of steel are fixed and a change in the design greatly increases the number of pieces of steel per ton, thereby increasing the cost of installation of this ton of steel, then the unit prices may not be upheld. Of course, this could also work in reverse.

- **Cardinal change**

  Although the contract may clearly state that the contractor is required to install all items or equipment necessary for the completion of the work, the courts may impose limits on this. For example, let's say the insulation installation contractor was told that there would be a certain quantity of 3-in. insulating material to use for preparing an estimate to insulate a boiler, and let's assume that the contract had a clause similar to the one previously noted. However, once the job got underway, the material supplied was actually two layers of 2-in. insulating material, which required a *substantial* increase in labor to install. Regardless of the wording of the contract, the courts may find in favor of the contractor since there was a drastic or substantial increase in the change of the work, a concept known as a cardinal change.

Insurance Management

Just like managing the power plant construction process to avoid costs from claims, protection from unexpected and accidental risks must also be provided and managed. This is usually done in concert with the insurance industry. Construction work, by its very nature, is a risky business. Aside from the personnel safety issues, which will be covered in chapter 9, there is a host of other risky and potentially costly issues. The first, and most important risk is the stability of the partners to the project, both owners and contractors. The next is a litany of accidental risks, such as physical damages, third-party issues, automobiles, and others. Although most of the mitigation effort for these risks is done long before the site mobilizes, it is important that the site personnel are familiar about the protections in place, their scope and limitations, and also the actions that the site must take to avail themselves of the coverage provided. Therefore, the next few pages will provide an overview of the typical risks that are usually insured and what must be done at site to keep this protection in place.

Surety bonding

Gambling on a contractor or subcontractor, whose level of commitment is uncertain or who could become bankrupt during the job can be an economically devastating decision. With most new power plant construction projects, as well as all outage work, being under pressure to complete with the lowest possible dollar cost to the project, contracts are often awarded to the lowest-priced bidders. Unfortunately, the lowest price does not always result in the lowest cost. So how is the owner or GC supposed to be sure the lowest price stays that way? The most common process used today is to use a surety bond.

A *surety bond* is a written agreement where one party, the surety, obligates itself to a second party, the obligee for the default of a third party, the principal. In the case of power plant construction work, a surety bond provides financial security and construction assurance to the owners that the contractors will perform the work and pay their subcontractors, craftsmen, and material suppliers. It is a risk transfer mechanism where the surety company assures the owner (obligee) that the contractor (principal) will perform in accordance with the contract documents. It offers assurance that the contractor is capable of completing the contract on time, within budget, and according to specifications.

There are alternative forms of financial security, such as self-insurance and letters of credit, but these are not as comprehensive as a surety bond. Almost all publicly held utilities are mandated by law to use surety bonds, and most private owners also require them. With surety bonds in place, the risk of project completion is shifted from the owner to the surety company, protecting both the company and its shareholders from the enormous cost of contractor failure. Subcontractors are also often required to obtain surety bonds to help the prime contractor manage risk.

Most owners/GCs will require three basic bonds. The first is to ensure that the contractor will stand behind his bid in the event of an award. This is called a *bid bond*. The second, called a *performance bond*, is to ensure that the project will be completed as provided in the contract. This is the heart of surety bonding. A third bond is usually required to ensure that the contractor pays all of his personnel, suppliers, and subcontractors and that they will not place a lien against the property. This is called a *payment bond*.

The first of these, the bid bond, is usually not of concern to the jobsite personnel. By the time they arrive on-site, the contractor has usually been selected and a contract signed, which then releases the bond. However, the second and third bonds, performance and payment, do require cognizance by the site staff. The performance bond, for example, is usually a function of the value of the contract. As the job progresses and changes are authorized, the value of the contract may also be changing, requiring notification to the surety company so the bonding value can be adjusted to maintain adequate protection. Often, the site personnel are responsible for notifying the individuals responsible for maintaining this coverage.

As opposed to insurance policies, which are written with the expectation of a number of losses, surety bonds are written with the expectation of only a few. Because of this expectation of only a few losses, the surety company will perform a rigorous examination of the contractor before issuing coverage. They will investigate to be sure the contractor has the following:[6]

- Good references and reputation
- The ability to meet current and future obligations
- Experience matching the contract requirements
- The necessary equipment to do the work or the ability to obtain it
- The financial strength to support the desired work program
- An excellent credit history
- An established bank relationship and line of credit

Because the intent of the surety bond is to protect the owner and/or prime contractor from the potentially devastating expense of contractor and subcontractor failure, if any of these criteria change, the surety company must be made aware of these changes. It is incumbent upon the bonded contractor to advise the appropriate individuals in these cases. For example, if the project requires some heavy construction equipment central to the performance of the work, let's say a 450-ton crane and suddenly this crane is no longer available, the contractor must work with his surety to come up with a solution that allows the job to proceed. Surety companies can prevent default on contracts by offering technical, financial, or management assistance. But they must be offered the opportunity to participate at the beginning, when the issues first surface.

Sometimes, even the best efforts of the contractor and the surety are not enough to prevent default. As we've said before, construction is a risky business. In the event of contractor failure, the owner/GC must formally declare the contractor in default. When this happens, the surety will conduct an investigation. Once it has been determined that the default is real, the surety's options, which are usually spelled out in the bond, are invoked. These options may include the right to re-bid the job for completion. They may include for him to bring in a contractor of his choosing to complete the job. Another possibility is for the surety to provide financial and/or technical support to the defaulting contractor. If all else fails, the surety can pay the owner the penal sum of the bond, leaving the owner with the task of completing the job using this money (which may be insufficient).

As is very obvious, having to engage the surety in the salvation of a project is not desirable. The preferred way is to use viable contractors and solid contract language to set up the job and then to work with the contractor to reduce the possibility of major problems.

The following is a classic case of not working together, and then having a *lose-lose* situation. The GC hires a subcontractor for a major portion of the work. The subcontractor arranges for performance and payment bonds, as required by contract. As the job progresses, issues arise that become contentious and lead to potential schedule delays. In an effort to pressure the subcontractor to get back on schedule, the GC starts withholding progress payments, in the guise of invoking LDs. This now puts a strain on the subcontractor's cash flow. Suddenly, he has trouble paying his labor and his suppliers. The labor, in turn, no longer performs at their peak and suppliers stop extending credit. What happens next?

With reduced productivity from the craftsmen, and with reduced supplies with which to work, the subcontractor gets further and further behind. The project is now definitely behind schedule. The owner becomes concerned and pressures the GC by threatening to invoke his LDs, which are much higher than those the subcontractor has with him. Finally, the surety is called in, the subcontractor either declares bankruptcy and abandons the site or is removed from the jobsite, and the GC and surety have to work out a way to get the job to the end.

The results are as follows:

- a delayed job that prevents the owner from generating power and receiving revenues
- a GC who has been forced to pay LDs to the owner
- a subcontractor now either in bankruptcy or at least with a

tarnished credit rating and reputation, affecting future business prospects

- a surety having to pay substantial sums to back up a bonded promise to complete the job, which will result in higher premiums the next time, leading to increased costs for everyone in the future

Why did all of this go so wrong? Simply because the GC started withholding payments from his subcontractor, instead of working with him and the surety to get the job back on schedule. With personnel on-site who understand the bonding process and who are aware of the future consequences of not notifying the surety as soon as issues arise, situations such as this scenario can be minimized. However, since most site personnel do not understand the subject of surety bonding, some basic training is often necessary.

Finally, a few words on payment bonds. This is the third surety bond usually provided on most sizeable construction projects, whether it's a new plant or a major outage. The labor and the material and equipment suppliers that a contractor uses expect to be paid for their products and services. Usually, they have provided these products and services long before being actually paid for them. Especially with third-party vendors, they may have extended significant amounts of credit, for which they anticipate being repaid in a timely fashion. If, for some reason, the contractor leaves the job without paying these people, they usually have the right, under most legal systems, to place a lien against the installed work, sometimes preventing the owner from putting the plant into operation.

To prevent this situation, owners frequently require a payment bond in addition to the performance bond to ensure this does not happen. This payment bond, usually backed by the same surety company that provides the bid and performance bonds, can then be invoked by the owner to pay off the contractor's creditors, resulting in the liens being removed.

Smaller projects, such as outage turnarounds, may not have performance bonds. In these cases, it is common for the contract terms of payment to require a withholding of 10 or 15% of the contract value, which won't be paid until the contractor provides a "release of lien." This release is usually a legalized document affirming that all suppliers have been paid, that the plant is free from liens, and that the contractor will defend and indemnify the owner from any future claims or liens related to the work (see fig. 4–4). Alternately, some owners will require a waiver of lien separately from the contractor and each of his suppliers.

LIEN AND CLAIM RELEASE FOR ORDER NO. ______________

Conditional upon payment to Seller, the sum of ______________________ dollars ($_______________) by ____________________________________, hereinafter "Purchaser", ________________________, hereinafter "Seller", does for itself, its successors and assignees, hereby release and discharge Purchaser, its officers, agents and customers from any and all claims, demands and liabilities whatsoever arising under or by virtue of the referenced Order.

Seller covenants and warrants that the premises on or for which the Work was performed; services rendered and materials furnished are free from all liens and claims chargeable to the premises by reason of Work performed, services rendered and materials furnished by Seller and by any subcontractor, supplier, employee and agents working for or under Seller. Seller agrees to indemnify, protect and save harmless Purchaser and its customer from any claims or demands for Work performed, services rendered and materials furnished by Seller under the referenced Purchase Order and to defend all actions arising out of said transaction and Seller shall pay any costs and expenses including reasonable counsel or attorney fees incurred by Purchaser or its customer in defense or settlement of any such claims and demands.

______________________(Seller)

Attest:

By:

Title:

State of

County of

On this __________day of ____________________, 20___ before me, the subscriber, personally appeared ________________________to me personally known and known to me to be the same person who executed the within instrument, and duly acknowledged that he executed the same.

____
Notary Public

Fig. 4–4 Lien and claim release form.
Courtesy of Construction Business Associates, LLC

Other insurances

Bonding the contractor to ensure performance is not the only insurance needed to manage the risks of the site work. There are many other risks that, if not properly managed, also could cause a job to deteriorate quickly. The following are some of the more common insurances provided for power plant construction projects, but they are not the only ones that might be encountered:

- Marine Transit

  This is insurance protection in the event that materials being transported to the jobsite are damaged or lost at sea.

- Builders' All Risk (BAR)

  This provides protection for the owner, contractor, and subcontractors in the event of loss or damage to materials, supplies, and equipment, as well as work put in place, from many causes, often including hurricanes, floods, and earthquakes. However, there are still some exceptions in every policy, such as theft.

- Third-party and general liability

  This protects the builder from claims of injury to a third party as a result of the work. Without this insurance, the owner could be held liable.

- Workers' compensation

  This covers anyone employed by the contractor in the event of injury during the course of work for the contractor. Without this insurance, the owner could be held liable.

- Automobile liability

  This insurance is for protection from liability in the event of damage to the automobile, to third-party property, or in the event of injury to personnel as a result of an accident involving the contractor's vehicles.

Although obtaining these insurances is a prudent risk management tool, there are loopholes that must be clearly understood. For example, a BAR policy usually provides for reimbursement of repeat or extra work in the event of a loss to the work. However, one must be careful how this is used. If the loss to the work was due to an inadequate design, the insurer usually will not pay. This situation could arise in the event of the collapse of a structure, say a coal silo supported on structural steel, which was determined to be underdesigned. (Sometimes, these damages may be covered by a Professional Errors and Omissions policy, but that is beyond the scope of the site team).

In the old days of power plant work, each contractor on-site usually provided all of these insurances. This obviously created duplicate coverage in many instances, and because of today's focus on the bottom line, this is changing. Although the insurance protections are still provided, there has been a shift to consolidation. The owner will now sometimes provide some of this insurance coverage for himself and most of the contractors on-site. Frequently referred to as a *wrap-up* policy or owner-controlled insurance program (OCIP), there are significant savings in premium payments by the owner purchasing one policy and having all of the affected contractors named as additional insured.

While saving the project the costs of multiple premiums, OCIPs also must be clearly understood by the contractors. Generally, there are deductibles that may be larger than some contractors care to encounter, so they may still want to obtain insurance coverage up to the level that the OCIP begins. Also, not every OCIP includes all of the these insurances. Classic omissions are workers' compensation and automobile liability. If these are not included in the OCIP, the contractors must procure them separately. (See chapter 9 for more on OCIP).

For these insurances to be effective, the site management, whether it is the owner's staff, the contractor personnel or subcontractors, must be aware of the coverage and they must know the requirements of notification, implementation, and documentation. Improper or delayed notification may partially or wholly invalidate coverage. The insurer usually reserves the right to mitigate the insured damage in ways he deems are in his best interest. If he is not given timely notification of the event, he may no longer be able to rectify the situation in a manner that is cost effective to him.

ACORD™ CERTIFICATE OF LIABILITY INSURANCE DATE (MM/DD/YYYY)

PRODUCER

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW.

INSURED

INSURERS AFFORDING COVERAGE	NAIC #
INSURER A:	
INSURER B:	
INSURER C:	
INSURER D:	
INSURER E:	

COVERAGES

THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. AGGREGATE LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	ADD'L INSRD	TYPE OF INSURANCE	POLICY NUMBER	POLICY EFFECTIVE DATE (MM/DD/YY)	POLICY EXPIRATION DATE (MM/DD/YY)	LIMITS	
		GENERAL LIABILITY COMMERCIAL GENERAL LIABILITY CLAIMS MADE OCCUR GEN'L AGGREGATE LIMIT APPLIES PER: POLICY PRO-JECT LOC				EACH OCCURRENCE	$
						DAMAGE TO RENTED PREMISES (Ea occurence)	$
						MED EXP (Any one person)	$
						PERSONAL & ADV INJURY	$
						GENERAL AGGREGATE	$
						PRODUCTS - COMP/OP AGG	$
		AUTOMOBILE LIABILITY ANY AUTO ALL OWNED AUTOS SCHEDULED AUTOS HIRED AUTOS NON-OWNED AUTOS				COMBINED SINGLE LIMIT (Ea accident)	$
						BODILY INJURY (Per person)	$
						BODILY INJURY (Per accident)	$
						PROPERTY DAMAGE (Per accident)	$
		GARAGE LIABILITY ANY AUTO				AUTO ONLY - EA ACCIDENT	$
						OTHER THAN AUTO ONLY: EA ACC	$
						AGG	$
		EXCESS/UMBRELLA LIABILITY OCCUR CLAIMS MADE DEDUCTIBLE RETENTION $				EACH OCCURRENCE	$
						AGGREGATE	$
							$
							$
							$
		WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? If yes, describe under SPECIAL PROVISIONS below				WC STATU-TORY LIMITS OTH-ER	
						E.L. EACH ACCIDENT	$
						E.L. DISEASE - EA EMPLOYEE	$
						E.L. DISEASE - POLICY LIMIT	$
		OTHER					

SAMPLE

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES / EXCLUSIONS ADDED BY ENDORSEMENT / SPECIAL PROVISIONS

CERTIFICATE HOLDER

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, THE ISSUING INSURER WILL ENDEAVOR TO MAIL ______ DAYS WRITTEN NOTICE TO THE CERTIFICATE HOLDER NAMED TO THE LEFT, BUT FAILURE TO DO SO SHALL IMPOSE NO OBLIGATION OR LIABILITY OF ANY KIND UPON THE INSURER, ITS AGENTS OR REPRESENTATIVES.

AUTHORIZED REPRESENTATIVE

ACORD 25 (2001/08) © ACORD CORPORATION 1988

Fig. 4–5 Certificate of liability insurance.
Courtesy of Acord

To ensure that the insurance coverage is as required and is actually in effect, most owners will not allow any contractor to start work on-site until proof has been provided of coverage and proof that the coverage will remain in force until the job is complete. This type of proof is usually in the form of a Certificate of Insurance that outlines the insurance and limits provided, names the insurer providing the coverage, and also specifically names all of the additional parties that are covered, called the additional insured (fig. 4–5).

Summary

Managing the risks of a power plant construction process is a very important part of managing the overall project. As some of the examples have shown, issues can arise in spite of the best efforts of the site management teams. Issues also can arise due to the direct actions or inactions of the site management teams. Things change during a construction process.

Some of these changes result from one party's actions against the other. Some of the changes are the results of third parties and some are due to causes outside of the control of any party. But whichever form change takes or from wherever it comes, it must be addressed and managed.

The tools to manage change are the claims process and the insurance process. The claims process is very dependent on the contractual clauses agreed between the parties, usually long before the site team has even been selected. However, the site team must become familiar with these clauses so 1) actions can be taken in time to avoid claims and 2) when claims issues do arise, they are handled appropriately.

As the project progresses, communications must be made an integral part of the process. When even the hint of an abnormal condition arises, the parties to the contract should review the issue and look for ways to resolve it. Allowing issues to move forward without proactive intervention often results in costly claims and disgruntled people.

The insurance process is also very dependent on agreements usually made prior to the site team selection. Differing from the claims process, however, the insurance process looks to third parties for resolution and protection.

Since most construction contracts are estimated, bid, and awarded based on known and predictable events, the costs of unexpected issues are not included. However, unexpected events do occur, and since they do, they must be managed in a way to minimize their impact on the project. This is done through the use of insurance companies bonding contractors for performance. It is also done through the use of insurance companies providing financial protection in the event of unexpected incidences or unforeseen perils.

Although the site management does not need to have insurance experts on its staff, it must have staff familiar with the concepts. They must know the requirements of what to do to protect the interests of the insured as well as the insurer. They must know when to make notification of events that might trigger a claim. They must understand the interrelationships between the owner, contractors, and subcontractors.

In summary, managing the day-to-day construction operations of a power plant project, whether it is a new plant or a retrofit, is complex in and of itself. But add to that the realities that nothing ever remains the same, that things are not always as they seem, and suddenly a host of unplanned, unexpected issues arise that must be managed to prevent a collapse of the project.

These are the risks that require intelligent planning, often long before the site even mobilizes. They require smart site managers that understand the potential for damage if left unattended. They require careful managing, in accordance with defined parameters, and they require an attitude of teamwork. The unexpected can be tamed!

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[6] Surety Information Office. *10 Things You Should Know About Surety Bonding*. Washington, DC: Surety Information Office, 2003.

5

SUMMARIZING THE CONTRACTUAL RESPONSIBILITIES

Before the site set up process begins, all of the contractual information that the site management team might need should be summarized into an easily readable document sometimes called a *contract abstract* (see Appendix C for an example of an abstract). This document would address items such as the following:

- Contract value
- Scope definition
- Milestone dates
- Payment terms and instructions
- Penalties/LDs
- Bonus requirements
- Extra work rates and procedures
- Delay notification process
- Insurance requirements
- Schedule requirements
- Daily, weekly, monthly reporting requirements
- Code compliance requirements

- Nonconformance reporting requirements
- Dispute resolution procedures
- Emergency Notification

It should highlight the specific requirements of each item, and it should identify what actions are required to maintain compliance. It should be designed so that it is easy for the site supervisors to use. All of them should either have their own copy or a copy should be readily available at any hour of the day or night. When an issue arises that requires contractual actions, such as a notification of a delay or a request to perform extra work, the responsible supervisor should be able to quickly access the document and determine what action to take. Also, this contract abstract should be supplemented to keep it updated with contract changes.

To gain an appreciation of the value of this document, let's digest each of the items and see where the use of this document can be an aide to the site supervisors to help avoid problems.

Contract value

Of course, the contract value is usually very straightforward. It is the amount of money to be paid by the buyer to the seller for the work to be done. However, the site manager may need to know the value of the work for determining how to approach contract extra requests. As an example, the contract may state that extra work is not to exceed 10% of the original contract value (usually because the site facilities and services will be inadequate to support a contract larger than 110% of the original scope). So if extra work requests reach this value, the site manager may now be required to have the contract renegotiated or turn down the request to take on more work.

Taxes should also be addressed if the site can impact them. For example, the project may be exempt from local or state sales tax on certain materials and services, if they form part of the permanent installed works. Highlighting this in the contract abstract will serve as a reminder that special accounts should be set up with local vendors, along with the appropriate documentation, so that purchases can be made without paying the sales tax.

Scope definition

A brief outline of the scope and intent of the site work should be provided. Although there will be many other documents, such as drawings, bills of materials, etc. for detailed information, the scope definition should be a statement of intent for the work. If the intent of the work is clear at the outset, many misunderstandings can be avoided. For example, if the statement of intent of the work is to "retube the condenser plus repair it such that it will continue to be usable for another 10 years," and if the waterboxes are found to be badly worn, this wording of the work scope suggests that repair of the waterboxes is part of the base contract and not extra work.

Milestone dates

Usually, the contractor's payments are linked to a series of specific events set out in the schedule, called *milestone events*. It is therefore crucial that the site staff knows well in advance what the critical dates are that affect payment. Including this information in the contract abstract will highlight it and allow them the opportunity to manage the work accordingly.

Similarly, there are often a series of penalty dates in a contract. Once again, by including these LD dates in the contract abstract, the site staff can manage the work process to avoid falling behind and having penalties imposed.

Payment terms and instructions

In chapter 2, there is a section describing typical payment requirements found in construction contracts. In the contract abstract, these particulars should be spelled out, especially with regard to dates. Again, it's all about the cash flow, and the front line site supervision is usually the group that has the most impact on meeting or missing the dates required for payment, so they need to know how the payments are tied to the schedule.

Liquidated damages

As discussed at various times throughout this book, LDs from a construction perspective usually relate directly to schedule performance. Not meeting certain milestones can trigger a series of penalties that take many forms. Sometimes there is only one penalty date—the end date. Other contracts impose a series of dates, frequently increasing the severity of the LDs as the dates progress along the schedule. Still others, while imposing a series of LDs, also *forgive* the earlier one if the succeeding ones are met.

Let's look at an example. A contract to erect a boiler usually has only a couple of milestones, drum raising being the most common and then the hydrostatic test. However, if the boiler is being built as a part of an overall new plant, it frequently becomes the critical path of the project since its steam is ultimately needed to spin the turbine. Therefore, the boiler contractor may have additional, artificial milestone dates imposed, each with increasing penalties. These extra dates are generally based on calculated completion percentages. So the LD structure might look like that in figure 5–1.

Boiler Milestone Completion Dates and Associated Liquidated Damages

Event	Date	LDs
1. Raise Steam Drum	January 1st	$ 5,000
2. Pressure Parts 50% Complete	May 1st	$ 7,500
3. Pressure Parts 75% Complete	July 1st	$10,000
4. Hydrostatic Test Complete	September 15th	$15,000
5. Unit Ready for First Fire	December 1st	$20,000

Note: Events 1 - 3 LDs forgiven if Event 4 date is met

Fig. 5–1 Example of progressive LDs.

It is important that all of the site management clearly recognize that their decisions may impact these dates, which then impact payments and that translates into cash flow, the lifeline of the project. By including these dates in the contract abstract document, the supervision will be more cognizant of their existence, as well as the impact of not meeting them.

Bonus requirements

In the event the contract was structured to include bonuses based on milestones, the site supervision should be aware of them. As with LDs, meeting or missing these dates will affect payments and cash flow as well as possible profitability.

Extra work rates and procedures

If there are to be any deviations from the contract scope and price, they must be handled in accordance with the prescribed dictates of the contract document, the extra work rates and procedures. Frequently, the allowance or disallowance of claims for extra work is based on timely notification and clear authorization to proceed. Understanding the requirements to be followed before starting any work that is additional to the base scope can be the difference between a profitable project or one with major losses. To illustrate this more clearly, let's look at the following example.

A major plant turnaround budgeted at $15 million is to be completed in 15 weeks. As the job enters its third week, the boiler contractor finds that the wall thickness of the hanger support tubes of the finishing superheating elements is below allowable tolerance. The replacement elements are on-site, with the hanger tubes as part of the elements, extending 3 ft beyond the elements. However, when cutting off the old elements, the remaining portion of the hanger tubes are so thin that they just burn up, ensuring that the new elements will not be able to be welded to the remaining hanger tubes.

The boiler contractor determines that with 13 weeks left before the outage is over, he can order, receive, and install these upper sections of the hanger tubes that were not removed. However, there will be a significant cost since the material is of high alloy and will require special heat treatment where they weld into the distribution header. This is discussed with the client's boiler supervisor, who agrees that the proposed solution makes sense. The contractor then proceeds to order additional tubing, removes the remaining superheater elements, and starts the difficult process of replacing the hanger tube sections into the headers and attaching the new elements.

All of this sounds very normal, just the kind of response the client's boiler supervisor expects from contractors. However, it's not always so simple. This time, there was a lack of communication between the client's boiler supervisor and upper management. Of the $15 million contract, only $4.5 million had been allocated to the superheater element replacement, and then this was only done to keep the boiler available as a standby steam source, something the supervisor did not realize.

Now, the boiler repair contractor had ordered additional materials, removed additional tubing, and completed a major repair that was not in the original contract. But worse than that, it was not a part of any contract amendment either! At an additional cost of $950,000 that was never *formally* authorized by the client, the contractor's management had a serious concern. Since the job was winding down, the contractor no longer had any leverage for negotiation with the client. The contract work scope had been completed, the additional work was complete, and demobilization was in progress. The client, on the other hand, had a real nice boiler, one with brand new superheater elements—but which was not really needed.

So what happened next? The job was over, everyone had demobilized, and the client's unit was performing optimally. The contractor was in heated discussions with the client, the shareholders were not happy with the contractors financial status, and the lawyers were lining up. Being astute contracting parties, both the contractor and the client had drafted the contract document so that very clearly defined procedures would be used in the event of extra work to be performed. It specifically said: "…shall not commence before the contracting officer has affixed his signature to the extra work notification document…". But unfortunately, these procedures were not followed; the extra work authorization was not signed.

There was no dispute as to what the contractor had done. An additional $950,000 worth of work was performed, and the client appreciated it. Unfortunately, there was no money to pay for it. The client budgeted $15 million for the total project, but only $4.5 million of this was allocated to the boiler work since the boiler did not warrant a higher expenditure; it was to be sidelined in the future.

As a post-negotiation session clarified, there was a finite amount of money available for this project. It was allocated among the different work scopes to be performed, each with its own priority. Had the boiler contractor followed the contract document requirements of not moving forward until *written* permission was obtained to do so, there would have been an opportunity for the client to reallocate priorities and shift money from some other work scope, maybe a controls job, to fixing the boiler for long-term use. However, in this case, the boiler owner did not intend to use the boiler long term and therefore would not have authorized the additional expenditure. The replacement of the superheater elements would have been cancelled and the client and the client's shareholders would have saved the cost of installing the remaining elements. The moral of this story—*know the procedures to be followed, and then follow them, before starting any extra work!*

In addition to understanding the procedures, it is also very important to understand the extra work pricing structure. Hopefully, it is a straightforward, uncomplicated one that is easy to implement. But since many contracts have extremely difficult, complicated formulas that are not easy to administrate, the site staff must prepare procedures to be used to satisfy the contractual requirements and avoid untimely delays in getting paid. At times, dedicating a group of administrative personnel to this task alone is money well spent.

Delay notification process

As illustrated during the previous discussion of extra work rates and procedures, it is important to understand the process and procedures to be followed when an event occurs that may trigger a need for extra work, and the same is true for an extension of time. The site supervision must know what specific rules to follow to avoid their request being denied.

It is not uncommon for the client to insist on very short windows within which to be notified of a potential request for time or money because other work may have to be shuffled or even cancelled in short order. The same holds for notification of delays. If the client is not formally notified in a timely fashion that there may be a delay, there may no longer be an opportunity to reschedule other activities that will be impacted, ultimately affecting the end date of the overall project.

Insurance requirements

Insurance, like taxes, is a subject left mostly to the experts in that field. It is not realistic to expect the site staff to be conversant in this subject, but they must be given instructions in what the contract requires. For example, there must be some type of coverage in the event a worker is injured, usually called *workers' compensation*. In many locations, notification that there is a project subject to workers' compensation claims is either unnecessary or if required, it is handled by the contracting party's home office. However, there are times when this is not the case and now it may be the responsibility of the site manager to register with the local authorities and obtain a certificate of coverage that has to be prominently displayed. The site manager most likely will not even be aware of this requirement unless it is spelled out in the contract abstract. Also, some clients will require proof of automobile and general liability insurance. The requirement to obtain a certificate of coverage for these insurances may also rest with the site staff.

There is also the issue of insurance claim procedures for damaged materials. Each carrier has to be properly notified in the event of damaged goods arriving on-site. They must be able to witness the damages and be afforded the opportunity to make good on their own account. Repairing the damage before giving the carrier the opportunity to resolve the problem may void any claims; the carrier may have preferred to just replace the damaged part.

Schedule requirements

Often the contract will require a specific sequence of schedule updates and submittals. This is usually done to force the contractor to continually review progress. It is often done to allow the master scheduler to integrate the schedules from all parties to the project. What is often overlooked or not even realized to begin with, is that the GC, who may be requiring the schedule submittals from all subs, may also have requirements from the owner and cannot report on these without timely feedback from the subs.

All of this can affect payments. Milestone dates that the owner has imposed on the GC may be quite different than those imposed on the subcontractors. But the GC may not be able to report on the progress of reaching the owner required milestone dates if the subs do not provide timely updates on theirs. Without accurate progress information, the GC may not get paid. If the GC does not get money in a timely manner, there may not be money available to pay the subs—it's all a matter of cash flow.

Daily, weekly, monthly reporting requirements

Jobsite reporting is important for many reasons. First and foremost, it forces the parties to review where they are, where they've been, and where they are going. Second, it gives the parties the opportunity to coordinate their activities as they prepare to move forward. Third, it provides a history of the events to date. Many contract documents do not devote much attention to the reporting requirements except to state that the contractor must provide a daily force report and a weekly written report of the activities for the week along with a three-week look-ahead plan. Sometimes that is sufficient, sometimes it is not. However, by not adhering to at least these minimum requirements (if so specified), the contractors can find themselves without valuable support in the event disputes arise.

So once again, it is important that the site staff knows when these reports are required, and that they provide their respective inputs in time for the report to be compiled and sent to the appropriate party.

Code compliance requirements

The technical section of most power plant construction contracts will spell out exactly which industry codes are to be followed. In addition, there may be statutory code requirements that apply even if the contract is silent on this and also, there may be internal company policies that dictate additional code compliance. This can be confusing, so it benefits all parties if the applicable code requirements are spelled out in the contract abstract, whether they are contractual, statutory, or just company policy.

Not only do the specific code or codes need to be called out, the specific sections of the code need to be identified and the applicable editions or case dates must also be specified. Usually, this is not an issue, but once in a while, there are changes in the codes that may impact the work to be performed. In these cases, if the work has to be redone because the incorrect edition of the code was used, the contractor is usually liable for the cost of the rework as well as any additional costs to get back on schedule as a result of the rework.

Nonconformance reporting requirements

Every company involved in power plant construction work today has to have a formalized quality program. Usually, the supervisors that work for these companies are knowledgeable about the company program as well as the procedures used to implement it. Generally, there are specific forms that are used to document that the work conforms to these requirements and then there are forms that are used when it does not.

But there are times when the client imposes the process and forms on the contractor. The supervisors in the field may not be aware of this unless the contract abstract clearly spells out which forms are to be used, how they are to be routed, and who is to be called in the event of discrepancies or nonconformances.

Dispute resolution procedures

Although we have already dealt with claims in the previous chapter, it is still important for the trigger points to be summarized in the contract abstract for all of the site management staff. The contract usually addresses how to handle issues that arise but cannot be resolved at the site level by specifying a series of steps that are to be followed, usually involving the higher management levels of each organization. Then at some point in the process, if resolution has not been obtained, it goes outside of the management ranks and into some type of third-party dispute resolution process.

Although most of the site management personnel will never be directly involved in the dispute resolution process, they need to be cognizant of the process. There may be specific documentation requirements. There may be specific notification procedures. There may be requirements to have weekly reviews of issues that may turn into disputes and if the party with the issue did not take advantage of this review process, the dispute may be disallowed.

Emergency notification numbers

Finally, the contract abstract document is a perfect place to record any emergency contact information. Whether the information is for notifying the public authorities or whether it is for obtaining services such as hazardous material clean up, having this information in one place reduces confusion in the event of an emergency.

6

SETTING UP THE JOBSITE

Once the contract negotiations are over and all parties have come to terms, both on technical issues and commercial conditions, it's usually time to get ready to start the job. The first step will be to set up the jobsite. It is here that attention to details will make the management of the project much easier. In fact, the whole purpose of the job setup is to facilitate the management process. Time should be spent thinking about all of the steps in the process of managing the project, before the actual labor efforts begin. Thought needs to be given to the administrative requirements, the actual site project management tools that will be used, the purchasing process, how quality will be measured and controlled, and how safety will be managed.

Often, only now is the site manager appointed. This manager may not know much about what transpired during the earlier phases of the project. The manager may be caught between trying to learn the details of the agreements made and trying to organize the site itself. Any help that can be provided will make this job much easier, and using the summary of the contract responsibilities, as described in the previous chapter, will help immensely as the manager goes about setting up the site.

Site Administration

With the details of the contract final and summarized, the process of setting up the actual site organization can start, and this means organizing the site administration. In order to ensure an orderly flow of information and an effective process of project controls, it is extremely important that the administrative processes are properly designed and correctly used. The basic administrative needs of most construction projects are the need to administer the supervision, the craftsmen, the payroll, the field office, the materials, and the tools, facilities, and equipment. Then there's the documentation, or record keeping that must also be established. But first, the basic needs:

- The task of administering the supervision, although not major, should be well planned. It is important to realize that the supervisory personnel set the mood of the project; their enthusiasm, or lack thereof, is directly imparted to the craftsmen, which, in turn, reflects directly on the work they perform. If the supervision is unhappy or not supportive of management, the project will be an uphill battle.

  Therefore, job assignment benefits, such as per diem payments, insurance provisions, automobile policy, housing allowances, single/married status, meals, home leave, etc. need careful review. The benefits must be attuned to the project scope, size, location, and duration. But they also must be reflective of the individuals and their needs. In other words, job benefits need to be meaningful for the individual, but they cannot discriminate against the others.

- Administering the craftsmen requires consistent coordination between the field supervisors and the office administrative staff. The craftsmen's function at the jobsite is to perform their tasks as expeditiously as they can. If they have their minds on other issues such as unfair task assignments, pending layoffs, safety matters, or even poor payroll procedures, their performance will be affected. Therefore, the field supervisors must make job assignments in a consistent and fair manner; they must treat the craftsmen with respect; and they must work within the jobsite rules and union regulations, if applicable. At the same time, the office administrative personnel must ensure consistent procedures are followed starting with the *brassing in* at the start of each shift through the calculation of the paycheck at the end of each week.

When the labor force is unionized, additional interfaces are required to ensure compliance with labor/management agreements. The jobsite rules must be clear before the start of work assignments and the availability of skilled craftsmen must be ascertained. An *open door* approach between union and project management will facilitate the resolution of misunderstandings throughout the job. Regular tripartite meetings between the owner, the contractor, and the union representatives will go a long way toward defusing volatile issues and setting the tone for the tradesmen and supervisors to work in harmony.

- Payroll administration can be a complex process. In addition to internal company requirements, there will be local, state, and federal rules. The simple task of applying for a job by a candidate requires not just confirmation that the applicant is capable of performing the work, but also that the applicant is legally allowed to do so.

  It is important that the weekly pay is calculated accurately, that the withholdings are in accordance with all legal (and union) requirements, and that supporting documentation exists. Time sheets must reflect the actual hours worked, differentiating between overtime and straight time. The pay must be calculated in accordance with the time sheets, the checks must be issued regularly, and the payments to the local, state, and federal governments must be made timely and accurately. The same holds true for the payments to the unions. Year-end reporting needs require that accurate records are maintained even though the job may have been completed many months before.

  The banking process needs to be seamless. A timely notification of anticipated payrolls needs to be communicated to the dispensing authority so that funds are available in time for the workers to cash their paychecks.

Finally, the basis of the project controls processes is usually a function of the man-hours expended compared to the man-hours still to be spent. The payroll process is generally the easiest place to record and categorize the man-hours expended. This may be done by the use of sophisticated computer programs, or on smaller projects it may be done using simple spreadsheets. Whatever the method used, if not used correctly and consistently, the status report of the job will not be correct and the projection to completion will be meaningless. (More on this in chapter 10.)

- The field office is the center of the site administration. By properly setting up this office, including all of the record-keeping requirements, the task of the supervision and management will be more efficient as well as more pleasant. The project abstract is a useful guide for setting up the various files. Correspondence files can be arranged to readily support requirements such as reporting rules, delay notifications, nonconformances, extra work authorizations, billings, and insurance claims.

  Equally important as setting up the field office at the beginning of the job is closing it down at the end. The contract may stipulate what records should be turned over to the client. The owner may have specific requirements regarding disposal of remaining materials and specialized tools. Internal company procedures may have certain regulations, especially with respect to record keeping, that are necessary to maintain compliance with legal, code, and quality requirements. Additionally, there may be special regulations affecting the retention of safety records.

- Material control is one of the more critical aspects of the job since without the availability of materials to install, the job comes to a halt. Therefore, it is important to have a good material control program; generally, a separate material control person will be required. The material control program should enable the field supervision to determine when specific materials will arrive at site, that they have actually arrived at site, in what condition, and where on-site they are stored. In today's world of electronics, these tasks can be greatly simplified by using a bar coding system.

- Administration of the jobsite tools, facilities, and equipment is an area where often money is spent needlessly. Since frequently 15–20% of the job budget is for these items, proper attention to setting up the controls will save aggravation and money when the job starts closing down. The jobsite management should procure tooling and equipment in keeping with their availability and the skills of the labor and supervision that will use them. Usually, there is more than one way to accomplish many of the tasks in working on a power plant, so it is important to investigate the cost of trading man-hours for the use of sophisticated tools and equipment. Also, on large overseas projects, shipping time and costs as well as demurrage and customs procedures may impact the decision more heavily than just the savings in labor efficiency.

  Once the list of tools, facilities, and equipment has been finalized, a view to the accounting rules is prudent. Depending on the value and useful life of the tools and equipment, the job may be spared the total cost of these items; this then enhances the profitability of the job. The same holds true for a decision to rent vs. purchase.

  As the job winds down, a concerted effort should be made to inventory all remaining tools, facilities, and equipment. Items not required any further should be disposed of and those still being used should be placed on a *watch list* so they can be removed as soon as they are no longer needed. Additionally, many of the more expensive pieces of equipment, like large trucks and cranes, can be replaced with less costly equipment or even with manpower. Often, it is very cost effective to assign a dedicated individual to expedite the removal of the tools, facilities, and equipment as the job starts winding down.

  A final note regarding tools and equipment: Sometimes it is desirable to loan or rent these items to third parties. Good business practices suggest that if this is done, proper legal and insurance protections are in place, such as a Hold Harmless Statement.

Complementing all of this, record-keeping requirements of the project must be addressed. This is basically a filing and paperwork process that requires examining the previously prepared contract abstract, sorting out what needs to be recorded and when, and then designing the proper forms and their distribution path. A typical job may require a set of documents as follows:

- Daily progress reports—There are many formats that can be used, but the format adopted must be able to capture the critical elements of the specific job. For example, it may not be important to document the daily weather when the work is all indoors. But if you're erecting an outdoor unit in the winter in snow country, weather documentation may be the difference between the imposition of a $300,000 per day delay penalty vs. an extension of time!
- Transmittal letters—Everything sent to other parties, whether it be drawings, change orders, pay requisitions, etc., should be sent with a transmittal form or letter. This transmittal form should include who it is being sent to, from whom, and the date it is being sent. If a response is required, it should be noted on the form. Often it is also desirable to have the recipient sign an acknowledgement of receipt.
- Document status logs—At the beginning of the job, a system of documenting the flow of the various documents of the project should be implemented. This may be a manual process for smaller projects, but on complex jobs, this should be a database system. The system should have the ability to provide information on what documents have not yet been processed, to give the status of those that are in process, and to sort on specific topics for historical information.
- Clarification memos or RFIs—Throughout the course of a project, clarifications are often needed from the owner or designer. These requests, often called Requests for Information (RFIs), should always be in writing, dated, and the responses should be logged.

- Correspondence—Keep correspondence simple, and use only one letter or memo per subject. Then be sure it is logged and filed accordingly.
- Minutes of meetings—There should be an agenda for every meeting, and minutes should be prepared shortly after the meeting is complete. These minutes should then be issued to all interested parties and filed according to topic.
- Status reports—Contractors should provide weekly and monthly status reports on every job. It is a good way to force the contractor to think through the events of the past and prepare for the next period, in a logical, systematic manner.
- Photographs—There is no better way to document what is happening on a construction site than with photographs or videos. With the ability to transmit photos electronically, problems and misunderstandings can be demonstrated in ways that are much more efficient than letters or marked-up drawings.

Finally, if in the past, there have been similar projects, a *lessons learned* session should be held with the participants of the old as well as the current project. Some of the ideas that may come from such a session are a need to identify employees of different contractors or contracts, by color-coding their hard hats. Trade-offs between sub-assembling components and installing individual parts can be discussed, possibly saving many man-hours of labor. Ideal use of heavy equipment such as costly cranes should be debated since, frequently, this is an area of cost overruns. Another idea for discussion is to review the feasibility of installing scaffold brackets, and maybe the scaffolding, before raising large components that require more work once erected. Decisions made at this stage of the project may have a major impact on the final financial outcome of the job.

In today's world of high-speed information technology, the flow of the information generated by the site administrative processes should be automated. The high cost of power plant construction today, and the costs of not meeting the schedule and budget commitments that were made, demand that management must have pertinent information to make decisions 24 hours a day, 7 days a week. This can be accomplished readily using a multitude of tools, ranging from simple e-mail attachments to dedicated centralized servers, which can be accessed by many. The recipient is usually less concerned with the method of information transmittal than he is with the timeliness of receipt.

Managing the Site

Some construction sites are huge, others are tiny; both are often terribly congested, fragmented, and in a state of total flux. The amount of time that can be saved by setting up a clear, streamlined site management process is tremendous. This goes all the way from where the workers park and where they eat to how they and their tools and equipment move around the site.

Traffic flow

The first item of business that should be addressed at the initial site planning meeting between the owner and contractors is how the traffic will flow. With a site plan and the project schedule in hand, all parties should be prepared to discuss how they intend for their materials to move from unloading to lay down and from the lay down area to the site and on the site. The same should be done for major equipment. This serves several purposes. The first is to establish what type of road beds need to be available and when they need to be available, but it also serves as a preliminary review of construction access needs. In other words, it highlights areas that need to be left open for crane or other large vehicle movement, like leaving steel out, not erecting certain buildings yet, or delaying the excavation for pipe chases and installation of elevated cable trays.

Next, access and egress of the workers must be addressed. Where will they enter the jobsite? How? By foot, bus, or car? How many will there be, at the different stages of the work, and what will be the jobsite obstructions then? What about working hours? Should there be staggered start and stop times? Maybe consideration of two entrance gates for large jobs can be the solution to crowded shift changes. Where will the change rooms be located, where will the sanitary facilities be, where will the workers eat? Very importantly, where should the first aid and ambulance service be stationed? Also, if elevators are used, how is the traffic regulated, are there adequate numbers or are there workers standing around for 15-minute intervals, being paid to wait on the next empty cab? Again, diligent preplanning will help minimize a lot of congestion and increase productivity.

For jobsites with a high density of equipment movement and/or personnel it sometimes pays to have one person dedicated to *traffic control*. With cumulative jobsite payrolls of more than $500,000 per day on large projects, saving one minute of confusion translates into $1,000, which is much less than the cost of the traffic controller.

Site housekeeping

There's no worse eyesore than a construction site, where all kinds of buildings and structures are just partially erected, and there's a swirl of paper, cups, rags, and other debris blowing around on a windy day. It's morally depressing and physically unsafe. Add to that spent weld rod ends and broken pallets and dunnage lying around. Then note the sloppy welding leads, the haphazardly strung electrical cords, and even workers' jackets, hard hats, gloves, and lunch bags strewn around, and what do you have? A place where no one looks forward to coming to work; a place that's ripe for an OHSA violation, and a place that is certainly not efficiently run.

As with traffic control, site housekeeping is an issue that affects everyone. There's seldom a project of any magnitude where the craftsmen who make the mess are the only ones who see the mess. Usually, many different workers, from many different contractors, use some of the same areas at the same time. Stepping over obstacles, avoiding dirty areas on the way to the workstation, or stopping to move cables and slings that are in the way, is an unnecessary delay for the person on the way to do a job. It is simply inefficient and potentially unsafe.

The most effective way to keep a site clean is for each employer to train workers in housekeeping and to emphasize it in safety meetings and during lunch breaks or shift changes. However, this is never 100% enough. So a separate housekeeping crew, with workers from each major employer, is often used to make regularly scheduled rounds of the premises to police the area. Often, this is under the supervision of the safety officers on-site, but it also can be led by a foreman from one of the employers, rotating from employer to employer on a weekly basis. The price is small when compared to the cost of the inefficiencies and the impact from a safety issue.

Site services

Almost no power plant construction site contractor is self-contained. Someone is providing the power. Someone is providing the construction water. Someone is providing the dust control, and someone is providing the trash removal. Often, that someone is the owner. On a very large project, it may be the GC. But usually the lower tier contractors depend on someone else to provide these services. The issue that usually arises is the adequacy and reliability of having them where they're needed and when they're needed.

Let's take the temporary power supply. It's uncanny how a power plant site can lose power just when it's needed most—such as at the peak of production welding on the boiler when the hydrotest date is in jeopardy. Whether the job is to construct a new unit or to overhaul an old one, the calculations for determining the peak power requirements are not rocket science. A simple summation of the maximum power requirements from all of the contractors, superimposed on the construction schedule, will readily determine what's required and when it's required. Then, it's simply a matter of applying the contractually agreed process to set up the temporary transformer, feed it, and distribute from it. Or is it?

No, it's not. There's more to it. There's the diligence of managing this power supply equipment, and more power than most any other common source of site service, this is the most critical. It requires maintenance. The leads in, the leads out, the contact points themselves, etc. require constant vigilance. Then, there's the need to be sure no one is tapping into more power than they are allocated. The best way to enforce this is to require those who need more than they asked for to bring generators for the additional power themselves, at their cost.

Next comes the supply of the construction water. Although not usually as critical as the supply of the electric power, it also requires a plan and the monitoring thereof. The same goes for trash removal and dust control, two areas that, if not properly managed, will have effects similar to those from poor housekeeping.

Site facilities

Site facilities, such as offices, warehouses, prefabrication areas, change rooms, and sanitary facilities should be located to reduce the movement of personnel and the need for heavy equipment. The closer to the work that the office is located, the less time is spent by the supervision walking/driving from the office to the work area and back. If warehouses are remote, there is always the temptation for personnel to need an item that requires an unproductive half hour or so to get. Placing the change rooms and sanitary facilities far from the work location is also counterproductive since the time required to go to and from the work site is not adding to productivity.

Prefabrication areas often cannot be placed near the work site, but when this is the case, thought should be given to fabricating smaller parts that are easier to transport over these larger distances. The cost may be less than the rental of the large equipment that often sits idle for days waiting for the larger pieces to be assembled.

Quality control and safety

Having said all of this, it is of paramount importance that the quality of the work and the safety of the workers are never jeopardized. Although quality and safety will be addressed in separate chapters, they are briefly addressed here to emphasize the importance of making them a part of the site management planning process, from the first day onward. When planning the flow of materials, equipment, and personnel, there are many opportunities to build in both quality and safety practices.

The flow and storage of materials can be planned so no rework is required due to damage in transit or damage from poor storage, such as not storing equipment in poorly drained locations, which could result in rusting or other deterioration. The movement of the equipment should be planned in accordance with personnel traffic patterns, to avoid loads being moved above the workers, such as in a well-planned lift using a crane (fig. 6–1).

Fig. 6–1 A safely planned lift—there are no personnel below the load.

The personnel traffic patterns should also be addressed with safety as a foremost consideration. Routing of workers, especially at shift change, should be planned away from other ongoing activities such as heavy equipment movement, excavation work, or overhead construction. But an area frequently overlooked is the vehicular traffic in the parking lots. If the workers drive to the job or use a common parking area, it is important to design the flow of their vehicles with safety in mind. Possibly, a traffic signal may be required, especially where they leave the lot and enter the public thoroughfare. Sometimes a flagman is required to control the traffic inside of the parking lot and often, physical barriers are needed to separate the workers still walking to and from their vehicles from those driving in or out of the lot.

Finally, when designing the traffic pattern for heavy equipment, barricading may be required to keep workers out of the path of the machine as well as the load it may be carrying.

When planning the site housekeeping activities, thought must be given to waste material storage areas. If the material is flammable, it must be located so no collateral damage is incurred in the event of fire. If it is hazardous or dangerous to the touch, such as sharp objects, it may need to be barricaded.

While setting up and coordinating the site services, safety again must be a top priority. Providing and distributing the temporary power is fraught with danger. Cables and wiring must be installed and terminated by licensed personnel. A third-party check should be made to ensure the safety of the installations, and periodic safety inspections as the job progresses will help eliminate unsafe conditions that frequently occur due to weather, wear and tear, and even unauthorized personnel making modifications.

Another hazard that is often created comes from watering the roads on green-field construction sites for dust control. If not properly scheduled, the roads can turn into slippery surfaces during the height of vehicular traffic. That can create a host of problems from vehicles sliding off the road to collisions between vehicles and construction equipment to personnel slipping and falling.

Finally, safety must be designed into the placement of the temporary site facilities, such as the offices, warehouses, prefab areas, change rooms, and sanitary facilities. They should be located such that access to them is via safe, secured routes.

Site Supply-Chain Management

On any project other than a very small repair job, all manner of purchasing is done at the site level. This ranges from the owner, who may be purchasing consumables and even small tools for all site contractors to use, to the individual contractors who will be purchasing whatever the owner is not supplying. It includes service providers, like the sanitary contractor who services the *port-o-johns*. The amount of money that is spent on a large, new construction project for these supplies and tools is tremendous. There are projects where these costs exceed 20% of the total field costs; they can go way up into the millions. So properly setting up this area of the job is an important consideration for the site manager.

Unless there are existing purchase agreements already established for use on different jobs, often called *blanket agreements,* it is usually the responsibility of the site management to make the arrangements for purchasing the supplies and services needed to support the site activities. Often, site managers are not well versed in the art of purchasing. Their background is managing labor, sequencing erection activities, and setting up rigging, machining, and welding work. They work under the assumption that whatever process worked at the last job should work here as well. Unfortunately, this is not the real world any more.

Site purchasing is a process that can have a significant impact on the financial results of a project. There are many different ways to approach this process, and each one has its plusses and minuses. For example, a large company can use its size to gain discounts due to corporate quantity purchasing. A local company can use its community presence to solicit expediency for critical support. A company with an alliance partnership with the supplier can leverage future business opportunities to satisfy the needs of the current job. But whatever relationship is used, there is a need to define the roles and responsibilities required to make the relationship successful. Assuming that the supplier will provide certain goods and services based on a standard set of specifications (instead of tailor-made for the project in question) will lead to problems. It must be recognized that contracting to suppliers involves more than just price. It also involves the specifics of the service and the delivery. But unless the site supervision has worked in the area before or unless the site staff already has a relationship with the proposed supplier, there needs to be a formal process to ensure the purchasing procedures are workable and satisfactory to all parties.

Especially during major outages with tight deadlines, failures in the purchasing process are seldom recognized until it's too late. The focus is usually on the end date, not the mechanics of the process, nor the efficiencies thereof. This can lead to an enormous amount of waste, in the order of 20% of the contracted goods and services.[1] Then it translates directly into loss of profit, sometimes for both the purchaser and the supplier. Therefore, it is important to clearly define the performance expected, in addition to the price, when entering into agreements for the purchase of the goods and services to be used at the site.

Performance expectations

Ultimately, just like with the main construction contract, subsupplier contracts or purchase agreements come down to the same thing: who is providing what for how much. When developing the service agreement, the overall job parameters must be placed as the paramount requirements. Many things can change as the project moves forward, from outright cancellation to changes in scope and changes in schedule—like acceleration or deceleration—to changes in site access and storage capacity. The more flexible the agreement is, the easier it will be to manage. Roles and responsibilities need to be addressed as explicitly as possible to avoid reopening negotiations due to these types of changes. It becomes very difficult to renegotiate about accountability that falls into unclear areas during the heat of the project. If the service providers feel that their profitability is being impacted, they may use their position to leverage the deal, which usually results in an unhappy relationship for the remainder of the project.

So performance expectations need to be clearly defined and documented. Specifically, performance metrics and accountabilities should be established. As an example, if the order is for the supply of radiographic services, the agreement should spell out exactly how the service is to be performed, in accordance with what codes or other criteria, and the level of personnel performing the work. Additionally, response time needs to be established such as, "Personnel to be on-site within four hours of initial telephonic notification." Responsibility for barricades must be clear and the time for delivering the film interpretation should be such that production work is not delayed. Also, final interpretation for weld acceptance should be defined, and the responsibility for retention of the films and interpretation records must be understood.

As a minimum, the typical site service order should include key answers to the following questions:

- Who is accountable for enforcing the provider's commitments?
- What are those commitments?
- How are those commitments measured?
- What are the time frames for supply/removal?
- How often is the process reviewed for compliance with the commitments?
- What are the consequences for failure to meet the commitments?

The reality

Problems do occur, and in the heat of the battle, they are often blown out of proportion, to the detriment of the job. Therefore, when structuring the service agreement, it behooves both parties to think through the process and plan at a detailed level. How each party will perform through each step of the process must be established and documented. Scenarios for both normal and abnormal situations should be reviewed. Steps should be developed to handle the abnormal situations, so as not to disrupt the ongoing flow of the portion of the job that is not impacted.

Going back to the radiographic service supply order example, there could be an ongoing, 6-hour nightly radiography session to keep up with production welding, when suddenly there is a need for radiography on a main steam line weld for a different contractor. The initial reaction from the radiographer may be to pull some of the resources from the regular work to cover the steam line. But that may put a hold on some of the original production welding—an unacceptable situation. The service order must be flexible enough to adapt to these kinds of occurrences, avoiding the sacrifice of one part of the project for the other.

The resolution

The tendency of each party in the new construction or outage project is to look at its own bottom line, in isolation from the rest of the participants. But the project is not just about the individual players. It is about the investors—those persons or institutions that have invested their resources in the company that owns the site and who may pull out whenever the return on their investment is below expectations. Therefore, it behooves both the buyer and the service provider to look at synergy—how can joining forces become more cost effective than the usual purchaser/supplier relationship—by becoming partners in the supply chain as opposed to unrelated auction participants. By becoming partners, especially if there are financial incentives for joint efficiencies, the stage is set for ferreting out opportunities to create value at all stages of the work.[2]

Although most company procedures require the typical vendor selection process to follow a "three quote and select the lowest bidder" scenario, that is exactly what often drives the relationship to be adversarial. An alternate approach is to use the bidding process only for identifying and prequalifying the suppliers. Then, the next step would be geared to maximizing value creation, as opposed to reducing costs through squeezing supplier margins and scope. However, entering into a search for mutual value creation requires an understanding of each party's objectives and finding ways to achieve fair resolutions to common issues.

For the purchaser, these objectives usually include the following:

- On-time delivery
- Reliability
- Quality

- Responsiveness
- Technical capabilities
- Track record
- Financial strength
- Safety record

While for the supplier, the objectives are more like the following:

- Profit margin
- Order size
- Order repeatability
- Standardization
- Pricing arrangements (and cash flow predictability)
- Accuracy of specifications
- Delivery schedule
- Purchaser creditworthiness

However, to arrive at this mutually rewarding relationship requires open communications, both during negotiations and during the execution of the work.

> *Investing the time and effort to understand each other's objectives and key decision-making criteria through open and timely communication provides greater transparency and increases the likelihood of developing a strategic supply chain relationship, as opposed to a one-off purchase with limited long-term value.*[2]

When purchasers identify suppliers with whom they have had successful relationships, they start looking at them as *key suppliers*. Once perceived as key suppliers, the vendors have gained the loyalty of their purchasers and generally have the inside track for more business. If they have performed admirably during the construction or outage at site, whether for the owner or the GC, they then have the opportunity to be considered for a long-term relationship with the owners or plant operators after the site activities are over, thereby gaining even more business.[3]

Summary

Setting up the jobsite is a task that should be well planned. The administration of the site processes must be streamlined and effective. The core of the site activities—the craftsmen—must have their needs serviced. They must be supervised efficiently, their paychecks must be timely and accurate, and they must have the tools, facilities, and equipment to perform their tasks. On the other hand, the project or upper management/investors require a streamlined and efficient flow of information. They must be able to respond to issues in a fashion that allows preemptive decision making.

The design of the site activities is critical. All participants in the project, from the owner down to the individual contractors should become involved in developing the flow of personnel, materials, and equipment, and they should do it with quality and safety as foremost considerations. It is these upfront efforts that will greatly reduce the potential for inefficient and costly movement of personnel and double handling of materials and equipment once the project gets under way.

Site services and site facilities can only be established for the good of all if all participate in the development of them. While the contracts between the parties will establish the basic responsibilities, no contract will cover every detail. Working as a team at the outset of the project and establishing who will provide what service and facility for whom will also facilitate a smooth working relationship once the site activities are in full swing.

Finally, most participants on-site will also be purchasing a variety of goods and services. The outlay for this can be very significant, and it is often poorly managed. Working with vendors early in the project stage (before the pressures of the daily site activities reach high levels) can help to establish efficient flows of these goods and services. More importantly, plans can be made to handle abnormal situations that invariably will arise.

Careful planning, teamwork, and a cooperative attitude at the upfront stage of the site setup will go a long way toward ensuring that the project runs smoothly and effectively.

References

[1] Yasin, J. and M. Blumkin, "Asset Management Assisted by Supply Chain Management for Services," *Energy Pulse Weekly* update 6 Feb 03.

[2] Excerpted from S. Budoff and V. Krupinsky, Saw Mill Capital, "Supply Chain Alliances Offer Added Value for the Power Industry," published in *Power Engineering,* November 2003.

[3] Ibid.

7

PERSONNEL

People. They're the key element of the project. Even with all of the technological advances during the past century of building power plants, whether the advances were in rigging equipment, welding methods, software for scheduling, or software for communications, the plant still doesn't get built, repaired, or revamped without people. Technology can take over some of the *how-to* functions but the *what-to-do* functions are still in the domain of the people.

Whether building the power plant, retrofitting it or just performing a major overhaul, there are usually three pools of personnel that are involved. The first is the supervision. They often plan the job, they set it up, and they manage it. Then, there's the labor, both skilled and unskilled, that actually does the work. They're the ones that make it happen. Finally, there are the third-party vendors, subcontractors, and OEMs—those supplying equipment and material as well as those providing services.

With the increasing focus on the ultimate cost of the project, it is important that the people selected to work on the project are cost effective. They must be efficient, knowledgeable, enthusiastic, reliable, and most of all, loyal to the job. Many times one hears that if it were not for the people, there would be no problems, the job would go smoothly. Well, if it were not for the people, the job would not get done. The people make the job, and they can break the job. So it is critical that the right people are chosen and that they are properly managed.

But to get the best people, and to get them to perform at their best, is not always so easy. There are many, many obstacles. There are shortages of skilled people. There are shortages of supervisory people. Vendors often get stretched to the limit during peak outage seasons. Jobsite pay scales are not always attractive. Available overtime may be limited. Weather may be a factor. Even if none of the foregoing applies, enticing the worker to do his or her best is often a challenge in itself.

Supervision

The supervision team is the glue that holds the job together. Where do these people come from? How can we be sure they are the right ones? How can we be sure they'll understand the needs of the job and be able to get the labor to perform? These are often the questions that are in the back of the minds of those responsible to set up the job.

Sourcing

During the 1990s, there was a significant loss of supervisors with experience in the power plant construction business. Many retired. Others left due to a slow down in the industry. Unfortunately, not many new ones joined up. This resulted in a net *brain drain,* a loss of tribal knowledge that is impossible to recover. Yes, a few of the old-timers are still willing to come out of retirement and help with specific tasks such as complex rigging or to provide some welding support. But very few of them will sign up for a long-term new construction project or even a full 14-week plant overhaul. So the problem that confronts the powers that be is: "Where do I get qualified supervisors to manage my site work?"

First, a description of the skills required must be prepared. Thought must be given to the technical requirements of the job—will electrical work be performed? What about civil work and/or structural steel erection? Will rigging expertise be required? What kind of welding will be performed, will it need to be code-certified, and will it be a major production or just a couple of high pressure piping welds? Is rotating equipment part of the scope, along with special alignment criteria? How about specialized knowledge requirements like turbine disassembly/reassembly or high-pressure piping cold pulling? Will there be a lot of instrumentation and controls work?

Once the technical requirements have been listed, the nontechnical requirements should be defined. Requirements such as the ability to manage other supervisors or the ability to manage a multitude of craftsmen should be clearly spelled out. If special skills, such as the use of certain field tools like a theodolite or the use of computers, are necessary for the position, this must be identified. If a second language is necessary or even desirable, it, too, should be part of the job description. Also, the working conditions that will be encountered should be included.

Finally, the preferred background of the person who will fill the position should be highlighted. Maybe there will be the need for this person to have already attained some supervisory experience. Maybe there is a need for a specific number of years of experience working on a certain make of turbine. Usually there's the requirement for a certain level of educational attainment. However, experience often can be substituted for some of the years of required education.

Once the parameters are spelled out, the actual job description should be prepared (see appendix D for an example of a job description for a typical field supervisor who will be responsible for the erection of a boiler in a new plant). There are several reasons for formalizing this. The first and foremost reason is to have a written document that can be used as a checklist for ensuring all skills and requirements are covered. The second reason for a formal document is to provide the person performing the job with a clear understanding of his or her responsibilities. The third reason is to minimize confusion among others, up and down the chain of command, as to who is responsible for what.

Having said all of this, however, job descriptions should not be filled with minutia. The mark of a good supervisor is that of one who knows the job to be done and can improvise. Too many details will restrict the supervisor's opinions for using common sense and place unnecessary burdens on the rest of the management team.

After settling on the job requirements and skill levels desired, the level and method of pay must be determined. The level becomes a trade-off between the amount budgeted for the job and the amount needed to attract the talent desired. Hopefully, when the job was estimated, the estimators used realistic numbers for the salaries of the required supervisors, and if the market has not changed significantly, these values should still be adequate. However, if the time between when the estimate was made and the job starts has stretched, or if the market becomes tight due to other projects needing the same resources, there could be problems attracting the desired supervision and still stay within the budget.

Good business practices suggest that a company should not inflate a salary offer just to attract a specific individual. Obviously, it happens, but if it does, it needs to be on a case-by-case basis, so as not to inflate the total company pay structure. So what else can one do if the situation arises where good talent is difficult to attract?

- An offer of permanent employment
- A guarantee of participation in a specific future project
- A bonus payment scheme
- Upgraded accommodations (if from another area)
- Family status versus single status
- Upgraded transportation
- Additional time off

After the pay level and conditions have been set, the method of payment needs to be arranged. There are several approaches to consider. One approach is to pay salary plus benefits and expenses. Another is salary, benefits, and per diem. A third is lump sum. Some formats are dictated by company policy while others are left to the preferences of the employee. The employee will often look at the tax implications of the structure, especially the per diem, which is sometimes taxable. Ultimately, if being hired just for the specific job, where one is generally referred to as a *contractor* or *contract employee,* it's the take-home pay, after taxes, that matters. The employee usually has purchased separately benefits such as life insurance, health coverage, and retirement plans.

Once the job has been described, the required skills for its performance identified, the pay scale determined, and the number of positions decided, it's time to look for candidates. Obviously, the first place to look is within the organization. But assuming there are no viable candidates there, a search on the outside must be initiated. Word of mouth is often used. The power plant construction industry is a tight knit group. Often, suitable candidates can be located through contacting only two or three acquaintances. But this is not foolproof. It does not work every time, so backup plans must be developed. Here is where the various staffing companies can be of service.

There are many companies, all over the world, that offer *contingent staff* personnel for power plant construction work. When working with these organizations, it is almost imperative that a job description is available. They use this information to search their databases for candidates. Once they have identified several prospects, they usually offer to arrange an interview for final selection. However, if the staffing agency is already well known and has been used before, they are sometimes asked to make the final selection and send the candidate directly to the jobsite. When this type of arrangement is used, there is often an agreement that in the event the candidate does not work out, the staffing agency will find a replacement, at no cost to the employer, except for the travel expenses incurred.

Using a staffing agency has some distinct advantages. As just noted, if the employee is not suitable, a replacement will be made at no charge. Usually, the employee's salary and benefits are paid by the staffing agency and their mark-up, or the rate they charge the employer, includes drug testing, workers' compensation, general liability and payroll taxes. This relieves the employer from those responsibilities, and all that is generally required is for the employer to sign the employee's time sheets so the employee can get paid and the staffing agency can invoice for the time.

But what is involved if the supervisory personnel are directly hired and paid by the employer? Beyond just the usual payroll process, which may already be set up to pay the labor, there are a host of additional requirements that must be followed when hiring (and while employing) them. There are federal and state laws that dictate these hiring and employment practices (in the United States).

- Antidiscrimination.

  The antidiscrimination law basically states that an employer may not discriminate against any individual with respect to compensation, terms, conditions, or privileges of employment because of the individual's race, color, religion, sex, or national origin. When rejecting an applicant, care must be taken not to be open to a claim of discrimination, even from circumstantial evidence. A classic example is the case where the candidate for employment 1) belongs to a racial minority, 2) applied and was qualified for the job, 3) was rejected, and 4) the job remained open while the employer continued to solicit applications from people with similar qualifications. Although the rejection may have been for very solid reasons in the view of the interviewer, the candidate may have seen it differently and can create lots of problems.

- Sexual harassment

  This is defined as unwelcome sexual conduct, whether verbal or physical, when 1) submission to or rejection of such conduct is used as a basis for employment decisions or 2) such conduct unreasonably interferes with work performance or creates an intimidating, hostile, or offensive working environment. Note that the harasser and the victim can be of the same sex as well as opposite sex.

- Accommodation for religious beliefs

  This regulation requires an employer to make reasonable accommodations to the employee's sincerely held religious, moral, or ethical beliefs. A real-life example is the case where practitioners of some religions want to pray at certain times during the working day. Provided this does not interfere with the ongoing work, especially in the case of office staff, the employer should accommodate this.

- Pregnancy

  Employers may not terminate or refuse to hire a woman on the basis of pregnancy, childbirth, or related medical conditions (unless the condition creates a hazard for the pregnant woman or for her fellow employees).

- Equal pay

  Employers may not discriminate between employees on the basis of gender by paying lower wages to employees of one sex than paid to employees of the other sex for jobs that require equal skills, effort, and responsibility, and that are performed under similar working conditions.

- Age discrimination

  The law prohibits discrimination solely on the basis of age against any individual who is at least 40 years of age.

- Americans with Disabilities Act (ADA)

  The ADA prohibits discrimination against any qualified individual with a disability who meets the skill, experience, education and other job-related requirements. The employer must make reasonable accommodations unless it can be shown that the accommodation would cause undue hardship. For example, it would be unreasonable to expect a contractor to make a wheelchair accessible ramp into the boiler structure for a worker since this may involve having to navigate through a maze of structural steel support members, then traverse vertically for many feet, and finally ramp back down to the bottom of the boiler furnace, possibly involving hundreds of feet of access ramp. However, it is not unreasonable to make a wheelchair accessible ramp into the site office trailer for a clerk to go to work because this would not entail the same complexities of ramp construction.

- Verification of eligibility

  Employers must not hire persons not authorized to work in the United States. Employers are required to make sure new employees fill out the "Employment Eligibility Verification Form" (INS Form I-9) upon being hired and provide proof of identity and eligibility of employment (as highlighted on Form I-9) within three business days of being hired.

- Retaliation is prohibited

  Legislation prohibits retaliation against an employee who files a charge against the employer for a violation of any of the foregoing.

- Record keeping

  Record-keeping requirements are imposed on employers under a number of laws. The most notable areas involve the retention of pay and time-keeping records and those records pursuant to antidiscrimination issues.

- Posting requirements

  Employers are required to prominently post official EEO notices to employees. It is recommended that both English and Spanish versions of these notices be posted.

Running afoul of any of the foregoing laws is not conducive to the smooth operation of the project. Most construction sites have very few secrets. When a case arises, word of it usually gets out. But to make matters worse, when rumors start that an action is pending by a grieved employee or candidate for employment, the facts often have a way of becoming distorted or exaggerated to the point of discontent among the workers on staff.

Finally, legislation provides for very steep penalties in the event of being found in contravention of most of these rules. Victims of intentional religious, sex, and disability discrimination can be awarded up to $300,000 per individual. For victims of racial or ethnic discrimination, there are no limits. Juries can penalize as they see fit! Since most power plant construction projects are already operating under limited budget constraints, incurring fines of these magnitudes can sure ruin an otherwise successful project.

Managing

The successful managers never stop recruiting the people they work with. They recognize that these people, like all people, have individual personalities. They all have needs and wants. Most like to be recognized for their contributions. Most like to be given the responsibility to manage their scope of the work and the latitude to decide how to do this; they do not like to be micromanaged.

As noted in chapter 6, the task of managing the supervision, although not major, should be well planned. It is important to realize that the supervisory personnel set the mood of the project; their enthusiasm, or lack thereof, is directly imparted to the craftsmen which, in turn, reflects directly on the work they perform. If the supervision is unhappy or not supportive of management, the project will be an uphill battle.

Successful managers use a variety of techniques. At the outset, when recruiting candidates, they know that job titles can have an impact. The word "manager" in the title often has a psychological uplifting effect. The title *construction site manager* is preferable to *site lead engineer*. Once the supervisor is on board, the successful manager knows that making a conscious effort to recognize accomplishments goes a long way toward instilling pride. Even something as simple as a brief note (e-mail is OK) recognizing a certain level of accident-free man-hours is effective—and the supervisor can use this as a tool to manage subordinates, by showing them that their efforts are recognized all the way to the top.

Successful managers acknowledge accomplishments on the supervisors' good days; on the bad days, they are supportive. They never use guilt to motivate since this will only backfire.

Supervisors need time for personal reasons. Since most power plant construction projects are run on 10-hour shifts, often 6 days a week, and frequently 2 shifts a day, scheduling time off for personal needs is difficult. Most supervisors come in a half hour to an hour early and they'll stay up to an hour or more after their shift ends. By the time they get home, there's little time for them to attend to their personal affairs or their family. They need to be able to make arrangements with their peers so they can attend to their personal needs without the fear of losing paid hours or upsetting management.

The average supervisors, especially those with many years of in-the-field experience, do not like to spend time on tedious tasks. They do not want to spend time counting welds completed, they don't want to go around counting condenser tubes installed, they don't want to research drawings for part numbers of bearings, valves, or other items to be installed. Yet someone must do this. Who? Often, university students interested in a construction career are available. Offering to support the supervisor with an assistant will free the supervisor to do the more critical functions of the job, such as directing the labor toward the completion of the project. It will also give the supervisor the prestige of being able to teach the student something about the business, a way of passing on tribal knowledge, which just may lead to a future supervisor being trained for the next job.

Most site supervisors, even those that are on-site just for the one project, still like to feel they are part of the family, like they are a company person. One way to cultivate this spirit is to hold periodic management meetings where they can be shown the impact of their project on the company's bottom line. Using these meetings to lay out company goals like safety numbers, and soliciting ideas from them on how to reach these goals goes a long way toward achieving this.

During times of supervisor shortages, using retired supervisors can be a solution. They usually come for a short time only, they are not looking to take someone else's job, and they bring a wealth of knowledge. But, they are also concerned about their money. Since many will be on or near to drawing Social Security benefits, it is important for the manager to understand how these benefits work and to discuss them with the retiree before the retiree starts work. Generally, if the retirees are under 70 years old, their benefits will be reduced if they earn beyond a certain threshold, so a flexible work schedule may be necessary—possibly no overtime or only working alternate days or weeks. This may also keep them closer to their families, something many will want since they probably spent most of their career away from them.

All of the site staff usually likes to be a part of the site team. They like to participate in the planning of the work, and this includes not just the site manager and immediate staff, but also the next levels. Often these "lower" tier staff members have information and ideas that the upper level staff does not, and excluding them from planning meetings robs the team of vital information. As an example, if the staff is meeting to discuss next week's start of installing the superheater elements, the welding technician should be invited to offer ideas on how the sequencing of the elements might affect the welders' access and efficiency. Equally important, the quality assurance supervisor, if invited, could offer insights into issues that might be encountered when examining the welds and with arranging for the third-party inspector.

Finally, successful managers take the time to become familiar with the work environment of their supervisors. They walk the site with them, wear the same safety equipment, and watch as the supervisors interact with the client, their peers, and the labor. They demonstrate a desire to understand the issues through the supervisors' eyes.

Although all of these ideas cannot be implemented on every site, it is important to understand that since the supervision is the glue that holds the job together, losing any of them can create chaos. If one jumps ship, the others may think about it as well. Keeping the supervisors happy and keeping them on the job and doing their job are critical to the success of the project. This will be seen not only in the successful completion of the current job but also by the client who might just place enough emphasis on the camaraderie that was seen in the staff to consider the same team for the next project.

Labor

If the supervision team is the glue that holds the job together, then the labor is the job itself. The same questions that must be asked about the supervision must be asked about the labor: Where do these people come from? How can we be sure they are the right ones? How can we be sure they'll understand the needs of the job and get it done? Then also, how do we get them to do it?

Sourcing

As with the supervision, during the 1990s, there was a significant loss of labor skilled in the crafts required for the power plant construction business. Many retired. Others left due to a slow down in the industry. Unfortunately, not many new ones joined up. This resulted in a net *skill drain*, a loss that only new people plus lots of training could replace. Generally, old-timers are not willing to come out of retirement to work in the crafts. Not being so young anymore, they are usually less agile and more susceptible to pains and strains. They sometimes make good trainers or even supervisors, but for hands-on work—for using the tools—they are not often well suited.

When planning for the craft labor for a job, the process is somewhat different than it is when sourcing supervision. Specific job descriptions are usually not prepared. If it is a union job, the union hall uses job titles to identify specific skill sets. For example, when the jobsite calls for 30 boiler tube welders, the hall knows that they must be certified for welding small bore tubes, in accordance with American Society of Mechanical Engineers (ASME) Section IX, and that they are expected to be able to weld without undue reject rates—*undue* being defined as "outside of the norm of the other welders." This does not have to be specifically written. Also, their years of experience seldom enter into the decision; often there are very young craftsmen working alongside some with many years of experience. It's their ability to perform the task efficiently and safely that is important.

Although the process of selecting the craftsmen is not as complex as that of selecting supervisors, one aspect is more critical: their pay. Since labor wages often comprise half or more of the total construction contract cost, even a few pennies saved per hour worked can result in significant savings on a major new power plant project. As with the budget for supervision dollars, hopefully when the job was estimated, the estimators used realistic numbers for the costs of the craftsmen, including any union fringes or other uplifts. Differing from supervision, these numbers seldom experience major fluctuations over short time periods; if the workers are unionized, there will be collective bargaining agreements in place with specific numbers and conditions. Of course, if a lot of time has elapsed, those agreements may have been renegotiated and then there could be significant changes.

However, when labor shortages occur there are fewer incentives to offer to the labor than there are for the supervision. One cannot offer permanent employment to the average construction worker. One cannot offer a guarantee of participation in a specific future project. Providing family status, as opposed to working far away from home, is not usually an option and it's the same with transportation. About the only two areas where some creative offers can be made are in the paycheck and in the work schedule.

In addition to offering overtime, which is sometimes limited by the budget and by the schedule, bonuses can be offered to entice workers to come to one job rather than another. One-time sign-up bonuses are sometimes effective. Offering a bonus to a worker who recruits a buddy has merit. Offering bonuses payable after a predetermined period of satisfactory work has been used. Job completion bonuses are popular, especially when they are tied to early completion.

Some workers prefer extra time off. When a job has been working 6 days, 10 hours per day for many weeks, a periodic Saturday off can work wonders; it does not need to be a day with pay, just a day away. Another approach is to offer longer days but shorter weeks. When the job is 40 hours, offer four days at 10 hours and 3 days off. When it's 60 hours, offer 5 days at 12 hours, with 2 days off. However, when contemplating any abnormal working schedule, the laws and the local practices must be reviewed. The general rule of thumb is that working more than eight hours in any one day will trigger overtime premiums, just the kind of cost that the job may be trying to avoid.

Once the pay issue is resolved, and once the working schedule is set, there is still the issue of the actual source of the workers. As discussed in chapter 1, there are various sources from where the labor can be obtained. If the job is to be a union job, the unions will be responsible to find the required number of personnel, with the requisite skills, at the time they are needed. It is strongly recommended to work closely with union management at the initial stages of planning a construction project so they can be prepared to meet the requirements of the project. If they anticipate a shortage of required skills, they may be able to pull workers from other union locals. They may be able to train additional workers or they may suggest looking outside of the union for workers willing to come to the job on a temporary basis.

If the job is nonunion, there are more places to look for people. A recommendation from existing workers is often an excellent resource. The workers already on staff do not usually want to see others come in that aren't up to the task. Often, the supervisory staff has a list of craftsmen they personally know, ones they've worked with in the past. Then, there are the local municipal and state labor departments. They have the list of workers drawing unemployment insurance payments, and they also have lists of workers looking for work even if they are not drawing unemployment. If all else fails, there are the third-party labor brokers, companies that specialize in keeping track of available workers that have the skills required for many jobs.

Using these labor brokers can have many advantages, just as there can be disadvantages. Similar to using a staffing agency for supervisory personnel, using a labor broker for the site level worker can remove the burden of running a payroll. They will do this on behalf of the contractor and bill only a fixed rate per hour worked. They will take care of all wages, payment procedures, benefits and fringes, and all filings with the authorities for payroll withholdings. But on the other hand, the workers now have a first loyalty to the agency. They know that their livelihood is dependent on first satisfying them and secondly satisfying the user. They know that once this job is over, it's the agency that will help them get the next job, not the contractor of the day.

If the labor is to be hired and paid directly, as with supervisory personnel, there are a host of additional requirements that must be followed. The following are the same practices that were spelled out earlier:

- Antidiscrimination
- Sexual harassment
- Accommodation for religious beliefs
- Pregnancy

  However, there are logical limits when involving field personnel.

- Equal pay
- Age discrimination
- ADA

  As with pregnancy, there are practical limits when employing field personnel.

- Verification of eligibility

  A word of caution is required here. Companies employing construction workers, in general, are often subject to inspection by the U.S. Immigration Service for adherence to their regulations. Be sure to have a properly completed INS Form I-9 for *every* worker on the payroll!

- Retaliation is prohibited
- Record keeping

  Although this may be onerous when there are hundreds of workers, it must be done.

- Posting requirements

  The EEO posters must be placed in conspicuous places like change shacks, lunchrooms, and other regular gathering places.

Again, legislation provides for very steep fines in the event of being found in violation of these rules. With upwards of 500 workers, for some of the main contractors on large power plant projects, there are many more possible whistle blowers than with the supervisory staff, so extra caution is paramount. In fact, training the management staff, including foremen, in these rules is strongly suggested. In the event there is an issue, being able to show that the site followed proactive procedures by training the staff will go a long way toward mitigating any antidiscrimination claim, if one arises.

Managing

Managing the labor is somewhat different than managing the supervision. The labor is there for one thing, to perform a skilled task, safely, get paid, and go home. The supervision, on the other hand, has many more complex jobs, one of which is to manage the labor. So the question is, how is this done? How does one get the best from the craftsmen safely and stay within the schedule and budget?

The first step is to instill a sense of *pride of the project* into the worker. If workers are proud to come to work every day, if they are proud to tell their friends and family where they are working, then the supervisor's job will be much easier. But how, on a fast-paced, oftentimes dirty, hot (or cold) outside environment with danger lurking everywhere? It's not easy. The workers often come from a variety of backgrounds. They may even be from different nationalities, speaking different languages. Cultural norms may not be the same. But there is a common denominator—just like the supervisors, they are all people. They all have needs and wants. Most like to be recognized for their contributions. Although they may not be given the responsibility to manage their scope of work and the latitude to decide how to do this, they also do not like to be micromanaged. They usually know their skills, they are proud of what they can do, and they want to be given the opportunity to do so.

But first, back to pride. Most craftsmen have worked hard to learn their skill. They have practiced and practiced and practiced to get it right. Not unlike good athletes, they know that they must continue to demonstrate their prowess to be recognized, and they will do this. But they also want to be part of a team, the team that is building the project. They need to be shown how their work impacts the job. They need to be able to tell others that what they are doing is important, and they want to be able to say why. Simple ways of making this happen is for the site supervisors to place productivity charts on the site. A large chart (see fig. 7–1), showing the goals of the work with regular updates, is a visual affirmation that the workers' efforts are 1) recognized and 2) contributing to the job—it instills pride in what they are doing.

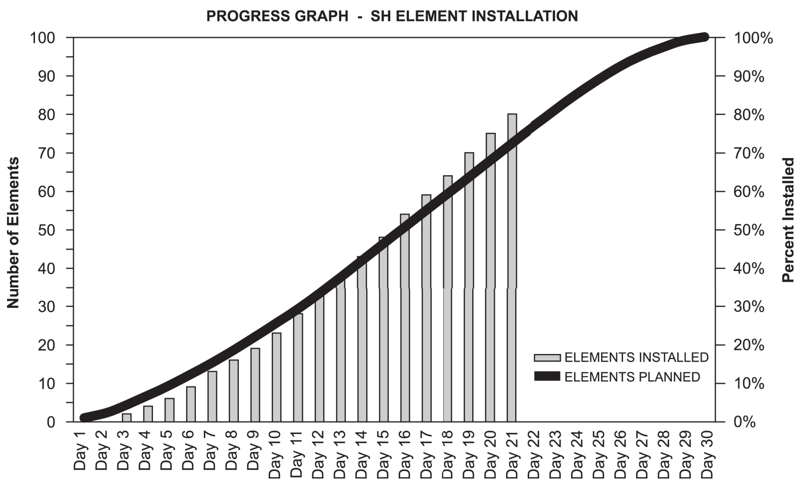

Fig. 7–1 Productivity chart.

Another *very important* metric for the craftsmen is the impact they can have on the safety of the project. No worker wants to get hurt. No worker wants to see peers get hurt. But accidents happen and people do get hurt. By including the workers in the management of the safety process and by advertising how their efforts impact the safety results of the project will also instill a sense of pride in the job they are doing. Just like productivity charts, safety metrics can be posted for all to see. (More on this in chapter 9.)

After pride, workers need to be enthusiastic. They should want to come to work every day. They should be led by supervisors that instill a sense of enthusiasm by treating them with dignity and respect. But their supervisors must be willing to listen. Sometimes, only the craftsman really knows how to be more productive. He or she is the one who is working in the tight spaces, spending all day in a cramped position. Often, only he or she sees how much time is wasted walking back and forth to get tools and consumables. When they work in an environment of pride and enthusiasm, an environment where the supervision is willing to listen, they can offer suggestions that will save time and money. Good supervisors recognize this and encourage it.

It all boils down to communication. During the hustle and bustle of the day-to-day activities on a construction site, it is difficult for supervisors or workers to take the time to really communicate. They generally spend their day issuing commands and then relaying the results to their managers. They do not have the leisure to explain why they've issued their commands. Therefore, time must be set aside to hold forums. One way is to select a few representatives from the workers, set aside 10 minutes after the daily safety meeting, and ask them to "gripe" about issues important to them. At first, they'll only talk about the things that are wrong. But once they see that there's a real interest in their concerns, they'll open up and say why it's happening and often offer suggestions on how to change it.

However, communication is a two-way street. The workers must be made to feel comfortable that they can say what's on their minds but then the supervisor must also listen. There must be an atmosphere of trust, trust that when comments are made or suggestions are offered, they are not ridiculed. Information should be shared not just from the employees up to their supervisors, but also from the supervisors to their employees. If a suggestion has been made, feedback should be provided that the suggestion is being acted on, what its status is, or, if it is being discarded, why. Supervisors must do what they say they are going to do or offer a good reason why they couldn't. Finally, supervisors should share with everyone the overall job status, good or bad, so the workers will know the effect they are having on the project.

What's been said so far is applicable in most any power plant construction environment. However, when the workforce is unionized, there are additional challenges in managing the workers. In an open shop environment, the workers are directly dependent on the employer for their job. But on a unionized project, there are third-party levels, or buffers, that must be navigated before an employee can be disciplined or terminated, which can affect the way site management must deal with the craftsmen. There is usually a job steward who gets involved, on the employee's behalf. There are the union officials such as the business agents and business managers who are available for the support of the worker. There is generally a detailed set of rules, agreed to in advance, that guide the process of hiring, assigning jobs, advancing, disciplining, and terminating employees. This sometimes has the effect of keeping the supervision and the workers at arm's length from each other, making it more difficult to develop a sense of camaraderie.

To overcome this sense of *them and us,* some organizations have implemented a system of cross communications between the owners, contractors, and unions, referred to as tripartite. Often, there are mandated, weekly tripartite meetings, held at the site, to offer everyone the opportunity to discuss issues that could become problems if not addressed. These meetings usually go a long way toward defusing volatile issues and setting the tone for the tradesmen and supervisors to work in harmony.

A typical result of a working tripartite relationship follows. At a particular power plant, there was a long-standing tradition of using a team of union boilermakers to waterwash the inside of the boilers whenever they came down for repairs. This process generally took almost a week since first, scaffolding had to be erected, then, the boilermakers would go inside, spend a few days washing the unit and exit, and last, the scaffold would be removed. However, one day the owner approached the union about making a change.

The owner knew of a contractor that had a technology for washing the units without installing all of the scaffolding and without using all of the boilermaker man-hours to wash the unit with the water lances they always used. This contractor had a system of stringing cables through the inside of the units and attaching special water-propelled wands that washed the units automatically. When the owner suggested this approach to the boilermaker union, there was an initial reluctance to accept this change from the traditional way of doing things—the concern was a loss of work for the boilermakers.

But because there existed a trust between the unions, the contractors and the owners, a tripartite trust, the union agreed to explore what this proposed change would mean. As it turned out, making the change allowed an extra few days of access to the boilers, which allowed the boilermakers the time to perform even more work than they had been doing before, and everyone walked away a winner.

Since the primary purpose of unions is to represent the workers, their efforts are not always in harmony with management whose primary purpose is to represent the company or shareholders. However, both the union and management have a stake in the outcome of each project, so they have a need to work toward encouraging the craftsmen to do their best. The union management recognizes that they cannot make the employees feel that the company cares, but they know that they can instill the opposite mind-set. Therefore, unions and management must always work hard to create an environment where the worker does feel wanted and where pride and enthusiasm in the project are a shared goal. No one wants costly labor strikes, least of all the owners and shareholders.

Regardless of the jobsite setup, whether open shop or union, there is one area that all supervisors can impact to create an upbeat and more enthusiastic workforce, and that is to equip the workers with the latest tools, maintain these tools in good working condition, and train the workers in their proper use. Few things are more aggravating to the craftsmen than not being able to work efficiently due to incorrect, malfunctioning, or broken tools. They quickly becomes discouraged when they have to stop work frequently to repair or replace their tools or when they know there are better tools suited for the job. The message that comes across is *cheapskate*. Their thoughts are; "If they're this cheap with the tools, where else are they cutting corners, on safety, wages, or what?"

Labor relations

Labor relations is a term that refers to the interaction between any employee and employer. Therefore, it applies to the supervisory workforce as well as to the craftsmen employed on the job. But since there are many, many more craftsmen than supervisors on the typical power plant construction site, the discussions pertinent to this subject have been included under the labor section of this chapter.

Heretofore, we have discussed some of the legalities of discriminatory issues for any hired person on the jobsite. We have also discussed some of the nuances that are involved when operating under the jurisdiction of a labor agreement. Here, we will address the organizations that are responsible to enforce the various labor relations rules and what is and what is not expected of a typical jobsite superintendent.

First, the Equal Employment Opportunity Commission (EEOC). What is it and what does it do? It is the United States federal agency responsible to enforce the laws that dictate hiring and employment practices, specifically enforcing compliance with the antidiscrimination statutes mentioned earlier.

Since construction work involves people, often lots of people, eventually, there will be a discrimination or harassment charge from a worker against another worker or supervisor. This usually takes the form of the aggrieved worker complaining to the EEOC who, in turn, notifies the employer that a charge has been filed. After an investigation, which usually requires the employer to provide certain documents and sometimes witnesses, the EEOC will determine whether or not a discriminatory act took place. If it did, the EEOC will then attempt to negotiate a settlement between the employer and the charging party and it will require the employer to establish a process where this type of discrimination won't happen again.

If the EEOC is not successful in negotiating such a settlement, it will file suit in court. Although there is no way to accurately predict the outcome of a court case, as has been discussed earlier, remedies may vary. They can range anywhere from simple reinstatement of back pay or promotions all the way to payment of compensatory and punitive damages, sometimes involving hundreds of thousands of dollars. Therefore, it is generally in the best interest of both parties to arrive at a settlement out of court.

Next, the National Labor Relations Board (NLRB). What is it? The NLRB is the United States' independent federal agency responsible to administer law in the private sector and governs relations between employees, employers, and unions. It has two principal functions: 1) to determine whether employees wish to be represented by a union and 2) to prevent and remedy unlawful, unfair labor practices. It does not enforce the various EEOC statutes described earlier. The agency does not act on its own. It only acts on charges filed by employees, employers, or unions.

If a complaint is filed with the NLRB, and if it finds reasonable cause to believe a violation of the law has been committed, just like the EEOC, it will seek voluntary settlement to remedy the situation. If these efforts fail, the case will go to court.

Let's look at the unionization issue. If a group of construction workers on a nonunion power plant project wish to band together to negotiate for something with their employer, as a single entity, they may seek to be represented by a union. To do so, however, requires certain specific steps, spelled out in the National Labor Relations Act. They must get their proposed union to file a petition requesting an election to determine whether the employees wish to be represented by this union for the purpose of collective bargaining. The petition must be supported by the signatures of 30% or more of the employees. The NLRB will then hold a secret-ballot election for participation by all eligible workers. The contractor, even though probably not in favor of this unionization drive, must allow the elections to be held, and is prohibited by law from using any intimidating measures to influence the voters.

Were it not for the NLRB and the laws it enforces, this type of unionization effort would be very difficult for the workers. The NLRB protects their right to be represented by a union. On the other hand, the employer has similar protections whereby the NLRB is required to assure a secret-ballot election conducted under very specific rules. If there is not a majority of "yes" votes, the employees are denied the opportunity to be represented by the union. But why do they want to be represented by a union in the first place? Usually, it is to negotiate for higher pay, possibly for some additional benefits like insurance, and sometimes for different working hours. The company, on the other hand, is normally not in favor of this effort by their employees because it will drive up their costs of the project, and this cost increase is generally not reimbursable from their client.

A final note: Workers employed as *independent contractors* and workers employed as *supervisors* are excluded from protection by the NLRB.

Next, let's look at a potential example of the role of the NLRB in enforcing an unfair labor practices claim. A nonunion contractor who has several power plant outage contracts within a 100-mile radius decides to *lay off* a specific certified pipe welder working at one of the outages. The welder knows that the other outage is still advertising for certified pipe welders, and applies for a job there. He is turned down. Subsequently, he files an *unfair labor practice* charge with the NLRB, stating that since he was acceptable for the contractor on the first site, he should be acceptable for the second. The NLRB encourages a voluntary settlement, which if not successful, will be scheduled for a hearing before an NLRB administrative law judge.

If this case goes to court, the welder's lawyer will argue that the welder 1) was laid off without cause from the first job and 2) the company discriminated against him by not hiring him at the second job.

The company's lawyer will argue that 1) the welder was laid off at the first job due to reduction in force since the first job was nearing completion and 2) the welder was turned down for employment at the second job because the first job recommended he not be hired, due to unsatisfactory performance (unfortunately, never documented). What's going to happen?

The NLRB judge will listen to both sides, summarize the claims and counterclaims as he understands them, and once again encourage a voluntary settlement. The claimants, the welder and his lawyer, will consider the maximum and minimum awards they could expect while the company has to consider its maximum and minimum exposure. For the welder and his lawyer, the most they could expect in terms of a financial award is the amount of *lost* wages from the second job that did not hire the welder. Since this was a plant outage, with only a few weeks remaining before completion, these unrealized wages will amount to only a few weeks of pay. The downside, of course, is not receiving anything.

For the company however, there are several factors to consider. First, since they did not document the worker's poor performance at the first project, their position is tenuous but fortunately, the unrealized wages they could be forced to pay is not significant to them. The second and more significant issue for the company is their reputation—do they want to send a message of "don't mess with me" or do they want to be seen as somewhat benevolent by agreeing to pay some amount of money to the worker?

Most likely, there will be a settlement, sometimes with the stipulation that the terms cannot be revealed to anyone, and the NLRB judge will then approve the settlement, closing out the case. What would the settlement actually be? Probably, the worker would get about 75% of the wages he would have earned had he been hired for the second job, but he would not be able to tell anyone, thereby keeping the company's reputation from being questioned.

Lastly, in the event of a jobsite already unionized, the NLRB also has a role to prevent and remedy unfair labor practices by the unions, if called upon. For example, one contractor's unionized employees may boycott the job through a strike or work stop action. If a second contractor's unionized employees also strike, in sympathy for the workers of the first contractor, the NLRB can be asked to obtain a court injunction against the union representing the workers of the second contractor. This should be recognized by the site supervision so they can take immediate action in such an event, thereby possibly reducing further turmoil on the site.

In the event of an EEOC discrimination charge or in the event of a NLRB unfair labor practice complaint, the charges are usually served on the lead site superintendent representing the worker's employer. Since the superintendent is usually not an expert in labor or labor relations law, it is very important that no response be made, in any manner, written or oral. The home office should immediately be notified and in the event there is pressure for comments, whether they are from the agencies involved, other employees, or the media, the superintendent should refer these requests to the home office; no response should be made from the site. The charges must be considered serious and must be handled in strict accordance with the laws governing them, including timeliness of responses. Legal assistance will be required.

Third-party Vendors, Specialty Subs, and OEMs

Even with all of the supervision and with all of the labor, there are some services that an owner or contractor will prefer to outsource. There are many reasons for this. Some services require skills of such a unique level that it is not practical for an individual owner or contractor to train his personnel to perform those functions when they are only performed once every five or more years. Sometimes there are risks associated with a particular activity such that performing the activity would impact the insurability of the contractor; subcontracting it to a specialty vendor puts the risk with the company best suited for managing it. Then there are times when it is just simply more cost effective to outsource than it is to perform certain construction-related activities oneself.

Third-party vendors

Third-party vendors are usually thought of as outside shops that provide specialized services, tools, or supplies. A very common example is a vendor providing services for turbine rotor repairs or generator rewinds. In the past, work on major equipment such as this would be performed in the vendor's shop. The equipment would be moved out from the plant, loaded on trucks and/or railroad cars, shipped to the vendor for repair and then brought back and reinstalled in the plant. Since it was impractical for the plant, or most any contractor, to have the equipment and personnel available to do these major repairs on-site, there really was no other choice.

However, this might create an additional risk for the project—a risk of something going wrong and then the machine not being back per the schedule. The problem might occur at the vendor's shop. Equipment could break down, there could be a labor action, or there might just be a work overload. The problem might be encountered during transportation to or from the shop. Trucks break down, bridges wash out, and roads become impassable due to snow or mudslides. Or the problem could be right in the plant itself, either with the removal of the machine, or with its reinstallation.

With the increasing focus on cost and schedule, more and more outage supervisors now want this kind of work to be closer to their control. They prefer for this work to be done within their facilities, preferably in place so that many of the potential risks just described are eliminated. This then requires the vendors to develop specialized equipment for doing this kind of work at their clients' facilities, and it requires them to train their personnel in the use of it. The cost for the service is now often higher than if it were done in the shop, but the risks to the schedule are reduced.

Specialty subs

There are many instances where it is more cost effective to subcontract part of the plant construction or repair. The rationale may be the unavailability of qualified personnel. It may be that the subcontractor can perform the work for a lower cost than doing it oneself. It may also be that the risks inherent in the specific work scope are not acceptable to the contractor's insurer.

An example of this last case is the installation, maintenance, and removal of scaffolding. Most scaffold work is for the provision of temporary access for personnel to get to areas not normally accessed. Because of the temporary nature of scaffolding, most insurers rate the potential for accidents involving personnel on scaffolding higher than they do for much of the other work. When an accident does occur, the cause or the blame is often seen to be associated with the erection or maintenance of the scaffolding itself, which then makes the installer of it liable. Since there are contractors who specialize just in the erection and maintenance of scaffolding and who are insured specifically for these types of risks, many owners and GC subcontract this specialty to them.

A similar situation exists with the removal or abatement of hazardous materials such as asbestos insulation. Due to insurance requirements, which require specialized training for the workers, most contractors will not work with asbestos. They use specialty subcontractors, thereby shifting the risk of incidences to those who have the training, experience and insurance to shoulder these risks. It's basically a matter of economics; the specialty contractor can usually perform these work scopes more cost effectively than a GC can.

OEMs

Differing from third-party vendors and specialty subs, OEMs offer a support very few of the other parties can provide: the original drawings, specifications, calculations, and even the in-house engineering staff that is specific for the part, machine, or equipment being installed or repaired. Short of reverse engineering a replacement part, especially if the equipment it is on is still fairly new, going to an OEM is sometimes the only way to acquire it. Even when considering reverse engineering, there may be an issue with the time required to engineer, manufacture, and ship the part. There may also be an issue with warranties since the OEM will certainly not warrant it.

OEMs also offer technical personnel, trained specifically on their product and equipment. These technical people have access to the engineering drawings and to the engineers who can answer questions and resolve problems when they arise. They usually know the best practices to be used when erecting, disassembling, and reassembling equipment. They can often offer cost-saving ideas during these operations and they almost always will guarantee the performance afterward.

However, they cannot offer to warrant the workmanship of another contractor's labor. Therefore, engaging the OEM's contracting division is a frequently used method for maintaining performance warranties for the installation of a new piece of equipment, whether it is a turbine, a boiler, or a precipitator. The OEM may not actually use its own in-house contracting division, it may subcontract the labor to a third party. But from the owner's or GC's perspective, the risk is still with the OEM, and they are protected. Again, it is a matter of money. Due to overheads, the OEM is frequently more expensive than a construction-only contractor, but it is often worth this cost differential to be able to shift the risk of incorrect or poor installation.

Summary

Just like scope determination, equipment selection, scheduling and budget preparation, personnel selection and managing has to be a planned and well executed process. A good construction job requires good construction people. Care in selecting the supervisory staff is of utmost importance. They set the tone of the project. Selecting and managing the labor is also crucial, and there is often less flexibility in the sourcing and in the rules for managing labor than there is for the supervision. The treatment of both the supervision and the labor is governed by some very specific guidelines that must be followed to avoid serious legal and financial penalties. The project management personnel and the site supervisory staff must all be familiar with these guidelines.

Rounding out the site work force are the third-party vendors, specialty subs, and OEMs. These are the organizations that are hired for the specialized expertise they bring, expertise that most owners and GCs do not have. They fill unique niches in the power plant construction business because of their specialized services, such as turbine reblading or rotor rewinding. They may specialize in services that are too risky for a larger contractor to undertake, such as scaffolding or asbestos removal. They may be the original manufacturer of certain equipment and therefore they may be the only group with the drawings, the calculations, and the engineering expertise to offer a guarantee of performance. Some of these support services are usually needed for any major power plant project, whether it's a new plant or an overhaul, so they, too, must be sourced and managed.

In summary, the site organization is made up of a diverse group of people, coming from many places. These people all have different roles to play in bringing the job to a successful conclusion. They interact with each other on a continuous basis. They require strong, knowledgeable, and enthusiastic supervision to set the mood and direction of the job. To keep harmony and maintain efficiency, they all have to work as a team. Each person on the job has a little piece of something special to offer and only when all of these special pieces are put together, will the job get done—on time and within budget.

8

ENSURING QUALITY

Often, one hears phrases such as: "A job worth doing is a job worth doing right" or, "It's funny how there's always money to do it right the second time." These phrases are expressions of attitudes, and quality is an attitude. Quality is a commitment that begins with the top corporate officials and flows throughout the entire organization. Adherence to quality and dedicated implementation of quality processes will be effective only when top management insists upon it; quality cannot be made when a commitment to it does not exist! Today's work environment demands not only a safe workplace but also quality products, services, and activities to satisfy customers' needs. Quality definitely impacts cost: positive quality generates a positive impact on the cost of the work while negative quality generates a negative impact. When there is a lack of quality, the symptoms are construction defects and the costs of correction.

Take the case of inadequate quality control for welding work. Suppose that the welders were allowed to draw rod from the welding rod room, go to the location of the work and just start welding. Without proper welding rod distribution controls in place, the welders could accidentally use the wrong welding rod, which could result in the welded joint being weaker than the rest of the tube or pipe, a situation that might not manifest itself for some years. Or without proper weld inspections, such as radiographic checks of the welds, defects could be present in the welded joint that would not be discovered until the unit hydrostatic test, possibly requiring expensive installation of scaffold for access plus all of the costs of performing the re-weld.

A policy must be established that sets the rules to be followed. A quality plan must be developed for each project, sometimes even sub-projects, following the rules of the quality policy. Controlling the quality of the site work then requires that a clear channel of communication be established between the workers, their supervisors, the designers and the quality enforcers. Individual responsibilities must be assigned and accepted for the quality plan to have any chance of success. There must be a system of controls that can be used to stop the work in the event of poor workmanship or incorrect construction and finally, there must be a feedback process that analyzes results and points to suggestions for improvement.

Policies versus Plans

Most everyone has an inherent understanding of the meaning of quality. But what about quality *assurance* vs. quality *control*? What's the difference and how does it impact the site? J.M. Juran, world-renowned expert in quality since early last century, explains:

> *Quality assurance is the activity of providing, to all concerned, the evidence needed to establish confidence that the quality function is being performed adequately whereas quality control is the regulatory process through which we measure actual quality performance, compare it with standards, and act on the difference.*[1]

In other words, quality *assurance* requires that there be formal plans for all phases of the work that spell out how quality (which could be fitness for use, meeting customer requirements, etc.) will be achieved. It requires a system for reviews to verify that the plans will result in quality as well as a system of audits to verify that the plans are actually being followed. Quality *control* (plans) then spell out the steps to be followed for whatever is to be controlled, setting a quality standard. For example, *measure* the actual production weld by performing the appropriate NDE, then *compare* the NDE results with applicable ASME code requirements and *act* by making the necessary repairs, retrain the welders, or change the process variable as applicable. With that now cleared up, one can see that quality assurance will be defined by a policy whereas quality control will be defined in a plan.

Does the site staff care? Most of the time, those not directly responsible to implement the quality programs do not always see eye-to-eye with the quality control staff; they focus only on the specific procedures they are required to implement. On the other hand, the site quality control staff focuses on the total project needs. They are on the front line responsible to implement the quality process. They must understand that the quality policy, established by the company's top management, represents the overall quality intentions and objectives of the organization. This becomes important when differences arise between specific site quality control plans and what the quality policy demands.

For instance, the company quality policy may require that product or service that does not conform to the contract requirements must be identified and controlled to prevent unintended use or delivery and to prevent reoccurrences. The welding quality plan, on the other hand, may be very clear on what to do to welds when radiographic examination reveals them to be defective, but it may be silent on how to prevent reoccurrences. The site quality team must be conversant with the quality policies to be able to see this shortcoming and they must then arrange to have the quality plan amended. In this case, adding a requirement to increase the number of welds to be examined from a welder whose weld reject rate is beyond preestablished limits would be part of the amendment. There should also be a section that spells out exactly how many additional welds are to be examined, and at what point the welder must be removed from the work and sent for retraining.

All of this, of course, has its cost implications. There are the initial costs of performing quality checks in accordance with quality plans. Then there may be additional costs for follow-up inspections as well as the costs for the rework required as a result of the initial inspections. However, the initial inspection costs are usually already included in the original jobsite budget. The additional costs are actually site controllable—controllable in the sense that better control of the quality of the workers' efforts will lead to less additional costs as a result of fewer defects found through the inspection process.

Communication

Controlling the quality of the work on a power plant construction site is all about people communicating. No one wants to do a poor job. No one wants the work to be shoddy but it happens all of the time and the challenge faced by most site managers is how to get it right the first time and how to avoid that costly rework. The place to start is in establishing an environment of communication. This is not the same as a chain of authority; that will still exist. An environment in which the workers, the supervisors, and the engineers/designers are comfortable in communicating with each other must be encouraged. This is not an easy task. It requires a dose of personnel management, ego stroking, and forcefulness—all at the same time.

The worker must *want* to do a good job; the worker needs to be motivated to have pride in the work and feel a sense of ownership in the finished product, whether it's the construction of a new plant or the repair in an existing one. Part of the motivation process needs to include a clear path of information flow, or communication, of what is expected. The craftsman must have quality-critical technical information at hand to remove the element of guessing. In addition to a written program that usually stays in the superintendents' offices, the worker needs to be able to *see* this quality-critical information, at the site where the work will take place. Going back to the welder, one way of aiding this process is for the quality control or welding supervisor to physically color-code the tube and pipe end joints with the same color that the weld rod will be marked with. In this manner, if anyone, worker or superintendent, notices weld rod ends in the vicinity of the work that have different colors than the tube or pipe ends, the work can be halted temporarily and an investigation can be conducted.

By providing the welders with work processes to promote quality, such as the color-coding discussed here, the welders are being drawn into the success of the project and *encouraged* to aid in the process of controlling quality—they are being encouraged to communicate by receiving information that will allow them to do the job correctly the first time and by using this information to notify others in the event of incorrect work. The worker and the superintendent have the opportunity to prevent poor quality from happening in the first place by communicating with each other at the beginning of the work.

Similarly, communications between the quality control staff and the site supervisors must be open. The site supervisors are usually consumed by the day-to-day operations of the site, keeping the project on schedule, keeping the materials flowing to the workers and providing the tools they need to do their jobs. They often neglect to put quality issues at the forefront of their decision-making process. Therefore, it is important that the quality control staff interface with those responsible for the production of the work. It is important that they communicate the quality requirements of the job. They must explain the importance of doing the work correctly the first time, and they must show what tools are available to facilitate this. The challenge for the quality control personnel is to convince the production staff that the effort to do the work right the first time is much less than the effort required to correct it later.

Then there are the communication channels that must be established between the site quality control staff and the off-site groups. There's usually a home office quality group that the site personnel must satisfy. They're the ones who normally set the policies and procedures to be used at site. They're the ones who usually advise the site on code and regulatory questions. They maintain final interpretative responsibilities of quality tests like radiographs and calibration data, and they also manage the audit processes. Without a clear communications channel, the site can end up waiting for extended periods for responses from the home office group. Hold points can turn into schedule delays, especially if third-party inspections that the home office is responsible to arrange are not timely. Imagine the need to get the insurance company's authorized welding inspector to witness the hydro test but no arrangements are in place. By the time this gets arranged, maybe three or four days later, the job could be subject to LDs for missing a critical milestone.

The home office group usually determines which edition of the applicable codes are to be followed and then communicates this to the field. For example, the ASME code requires that a boiler be installed in accordance with the edition of the code to which it was designed and manufactured, and the home office should advise the field personnel which edition this is. In one specific instance, a contractor was installing a boiler using the 2001 Edition, 2003 Addenda of the ASME code, which was in effect on the contract date. Through a breakdown in communications, the contractor's site personnel did not realize that this boiler had actually been designed and fabricated in accordance with an earlier edition, 1998 Edition, 2000 Addenda; the contractor only found this out when the third-party authorized inspector asked him why he was not stress-relieving the 180 riser tube welds.

The code edition in effect at the design stage required post weld heat treatment for these welds but the subsequent code edition deleted this requirement. Since the contractor was working to the "latest" code requirements, as specified in the contract, there was never a plan to stress-relieve these 180 welds. However, for the authorized inspector to accept and *stamp* the boiler, it had to be built to the code edition in effect during its design and fabrication, which meant the contractor was required by code, not contract, to do this stress relieving. Unfortunately, 180 welds are a lot of welds to stress-relieve when it was not originally priced or planned. In this case, the cost equated to approximately $50,000. Clear and constant communications helps avoid these types of misunderstandings and potential exposure to additional costs.

Planning

Setting up the jobsite quality organization requires some forethought. As discussed previously, there are preestablished requirements that must be met. Then there are costs that must be considered both in terms of the impact the group will have on the overall budget as well as the impact they will have on the schedule, which is also a cost to the project. Finally, the establishment of the quality group at site must be designed so that they can seamlessly communicate across all boundaries.

What will be some of the group's primary functions? Will they be required to inspect off-site materials before they are shipped to the site? For example, if duct pieces are manufactured and assembled elsewhere, especially if being done in a shop not accustomed to providing parts for power plants, will someone from the site be required to visit the shop and verify that the parts are being manufactured and assembled in accordance with specifications? Take the case of duct being assembled in a third-world country where quality control, in the classic sense, is not the norm. Left unchecked, this material may well arrive at site with missing welds, out-of-tolerance squareness/roundness, and even with dimensional mistakes. The cost to repair these types of errors on-site can be tremendous compared to fixing or eliminating them while the material is still at the shop.

Will the quality group be responsible to track and provide releases for work to continue, after hold-point inspections? Will they be held accountable if releases are not made in a timely manner due to an inadequate number of inspectors? How do they handle a sudden increase in defective work, which then requires a sudden increase in inspections? What about all of the record keeping, the paperwork, and the electronic data manipulations? The quality group usually holds the records that verify the acceptance of completed portions of the work, and they must be able to make them available.

So, when the site quality group is being established, questions like the foregoing must be asked and answered. Obviously, there will be someone appointed as the leader of the group. This person will have to work in concert with the site manager and possibly with other site organizations as well, when determining how to structure the group. Some site managers view the quality group as an annoyance, both in terms of cost to the job and in terms of disruption to productivity, reinforcing the earlier attitude of "funny how there's always money available to do it a second time." Having adequate staff to do it right the first time is cheap insurance. There is no need to let quality deteriorate to a point where rework affects the project program and where the cost of this poor quality affects the jobsite budget, all due to not wanting to spend a bit more money upfront.

Also, when staffing the quality group, forward-thinking managers look to the turnover phase of the work—that stage where the construction group starts releasing the installed plant to the commissioning group. This is a time period of pending chaos. Deadlines are usually just around the corner. Resources are stretched because the construction team is trying to demobilize. But someone must still prepare the mountains of paperwork required to ensure smooth turnovers of each defined piece of plant or equipment or area. These turnover packages, often consisting of numerous reports and other documents, can be very time-consuming to prepare. The review of them by the recipient can also require extra time, especially if they are incomplete or incorrect. So staffing of the quality group may actually need to increase as the project nears the completion of the construction phase, just to avoid delays in turning over plant, which could then lead directly to delayed start up and subsequent LDs.

Responsibilities

Who has the responsibility for the quality of the work delivered to the end user? Generally, the contractor or GC is contractually bound to a certain level of workmanship, and this workmanship is underwritten by a warranty. Since sometimes defective work may not be readily apparent upon turnover—usually referred to as *latent defects*—the cost for repairing this work, especially if it is not discovered until after the contractor leaves site, can be very high. So it is in the interest of the contractor's site manager to ensure quality is an important priority. Usually, an analysis of the *extra* costs to make repairs and reinforce quality checks will show that this cost is preferable to performing warranty work later. Therefore, site managers must understand their responsibility when it comes to doing it right the first time.

Their challenge, then, is to set up the quality organization with specifically assigned responsibilities. A point person, or manager of quality is normally assigned to accept overall responsibility to ensure the quality process is right for the project and functions as designed. This person should be experienced in the type of construction being performed. In other words, this person should be familiar with the art of welding and welding processes if there is much welding to be performed. This person should be well versed in alignment and micro-measurement procedures if major turbine and turbine rotor work is done on-site. This person should also be familiar with electrical standards and structural steel and civil works procedures when the project consists of building a new power plant.

Usually, the quality managers know specific individuals with whom they are comfortable working. These individuals have probably been members of their team on a previous project, and they will understand the peculiarities of a power plant project. They will know the importance of the paperwork required, and they generally understand the impact of paperwork delays, such as delayed turnovers that can lead to delayed completion and ultimate LDs. The quality managers, by employing these individuals, can be comfortable delegating responsibilities that then allow them some time to interface with parties exterior to their group.

To be effective at managing the quality process on any construction site, the quality manager must have the time and knowledge required to *play politics*. Since quality control is often perceived as undue interference by the average craftsman and superintendent, it is important for the quality manager to gain the trust and cooperation of these personnel. They have to be shown by the quality manager the importance of working together to achieve a quality project. The quality manager also has to work with the home office staff, providing them with the assurance that what's being done on-site is in keeping with company standards and contractual obligations. It is important to solicit their support when contractual interpretations are required and to be able to rely on them to keep the site group updated with revisions to standards and drawings.

The rest of the jobsite staff also must be held accountable for the work performed under their supervision. Since the craftsmen actually work for the site superintendents, not the site quality staff, it is the site superintendents who must manage these workers so their workmanship meets the quality requirements of the job. The quality staff is responsible to perform the tests necessary to check on the quality of the work and advise the workers' supervisors when the work is substandard. But then it is these superintendents' responsibility to take corrective actions and implement measures to avoid further deterioration of the work.

Although the quality control group on-site, along with the workers' supervisors, are the front line enforcers of quality, everyone else associated with the job also has a responsibility to ensure the work meets all quality standards prescribed. Nonconformances cost. Studies have shown that nonconformances or the cost of poor quality can add significantly to the cost of the job. Industry-wide, in the last 10 years, hundreds of millions of dollars have been identified as *lost money* due to poor quality. This is unnecessary. Those with front line responsibilities must be held accountable to have their workers perform in accordance with established jobsite standards. Those not on the front lines still have a responsibility to support the system. They may be the material controls people who must have a system in place that gets the right parts to the right place at the right time and in the proper condition. They may be the schedulers who have the responsibility to advise the site staff of potential issues, or relief of constraints, as soon as they appear, to provide the front-line staff with maximum opportunity to be flexible for work arounds. The top-level supervision—the site managers—must accept their responsibility to support their quality staff in the performance of their duties.

Audits

Quality control is often perceived as an ugly term. It's not an issue of quality; it's an issue of control. But somehow, the quality of the work must be controlled. Quality requirements are usually spelled out by contract, often referring to various codes, laws, and standards. Some are also unwritten, accepted *industry standards.* But until an *enforcement* process is put in place, there is no guarantee that the prescribed standards will be met. The client, the end user, and the regulatory authorities want assurances that the work is performed in accordance with all requirements. So in addition to the quality control processes performed at site, an audit system must be included.

Generally, there are two types of audits: internal (or self-audits) and external (or third-party audits). Both types have the same goal: assessing whether the quality controls are being followed. The internal audit is performed by personnel from within the organization being audited, but not by those who are performing the activities that are being audited. The internal audit plan should be developed taking into consideration the status and importance of the activities and areas to be audited as well as the results of previous audits. This audit plan should be reviewed after each audit and updated if necessary. The audit results should be documented and analyzed for quality trends. Senior management should be informed of the results.

External audits, generally subcontracted to a third party, should be used to remove any possibility of bias that may occur during an internal audit. Most quality programs require periodic third-party audits for this very reason. As with the internal audit, a plan should be developed taking into consideration the status and importance of the activities and areas to be audited as well as the results of previous audits. However, the auditing team must be given the flexibility to go beyond the *plan* and investigate any other areas or processes that they believe may impact the work they are auditing.

After the completion of either of these audits, company management responsible for the areas audited should review the audit results and implement corrective actions on deficiencies found during the audits. Follow-up actions should then be implemented to verify that the corrective actions were taken, along with documenting the results.

At site, the quality group often perceives audits as intrusions into their space, just as the front line workers perceive quality control as an intrusion into their world. But without these controls, there is no independent verification that the work is being performed according to requirements, and that the possibility of warranty work being required has been reduced and/or eliminated. To make audits go smoothly, the site quality group should envision what outside auditors would look for, what paper trails they would want to verify, and they should make sure these are in place. They should consider the interruption an external audit will create in their operations and have a plan in place to provide coverage in the event they are required to be away from their normal duty stations.

For example, a third-party audit of a large power plant construction project might last some days. At the minimum, the lead quality person, the manager of the group, would have to dedicate a significant portion of time to this audit. If the paperwork were not readily available, other quality staff personnel would also be needed to identify, find (sometimes create), and explain various forms and compliance to procedures. This would take away from the time for them to perform their normal duties say, inspecting welds or verifying coupling alignments, which would then delay production work on the site.

Since this adds to the perception that quality control is a hindrance to the work, it is in the best interest of the project for the quality group to be well prepared to maintain coverage of their duties while being audited. An effective way to accomplish this is to agree upon a schedule of audit activities, some possibly being performed after normal working hours, to minimize jobsite disruption. With a time line established, the auditors will know who will be available when, they will know what they can review when and for how long, and they will be able to streamline their work as well.

There is a cost for audits. The site disruptions and the time the site personnel spend on behalf of the audits is time not directly benefiting the job. That is not to say the audit is not a benefit because it is. However, these are hours that the staff on-site is not deriving a direct benefit from. Then there is also the cost for the auditors themselves. Usually, the jobsite, or the home office charging the jobsite, are the ones who pay for these costs. They can be significant, especially since they are often conducted on an extended schedule and they involve the travel and living costs of the auditors. But these costs should be viewed as the cost of insuring that there will be a lower likelihood of rework required as the project proceeds and that there is less chance of warranty work after the job is over.

Analysis

No discussion of quality is complete without addressing ways to improve the process. Since quality assurance and quality control are people-oriented activities, the process cannot be reduced to the ones and zeroes of the electronic medium. People work and people inspect; they are not robots, programmed to perform the same task in the identically same way every time. Therefore, there will always be variations. The intent of analyzing these variations is to reduce them.

An important function of the site quality group is to maintain statistical records of the results of their inspections. Similar to measuring productivity for the purpose of increasing output, measuring quality is for the purpose of reducing defects. As an example, measuring the weld defect rate of the welders will identify which welder is experiencing unacceptable rates. Analogous to productivity, when a welder is making welds that are not acceptable, his productivity is sub-par, or put another way, unacceptable. The quality control inspector, when charged with the responsibility of tracking the reject rate of welders, is actually contributing to the management of jobsite productivity and the overall results of the project.

Let's look at the example in figure 8–1. This is a superheater and reheater replacement job with just over 1,000 2-in. welds to be made in eight days. It requires 40 welders working two 10-hour shifts with a productivity of three welds per shift, each, to complete the job per schedule. Also, let's assume a labor cost of $35.00 per man-hour.

Cost Impact of Weld Rejects

Required to meet schedule						
1065	welds					
8	days			133	welds per day	
2	shifts			67	welds per shift	
10	hours per shift					
3	manhours per weld			3	welds per welder per shift	
					requires	
				20	welders per shift	
					at	
			$	35.00	labor cost per one manhour equals	
			$	111,825	total labor cost, or	
			$	6,989	labor cost per shift	
Actual Results						
	Weld Reject Rate					
	0%	for		17	welders =	3 welds per welder per shift
	33%	for		3	welders =	2 welds per welder per shift
					totaling	
				63	average welds per shift with	
				17	shifts required for job completion equals	
				1	extra shifts required or	
			$	6,989	in labor cost overrun	

note: numbers not exact due to rounding

Fig. 8–1 Cost impact of weld rejects.

Now, let's say that through normal NDE inspection, three of these welders each have one weld rejected every day. If this were to go on for the total eight days of the job, the result would be the need to work one extra shift, which in the case of this example would add almost $7,000 to the job. However, by diligent analysis of statistics, the quality control inspector can bring this trend to the attention of the welders' supervisors who, in turn, can make a change—early—to avoid this trend continuing. If the change is made early enough, say after the second or third day, there's the chance that the extra shift won't be necessary and the job will have avoided this $7,000 adder. This is one way to avoid the cost of poor quality!

Summary

A shift is delayed here, a milestone is missed there. Was it because of a poor attitude that led to poor quality? Many times, it was. There is a quantifiable cost for poor quality. It goes far beyond just the cost of the repair. If it delays the job, there are concurrent overhead costs that can't be recovered for the contractor and there are revenues that can't be generated by the plant. If it triggers LDs, there may be penalties that wipe out any hope of the contractor making a profit. If it leads to warranty problems after the job is complete, both the plant and the contractor may incur major costs and downtime. Poor quality is costly.

Poor quality must be avoided. This requires strong commitment from the top. It requires a system of communications between all parties, the field, the site office, the home office, and any third parties such as the regulatory agencies. Since the management of quality is often perceived as an intrusion and a hindrance to productivity, managing a successful quality program necessitates people with good personnel management skills. The workers must be convinced to want to do a good job. Their supervisors must be made to understand that quality checks are good for the work. The right expectations must be communicated, and the tools required to do a quality job must be made available.

In the same manner, communications between the site and the home office support groups are important as well. For example, when the site depends upon the home office for arranging third-party inspections, this has to go off without a hitch because it's usually a stop-work hold point that can affect the schedule and even invoke LDs.

At the heart of the quality management program lie the policies and the plans. The policies are there to convey the intent of the organization with statements that spell out what management expects. The plans spell out the steps to be followed to achieve these expectations. They state how to measure for quality work, how to act when work is below expectations, and what to do to prevent recurrences. The site staff must understand both. They must be sure that the work meets the expectations stated in the policies and they must be sure that this has been proven by implementing the plans.

It is incumbent upon the top site management to organize a quality management group that can vouch for the quality of the work performed. The group must have qualified individuals, accustomed to working with power plant equipment. But if the job is broad, like a grass roots new plant project, then the group may also need skills in managing the quality of civil work, steel erection, and electrical work. Since a large part of the quality group's efforts can affect progress and the potential for warranty work, they can have a significant impact on the costs of the project, so understaffing in this area is not wise. The group acts as an insurance policy protecting against financial losses.

For the quality plan to be effective—to be in compliance with the quality policy that underlies the job—a verification system is generally required. This is the purpose of the audit process. It is there to provide independent verification that quality control plans are being implemented. Although sometimes viewed as an intrusion into the work at the site, this process actually lends credence to the work of the quality staff and ultimately, to the quality of the work performed by the craftsmen themselves.

There are many studies on the cost of nonconformances. They point to millions of dollars needlessly spent and an equal amount needlessly lost due to the inability to operate the plant. Included are delays associated with rectifying poor quality as the job is progressing. There are the costs of the rectifications themselves, but there are also the costs of lost revenue generation on the one hand and penalties on the other. Then there are the costs of latent defects, those warranty issues that only come to light after everyone has left the site. Those repairs and their associated downtime can be crippling. A good quality control program can help alleviate this. And a good program will also enhance production.

By measuring quality often and analyzing the results daily, trends can be observed. When these trends show that certain work continues to be below par, there is often time to make a change and save the day. The quality staff should be in constant communication with the front line supervisors, providing data and trend analysis to help them reduce nonconformances and increase productivity. Avoiding an extra shift or two by being proactive with the jobsite superintendents has a positive impact on productivity; it's the attitude of doing it right the first time.

References

[1] Juran, M., *Quality Control Handbook, 3rd edition*, New York: McGraw-Hill, 1974.

9

MANAGING SAFETY PERFORMANCE

Everywhere we look, every item we buy and every instruction we read has a safety warning label. The simplest of gadgets, like a small battery-operated calculator, comes with a half dozen safety bullets, similar to the following:

- Read and understand all instructions
- Keep all instructions
- Follow all warnings and instructions marked on the product
- Do not use this product near water
- Clean only with dry cloth
- Do not dispose of batteries in a fire

When the items become more complex, say a small electrical tool, we see additional warnings and the safety instructions become more explicit.

- Work Area
  - Keep work area clean and well lit.
  - Do not operate power tools in explosive atmospheres.
  - Keep bystanders, children, and visitors away while operating power tools.
- Electrical Safety
  - Double-insulated power tools are equipped with a polarized plug (one blade is wider than the other). This plug will fit in a polarized outlet only. Do not change the plug in any way.
  - Avoid body contact with grounded surfaces.
  - Don't expose power tools to rain or wet conditions.
  - Do not abuse the cord.
  - Use proper extension cord for outdoor use (marked "W-A" or "W").
- Personal Safety
  - Stay alert, watch what you are doing and use *common sense* when operating a power tool.
  - Do not use tool while tired or under the influence of drugs, alcohol, or medication.
  - Dress properly. Do not wear loose clothing or jewelry. Contain long hair.
  - Avoid accidental starting.
  - Do not over-reach and keep proper footing and balance.
  - Use safety equipment. Always wear eye protection.

- Tool Use and Care
  - Secure and support workpiece.
  - Use correct tool for intended application. Do not force tool. Disconnect plug before making adjustments
- Service
  - Tool service must be performed only by qualified repair personnel.

One can only imagine what safety warnings come with a major piece of construction equipment. So if individual gadgets, tools, and construction equipment have increasingly complex safety warnings, what should be written for a major power plant construction project? Certainly it will be complex.

But before we delve into the heart of construction safety, let's first look at these warnings; they're all about common sense. Years ago, these warnings did not exist. What changed? Did people lose their common sense? Not really. People changed their view of accepting responsibility. There has been a major shift from accepting responsibility for one's own actions to placing the blame on others for not preventing oneself from getting hurt. This shift has occurred throughout the social fabric of our current-day culture, encompassing everything from the simple gadgets to public services and on to major projects. Today, we are asking the corporate world to protect us from ourselves. Courts are passing judgments, and governments are passing legislation that the corporations must protect the individual and that the corporation's management may be held accountable. This boils down to equating safety with financial risk to the corporation and personal risk to its management. If the corporation does not do whatever may be necessary for the individual to safely use their product or service or to safely work in the corporation's plant and facilities, then the corporation will pay and its management may go to jail!

So, why all of the warning labels on products, or why all of the safety disclaimers for services, or why all of the emphasis on training and protective devices for workers on company property? Because companies do not want to have to spend money for losses resulting from failures to act or operate in a safe manner and their management does not want to go to jail. They know that the cheapest losses are the ones that will never happen. First, the responsible corporation of today will do what it can to make the individual aware of a potential danger. Second, the corporation of today will insulate the individual from a potential danger. Third, they will educate about potential dangers; and fourth, they will train the individual to avoid and/or protect themselves from the danger. They do it because it's all about the money.

The Financial Impact of Safety

Although ensuring that good safety is practiced is first and foremost a moral obligation for any corporation, the corporation is *encouraged* to ensure its employees practice good safety through measures that directly affect its profitability. These measures are varied. They go from the clearly visible medical costs of injuries to the insurance premiums that reflect injury frequencies. They go from the *hidden* costs of accidents to the loss of funds for corporate growth and improvement (fig. 9–1). The corporation is not the only one who loses. The workers themselves often also lose dollars—in addition to their misery, which cannot even begin to be quantified.

The Real Cost of Job Site Accidents

Visible Costs per OSHA Recordable		
Medical Costs	$	25,000
Insurance Premiums Increase of 6.0%	$	3,570
"Hidden" Costs per OSHA Recordable		
Lost Time Wages for one crew	$	1,800
Damage to Tools & Equipment	$	500
Decreased Workers' Efficiency of 10% for Half Day	$	1,320
Total, Per OSHA Recordable	$	32,190
Total for 100 OSHA Recordables	**$**	**3,219,000**
Loss of Business		***Priceless !***

Assumptions:
- Contractor with $200,000,000 annual revenues whose:
  - Average Labor Cost is $120,000,000 with 4,000 Workers
  - Average Annual Payroll is $85,000,000
  - Average work week is 40 hours @ $30 plus 10 hours @ $45
  - Workers' Comp Premium is 10% of payroll
- OSHA Recordable Rate of 7.7 which equals
  - 100 OSHA Recordable Accidents
- OSHA Recordable Accident Costs = 70% of Total Costs

Fig. 9–1 The real cost of jobsite accidents.

Determining the money spent for medical claims due to on-the-job injuries is a fairly straightforward process. Although costs vary greatly, depending on the nature of the injury, overall power plant construction injuries range from eye injuries costing several hundred dollars each to soft tissue injuries (injuries to the back, shoulder, or knees) costing $30,000 or more. An overall average insurance claim for all injuries incurred, taken from a variety of sources including contractors, utilities, and industry publications during the past five years, is in the neighborhood of $15,000 per injury. Obviously, there are contractors and owners who experience lower costs and there are others who experience double and triple these numbers. Also, these values represent medical costs only, not death-related payments, lost wages, or penalties imposed by regulatory agencies.

Insurance premiums are closely tied to these medical costs and accident rates. While referred to here as *insurance premiums,* the term also applies to those organizations that self-insure and are required to accrue the money that will be needed for payments in the future. If a company's accident rate increases, so will its premiums or accruals. Even though today's accident won't retroactively raise premiums, it will affect the rates in the future, which therefore increases the total cost impact of accidents.

The next cost category, the hidden cost of accidents, is not so easy to calculate; therefore, it is frequently overlooked. However, these costs are just as real and they definitely affect the performance of the work and the bottom line of the job (fig. 9–1). Some of these costs include the following:

- Time lost by the injured worker, the supervisor now attending to the worker, and the rest of the crew who gets involved in helping the injured, or just standing there watching.
- Damage to tools, equipment, and possibly installed materials.
- Inefficiency due to a temporary decrease in the morale of the total jobsite.

The cost of workplace accidents continues to spiral in ways almost impossible to calculate. For instance, using the example in figure 9–1, the contractor generating $200,000,000 per year in revenues, and experiencing 100 OSHA recordable accidents that year, has suddenly incurred a cost of more than $3 million, or 1.5% of annual revenues. This money could have been put to use in 1) safety training, 2) newer or better equipment for use by the workers, 3) hiring additional support staff, 4) providing additional payroll incentives or bonuses, or 5) returning more profits to the owners and investors. Or the contractor could have done some of each. Making these kinds of investments, with money available if the number of accidents were reduced, would probably return much more than a 1:1 ratio—something now not possible.

But the costs do not even stop with the lost opportunities for investment. If the accident results in an OSHA violation, there could be penalties that can range anywhere from a few hundred dollars to a million or more. If the accidents result in an increase in the experience modification rate (EMR), in addition to an increase in premiums, the contractor may also be subject to disqualification by utilities from bidding on future jobs. If the ultimate disaster occurs, the loss of life, the contractor could easily be told to leave the job and not return for a long, long time.

In summary, one must recognize that profit lost through injury to workers is not recoverable from an insurance policy—it is unrealized money!

Communicating

Communication is the primary and most important tool available for managing safety. Management must talk with the supervision. Supervision must talk with the workers. The workers must talk with each other and their supervisors, and the supervisors, in turn, must provide feedback to management. There should be training, demonstrations, and regular support sessions that include the plant personnel and the contractor personnel, and union management when their members are on-site.

But for the communications to be meaningful, they must be based on a specific set of rules or standards. It is important that everyone communicates in like fashion, that everyone talks the same language and that everyone follows the same plan. The best way for this to be accomplished is to develop a written safety program. Theodore Christensen of Liberty Mutual Loss Prevention[1] put it this way:

> *Everyone likes things in writing. It's a tangible guarantee that work will be done or rules will be followed. This is particularly true when it comes to developing and utilizing a consistent company safety program. Putting together a written safety program is a critical first step toward documenting company*

policies and procedures for accident-free construction, yet many contractors do not have one. It is much more than just a list of rigid work rules. Written safety programs are important because they delineate responsibilities and expectations for everyone. They also provide guidance for field supervisors so they can handle unexpected conditions. More importantly, a written safety program demonstrates a firm's commitment to ensuring employee welfare and building a better bottom line.

But communication goes beyond just the written program. It also encompasses the supervisors and the responsibilities they have for implementing the safety policies. It includes the employees and their responsibilities. It includes management and the responsibility they have for providing the written safety program and the training to enable everyone to work within its confines. There are the external agencies, such as OSHA and their inspectors who must be able to communicate with the parties being inspected. They must be able to discuss the latest legislated and administrated requirements that must be met on the jobsite and the governmental consequences of not being in compliance. If there are any special incentive programs for the workers or for the supervisors, these must be clearly communicated so the programs create their intended results.

However, the most influential manner of communicating is the direct one-on-one between the workers and between the workers and their supervisors. It is the responsibility of the supervisory staff to establish a teaming environment where workers will want to talk among themselves about safety issues and where they will also talk to their supervision about the same things. However, this requires that the supervisors have good interpersonal skills, something that is not always the case.

When supervision is short on interpersonal skills, it is their management's responsibility to provide them the training necessary to become good communicators. Ultimately, the supervisors must understand that the various parties involved in the project are individuals who have feelings that must be respected. It makes no difference if the individual is a first-time participant in the project or if he has been on-site many times before.

Policies and Programs

So what make a good written safety policy? The first step in answering this question should be to identify the stakeholders in a safety program and determine what they want and/or need. The first of these stakeholders is really the companies, both the owner/operator of the plant and also the contractor doing the work. Then, it's the workers themselves. But there are more. There is the insurance underwriter who has a stake in ensuring a good safety program exists. There are the external agencies and their inspectors, and there may well be the third-party public who also wants protection from the actions (or lack thereof) of the workers.

The owner/operator of the plant certainly has reasons to want an effective safety program. It's his power plant where the work is being done. He wants a reputation of providing a safe working environment. He wants consistency between his personnel and those of his contractors. Usually, his safety program will be the site *umbrella* program that everyone working on the site must abide by. It will include things like standardized lock-out/tag-out procedures for electrical work. It may require specific drug and alcohol testing of all workers on the site, regardless of employer. If the job is at a nuclear plant, the requirements may be even more rigid, and the federal government will be involved.

The contractors working in the power plant have numerous reasons to want a good, clearly written safety program. As already discussed, there's the simple fact of the economics of safety—a good program saves money. There are also the quality and efficiency factors that increase with the implementation of a well-written safety program—a safe environment engenders workers who produce more, more quickly, and more efficiently. There's the possibility of being barred from future work or even being removed from current work in the event of poor safety, especially if it is due to a poor program.

The workers themselves obviously want to go home just like they arrived—safe and sound of body and mind. They want to have a safe environment where there's no need to worry about falling objects, falling through unguarded openings, or falling from any height. However, they also want to know that their coworkers are looking out for them. They know that a simple act of carelessness can cause a fatal accident, like dropping a 2-lb hammer from 25 ft, which can cause a fatal skull fracture.

The insurance underwriters have a set of needs that should be included in any written safety program. First is an introductory page, signed by top management, which shows executive support for the program. Next is a demonstration of risk management beyond just employee injuries; the program should also cover potential damage to materials, tools and equipment, and protection for third parties. Then they want to see a defined set of periodic inspections that force attention to the program. They want to see a method of enforcement and empowerment that give the program the teeth, or strength, for providing a safe environment that will keep future accidents at bay, thereby reducing the amount the insurers may have to pay out.

The governmental agencies, especially OSHA, also have specific standards that most contractors must meet. These, too, should be included in any written program, along with an explanation of how to react when confronted by a visit from the OSHA inspector.

Written safety policy

Once the needs of the various stakeholders are ascertained, the task of preparing the written policy can begin. A good policy is often divided into the following eight parts:

1. A demonstration of management commitment
2. A description of required physical safeguards
3. A program of inspections
4. A training program
5. A description of required personal protective equipment (PPE)

6. A listing of the rules
7. A procedure for investigation and correction of infractions
8. A description of the lines of communications and responsibilities

The first part of the written policy should clearly demonstrate that top company management is 100% committed to enforcing the safety process. A clear statement must be written that management can use, in court if necessary, to show their intent. A statement such as "The prevention of injuries or illnesses will be given precedence over operating productivity" is a good start. A statement of goals and objectives is helpful since often *what gets measured gets done.* Also, responsibilities and lines of communications should be referenced since they hold the program together. Finally, management must be able to demonstrate that they are following their own guidelines and commitments by indicating some kind of personal involvement.

Parts 2–7 are the specifics that management expects to be addressed by the safety program itself. They should be included in the policy to ensure that the safety program itself addresses them in detail. The eighth part, a description of lines of communication and responsibilities, should address the interaction management expects between all parties. It should spell out that the employer accepts the responsibility for the leadership of the safety program and for its effectiveness and continuous improvement. It should spell out that the supervisors are responsible for ensuring all work is performed with the utmost regard for the safety and health of everyone involved. The employees' responsibilities should also be addressed by stating that they are responsible for complying with all of the rules and regulations of the safety program and that they are responsible for the continuation of a safe job.

Written safety program

It is not the aim of this book to address safety programs in detail. Each company, each organization within a company, and each employee within these organizations have different needs that a safety program must address. One program does not fit all. However, each program that is used during the construction activities at a power station does have certain similarities that can be grouped generically. Following are some of the key elements of an effective safety program:

- A definition of safety

  This could be something as simple as: "The control of recognized hazards to attain an acceptable level of risk by ensuring a safe and healthy work environment with the goal of eliminating all accidents and injuries."

- The objectives of the program

  These could be listed as follows:

  – Meet the moral obligation of protecting human resources
  – Control accident costs because they impact current and future business
  – Uphold the organization's reputation
  – Reduce the possibility of litigation
  – Reduce the possibility of penalties

- The philosophy of the program
  – All injuries must be prevented
  – Safety applies to *everyone*
  – Both employees *and* management must promote safety
  – Safety must be continuously improved

- Measuring the results

  Once again, the old adage of "what gets measured gets done" applies here. Typical measurements should include the following:

  – Daily inspections of the worksite with corrective actions taken and documented

- Periodic inspections by management
- Documented safety meetings
- Accurate injury statistics—a good cross section of categories are as follows:
  - Total claims
  - OSHA recordables
  - Lost workday claims
  - Soft tissue injuries
  - Eye injuries

- Pre-project planning

  Project management, design engineers, safety engineers, and site representatives should meet during the conceptual phase to review design parameters for establishing safety requirements that will result in meeting the objectives of the program. They should endeavor to:

  - Design to eliminate the hazard
  - Design to guard from the hazard
  - Ensure proper procedures will exist to train for dealing with the hazard
  - Specify personal protective equipment and actions if the hazard must be encountered

- Pre-mobilization planning
  - Qualify any proposed contractors before award
  - Perform a job hazard analysis
  - Establish a site safety coordinator
  - Establish a site safety council
  - Establish employee orientations

- Establish safety inspections and audits
- Establish procedures for accident *and* near-miss reporting and investigations
- Determine on-site medical facilities to be provided
- Establish emergency procedures
- Agree upon a housekeeping plan and responsibilities
- Establish a substance abuse program
- Decide on a rewards program

- Pre-task planning
  - Identify sequential project steps and associated hazards. Plan for and write into the work plan specific safety requirements such as personal protective equipment to be used, special barriers or other protective devices to be installed, and any specific training that may be required such as confined space training.
  - Ensure specific programs exist for handling project-specific hazards.
    - Hazard communication program
    - Blood-borne pathogens program
    - Substance abuse program
    - Confined space program
    - Respirator program
    - Arsenic program
    - Asbestos program
    - Cadmium program
    - Lead program
    - Vanadium program
    - Lock-out/tag-out procedure

- Hiring procedures

  Ensure consistent, legal policies are in place to evaluate employee capability against job difficulty. Require that a medical profile questionnaire be completed by every hired employee to avoid possible reoccurrence injuries as well as obtain information relative to high blood pressure, heart condition, and insect bites (as pills or kits may need to be located quickly in the event of an emergency).

- Training and orientation

  Go beyond generic programs and highlight site-specific conditions and requirements.

- Communications
  - Safety meetings
  - Tool box meetings
  - Project safety council meetings
  - Tripartite safety reviews (if applicable)
  - Posters and decals
  - Newsletters
  - Suggestion box
  - How to deal with language barriers

- Record keeping

  Determine the governmental, client, and corporate requirements for keeping records, especially those that must be visibly posted and those that must be maintained after the close of the project. Accurate records assist management in maintaining a superior safety program.

Managing the Process

Seldom are power plant construction projects totally self-performed. The owner/operator contracts a GC. The GC contracts other major contractors, and they, in turn, subcontract specialty work. There's often a multi-level tier of contractors that will all be working on the same site, often on the same project, and at the same time. It's a formula for disaster—if not tempered with diligent planning and structured cooperation.

As already discussed, there's a lot at stake when safety is not properly managed. The owner can lose, the contractors can lose, and employees can suffer serious injuries and die! When there are multiple levels of contractors, each with its own set of goals, rules and responsibilities, the task to maintain a workable safety program can be daunting. How does the owner get its mandates imposed? How does the GC satisfy his client? How does he satisfy his own, internal demands? How does he ensure that the contractors below him stay in compliance with 1) the owner's requirements, 2) his company's demands, and 3) still satisfy their own internal requirements? What about the lower tier subs? They must work in compliance with the rules from all of the above. It's a delicate juggling act, but one that can be accomplished, successfully, if designed at the outset and enforced during execution.

From the owner/plant operator on down to each respective level, there are certain protocols that, if followed, will increase the likelihood of a cohesive site safety plan, whether the job is a three-year green field construction project or just a two-week emergency plant turnaround. In general, five distinct, interrelated but separate processes are involved: prequalification, selection, pre-job activities, work-in-progress activities, and evaluations (see fig. 9–2). Since so much hinges on the successful integration of the safety operations of all contracting tiers, from life savings to monetary savings to corporate survivals, it is important to review them.

Fig. 9–2 Contractor safety management process.

Prequalification

As when determining how to structure safety policies and programs, stakeholder requirements must be understood. They must be spelled out and prioritized. They must include the requirements of all of the stakeholders *up the ladder* and often they must include the needs and requirements of others such as governmental agencies and special public demands. Once they are determined, these requirements should form the basis for a contractor prequalification questionnaire. This questionnaire should be the same for every tier of contractor to avoid misinterpretation of priorities once the job is underway. As a minimum, all tiers should be requesting the following information from their contractors and subs:

- Organizational hierarchy and authority
- Company work history
- Safety and health performance statistics including OSHA recordables and EMR for at least the past three years

- Regulatory (OSHA, Environmental Protection Agency [EPA], etc.) citations for the past three years
- Safety and health policies and programs
- Substance abuse program
- Insurance carriers and limits
- Safety and health training and evidence of use

Once the questionnaire is complete and satisfies the requirements of all of the stakeholders, it should be sent to all contractors that are interested in working on projects with the purchaser. They should be encouraged to complete the questionnaire in its entirety and also submit any additional information they feel will help the decision makers. Upon receipt of the completed questionnaires, they should be reviewed and any questionable information should be clarified and/or verified. With this information now available, an evaluation can be made by comparing the information provided with the internal requirements of the company. This will then generate a list of safety *prequalified* contractors for consideration when planning future jobs.

Finally, it is important to ask all of these prequalified contractors to update their information annually. This is especially important for safety and health performance statistics and for regulatory citations. Also, the insurance information should be updated and the evidence of training should be provided every year.

Contractor selection

Once the prequalification process has been completed and questionnaires sent out and received back and evaluated, a list will be available for use in selecting which contractors will be invited to bid. Then a selection process must be developed that will determine which contractors are suitable for what projects. Not all contractors will be suitable for every type of job; one major differentiator in the power industry is fossil or hydro work vs. nuclear projects.

After determining which contractors are prequalified, the business needs of the purchaser enter into who is short-listed to bid. The purchaser should prepare a bid specification that clearly spells out any specific safety requirements and any special conditions such as unusual hazards that may be encountered on the job. This could be specifics about existing or suspected asbestos, it could be cautions about underground utilities, it could be warnings of expected vanadium on boiler tubes or arsenic in the fly ash, and it could be information related to ambient conditions such as high noise areas. Those contractors that are on the approved list of suppliers should then be interviewed to establish their ability to meet all of the unique requirements of the job specifications and those that meet the required criteria would then be selected to be asked to bid.

At this point, a pre-bid meeting will usually be held, with all of the potential bidders attending. At this meeting, all of the known and potential safety hazards should be discussed. The contractors should all be encouraged to ask questions and express any of their concerns. They should be told what the purchaser will be providing in the way of safety protections and they should be told what they must price and provide. For example, if the owner or GC is providing first aid facilities and/or an on-site nurse or ambulance, this should be clarified. If there is to be any cost sharing of these services, this information should be made clear during the pre-bid meeting so the contractors can prepare their quotations accordingly.

After detailed bidding and negotiations, which at this point are more focused on technical and commercial issues, the safety element should be reevaluated to ensure that compliance to the original requirements will still be met. If all is in order, a contractor can then be selected and an award made.

Pre-job activities

With the contractor selection process completed, planning the job can begin. Issues such as site orientation, site-specific safety plans, site work plans, and training and compliance reporting need to be addressed. All parties should reconfirm who has the responsibility to provide which of the required safety services such as first aid, ambulance, nurses, etc. As with the contractor selection process, a lot of effort is required to properly plan for a safe and effective job—one that will allow the workers to go home the way they came to work, safe and sound. A cost-benefit process should be used, but it should not be used with the cost of the *actions* taken or the equipment purchased to implement a specific safety requirement. Rather, it should be used with the potential cost of *not* taking the action or *not* purchasing the equipment. In essence, these are the costs that could be encountered when luck is not on the side of the worker.

The first step for all parties that will be involved in the project should be a thorough familiarization with the proposed site location, whether a grass roots location or an operating plant. The owner's rules and requirements should be clearly identified. This could mean that certain areas will be off limits to workers during specific times of the day. It could mean that all personnel must be familiar with a particular emergency warning siren and the specific routes to be used in the event of an emergency. It may be that the owner is providing the workers' compensation insurance, and therefore any injured worker has to follow a unique procedure for treatment (more on this later).

Next would be a discussion of the actual planning of the work. **Planning safety into a project is just as important as setting production schedules and planning for the delivery of equipment and materials.** There is no substitute for thorough pre-task safety planning. Each step of each contractor's proposed work plan should have a safety element that addresses anticipated hazards and how to eliminate or guard against them.

For example, when preparing to lift heavy equipment such as a waterwall panel or a boiler steam drum, the rigging and lifting work plan should include steps such as the following:

- Third-party review of the lifting calculations
- Confirmation of the weights involved in the lift
- Inspection of the lifting equipment (crane, tuggers, or jacks)
- Inspection of the wire rope for size and wear
- Clearance of the lifting path—*e.g.*, no structural steel in the path of the lift
- Clearance of area from any nonauthorized personnel

Similar to an airplane pilot always going through his checklist, not following these procedures could have catastrophic consequences. Not having a third-party review of the lifting/rigging calculations can be disastrous. Notice the severely bent spreader beam at the top of the photo in figure 9–3. Fortunately, the only result is the bent panel. There were people standing nearby, and if the rigging had snapped, someone easily could have been injured.

Fig. 9–3 Bent spreader beam.
Courtesy of Construction Business Associates, LLC

In the photo in figure 9–4, where a boiler steam drum is being raised, the area below the lifting operations is designated as *off limits* with barricade tape to keep people out. This is a double protection so that if the lifting cable snapped during the lift, there would be less chance of injury to personnel. However, if the cable snapped and the drum fell back down, there would still be major problems for the whole site. First, there would be the cost of repairing any damage to the drum, lifting equipment, and any areas involved. Then re-rigging and raising the drum again would double the cost of that activity. There would be the lost time and lost productivity. Finally, there would be a mood change with the workers wondering why basic safety issues were not being addressed.

Fig. 9–4 Site safety barricade tape.
Courtesy of Foster Wheeler Corp.

Finally, as part of the pre-job activities, safety training should be established. Most projects will require an initial site-specific orientation for each and every worker that comes on-site, sometimes lasting four hours. Some sites also require that before even being allowed on-site, each person, whether they are workers, supervisors, or outside managers, must have successfully completed a 10-hour OSHA safety course. Then there may be specific situations that require additional training, such as confined space access, forklift truck operations, fire watch, hazardous material handling, and so forth. All of these requirements should be reviewed prior to the actual start of the work.

Work in progress

Once the site work starts, continual monitoring by management of the safety process is very important. Contractors must monitor themselves, and owners and their GCs must monitor the contractors below them. There should be specific reporting requirements stipulated in the contract, that every level of contractor on-site should be following, in addition to the regulatory OSHA requirements. Regular inspections should be made and documented by the contractor performing the work as well as by higher tier contractors and the owner. In addition to individual contractor daily inspections, a weekly composite inspection conducted by the owner or GC is useful as the different parties can see, first-hand, their impact upon one another.

As part of the inspection process, conformance to policies and procedures should be verified. If a contractor's procedure requires a medical profile of every employee on the job, verify that this is being properly reviewed, noted, and filed as required. If every employee is required to obtain and read an employee safety handbook, it should be verified that everyone has received and read one. Verification of foreman and supervisor training should be available along with all training records and certificates. A spot check of the correct use of the substance abuse procedures should be done, and a regular review of the accident reporting process should also be performed.

In the unfortunate event of an accident, it is extremely important to immediately investigate the issues surrounding the incident. There should be a standard format for this investigation, and it must have enough information to satisfy the contractual requirements of the job, the internal requirements of the contractor, and the regulatory requirements of OSHA or the EPA. But in addition to these and other standard requirements, a section should be included in this accident investigation procedure to (a) describe what actions could have been taken to prevent the accident and (b) what action is recommended to prevent a reoccurrence of the incident.

As part of the work-in-progress safety management and resultant cost control, regular reporting of safety walk-downs, specific inspections, and accident investigations are a necessity. Owners and GCs should always keep detailed records of what their contractors are and are not doing. This will help in identifying issues that are unique to the site, in time to correct them before an accident occurs. It will also be helpful for updating their contractor prequalification records, in support of the next project.

For the contractors actually employing the workers, regular reports beyond just the regulatory OSHA logs should also be maintained. These reports should be designed in a way that they can be used to trend safety results with the intent of managing trends. In other words, since often only "what gets measured gets done," if safety trends are correctly measured, they can be managed.

Finally, every jobsite should be prepared for emergency evacuations, especially in an already operating plant. When an emergency occurs, whether it's a weather-related event such as a tornado or whether it's an earthquake, a riot, a coal bunker explosion, or a steam or gas line rupture, the people working in the area must know what to do and where to go. Predetermined exit routes should be established by the owner and explained to all employees on-site. This should be done during the site orientation and repeated at least monthly during safety meetings.

Evaluation

The final step in managing the safety process is a closing of the safety management loop (fig. 9–2). The loop started with the prequalification of contractors, it went on to their selection, then followed with a pre-job activity phase, followed by a work-in-progress step, and now must be closed with the evaluation of the previously selected contractors.

If the proper records have been kept, updated, and evaluated for performance management, then the information exists to evaluate the contractors on their safety performance during the execution of the work. Depending on the criteria selected by the principals, each contractor can be compared to the standards required of him, and he can also be evaluated against the commitments he made in his safety policies and programs. Records of site visits by his management can be used to determine their commitment to safety. If problems were encountered, their responses can be used to gauge the depth of their seriousness. This, then, would be the criterion used for the next round of prequalification evaluations.

Some Options

So far, most of this chapter has been devoted to the *traditional* way of working with safety. But that does not mean these are the only ways to manage the process. Today, the construction industry in general and the power plant construction industry in particular, have reached a plateau in the quest to reduce safety incidences. Great strides were made during the past decade with some companies reducing their OSHA recordable incidences by factors of 25% or more, *annually*. However, there comes that point when reducing by percentages no longer is realistic. For example, if a contractor has two recordable injuries in a calendar year, reducing this by 25% is not possible; it must be either 50% or 100%. Using the old method of the *carrot and stick* will not work when striving for reductions of 50 or 100% at a time. Different methods are needed. The ones that follow are not necessarily new in concept, but they have yet to be embraced by all of the industry. Maybe that will change as more and more emphasis continues to be placed on managing the costs of the power plant construction process. As has been noted by various members of the industry's management, enhancing a company's safety performance will reduce costs and improve profitability.

OCIP

When a power plant owner decides that the cost of the construction work at the plant or jobsite needs a dramatic reduction, one of the most effective ways he has of doing so is to remove risks from the contractors and take them on directly. This is what happens when the owner takes over the insurance responsibilities for a construction project, something usually referred to as an owner-controlled insurance program (OCIP). By doing so, the costs of the insurance no longer reside with the contractors; the owner assumes them directly, often at a reduced rate, since they are usually spread across a larger base. However, what insurances would the owner want to control? Depending on the propensity for assuming (and managing) risk, they could be any of the following:

- General liability

  This includes coverage for equipment and property damage, personal injury, third-party involvement, products, and completed operations and employer's liability coverage.

- Excess general liability

  This provides coverage in excess of the limits of the typical general liability policy.

- Professional errors and omissions liability

  This provides coverage for negligent acts, errors, or omissions by those contractors whose scope of work includes providing design and other professional services.

- Pollution Liability

  This provides coverage for liability arising from pollution releases during construction work.

- Builder's Risk

  This usually provides coverage under an *all risks* format for physical loss or damage to the work or any part thereof, generally also including floods and earthquakes. However, it frequently excludes coverage for loss to materials not being incorporated into the project as well as excluding coverage for the tools and equipment being used on the project.

- Workers' Compensation

  This is the coverage required in the event a worker sustains injuries related to that worker's performance on the project. Not all owners that provide project-wide insurances elect to provide workers' compensation coverage for the project.

The cost savings to the owner when implementing an OCIP varies. Depending on the coverages elected, it varies by job size and duration, by the job scopes involved, and depending on the track record of the owner in managing risks and on the contractor's history of risk control. However, a study performed by the author in the late 1990s while working at a Midwest utility showed that providing coverage for just the workers' compensation component of a series of plant renovation projects removed $5 per man-hour for each and every man-hour worked by the contractors that were selected to participate in the program.

Not all contractors were selected to participate because some contractors' work scopes involved work that had a very high risk associated with it, like asbestos abatement and scaffold erection and dismantling. But for the utility, removing $5 of cost for every man-hour the selected contractors worked added up to significant savings. Some of these savings were then used by the utility (owner) to manage safety performance across a multitude of plant sites. The accidents that did occur cost on the average of $3,000 each, but were very rare due to the active participation of the utility and all of its contractors in managing the safety process. As insurance rates continue to increase, this may be one of the most cost-effective ways to curtail construction costs, provided that the owner can manage the process.

For the work performed at these sites, several specific actions were taken by the owner. First, a rigid contractor prequalification and selection process was used. Then, safety teams were formed with the power station operating personnel integrated into these safety teams. The local union leadership was also included in all safety meetings and inspections. This afforded all parties to see the impact they were having on each other and fostered a team spirit that essentially eliminated finger pointing.

In addition to these moves, the owner also provided full-time on-site construction-trained nurses. Their responsibilities included collecting and processing the drug testing samples of all of the workers when they first came on-site, during random testing, and in the event of an accident. They were also responsible to attend to any and all incidences of injury and if necessary, arrange off-site medical attention. They were also asked to be responsible for site-specific safety campaigns, including publishing weekly safety letters and providing attention-getting safety posters.

Owner management also took a heightened interest in how the safety process was being managed since the risk of the program was now squarely on their shoulders. They visited the worksite frequently; they interacted with the workers, the supervisors, and the safety teams; and they arranged special forums to demonstrate to all of the participants that the owner was *very interested* in having a safe and healthful project, for all. The bottom line result was a positive monetary savings for the owner, when measured against previous projects, and a significant reduction in the OSHA recordable rates for the project overall and for the participating contractors as well. Not only did the owner win but so did the contractors.

Behavioral-based safety

No discussion of safety would be complete today without discussing behavioral-based safety. In a nutshell, the principle of behavioral-based safety is to get the workers to take responsibility for themselves by fostering an attitude of safe practices. The emphasis is shifted from focusing on incidences that have happened to incidences that were avoided; *i.e.*, always perform in a safe manner—be proactive.

Behavioral-based safety is a process that is designed to make the workers aware that *they* are the first line of defense for their own safety. Its underlying tenet is that the root cause of unsafe behaviors is that individuals' attitudes, beliefs, and values place time, comfort, and convenience ahead of safety. The belief is that there are two basic types of behavior that cause accidents.

1. Unconscious behaviors which are characterized by daydreaming, inattention, and repetitive tasks
2. Conscious or deliberate behaviors which are characterized by taking shortcuts or exhibiting other risky behavior

Behavioral-based safety programs are not easy to implement. Their underlying premise is that attitudes must be changed, and then these attitudes must be constantly reinforced. This takes time, and many power plant outage jobs are not long in duration. Usually, when the craftsmen arrive at the jobsite, they are immediately assigned to specific tasks with the weight of a ticking clock or schedule bearing down on them. Time is usually of the essence, and unless the job is a long-term new construction project, no one wants to take the time to assess workers' attitudes, indoctrinate them into a new mind-set and then constantly monitor their behaviors. However, to escape from the plateau where many contractors (and often owners as well) have been working, this attitude has to be revised.

Behavioral-based safety, as the name suggests, is a system of reinforcing good safety habits, as opposed to the standard system of measuring bad safety results and implementing procedures to reduce the statistics. A typical method of reinforcing good safety habits is to develop a list of observable behaviors that can be tracked and trended. For example, a typical list might include the following:

- Wearing hard hats
- Wearing safety glasses
- Using face shields
- Using burning goggles
- Wearing hearing protection
- Wearing safety harnesses

The employees are then observed, maybe twice per shift, and their behavior is recorded—how many were wearing or using these protection devices and how many were not. This data is then presented as a percentage of safe acts with the target being to reach 100%. The goal is to have everyone focus on safe acts by providing feedback to them of their safe behaviors.

The old method of continuing to focus on unsafe acts, loses its effectiveness once there are fewer unsafe acts to record, and with fewer acts to record, there is less data for feedback. Less feedback, then, means less focus, and less focus evolves to less effort to go beyond the plateau.

The ideal approach to implementing behavioral-based safety is to start long before the site work actually begins. Workers' attitude assessment and behavior modification training should start some weeks or months before they reach the jobsite. With a unionized work force, or with a permanent plant team, training could be planned and implemented in a manner to coincide with the start of the project. Then the project would serve as a continuing training ground. Although this approach appears to ask the parties to spend money for safety training before the site work even begins, this should be balanced against the reduction of the cost of safety incidences that will occur once the work begins; it should be viewed as the *cost of avoiding costs* that could be incurred by continuing to use the old methods.

When it is not feasible to start the attitude assessment and behavior modification before a job begins, there are still ways to implement this process. There are various studies that show that 80% of workplace injuries result from the actions (or inactions) of 20% of the workers. This suggests that by focusing on those 20%, first and foremost, the majority of the unsafe behaviors usually found on the jobsite can be arrested and revised before they turn into accidents.

For instance, the previously discussed safe habit monitoring could be increased to every two hours for the first day or two of the job. Very likely, there will be some workers who will be found not using their PPE. These specific individuals could then be targeted for closer observance than the remaining workforce, and they could also be singled out for additional safety training and behavior modification.

Let's look at an example. Figure 9–5 is a representation of potential safety behaviors and their related costs superimposed on a *behavior* scale. The bottom half of the chart depicts typical unsafe behaviors and the potential costs to the organization. For instance, not wearing safety glasses could cost anywhere from nothing up to $10,000, depending on the severity of the accident that would have been avoided had the proper glasses been worn. The middle of the negative behavior scale suggests that costs of $100,000–500,000 could be incurred if a worker neglects to fix an unsafe area, such as replacing a piece of grating that he sees has been removed by someone else. Then there's the drastic bottom end of the scale, showing the potential disaster that can result if a worker neglects to lock-out a piece of equipment before working on it—*death*.

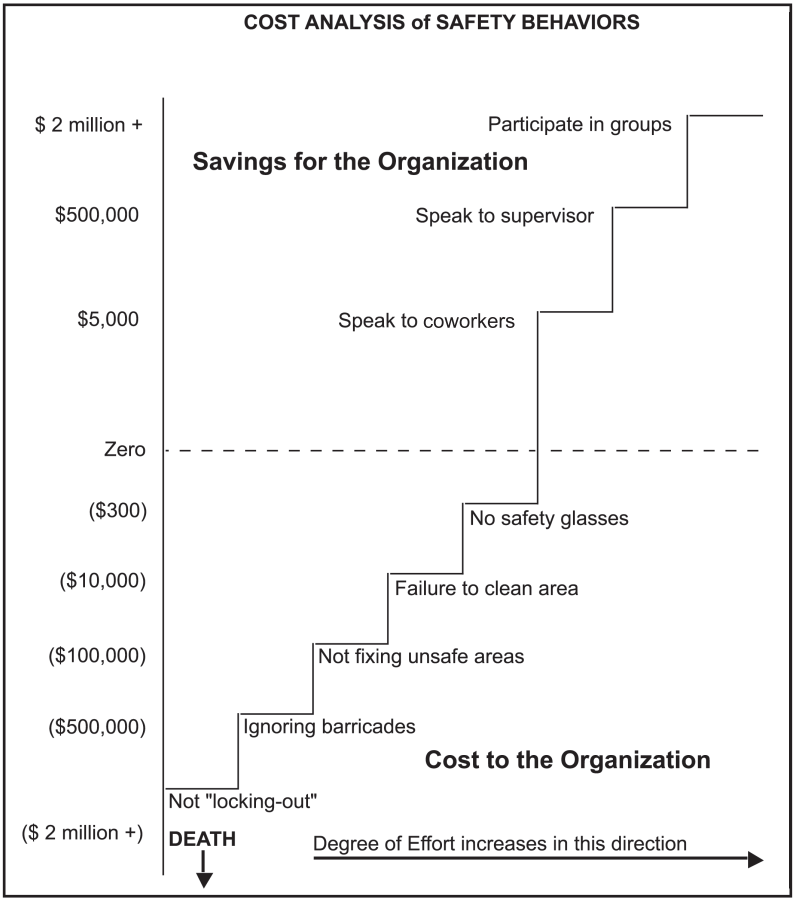

Fig. 9–5 Cost analysis of safety behaviors.
Courtesy of Construction Business Associates, LLC

But what about changing attitudes? With appropriate attitude adjustments, behaviors change. The upper half of the scale demonstrates cost avoidance (or job savings) that could be expected when positive behaviors are demonstrated. In the case of this example, a worker speaking to his coworker, suggesting that he use burning goggles could result in avoiding safety-related costs of up to $5,000. By speaking to a supervisor about unsafe situations, such as noticing that a handrail is missing or that a rigging cable is frayed could avoid major safety related costs, possibly up to a $500,000. Finally, the sky is the limit when it comes to cost avoidance resulting from group discussions—it's the old adage of two heads are better than one. Group discussions can take place during safety meetings, during lunch breaks, during training sessions, and even when off the job. The key here: *communicate*.

However, to reinforce this positive safety behavior, some type of measuring system must be developed. Contrary to the typical system used for tracking bad safety habits, this system must focus on good safety habits. The idea is that feedback and recognition of positive safety behavior will feed upon itself and create a snowball effect of working in a safe manner.

Zero injuries

One of the elusive goals of all construction safety managers has been: how do we have zero injuries? The implication is that by eliminating all *at-risk-behavior,* zero injuries will result. There certainly are organizations that go for an entire year with not one single injury, however, most companies still follow the mantra of comparing themselves with the industry *averages,* whatever they are. The industry averages, of course, are derived from a pool of the results of many companies that can range anywhere from very high numbers to the elusive *zero*. So when comparing a company average to the industry average, it is not possible to determine who is a consistent *zero injury* company and who is not—it's not even possible to determine who is a good safety risk. It is only possible to say that the numerical average of a company's safety results is better (or worse) than that of its competitors—whatever that means.

So the concept of zero injuries is often talked about but seldom pursued, even though there are some organizations that achieve it regularly. Why is that? Why settle for the average? Why not emulate the best? There is research that suggests that the return on investment for implementing a zero injury process can be as high as 300%!

Similar to the previous behavior-based safety philosophy, zero injury-based safety program management requires a change in culture. It requires a change in the thinking of management and employees. It requires a change in the belief that injuries are inevitable; it requires a belief that although injuries do occur, this does not mean that they must occur! It requires a major training effort to reprogram the thought process of most of the employees as well as their managers.

One of the obstacles in attempting to instill a zero injury concept into the thought process of management is the old numbers game. Numerical goals are set that challenge the previous reporting period, but these goals are still numbers higher than zero. Another obstacle is the belief that zero injuries are impossible; but again, there are organizations that achieve this, although not many. Then there are those who say that the companies with the low numbers, or the zero rates are just plainly manipulating the statistics—saying that figures can lie and liars can figure. The zero injury concept says that setting goals of anything more than zero sends the message that *some* injuries are acceptable!

Research has shown that there is always something else, or something more, that can be done to be safer. Sometimes it's mechanical, such as additional guards on a piece of machinery or barricading certain areas. But other times, it's a process of training, of educating the workers to think safety *all of the time*. Maybe the time to start is today. One often hears that zero injuries are impossible, but one only needs to stop and think: zero injuries are impossible over what period of time? Did an injury occur today? If not, then maybe the approach should be to simply repeat today's actions tomorrow and after tomorrow and on and on.

Another way to approach the skeptics of zero injury goals: start a project by saying that there's a new program to significantly reduce injuries on the job, let's say only two OSHA recordables will be allowed. Then look at the skeptics and ask them which two workers should be assigned to be the injured parties, and have them go and tell those two workers that they're it, they've been targeted as the sacrificial goats.

The zero injury concept requires a commitment to be willing to sacrifice other project goals in favor of safety. Schedules may have to be compromised and productivity may take a hit, but when doing the math, working safely is usually the more cost-effective approach. One only has to run the numbers to see what a serious injury or death would cost vs. some LDs for delays or some additional staffing to countermand productivity issues. Safety must become a core value within the organization for zero injuries to be a reality. Once it becomes a core value, it *will* contribute to the bottom line of the organization.

But what needs to be done at a site level to support a zero injury process? Often, not much different from what is always done, including the following:

- Pre-job activities, as described previously
- Safety orientation *and training*
- Written safety policies, as discussed earlier
- Written safety programs, so everyone is following the same process
- Worker involvement, including the family
- A constant reminder, such as awards, free lunches, or incentive programs
- Substance abuse programs
- Accident investigations, including near misses

But most of all —

- Demonstrated commitment to safety by top management

The site management must mirror top management's position that the company has a commitment to zero injuries. There will be no safety goals other than the number zero. There will not be any comparisons to anyone else. There will be just one simple measurement—there were injuries or there were not—no more, no less. To succeed, there must be a complete devotion to the elimination of unsafe behaviors by all—workers, supervisors, and management.

However, care must be taken that when zero injuries are reported, zero injuries are actually sustained. It is common for employees to rally behind a corporate cause solely because it is expected, even though not realized. Employees may hide some injuries, and this is not the intent of the program. Hiding injuries does not translate to better productivity, it does the exact opposite—the worker is now less productive and the intended cost savings are not realized. When working toward a zero injury result, any injuries that do occur must be acknowledged so the cause of the injury can be investigated and rectified; else it will happen again and again, negating the whole process. The zero injury safety process is powerful, when properly implemented.

A final word about hiding injuries: if an injury, no matter how minor, is not reported immediately, and later it develops into something more serious, the insurance carrier may refuse payment for medical and/or compensation costs. For example, a minor contusion injury to the neck or shoulder is not reported. Weeks later, it develops into a blood clot that requires hospitalization and surgery. These costs would be denied by the insurance carrier because there is no record of the injury that led to the blood clot. Even if fellow employees insist that they witnessed the incident, since there is no official record of the injury occurring, no payment will be made. How can the insurance carrier be sure the incident did not happen while the employee was *away* from the job, unless there's a record *on* the job?

Workers' compensation fraud

All site management, the supervisors and the foremen, should understand the workers' compensation law and how much a continuing claim can cost the company. Since the supervisors are usually the managers who have the closest working relationship with the workers, their support is key to making the process work. In the event of an injury, the supervisor should get in touch with the employees and their attending physicians. They should let them know how much everyone looks forward to their return and how valued their contribution is.

The supervisor should talk with the physician and ask for the employee to be released for alternate duties as soon as possible, and to advise which tasks are not suitable for the employee to perform. Preferably, the employees should be returned to their original job but maybe with restrictions on their activities. Otherwise, an alternative job should be found. Either way, the workers should be returned to duty as soon as possible and their job assignment should be upgraded as they recover.

Managing the return-to-work process should not be the duty of one individual supervisor; it should be shared among the supervisory team. Often it should be done in concert with the insurance company; they usually have lots of experience in managing a worker to full recovery. The process should be regarded as a financial management challenge, a challenge of getting the maximum productivity from the employee while keeping the medical expenses to a minimum. This requires close communication between the employees, the supervisors, the physicians, and the insurer.

However, an unpleasant but realistic possibility must always be considered—the possibility of fraud. Fraudulent workers' compensation claims occur. Claims even though the worker was not injured on the job, claims where the injury is only an aggravation of a previous ailment, and claims where the severity of the injury is exaggerated are not uncommon. These kinds of claims are very costly to the insurance and construction industries. Fortunately, there are certain employee behaviors the site supervision can use as indicators to monitor for the possibility of fraud, including the following:

- Disgruntled, facing firing or lay-off
- Short-term employment history
- Experiencing financial difficulties
- Early Monday or late Friday injuries
- Un-witnessed injuries
- Details of accident are vague
- After the injury, the employee is seldom home

Good communication between the supervisors and the worker and between the worker and the worker's peers will usually ferret out these issues that can then be addressed with the worker and the insurance carrier. It is important that all alleged injuries be challenged; insurance carriers employ investigators for just this reason. Since fraudulent claims are usually high-dollar claims, if they are not dealt with promptly and properly, they could go on for years.

Summary

Accidents result in unrealized profits. There are the direct costs, there are the hidden costs, and there are the costs of lost business. There are also the possibilities of damaged worker morale, regulatory penalties, and jail time for the executives. None of these costs are recoverable through an insurance policy.

The first line of defense against jobsite accidents is proper communication. The needs of the stakeholders must be communicated to the organization, which in turn then puts these needs into written policies. From the written policies, written safety programs can be developed and these programs can then be used as tools to manage the safety process.

Power plant construction projects are not self-performed. There are many parties involved and this requires a coordinated process for managing safety. First, there must be a process to prequalify contractors. Second, a selection process must be established to ensure that only the *right* contractors are given the opportunity to bid for work. Third, once contractors have been selected to participate in the project, the pre-job planning can begin. The fourth step in the process is for everyone—contractors and owners—to monitor and manage the work-in-progress activities toward achieving the results established for the project. Finally, the fifth step is the post-mortem evaluation of the various contractors and determining if they should be allowed to participate in future projects.

Everyone should think safety every time a job is started. The safety equipment that is provided must be used. Questions should be asked, and the workers should be encouraged to ask if there is any uncertainty regarding the safe way to perform the work or how to use the safety equipment. Owners, contractors, and workers must make the safety program the best that it can be. An effective safety program is one of the best methods a business can use to stem the profit drain from equipment damage, personal injuries, and associated litigation.

There are various ways to approach the management of jobsite safety. In addition to the standard method of using a carrot and stick to reduce accident statistics, there are programs such as the OCIP where the owner assumes the risk for managing the site safety program. Then contractors do not add the costs of insuring these risks to their contracts. There are behavior-focused programs, like the behavior-based safety program that shifts the focus away from the number of accidents and toward the number of positive safety behaviors or acts. There are programs that do away with scrutinizing standard statistics like OSHA recordables, lost work day injuries, etc. Instead, they only focus on achieving zero accidents; no other measurement has meaning. With the industry safety performance having neared a plateau at many organizations, less traditional approaches toward managing safety must be considered, and these are some options.

Owners and contractors must spend time relating the cost avoidance of good safety management to the bottom line of the company. There are many, many ways to manage the safety process of any power plant construction project, but whatever method is used, it should be one that will drive down the potential cost of faulty safety actions. Working safe and generating profits go hand in hand. Anything less is simply a poor method of management.

References

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10

MANAGING THE FINANCIALS

Today, it's all about the money. Managing the construction activities of a power plant project requires more than it did in the past. Many of the plants that are running today are running for one reason only: to generate revenues that will flow to their owners and investors. Just look at today's energy-related news media. Article after article talks about power generation assets being sold, sometimes for just cents on the dollar, or projects being stopped before completion, or mothballed, many with no return on the investment, strictly because the first rule of the industry is no longer the one that says "reliable energy generation at any cost." Today, power generation facilities are built and maintained to generate power for sale at prices that will net the investor a tidy return. This mind-set affects the construction of any of the power plants being built or the construction efforts of any of the power plants being overhauled. If the investor feels that the cost to complete the plant or the cost to rehabilitate it will reduce the return on his investment below a precalculated level, the project will be cancelled.

Therefore, if a project has survived through all of its stages to finally reach the construction phase, it is extremely important that this remaining phase be scrupulously and financially managed. Many excellent site construction managers, those with many, many years of experience building some of the largest plants in the world, are not accustomed to managing the finances of the site work to the standards demanded today. Yes, they understand about man-hour control, and they understand how to watch over the costs of supervision and tools. But many do not have the experience to be able to predict the outcome of the finances in time to a) notify their management of impending issues before they become major and b) take preemptive actions to jolt a poorly trending job out of its doldrums.

However, the first step for everyone is to become aware of the *need* for managing the financials of the construction process, as opposed to just reporting them. This ranges from the usual reporting that provides an indication of how the money has been spent vs. how it was planned to be spent all the way to predicting how the finances will look once the work is complete. The plant stakeholders of today want this information, not only periodically, but also instantaneously. They want this information to be able to make financial decisions in time to protect or enhance their investments.

These investors are not usually looking for a way to shed their investments, they usually want to maintain or increase their return on them. This is where good financial management of the construction phase can have a significant impact. By accurately tracking the costs of the work-in-progress, by actively predicting the cost-to-complete and by having this data available instantaneously, these owners and investors will have the data they need, when they need it, to make their financial decisions.

What's Needed to Manage the Risks?

Control of the job's finances is the single most important administrative function to be performed yet it is often given only cursory attention at the jobsite. This is generally due to two factors a) the lack of understanding financial management and b) the lack of time for doing financial management. Many of today's jobsite managers and superintendents came up through the ranks, often starting their career working as a construction craftsman. They seldom, if ever, had formal schooling to learn the art of financial management. They were seldom, if ever, exposed to the need to know and understand how the numbers were used by the accountants and by the management that periodically visited the jobsite. The others, although often college graduates with some understanding of financial management, are often untrained in the importance that financial management has in the construction environment.

By the time the former group of current-day managers and superintendents started rising through the ranks of construction management organizations, they gravitated toward what they knew best, what they were comfortable with, and that was planning the work and running the labor in the field. Because of this, they seldom, if ever, had the time to look at financial reports, let alone try to understand them, evaluate what's needed to manage the risk, and use this in their decision-making process. They were constantly looking for ways to maximize the productivity of the craftsmen under their jurisdiction. They were always *putting out fires* by focusing their attention from one emergency to another, and this left them with very little time to learn, let alone understand and use the financial management systems needed for the successful construction project of today.

The group of jobsite managers that come with a background in higher education are often inexperienced in the needs to adequately manage the jobsite finances. They seldom spent much time in the field and generally had little or no training from the home office as to the importance of managing the finances of the job. Similar to their counterparts who came up through the construction ranks, they are often more focused on scheduling and productivity since their background is more aligned with computer-related activities and data manipulation.

So when it comes to trying to determine what information is needed, and what information is not, many jobsite managers may be without the skills or time to make that determination, which also must include what their stockholders require. Therefore, they may need the support of their home office to provide guidelines to be followed. They may need to bring in a specialist in construction site financial management to help set up the formats and controls. Although not often used, valuable input can come directly from the jobsite managers themselves—their past experiences.

When planning the financial control system, the site manager should take some time to reflect on past experiences. The many issues encountered during previous projects should be listed and notes should be made of what information was available to help manage back then. Those issues should be reviewed while thinking of additional information that, although not available at the time, would have made the management of those issues easier. This is the information that will be most useful when setting up the financial management system that will be used to run today's job. (One way to do this is to have a brainstorming session with some of the participants of the earlier projects and some of those scheduled to participate in the new one).

But what is some of this information that will be needed to properly manage the site financials? To help answer this question, let's live through an earlier job. Let's assume the job was a 14-week major outage, one that had been in the planning stages since a previous outage, three years earlier. Assume that the scope had included some turbine rotor reblading, that it included condenser retubing and waterbox rebuilding. Assume that there was extensive boiler waterwall and superheater element replacement as well as coal mill and classifier work, boiler and ductwork asbestos abatement, and the usual change-out of pump seals and valve packing. In addition, assume there was the tie-in of new precipitators that had been built before the unit went off-line (fig. 10–1).

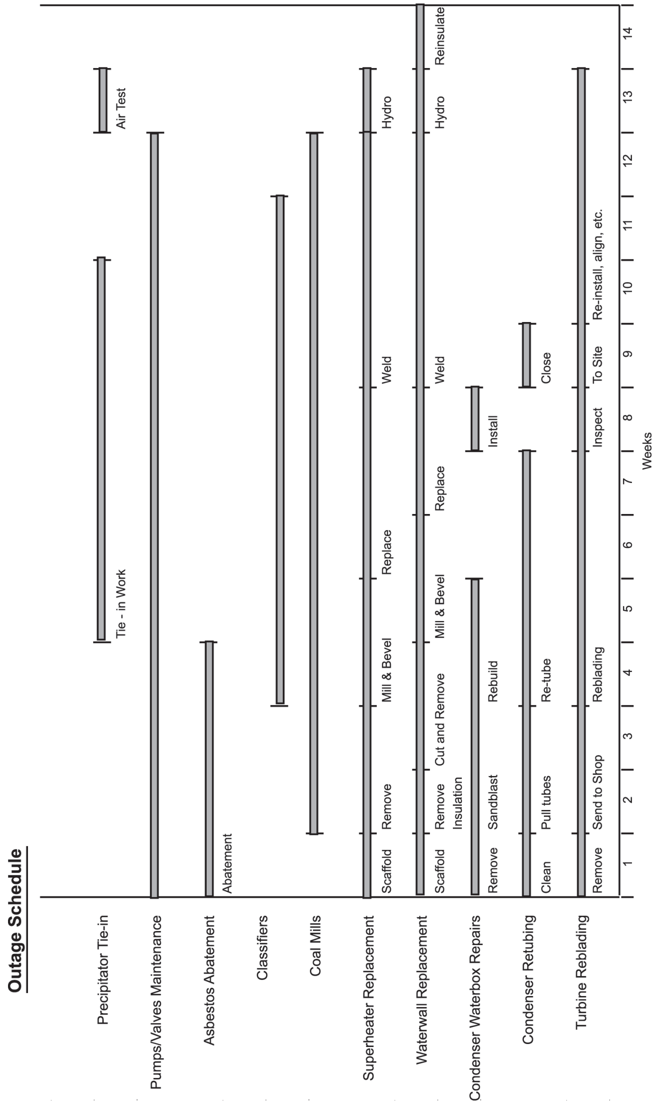


Fig. 10–1 Outage schedule—planned

Looking at the schedule, figure 10–1, there was a lot of activity planned for this previous outage. Most of the work had been scheduled to be performed on-site, so its execution would be under the direct control of the site manager. All except for the turbine rotor reblading; that was planned to be done off-site, either in the shops of the OEM or in a third-party vendor shop. Therefore, the reblading needed to be coordinated with the site program to ensure that the rotor would be shipped off-site in time to reach the shop as scheduled. If it missed this time frame, other work already scheduled in the shop would start, and the work on this rotor would be delayed. Also, the return of the rotor needed to be closely coordinated so there would still be time to reinstall it before the scheduled completion of the outage. This actually would necessitate a periodic *eyes-on* update of the shop work as it progressed.

But what did happen? According to the actual outage schedule in figure 10-2 the rotor removal work took longer than scheduled. In fact, it took 12 days instead of the scheduled 7 and by the time it was out, the scheduled transporter was no longer available. Obviously, this caused a lot of panic since the repair of this rotor was critical to the success of the outage. Suddenly, the rotor was late, no back-up transporter had been arranged, and the repair shop had other work to put into the time slot allocated for this rotor work. In the heat of the moment, the site manager talked with the repair shop and agreed to pay them for holding open the bay for the rotor for the few days of delay. He also agreed to pay the overtime required to complete the reblading and balancing by the date originally scheduled. But he also insisted on having a full-time expeditor in the shops to provide daily progress reports.

Once that was agreed, another transporter had to be located since the first one was no longer available. Although one was finally located, it had to come from farther away, which meant two drivers double-shifting to get to the site when needed. All in all, there was a significant increase from the costs originally budgeted for this portion of the project. Ultimately, the rotor did get to the shop; the shop worked significant overtime to complete the reblading as originally scheduled and shipped the rotor back to the site in time for installation, in accordance with the outage schedule (fig. 10–2).

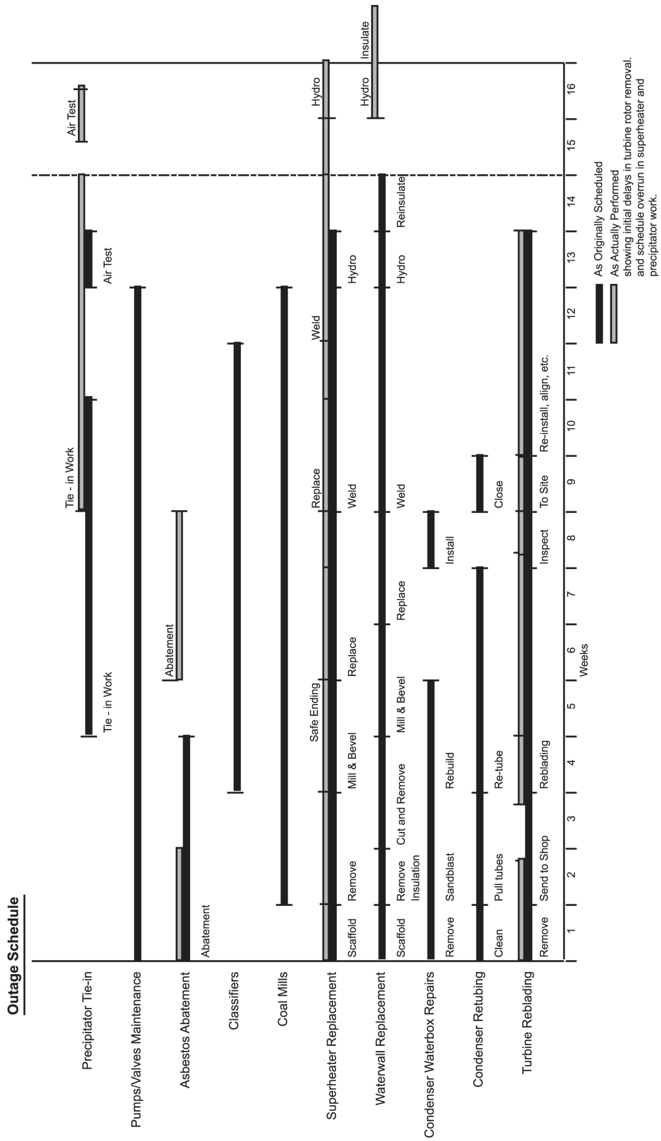


Fig. 10–2 Outage schedule—actual.

In reviewing this phase of that earlier outage, the site manager of today's outage might wonder what could have been done differently, especially now that the owner is focusing more and more on the total cost of the outage work. Two possibilities come to mind: 1) the outage could have been delayed to accommodate the delay caused by the rotor removal or 2) a rebuilt replacement rotor could have been sourced. Either of these two options would, of course, involve agreement by the owner, the plant operations personnel, and, in the event of delayed project completion, input from the electric system operator. However, adopting one of these options may have been more palatable than the expensive course that was taken. Delaying the completion would have meant some additional site establishment costs, and it would probably have meant a period of lost revenue; but the owner would have been able to evaluate these issues if only given the opportunity. Although also an expensive choice, opting for the use of a rebuilt replacement rotor may have been acceptable. Why? Because this would have provided the plant with a replacement rotor in the event of a future emergency, and the cost of this rotor would have been a capital expenditure, not charged to the current outage.

After evaluating these alternatives, the site manager preparing for the upcoming outage would most likely determine that to be able to make an informed decision today of how to proceed in the event this rotor problem occurred again, the decision makers would want detailed cost estimates, almost on a daily basis, as to the cost of 1) extending the outage or 2) buying a replacement rotor. So while developing the list of important financial data for this next outage, the site manager and the owner's representatives might arrange that each critical phase of the project would be managed as a discreet project, in and of itself. Due to their criticality, these phases would be tracked almost daily, against presupposed mini-milestones. A probability analysis would be done to determine how likely the predicted events would occur based on changes in their underlying assumptions. This would then be used to determine if alternative scenarios needed to be considered and if so, planning could then begin.

For example, using the same turbine rotor scenario where there was one week allocated for removal of the rotor, ready to be loaded on the truck, the next outage plan should include a daily, or maybe even twice-daily review of the progress being made. The underlying assumptions, such as labor, tools and factory representative availability would be closely monitored to be sure that if any shortages or delays arose, they could be dealt with immediately, or factored into the next iteration of schedule reevaluation. The same process should also be used for the removal of the turbine casing bolts. Since the removal of these bolts is often more of an art than a science, some probability of success should be applied to this portion of the schedule reflecting the possibility of the bolts not coming out as easily as planned—which was actually the cause of the delay in the first example.

Looking again at figure 10–1, the next project-critical scope of work had been the replacement of sections of the boiler waterwalls. During this outage three years ago, there were no problems but that doesn't mean there won't be any problems this time. It only means that the probability of issues arising is less than before, provided that the underlying assumptions remain the same. As we'll see shortly, a delay in the superheater work created a delay in the hydro testing and reinsulation of these waterwalls.

Figure 10-2 shows there were problems with the replacement of the superheater elements. Although this work was not originally on the critical path, it became critical and delayed the entire outage.

When the work was planned for that last outage, the field staff and the engineering groups did not spend much time discussing the replacement of the superheater elements since this was work regularly done by the contractors involved. During that earlier outage, the area was scaffolded, the elements were removed, and the header nipples were cut and beveled to the proper dimensions, all with no unusual issues, right on schedule. However, when the first elements were placed into position and tack welded, the welders realized they were welding dissimilar metals. Since the welding procedures did not allow for this, the welding could not continue. The elements had to be brought back out of the unit and *safe ended*. This required ordering *safe ends*. Although the safe ends arrived quickly, it took a tremendous amount of time to cut back the ends of the new elements, bevel them, and then weld the new safe ends on to them. Then, only after all of that work, could the new elements be raised again and finally welded into place. This, unfortunately, led to a two-week overrun in the completion of this scope and in turn caused the two-week delay of the project.

By reviewing all of the foregoing information, when planning for the next job, an upfront decision can be made to include (or not include) a contingency for a similar reoccurrence. Of course, at the outset of the job itself, a quick check can be made to be sure that the replacement superheater elements are safe ended. If not, arrangements still can be made early in the project to avoid the problems incurred during the previous outage. But that doesn't mean other things will not go wrong.

Suppose the elements are manufactured incorrectly, such as incorrect tube diameter or tube thickness, or other dimensional errors? The typical project manager or superintendent does not have the time to measure every piece of material that arrives at site. They rely on the engineers and the manufacturers. So it is still necessary to track the progress of even noncritical work scopes and be prepared to factor in lower probabilities of achieving predicted dates in the event problems arise. In this case, what is important is to closely monitor the replacement work to be sure dimensional discrepancies are discovered in a timely manner.

Rounding out the review of this earlier project, there also were problems with the precipitator tie-ins. They did not complete on time. The problems arose when the ductwork asbestos abatement became entangled in problems of exposure. The abatement contractor did not properly enclose the work areas and two weeks into the job, workers in other areas started complaining of being exposed to airborne asbestos fibers. The asbestos abatement then had to be stopped. Environmental inspectors arrived, evaluated the situation, and imposed additional requirements that the contractor had not intended to use. Ultimately, this caused a four-week delay in the completion of the abatement work, directly delaying the tie-in of the precipitators and the subsequent air test of the unit.

Once again, the lessons to be drawn from this mishap are similar to the last two. Neither the asbestos abatement nor the precipitator tie-in work was on the critical path, but they were linked such that the tie-in work could not start until the abatement work was complete. This essentially put their combined scopes on a critical path and therefore, their work needed to be monitored much closer, along with a contingency plan if there were problems. As an example, the abatement work needed to have been inspected, early in the job, to see if it was being properly performed. Then, as soon as problems arose, an analysis could have been performed to determine the probability of this delay affecting the start of the tie-in work. Assuming that it might, alternate scenarios could have been prepared. One such scenario could have been to just replace the contractor. Another could have been to solicit the assistance of the environmental inspectors in isolating just the affected areas, not shut down all of the abatement work. Just as before, the costs of these options could have been evaluated and compared against each other and against any possible schedule extension, if one could have been foreseen to occur.

Each job is unique and no one will ever be a mold for the next. But by collectively reviewing what's happened in the past, applying those scenarios to what might happen in the present, and then running a probability analysis on those assumptions, a decision tree can be formulated. This tree can then be used to evaluate optional scenarios in the event of issues arising, allowing the owner or investor to make decisions based on his or her financial needs.

Structuring the Financial Outline

The next step in the process of preparing for managing the finances of the project is to prepare a format for the anticipated expenditures. It should include categories similar to those used when the work was estimated, such as labor, supervision, tools, equipment, small tools and consumables, etc. It should also allow for contingencies such as those just mentioned. The spreadsheet shown in figure 10-3 is from an actual boiler outage and the first column, labeled *Description,* is one example of this format.

Financial Status Report

Description	Budgeted	Expended to Date	Percent Expended	Projected at Completion	Projected Variance	Variance Percent
Field Labor Wages	1,202,606	1,203,467	100.07%	1,215,000	(12,394)	
Bonuses/Vacation	10,000	0	0.00%	10,000	0	
Total Field Labor ($)	1,212,606	1,203,467	99.25%	1,225,000	(12,394)	-1%
Total Field Labor MH	67,255	64,063	95.25%	65,000	2,255	
Avg. Wages PerLabor MH	18.03	18.79	104.19%	18.85	(0.82)	
Supervision Wages	396,328	264,431	66.72%	310,000	86,328	
Supervision Expenses	106,674	120,164	112.65%	116,674	(10,000)	
Total Supervision ($)	503,002	384,595	76.46%	426,674	76,328	15%
Total Supervision MH	5,081	4,367	85.95%	5,081	0	
Avg. Wages Per Supervision MH	78.00	60.55	77.63%	61.01	16.99	
Field Accountant Wages	52,524	41,210	78.46%	78,016	(25,492)	
Field Accountant Expenses	25,842	23,557	91.16%	25,842	0	
Total Field Accountant ($)	78,366	64,766	82.65%	103,858	(25,492)	-33%
Total Field Accountant MH	1,094	1,496	136.72%	1,625	(531)	
Avg. Wages Per Accountant MH	48.01	27.55	57.39%	48.01	0.00	
Small Tools & Consumables	75,000	185,500	247.33%	175,000	(100,000)	
Office Costs and Supplies	40,000	21,677	54.19%	23,000	17,000	
Freight on Sm. Tools & Cons.	11,000	8,536	77.60%	9,000	2,000	
Total Sm. Tools & Consumables	126,000	215,712	171.20%	207,000	(81,000)	-64%
Percent of Field Labor Wages	10.48%	17.92%		17.04%	(0.07)	
Lifting Equipment (cranes, hoists, trolleys,etc.)	30,000	43,441	144.80%	50,000	(20,000)	
Welding Machines	15,000	24,861	165.74%	24,861	(9,861)	
Milling Tools	10,000	4,941	49.41%	4,941	5,059	
Others	74,000	66,789	90.26%	68,500	5,500	
Freight on Tools & Equipment	10,000	11,446	114.46%	12,500	(2,500)	
Total Tools & Equipment	139,000	151,478	108.98%	160,802	(21,802)	-16%
Cost Per Field Labor MH	2.07	2.36		2.47	(0.41)	
Weld Rod	10,000	10,823	108.23%	12,000	(2,000)	
Contract Material	15,000	15,051	100.34%	15,000	0	
Temp. Construction Material	17,000	2,238	13.16%	10,000	7,000	
Freight on Materials	9,500	1,500	15.79%	1,500	8,000	
Total Material	51,500	29,612	57.50%	38,500	13,000	25%
Insulation / Lagging / Abatement	211,000	198,000	93.84%	211,000	0	
NDE (including UT)	35,000	25,000	71.43%	15,000	20,000	
Stress Relieving	58,349	74,000	126.82%	74,000	(15,651)	
Other Supervision	8,500	0	0.00%	0	8,500	
Total Sub-Contractors	312,849	297,000	94.93%	300,000	12,849	4%
Builders Risk Insurance	5,000	0	0.00%	3,820	1,180	
Insurance	5,000	0	0.00%	3,820	1,180	24%
Contingency	0					
Profit Margin	150,000					
Contingency & Margin	150,000					
Company Overhead	351,677					
Total Overhead	351,677					
					Net Profit	
Totals:	2,930,000	2,346,631	96.64%	2,465,654	112,669	3.85%

Report Period Information:		Current Week Information:	
1.) Number of Workers Current Week:		1.) Number of Workers Current Week:	
Craft Workers:	66	Craft Workers :	25
Supervisors:	5	Supervisors:	4
Total Force:	71	Total Force:	29
2.) Number of Shifts Currently Working:	2	2.) Number of Shifts Currently Working:	1
3.) Hours Per Shift Currently Working:	10	3.) Hours Per Shift Currently Working:	8
4.) Days Per Week Working:	7	4.) Days Per Week Working:	5
5.) Physical Percent Complete:	98%	**5.) Physical Percent Complete:**	99%

Fig.10–3 Financial status report.
Courtesy of Construction Business Associates, LLC

However, it is important to realize that these categories are for summary purposes, for the use of high-level reporting. There must still be a much more detailed breakdown of the work and its reporting categories. For example, the work should be divided into as many work breakdown structures (WBSs) as is practical to report against. If the job entails the replacement of superheater elements, there should be a subcategory for removal, another for milling and beveling the header nipples, another for installing the new elements, and one for welding out the replacement elements; this is important to assist in measuring and managing productivity. Then the man-hours expended in these subcategories should be *rolled up* to a WBSs, which in turn should be *rolled up* to a summary category such as the *Field Labor* category in figure 10–3.

Further examining the example in figure 10–3, the *Supervision* and *Field Accountant* categories should include the payroll costs of the personnel as well as any travel and living expenses associated with their work. The *Small Tools* in the next category should generally include items such as hand tools, cutters, reamers, and other tools that have a short shelf life. These are usually tools that are not expected to be reused once the job is complete and cost less than some predetermined amount, say below $1,000. The items called *Consumables* are items such as rags, oils, greases, grinding wheels, and any other item that is not reusable. It is also suggested that when these items have to be shipped from elsewhere, the cost of shipping them should be tracked. On remote sites, these shipping costs can become substantial, sometimes rivaling the cost of the small tools and consumables themselves. In these cases, it becomes prudent management to plan ahead and prepare a few large orders that can be shipped by surface freight instead of falling into the trap of making multiple emergency orders that require air shipments.

The next category, *Tools and Equipment,* is generally used to report items that are expected to be reused on future jobs and cost more than $1,000. These would be items such as chain hoists, grinders, and drills. Equipment would include welding machines, milling equipment, and large lifting devices such as cranes, hoists, trolleys, and jacks. The freight costs for this type of construction apparatus easily can be significant. For example, in addition to the costs for transporting a large crane to and from the site, there may be costs for temporary preparation of roadbeds and bridges, removal of overhead obstructions and possibly special police escorts.

Continuing with figure 10–3, the items in the *Materials* category are usually materials purchased at the jobsite and they fall into two categories, those forming part of the final product and those that do not. Often, it is important to differentiate between the two due to tax issues; the material forming part of the final product may be eligible for tax exemptions if the final product is tax exempt, whereas the temporary construction materials may not. Weld rod would be a classic example of material forming part of the final product. Scaffold boards and fit-up bolts for structural steel would be considered temporary construction materials. Again, freight may be significant if the job is at a remote location.

Often, subcontractor costs are managed as a package. In other words, many contractors and owners only look at the bottom line of the costs from their subcontractors, and this is all right when there are no problems. This is what has been portrayed in the *Subcontractor* category of figure 10–3. However, when the subcontracted portion of the job becomes a significant percentage of the overall project, these costs should be detailed and reviewed with the subcontractors as if the subcontract did not exist, and therefore, this category sometimes needs to be expanded. This would allow subcontractor costs to be compared to their budget, and in the event of shortfalls, discussions could be held immediately to develop a plan of recovery.

Some contractor managements prefer to conceal contingency, profit margins, and overhead costs from the field staff. Certainly, most do not want to expose this information to their competitors. Although the example in figure 10–3 includes this information, it is not crucial for the management of the site activities. It does, however, provide a picture of how the site work will impact the overall financial results of the project to those responsible for the financial well being of it.

Finally, to offer a complete picture of the costs affecting the job, a synopsis of the on-site personnel is frequently helpful. At the bottom of figure 10–3, two time periods are shown. One reflects the week the costs were recorded, and one reflects the current point in time. The difference is generally due to the time lag between when the costs are captured and when they get recorded, frequently a week. The same is true for the percentage of completion, so it is also shown twice.

Once the categories for the financial reporting have been established, the job estimate can be subdivided and entered into the next column, here labeled *Budgeted*. Sometimes it will be difficult to take the estimate as prepared by the estimator, or as sold by the salesman, and apply it to the categories previously described. However, it is important to find a way to do this so the work can be managed properly and feedback can be provided for estimating the next job. Sometimes it may require that the site manager and the estimator sit down to redistribute the numbers in the estimate in accordance with the categories required for managing the job. However, once this is done, an interesting picture will emerge; the impact that each of these categories is expected to have on the overall job.

While not unexpected that the labor portion is the largest single expenditure anticipated for the project, the other categories can vary significantly, depending on the work scope, the job location and the skills of the available labor and supervision. In this example, the budgeted labor is approximately 41% of the total budget. But the supervision costs, with a 17% impact, will dramatically affect this project as well, which suggests that the site manager must also manage the costs in this category very closely. Since almost one quarter of the costs of the supervision is relating to living expenses, it may be more cost effective to arrange for a single apartment house with a cook and maid instead of each supervisor living in a separate hotel room and eating in a restaurant every day.

The other expenditure categories shown in figure 10-3 are much smaller, suggesting that for this specific project, focusing mostly on the labor, supervision, and subcontracts will have the most impact on the job.

As this spreadsheet reflects, having determined which categories to use for reporting and having distributed the budgeted numbers into these categories, the rest of the spreadsheet is easily completed. Columns are established for: a) the amount expended, b) the percent this is of the budgeted amount, c) the amount projected at completion, and d) how far this deviates from the budget or variance.

Data Gathering

The next step in preparing to report the financial status of the job is to set up a system of collecting costs and entering them into their categories per the previously structured spreadsheet. The first information that is required is the amount already expended. This can often be problematic because accuracy is important. The timing of data availability often becomes very frustrating. Although the actual man-hours and resultant payroll costs are never more than a few days old—due to the need to prepare the workers' paychecks in a timely fashion—the supervisors are often weeks behind in submitting their time sheets and expense reports. The vendors from whom materials are purchased and from whom equipment is rented are sometimes months behind. Most site staffs do not have the luxury of chasing after these costs while the job is ongoing, so the costs recorded in the *Expended to Date* column of the spreadsheet in figure 10-3 are generally just those costs captured to date by the accounting system. This column is essentially just a representation of the flow of the cash-out-to-date.

The next column, *Percent Expended*, therefore only represents what's in the accounting system, not necessarily what's been spent. The following column, the *Projected at Completion* column, is the heart of the report. It is actually comprised of two sub-columns, the first of which approximates the difference between the expended numbers as reported in the accounting system and the debt still owed that has not yet been entered. This first sub-column is used to keep track of the site staff and commitments made to vendors. In the case of the previous example, since the site staff is such a significant part of the job cost structure, it would be necessary for someone to maintain a log of all supervisory personnel charging into the job. This log could then be used to approximate the supervisory costs already incurred, although not yet reported and claimed.

For the vendors, which also include subcontractor billings owed but not yet received and/or processed, a log of commitments made to date is a useful tool that can be used to determine how much still has to be paid for work already performed. This forms the basis of the first sub-column. The second sub-column is made up of the projected costs to get the job from the present day to the end, and when added to the first, it forms the total projected costs to complete the work. Calculating the percent of variance will then quickly show where problems may be lurking. Looking at figure 10–3, after inputting the costs to date, adding those costs owed but not yet collected by the accounting system, and then adding the costs anticipated to complete the project, the message is clear. One can see there is a 1% overrun projected for the labor budget and significant overruns of the accounting and all tools and equipment costs. The supervision budget will have some money left over, as will the materials and the subcontracted budgets. All in all, this job, which is almost complete at this point, will be profitable for the contractor, but not as profitable as planned; due to a 1.5% expected cost overrun, the profitability of the job gets hit with a 25% reduction—a tough wake-up call now that net profit is projected at $112,669 versus the budgeted $150,000.

Comparing the Actuals with the Expected and Predicting the Results

Although the Financial Status Report, as shown in figure 10–3, is an important tool for managing the finances of the project, it is just a static tool showing the financial status of the job at a single point in time. To be able to *predict the future,* more is required. Comparisons must be made between what was planned and what has happened. Then predictions can be formulated by viewing the trends the data portrays and actions can be taken to impact those trends. This is the crux of the process of managing the job through its finances—projecting the trends and taking preemptive action when required.

Trending

Figures 10–4 and 10–5 each contain two graphs showing the trending of a job and how to use these trends to manage it. Although based on real-life cases, the graphs have been modified so each follows the same base line data. They depict the same project, but with four different possibilities. Each is based on a 14-week outage with a budget of 330,000 man-hours; total job costs are not used for several reasons. The first reason, as previously pointed out, is that the actual cost data often trails by weeks or months. The second reason is that most construction budgets are actually based on the man-hours required to do the work. Therefore, using man-hours as a cost marker is generally a good indicator of the total job costs. Third, the man-hours are usually the first data that is available.

These graphs each depict four pieces of information that, when viewed together, will provide a strong indication of the direction of the job, at an early stage, in time to take preemptive action, if necessary. The left-hand axis is a measurement of the man-hours of the work while the right-hand axis denotes percent complete. The intent of these graphs is to compare the man-hours expended and the actual percent completion achieved for those man-hours with the planned percent complete curve. By making a comparison between the man-hours expended, the percent achieved for those man-hours, the man-hours budgeted and the percent planned, one can readily see if the job is heading for trouble or success.

This first graph in figure 10–4, Progress Graph 1, shows a well-planned and well-executed job. The man-hour expenditure curve remained below the planned percentage of completion curve as well as remaining below the actual percentage of completion curve. The actual percentage of completion curve remained above the planned percent complete curve. This is referred to as a positive variance or Δ (delta). In contrast, the second graph, Progress Graph 2, shows a job with a negative Δ; it is a job in trouble.

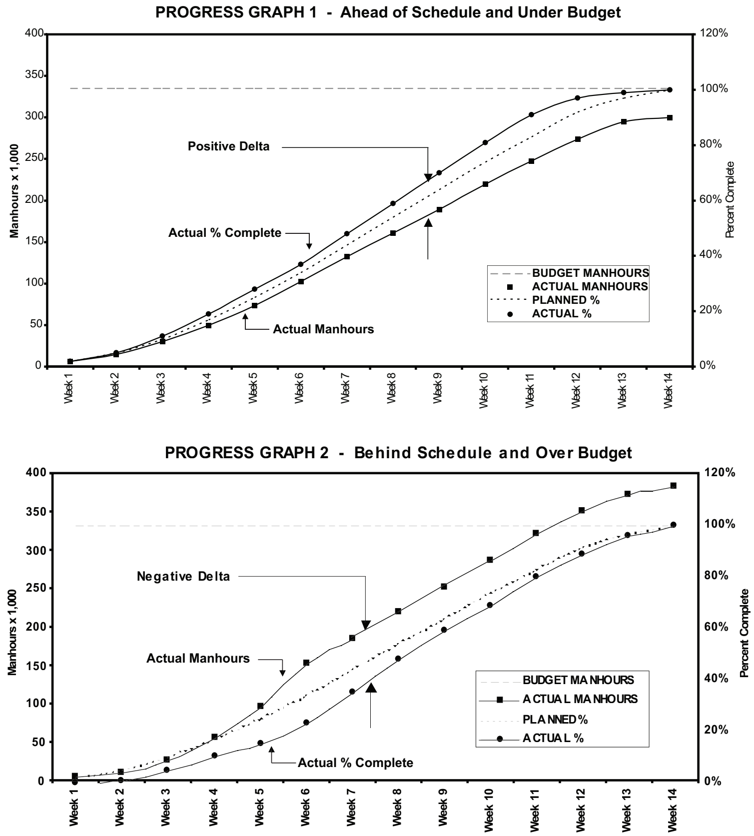


Fig. 10–4 Progress graph 1 and 2

The man-hour expenditure curve in this second progress graph is above the planned percentage of completion curve as well as being above the actual percentage of completion curve. The actual percentage of completion curve is below the planned percent complete curve. This is referred to as a negative variance, or Δ, and basically says that more man-hours (or money) are being spent than progress being made. It's usually difficult to get out of this situation, but not impossible if caught early enough, as will be demonstrated by the graphs in figure 10–5.

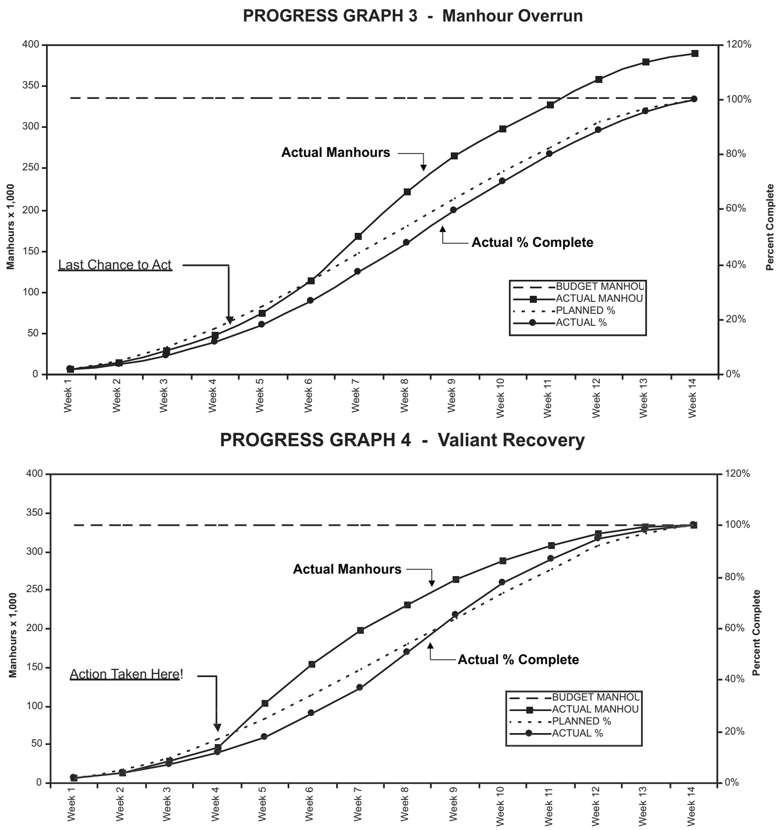


Fig. 10–5 Progress graph 3 and 4

Progress Graph 3, in figure 10–5, similar to the previous graph, shows a job with a negative Δ. But note that until about the sixth week, both the actual man-hours being spent *and* the percentage actually being gained were below the planned percent curve. This suggested that there was still a chance to complete the work on time and without going over budget, but action needed to be taken back in the fourth week. Following the time line until the end of the job, however, shows that the action taken was seemingly just a gradual, possibly daily, ramp-up of manpower that did not jolt the job out of its slump. This job did complete on schedule, but at a cost of almost 20% above budgeted man-hours, and barring any major shake-ups, *this was predictable from the very beginning!*

In contrast, Progress Graph 4 also shows a job with a negative Δ, or in trouble, just like the previous one, but with the difference that drastic action was taken. Note that in the fourth week, the manpower was dramatically ramped-up. This created an increase in the rate of completion, which met with the planned percent complete curve by the ninth week. Thereafter, the manpower was gradually reduced, and the job completed on time *and within the budgeted man-hours*.

Using these methods of graphing the man-hours being expended on a project, and comparing them with both the percentage of completion expected and with the percentage of completion attained, one has the opportunity to make decisions in time to impact the outcome of the job. The key, however, is to start this process at the very beginning and then closely monitor the trends and make changes early, in time to avoid unpleasant surprises and still have an impact on the job.

Looking once more at Progress Graph 2 in figure 10–4 and both progress graphs in figure 10–5, by the fourth week, their percent complete curves were trending further and further away from their planned percent complete curves. Their man-hour expenditure curves were closely tracking their percent complete curves, suggesting that the man-hours being expended for the progress being attained were essentially at the right level. But the actions taken on the job represented by Progress Graph 4 (the Valiant Recovery) showed that an early dramatic ramp up in man-hours can pull up the completion percentage and even allow time to ramp back down to stay on budget. That's what was done, and it worked.

Estimate validation

However, all of these tools are based on some underlying assumptions. The first assumption is that the estimate is a good estimate. To know that it is a good estimate requires several things. It requires validation. Once the validation is complete, the estimate needs to be benchmarked. After being benchmarked, it should be analyzed for acceptability of the risks to be incurred.

But what is meant by validation? Usually, the site management is handed the estimate or budget, which has been completed by someone else—someone who may not ever be expected to become involved in the job itself. So it is incumbent upon the site staff to review the estimate and its underlying assumptions, in other words, to validate them. Each of the assumptions needs to be reviewed to be sure it's still applicable. If there are cost implications, they need to be identified and noted. Some of the more common assumptions include the following:

- Realistic *notice to proceed*, or release dates, which are used to set certain actions (like preassembly work) into motion
- When and in what condition materials will be arriving
- Who supplies the construction power, compressed air, and water
- What the working schedule will be
- What condition the existing plant is in, such as squareness of the boiler
- That there will only be three days of lost time due to the weather
- The basis used for establishing costs such as labor rates and equipment rentals

If any of these assumptions have changed from the time the estimate was prepared, the new conditions must be considered when preparing the financial management tools. This may require a reevaluation of the estimate and related budget, essentially a risk analysis; it may need to be increased or decreased. The same applies to the schedule. It could be impacted by a change in any of these assumptions, and a change in schedule almost always has a corresponding impact on the budget.

This may be as simple as reviewing the list of assumptions, providing that old fashioned *gut feel* and saying, "Yes, that's exactly what will happen." Or it may require a more complicated review, one that requires a Monte

Carlo type of analysis of some of the risk assumptions. For example, for the weather-related lost time assumption, a 50-year search of past weather patterns may show that in some years there would have been nine lost days and in other years, none. Applying a Monte Carlo simulation would enable the site manager to *predict,* within a prescribed factor of accuracy, the actual number of days of delay that might be encountered. Additionally, upper management may relate, understand, and be more comfortable with the *probability* of finishing on a certain date after this type of analysis.

After completing the validation process, a benchmarking review of the estimate should be performed. This should take the form of two reviews: 1) a comparison of the estimate with the results of projects already completed by the organization and 2) a comparison of the estimate with estimating standards and results found throughout the industry. The first is straightforward; it is simply a process of comparing the internal company records of a previous, similarly executed project with the estimate at hand. The second may be more complex since usually, the assumptions underlying the current estimate may not be the same as those upon which the *industry standard* is based. For example, if the industry standard is to assume 2.5 man-hours per boiler tube weld, how should this be modified if the current project is expected to encounter very difficult access, possibly requiring window welds?

WBSs

Upon completing the revalidation of the estimate and especially its underlying assumptions, the work breakdown structures, or WBSs, must be addressed. The WBSs are established for ease in reporting costs as the project progresses. However, they also have two other important purposes: to be used as a tool for measuring the progress of the work and for projecting the outcome of the job, both in terms of schedule and in terms of cost.

Because of their use as a tool for these last two services (measuring progress and projecting outcome), the WBSs must be assigned realistic values of importance relative to their overall impact on the job. For simplicity, let's return to figure 10–1, a job with 10 activities, or WBSs. The first activity shown is the turbine reblading, which will be assigned a value of 5% of the total job man-hours. The next is the condenser retubing and waterbox repairs, assigned 25% of the job man-hours. The pressure part work and the waterwall and superheater replacement, are also collectively assigned 25% of the costs, and the work on the coal handling equipment is assigned 10%. This totals 65%. If the rest of the work scope is assigned a cost impact of 40%, we have values of WBSs that add up to more than 100%. Since that's not possible, a realistic approach must be taken when assigning values, or as they are better known, *weighted values,* to each WBSs.

Once the WBSs are weighted, they can then be used for determining progress and predicting outcome. As an example, when the WBSs representing the condenser work shows that the work is at its halfway point, the time for its completion can be considered half spent, as well as its costs. This then also reflects about 13% of the total cost of the project, which has been incurred, because half of its 25% impact on the job has been spent (fig. 10–6 Cost to complete).

Budgeted	Outage	Weighted			
WBS	Manhours	Value			
1. Turbine Reblading & Repairs	15,000	5% (includes shop labor)			
2. Condenser Repairs	83,000	25%			
3. Pressure Part Replacement	82,000	25%			
4. Other	150,000	45%			
	330,000	**100.0%**			
Current Status	Percent	Earned	Earned	Manhours	Budget
WBS	Complete	Value	Budget	Expended	Expended
1. Turbine Reblading & Repairs	35%	2%	5,250	6,000	40%
2. Condenser Repairs	50%	13%	41,500	38,000	46%
3. Pressure Part Replacement	40%	10%	32,800	37,500	46%
4. Other	60%	27%	90,000	92,500	62%
		51%	169,550	174,000	53%
Projected to Completion	Manhours	Manhours at	Budget		
WBS	to Complete	Completion	at Completion		
1. Turbine Reblading & Repairs	11,143	17,143	114%		
2. Condenser Repairs	38,000	76,000	92%		
3. Pressure Part Replacement	56,250	93,750	114%		
4. Other	61,667	154,167	103%		
	167,060	341,060	**103%**	**(11,060) overrun**	

Fig. 10–6 Cost to complete.

Earned value

Earned value is a measurement of results against efforts. The WBSs described earlier are the tools used to measure earned value. When a specific scope of the work, a WBSs, is partially completed, a certain number of man-hours are *earned*. As shown in the column in the middle of figure 10–6, the number earned, or earned value, is determined by multiplying the percentage of completion for the specific WBSs by the man-hours budgeted for it. But, *it is important to realize that the amounts earned and the amounts spent are independent of each other*.

Again, let's refer to figure 10–6 and take the example of the condenser repairs. This work was budgeted at 83,000 man-hours. When it is 50% complete, it will have *earned* 41,500 man-hours, even though only 38,000 man-hours were *spent* to reach this point. Regardless of how many man-hours it takes to complete the tasks, upon completion they will have *earned* only 83,000 man-hours.

Let's look at the total job. At the point in time indicated in the example, where the condenser work is 50% complete, the turbine work is 35% and so on, the overall completion status of the outage is 51%. This was determined by calculating the earned value of each WBSs at this point in time—by multiplying its physical percent complete by the weighted value of the WBSs—and then adding them together to arrive at the 51%. However, note that 53% of the budget has been spent. How was this determined? It is the sum of all the *actual* man-hours that were spent divided by the total *budgeted* man-hours—174,000 man-hours divided by 330,000 man-hours. So what does this mean? It says that for 53% of the man-hours *expended* to date, only 51% of the work has been *earned* (the earned value).

Cost to complete

These results suggest that if no action is taken and the remainder of the job continues in a similar fashion, at the completion of the work, the budget will be exceeded by 3%. To determine this, the man-hours expended to date were divided by the attained percent complete to obtain the projected cost at completion for each individual WBSs. Then, the man-hours expended to date were subtracted from the projected cost at completion to arrive at the man-hours to complete. Finally, each of these columns was summed to arrive at the amount of man-hours for the total outage. The projected 3% overrun of this outage budget then translates into an extra 11,060 man-hours that are projected to be required to complete the work and the "cost to complete" at this point in time is 341,060 man-hours (which includes the 11,060 man-hour overrun).

Summary

Again, it really is all about the money, and if the managers aren't managing to the bottom line, the investors will shut them down. The site managers of today are obligated to tell their managers and investors what's happening with the money. Not only what happened with the money just spent, but what's expected to happen with the rest of it as well. First, they must understand this responsibility. They must know why their stakeholders are interested and then they must have the tools and support to provide the information their investors will want, when they want it.

They have to understand what information is needed to manage risks. But to do so, they also have to understand what risks could be incurred. No one manager has *the* crystal ball to be able to predict the future but most do have the background experiences that offer some insight into what might happen. If they don't, they usually have access to someone who does. Properly formulated, a brainstorming session involving past and present participants can lead to a wealth of ideas on what to track, how to use this information, and where to focus. Reflecting on past experiences can provide very useful guidelines for managing the future.

Once a clear picture has been developed for what is needed, the project expenditure categories can be formulated. This will lead to a reporting format, the financial report, that is sensible for the project, is a tool for predicting the future and will be a source of invaluable data when the next project is being bid.

But the financial report is just that. It is only a report, a repository of historical data. The jobsite manager of today cannot stop there. He must extrapolate this data to predict the future or at least to give his investors some idea of what might happen if the present course of action continues. He must trend the historical data, preferably with an easily visual chart, that can *project* to completion. He must do this early in the project and he must do this regularly during the project. By doing this, there remains the opportunity to take action that can impact the job's outcome, in time to realize the results that were wanted, thereby avoiding unpleasant surprises. Without this, that opportunity may be gone—there is a maxim that says once a project has reached the 20% completion point, the opportunity for change is almost gone.

There are tools that can be used to extrapolate the results from a current point in time to project the future. One such tool is the graph that compares the plan with the actual. By projecting the actual to the future, this can give an idea of whether things are going right or wrong and offer the opportunity to make a change in time to impact the job—it's called *trending the job* and it is very powerful.

Another necessary tool is the cost to complete model. This tool can suggest where the cost at completion may be if no change is made. It won't suggest when to take action but it will suggest what may happen if action is not taken (which may be OK). However, here it is very important to capture the costs by categories that lend themselves to the actual activities of the job—the WBSs. At the same time, it is necessary to communicate the time line basis of the data and the time line of today; data skewed due to *timing* of results must be used accordingly.

All of these tools are theoretically good, but are they valid? This is an important question; validation of underlying assumptions must be part of the plan. Is the estimate right? Are its assumptions still valid? What are the chances these assumptions may change? Has the estimate been benchmarked—both in-house and in the industry?

Then there are those WBSs. What are they, how were they developed and how will they be used? They first of all serve as a structure for collecting the costs. But then, they become a tool for measuring progress and projecting outcome, and this is possible because of their individual impact on the job, their weighted value.

Finally, a step toward productivity must be made. Although the subject of productivity is reserved for the following chapter, it requires linkage to earned value, which is described herein. *Earned value* is the measurement of results against efforts. It is not an earning for effort expended, it is an earning for results gained. Regardless of the effort expended, 50% gained is just 50% gained!

11

MANAGING THE SITE ACTIVITIES: COST CONTROL

Managing the jobsite finances, the subject of the previous chapter, does not, by itself, guarantee a successful outcome. It provides early warnings of problems, which can be used to make changes to alter the future. But what changes should be made, what can be changed? There are a host of items as follows:

- Manpower
- Schedule
- Tools and equipment
- Consumables
- Materials
- Site services

Making changes to the way any of these items are managed will impact the job. As described in the previous chapter, changing the manpower can dramatically alter both the schedule and the cost of the project. A change in the schedule, either compressing or extending it, will affect the final costs. Making a change in the way the tools and equipment are being used or managed can influence the end result. The same is true for the other items. Since all of the items listed here are integrated to form the total project, making changes in one will cause an effect in the others.

The purpose of this chapter is to delve into these items and explore how they should be cost-effectively managed and how to make changes, if necessary, to realize a net change to the bottom line, in other words, making cost-effective changes. Tools such as productivity management will be discussed. Business controls will be reviewed. The pros and cons of on-site vs. off-site work will be discussed. E-commerce and the Internet will be addressed. Outsourcing will be reviewed and so will bar coding.

Before exploring how to manage the various segments of the job, a determination must be made of what is important and what is not. Not all of the items listed previously are important in all of the projects, all of the time. Not all jobs will require large, heavy equipment. Not all jobs will be involved in purchasing materials. The importance of some of the segments will change as the project progresses. It is important to know where to focus one's attention to maximize the return for that effort.

Manpower (and Productivity)

To assist in this determination, an evaluation of each item as it relates to the overall cost potential of the project is important. Manpower is usually the single largest component of any construction project. For a grass roots new power plant project, the labor costs can range from 35–65% of the construction costs, depending on where the job is located, where the labor comes from, and what kind of job it is. In other words, for a combined cycle job the labor component would be on the lower end of the scale whereas a new coal-fired project would be more labor intensive. For a major outage, again, location and job scope will be a large determinant of the labor proportion of the job costs, but generally, the labor component will play a more significant role. This is due primarily to the removal/demolition component of the work, which is not present in new construction projects.

But regardless of the percentage of the job costs that are attributable to the labor segment, since it is still one of the largest factors, managing it is the single most important facet of the project. When the labor is not properly managed, the remaining segments of the project are strongly impacted. Supervision may need to be reinforced; the schedule might suffer; additional tools and possibly longer durations of costly equipment may be required; the use of consumables may be increased, and safety and quality may suffer as well. All in all, when labor is not effectively managed, the job suffers.

To get a handle on managing labor requires an understanding of what is expected vs. what is being achieved, in other words, labor productivity. Labor productivity is a very complex subject. Many books have been written on the subject. Norms are constantly changing and this keeps the subject open. Here, the purpose is to describe some techniques for managing productivity.

First, a listing of some of the categories of the work that can be readily measured.

- Electrical
  - Conduit installation, by the foot
  - Wire and cable installation, by the foot
  - Terminations, by the number
- Mechanical
  - Piping installation (large bore, small bore), by the foot
  - Welds completed (by the weld, by the equivalent weld)
- Insulation
  - Flat surfaces, by the square foot
  - Piping (large bore, small bore), by the linear foot

Next, the categories to be measured should be selected, and they should tie in directly to the WBSs established earlier, during the design of the financial control system. Depending on the work scope, not all categories will be applicable; at times, additional categories will be required.

However, there's more required than just selecting the categories. Each category should be subdivided into discreet areas of the work, which may or may not be identical to the WBSs. For example, a WBSs may be installing cable from the various pieces of equipment to a new control room. But since this work will entail many different pieces of equipment in many different locations, each major run of cable and wiring should be measured separately because the degree of difficulty for each may be significantly different.

The same applies to welding. The productivity of welding waterwall panels in a boiler with convenient scaffold in place will be very different than that encountered when welding replacement sections of dissimilar metal welds in the superheaters. Access will be a major factor as will the type of welding required, especially if preheating is required.

With the categories of work to be measured decided, expected production can be established. This can be obtained from industry standard references, it can be obtained from local labor organizations, or it can be obtained from the records of jobs previously performed. These expected production rates then become the norms.

Next, daily measurement of each activity should be made and plotted, similar to figure 11–1. In the Welding Progress chart of figure 11–1, the white bars show the planned or required welding production necessary to complete this activity by the end date. However, by comparing the white bars with the dark bars, it can be readily seen that the initial welding was less than what was established. Or put another way, the production or progress for this phase of the work started out lower than required. As the job progressed, the production increased, exceeding the daily requirement for approximately half of the duration, after which it was reduced to enable completion per the original plan.

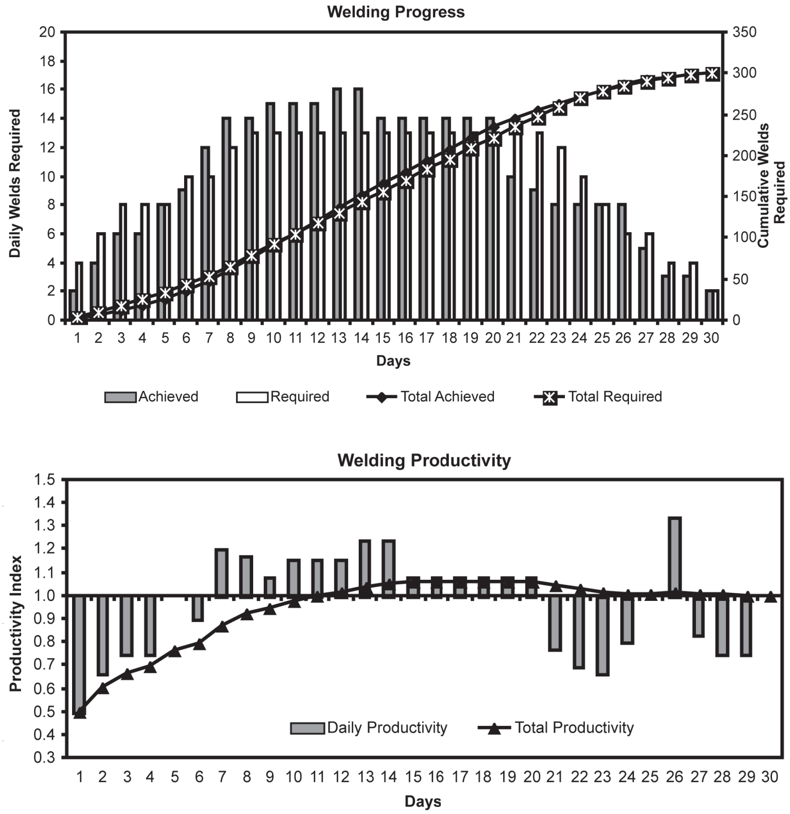


Fig. 11–1 Welding progress and productivity

There are also two progress curves plotted on this graph: the cumulative welds required to meet schedule and the cumulative welds achieved. When this work first started, it was behind schedule, as shown by these two lines; and it did not reach the required level of production until 11 days later. Then it actually exceeded the required production for the next 12 days and finally stayed almost exactly on target for the last 7 days.

As a matter of interest, one might question why not just divide the number of welds by the number of available days and have a level production plan, in this case, 300 welds divided by 30 days to arrive at an even production level of 10 welds per day. This might be possible in many instances where no work is required beforehand. In this example, however, the work was related to installing economizer elements in a boiler. To maintain schedule for the overall job, the welding for this phase was started as soon as there were enough elements hanging in place to give the welders some work. Then, as more elements were hung in position, more welders were brought in; and as the elements were welded out, the number of workers was reduced accordingly.

It is important to note that although the first graph in figure 11–1 reflects the number of welds of a particular job, it could just as easily reflect any of the other categories established for the project, such as the number of electrical terminations, feet of piping, or square feet of insulation. The purpose is to measure progress and productivity, at a discreet level, so the work can be managed in a cost-effective manner.

Using a chart such as the one just discussed is a common method of measuring production. Another method is to perform a calculation of the productivity and then graph it. When this method is used, the norm is set at 1.0 (equal to 100%). Anything less than 1.0 is a reflection of under-producing while anything higher than 1.0 is an indicator of additional progress. The second graph in figure 11–1 shows the same data as in the first graph, except it is now in the form of productivity. As seen before, the progress, or productivity at the beginning of the job is less than 1.0, or behind the plan or the norm. As the job moves forward, on the fifth day, the productivity is exactly 1.0, and it stays above that until the work effort is reduced to coincide with the schedule. Note that the cumulative productivity reaches 1.0 on the 11th day and then stays above or at this number for the remainder of the job. Obviously, this is what is wanted.

But now that productivity can be measured, what can be done to affect it? Many things. First, there's the skill level of the craftsmen themselves. The right people must be assigned to the right task. Then there's the number of workers assigned. The right number of workers must be assigned to keep the work moving in accordance with the schedule. There are the tools and equipment. The right tools and the correct equipment must be available to perform the work. Adequate consumables must be available. Workers standing around waiting on these items will not be productive. Finally, there's the schedule, or work program itself. Take the case of installing superheater elements in a section of a boiler that requires refractory pours simultaneously with the element installation. The boilermakers install two or three elements, then they come out of the area while the refractory is poured. They go back and install three more, come out while refractory is poured again, and so on and so on. Not very productive. A change in the work plan and a change in the schedule might be in order to get an increase in productivity here.

There is one other measurement of productivity that is particularly relevant to the power plant construction business: the measurement of the welders' productivity. Since welding is often a major part of the work in a power plant and since this work is often on the critical path of the job, measuring the welders' productivity is a way to gauge their effectiveness. However, since welders often work on different size welds and at different times, it is useful to establish a common denominator against which the welders' work can be measured.

To do this, a common practice is to calculate how many *equivalent welds* are contained in each weld and then measure the amount of equivalent welds a welder, a pair of welders, or the whole team of welders makes in any one day or week and compare this with the preestablished norm. Developing the equivalent welds is done as follows:

- Calculate the amount of weld material required to weld two 2.0-in. diameter tube ends with a wall thickness of 0.25 in. each. Call this 1 equivalent weld.

- Calculate the amount of weld material required to weld each weld on the job and divide this by the amount of weld material required to weld the 2.0-in. diameter tube. This will determine the total equivalent welds.

However, since that's not a straightforward calculation, the following method is commonly used:

- Subtract the square of the inside diameter from the square of the outside diameter and multiply by 0.5714, like this: $(OD^2 - ID^2) \times 0.5714 =$ *number of equivalent welds*

The productivity measurement is then done the same way as before, except now, instead of counting actual welds, the equivalent number of welds is used. For example, if the tubes to be welded have a diameter of 2.75 in. and a wall thickness of 0.375 in., these tubes would be considered to have 2.04 equivalent welds each. If the same tube has a wall thickness of 0.625 in., its equivalent weld count would be 3.04.

Scheduling

No power plant construction job is run without some type of schedule, even if it is very rudimentary. No power plant owners would allow their money to be spent without a plan, or schedule, that provided some semblance of order for the execution of the work. So, after manpower management, schedule management is second in the order of importance to the project. But to delve into all of the ways to schedule a project and to explore all of the different tools and methods that are available to do this, would require more space than this book can provide. The subject of planning and scheduling, like labor productivity, generates its own volumes of books.

However, no book on any type of construction, including power plant construction, would be complete without some discussion of the subject. However, the discussion here will be limited to how an efficient scheduling process contributes to the financial health of the project.

There are many different methods available to schedule a job ranging from a hand sketch to a simple bar chart to sophisticated computerized programs. Each has its unique advantages and disadvantages. Not every project requires the most sophisticated process; some projects can suffice with a hand-drawn bar chart. However, most power plant construction projects consist of hundreds and hundreds of items, even thousands at times, and managing this many *mini-projects* requires sophistication.

The most common scheduling programs are commercially available from a variety of vendors. Quite often, the decision to purchase a program will depend upon the existing software already in use for estimating, accounting, payroll, personnel management, and purchasing. To be able to integrate the schedule with payroll and purchasing information and compare all of this data with the original estimate or use it to prepare a future estimate, often justifies the higher-priced software programs available on the market.

Once a software package has been selected, the next hurdle is to get it installed and populated with the site-specific data. Some organizations have full-time professional schedulers on staff who can sit down with the original estimators of the job and build the outline of the schedule. Then they can get with the site supervisory team and input all of the WBSs and any other detail that will be used to manage the daily activities of the project. They can also work with the site accounting, purchasing, and payroll staff to integrate the jobsite costs, arranging for a system that allows these costs to be input only once; for example, they may set up a central repository for all data to be sent after inputting and from which each respective user can upload information as needed.

After the schedule has been "built," it needs to be reviewed to ensure that the logic makes sense and that all potential outside impacts or constraints are reflected. For example, if the schedule is for use by the GC, it must also address the work scopes of each of the subcontractors. This can be done on a macro scale, using higher-level work groupings than the subcontractor would use. The GC's schedule must also address impacts from the owner. These could be issues such as receipt of permits to allow the work to proceed, they could be hold points that the project lender may require, or they could be equipment de-energizations or access to areas that only the owner controls. But an independent, third-party review is always beneficial. By employing a third party, which may well come from within the organization, any bias from the builder of the schedule will be removed.

With the schedule complete, reviewed, and accepted by all parties, its maintenance process must be established. Many projects have well-built, excellent schedules when the job first starts, but the schedule is not maintained in an orderly fashion. Too often, the scheduler is assigned duties outside of scheduling. Other times, the scheduler is a *pure scheduler,* someone who is a software whiz but has no idea of the difference between a boiler steam drum and a turbine rotor. Either of these situations prevents the scheduler from being able to thoroughly analyze the data being provided for input to the schedule. Therefore, it is very important that the scheduler is familiar with the components of the work and also has the time to do this job.

As an example, here is what can go wrong when the scheduling is not properly maintained. Take the case of the erection of a new boiler. Normally, as the work progresses, the field superintendents generally provide the scheduler with updates on the progress of the work. The superintendent responsible for the backpass may report that the reheat elements are 50% erected. The scheduler, if not familiar with the components of a boiler, will simply enter this information into the schedule. But suppose the superintendent was wrong? His foreman may have given him erroneous information or he may have just been guessing as to the percent complete, not actually having had the time to make a physical count of the number of elements installed. Either way, if the scheduler is a power plant–experienced member of the site staff, he would have walked through the job before the superintendents gave their reports so that he would be able to second-guess them. In this case, he would have been able to ask how can 50% of the elements be erected when 75% of them are still in the lay down yard? He would have been able to avoid erroneous reporting, in this case, *over-reporting*.

The opposite also happens; the field staff sometimes reports less progress than actually achieved, sometimes referred to as *keeping something in the back pocket*. Just like over-reporting, under-reporting is also an undesirable way to manage a job. In the case of under-reporting, cash flow may be hindered; and as discussed in earlier chapters, reduced cash flow, the lifeline of a contractor, can lead to serious consequences.

An error frequently made when setting up the jobsite management procedures is not providing a single source control for all scheduling activities. On a job with more than one contractor, it is important to have *only one* master schedule, and *all* other schedules must be synchronized with this one program. Otherwise, chaos will set in.

What generally happens in the event of nonsynchronized schedules is that each contractor, and even their subcontractors, will build a schedule to suit their needs with minimal regard to the needs of other contractors. The electrical contractor may schedule the installation of cable tray and cables across the rear of the boiler at a point in time before the boiler contractor has scheduled the installation of the reheat elements into the backpass. If the work proceeds in this fashion, the cable trays and cables may have to be removed and then reinstalled so the reheat elements can be erected, or the erection scheme for the reheat elements may have to be redesigned. Each option is costly and could have been easily prevented if both schedules had been synchronized and reviewed by a single individual in charge of the project scheduling process.

Now, having addressed the importance of building a proper schedule, and the importance of managing its maintenance, we must also address the importance of keeping copies of all schedule updates and revisions. This becomes crucial in the event of disputes. As discussed in the chapter on claims avoidance, when all of the schedule updates and revisions are available, the claims process goes much smoother. Facts are facts, and if the scheduling process was properly managed, the impacts of delays, extra work scopes, and accelerations can be readily established. Without these earlier schedule revisions available, claim managers must spend extra time, and money, to *reinvent* the sequence of events that ultimately leads to increased costs for all concerned.

Tools and Major Equipment

Directly managing the site tools and equipment can yield major savings. Although the cost of the tools and equipment of a 14-week outage may run in the neighborhood of only 10% of the total jobsite costs, on a new construction project, they may easily exceed double this percentage. So if the construction costs of a new plant are $50 million, 20% of this is $10 million, a sum that easily justifies direct management of this area of the job.

Many site superintendents focus most of their attention on only three aspects of the job: 1) labor, 2) schedule, and 3) safety. They seldom spend much time worrying about the tools and equipment being used; this is treated as an entitled supplement for the management of the labor and the schedule. Consequently, tools, especially hand tools, are often ordered at the last minute, when the stock is gone. They are also often procured and held as *private stashes*, not made available to any other work crew (fig. 11–2). In the first instance, this can create unnecessary freight costs when overnight or next-day shipment is required. In the second instance, it creates unnecessary inventory, which equals unnecessary costs.

Fig. 11–2 Excess inventory of tools.
Courtesy of Construction Business Associates, LLC

A similar situation occurs with large equipment such as cranes. Although the procuring or renting of a crane is usually planned in advance and is based on the lifts that need to be made, the disposition of this equipment is another matter. Once again, the site superintendents often treat this equipment similar to the way they treat their tools, as an entitlement for managing the labor and schedule. Frequently, after the main tasks for which the equipment was ordered are completed, the equipment sits idle on the jobsite, either because someone has a thought about using it for an additional task in a few days, or because everyone has now forgotten about it. Either way, it usually continues to incur costs by way of rental fees; or if self-owned, it incurs direct jobsite charges for its depreciation.

To alleviate the incurrence of these unnecessary costs to the job, one individual should be assigned to manage all of the tools and equipment. This person would be responsible to make an inventory of all tools and equipment on-site. Then an assessment of the remaining needs would be prepared, say on a weekly basis, and the two compared. Surplus items would then be released immediately and a plan developed to manage the shortfall. Subsequently, a review would be made of ways to substitute less costly tools and equipment for those still being used. As the job neared the end, daily reviews would be made. Even if this process only saved 1% of the tool and equipment costs, on a major job this would far exceed the cost of the person managing it.

In addition to managing the jobsite tools and equipment, it is also important to review the rigging plans at the beginning of the job to explore if there are more cost-effective ways to perform the task. For example, figure 11–3 shows a hydraulic crane being used to erect waterwall panels in a boiler. Is this cost effective? There's only one way to be sure and that is to assess the expected costs for the rental of this crane and its expected duration and compare them with the costs of doing the job using tuggers. In the end, it will be a function of savings in labor costs due to a shorter time span by using the crane vs. the higher costs of renting a crane as opposed to using tuggers and their associated costs.

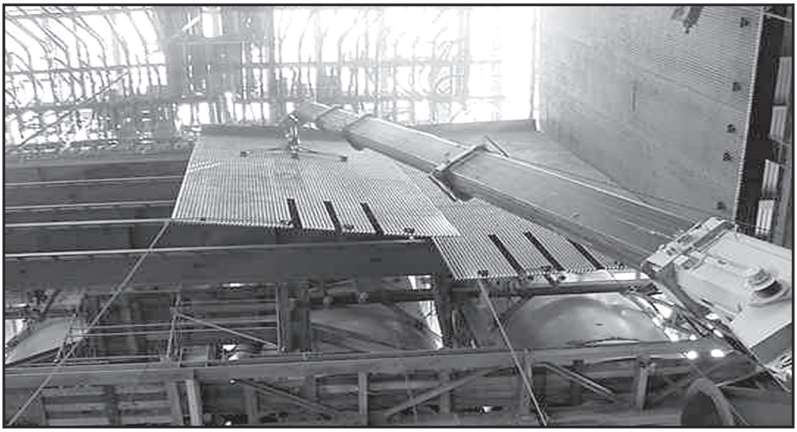


Fig. 11–3 Is this more cost effective than using a tugger?

Consumables

Just as it is important to manage tools and equipment, it is equally important to manage consumables. Although not as costly as tools and equipment, consumables still impact total site costs, ranging 5–10%. Therefore, reigning in unnecessary waste in this area has an affect on the bottom line. When no specific plan is made to manage these items, they end up being treated in the same way as the tools and equipment are treated when they are not independently managed—they are treated as an entitlement.

There are several ways to manage consumables. The simplest is to include it in the duties of the person assigned to manage the tools and equipment. This person would then do precisely what he does with the tools; make an inventory of all consumables on-site. Then he would make an assessment of the remaining needs, say on a weekly basis, and compare the two. Surplus, unused items would then be returned for credit, and a plan would be developed to manage any shortfall. This is usually adequate for a short duration outage. But what about a long-term, 18-month construction job?

Since it is difficult to plan for the use of consumables stretching for an 18-month period, a risk shift to the supplier of the items is often effective. One approach is to contract with the supplier of the items for making available a predetermined minimum number of these supplies, at all times. The contract should state that the supplier establish a facility on-site (a trailer or maybe a fixed building) for housing these supplies. The workers could then go to this facility and draw out the consumables they need for their particular task. The supply clerk, an employee of the supplier, would be responsible for recording the cost of these items to the proper accounting code, he would be responsible for tracking the inventory, and he would be required to reorder as the stock dwindled.

At the completion of the job, any consumables remaining in the supply shack or trailer would remain the property of the supplier. Any unused supplies still remaining on the site would be returned to the supplier, for a credit, and he would then remove his facility from the site. This type of arrangement has the advantage of shifting the risk of overstocking from the contractor performing the work to the supplier providing the consumables. In the event of shortages, the supplier would be responsible to supplement his on-site supplies from his other locations or stores.

Materials

Not every job will require that the site team procures and/or manages the materials to be installed. Often, this will be the responsibility of the owner, OEM, or GC. But there are those jobs that are delivered and erected (D&E), where the on-site contractor has the responsibility to procure, deliver, store, and erect the materials. This has its good points and its bad ones. The good points are that the site has more control over what is being provided, when it is delivered, and often, how it is stored. This makes the job of scheduling the work, manpower, tools, and equipment easier. It allows the contractor to work directly with the manufacturer or supplier to arrange for *construction-friendly* components, components that are designed for ease of installation.

The downside of this approach is that the site management is now solely responsible for on-time deliveries, correcting manufacturing errors and any difficulties in installing the materials. They now have to provide their own purchasers and expeditors. They may need additional engineering staff to work with the manufacturers. They no longer have anyone else to point a finger at when the materials do not arrive when promised and in the condition promised.

Since most construction contractors do not normally have personnel experienced in engineering, purchasing, or expediting, material management is generally not part of their scope. When forced upon the contractor, it often diverts site management's attention from the daily site work activities, which can result in less effective site managing and increased costs.

Site Services

Site services are needed by everyone on-site, from the owner down to the GC and from the GC down to the contractors and their subcontractors. Everyone needs a place to park. Everyone needs a place for their offices and other facilities. Everyone needs power, water, maybe compressed air, and trash removal. Traffic control is important on a new construction site and road maintenance may be required. Security is always a major item. Maintenance of storage/lay down areas has to be done by someone. Nighttime lighting may be necessary. First aid and possibly ambulance services may be required. Sanitary facilities, fire protection, and sometimes communication facilities may also be needed. The responsibilities for all of this have to be assigned and assumed.

Usually, the GC assumes these duties for a new construction project. If it is work in an existing plant, frequently, the owner is in charge. But to whomever these responsibilities are assigned, they will still want to economize the expenditures. It is not easy to please all of the contractors and suppliers that are depending on these services and still remain frugal. Everyone wants their facilities to be located right next to their work. Everyone wants to park right next to their own facilities. Many contractors want unlimited power supplies to do their work and many want lay down and preassembly lots within easy reach and well maintained.

The typical construction site is never designed to provide all of this. Most existing plants where an outage is scheduled are even more restrictive. There's never enough of everything to please everyone. So the owner or the GC resorts to a juggling act. Some of the responsibilities are shifted down the line. The owner of an existing plant may require the individual contractors to provide their own compressed air. They may require them to rent land outside of the plant for lay down and preassembly. The GC on a new construction project may insist that all parking be outside the premises, and buses will be provided to transport the workers from there to the job.

Most contractors don't like to share. They also don't want to be moved from location to location. They want to establish on-site and put that phase of the job behind them. So it is incumbent upon the owner or the GC to plan the supply of site services and to manage them well. But it is equally important for the contractors to plan ahead and advise the owner or GC of their needs long before they are required.

When there is no coordination of site services, inefficiencies result. Welders may stand around waiting for additional power to be provided. Riggers may wait while access is prepared to allow a large component to be brought to them. Manpower may need to walk up many flights of stairs while the access elevator is being repaired. The examples go on and on. The party responsible for providing these services must work closely with all of the end users. They must manage this as a stand-alone project. The costs of not doing so are often intangible, but nevertheless, they are real.

Keeping It All Together

Managing all of the activities on a power plant construction site, especially when it's a fast-track project or a tightly scheduled turnaround, is hectic at best. There are so many different activities, so many different entities, and so many different needs that an organized process is required. Typical site managers, whether they are the owner's representative, the lead people for the GC, or the No. 1 people for the contractor, have more duties than sometimes seem humanly possible to perform. Added to the daily *emergencies* that arise, the site managers have almost no time to verify that everything is going as it should, all of the time. A systemized check-off procedure is needed to maintain some semblance of order.

The design of this system cannot be complicated, because if it is, it will not be used. It can be lengthy, but it must be logical and it must be organized. One approach is to follow a process similar to an auditing procedure. First, classify the project into its various business elements:

- Project management
- Administrative functions
- Purchasing
- Labor
- Safety
- Quality

Then make a list of each activity, business requirement or document to be kept on-site. Review each of these items and place a "yes" or "no" next to each. However, don't review the total list of items all at once. Space the reviews over a period of days or weeks. Subsequently, make spot checks using this list as a guide. (See Appendix E, for an example.)

Many projects can benefit from a direct review of the items exactly as they are listed in Appendix E. All of the items will not necessarily apply to any single project. Some can be eliminated while others may need to be added. But the importance of using such a procedure is that there is now a process that can be followed, consistently, to help maintain a focus on the business side of managing the site activities.

E-commerce and the Internet

What is e-commerce and how can e-commerce and the Internet facilitate good on-site construction management? As technology evolves and as companies streamline in the name of cost reduction, more and more businesses are using electronic media for and in their daily business. They use it for communications. They use it for storage of information. It gets used to manipulate data. It provides a portal for information exchange without time-sensitive boundaries. It is often referred to as business-to-business (B2B) exchange. But where is its applicability for a construction project?

Let's go back to the different segments of a construction project: the manpower, schedule, tools, etc. Each of these can be impacted, beneficially, with the right application of electronic technology. Manpower management can and is being done through the use of large databases that allow for searching out persons with the specific skills that are needed for the job at hand. This information is available from in-company files, labor brokers, and union halls for the benefit of the site management looking to man a job. These databases can provide experience backgrounds, educational training, and technical skills for literally millions of workers who have the potential of working on-site. What used to be strictly a laborious word-of-mouth process of identifying workers and supervisors has become a much more refined process of searching and selecting the right person for the right job.

The process of scheduling was the first to become *computerized*. With the development of logic links tying hundreds of items together, the use of the computer became standard. It allowed not only the linking of items together but also the calculation of floats, or the loss thereof, when an item's time slot or duration was changed. From this stage, it became second nature to link various schedules together electronically. This allowed different parties on the project to integrate their respective programs with the master program, producing a total project program that would highlight the impact of one contractor's actions upon the others.

Taking this a step further, schedules are now updated by input, not only from the various contractors, but also from suppliers of equipment and materials. Say that the turbine pedestal pour is scheduled to commence on a certain day, but the concrete supplier has a mix-up in the availability of trucks, creating a two-day delay. This can be electronically *piped* right into the master project schedule where the impact on all affected contractors can be immediately seen. This allows for work-around options to be explored and implemented, avoiding inefficiencies by keeping the labor productive, even if on another task. It allows for on-the-spot planning.

Tools and equipment management can be done so much easier by using e-commerce. Tracking of the tools can be done by the use of bar codes. Each tool can be marked with specially formulated labels (or sometimes just engravings) that allow anyone with a complementary handheld scanner to send information to a central data base that will advise those responsible for managing the tools of the status each one. Information on who has the tool, where they are working, and what cost codes are involved is instantaneous. If the tool is lost or broken, this can be recorded and inventory can be updated, a new tool can be ordered, and/or repair of the broken tool can be scheduled.

Major equipment management is also much easier when all of the information resides in one database. If the contractor owns the equipment, it can be tracked as to location and requisite cost codes. If a third-party rental company owns it, they can access their records and know exactly where it is and when it is scheduled to return. For either party, the equipment's maintenance can be tracked and automatically scheduled. But for the user of the equipment, its usage performance can be calculated, allowing for fact-based decisions on how to get the most for its cost.

Managing consumables is another area perfect for e-commerce. Since many of the consumable items on a power plant construction project are repetitive items, lending themselves to be purchased in bulk, e-commerce makes this process painless. With a tracking system that feeds into a central database, those responsible for purchasing can be electronically notified when the stock of a particular item is low. They can then order more, electronically if they are linked to the supplier, and the supplier can invoice in the same manner. After receipt of the items, an electronic or scanned inventory can be made and if this tallies with the data used for purchasing, payment can be authorized immediately.

Even managing the day-to-day needs of the site services can be expedited using e-commerce and the Internet. Trash removal services can be scheduled and updated with the service provider on a live basis. Construction power usage can be tracked and compared against projected demand to help decide when increases or decreases will need to be made. The tracking of open areas, the planning of roads, both temporary and permanent, can be made and transmitted to all parties on the site, without the need to wait for the next scheduled meeting.

But the most powerful effect the electronic media and the Internet can have is in the business management side of the site work. The investors and the owners of the power plant facilities expect timely, fiduciary management of the construction on their facilities. They want information to be able to make decisions that may affect their total investment portfolios, going beyond just the plant in question. They do not want surprises. As stated by John Long, Senior Vice President for Generation, Constellation Energy, in the Introduction to this book,

> *The successful power generators are those who can consistently meet and beat their forecasted earnings. Excellence in project management and project controls are vital competencies to achieve those goals.*

Today, excellence means being able to collect data, digest its meanings, and transmit these results to the decision makers. The electronic media and the Internet are excellent tools for this.

Looking back at manpower management, looking at the ways schedules can be handled and seeing how close attention to tools and major equipment can affect the job shows that e-commerce and using the Internet are paths of project management that offer flexibility and control. Rolling in the consumables and materials and even including the management of the required site services just enhance this. IT is a vehicle for the power plant owners to satisfy their investors that their business is under control. The commonly used buzzwords are *centralized, enterprise,* and *program control.* But the bottom line is that data is collected in a central repository, in a timely, instantaneous manner so it can be distilled according to the needs of the user, in time to make proactive decisions.

Interfacing is the key. There are many organizations providing many different services to a host of end users and not all use the same platform for data collection nor information dissemination. One contractor may be accustomed to using software A for scheduling. He may have homegrown payroll systems and use a third-party program to marry the two. Another contractor may use completely different systems, grown out of the need to satisfy clients in a different industry. A third contractor may have still a different variant on these processes and then there's the GC who is trying to marry them all. It can be a juggling act, at best, unless there's a program or process to interface all of this information.

Fortunately, there are programs, there are vendors and often there are in-house providers who can assimilate all of this data and provide feedback that will meet the requirements of every entity on the job. The information from the first tier contractors can be fed into a central repository, collated with the requirements of the GC's project needs, and superimposed on the owner's requirements to allow the parties in charge of the project to make decisions in time to still impact the work. Basically, these systems work as follows:

All site information, such as budget, WBSs, cost, man-hours, schedule, material control, nonconformances, request for information, safety, etc. are electronically stored in one central location. The path the information uses to arrive at the central repository is not relevant, the information can come via any software program, even competing programs. For instance, one contractor may be using a scheduling program that is in vogue today while another may be using one that was in vogue the year before; it does not matter. The same is the case for information from the accounting group. One may feed information using a spreadsheet while another may be using a database format.

Then a retrieval system is designed to provide information (as opposed to data) for use by personnel according to their needs. For example, the site manager might want to know the overall status of the electrical work on a large new power plant project. There may be four or five different contractors involved, one for the basic grounding grid, one for the high voltage switchgear, one for the control room, one for the exterior cable trays and cabling to all of the equipment and several others who are responsible for installing instrumentation and controls. With all contractors feeding their data into the central repository, the site manager can call for and look at collated information showing current and planned progress, costs vs. budget and documented issues that either have been resolved or still need to be resolved. The system can also be designed to integrate with home office, or corporate systems, so if the home office wants to see the committed costs to date, or the total man-hours used and projected, they can simply access it by a click of their computer mouse.

There are also two additional benefits of using a system like this: overall "dashboard" viewing, and "drill-downs." For the busy site managers, the system can be designed to provide a status report of all major projects, or contractors on-site, showing budgets, costs and committed costs to date, projected final costs, schedule information, requests for information resolved vs. still outstanding and overdue, nonconformances and also safety statistics. An additional feature that can be built in as well is adding notes to clarify, or explain why some of the indicators are the way they are, thereby sometimes avoiding the need to drill down.

The dashboard, as the example in figure 11–4 shows, provides summary information, rolled up to any level desired by the viewer, with green, yellow and red traffic-light type of symbols that advise the recipient of the condition of each portion of the projects status. Looking at figure 11–4, one can see that the grading project is in trouble. Both cost and schedule are highlighted in red, and a quick glance at the approved and projected funds shows why. The note, at the end of the line, even talks about bankruptcy possibilities, suggesting this particular part of the job requires immediate attention.

ABC Power Project
Anywhere, USA

Major Site Activities Summary
August 2004

Executive Summary

Project	Contractor	Approved Funds	Projected at Completion	Cost	% Compl	Schedule	RFI	NCR	Safety	Notes
Grading	Morse Earthworks	$ 275,000	$ 400,000	R	87%	R	Y	G	G	Sub may resort to bankruptcy protection
Foundations	Municipal Foundations	$ 500,000	$ 575,000	Y	55%	G	G	R	G	NCR's starting to affect costs
Electrical	Ramsey Electrical	$ 275,000	$ 275,000	G	5%	G	G	G	G	Contractor just mobilized
Electrical	Specialty Instruments	$ 480,000	$ 480,000							Contractor not yet on site
Turbine	Self Performing	$ 8,500,000	$ 8,500,000							Activity not yet started
Boiler	Boiler Specialists	$ 40,000,000	$ 40,000,000	G		Y	G	G	G	Material delays may affect schedule
Site Total		$ 50,030,000	$ 50,230,000		0.5%					

Key:
G Green = No Problems Envisioned
Y Yellow = Potential Problems Ahead
R Red = Requires Management Attention

Fig. 11–4 Dashboard view of major site activities.
Courtesy of Construction Business Associates, LLC

The foundations project is also worthy of attention, but for different reasons. Here, the costs are creeping up. Worrisome is the fact that there is a red warning light under the NCR (nonconformance report) column. This indicates that there is an issue with NCRs to the specifications that either could translate into money or schedule problems as the project proceeds.

At the point in time of the subject report, there do not seem to be any electrical construction issues, but the boiler contract has a cautionary yellow indicator in the schedule column, and the note points out that material delays may affect schedule, soon. This is the kind of "instant" warning that can assist the site manager in determining where to focus his time, and whether or not he needs to "drill down" further to see what else may be lurking in the shadows.

The other benefit of using this type of system is the ability to "drill down" and get to any detail, such as the man-hours expended to date for a particular concrete pour, or the number of lost time accidents one of the electrical contractors has experienced—including the details of each accident. It is actually this ability to drill down that makes the dashboard so valuable. By having the confidence that the data underlying the dashboard view is available, at the click of a mouse button, lends the necessary confidence to the user that what's being seen is what's actually happening.

Some organizations go beyond just the site use of this type of project management tool; they integrate it with their corporate systems. For example, the details of a specific job, such as the one in figure 11–4, can be added to the details of many other projects, whether similar or not, to keep track of and manage total corporate resources like capital expenditures, supervision, company-wide safety statistics, overall cash flow, tools and equipment tracking, and so on. Properly designed, this type of system can be accessed from anywhere in the world; the possible uses are many. But the single key is that it is no longer just a repository for data, it is also a window into the information for those that need it the most—for them to make proactive decisions—keeping with the concept that quiet proactivity is always better than heroic reactivity. It helps projects complete sooner, at less cost and with greater stakeholder satisfaction.

There are still more uses of e-commerce and the Internet that can facilitate the management of a construction site. One such example, not mentioned here, is the transmittal of drawings over the Internet. This alone, can save an enormous amount of shipping and handling of paper documents. Drawings can be transmitted electronically to the site and printed for only those workers and supervisors who have a need for them. Additionally, when errors are discovered or work-arounds are required, communications between the field and the engineers can be expedited. When accompanied by live video feeds, the site superintendent and the home office engineer can correspond just as if they were standing together on-site with the drawings in their hands.

Another example is bar coding. To speed up data gathering, many segments of the construction process lend themselves to the use of bar codes, that series of vertical lines of varying thickness that are on almost every item purchased in any store today, from groceries to clothes to automobile tires. The information that these bar codes contain is enormous. By placing a bar code on a tool and then scanning it periodically and adding the cost code to which it should be charged at the moment offer the site accountants more options. They can charge the tool's cost to the proper WBSs, they can update the total usage time of the tool, and then automatically schedule it for maintenance, replacement, or recalibration.

Having incoming project materials be bar coded can assist in identification and material receipt inspections. This can be used to determine where to store the materials, especially in regard to when the material needs to be accessed and used. For example, if the original construction plan was to preassemble the boiler waterwalls, along with buckstays, sootblower, and observation port seal boxes, arranging the storage of each of these separate components as they arrive on-site is important. Using bar codes, these items can be *flagged* to be stored in proximity of each other, and they can be coded so that once they are all on-site, the scheduling department is notified that the preassembly work can start.

Other uses of bar coding can extend to personnel. Bar coding their identification badges can eliminate the *brassing in* process still used at many sites. It can even aid in reducing the need for the foremen and time keepers to manually input a worker's time and reduce the possibility of charging the time to the incorrect cost code or WBSs.

Some site superintendents also expedite the data gathering and communication steps of the e-commerce process by using handheld personal digital assistants (PDAs). Some of these devices can be used to read bar codes on equipment as it is received and some can be used as keyboards to enter information that the superintendent wants to transmit to the central repository of data. Others can also be used as cellular phones or as walkie-talkies. The phrase "untethered communications" is used to describe this type of information transmission because these devices either store the data until they are plugged into a receptor for downloading or they transmit the data wirelessly to wherever it is to be stored.

Rugged handheld tablets are another tool, similar to the PDAs, that are entering the construction industry. These are designed to hold large amounts of data, such as drawing files, and they can then be used to update, or redline, drawings on the spot. The tablet can be programmed to constantly update a central database and other tablets as well, so that all is not lost if one tablet suddenly falls 200 ft off the building structure.

None of this suggests that e-commerce and the Internet are going to replace the art of human thought. Systems break down; people make mistakes when entering data and others err in its interpretation. There will always be a need for a live human being to look over the shoulder of the electronic transactions and provide a reality check.

Summary

Managing the site activities of any construction job can be an enormous undertaking. Making a change to any one of the variables impacts the others. Manpower loading affects the schedule. Scheduling changes affect the cost of the tools and equipment. Not allowing for the right amount of consumables, at the right time, can affect both the manpower efficiency and the schedule and not taking proper care of the materials received on-site can wreak havoc with the job. The management of the site services, which every entity on the job depends upon, is obviously one of the most important responsibilities the GC or owner assumes. But keeping it all together and then daring to delve into the new technologies of e-commerce and using the Internet to assist in the management of the job can reap benefits that sometimes stretch the imagination.

Manpower, the heart of the project, must be managed with regard to productivity. A man-hour used is a man-hour spent; it cannot be reclaimed. It is probably next in importance to cash flow for the contractor on a fixed price project, and it is usually first in importance to an owner on a cost-reimbursable contract. Therefore, knowing how to track productivity and knowing when, if, and how to react can spell the success or doom of the work.

Scheduling, which is integral with manpower management, is just as important. Sending erroneous information creates all kinds of difficulties. Cash flow can go wrong, costly rework may result, and keeping accurate records of the schedules is critical in the event of claims.

The management of the tools and major equipment cannot be overstated. Too often, these items are treated as entitlements, and when they represent up to 20% of a project's costs, even a small percentage of savings can more than pay for the cost of managing them. The same holds for managing consumables, where there is often the additional opportunity to not just manage these, but also to shift the risk of the overall costs from the contractor to the supplier.

Site services are that shared resource that everyone on-site requires to be effective. The owner or the GC that assumed the responsibility to manage these resources must accept the responsibility to adequately and fairly parcel out these resources and not unduly penalize one contractor for the benefit of another.

Although all of these pieces of the site works puzzle must be discreetly managed, they ultimately must be pulled together to form a cohesive project. Since even a *simple* power plant project is a colossal undertaking, any tools that can make the site managers' jobs somewhat easier should be considered for use. A simple checklist of all of the major business elements of the project can often reduce what seems like a nightmare to a manageable process. Using a checklist, like the one in Appendix E, can be a way to maintain one's sanity.

But there are even more tools, more technology that can be used to relieve some of the burden of the site manager who is trying to be everywhere at once. E-commerce, the Internet, or the tools of the electronic age, which are continuously evolving, have great potential for easing the site manager's daily duties. Setting up central repositories of data, designing systems that will distill this data into useful information and then providing clear dashboard type of reports for decision making is the kind of leap that the 21st century is all about.

Bar codes and PDAs are some of the hard tools available to assist in implementing these new technological advances. They're here today, but tomorrow there'll be still more. Evaluating, experimenting, and being amenable to using new tools such as these will be the mark of the future site leaders. The need for the hands-on skills will not go away, but the tools to free up the time to allow the hands-on skills to be used will be a complement to every site management process.

12

PULLING IT ALL TOGETHER

Many power generation plants today are in business specifically to make money. For them, generating power is just a means to an end. Their investors are there for one reason only: to make money. If the returns do not meet their expectations, they will shift their money elsewhere. It is vital that the management of the plant understand that. Even if the plant still operates in a regulated environment, reducing costs by managing to the bottom line is still important. Investors' returns, whether regulated or not, are still *their* returns and whoever impacts these returns has an obligation to help maximize them. That means prudent management of all phases of the plant operations is of paramount consideration, and this includes the often-neglected site construction phase. Put another way, it's now all about the money!

As the introduction to this book emphasized, managing the construction activities of a power plant project today requires a different focus. Equipment, technology, and operational skills have evolved. Sophistication is more in demand than ever before. Not only are just-in-time deliveries important to facilitate smaller footprints and lay down needs, they're important for the cost of inventory control and storage fees. Not only are pretrained craftsmen important for being able to hit the ground running, they're important for the cost savings in on-the-job training avoidance that translates into saved man-hours and a reduction in schedule and costs. Not only is an emphasis on safety morally correct and an often-demanded requirement to work on many of the sites, but now it is also a major factor of the bottom line labor costs. The same goes for quality, and the list goes on and on.

The management of the construction phase of a power project will impact the total costs of that project, whether it's building a new plant or rehabilitating the old. Although the construction phase occurs at the end of the project process, it is really the tail that wags the dog. The project process may start in operations, it may start in maintenance, or it may start in engineering. But then it moves into budgeting and from there, to project management. Once, twice, or three times it is reviewed, then engineered, parts and equipment are procured, and finally it goes to the field. By then however, the cost of a change, the cost of inefficiency, or the cost of cancellation can be devastating. The trick is to link all of the phases upfront and then manage them collectively, toward a successful conclusion. The investor expects nothing less.

It's as simple as knowing that the economics of a managed process are controllable; the economics of a random one are not. The time value of the money borrowed to build the plant, or even upgrade its components, is significant. The unavailability of a revenue stream before the plant comes online has a direct impact on the return to the investor. The insecurity of entering into an unmanaged construction project, especially with all of the risks associated with construction work, has a cost component in the guise of insurance, contingencies, and other protections. As stated earlier by one of the power generation community's premier investors, their commitment to their investors is to make sure that management has the processes in place to manage project risks; at the end of the day, there are no silver bullets to success.

These past chapters have delved into many aspects of the power plant construction process. Subjects have ranged from the planning process, which included how to structure the delivery of the project itself and discussions of resourcing and contingencies, to understanding the contractual commitments that were handed down to the site staff. It is seldom possible for the site staff to influence the specifics of contract terms, especially since the bidding process, the negotiations, and even the final agreements usually take place long before the site managers are assigned. But it is still important that these managers understand what has been agreed upon, what has been committed, and what they must expect and enforce. They must understand the impacts of their actions upon the requirements they are obliged to carry out such as the final schedule, price, and ultimate cost to the job or the contract.

They must understand that there are rules to be followed. Every contract today has a legal framework. It has terms and conditions that can be enforced in the courts worldwide. If the owner or investor feels that things have gone awry, litigation may ensue. If the contractors or suppliers feel they've been injured, lawsuits will fly. There are jobs where it seems that more time and money is spent on preparing for mediations, arbitrations, and litigations than there is spent getting the job completed to the requirements of the original stakeholder agreement.

This litigious environment has given rise to an era of risk management by opening new avenues of claims avoidance and insurance management; lawyers are now an integral part of building a power plant—they're even there for just a rehab job. This environment forces the jobsite managers of almost all power plant construction projects to not only understand the rules of the game, but to have them in front of them for reference before saying much of anything to anyone.

But there's still the responsibility of setting up the site, recruiting the personnel, getting the work done and walking out with one's head held high. How is this done, especially when it seems that all odds are against a successful outcome? The site manager and the staff that support this function do have the tools available to operate in today's world of litigation, distrust, ruthlessness, and constantly changing parameters. But they may need to learn new techniques and new philosophies to apply them. However, one thing has not changed—it's still construction management, not rocket science.

The business of managing a power plant construction project still requires satisfying the powers that be. These powers may not be the same owners that were around in the past, but they're still owners—owners interested in their money and its safety and the return that they will see.

The shift that is permeating this industry is that many of these owners are not interested in megawatt hour generation; they are interested in dividend dollar generation—manage the plant works to generate profits. In other words, manage the construction activities as if the money being spent on this work was the money from one's own pocket.

Many ideas, processes, and examples have been used throughout this book to address the various phases of managing the construction of power plant projects. They each have their own values. They each can be applied in many circumstances. But when put together, in a preplanned format, the information provided multiplies by several factors. The information that results from all of the well-thought-out data can influence decisions to completely change the course of a project. Pulling together this data and presenting it in informational reports will allow the site management, the operations management, and the investors to make informed decisions about whatever issues may arise.

What comes next is an orchestration of the effort required to pull it all together, followed by a discussion of the importance of communicating this information up and down the organization. Finally, there is a brief discussion on the importance of timely information and how it can impact other projects and endeavors.

Information for Decision Making

To enable the various levels of management to make informed decisions during the progress of a project, many different sources of information must be tapped. A well-designed construction job will have a series of reports, all existing for the purpose of providing information to show where the job is, where it may be headed, and where opportunities exist to change its course. Figure 12–1 show a decision-making tree in the form of a Jobsite Reporting Hierarchy. At the top sits the Decision Maker. At the disposal of this decision maker are financial reports, progress reports (discussed further later), and progress information relative to the financial position of the project. With these three informational reports, the decision maker can readily see where the job stands, how it is trending, and he can see this in time to avoid surprises at the end. That is not to say that the course of the job can always be changed, but at least the issues can be seen and they will not be a surprise at the end.

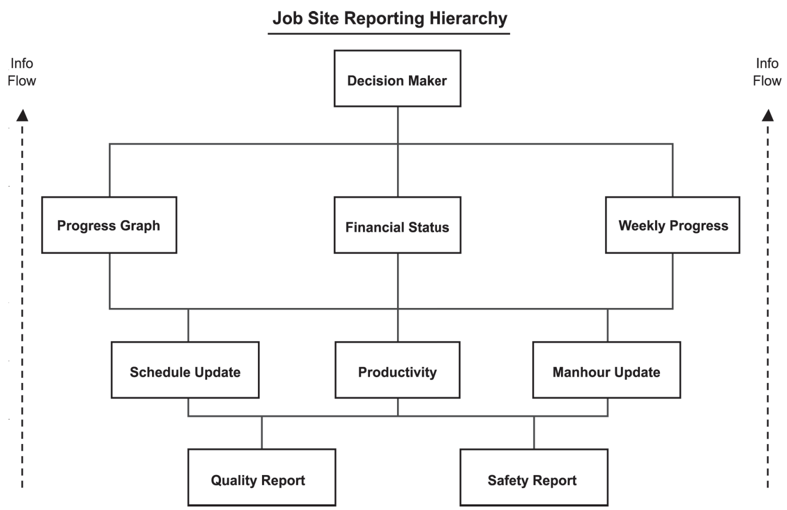


Fig. 12–1 Jobsite reporting hierarchy.
Courtesy of Construction Business Associates, LLC

Financial status report

First, there are the financial status reports. As discussed in chapter 10, there is a lot of financial data available. It must be collected and reported in a fashion that results in information and it must be useful information. A site manager generally has a budget to pay for the job, and this budget is generally subdivided into categories similar to those used to estimate the total cost for the job when it was first being structured. The first column of numbers in figure 10–2, is such a budget. It tells the site manager how much money has been planned for labor, how much has been planned for supervision and accounting support and how much has been planned for small tools, consumables, equipment and materials, and in this example, even specialty subcontractors and insurances.

In this figure, there is also the expended to date information that may be the first indication of how the job's financials will look at the end. A quick glance at these expended numbers may provide this indication, but it is by no means always reliable; there are too many unknowns. For instance, this column does not include money already committed but not yet expended. There are usually issues with timing, where there are expenditures outstanding that have simply not been recorded. There's often the problem of vendors and contractors not issuing invoices in a timely manner. But it is an all-important first base of data gathering that will be necessary to build the overall outlook for the job.

The next column, the projected at completion column is the one that tells the story, the story of at what cost the job is expected to complete. But how does one get to it? That requires several things. First, it requires an approximation of outstanding expenditures that have not been recorded. To that must be added outstanding invoices. Then a projection must be made of the costs of the project to the end of the job. To make this projection requires more specific knowledge of where the job stands in relation to schedule, productivity, and man-hours expended, as discussed next.

In chapter 11, both schedule and productivity were discussed; man-hour expenditure reporting was not discussed since this is normally a part of either the schedule updating process or a part of the accounting process. However, all three tools will be required to complete the projected at completion column of the financial status report.

The first piece of information needed to project the cost to complete the work will come from the schedule. Most schedules have a mechanism for tracking days allocated to an activity against days remaining, similar to what is shown in figure 12–2. These recreated schedule formats show the activities of one area of a boiler erection project. Each activity is linked to the next and has an associated original duration of days (or maybe hours or shifts if it is an outage) and a remaining duration to completion. Each activity also has the percent complete associated with it. In this example, the first five activities of chart 1 seem to be fairly well on track, all being complete. However, the sixth one, Activity A 1239, align and weld furnace intermediate rear wall to upper wall, seems odd. It shows only 25% complete but almost half of its original duration already used. The first chart says very little about the next two activities, only that they have not yet started. Is this per plan, or is there a problem here? To find out, the rest of the schedule is needed, with the early start and finish columns filled in as well as the total float. This is shown in the second chart of figure 12–2.

Chart 1

Activity ID	Activity Description	Orig Dur	Rem Dur	% Compl	Act Dur	Early Start	Actual Finish	Total Float
A 1234	Raise furnace upper rear buckstays	3	0	100				
A 1235	Raise furnace intermediate rear wall	1	0	100				
A 1236	Attach furnace upper rear buckstays	6	0	100				
A 1237	Raise furnace intermediate rear buckstays	3	0	100				
A 1238	Install furnace lower rear wall	5	0	100				
A 1239	Align and weld furnace int. rear wall to upper wall	13	8	25				
A 1240	Raise furnace lower rear wall panels	1	1	0				
A 1241	Align and weld furnace lower rear wall to inter. wall	6	6	0				

Chart 2

Activity ID	Activity Description	Orig Dur	Rem Dur	% Compl	Act Dur	Early Start	Actual Finish	Total Float
A 1234	Raise furnace upper rear buckstays	3	0	100	3	12-May	14-May	0
A 1235	Raise furnace intermediate rear wall	1	0	100	2	15-May	16-May	-1
A 1236	Attach furnace upper rear buckstays	6	0	100	4	16-May	22-May	2
A 1237	Raise furnace intermediate rear buckstays	3	0	100	3	26-May	27-May	0
A 1238	Install furnace lower rear wall	5	0	100	8	29-May	6-Jun	-3
A 1239	Align and weld furnace int. rear wall to upper wall	13	8	25	5	5-Jun		-2
A 1240	Raise furnace lower rear wall panels	1	1	0	0	24-Jun		
A 1241	Align and weld furnace lower rear wall to inter. wall	6	6	0	0	25-Jun		
Note: Work Scheduled for 5 Days per Week (updated 13 Jun 2005)							Total Float	-4

Fig. 12–2 Typical construction schedule duration format.

Chart 2 in figure 12–2 shows the work at the same point in time, but with additional information. Here, one can see when the activities were originally scheduled to start, as of the last reporting period how long they have been worked on, and their actual status as of this reporting period. Note the following:

- By adding the total float for the work of the first four activities, one day was gained.
- The fifth activity had a problem; three days were lost, bringing the total work two days behind schedule
- The sixth activity, #A 1239, seems to be rapidly losing ground. Five days have been used and only 25% of the work has been completed, resulting in two lost days of float, bringing the job total to four lost days.

To sum up, this portion of the project seems to have lost four days. It is not yet complete and the welding of the intermediate rear wall to the upper wall seems seriously behind schedule. How will this affect the end date? To determine this now requires a look at the productivity analysis, a tool that was also discussed in chapter 11.

Figure 11–1 showed a typical welding progress curve. Reproduced as figure 12–3, and populated with data from the previous example, quite a different story appears. Contrary to the information gleaned from the data provided by the schedule update, which shows that Activity A 1239 has already used 38% of its allotted time (5 days out of 13) yet only 25% of the welding is complete, progress is essentially as scheduled. The daily welds required, as well as the cumulative welds are essentially on target. Although welding work will always bear watching, most likely this activity will complete without losing any time, suggesting the two days of float earlier shown as lost to this activity are most likely not lost.

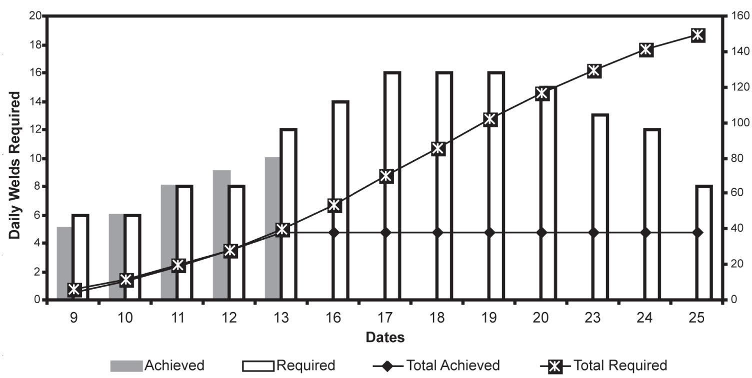


Fig. 12–3 Welding progress.

Next, referring to the productivity graph in the same figure, it is clear that the total productivity index is almost at 1.0, where it needs to be, and although the daily productivity fluctuates, it is the cumulative progress or productivity that matters. This clearly demonstrates that the job progress and the story being told by the various bits of data about the progress and probable outcome always require thorough analysis.

This scenario shows that for this particular part of the project, the welding work currently underway will most likely continue to track according to plan. This suggests that the original 13 days allocated to this activity will suffice and no additional schedule or monetary reserves will be required. It does not, however, overcome the fact that the total job is still a full two days behind schedule, as it was when the welding work started. There's nothing in the schedule to indicate that this will change, so barring additional information, the site manager must reflect a two-day negative float, and its impact on the schedule and cost in the next progress report.

When a job deviates from its schedule or cost, these deviations must be reflected in the job schedule and the financial status reports as soon as this is known. Continuing with this example, the current state of this job seems to be a potential two-day delay. If this were a short turnaround, this could have a significant impact on the project's outcome. Not only might two days' worth of extended overheads, equipment, tooling, and supervision costs be significant, the loss of two days of revenue generation, especially during peak demand, could be more than a million dollars. The sooner management is aware of this potential delay, the sooner alternate arrangements can be made for obtaining power from other sources to meet committed supply and mitigate the need to buy power for redistribution at spot prices.

However, if this delay is part of a much larger, long-term project, there may be opportunities to correct the deficiency. On a long-term project, manpower can be reallocated to help make up lost production. Extra shifts, or even extra hours per shift can be employed. But that does not eliminate all of the costs associated with the delay. Shifting manpower takes it away from other work activities that will suffer. Extra shifts or additional hours per shift will cost in terms of premium time.

To correctly reflect the impact this two-day delay will have on the job, the additional time on the short-term job must be reflected in the schedule update. The additional costs to support this time must be shown as part of the projected at completion section of the financial status report, possibly causing a projected overrun in the budget. This will then be a signal that more money may need to be allocated to complete the work, or other scope may need to be reduced or eliminated.

If the delay is associated with a longer-term job, and if it can be absorbed into the existing schedule, its cost impacts should still be reflected in the projected at completion column of the financial status report, possibly leading to a similar overrun scenario, which may need special attention.

Rounding out the information necessary to complete the projected at completion column is the rolled up total of the man-hours projected for each activity, along with those already expended. As part of the analysis, after knowing the duration expected from the schedule analysis, the productivity data to date can be used to assist in estimating the total man-hours required to complete the activity. This information is then entered into the financial report, converted to dollars, and added to the remaining categories to arrive at the financial projection for project completion.

Progress graph

By following this process, upon completion of the financial status report, the information will be available to complete the progress graph. As discussed in chapter 10, this progress graph is a very handy tool to quickly see where the project is, where it is trending, and if there's still time to react in the case of problems. Plotting this graph is straightforward. The man-hour expenditure data is available from the man-hour updates used to prepare the financial status report. The actual percentage of completion data is available from the schedule update information. The budgeted man-hour data is available from the financial status report, as part of the budgeted column, and the planned percent complete information is available from the schedule.

As discussed in chapter 10, the progress graph provides management with an instant view of whether or not the site work is trending in the desired direction. A quick glance can point to potential problem areas before they occur, often in time to take corrective action, and even when action is not possible, at least there won't be surprises.

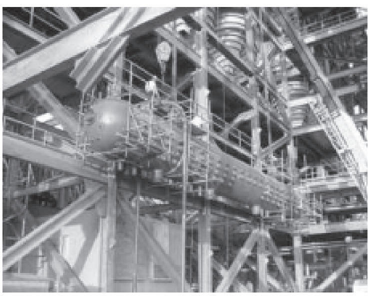
Weekly progress report

To put a *face* on the information in the reports discussed so far, a written progress report is often prepared. This is usually a weekly report, one page long, with a series of one-line statements regarding the status of the more important activities of the job. It usually highlights one *special* event of the week and then has several pertinent photographs of ongoing work. There are a few simple statements regarding any problems that are, or will affect the work. Sometimes, it will also include a brief statement about the plans for the next week or two. It is not intended to replace any updated schedules nor any look-ahead plans. These are still required as a normal part of the job planning activities. A typical report would look something like figure 12–4.

WEEKLY PROGRESS REPORT
Any Utility
Anywhere, USA

Week Ending
31-Mar-04
Weather: Sunny, 85°

Highlight of the Week



Steam Drum erection

Progress This Past Week

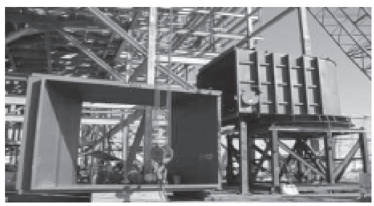
1 Steam Drum raised on schedule
2 Welding FBHE Final SH Elements
3 Ground Ass'y Economizer elements
4 Ground Ass'y RH Elements
5 Weld membrane of Furn. Up sidewalls
6 Weld membrane of backpass rear wall
7 Attach Buckstays on backpass rear wall
8 Offload contract material arriving from port
9 Installing FBHE Final SH Elements
10 Removed Drum Lift equipment from unit
11 Preparing double wide panel transport trailers
12 Installing Duct in unit
13 Setting Stress Relieving equipment on unit
14 Setting welding machines on unit

Problems

1 No Hanger Rods for Duct erection
2 Transport Trailers arrived late
3 Buckstays misfabricated
4 Welders leaving job for nearby OT work

Safety
No OSHA recordables this week

Progress Photos



Duct erection in progress

Reheat Element preassembly

Percent Complete
Planned 19.5%
Actual 18.5%

Equivalent Welds Complete
Planned 1,250
Actual 1,315

Fig. 12–4 Weekly progress report.
Courtesy of Construction Business Associates, LLC

Sometimes the report will include additional information such as percent complete and welding that was planned vs. what was completed. This information comes directly from the schedule updates and productivity data.

Other reports

Referring again to figure 12–1, the second tier of reports, the schedule updates, the productivity graphs, and the man-hour updates are important, but they do not provide much information on which to act. They collect data to be used in preparing the first tier information reports which are then used for making decisions. In fact, as was seen with the schedule update discussed previously, taken by itself, some of the data in the second tier reports could have led to the assumption that the job was starting to slip further behind.

Finally, there are two other reports that provide both data and information by themselves. These are the quality report and the safety report shown on the third tier of figure 12–1. Both have been described in their respective chapters on quality and safety, but it bears repeating that the information from these reports is very useful for preparing the three main reports: progress, financial, and weekly.

The quality report can point to areas of rework or pending rework that may not be apparent to the schedulers when they update the schedule. If there is a lot of rework pending, this needs to be taken into account when the schedule is being updated, and it subsequently must be reflected in the updated financial report. Repeating the example about code editions in chapter 8, things can be happening that others may not realize. In that example of using the wrong edition of the ASME code, there will be an issue of schedule since the other work in the area will be interrupted while all of these welds are stress relieved. There may be an issue of delaying the hydrostatic test, and there's certainly an issue of increased cost.

A similar situation arises with the information from the safety report. If it shows that safety is slipping, there could be a productivity issue looming nearby that needs to be considered when updating planned productivity charts for the various activities.

A quick word on narrative reports. While it is nice to have them when researching what happened on a job after the fact, it's time consuming to write them and they are very subjective in content. Very few jobsite personnel have the time to write them, let alone read them. For a very large project, they may be worthwhile or even required by various lending institutions, but then they should be prepared by someone other than the site staff. Home office personnel, familiar with the job and its conditions, are usually better suited to address these types of reports.

Communicating Up and Down the Chain of Command

Reporting is a *must* on any project. Just like everyone has a boss, everyone must report to someone on what they're doing. On a power plant construction site, there are many levels in the chain of command. It starts with the worker, the craftsman who does the actual work. From there, the next link in the chain is the foreman, the one responsible for assigning the work to the workers and ensuring that the work is done. The next level is generally one of the general foremen, or *the* general foreman who, in turn, reports to the superintendents on the job. At this point, the superintendents usually are responsible to their site manager for the work that is being done, and they are responsible to keep the site manager apprised of the conditions of the work, its progress, its costs, and any potential problems that may arise.

Beyond the site organization, whether it's the organization of a contractor or the organization of an owner self-performing the work, there are the stakeholders. These are the people who make the decisions that need to be made when the work is not going as planned. They may be higher level managers within the power generator's organization. They may be members of an alliance that has been formed to manage and operate the plant or they may be an independent group that represents the ultimate owners of the facility. But whoever they are, they need and deserve accurate reports on the status of the construction activities at site.

The requirement to provide accurate reporting up the chain of command has been reiterated many times throughout this book. The stakeholders need good information to make determinations that will affect their money. But what about reporting *down* the chain of command? Is there a need to keep the personnel on the lower levels of the command chain informed of the plans and actions of those from above? Most modern day management theories will say yes. They will say that an informed worker is an involved worker; understanding the *why* of an instruction is what will motivate the worker. Certainly, there's very little to be lost by keeping everyone informed of the decisions that are being made by the powers that be and there's also little to be lost by providing the reasoning for those decisions.

There are organizations that share everything, everything down to the last dollar being committed on the job and the effect every change has on the bottom line of the project. Some even go so far as to divulge the cost of each of the participants so anyone wanting to calculate the potential impact of a decision will have the tools to do so. There are other groups, however, that do not go so far. They are concerned about information that will leak to their competitors and even to their clients, whether these clients are the current ones for the specific job at hand or clients from past or for future work.

The issues involved in reporting results up the chain of command are different than those involved in reporting results down the ladder. To report information, it is important to understand what will be done with it. Since information can be presented in an unlimited number of ways, for it to be efficiently used requires that it be tailored to the needs of the recipient. The recipients at the top half will use the information very differently than those below. For example, the contractor's home office manager, to whom his site manager is responsible, may need to know, as early as possible, if additional supervisory personnel may be required in the near future. This means that the site manager must emphasize staffing and the financial impact the lack of staffing may have on the work.

On the other hand, the client will not worry about the contractor's staffing; he will worry about the effect of the contractor's activities on the other contractors on-site—an issue that the contractor's home office will not care about. Then there are the other contractors on-site. They will be concerned about every other contractor's activities as well as the plans and actions of the GC and the owner. What about the workers? What do they care about? Just ask them. They care about a safe workplace. They care about a financially solvent employer. They care about their reputation of doing a good quality job. But for them to know the status of these issues, someone must communicate this information down to them.

Are the safety reports distributed to the craftsmen that actually do the work? Do they get to see how the job they are working on is rated compared to the goals of the project and compared to the standards of the industry? Do they get to see if there are financial problems with the job, their employer or the investor/owner? Will they be able to glean whether or not the job may shut down in a week or so due to the insolvency of one of the parties—and therefore they'd better start looking for another job right away? Do they get to see if the work they are doing meets the quality requirements that are expected by contract and by generally accepted industry standards? Will they have a reputation of having worked on the job that could "never get it right" or will their peers look in awe at those who completed the work ahead of schedule, below budget, and without a single nonconformance or safety infraction? It all requires communications.

This is not to suggest that the exact same information is provided to everyone. Of course, there are *confidential* matters that cannot be disseminated; some things are restricted by law. Sometimes, certain financial specifics must remain in-house. But there are many ways of portraying the results and the status of the job without divulging the details.

For example, using percentages instead of actual numbers will often convey the information desired and still protect its confidentiality. Let's say that the actual costs of the work are to be held in confidence. That does not preclude management from disseminating the information that the job is 65% complete but only 58% of the budget has been spent—therefore congratulations are in order for everyone involved. The same principle applies to safety results. Often, the exact numbers are withheld due to legal or other reasons, but the percentages can be released—percentages like "we have achieved an OSHA recordable rate of 90% of target!" The list goes on and on.

However, even if actual numbers are not confidential, the audience should still be considered. Sometimes the information sent to upper management does not convey the message that should be sent to the workers and vice versa. The reports that go to upper management about the details of the problems with the transportation of the turbine rotor back to the site may not mean much to the site workers. But knowing that the rotor will not be arriving for another two weeks may have a meaning to site workers. To the mechanics this may mean that they really can take their kids fishing for a week since there'll be some down time.

The important thing to remember is the audience, those for whom the report is intended and what they will do with it. The best course of action is to ask each level in the chain of command what they want to know and why. In this manner, the reports can be tailored to suit the purpose of the recipients and a clearer channel of communication will have been established.

Program (Enterprise) Control

In today's world of doing more with less and making decisions with the scarcest of information, it is important that the interrelations between projects are considered. These interrelations are between resources like money, personnel, tools, etc. Although not normally the purview of the jobsite manager, due to their interrelationship, the site manager must be aware that the decisions made on the site in question may affect other sites. To minimize disruptions due to this, it is often helpful for the managers of various jobsites within any one organization to remain cognizant of the status of the other sites. Therefore, some reports should be made available to the managers of those sites.

Manpower availability is often an issue. When several major projects are in progress at the same time, skilled labor can become a scarce commodity. Frequently, it's the site that offers the most overtime pay that gets the best workers. To minimize disruptions due to this issue, coordination among sites is important. A power generator with multiple sites in any one area should always be aware of the demand on the local labor pool. When several outages are scheduled at the same time (which often happens due to the short windows when units can be offline), the smart site managers coordinate labor needs. They keep each other informed about the hours they plan to work, in order to avoid manpower hopping from job to job chasing the overtime premium. They also coordinate the labor skills they will need. For example, when one site is scheduling major welding work, the other site should not. The other site should attempt to schedule their major welding work either before the previous site requires welders or after.

Similar coordination is important when a contractor is planning major equipment usage, especially if it is owned by the company. If there are several new construction projects planned in the same area, the availability of heavy lifting equipment may become critical path. The contractor's site managers should keep each other appraised of their intentions to use this equipment so they all do not need it at the same time. Just by sharing jobsite schedules, each can see what the other is planning and use this information to coordinate the use of this equipment. For example, if a contractor on one site is planning to set the generator on its pedestal in the third week of a particular month, and his counterpart at another site needs some of the same equipment to raise a boiler drum, they would do well to stay in touch about their needs to avoid having to rent additional equipment.

One of the most important resources to be coordinated, whether by an owner or contractor, is cash. An owner must make available cash to pay internal and external suppliers across the total organization. To do this, a consolidated cash flow chart will be required and must be kept updated. The input to this chart comes from two places. First, it comes from the needs of the suppliers at all locations, based on their anticipated plans; this is the cash draw. Then it comes from the cash sources that could be revenue generation, internal cash draw down, or lending institutions. The two have to balance to ensure that 1) there will be enough cash available to pay the suppliers and 2) that there won't be an unexpected excess of cash.

For a contractor, especially one active on multiple sites, cash flow is equally important. The contractor must pay the labor and the suppliers at all sites, and the contractor must be aware of the cash requirements required to do this. But he also needs to balance these requirements with the expected inflow of cash to avoid the need to borrow money to cover shortfalls and to avoid unnecessary cash build-up.

Coordinating these resources can be done in many ways. The simplest for the site manager on any one site is to just talk with the other site managers. However, when projects are large and complex, this is generally not effective. Often, there are so many other urgent issues that communicating beyond the immediate site is not a high priority in the mind of the site manager. There is not always time to focus on issues related to off-site activities, even though this may eventually create problems like the following:

- no money in the account to fund payroll
- specialized equipment not available requiring expensive third-party rentals
- local labor not available requiring travelers and the resultant costs for their travel and living expenses

To assist with the dissemination of information that may be useful to all parties in an organization, there are various tools that can be used. One such tool was discussed in depth in the E-commerce and the Internet section of chapter 11. That tool was an executive summary dashboard. All data that is generated during the course of all projects can be dumped into a central repository, from which information can be assimilated based on the needs of the user. Referring to figure 11–4, the executive summary dashboard, columns could be added for manpower availability vs. manpower in use, and this could be by individual crafts or by total personnel. Additional columns could be added for specialized equipment availability vs. that which is either in use or scheduled to be used, and most importantly, a column reflecting cash in vs. cash out could be added.

Figure 12–5 is an example of such a view for tracking labor across an enterprise or area. It shows three different labor skills, where they are available and the total available for the work in the area. Although in this example, the supply of mechanics and electricians seems to be adequate, there is an issue with the availability of welders. Local 1 will only have three welders available at the end of the month, and since that is below a predetermined threshold (in this case 5%), the red button is illuminated signaling that action is required. Local 60 seems to be only in the cautionary mode, but the total number of welders available from both union locals is still below the 5% threshold. Anyone with a need for welders, who also has access to this report, will instantly see that there will be problems. They can *drill down* by clicking on the appropriate button and find out which projects are planning to use these welders and for how long. With this information then at hand, plans can be made to either rearrange schedules or start looking for welders outside of the immediate area.

ABC Power Project — **Labor Availability**
Anywhere, USA — **August 2004**

Executive Summary

Skilled Crafts	Union Local	Total Labor Pool	Projected Use At Month End	Percent Available	Availability
Welders	Local 1	94	91	3%	R
Welders	Local 60	75	67	10%	Y
Total		169	158	6%	R
Mechanics	Local 118	111	62	44%	G
Electricians	Local 134	266	31	88%	G

Key:
- G — Green = No Problems Envisioned
- Y — Yellow = Below 10% Availability. Potential Problems Ahead
- R — Red = Below 5% Availability. Requires Action

Fig. 12–5 Labor dashboard.
Courtesy of Construction Business Associates, LLC

Since most organizations would be uncomfortable allowing just anyone unlimited access to these reports, restrictions can be built into the program that limit access to specific individuals and limit the information they are allowed to access within the reports. Built with some foresight, *instant alert* reports could be automatically delivered to individuals who need to be aware of pending problems. In the case of the previous example, a copy of this specific report could be automatically sent by e-mail (and regular mail as well) to each site manager that has projects in the area, as well as the home office labor coordination group. In this way, those who need to be aware of this issue would find out about it right away. Otherwise, they may not become aware of the problem until they happened to review the report during their regular review cycle.

Summary

It bears repeating that many power generation plants of today are in business to make money. Generating power is often just a means to an end. The owners and investors are there for one reason only: to make money. If the returns do not meet their expectations, they will shift their money elsewhere. For them to feel comfortable that their investments will continue to meet their expectations, they must have information about the activities going on at the plant and especially the activities during major construction work. To get this information requires that the site management provide timely and accurate reports that can be used by the decision makers.

The three basic pieces of information that are usually required are 1) progress, 2) schedule, and 3) cost. Using a blend of these three, a good picture can be painted of the status of the work. However, there's more that needs to be known—the future needs to be known as well. Although there's no such thing as a 100% guarantee of accurate predicting, there are tools that can assist in determining the outcome of the job. Used early enough in the project cycle, these tools can point to potential problems, they can suggest what to do to mitigate them, and they can suggest when to do it. These tools are the graphs that depict trending and productivity.

The first tool, the progress graph, compares project completion with the cost of the work. It allows the user to *see* if the job is proceeding as planned and if it is within budget, and it also allows the user to determine how the results of the moment are trending. (Are they trending toward a successful completion or are they trending toward trouble?) The data used to generate this information is supplied by the schedule updates, the productivity graphs and the man-hour updates. It is important to use all of this data together. Any one piece by itself has the potential for leading to erroneous conclusions.

The second tool, the financial status report, compares the total cost of the work completed with the budget for the job. It also contains a projection of where the costs may be when the work is complete. The data used to prepare this information also comes from the schedule updates, the productivity graphs and the man-hour reports. However, the projections rely on information developed with the progress graph.

The third report, the weekly progress report, provides an overall picture of what is happening on the job. It points out actual progress, and it advises of issues that are either current or pending. Prepared with some photographs, it provides an understanding of how the job is progressing.

Finally, the quality report and the safety report are tools that often unmask issues that are below the surface but may impact the project. When quality starts to suffer, re-work will soon be an issue that directly impacts the schedule and the costs. When safety starts to slip, productivity will suffer, which again will have an impact on both schedule and cost. Although these two reports are listed at the bottom of the hierarchy of reports, their importance should not be diminished.

Concurrent with preparing reports, thought must be given to their recipients. Management above the site has needs that are very different than the workers and management on the site. Top management, owners, and investors, need information that speaks to additional support the site may require. They need to know if more supervision, tools, equipment, and money are required. They also want information to help them coordinate with others that are involved, such as other contractors on-site.

The site staff and workers, on the other hand, have different needs. They are not in a position to bring support from the outside, but they are in position to affect changes on the inside. They want to know if everyone is working safely. They want to know if they are providing quality work. They want to know if they are on schedule and if disruptions in the work are expected. They want information that helps them do the best job they can.

There is also information that needs to be shared with other parts of the enterprise, with other jobsites and the home office to assist in the coordination of the overall corporate efforts. This is information such as expected drain on manpower, expected need for specialized equipment and cash flow needs. If the organization, whether it is the owner or a contractor, has more than one project underway, it needs to share information about what resources are available where, and what resources will be required when. This will avoid duplication of efforts and unnecessary rentals of equipment when rescheduling of events could have prevented it. It is also important for leveling cash flow.

Sharing information across the enterprise requires preplanning. It requires that a process is put in place to deposit the data from all sources and then to generate information from this data that can be used to streamline the overall operations. One convenient method of providing this information is to present it in a dashboard fashion. This will avoid information overload, the classic reason why many people never use the information they have at hand—because it overwhelms them.

In summary, there is a lot of data generated on a power plant construction site. Some of it comes from the owner. Some comes from the contractors. Other data comes from third parties, but it all reflects what is happening at the site. The challenge is to put this data together in a way to generate information that can be used by the various parties for decision making. Not all of the information is needed by all of the parties all of the time. To avoid inundating people with information that has no bearing on their part of the project, the reporting process should be designed to provide only what is needed and for whom it is needed. When pulled together in a well-thought-out manner, the decision makers responsible for the project will have the information at hand in time to take proactive steps that may still change the trend of the job before it is too late.

13

DOING IT OVERSEAS

When economic pressures to expand the business can't be relieved in the home market, globalization becomes an answer. Many power generators have strategic plans that part of their asset base will be outside of their own home country. However, in many of these new countries there are few, if any, contractors experienced in building and maintaining power plants that can support the needs of these power generators. Since the move into these new countries was made with the intent to make money, these power generators want to be able to build and maintain their plants with minimal disruptions, and they want minimum downtime so their units will stay online and reliably generate revenues. This often requires the new plant owners to import expertise from outside the host country—in other words, inviting contractors from other countries to build and maintain these plants.

But how does one attract a contractor to work abroad? Why would a contractor want to leave the comforts of home and enter the unfamiliar world of overseas work? There are many reasons but the most basic is always money. Most overseas jobs have the potential for high profit margins, and high margins are what owners and investors are always looking for. Of course, nothing comes for free. The cost of higher profit potential is the assumption of higher risk. More aspects of the contracting process are at risk for cost and schedule overrun when working overseas than would be the case if the work were being performed at home. These issues include the following:

- Material and equipment deliveries can become unpredictable when being transported by ship and passing through customs
- Labor sourcing can become embroiled in political red tape
- Cash flow can become unreliable
- Cultural differences can lead to misunderstandings
- Workmanship or quality standards may be done to a different standard

Fortunately, most of these issues can be managed, and the risk of them derailing the project can be minimized accordingly.

Technology has allowed the perceived world to grow smaller so venturing into the international arena is now much less complex. However, that does not mean venturing into the international arena should be done without first performing due diligence. Several questions must be asked: Does it matter whether the work is in Bangladesh or Borneo? Do the basics of a typical construction job still apply? What can one expect if asked to manage a job in Argentina or Zaire? One can't just grab a hardhat and catch the next plane. Just the basics of time zones, passports, and visas make getting to some of these locations a challenge. So before venturing into the unknown, it is important to assess the skills of the organization. Then it is important to understand the client and the client's needs. A clear plan must be developed to answer many questions, and a process must be designed to address the unknowns.

The Basic Construction Needs

No two projects are ever the same, whether they are domestic or not. Each has its own challenges, but usually the challenges on a domestic job are predictable at the outset while those on an international one may not be. So before venturing abroad, the basics of the business must be reviewed. First, a review needs to be made of the basic requirements for construction. Specifically, what disciplines does the job require: civil, mechanical, electrical? Are these disciplines as mature in the proposed market as they are at home? Are the typical skills of masons, carpenters, mechanics, boilermakers, pipefitters, millwrights, and electricians available? Is the labor familiar with using the same tools and equipment that are used at home, and are the company supervisors familiar with the habits and experience level of the local crafts and their supervisors? Are local personnel available to be supervisors? Are they hands-on supervisors or are they white collar hands-off? Is there a language barrier? Is there a cultural barrier? How will all of this affect productivity? What should be done if there are issues?

Next, the source of the labor skills must be identified. Are there unions and are they skill or employer based? Are these unions a good source for the labor required? Can labor be obtained for just the duration of the project, or is there a risk that once hired, the worker is suddenly a permanent employee? What about the pool of available labor? Is it adequate to support the needs of the project, and if not, is there time for training? Or will labor have to be imported, and from where, for how long, at what cost and political capital?

Then what about the source of materials, both raw and manufactured? How much can be procured locally and with what speed and quality? What are the contractual requirements for sourcing? What are the legal requirements for using local manufacturers? What is the cost trade-off between local procurement and importing? If importing, where are the preferred locations in terms of product specification and in terms of country-to-country trade preferences? How are the customs facilities and how long does it take to clear materials through them? Who pays the demurrage if shipments are delayed in customs?

There's the case of a barge load of power plant parts, manufactured in the United States, being shipped to India. While nearing its destination, it was hit by a cyclone and the barge sunk. Since much of this equipment was on the critical path for installation, the project schedule was disrupted and even though the material was insured for replacement, many of the site disruption costs could not be recovered.

Then there's the issue of improper packing lists and bills of lading. The site may receive copies of these listing the materials that are on the way, only to find out upon receipt that the lists were incorrect and the boat load of materials that arrived turned out to be pipe insulation instead of the piping itself. What happens if the materials are damaged in transit, and the OEM is on the other side of the world (see fig. 13-1)? Many things can go wrong.

Fig. 13–1 Damaged materials.
Courtesy of Construction Business Associates, LLC

The same applies to tools, equipment, and consumables. A review must be made of what is available locally vs. what needs to be imported vs. the cost and time trade-offs. Questions need to be asked such as: What are the contractual requirements for sourcing? What are the legal requirements for using local suppliers? If tools and equipment need to be imported, the sourcing of spares and repairs must be considered.

The basic building blocks of a construction project, labor, supervision, materials, and tools must be clearly understood before venturing abroad. A failure to properly assess them will lead to a failure to properly utilize and support them, which in turn will lead to disaster.

After developing a comfort level with these primary building blocks, the administrative side of the business should be addressed. How was the job estimated? What are the labor costs now and what productivity can be expected? What about working hours, both legal and real? What happens during holidays, do the workers even show up? How many holidays are there?

How will the project be controlled? What scheduling software will be used, who is available to use it and how will information be transmitted to those who have a need to know? Although electronic transmittal of reports, schedules, photos, etc., are commonplace in many parts of the world, it is still not standard everywhere, and often the plant to be built will be where nothing has been built before.

Most importantly, there's the cash flow. At home, work is done, workers and suppliers are paid, invoices are prepared, and checks are received. That's not always the case across the border. First, there is the source (or sources) of the money. Will it come from a local company, the local government, local banks, foreign banks, international lending agencies, or even third-party countries? This is very important since it will affect the timeliness of cash flow, the single largest cause of the demise of construction companies.

On a large power plant construction project in India, a U.S. contractor suddenly had problems receiving payment in his local bank account, but the workers still needed to be paid. After exhausting all channels of monetary transfers, the contractor used the *risky* method of hand-carrying traveler's checks into the country, cashing them at the local bank, and then paying the workers.

After settling the sourcing of the money, there comes the issue of its currency. Will there be one, two, three, or even more currencies involved? What will be the contractual tie between them and what will be the realistic fluctuation among them? Profits have been made and lost just on the luck, or lack thereof, of currency fluctuations. The same holds true for the cost of living or inflation protections.

Finally, the actual methods of money transfers need to be precisely defined. Issues such as letters of credit, bank guarantees, and payment authorizations should be clearly defined. They must also be reviewed by legal counsel versed in the laws of the different countries to prevent delays once the job is rolling. Again, it boils down to a matter of cash flow.

The Cultural Effect

Once it's been determined that there is value in seeking business overseas, and that the basic construction needs can be handled, the next issue to explore is that of the effect of working in a different culture. First and foremost is the language. Is it the same? Is it similar? Or is it totally foreign? It is important to understand that even though the words are understood, many times the meaning is not. Even using a translator may not be enough; sometimes a technical person may also be required. Sometimes there's even a problem for those speaking the same language to understand each other. Imagine someone with the drawl of southern Louisiana communicating with someone from the highlands of Scotland. English may be English, but the words, the inflections, and the different accents can lead to problems in understanding one another.

Then there are the cultural differences. There's everything from the acceptance of siesta time in the afternoon to the position of one's feet when sitting in a chair to understanding that a nod of the head is not necessarily a gesture meaning "yes." There are many other misunderstandings like the word *mañana,* which does not always mean tomorrow, it sometimes means just *not today*!

A major challenge can be the politics of the country. Local issues may give rise to demonstrations, which are handled differently in different countries. In one case, the president of the country was ousted by the public banging of pots and pans, and the following day a soccer match brought the whole country to a standstill. Sensitive times such as those leading up to political elections can make travel and communications difficult.

While on one power plant construction project in a third-world country where elections were just two days hence, the author received a call early in the morning from the plant manager. He warned not to come to the plant that day—the plant had been "taken over" by the local government soldiers to ensure no disruptions to electricity supply during the election that the incumbent president intended to win. No one was allowed in or out of the plant until the elections were over and all of the votes were counted. Of course, the project end date was still expected to be met, even though days were lost.

Pressures from internal and external forces can sway public opinions, overnight—from being met with open arms to being no longer welcome. On a social level, some countries do not look favorably on a mixing of foreigners with their population. In other countries, there is the issue of external as well as internal disruptive forces. The Middle East can often be a center of unrest. During the construction of a series of power plants in Saudi Arabia, there were some external zealots who entered the country and disrupted some of the holy shrines. The local government immediately isolated the country from the rest of the world to take care of this problem. But this cut-off from all channels of communications made it impossible to track the progress of incoming equipment, personnel, and other supplies. It shut down all communications with the home office who was providing technical and logistical support to the project. Once again, the schedule was still expected to be met even though there were these disruptions.

Internal opposition forces are also an issue when they are using the presence of foreigners to twist the arm of the government. This is becoming more prevalent as the world experiences an increase in global terrorism. Security is sometimes required, and it may be needed 24 hours a day.

Learning to navigate these constraints is a very important element in being successful overseas. Knowing how to *fit in* also requires knowing how to do so without breaking the rules and regulations of the home base country. This becomes especially critical with the issue of bidding jobs and awarding or being awarded contracts. It may be common practice to bribe local officials for expediting paperwork, awarding contracts, and other issues but most contractors' home countries prohibit this. Corruption is becoming more prominent with prosecutions in many corners of the globe from Africa to Germany and from Egypt to Indonesia.

These issues must be addressed because they arise with the movement of personnel, materials, tools, and equipment across the borders of both the supplying country and the host. Immigration and customs regulations can be perceived as maddening obstacles designed to impede progress. Unless carefully researched, hours of frustration, lots of money, and valuable time will be wasted. Usually, the first-time contractor avails himself of the services of a local agent who has the know-how and connections to navigate the host country bureaucracy.

There was a project in the Caribbean that fell victim to both immigration *and* customs problems. The host country, where a small power plant was to be built, had strict rules about bringing in foreign workers and importing heavy equipment. These rules were designed to encourage using the local labor and suppliers. Unfortunately, the local labor did not have all of the skill levels required to perform the work, and the rental costs of the heavy equipment needed to do the work were much higher than the budget allowed. So a plan was set in motion to import the labor and the equipment.

When the imported workers arrived on the island, the local immigration officials refused to issue work permits, thereby refusing the workers permission to do the work for which they came to do; no one had thought to apply for these permits beforehand. Therefore, the workers had to return to their homes. The contractor had to go through the process of applying for work permits for each of the workers to be imported. This entailed first advertising for these skills within the local populace, then interviewing and testing all of those who applied (only two met the requirements), and then proving to the government that all avenues of resourcing had been exhausted. After that, the contractor was required to apply for a work permit for each worker that was intended to be brought into the country, not only providing his name and address but also proof that he actually did posses qualifications that were not available in the host country.

As the weeks went by and the work permits were still not issued, the appointed "foreign" workers started looking for and accepting other work in their home country. However, the contractor had applied for the work permits by individual names for each of them and was therefore dependent on their availability once these work permits were issued. So to keep these workers available, the contractor was forced to pay them a *standby fee,* which certainly was not anticipated when the project budget was developed.

This permitting process took almost two months, during which the contractor could make no appreciable progress on the job, but was still required to pay the workers to have them available. Since the job had a fixed end date, once the workers did arrive on-site, they had to work overtime to make up for the time lost during the permitting process. This also cost the contractor money that was not in the budget.

But to make matters even worse, the contractor had also rented from an offshore source the heavy lifting equipment that was required for the work. When this equipment arrived at the host country port, the customs officials immediately confiscated it. To protect the local equipment rental industry, the country had a protective tariff schedule that made it extremely costly to import equipment of this type. Finally, the contractor had to send the rented equipment back to the vendor and lease equipment from the local supplier even though his prices were much higher. Then the contractor had to pay for the time the originally rented equipment was away from its home base, plus storage charges in the host country port. Once again, money spent that was not in the budget.

Needless to say, this was an unprofitable job for the contractor. But it did not have to be that way. With proper due diligence at the outset, the contractor would have found out that although the local labor did not possess the skills required for the work, there were skilled craftsmen available in another country that had a treaty with the host country allowing workers to transition between the two countries without the formality of work permits. This would have avoided the two months of lost time as well as the costs of the standby time and the overtime premium required to catch up on the schedule.

With regard to the equipment rental, due diligence also would have uncovered that the local equipment suppliers were willing to negotiate a project-specific agreement, thereby allowing the contractor to avoid the original rental costs plus the storage fees and the aggravation endured in dealing with the customs officials. The job could have been a winner but for the lack of forethought and due diligence.

Visas and work permits are generally required for personnel brought in from other countries. This is for several reasons: control of who comes in and who leaves the country, control to ensure the local craftsmen have the first chance at performing the work, and finally, control to be sure all income tax obligations have been met. In some countries, this is a very straightforward process while others have very cumbersome and expensive processes. But failure to comply with these immigration requirements can result in costly fines, expulsion from the country, and sometimes even imprisonment.

Cultural differences also affect the approaches to safety and quality. In many countries, safety is not perceived in the same way it is at home. The monetary impact is not severe and the evaluation of risks is more tolerant. Quality control may be viewed as an impediment to the schedule and therefore relegated to the lower end of the importance of the project. Many, many times, the single driving factor is to complete the job per the schedule and let tomorrow take care of itself.

The initial response to the disruptive effect that an injury or death can have on a project in some of the more remote countries of the world is that there are plenty of workers just waiting for a position to become available. Often, contractors attempt to provide safety training using their tried and true tools brought from home, tools such as the widely used training films from several companies with renowned safety records. Most of this is not absorbed by the local workers, even when translated into their language. More effective are homemade training films using the local workers as actors along with the tools and equipment they will actually be using on the job.

On one major project in Africa, where there were several different tribal languages, workers from each of the tribes were recruited to assemble scaffolding. They assembled two different sets of scaffolding, one of which was assembled correctly, in accordance with all safety requirements, while the other was assembled incorrectly. A spokesman was selected from the group to narrate the differences between the two assemblies while the whole process was being filmed. This was done with the three major language groups and then these films were used at the weekly safety meetings. At other times, photographs of safe and unsafe conditions of the job were used to reinforce the concept of safety.

Unfortunately, poor safety in many areas of the world does not impact the costs of the contractor. Issues such as workers' compensation and safety EMRs are not in existence in many of these places, so the financial incentive to have a safe job is not there. Also, regulatory agencies similar to the U.S. OSHA agency often do not exist so not only are there no financial incentives to maintain a safe workplace, there are no regulatory ones either.

Quality can also be a thorny problem. Although the owner of the plant will expect the contractor to do a quality job, the perception of quality is often different, depending on who is viewing it. The owner may expect a certain level that exceeds the local norm. The contractor, in trying to enforce these quality requirements, may have difficulty in getting the local work force to understand the requirements and the need for doing things differently. Often, the attitude among the local workers is that quality is just an impediment, schedule is the only requirement, and "tomorrow will take care of itself." With international code requirements not fully adopted by many localities, it is sometimes difficult for a contractor to remain competitive when the local standard is not up to the usual standard he is accustomed to working with.

Finally, there is the difficulty of being competitive. If local companies bid directly, often they have the political connections to be moved up in the evaluations; and often the bid score is a function of local content. If there are bidders from third-party countries, they may be subsidized by their own government, which allows them to submit a lower initial price. Overcoming these obstacles often requires partnering with either a local company who has the required political connections or partnering with a third party from a country with special government subsidies or a combination of both. These types of arrangements, whether they are joint ventures, limited partnerships, or plain two and three tier subcontracts, necessitate internal agreements on the sharing of risks, responsibilities, and rewards before submitting a bid for the work at hand.

Once the contract is in place, there is often the issue of who is responsible for what. Depending on the contractual relationship between the various parties, different expectations exist. If the contractor has entered into a joint venture with one local partner, there needs to be a crystal clear understanding of each party's responsibilities. For instance, if the local partner is expected to smooth the way with the host country bureaucracy, examples should be drawn up that demonstrate the expectations. If the relationship extends to additional partners, say one or two nonlocal contractors in addition to the local partner, then issues of risk sharing become more complex. Once the site is mobilized, the staff should make a list of the potential issues they might encounter and ask that an informal working document, or pro forma, be prepared to be used as a guide in the event of the occurrence of issues.

How to Succeed

So now the decision has been made to venture abroad, a contract is in place, and it's time to start the job. The basic construction-related issues have been researched, the cultural impacts have been evaluated, and a partner has been found. The next step is to move onto the site.

Step one will be to abstract the contract. As discussed in chapter 5, the abstract should highlight the details that will be the basis from which the job is ultimately managed. However, in the international arena, some of these details may be radically different from those one is accustomed to seeing at home. Frequently, the original specifications that now form part of the contract were prepared by consultants who do not have a wealth of experience working in the country at hand. Due to various local expectations, as well as international lending agency rules, they will often have ties to specific milestones, which are not in keeping with the contractors' usual business experience.

Often, equipment and materials are required that may seem to be counterproductive to the overall success of the project. The schedule may be unrealistic given the labor norms of the host country. Penalties may be onerous and bonuses probably will not be offered.

To properly evaluate the intent of the contract and how to comply, the site staff now must research many of these issues. Issues such as the standard labor conditions, like expected vs. required overtime, must be evaluated. Equipment rental arrangements must be made—they may be quite different from the way this is done at home.

Someone must review the technical portions of the contract and evaluate the most cost-effective ways of performing the construction. In other words, is it better to use more manpower and import less tools and equipment; is it better to bring in specialized equipment and use less manpower; or should large modules be preassembled offshore and brought in? Sometimes others will have made these decisions and preassembly may already be underway.

As with the review of any contract, careful attention should be paid to the legal and commercial terms and conditions as well as tax considerations such as where to receive and bank progress payments. Advice should be solicited from local sources, legal firms accustomed to doing business in the area, and even the commercial attachés or embassies of the home country.

Then once the contract is understood, it's a matter of managing the job. The use of the contract abstract is as important here as it was before. The job set up, the job administration, and the financial controls are all as important on an overseas project as they are with a domestic one. Although there will be additional steps to the procedures suggested, the basics remain the same. Multiple currencies may complicate the financial reporting process and the definition of productive man-hours may hamper comparisons with traditional measurements. For example, in some localities, productive man-hour statistics do not include the support labor.

Therefore, when one assumes four man-hours to weld a tube, this does not include the helper, only the skilled welder although the cost of the helper cannot be ignored.

In order to save on costs, it is generally desirable to use local personnel for the administrative job functions. However, it is important that these people have the proper training and understanding of the job they are expected to do. If possible, they should have the opportunity to interface with the home office staff they are being asked to work with remotely, so both groups can gain an appreciation of each other's needs and constraints. This becomes important when the local staff is expected to report results at specific times of the day, week, or month, but due to other immediate on-site pressures, cannot do so. An understanding of each other's needs will help to set the proper priorities.

As discussed earlier, quality control and safety are sometimes viewed in a lesser light than at home. Although it may seem that this approach is cost-effective, it is not. Even when man-hour costs are low, doing the job a second time still impacts schedule, it requires re-use of tools and equipment, and extended supervision may be required. Equally, poor safety practices cost money in terms of additional repair work, lost man-hours, medical bills, and supervisory time. Both poor quality and poor safety impact worker morale. The successful contractor provides the workers with the proper tools, the correct quality and work procedures, and a safe environment in which to work.

The success of an international project is dependent on many things that are not considered domestically. Therefore it is important to enter into the business venture with an open mind. There will be different understandings over the same issue. Patience is a key virtue. Where a domestic project may have a time span of two or three months from specifications to mobilization, it can take two years on an international one. This, by itself, often is a reason why contractors do not want to pursue work overseas.

Just like domestic work, not all overseas projects are for every contractor. The process of determining which one to go after should be methodical. Sometimes it's better to say "no" than to enter into a job with too many unknowns. It's best to be project specific, selecting only those projects that are close to the core competency of the contractor. If there's massive civil work involved and the contractor does not have experience in this area, this may be a job best left for others. But selecting the right job, having a desire to succeed, and staffing it with the right personnel can produce results that are often double what can be achieved at home.

It is important to have available a pool of loyal, proven supervisors and specialist craftsmen that are willing to work overseas. It is preferable that some of these people even live in other countries where traveling internationally is common. It is also important to be prepared for the unexpected. Politics can take center stage. Financial liquidity often takes on a new meaning when unexpected banking snafus arise or bank holidays prevent a money transfer. Climate conditions must be investigated, from sandstorms in the Middle East to monsoons in Indo-China.

Then there are the *local customs* that must be considered. For one project in the Far East, the contractor wanted to build a housing complex for the expatriate staff. The land had been selected and negotiations for purchase were almost complete with the 12 different families that lived there when suddenly the local townsfolk insisted that they wanted a baseball field (for free). After much negotiation and time, an agreement was reached that a field would be built and maintained by the contractor, but at a different location. Of course, during the time of these negotiations, building the housing complex could not begin and the expatriate staff had to use hotels and restaurants incurring costs they had not budgeted for.

Political connections are often crucial to being successful. The local partner is generally the party that provides these connections, but the expatriate contractor may be asked to help. In addition to offering support in terms of training, supplies, and equipment, often the contractor is also asked to include in his team some of the family members of the local politicians. Although these added employees may not be able to provide any direct support to the project, they can still be used as consultants when advice is required on issues such as how to get a police escort for moving a large load, like a boiler steam drum, from the port to the jobsite. Or maybe the project is on a tight schedule and a religious period (such as the Muslim Ramadan) is coming, and the contractor wants to know how to minimize disruptions during this period of fasting by the workers.

The first and the last rules of being successful on an overseas project are: *be patient*. Do not take shortcuts; they will end up costing more before the job is done. Just like a job in the home country, do things right by doing the right things. Remember that each culture has its own proud heritage and show your respect (see fig. 13-2).

Fig. 13–2 A display of national pride.
Courtesy of Construction Business Associates, LLC

Appendix A

JOB SITE VISIT INFORMATION SHEET

Name of Prospect ______________________ Date of Visit ______________

Work Description ____

Address of Prospect ____

Person making Visit ____

Name and Position of person representing customer ____

Consulting Engineer ____

Specifications available Yes ☐ No ☐ Estimated Start of Site Work ______________

Job Site location ____
Route or Street Town

____
County State

Site Plan available from customer Yes ☐ No ☐

Describe existing buildings ____

____

ACCESS AND STORAGE AREAS

ACCESS ROAD
Describe length, type, surface, width, sharp curves. Any change necessary? Who maintains?

____

____

____

____

PARKING AREA
Describe, distance from work area and change room.

____

____

Buses required Yes ☐ No ☐ Who Provides? ______________

____

____

<u>DELIVERY POINT</u>
What is location of nearest common carrier free delivery point. Any improvements needed or expected. Are other contractors using? ______________________

<u>STORAGE AREA</u>
Describe including access, soil conditions, overhead lines. Share with anyone? What is Instrument storage? How to protect against damage and pilferage? ______________________

Access from three sides ☐ two sides ☐ one side ☐

Will temporary buildings be required? Yes ☐ No ☐ If yes, what kind ________ Who Supplies ________

Will electricity be required? Yes ☐ No ☐ Who supplies ________
What is available? Voltage ________ Cycle ________ Power ________
If lines to be run, how far? ______________________

Will telephone be required? Yes ☐ No ☐ Who supplies ________
If lines to be run, how far? ______________________

<u>SUBASSEMBLY AREA</u>
Describe. Will it be in storage area or at work site? Is it shared? ______________________

Distance from common carrier free delivery point to storage area ______________________

Method of material movement from delivery point to storage area. Any interferences? ______________________

Distance from storage area to work area ______________________

Method of movement of material from storage area to work area. Any interferences? Describe all access to work area. Can subassemblies be handled? Will other contractors cause interferences? ______________________

FACILITIES

<u>FIELD OFFICE</u>
Location, size, type required. Required electric power. Any present facilities. Who supplies? ______________________

<u>TOOL ROOM</u>
Location. Dark room location. Who supplies? ______________________

SANITARY FACILITIES
Who furnishes? Location, number and type? Can there be urinals in building? ______

CHANGE ROOMS
Type, size, number needed. Electric power needed? Type of heat? Distance from work area? Who supplies? ______

FIRST AID
Who furnishes? Distance to nearest doctor and hospital? Vehicles required for transportation to doctor or hospital? ______

ELECTRIC POWER
What is presently available? Voltage ______ Cycles ______ Power (KW or KVA) ______
What is present location? What will have to be done to bring it in? Are transformers required? How will power be made available for welding machines and other equipment? ______

LIGHTING
What exists in the way of temporary lighting? Who will furnish? Where is power available for lighting? What KVA is required? ______

WATER
Is construction water available? Yes ☐ No ☐

If so, where? ______

Is drinking water available? Yes ☐ No ☐

If so, where? ______

Is ice available? Yes ☐ No ☐

If so, where? ______

Can electric water coolers be used? Yes ☐ No ☐

COMPRESSED AIR
Who will furnish? ______

Is operator required? Yes ☐ No ☐

Needed cubic feet per minute ______

Length of time required ______

Will manifolding be required? Yes ☐ No ☐

CRANES

Number needed Capacity Type
Number needed Capacity Type
Number needed Capacity Type

What is the local rental situation?

ELEVATORS

Can present ones be used?
If temporary hoists are needed, what type?
Where installed?

Heating and ventilation for trades on job: What will be required?

Debris and scrap handling facilities: What will be required:
Who will furnish?

PERSONNEL

Proposed number and type of superintendents: No. Type Timing

Name of lead superintendent:

Unions: Locals having jurisdiction Craft Lodge No. Location Distance to job

Work load in area

Hours being worked in area

Estimate of availability of qualified people

OTHER

Any unusual items in specifications ______________________________

Remarks ______________________________

____
Signature of person making visit

Appendix B

Contract Responsibilities Matrix

	Item	By Owner	By Contractor	By Sub
1.	CIF	________	________	________
2.	Harbor Charges (Dockage Fees, Unloading Fees, Demurrage Charges, Permits, Licenses, or Other Levies)	________	________	________
3.	Custom or Import Duties	________	________	________
4.	Transport of Materials and Unloading (Port to Job site)	________	________	________
5.	Unloading of Materials at Job site	________	________	________
6.	Transport of Material at Job site	________	________	________
7.	Material Lay down and Storage Area Prepared for Heavy Equipment Movement (State Acres Required)	________	________	________
8.	Maintenance of Storage Area	________	________	________
9.	Inside Storage — Warehouse (State Required Square Footage)	________	________	________
10.	Job site Office & Facilities (State Required Square Footage)	________	________	________
11.	Furniture, Equipment, and Air Conditioning for Office	________	________	________
12.	Job site Tool Room	________	________	________
13.	Job site Change Room	________	________	________

	Item	By Owner	By Contractor	By Sub
14.	Housing for Contractor Personnel	________	________	________
15.	Housing for Vendor Representatives	________	________	________
16.	Housing for Locally Hired Personnel	________	________	________
17.	Housing and Mess Facilities for Workmen	________	________	________
18.	Medical Facilities	________	________	________
19.	Transportation for Contractor Personnel	________	________	________
20.	Transportation for Vendor Representatives	________	________	________
21.	Transportation for Workmen	________	________	________
22.	Sanitary Facilities			
	– Administration	________	________	________
	– Staff	________	________	________
	– Workmen	________	________	________
23.	Water			
	– Construction	________	________	________
	– Drinking	________	________	________
24.	Security			
	– Job Perimeter	________	________	________
	– Job Work Area	________	________	________
25.	Fire Protection			
	– Job site	________	________	________
	– Work Area	________	________	________
26.	Trash and Debris Removal (If off-site, state distance)	________	________	________
27.	Safety			
	– Job site	________	________	________
	– Work Area	________	________	________
28.	Electric Power (State required KVA)	________	________	________
29.	Distribution of Electric Power	________	________	________
30.	Communications			
	– Telephone	________	________	________
	– Telefax	________	________	________
	– Radio	________	________	________
	– Computer Link/Satellite	________	________	________

	Item	By Owner	By Contractor	By Sub
31.	Air for Construction Use (State required CFM)	________	________	________
32.	Distribution of Air	________	________	________
33.	Nondestructive Testing	________	________	________
34.	Interpretation of Nondestructive Testing	________	________	________
35.	Stress Relieving Equipment	________	________	________
36.	Welder Qualifications			
	– Test Coupons	________	________	________
	– Cost of Qualifications	________	________	________
	– Cost of Welder Training (if required)	________	________	________
37.	Interpretation of Welder Qualification	________	________	________
38.	Weld Rod			
	– Pressure Parts	________	________	________
	– Non-Pressure Parts	________	________	________
39.	Hydrostatic Test			
	– Water	________	________	________
	– Chemicals	________	________	________
	– Test Pump and Gauges	________	________	________
	– Fill Pump	________	________	________
	– Labor	________	________	________
40.	Chemical Cleaning			
	– Boil Out	________	________	________
	: Chemicals	________	________	________
	: Operation	________	________	________
	: Assist Labor	________	________	________
	– Acid Cleaning	________	________	________
	: Chemicals	________	________	________
	: Operation	________	________	________
	: Assist Labor	________	________	________
	: Disposal of Chemicals	________	________	________
41.	Grout			
	– Materials	________	________	________
	– Labor	________	________	________
42.	Fit Up Bolts (Temporary bolts usually not supplied with material)	________	________	________

	Item	By Owner	By Contractor	By Sub
43.	Paint			
	– Final Paint	________	________	________
	: Material	________	________	________
	: Labor	________	________	________
	– Touch-up Paint	________	________	________
	: Material	________	________	________
	: Labor	________	________	________
44.	Scaffolding			
	– For Base Project	________	________	________
	– For Inspections	________	________	________
45.	Weather Protection			
	– For Stored Materials	________	________	________
	– For Work Area	________	________	________
	– For Construction Equipment	________	________	________
46.	Local Permits, Licenses, Fees, or Other Levies	________	________	________
47.	Insurance			
	– Builders' All Risk	________	________	________
	– Property Damage	________	________	________
	– Public/Third-Party Liability	________	________	________
	– Vehicle Insurance	________	________	________
48.	Temporary Facilities and Consumables Required for Construction	________	________	________
49.	Interpreters	________	________	________
50.	Air Pressure Test			
	– Temporary Blanks	________	________	________
	– Fan or Blower	________	________	________
	– Labor to Conduct Test	________	________	________
51.	Refractory, Insulation, Lagging			
	– Materials	________	________	________
	– Labor	________	________	________
	– Special Tools/Fab Facilities	________	________	________
52.	Performance Bond	________	________	________
53.	Payment Bond	________	________	________
54.	Completion Penalty Fee (L/D's)			
	– Amount	________	________	________

Appendix C

Contract Abstract

CLIENT NAME
Units Nos.
Project Name
Date Last Revised

Contract Number:	____________			
Project Name:	____________________________			
Location:	____________________________			
Contract with:	____________________________			
Client P.O. Number:	____________________________			
Contract Value:	**Original**	**$** _______________	**Revised $**	____________
Taxes:	____%	**$** _______________	**$**	____________
Total Contract Value:	**Original**	**$** _______________	**Revised $**	____________

Type of Contract: Fixed price for installation.

Scope Definition: Below is a detailed listing of the mechanical and electrical installation scope to be completed for the ______________ replacement at ____________________________________.

Award Date:	1st Unit________________	2nd Unit _________________
Mobilization Date:	1st Unit________________	2nd Unit _________________
Hydrostatic Date:	1st Unit________________	2nd Unit _________________
Turbine Synch Date:	1st Unit________________	2nd Unit _________________
Completion Date:	1st Unit________________	2nd Unit _________________

Payment Terms: NET 30 as follows:

	1st Unit	2nd Unit	Total
- 20% after Mobiliz.	$ _______	$ _______	$ ________
- 10% at 20% Compl.	$ _______	$ _______	$ ________
- 10% at 40% Compl.	$ _______	$ _______	$ ________
- 10% at 60% Compl.	$ _______	$ _______	$ ________
- 20% at 80% Compl.	$ _______	$ _______	$ ________
- 20% at 100% Compl.	$ _______	$ _______	$ ________
- 10% at 6 mos. Run	$ _______	$ _______	$ ________
TOTAL			$ ________

Progress reports, signed by owner rep, due at contractor home office billing department before 4 PM every Friday.

Penalties: $____________ per calendar day L/Ds on schedule, capped at _____% of revised contract value

Bonuses: $____________ per calendar day for early completion, capped at _____% of revised contract value

Extra Work Approval: ________________________ ______ hours from the realization that scope changes are required
Extra Work cannot exceed _____% of
Original Contract Value.

Extra Work Rates:
Craft A $_______/hr ST $_______/hr OT
Craft B $_______/hr ST $_______/hr OT
Craft C $_______/hr ST $_______/hr OT

Delay Notifications: _____ days from the beginning of the delay

Proof of Insurance: Auto ____
Workers' Comp ________________________________
General Liability _______________________________

Schedule Submittals: ____

Daily Reports: Due at ______________ (time)
Weekly Reports: Due on ______________ (day)
Monthly Reports: Due on ______________ (date)

Code Requirements: ASME _____, National Board_____, AISC _____, NFPA _____

Nonconformances: ____

Dispute Notifications ____

Emergency Notification Numbers: Fire______________ Police ________________
HAZMAT _________ OSHA ________________
Rescue __________ Hospital ______________

Other: ____
____
____
____
____

Appendix D

Project Job Description

Job Title: **Boiler Supervisor**

Job Site: South Point Station, Anywhere, USA

Direct Reports: Welding Supervisor (1), Field Supervisors (3), General Foreman (1)

Date: January 1, 2005

Overtime Premium: No

Job Summary: **This section focuses on the main purpose of the position, in one to four sentences.**

Plan, schedule, and erect two circulating fluidized bed (CFB) boilers, including rigging, welding of pressure and nonpressure parts, erection of air heaters, installation of fans, and assembling and installing the ash removal system. Assist with the overall plant planning and scheduling efforts, coordinating the boiler work with the remainder of the plant, including civil, piping, electrical, instrumentation, and insulation. Provide a safe working environment and maintain safety performance within company guidelines.

Essential Duties: **This section contains a list of the top five to eight responsibilities for the position. However, from time to time, other duties may be required.**

1. Plan and schedule the work activities.
2. Arrange for the field craft to erect the boilers and ancillary equipment.
3. Supervise the assigned support staff in the performance of their duties.
4. Prepare progress and look-ahead reports.
5. Estimate remaining man-hours, tools, and equipment required for completion.
6. Provide support to the site safety program.
7. Ensure the work is performed in accordance with the quality requirements.

Qualifications: **To perform this job, the individual must be able to perform each Essential Duty satisfactorily. This section contains the knowledge, skills and abilities required.**

1. Ability to work with minimum supervision is required.
2. Good communications and interpersonal skills required.
3. Knowledge and past experience of CFB boiler erection required.
4. Safety management skills are required.
5. Proficiency in MS Office and e-mail required.
6. Success in safety management must be demonstrated.
7. Spanish as a second language preferred.
8. Prior "hands-on" experience in rigging and welding preferred.

Education and Experience: **This section contains the minimum educational and experience levels that are necessary to perform this job.**

1. Bachelor degree in a technical field such as mechanical, electrical or civil engineering.
2. 10 years of experience in power plant outage or new construction management.

Working Conditions: **This section contains the conditions that may be encountered at the worksite and the requirements to work there.**

Frequent bending, reaching, and climbing up many levels of outdoor, open-grating stairs will be required. The work will take place on an open, outdoor construction site with dusty, hot, and oftentimes rainy conditions. Constant use of safety equipment such as hard hats, safety glasses, safety shoes, gloves, and safety harnesses are a site requirement.

Comments: None

Signatures:

Employee: ____________________________________ Date: ___________________

Supervisor: ___________________________________ Date: ___________________

The statements herein are intended to describe the general nature and level of the work to be performed. They are not intended to be construed as an exhaustive list of all responsibilities, duties, and skills required of personnel so classified.

We are an Equal Opportunity Employer

Appendix E

Business Controls
A Checklist

Y	N	

Project management

Y	N	
		Project Execution Outline
		Business Practices Review
		Extra Work Authorizations
		Contract On-Site
		Estimate On-Site
		Schedule On-Site
		Contract Abstract On-Site
		Cash Flow Chart On-Site
		Scope Clearly Identified
		Liquidated Damages Understood
		Bonus Understood
		Delay Claims Notification Understood
		Drawings On-Site
		Bills Of Materials On-Site
		Weekly Financial Report
		Compare Weekly Financial Report with Home Office Cost Reports
		Special Bonuses Accrued
		Daily Log

		Weekly Status Report
		Weekly Progress Graph
		Weekly Labor Progress Worksheets
		Extra Work Rates with Client In File
		Extra Work Rates with Subcontractors in File
		Minutes of Weekly Customer Meeting
		Notification to Customer of Delays, Problems, and/or Potential Claims
		Plan for Storing Tools and Equipment after Job
		System for Tools and Consumables Control
		Storage System for Expensive Items
		Tool Inventory
		Brass/Time Card System
		Daytime Security Guard
		Night/Weekend Security Guard
		Lunch Box Check
		Material Receipt and Inspection Reports
		Welding Forms On-Site

Notes:

Administrative

		Craftsmen Job Applications
		Employment Record Forms Available
		W-4
		I-9
		Local Labor Employment Contracts Available
		Union Agreements Available
		Visas
		Work Permits
		Verification that Payroll Deductions are Current

		Job Time Report
		Time Distribution Report
		Authorized Inspector P.O.
		Jobsite Record Control Log
		Jobsite Close-Out Records Transmittal
		Petty Cash Accounting
		Field Expense Report
		Lay-Off Notices In File
		Insurance Coverage
		Payroll Data Backed Up
		Hold Harmless Statement For Renting To Third Parties
		Backcharge Claims
		Extra Work Authorization
		Time, Material, and Rental Records
		Bank Account Reconciled
		Contract Abstract Available
		Billing Procedures Available
		Jobsite Address Available to Vendors
		E-mail Set Up
		Company Rules Given to Employees
		Notice of Workers' Comp Posted
		First Aid Facilities
		Ambulance/Hospital Facilities and Plans

Purchasing

		Three Quotes In File
		Single Source Letter In File
		Field Purchase Orders In File
		Purchase Order Requisitions
		Purchase Order in File
		PO Supplements In File
		Vendor Backcharge Log

		Subcontractor Extra Work Order Log
		Contractor Insurance Certificates Available
		Gasoline Tax Exemption Certificate
		Sales Tax Exemption Certificate

Labor

		EEO Poster Displayed
		Workers' Comp Certificate Displayed
		Sexual Discrimination Poster Displayed
		Sexual Harassment Notice Displayed
		Anti-Drug Policy Poster Displayed

Safety

		Safety Manual On-Site
		Pre-Task Plan Available
		Job Safety Plan Available
		MSDSs In File
		Hazard Communication Program Available
		Confined Space Program Available
		OSHA Posters Displayed
		Scaffold Tags Used
		Safety Glasses Used
		Hard Hats Used
		OSHA 200 Log Displayed
		Competent Person Identified
		Lock-Out/Tag-Out Procedure Used
		Employee Safety Handbooks Issued
		Employee Safety Handbook Receipt In File
		Tool Box Safety Meetings
		Work Rules Posted
		Awards Program
		Local Medical Providers Arranged
		Graph of Safety Indicators

		Safety Team in Place
		Coffee Machines Must be Commercial Grade
		Self-Inspection Records Available
		Formal Process for Employees to Report Near-Misses
		Near-Misses Being Tracked
		Outside Service to Clean Up Blood
		Primary Responder for Each 50 Workers
		Any Brown, Two-Prong Extension Cords
		Plan in Place to Handle the OSHA Inspector
		"Mock" OSHA Inspection Made
		OSHA Inspection Kit Available
		Forklift Training -- Site Specific
		Record Keeping per Requirements

Quality

		Nonconformance Reports
		NCR Log
		Welders' Qualification Records In File
		Quality Control Plan Available
		Authorized Inspector Involved
		QA Manual On-Site
		NDE Plan Available
		NDE Subcontractor Identified

Courtesy of Construction Business Associates, LLC

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