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Standard Handbook of Plant Engineering

THIRD EDITION



ROBERT C. ROSALER

STANDARD HANDBOOK OF PLANT ENGINEERING

Robert C. Rosaler, P.E. Editor-in-Chief

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PREFACE TO THIRD EDITION

This volume is dedicated to my three young grandsons, Jonathan, Gregory, and Maxwell, whose generation holds the keys to a safe, just, prosperous, and tolerant new world. I hope this book contributes to that lofty ideal.

I express my appreciation to the authors and their sponsoring organizations for their contributions. Also, my thanks to the Board of Advisors and McGraw-Hill editor Ken McCombs for their advice and guidance, as well as to M. R. Carey of North Market Street Graphics for an outstanding copyediting job.

PROTECTING FACILITIES PERSONNEL AGAINST TERRORIST ATTACKS

As this book is nearing publication, our country has been subjected to a series of unprovoked attacks ranging from the deliberate destruction of several buildings, with accompanying loss of life, to the deliberate spreading of toxic anthrax spores, along with threats to broaden these actions.

Our plant engineering colleagues have responded to these events by offering specific advice to minimize the impact of the spread of toxic biological substances:

- Keep the ventilation system on, so as to maintain indoor air pressure slightly higher than that outside.
- Add high-efficiency particulate air (HEPA) filters to the HVAC system immediately.

By the time you read this, other procedures will have been suggested as well.

The reader is urged to implement this advice. Also, it is important to maintain close communications with your engineering society to keep abreast of this problem and its solutions.

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Robert C. Rosaler, P.E.

PREFACE TO SECOND EDITION

In addition to updating all technical discussions, this Second Edition adds coverage of plant engineering management, with particular stress on maintenance and workplace safety. This reflects the increasing role of the plant engineer in corporate management.

The editor expresses appreciation for the excellent cooperation shown by the authors and their organizations in updating or entirely rewriting individual chapters as appropriate. Also, a thank you to the Board of Advisors of this edition, who helped redirect the emphasis of the work. Finally, a word of gratitude to Robert W. Hauserman and Stephen M. Smith of McGraw-Hill, who willingly provided wise editorial advice.

This Second Edition is dedicated to my dear departed brother George, who embodied all that is good in the world.

Robert C. Rosaler, P.E.

PREFACE TO FIRST EDITION

Virtually every industrial activity has been affected, often in revolutionary ways, by the surge of technology. Because it is so central to virtually all manufacturing and service facilities, plant engineering is *uniquely* affected. It is “in the middle” in the sense that the plant engineer must, increasingly, have a broader knowledge of an ever-widening universe.

Events of the past decade have further served to accent the importance of the plant engineer’s role in corporate operations, notably the demands for energy conservation and pollution control.

This Handbook is a response to these changing conditions and needs.

Arranging a logical structure and index to meet the needs of all engineers required considerable thought. The structure finally developed here is a reflection of the procedural sequences that occur in the plant facility itself: Planning and Construction, Plant Equipment Procurement and Operation, Maintenance. Individual equipment is covered broadly with descriptions of operational features, installation, and maintenance. Managerial aspects are included only where they interface closely with technical matter.

The objective of the book is to provide the reader with sufficient data on any specific equipment to permit judgment on choices and an insight into “how it works” and how to maintain it.

We want to express our appreciation to the authors and their organizations for their generous contributions and prompt execution of their tasks, and to the Board of Advisors for their guidance, particularly Leo Spector, Chairman of the Board and Editor of *Plant Engineering* magazine. For initial suggestions on the outline, we wish to thank Stewart Burkland. We also received excellent guidance and encouragement from Harold Crawford, Ruth Weine, and M. Joseph Dooher of McGraw-Hill. Our thanks go, too, to Dorothy Smith and Betsy Watson for helping to keep the project moving.

Saul Poliak, to whom this Handbook is dedicated, founded the National Plant Engineering Exposition and Conference which has been held both nationally and regionally since 1950. He has also pioneered similar expositions and conferences in the United Kingdom, Europe, Central America, and the Far East. It is widely recognized that he has been a major force in advancing the awareness of the critical plant engineering function in the industrial societies.

*Robert C. Rosaler, P.E.
James O. Rice*

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SECTION 1

THE PLANT ENGINEER AND THE ORGANIZATION

CHAPTER 1.1

OBJECTIVES AND PHILOSOPHY

Hugh Blackwell

Alcoa/Mt. Holly

Goose Creek, South Carolina

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INTRODUCTION

The degree of success of a plant engineer will be measured not by his or her ability to recite equations, balance budgets, complete capital projects, or maintain equipment, but by the ability to lead others in the face of insufficient personnel, resources, and time to do the job comfortably. In years past, internal workloads determined our pace of progress. Today, external information and customer demands drive behavior and pace. In order to successfully *manage* information and *lead* people, plant engineers must:

- Be a part of the management team
- Know the workforce culture
- Understand and implement strategic planning
- Thrive, not survive

How one goes about addressing and prioritizing these concepts will determine the success or failure of the organization.

THE MANAGEMENT TEAM

The term *management* is misleading because it implies that one is managing *people*. In fact, people don't follow people (managers), they follow *vision*. Therefore, the key to a successful management team is not in its ability to tell people what to do but in its ability to help them align their vision with that of the overall organization.

It has been said that organizations are much like people. Both have five senses: purpose, community, urgency, responsibility, and commitment. A sense of purpose refers to *mission* and *vision*. As a plant engineer, you need to ask yourself why you are there. Do your personal goals align with those of your organization? If not, one of three things is apt to happen: you will either convert your goals to those of the organization, comply with them because they allow you to remain in your "comfort zone," or you will eventually leave.

A sense of community simply means don't reinvent the wheel! Many others have gone before us. How did they do it? Cross-functional teams are a great way of accelerating the learning process. Having access to the Internet or to intranet web sites is another great way of

creating a sense of community. The success of any engineering or maintenance organization hinges on its ability to *communicate* through crucial windows of opportunity. D. Edward Deming once said, “There’s no such thing as instant pudding!” Developing a sense of community is absolutely crucial and essential to long-term survival and growth. It doesn’t happen overnight, as a result of a promotion, or with a change in top management.

Probably the most important of the five senses is the sense of *urgency*. The leaders among our ranks must have a sense to *act*, not to *wait*. We’ve all heard that there are three types of people: those who *make* things happen, those who *watch* things happen, and those who *wonder* what happened. The speed at which engineering organizations advance will be measured not by the number of computer programs or software packages employed, but by the speed at which people learn and apply new technologies and concepts.

Simply stated, priorities change. Therefore, we must be flexible. We must be willing to “get out of the box,” yet stay within the realm of reality. The concept of *breakthrough thinking* comes to mind. Paraphrasing what Joel Barker once said, “We will live out the remainder of our working lives in a state of change.” In many cases, there is no longer time to adapt our processes to new demands; rather, we should adopt *new* processes and concepts.

One definition of insanity is “doing the same thing over and over yet expecting different results.” If we expect or desire different results, we must do things differently. Said another way, if you don’t like what you’re getting from others, change what they are doing. Most people naturally resist change; therefore, a sense of urgency is essential to identifying the sources of resistance to change so progress can begin. Don’t spend all your time trying to manage change. Instead, *plan* for change. None of us has a crystal ball, but time spent thinking about the future is better spent than thinking about the past or present. It’s much easier to plan for change than to change plans.

The word *responsibility* brings to mind two words: *leadership* and *accountability*. A sense of responsibility is accepting accountability for your actions and the outcome of your work. It matters not whether you are a process engineer, project engineer, plant engineer, engineering manager, engineering team leader, or corporate vice president of engineering. We all are leaders at various times. Engineers often lead bid meetings, frequent project reviews, periodic budget reviews, safety briefs, and postproject completion reviews.

Leadership should be an *enabler* to success, not a push to get things done. Enabling leaders do two things well—they both create and sustain an environment where people can grow professionally and personally. Enabling leaders don’t focus on doing just the right things, but on doing things right! Success is a shared responsibility.

Last, but not least, is creating a sense of *commitment*. Commitment is cooperation with communication. As you communicate with others, ask yourself these three questions: why are you here, what do you want, and what have you learned? We are all in the business of lifelong learning. So, if your answers to these three questions are not consistent with your personal mission statement and aligned with the organization’s vision, you’ve got an important decision to make.

It’s often been said, “You are what you do, not what you say!” Leading by example is the best measure of commitment. Vince Lombardi once said, “It’s not whether you get knocked down, but whether or not you get back up.” Commitment and continuous improvement go hand in glove. Not unlike encouragement, commitment is a gift we give each other.

THE WORKFORCE CULTURE

Plant engineers must know the culture of the workforce. How do things get done around here? Many hierarchical organizations of the past are gone, replaced by flatter and more flexible relational organizations. Today, many plant engineers effectively get their work done horizontally rather than vertically. Successful engineering organizations have commonly shared values (at all levels within the organization), identified key-results areas, and dynamic metrics to track performance.

Values tell us how to accomplish our mission. In short, values govern behavior. Unfortunately, all organizations have embedded cultural filters that filter ideas, information, and data. Once filtered, ideas yield action and drive results. *Proactive* plant engineers want ideas (based on sound values) governing future operations. It has been said that managing an operation from behind a desk is a dangerous thing. To be understood, your values must be seen on the shop floor by your actions and involvement in day-to-day activity, not by your title or level of education.

Values also provide a common language for aligning leadership with rest of the organization. It is the plant engineer's sole responsibility to define and document the values of the engineering organization. Typically, these values include such things as involvement and participation, continuous improvement, a focus on people, maintaining levels of quality, exceeding customer expectations, and maintaining an awareness of costs. Once understood by all, values not only govern behavior, they also define "organizational north."

Organizations that base their vision on values seldom fail. With a clear vision, values lead to ideas and results. Without a clear vision, values aren't important and outcomes are uncertain or unpredictable. Do your homework. Share your values and ideas with others. Admiral Hyman Rickover, renowned as the father of the nuclear Navy, once said, "Simple minds discuss people, average minds discuss events, great minds discuss ideas."

STRATEGIC PLANNING

Within the past 5 to 8 years, there has been a tremendous amount of activity within industry centered on the concept of strategic planning. The concept is not new, but getting the entire organization involved in the process *is* a change from the past. It's often referred to as "genius-level thinking"—that is, no one person is smarter than the collective experience and knowledge of a group of people. Collectively, we are smarter than any one of us alone. The success of strategic planning is attributable to just that—genius-level thinking at the group level.

Organizations without strategic plans are at risk. Topics typically addressed in strategic plans include such things as safety, revenue, facilities, infrastructure, information systems, competition, and customers. The key to successful strategic planning lies in the timely execution of related tactics, but each of these topics is important for the following reasons:

- *Safety.* People are still getting hurt.
- *Revenue.* Long-term price declines are prevalent.
- *Facilities.* Older plants cost more to sustain and maintain.
- *Infrastructure.* Reliable equipment is essential to profitability.
- *Competition.* It's global and getting tougher.
- *Customers.* They are demanding more for less.

The bottom-line purpose of strategic planning is to ensure long-term viability and growth, the cornerstones of which are *quality* to customers, *returns* to owners, and *opportunities* for employees. None of these happen in a vacuum and none should be a strange concept to a plant engineer. In short, plant engineers must be actively engaged in strategic planning, not stereotyped as just a technical resource when needed.

THRIVING, NOT SURVIVING

Successful plant engineers of the twenty-first century will be those who are regarded as thrivers, not survivors. *Survivors* tend to stay out of sight and do only what is asked. Although strong technically, they are not change agents and tend to do things the way they have always

done them. *Thrivers*, on the other hand, typically bring energy, insightfulness, concern for the future, and recognition to individuals and groups. They work to become part of the management team that adds value to the bottom line. Their contribution to profitability is by design, not coincidence. Thrivers aren't consumed by process changes—they invent them.

In the absence of good reliable information, perception becomes reality. Perceptions are not right or wrong, but they *are* good and bad. Too often plant engineers are looked at as being comfortable, passive, and unimaginative. None of these conditions is remotely related to reality in a progressive organization. We operate in a worldwide competitive market governed by four Cs: continuously changing, competitive climate. The plant engineering organization must keep ahead of the game or get out of the way. An engaged plant engineering group can see the direct relationship between what it does daily and the financial impact on the company's bottom line.

Plant engineers must understand the business case for action. Again, why are we here? Determine the current condition. How are things done around here? Are there opportunities for improvement? If so, define the target condition. What's possible and achievable? The key to this improvement process is developing a realistic action plan to get from the current to the target condition. Timing is everything.

Successful plant engineers know and understand the following very clearly:

- The current and desired state of the engineering function
- The bottom-line impact on plant profitability
- Their internal vision of the future
- Their mission, vision, and organizational values

Don't underestimate the power of values. Values govern behavior ("walk the talk"). Behavior defines your work ethic (what gets measured gets done). Work ethics enable profitability (continuous improvement). Profitability drives survivability (carried out by thrivers). And survivability overcomes the competition (benchmark the best).

SUMMARY

In summary, folks on the floor want leadership by example, not leadership lip service. The folks in the front office want acceptable returns on investment, not cost overruns. The folks under your charge want a caring, consistent, enabling leader who can create a sense of urgency when needed, understand and share concerns, communicate up and down the line, energize folks for broad-based action, focus on short- and long-term results, and never lose his or her sense of humor. Engineering organizations that thrive are characterized by the following six attributes:

- Work is interesting and challenging.
- People, not events, make the decisions.
- Management sets the direction, and then gets out of the way.
- Paradigms are allowed and encouraged to shift.
- Success is a shared responsibility.
- Confidence, not comfort, is sought.

Where will you be when margins are close? The challenge is real, and the choice is yours.