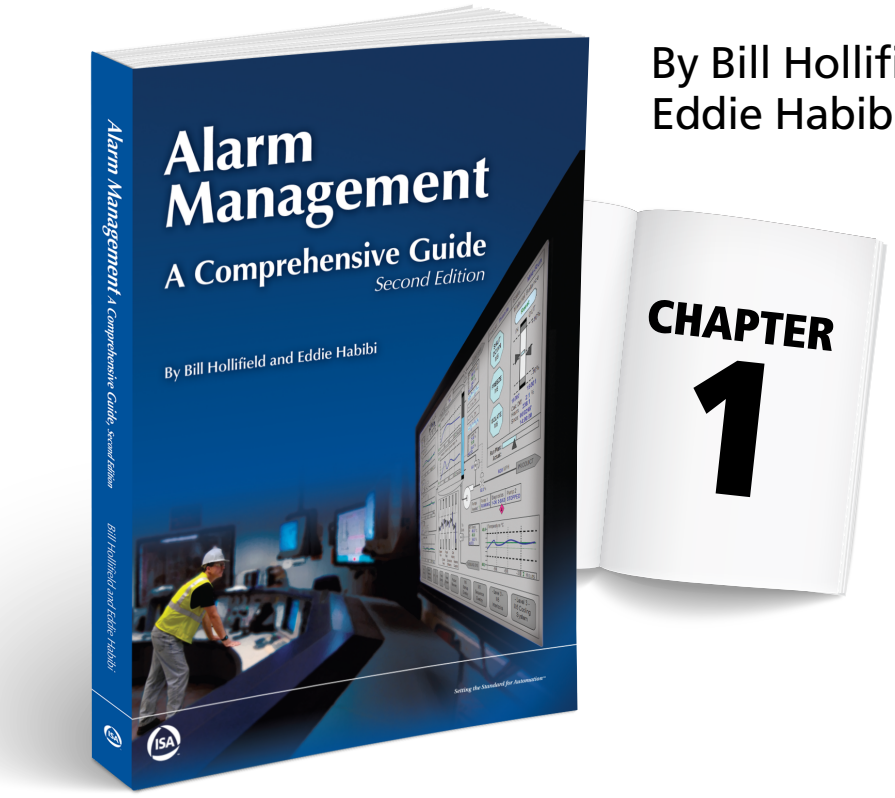
Chapter 1 of
Alarm Management
A Comprehensive Guide
Second Edition
By Bill Hollifield and Eddie Habibi

Alarm Management
A Comprehensive Guide
Second Edition



By Bill Hollifield and
Eddie Habibi

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Alarm Management: A Comprehensive Guide

Second Edition

Practical and proven methods
to optimize the performance
of alarm management systems

By
Bill R. Hollifield
PAS Principal Alarm Management and HMI Consultant
&
Eddie Habibi
PAS Founder and CEO

Foreword by
Jim Pinto
Automation Industry Executive, Analyst, and Commentator

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Research Triangle Park, NC 27709

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Foreword

"Unintended Consequences"
by
Jim Pinto

You are reading an important book, about an important problem and its solution.

Technology has often advanced faster than our ability to use it effectively. We embrace the newest, shiniest technical toy and only later realize the unintended consequences. The manufacturers of our process automation technology innovate furiously, giving the end user thousands of choices and capabilities. It is in the use (and misuse) of these capabilities that we achieve both spectacular success and spectacular failure! And such failure is often due to the adoption of technology in the absence of wise guidelines for its effective use. This book is written to provide exactly that—wise and experienced guidance about a very problematic area of technology, the modern industrial process alarm system.

The advance of automation technology has enabled improved processing and system optimization for complex mixes of raw materials, operating environments, and process methodology adaptations. Global competitiveness and demand have required increased production using less energy, with less waste. Effective alarm system design and management are key elements in meeting these challenges.

Many alarm systems have been implemented without any proper guidance, and what we now know to be very poor practices were implemented and continued. Vastly over-alarmed systems producing thousands of alarms per day became common. Poorly performing alarm systems have been cited as specific contributing factors to major accidents and losses.

That's where this book is useful. It is written by individuals with vast experience in the different plants, processes, and environments requiring effective alarm management. It is filled with good examples and explanations of procedures, with practical lists and tips on how one should proceed. It is based on hundreds of successful projects.

This book is practical and instructive, written from a vendor-neutral standpoint making it valuable to suppliers, integrators, and end-users alike. It is a book for managers, process engineers, and operators; an essential textbook to keep around and refer to regularly. I particularly enjoy the practical quo-

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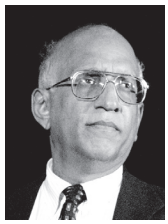
tations and real-world examples. Since the first edition of this book was published, alarm management has advanced considerably and remains a high-profile topic. Three years of additional experience has provided new topics and insights in the content and examples in this second edition.

The Future

Process automation technology will continue to rapidly advance in both capability and complexity. The control system must become self-correcting and self-optimizing—which means the system must adapt heuristically to reduce, not increase, the need for operator intervention.

True process effectiveness will not result from training operators to manage increasingly complex systems; it will come from training the system to incorporate the knowledge of the operator. This is one way the "aging workforce" problem and the near term retirement of most experienced plant personnel will be addressed.

The authors have performed a real service to the process industries by the publication of this second edition.



Jim Pinto
San Diego, CA
October 2009

Jim Pinto is founder (and formerly President and CEO) of Action Instruments. He is a technology futurist, venture capitalist, speaker, industrial automation commentator, analyst, and consultant. He has authored two books and writes for several webzines, journals, and magazines. Jim serves as an international consultant in strategic business planning, marketing, sales channel development, technology planning, and acquisition strategy. He is a member of the Association of Professional Futurists and the World Future Society.

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Introduction

"There are more things to alarm us than to harm us, and we suffer more often in apprehension than reality."

—Lucius Annaeus Seneca

Why We Wrote the Second Edition

In 2006, we published the original edition of *The Alarm Management Handbook*. It was then republished by ISA (with minor changes) as *Alarm Management: Seven Effective Methods for Optimum Performance*. The response to these books has been amazing. Thousands of copies have been sold. In some cases, single companies bought dozens of copies for their multiple sites and engineering organizations. We've had positive feedback from hundreds of readers.

The purpose of the original book was to capture in one volume the current body of best practices knowledge for improving and optimizing the performance of a modern alarm management system. The book focused on practical advice, strategies, and techniques. In 2006, there was no such alarm management reference book with such a practical focus.

The past four years have seen much growth and improvement in the alarm management landscape.

- Alarm Management has consistently remained as a high profile topic at technical symposia.
- Control systems manufacturers are beginning to understand the problems inherent in their system designs, and are making improvements.
- System implementers have begun to realize that rule-of-thumb methods of alarm configuration will cause big problems for the system owner, and are adopting improved methods.

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- Third-party companies have continued to lead in technical innovations and advanced alarming solutions.
- Hundreds more successful implementations of alarm management principles have taken place, providing additional terabytes of data which continue to confirm the validity of the principles in this book.
- The electric power generation industry has begun widespread and concerted efforts in alarm management, accompanied by an alarm management recommended practice document published by the Electric Power Research Institute (EPRI), a document co-authored by the authors of this book.
- The American Petroleum Institute (API) is working on a recommended alarm management practice for pipelines (RP-1167), intended to be published in late 2010 or early 2011.
- ISA has (finally!) completed and published a standard on alarm management, an effort underway since 2003. This second edition contains information on this important development.

Given these factors, it makes sense to update the content within this book, and to provide additional guidance on some topics based upon the latest data and experiences.

This second edition, like the original work, will remain an intentionally different kind of book than you usually find in engineering circles. It is based on hundreds of person-years of extensive experience working with industrial control and alarm systems in almost every industry. All manner of practices make up the background information used in producing this book–the good and the bad, the best and the worst. The basis includes a working knowledge of the guidelines, standards, articles, reference works, and other materials on the subject, along with knowledge and experience obtained from hundreds of alarm management improvement projects.

Breakthrough results have been achieved by following the principles contained in this book. The principles herein can also enable new systems to be initially configured correctly, and not require expensive re-engineering after problems later become apparent.

In this book, you will find actual examples of good practices and poor practices. The various problems of alarm systems are covered with precise guidance on how they come about and how to effectively correct them. We know operating companies are limited by time, money, and

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resources. We do not advocate academic, theoretical, or impractical approaches to the problems. Instead, in this book you will find fact-based, field proven, straightforward, and practical solutions.

Changes and Additions in the Second Edition

This second edition includes an additional 50 pages of information and many new figures. Questions and comments from readers of the original edition helped shape the new content. Much of the additional text provides more thorough discussion of specific topics, and almost every section in the book has been revised. There are some completely new sections and chapters as well.

The major changes and additions include:

- Where are we now—four years after the first edition
- Details and impact of the new standard *ANSI/ISA-18.2-2009 Management of Alarm Systems for the Process Industries*
- Changes in the regulatory environment
- Additional discussion on the human factors issues associated with alarm analysis
- Additional information about alarm management and batch and discrete manufacturing processes
- Additional information on alarm bad actor resolution
- Additional information on diagnostic alarms
- Alarm classification
- Improvements in alarm rationalization techniques
- A thorough examination of staged approaches to alarm rationalization
- Additional information on advanced real time alarming techniques
- An update on the future of alarm management
- An enhanced appendix on alarm philosophy documents
- An updated appendix on both High Performance HMI concepts (proper operator graphics) and control loop optimization methods

Is This Book for You?

This book specifically targets alarm management related to modern Distributed Control Systems (DCSs). This designation includes SCADA systems (Supervisory Control and Data Acquisition). These flexible and capable systems are used throughout various industries, including oil and gas, refining, chemical, petrochemical, pulp and paper, pharmaceu-

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ticals, power generation, minerals processing, discrete manufacturing, and others. Both DCS and SCADA types of control systems have identical concerns and solutions to alarm management issues. In this book, use of the term "DCS" includes SCADA systems.

The most common scenario this book addresses is a processing facility—continuous, batch, or discrete—with one or more operators using a modern control system. This is typically the case in the chemical, petrochemical, refining, power generation, pipeline, mining and metals, pharmaceutical, and similar industries. The product being made, extracted, or transported is immaterial—be it gasoline, megawatts, polymers, aspirin, or aluminum. The alarm problem is the same. If you have such a facility, you will find this book valuable.

This book also serves those involved in designing and modifying such facilities. Proper alarm management practices are most effectively and inexpensively accomplished in the original specification, design, and configuration of a control system. Many companies now require the application of these principles in the design phase; this book will tell you how to do it right the first time.

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CHAPTER 1

Alarm Management Best Practices: Highly Condensed

"My definition of an expert in any field is a person who knows enough about what's really going on to be scared."

—P. J. Plauger

1.1 The Alarm Problem

A poorly functioning alarm system is often noted as a contributing factor to the seriousness of upsets, incidents, and major accidents. Significant alarm system improvement is needed in most industries utilizing computer-based SCADA or distributed control systems; it is a massively common and serious problem. Most companies have become aware of the need to thoroughly investigate and understand their alarm system performance. Alarm management is a fast-growing, high profile topic in the process industries. It is the subject of constant articles in the trade journals and at various technical society meetings and symposia.

Having decided to investigate this area, how do you proceed? Your time and resources are always limited. The subject is complex. Alarm system improvement involves an interlinked combination of technology and work processes.

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1.2 People Who Can Help

You should seek help from the best experts in the field. You want information, advice, products, and services from:

- People who are acknowledged experts in the alarm management field, with in-depth understanding of the historical and current problem, the science and literature, the studies and standards, and the range of solutions
- People with in-depth knowledge of process control, distributed control systems, human-machine interfaces, process networks, and critical condition management
- People with experience in every stage of a successful alarm system improvement project, along with many examples of successful projects
- People who understand work processes based on successful experience in different industry segments. You want to know what your industry is doing, what are the best and most efficient practices, and frankly, what the worst practices are.

1.3 The ANSI/ISA-18.2-2009 Alarm Management Standard

In 2003, ISA began developing a standard on alarm management. Dozens of contributors (including the authors) from many industry segments spent thousands of person-hours participating in the development. After six years of work, the new standard *"ANSI/ISA-18.2-2009 Management of Alarm Systems for the Process Industries"* is now available at www.isa.org.

The issuance of ISA-18.2 is a significant and important event for the process industries. It sets forth the work processes for designing, implementing, operating, and maintaining a modern alarm system, presented in a life cycle format. This standard will definitely have a regulatory impact, but more on that later.

This second edition contains a lengthy chapter on understanding and implementing this standard. Readers of this book should not expect to learn much that is basically new or different from reading ISA-18.2. Standards intentionally limit and concern themselves with *what* to do rather than *how* to go about doing it in an effective and efficient manner. By design, standards contain the *minimum acceptable* and not the optimum. This book exists to provide detailed guidance and impart detailed knowledge far exceeding the content of a standard.

There is no conflict between this book's seven step approach and the ISA-18.2 life cycle approach—there is only some different nomenclature

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and arrangement of the topics. The seven step approach is well proven for efficiency and effectiveness.

1.4 Seven Steps to a Highly Effective Alarm System

Here is a brief outline of a best practices approach in a typical alarm management project. These straightforward steps can be easily implemented in any work process framework, such as Six Sigma. The first three steps are universally needed for the improvement of an alarm system. They are often done simultaneously at the start of a project.

Always needed steps:
Step 1: Develop, Adopt, and Maintain an Alarm Philosophy
Step 2: Collect Data and Benchmark Your Systems
Step 3: Perform Bad Actor Alarm Resolution

These first three steps are placed first in the process because they collectively provide the most improvement for the least expenditure of effort. They provide the best possible start and the fundamental underpinnings for the remainder of steps necessary for effective alarm management.

Steps to implement to improve alarm system performance:
Step 4: Perform Alarm Documentation and Rationalization (D&R)
Step 5: Implement Alarm Audit and Enforcement Technology
Step 6: Implement Real-time Alarm Management
Step 7: Control and Maintain Your Improved System

Step 1: Develop, Adopt, and Maintain an Alarm Philosophy

An Alarm Philosophy is a comprehensive guideline for the development, implementation, and modification of alarms. The philosophy says "*Here's how to do alarms right!*" It provides an optimum basis for alarm selection, priority setting, configuration, response, handling methods, system monitoring, and many other topics. In this book, you will learn exactly how to develop an Alarm Philosophy, complete with examples. An Alarm Philosophy will be an immediately useful document covering the entire range of alarm topics. It will reflect a full understanding of the alarm problem and the proper practices to follow.

Step 2: Collect Data and Benchmark Your Systems

Analysis is fundamental to improvement. You must analyze your alarm system to improve it. You should look for alarm analysis software with full graphical and tabular output, easy access to the full control system event journal entries, automatic report generation, web-based report

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viewing, and so forth. You want a comprehensive and complete set of alarm analyses to enable you to pinpoint your exact problems and apply the most efficient solutions.

Since operator changes (e.g., controller setpoints, modes, and outputs) are recorded by most DCSs in a similar fashion to alarm events, you will want software that includes the analysis of such events. The results can be amazingly useful, and can point out areas where control schemes are not working as designed or where operating procedures or operator training need improvement. While this book is focused on alarm management, we include a section on the benefit of these operator change analyses.

There can be no improvement without an understanding of your starting point. A comprehensive Baseline Report sets your benchmark and will enable you to target your resources to get the most improvement possible for the minimum cost and effort. The start of an improvement effort requires an examination of your actual data.

Step 3: Perform Bad Actor Alarm Resolution

Based on the analysis of hundreds of systems, there are always several varieties of nuisance or Bad Actor alarms. This book contains an efficient and effective process for analyzing these and provides exact recommendations for configuration changes to improve their performance. The average improvement is over a 50% reduction in overall alarm events for a relatively minimal effort. While on some systems this result may not meet an overall improvement goal, it is a great first step, providing much-needed immediate relief. It also establishes the credibility of the alarm management effort with an immediate early success.

These first three steps are universally needed for the improvement of an alarm system. The following steps generally involve more time, resources, and expense. Some of them may or may not be needed depending on the performance characteristics of your system.

Step 4: Perform Alarm Documentation and Rationalization (D&R)

Many existing systems need a total rework—a review of the configuration and purpose of every alarm. We call this Alarm Documentation and Rationalization (D&R), also commonly called Alarm Objective Analysis, among other terms. You will want to use a software-assisted methodology to make D&R fast and efficient. Besides just having software, there is an art to performing a D&R in an efficient manner. The knowledge herein is based upon participation in the rationalization of hundreds of thousands of points. This experience provides detailed knowledge of the common problems and the

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best solutions, which are provided here in this book. One result of a D&R effort is the creation of a Master Alarm Database, which contains the post-rationalized alarm configuration with changed setpoints, priorities, and so forth. A Master Alarm Database has several uses.

Step 5: Implement Alarm Audit and Enforcement Technology

Once your alarm system is improved, it is essential to ensure the configuration does not change over time unless the changes are specifically authorized. DCS and SCADA systems are notoriously easy to change, which is why software mechanisms that frequently audit (and enforce) the current configuration versus the Master Alarm Database are needed. Paper-based Management of Change solutions for DCS configuration (alarm or otherwise) have a wide and consistent history of failure.

Step 6: Implement Real Time Alarm Management

Based on the performance you need your alarm system to achieve and the nature of your process, you may want to implement more advanced alarm handling solutions, such as the following:

- **Alarm Shelving:** A safe, secure way to temporarily disable a nuisance alarm until the underlying problem can be corrected. Most control systems have inadequate mechanisms to properly control temporary alarm suppression. Computerized lists of shelved alarms, with time limits, reminders, and auto-re-enabling are necessary. It must be impossible to temporarily suppress an alarm and then forget about it—a very common and dangerous occurrence throughout industry.
- **State-based Alarming and Alarm Flood Suppression:** Algorithms detect when the plant changes operating state (such as startup, shutdown, different products, rates, feedstocks, etc.) and dynamically alter the alarm settings to conform to the proper settings for each state. State-based settings for inadvertent shutdown of a piece of equipment have proven to be effective in managing most alarm flood situations.
- Operator Alert Systems: Once the alarm system has been properly reserved for things meeting the requirements of *what should actually be an alarm*, there may remain a need for an operator-configurable notification tool explicitly separate from the alarm system. Such operator alert systems are a best practice and are described later in this book.

Step 7: Control and Maintain Your Improved System

Processes and sensors change over time, and alarm behavior will change with them. Alarms working correctly now may become nuisances or malfunction in the future. Effective management of change methodolo-

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gies, and an ongoing program of system analysis and correction of problems as they occur, is needed for an effective alarm system.

1.5 Summary

If you know or suspect you have an alarm problem, read this book and begin doing the things it recommends.

This is an excerpt from the book. Pages are omitted.

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ABOUT THE AUTHORS

Eddie Habibi
Founder & CEO
PAS Global, part of Hexagon

Eddie Habibi is the founder and CEO of PAS Global, part of Hexagon, a leading provider of software solutions for the industrial sector. A visionary and thought leader in the fields of industrial control systems and operational technology, he is a renowned industry speaker, author, and business executive. Eddie's expertise spans industrial cybersecurity, the Industrial Internet of Things (IIoT), Industrie 4.0, data analytics, and operations management, and his guidance is highly valued by commercial enterprises, government organizations, and industry associations worldwide. In 2017, Eddie was listed by *CRN Magazine* as one of the 30 Internet Of Things Executives Whose Names You Should Know. He is the co-author of two popular best practices books on operational risk and safety management: *Alarm Management: A Comprehensive Guide* and *The High Performance HMI Handbook*. Eddie holds an Engineering degree from the University of Houston and an MBA from the University of St. Thomas.

Bill Hollifield
Principal Alarm Management and HMI Consultant
PAS Global, part of Hexagon

Bill Hollifield is the principal consultant for both Alarm Management and High Performance HMI for PAS Global, part of Hexagon. Bill has 30 years of experience in the petrochemical industry in engineering and operations, and an additional 15 years in alarm management and HMI software and services for the petrochemical, power generation, pipeline, pharmaceutical, and mining industries. He is a member of the ISA SP-18 Alarm Management committee, the ISA SP-101 HMI committee, the American Petroleum Institute's API RP-1165 HMI committee, and the Engineering Equipment and Materials Users Association (EEMUA) Industry Review Group.

Bill is co-author of *Alarm Management: A Comprehensive Guide, The High Performance HMI Handbook*, and the Electric Power Research Institute (EPRI) Guidelines on alarm management and HMI for both power generation and transmission. He has a BSME from Louisiana Tech University and an MBA from the University of Houston. In 2014, Bill was made an ISA Fellow. He's a pilot and has built his own airplane—a Van's RV12.

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