

Third Edition

Safety and Security Review for the Process Industries

Application of HAZOP, PHA,
What-IF and SVA Reviews

Dennis P. Nolan

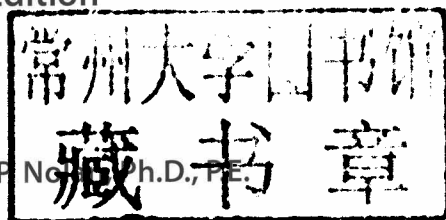


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Dennis P. Nigam, Ph.D., P.E.



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PREFACE

This document is intended as a typical guideline and reference book that may be applied at industrial facilities, commercial processes, and systems. It is suggested that this document is used as a practical reference to prepare the safety review requirements for process safety or security management systems. The first edition of this book was entitled *Application of HAZOP and What-If Safety Reviews in the Petroleum, Petrochemical and Chemical Industries* and was issued in 1994. Since that time the use of PHAs has become more prevalent and the threat to industrial and commercial facilities from security incidents has also become more relevant. Numerous other industrial and trade organizations have also since published similar guidance documents for PHAs and SVAs. It was therefore felt prudent to update this book to include these aspects and also incorporate additional technical updates and features.

It has also been requested that I include other types of safety reviews that are being increasingly used to look more technically as such risk in the process industries such as SIL analysis, and I have been involved in numerous safety and security reviews previous to and after writing this book. I have captured many hints and shortcuts to improve on the formal classical method of these reviews to improve on their scope, economics, and timing. These aspects are vitally important to the management of major project designs and existing facilities. The outcome of these studies also reduces the potential incidents from existing, unknown hazards or security threats.

The forms and checklists presented in the book can be downloaded on the companion website: elsevier.com/9781437735185.

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ABOUT THE AUTHOR

Dr. Dennis P. Nolan has had a long career devoted to risk engineering, fire protection engineering, loss prevention engineering, and systems safety engineering. He holds a Doctor of Philosophy degree in business administration from Berne University, Master of Science degree in systems management from Florida Institute of Technology, and a Bachelor of Science degree in fire protection engineering from the University of Maryland. He is a U.S.-registered professional engineer in fire protection engineering in the state of California.

He is currently an executive management staff of Saudi Aramco, located in Abqaiq, Saudi Arabia, site of some of the largest oil and gas fields in the world. This operation also contains the largest oil and gas production and separation facilities in the world. The magnitude of the risks, worldwide sensitivity, and foreign location make this one of the highly critical fire risk operations in the world. He has also been associated with Boeing, Lockheed, Marathon Oil Company, and Occidental Petroleum Corporation in various fire protection engineering, risk analysis, and safety roles in several locations in the United States and overseas. As part of his career, he has examined oil production, refining, and marketing facilities under severe conditions and in various unique worldwide locations, including Africa, Asia, Europe, the Middle East, Russia, and North and South America. His activity in the aerospace field has included engineering support for the NASA Space Shuttle launch facilities at Kennedy Space Center (and for those undertaken at Vandenberg Air Force Base, California) and “classified” national defense systems.

Dr. Nolan has received numerous safety awards and is a member of the American Society of Safety Engineers. He is the author of many technical papers and professional articles in various international fire safety publications. He has written several other books, *Handbook of Fire and Explosion Protection Engineering Principles for Oil, Gas, Chemical, and Related Facilities* (1st and 2nd editions), *Fire Fighting Pumping Systems at Industrial Facilities* (1st and 2nd editions), *Encyclopedia of Fire Protection* (1st and 2nd editions), and *Loss Prevention and Safety Control Terms and Definitions* (1st edition). Dr. Nolan has also been listed for many years in “Who’s Who in California”, “Who’s Who in the West”, “Who’s Who in the World,” and “Who’s Who in Science and Engineering” publications. He was also listed in “Living Legends” (2004) published by the International Biographical Center, Cambridge, United Kingdom.

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Purpose

This book is intended to provide guidance to qualitative hazard analyses conducted for industrial and commercial processes, specifically for Preliminary Hazard Analysis (PHA), What-If, and Hazard and Operability (HAZOP) review teams. It also highlights how the methodology and procedures used for these reviews can be adopted and applied for Security Vulnerability Analysis (SVA). This book describes the nature, responsibilities, methods, and documentation required for the performance of such reviews. This ensures these reviews are conducted in a timely, effective, objective, and consistent manner as may be prescribed by a company's Process Safety Management (PSM) policy and security requirements. This book relies heavily on the common practices in the petroleum, chemical, and petrochemical industries since most of the major hazardous processes are located in these industries, and these facilities are increasingly becoming a potential target for security incidents.

The safety and security of process facilities are important parts of a company's operations. Worldwide petrochemical safety regulations, international security threats, and a company's own PSM policies would require that a hazard identification, process safety, and security analysis review of its existing and proposed operations be accomplished.

The limits of hazardous substances cited by both the U.S. Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA) regulations dictate the application of PSM elements at almost all of a petroleum or chemical company's facilities. These reviews are intended to reduce the probability and/or consequences of a major incident that would have a detrimental impact on the employees, the public's well-being, onsite or offsite properties, the environment, and most importantly to a company itself, its continued business operation and survival. It should also be noted there may be a general adverse public reaction and, therefore, a company's prestige may suffer. Hazard identification and process analysis reviews are not intended to identify the minor "slips, trips, or falls," rather these are the responsibility of the company's

general safety requirements that are well established and can be analyzed with other tools, e.g., Job Safety Analysis (JSA).

In March 2003, the United States implemented Operation Liberty Shield to increase the readiness and security in the United States primarily due to international threats from nongovernment affiliated self-motivated political and religious groups. One objective of this operation is to implement comprehensive process security management programs into existing OSHA, EPA, and FDA laws to address deliberate acts of threats of terrorism, sabotage, and vandalism. In April 2007, the Department of Homeland Security (DHS) issued the Chemical Facility Anti-Terrorism Standard (CFATS). The objectives of the DHS are to identify, assess, and ensure effective security at high-risk chemical facilities. Included in this standard are the requirements for facilities handling chemicals above a threshold amount and to submit an SVA for DHS review and approval along with a site security plan. A potential fine of \$25,000 per day, an inspection and audit by DHS, or an order to cease operations is stated for noncompliance. The type and amount of chemicals handled which require submission of screening review and SVA submittals have been listed on the DHS website. Additionally, internal company security procedures, although confidential, would also require that an adequate security review be undertaken to identify and assess such risks. Since the methodology of conducting process security reviews is similar to existing process hazard analysis reviews, they can be adapted to fit within the parameters of existing procedures established for these analyses. Both American Petroleum Institute (API) and American Institute of Chemical Engineers (AIChE) have also issued their own guidelines to assist companies undertaking process security reviews. A major process safety consultant recently stated that statistics show that the use of outside security experts for the consultations of protective services has increased by 200% in the last 5 years. This was due to escalating concerns over workplace and domestic violence, privacy and security practices, and terrorist threats. Process security reviews are not intended to identify minor thefts or mishaps; these are the responsibility of the company's general security requirements that are well established and can be examined with other financial auditing tools.

The purpose of the evaluations described in this book is to identify the major risks that have the potential to severely impact the industry. It identifies simple processes and procedures to apply these reviews in an easy and practical manner.

PHA, What-If, and HAZOP reviews are the most common industrial qualitative methods used to conduct process hazard analyses, while SVAs



Figure 1.1 Fire services incident identification and pre-planning

are typically applied for process security analyses. It is qualitatively estimated that up to 80% of a company's hazard identification and process safety analyses may consist of PHA, What-If, and HAZOP reviews, with the remaining 20% from checklist, Fault Tree Analysis (FTA), Event Tree Analysis (ETA), Failure Mode and Effects Analysis (FMEA), and so on.

An experienced review team can use the analyses described to generate possible deviations from design, construction, modification, and operating intent or from deliberate actions that define potential consequences. These consequences can then be prevented or mitigated by the application of the appropriate safeguards.

The reader is reminded that a PHA, What-If, HAZOP, or an SVA report is a living document for a facility. As changes are made to a facility or its procedures, the applicable review is to be updated to represent the current facility. Process hazard analysis reviews are also required to be updated and revalidated every 5 years as a minimum by U.S. regulations (OSHA and EPA). Also, since the terrorist's agenda has not subsided, threat assessment/vulnerability analysis needs to be continually reevaluated.

A completed review report can be used to demonstrate to interested parties that a prudent analysis has been accomplished and all possible actions have been examined and/or implemented to eliminate major hazards or minimize the threat. It has been noted that the Chemical Safety and Hazard Investigation Board (CSB) routinely examines hazard analyses that have been performed on processes which they are reviewing, to ensure that they were performed adequately.

This book can also be referred to by review team members. It will serve as a reminder of their duties and responsibilities in the performance of the required reviews and report development.

Scope

These guidelines should be considered for all of a company's facilities, domestically and internationally. They are intended to be applied at both permanent and temporary facilities, whether located onshore or offshore.

The typical review is usually intended to be a formal audit review of an "essentially" complete project design or modification to ensure that the probabilities or consequences of major incidents have been eliminated or reduced to acceptable levels prior to being placed in service. Risk analyses should be continually conducted as part of the project design to avoid the identification of major concerns by the later reviews. In fact, documentation from a design risk analysis should supplement the formal HAZOP, PHA, What-If, or SVA reviews.

Process safety and security reviews are not intended to replace or duplicate a project design review. Unusually, complex or large projects may require several levels of a safety or security review during their design phase. These may be initiated at the conceptual, preliminary, detailed, and final design stages. Such levels are usually encountered in multimillion dollar offshore facilities, refinery, or chemical processing plant projects where major changes occurring later in the design would be severe in economic and schedule terms. These multilevel reviews start at a broad viewpoint and gradually narrow to specifics just as the project design proceeds. Where operating procedures are not available during the design, a supplemental PHA, What-If, HAZOP, or SVA review may be considered for these documents. In fact, an initial review may recommend that subsequent final designs be again evaluated by a PHA, What-If, HAZOP, or SVA as a follow-up. It is essential that these follow-up reviews be completed as incidents investigated by the CSB have identified failure to perform a follow-up risk analysis as a contributing factor in some incidents.

During the period of initial implementation of process safety and security management policies, existing facilities may also be the subject of PHA, What-If, HAZOP, or SVA reviews.