GUIDELINES FOR

REVALIDATING A PROCESS HAZARD ANALYSIS

with website

2

SECOND EDITION

An AIChE Technology Alliance
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WILEY

GUIDELINES FOR REVALIDATING A PROCESS HAZARD ANALYSIS

This book is one in a series of process safety guidelines and concept books published by the Center for Chemical Process Safety (CCPS). Refer to www.wiley.com/go/ccps for full list of titles in this series.

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GUIDELINES FOR REVALIDATING A PROCESS HAZARD ANALYSIS

Second Edition

WILEY

This edition first published 2023

A Joint Publication of the American Institute of Chemical Engineers and John Wiley & Sons, Inc.

Registered Office
John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, USA

Editorial Office
111 River Street, Hoboken, NJ 07030, USA

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Wiley also publishes its books in a variety of electronic formats and by print-on-demand. Some content that appears in standard print versions of this book may not be available in other formats.

Library of Congress Cataloging-in-Publication Data Applied for:

Hardback ISBN: 9781119643609

Cover Images: Silhouette, oil refinery © manyx31/iStock.com;
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ACRONYMS AND ABBREVIATIONS

AIChE	American Institute of Chemical Engineers
ALARP	As Low As Reasonably Practicable
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ATEX	ATmospheres EXplosible
BLEVE	Boiling Liquid Expanding Vapor Explosion
BMS	Burner Management System
BPCS	Basic Process Control System
CCPS	Center for Chemical Process Safety
CIA	Chemical Industry Association
CMMS	Computerized Maintenance Management System
DCS	Distributed Control System
DHA	Dust Hazard Analysis
DMR	Damage Mechanism Review
EHS	Environment, Health, and Safety
EPA	Environmental Protection Agency
ETA	Event Tree Analysis
FMEA	Failure Modes and Effects Analysis
FTA	Fault Tree Analysis
HAZOP	Hazard and Operability
HCA	Hierarchy of Hazard Controls Analysis
HHC	Highly Hazardous Chemical
HIRA	Hazard Identification and Risk Analysis
HRA	Human Reliability Analysis
ICI	Imperial Chemical Industries
IEC	International Electrotechnical Commission
IEF	Initiating Event Frequency
IPL	Independent Protection Layer
ITPM	Inspection, Test, and Preventive Maintenance
LOPA	Layer of Protection Analysis
MAWP	Maximum Allowable Working Pressure

MCC	Motor Control Center
MI	Mechanical Integrity
MOC	Management of Change
MooC	Management of Organizational Change (See OCM)
NFPA	National Fire Protection Association
OBRA	Occupied Building Risk Assessment
OCM	Organizational Change Management
OR	Operational Readiness
OSHA	Occupational Safety and Health Administration
P&IDs	Piping and Instrumentation Diagrams
PFD/PFOD	Probability of Failure on Demand
PHA	Process Hazard Analysis
PPE	Personal Protective Equipment
PLC	Programmable Logic Controller
PSI	Process Safety Information
PSID	Process Safety Incident Database
PSM	Process Safety Management
PSSR	Pre-Startup Safety Review
QA	Quality Assurance
QRA	Quantitative Risk Analysis
RAGAGEP	Recognized and Generally Accepted Good Engineering Practice
RBPS	Risk Based Process Safety
RMP	Risk Management Plan
RP	Recommended Practice
SCBA	Self-Contained Breathing Apparatus
SDS	Safety Data Sheet
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SME	Subject Matter Expert

GLOSSARY AND NOMENCLATURE

This Glossary and Nomenclature section contains process safety terms unique to this Center for Chemical Process Safety (CCPS) publication. The CCPS process safety terms in this publication are current at the time of issue. For other CCPS process safety terms and updates to these terms, please refer to the "CCPS Process Safety Glossary" [1].

Complementary Analysis/Analyses: Beyond the core analysis, this includes any additional analyses on specific topics required by policy or regulation to complete the minimum requirements for a process hazard analysis (PHA). Complementary analyses often address topics such as human factors and facility siting, and range in complexity from simple checklist analyses to sophisticated computer modeling. Like the core analysis, any complementary analyses must be included in the scope of a revalidation.

Core Methodology/Core Analysis: This is the primary method used to identify, evaluate, and document process hazards and their consequences and risk controls. Although other PHA methods are available, one of the following three techniques is most commonly used: Hazard and Operability (HAZOP) Study, What-If/Checklist, or Failure Modes and Effects Analysis (FMEA).

Facilitator/Leader/Study Leader: Universally, PHA revalidation teams must include at least one person knowledgeable in the hazard analysis methodology being used. The terms "facilitator," "leader," and "study leader" are used interchangeably in this book, as they are in general practice, but the person's actual role is a blend of both facilitator and study leader. As facilitator, they should engage all other team members in the correct application of the chosen hazard analysis technique and make the work process easier. They should also ensure that the PHA team follows the relevant rules and guidelines specified for the study. Simultaneously, they should lead the team to complete the revalidation efficiently and accurately without stifling the team's imagination and curiosity as they try to identify hazards of the process.

Hazard Identification and Risk Analysis (HIRA): This collective term encompasses all activities involved in identifying hazards and evaluating risk at facilities, throughout their life cycle, to make certain that risks to employees, the public, or the environment are consistently controlled within the risk tolerance of the organization. PHA revalidation, as described in this book, is also generally applicable to the revalidation of HIRAs.

Incident: Use of the single term "incident" throughout this book is intended to include of the incident definitions listed in the CCPS glossary definition. These

include "catastrophic incident," "incident," "near-miss incident," and "process safety incident/event."

Process Hazard Analysis (PHA): This review is an organized effort to identify and evaluate hazards associated with processes and operations to enable their control. Normally, the analysis involves use of qualitative techniques to identify and assess the significance of hazards. Reviewers judge risks and develop appropriate recommendations. Occasionally, quantitative methods are used to help prioritize risk reduction. In this book, the term "PHA" encompasses all the activities involved in creating and revalidating the resulting PHA document.

Process Safety Management (PSM) System: A management system that focuses on prevention of, preparedness for, mitigation of, response to, and restoration from catastrophic releases of chemicals or energy from a process associated with a facility. In this book, the term "PSM" broadly encompasses management systems anywhere in the world with similar intent, regardless of their official name, whether required by regulatory authorities or by organizational policies. PSM issues related to a specific jurisdiction, such as the United States Occupational Safety and Health Administration (OSHA) PSM, are noted in this book.

Semi-Quantitative Risk Analysis: This evaluation uses a risk matrix with a numeric frequency scale and a descriptive, qualitative consequence scale. Any risk analysis based on such a matrix is inherently semi-quantitative (part numeric, part descriptive). This terminology is sometimes incorrectly used to describe a simplified, but fully numeric, QRA.

Simplified Quantitative Risk Analysis/Simplified Process Risk Assessment: Quantitative risk analysis (QRA) involves the systematic development of numerical estimates of the expected frequency and/or severity of potential consequences associated with a facility or operation. The estimation process may be based on conservative rules and order-of-magnitude data to simplify the analysis. Simplified QRA techniques, such as Layer of Protection Analysis (LOPA), are typically used to identify whether the risks of evaluated loss scenarios are managed to tolerable levels.

Supplemental Risk Assessment: This includes any additional analyses used to improve the quality and consistency of risk judgments in a PHA. Common techniques range from (1) simple categorization on a risk matrix to (2) simplified risk analysis techniques such as LOPA and bow tie analysis to (3) detailed QRAs. Supplemental risk assessments are typically included in the scope of a revalidation to be consistent with the requirements of the facility owner and applicable regulations.

ACKNOWLEDGMENTS

The American Institute of Chemical Engineers (AIChE) and the Center for Chemical Process Safety (CCPS) express their gratitude to all members of the *Revalidating Process Hazard Analyses Second Edition* subcommittee and their CCPS member companies for their generous efforts and technical contributions in the preparation of this book.

The chair of the subcommittee was Laura Acevedo Turci from 3M. Warren Greenfield was the CCPS consultant. The subcommittee also included the following people who participated in the writing of this *Guidelines* book:

Alok Khandelwal	Shell
Curtis Clements	Chemours
Jennifer Bitz	CCPS
Jordi Costa Sala	Celanese
Lisa Parker	Braskem
Manuel Herce	DuPont
Marty Timm	Praxair - Linde - Retired
Michael Hazzan	AcuTech Consulting
Mohammad Baig	Bayer

CCPS especially wishes to acknowledge the contributions of the principal writers from ABSG Consulting Inc. (ABS Consulting):

Derek Bergeron
Bill Bradshaw
Don Lorenzo

The writers wish to thank the following ABS Consulting personnel for their technical contributions and reviews: Tom Williams and David Whittle provided technical review of the book. Lynn Purcell edited the manuscript. Susan Hagemeyer helped prepare the final manuscript for publication.

Before publication, all CCPS books are subjected to a thorough peer-review process. CCPS also gratefully acknowledges the thoughtful comments and suggestions of the following peer reviewers. Their work enhanced the accuracy, clarity, and usefulness of this *Guidelines* book. Although the peer reviewers have provided many constructive comments and suggestions, they were not asked to endorse this book and were not shown the final manuscript before its release.

Ahmad Hafiz Zeeshan	Tronox Australia
Allison Knight	3M
Bernard Groce	Calumet Specialty
Dan Sorin	Novachem
Denise Chastain-Knight	exida
Don Connolley	aeSolutions
Felix Azenwi Fru	National Grid
Gill Sigmon	AdvanSix
James Martin	Corteva™ Agriscience
Kristine M. Cheng	Chevron
Lisa Long	OSHA
Matias Massello	Process Improvement Institute
Michell LaFond	Dow
Michelle Brown	FMC
Muddassir Penkar	Heartland Petrochemical Complex Interpipeline
Nick Ashley	W.R. Grace and Company
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Rizal Harris Wong	Petronas
Robert Feuerhake	Lanxess
Ruel Ruiz	3M
Scott E. Swanson	Intel
Tekin Kunt	PSRG

PREFACE

The American Institute of Chemical Engineers (AIChE) has helped chemical plants, petrochemical plants, and refineries address the issues of process safety and loss control since 1967.

The Center for Chemical Process Safety (CCPS), a directorate of AIChE, was established in 1985 to develop and share technical information for use in the prevention of major chemical accidents. CCPS is supported by a diverse group of industrial sponsors in the chemical process industry and related industries who provide the necessary funding and professional guidance for its projects. The CCPS Technical Steering Committee and the technical subcommittees oversee individual projects selected by the CCPS. Professional representatives from sponsoring companies staff the subcommittees and a member of the CCPS staff coordinates their activities.

Since its founding, CCPS has published many volumes in its "Guidelines" series and in smaller "Concept" texts. Although most CCPS books are written for engineers in plant design and operations and address scientific techniques and engineering practices, several guidelines cover subjects related to chemical process safety management. A successful process safety program relies upon committed managers at all levels of a company, who view process safety as an integral part of overall business management and act accordingly.

This book is an update of the 2001 book "Revalidating Process Hazard Analyses". In 21 years since the publication of the first edition, PHA and PHA revalidation have evolved, and the methods for conducting them have changed and improved. This updated edition addresses the complementary analyses and supplemental risk assessments that often are incorporated into PHAs. It reflects the knowledge gained by the CCPS, writers, and the project committee members, who collectively, have more than 100 years of practical experience in conducting and revalidating PHAs.

This book was written to enhance the knowledge and provide insight and guidance to those who are involved with the planning and execution of PHAs and are responsible for updating and revalidating PHAs. Multiple audiences should find this book useful. Those who manage the PHA program will find guidance for resources and timing. Those who must determine the type of revalidation necessary will find tools for analyzing the past PHA and related studies. PHA teams will find checklists and other tools in the appendices for use during the study.

DEDICATION

Updating and Revalidating Process Hazard Analyses

Is dedicated to

Walt Frank

Walt Frank is a process safety professional with a wide range of experience and expertise that is helping to improve process safety worldwide.

From his early entry into process safety at DuPont through consulting at ABS and later as President of Frank Risk solutions, Walt has always been dedicated to sharing process safety knowledge and expertise through his many contributions to both NFPA and CCPS.

Walt was a primary writer for the first edition of the Revalidating Process Hazard Analyses. He has also been a key contributor to several other CCPS books. In addition, he is the current chair of the CCPSC Exam committee and is a key contributor to the CCPS Golden Rules for Process Safety project.

Walt is often the driving force that helps teams focus on the key process safety aspects requiring development and presentation in a clear and precise manner. He has a keen eye for details and sets similar expectations for his colleagues and team members. He is persistent in pursuing perfection.

Walt is a Registered Professional Engineer, AIChE Fellow, CCPS Fellow, Certified Process Safety Professional (CCPSC) and a CCPS Emeritus. CCPS is proud to dedicate this book to Walt in recognition for all he has given and continues to give, to the process safety community.

Anil Gokhale & Warren Greenfield

INTRODUCTION

OBJECTIVE OF THIS BOOK

For years, formal process hazard analyses (PHAs) have been performed on processes handling hazardous materials, and most companies have included requirements for the conduct of PHAs in their process safety management (PSM) programs.

Most company PSM programs also include requirements to revalidate the PHA periodically. Such requirements are intended to ensure the PHA for a process is complete, up to date, and thoroughly documented, considering the changes and incidents that have occurred in the process and the operating experience gained since the prior PHA was conducted. In jurisdictions where PHAs are required by regulation, periodic revalidation is usually required to maintain regulatory compliance.

Because the efforts to revalidate the PHA can involve a significant investment of time and resources, it is important that the revalidation effort be thoughtfully organized, conducted, and documented. This book addresses the need, identified by the CCPS, for supplemental guidance with respect to considerations unique to the PHA revalidation task.

SCOPE OF THIS BOOK

This book provides an organized approach, and several tools, to revalidate a PHA. However, it does not provide a "one-size-fits-all" approach for revalidation. Neither is it intended to provide the "one true solution" to the task. Readers and companies should develop procedures based upon an evaluation of their specific requirements. Although the concepts in this book could be adapted for revalidation of other studies (e.g., security analysis and financial risk analysis), the book was written exclusively with the intent of revalidating a PHA and the documentation/studies directly associated with a PHA. Revalidation of other stand-alone analyses is outside the specific scope of this book.

This book assumes that the reader is familiar with the conduct of a PHA. While some introductory material on general PHA activities, methodologies, and risk assessment is provided in Chapter 1, this book is not intended to be an instructional text covering the general conduct of a PHA or application of supplemental risk assessment techniques (such as Layer of Protection Analysis [LOPA] or bow tie analysis).

This book is a supplement to the CCPS book *Guidelines for Hazard Evaluation Procedures* [2, p. 8] and is premised on the same concept stated in the book:

> ***This book does not contain a complete program for managing the risk of chemical operations, nor does it give specific advice on how to establish a hazard analysis program for a facility or an organization. However, it does provide some insights that should be considered when making risk management decisions and designing risk management programs.***

This book outlines a demonstrated, common-sense approach for resource-effective PHA revalidation. This approach first examines a number of factors, such as PHA requirements, the quality of the prior PHA, and the operating experience gained since the prior PHA (including changes and incidents that have occurred). A revalidation approach is developed based upon this input. The revalidation concept described in this second edition has been updated based on experience and knowledge gained since the first edition was published over 20 years ago.

HOW TO USE THIS GUIDELINES BOOK

To use this book effectively for PHA revalidation, it is helpful to follow the chapters in sequence. The book progresses through each key/major step in the process of revalidating a PHA.

Chapter 1 – Overview of the PHA Revalidation Process explains the role of PHA and PHA revalidation in understanding and managing risk. It describes two revalidation approaches and the typical analytical tools used in revalidation activities.

Chapter 2 – PHA Revalidation Requirements explains the external and internal requirements that must be satisfied by a periodic PHA revalidation.

Chapter 3 – Evaluating the Prior PHA explains how to identify deficiencies in the prior PHA (with respect to current requirements) and to evaluate its usability in revalidation activities.

Chapter 4 – Evaluating Operating Experience Since the Prior PHA explains how to gather and evaluate information (arising from process changes, equipment changes, procedure changes, organizational changes, new research, incident investigations, etc.) that could materially alter the risk judgments documented in the prior PHA.

Chapter 5 – Selecting an Appropriate PHA Revalidation Approach explains how to use the knowledge and insights gained from evaluating the prior PHA and operating experience to select a thorough and efficient revalidation approach.

Chapter 6 – Preparing for PHA Revalidation Meetings explains how to assemble the resources necessary to conduct revalidation meetings and how to document them successfully.

Chapter 7–Conducting PHA Revalidation Meetings explains how to facilitate the use and interaction of resources to achieve the revalidation objectives.

Chapter 8 – Documenting and Following Up on a PHA Revalidation explains how to create a revalidation report likely to meet applicable requirements and how to help ensure elevated risks discovered during the revalidation are communicated and resolved.

Appendices – Sample Checklists are available in the appendices for use in PHA revalidation. Electronic versions of the checklists in the appendices are available at

www.aiche.org/ccps/publications/reval2ed

Password: revalbooked2