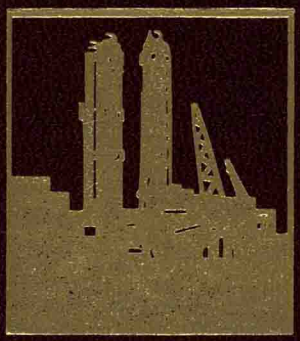
Second Edition



Guidelines for Evaluating Process Plant Buildings for External Explosions, Fires, and Toxic Releases

WILEY

An AIChE Technology Alliance
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Center for Chemical Process Safety

GUIDELINES FOR EVALUATING PROCESS PLANT BUILDINGS FOR EXTERNAL EXPLOSIONS, FIRES, AND TOXIC RELEASES

Second Edition

Center for Chemical Process Safety
New York, NY

A JOHN WILEY & SONS, INC., PUBLICATION

Library of Congress Cataloging-in-Publication Data:

American Institute of Chemical Engineers. Center for Chemical Process Safety.
Guidelines for evaluating process plant buildings for external explosions, fires, and toxic releases. — 2nd ed.
p. cm.
Rev. ed. of : Guidelines for evaluating process plant buildings for external explosions and fires. © 1996.
Includes index.
ISBN 978-0-470-64367-9 (hardback)
1. Chemical plants—Fires and fire prevention. 2. Explosions. 3. Chemical plants—Risk assessment. 4. Hazardous wastes. I. Guidelines for evaluating process plant buildings for external explosions and fires. II. Title.
TH9445.C47A46 2012
660'.2804—dc23 2011049805

Printed in the United States of America.

10 9 8 7 6 5 4 3 2 1

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

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ACKNOWLEDGMENTS

The American Institute of Chemical engineers (AIChE) and the Center for Chemical Process Safety (CCPS) express their appreciation and gratitude to all members of the Guidelines for Evaluating Process Plant Buildings for External Explosions, Fires, and Toxic Releases, Second Edition project and their CCPS member companies for their generous support and technical contributions in the preparation of this book. The AIChE and the CCPS also express their gratitude to the team and project managers from Baker Engineering and Risk Consultants who, under the direction of Mr. Quentin Baker, devoted time and expertise to ensure that this project would meet the needs of industry.

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Second Edition

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CCPS wishes to acknowledge the many contributions of the Baker Engineering and Risk Consultants team with special recognition for outstanding and innovative contributions to the primary authors Quentin Baker, Raymond Bennett, and Michael Moosemiller, and to the technical contributions of Jatin Shah and John Woodward. Thanks also go to Moira Woodhouse for technical editing and pulling all the pieces together in the manuscript, and Joanna Sobotker for administrative support throughout the project.

Before publication, all CCPS books are subjected to a thorough peer review process. CCPS gratefully acknowledges the time and expertise these peer reviewers put into their reviews and acknowledges the thoughtful comments and suggestions. Their work and perspectives enhanced the accuracy, clarity, and value of these Guidelines.

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# 1	Not disclosed
# 2	Not disclosed

GLOSSARY

Accident: An unplanned event or sequence of events that results in an undesirable consequence.

Acute: Single, short-term exposure (less than 24 hours).

Aggregate Risk: Societal risk for on-site workers in occupied buildings (API 752).

Blast: A transient change in the gas density, pressure, and velocity of the air surrounding an explosion point. The initial change can be either discontinuous or gradual. A discontinuous change is referred to as a shock wave, and a gradual change is known as a pressure wave.

Blast Load: The load applied to a structure or object from a blast wave, which is described by the combination of overpressure and either impulse or duration.

BLEVE (Boiling Liquid, Expanding Vapor Explosion): The explosively rapid vaporization and corresponding release of energy of a liquid, flammable or otherwise, upon its sudden release from containment under greater-than-atmospheric pressure at a temperature above its atmospheric boiling point. A BLEVE is often accompanied by a fireball if the suddenly depressurized liquid is flammable and its release results from vessel failure caused by an external fire. The energy released during flashing vaporization may contribute to a shock wave.

Building: A rigid, enclosed structure.

Building Siting Evaluation: The procedures used to evaluate the hazards and establish the design criteria for new buildings and the suitability of existing buildings at their specific locations.

Building Geographic Risk: The risk to a person who occupies a specific building 24 hours/day, 365 days/year.

Combustible: Capable of burning.

Confinement: Solid surfaces that prevent movement of unburnt gases and a flame front in one or more dimensions.

Congestion: Obstacles in the path of the flame that generate turbulence.

Consequence: The undesirable result of an incident, usually measured in health and safety effects, environmental impacts, loss of property, and business interruption costs. For building siting, consequence refers to building damage and occupant vulnerability from the potential effects of an explosion, fire, or toxic material release. Consequence descriptions may be qualitative or quantitative.

Consequence Based Approach: The methodology used for building siting evaluation that is based on consideration of the impact of explosion, fire and toxic material release which does not consider the frequency of events.

Deflagration: A propagating chemical reaction of a substance in which the reaction front advances rapidly into the unreacted substance, but at less than sonic velocity in the unreacted material.

Detonation: A propagating chemical reaction of a substance in which the reaction front advances into the unreacted substance at or greater than sonic velocity in the unreacted material.

Essential Personnel: Personnel with specific work activities that require them to be located in buildings in or near a process area for logistical and response purposes.

Explosion: A release of energy that causes a blast.

Flammable: A gas that can burn with a flame if mixed with a gaseous oxidizer such as air or chlorine and then ignited. The term *flammable gas* includes vapors from flammable or combustible liquids above their flash points.

Flame Speed: The speed of a flame burning through a flammable mixture of gas and air measured relative to a fixed observer, that is, the sum of the burning and translational velocities of the unburned gases.

Flammable Limits The minimum and maximum concentrations of combustible material in a homogeneous mixture with a gaseous oxidizer that will propagate a flame.

Frequency: Number of occurrences of an event per unit of time.

F-N Curve: A plot of cumulative frequency versus consequences (expressed as number of fatalities).

Hazard: An inherent physical or chemical characteristic (e.g. flammability, toxicity, corrosivity, stored chemical energy, or mechanical energy) that has the potential for causing harm to people, property, or the environment.

HVAC: Heating, Ventilating and Air Conditioning.

Impulse: A measure that can be used to define the ability of a blast wave to do damage. It is calculated by the integration of the pressure-time curve.

Incident: An unplanned event with the potential for undesirable consequences.

Individual Risk: The risk to a person in the vicinity of a hazard. This includes the nature of the injury to the individual, the likelihood of the injury occurring, and the time period over which the injury might occur.

LFL (Lower Flammability Limit): The concentration of a combustible material in air below which ignition will not occur. It is often referred to as the Lower Explosive Limit (LEL). Mixtures below this limit are said to be "too lean."

Lookup Table Approach: See "Spacing Table Approach"

MCE (Maximum Credible Event): A hypothetical explosion, fire or toxic event that has the potential maximum consequence to the occupants of the building under consideration from among the major scenarios evaluated. The major scenarios are realistic and have a reasonable probability of occurrence considering the chemicals, inventories, equipment and piping design, operating conditions, fuel reactivity, process unit geometry, industry incident history, and other factors. Each building may have its own set of MCEs for potential explosion, fire or toxic material release impacts.

MOC (Management of Change): A system to identify, review and approve all modifications to equipment, procedures, raw materials and processing conditions other than replacement in kind," prior to implementation. [Management of Change is an element of the U.S. Occupational Health and Safety Administration (OSHA)'s Process Safety Management (PSM) regulation.]

Occupant Vulnerability: Proportion of building occupants that could potentially suffer an injury or fatality if a postulated event were to occur. The level of injury is defined according to the technical basis of the occupant vulnerability model being used.

On-site Personnel: Employees, contractors, visitors, service providers, and others present at the facility.

Overpressure: Any pressure above atmospheric caused by a blast.

Permanent Building: Rigid structures intended for permanent use in fixed locations.

Portable Building: Rigid structure that can be easily moved to another location within the facility.

Probability: The expression for the likelihood of occurrence of an event or an event sequence during an interval of time. By definition, probability must be expressed as a number ranging from 0 to 1.

Process Area: An area containing equipment (e.g. pipes, pumps, valves, vessels, reactors, and supporting structures) intended to process or store materials with the potential for explosion, fire, or toxic material release.

Probit: A random variable with a mean of 5 and a variance of 1, which is used in various effect models.

PSM (Process Safety Management): A program or activity involving the application of management principles and analytical techniques to ensure the safety of chemical process facilities. Sometimes called *process hazard management*. Each principle is often termed an "element" or "component" of process safety. [This can also refer to the U.S. Occupational Health and Safety Administration (OSHA)'s Process Safety Management (PSM) regulation 29 CFR 1910.119.]

Qualitative: Based primarily on description and comparison using historical experience and engineering judgment, with little quantification of the hazards, consequences, likelihood, or level of risk.

QRA (Quantitative Risk Assessment): The systematic development of numerical estimates of the expected frequency and/or consequence of potential accidents associated with a facility or operation based on engineering evaluation and mathematical techniques.

Reflected Pressure: Impulse or pressure experienced by an object facing a blast.

Risk Based Approach: A quantitative risk assessment methodology used for building siting evaluation that takes into consideration numerical values for both the consequences and frequencies of explosion, fire, or toxic material release.

Risk Based Inspection: A risk assessment and management process that is focused on loss of containment of pressurized equipment in processing facilities, due to material deterioration. These risks are managed primarily through equipment inspection.

Scenario: An unplanned event or incident sequence that results in a loss event and its associated impacts, including the success or failure of safeguards involved in the incident sequence.

Semi-quantitative: Risk analysis methodology that includes some degree of quantification of consequence, likelihood, and/or risk level.

Shelter-in-Place: A process for taking immediate shelter in a location readily accessible to the affected individual by sealing a single area (an example being a room) from outside contaminants and shutting off all HVAC systems.

Side-on Pressure: The impulse or pressure experienced by an object as a blast wave passes by it.

Spacing Table Approach: The use of established tables to determine minimum separation distances between equipment and buildings intended for occupancy. Industry groups, insurance associations, regulators and owner/operator companies have developed experience-based spacing tables for minimum building spacing for fire.

Toxic Material: An airborne agent that could result in acute adverse human health effects.

Vapor Cloud Explosion: The explosion resulting from the ignition of a cloud of flammable vapor, gas, or mist in which flame speeds accelerate to sufficiently high velocities to produce significant overpressure.

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