

**Table 1****Equipment Involved in Dust Explosions**

Equipment	U.S. (FM,1985-95) + (IRI,1975-2001)		U.K. (1979-1988) (HSE)		Germany (1965-85) (Eckhoff, 1997)	
	# Incidents	%	# Incidents	%	# Incidents	%
Dust Collectors	156	42	55	18	73	17
Grinders/Pulverizers	35	9	51	17	56	13
Silos/Bunkers	27	7	19	6	86	20
Conveying System*	32	9	33	11	43	10
Dryer/Oven	22	6	43	14	34	8
Mixers/Blenders	> 12	> 3	7	2	20	5
Other or Unknown	84	23	95	31	114	27
Total	372	100	303	100	426	100

\* Conveying systems include conveyors, ducts, and elevators.

# Guidelines For Safe Handling Of Powders And Bulk Solids

**L Cohen**



## **Guidelines For Safe Handling Of Powders And Bulk Solids:**

*Guidelines for Safe Handling of Powders and Bulk Solids* CCPS (Center for Chemical Process Safety), 2010-08-13 Powders and bulk solids handled widely in the chemical pharmaceutical agriculture smelting and other industries present unique fire explosion and toxicity hazards Indeed substances which are practically inert in consolidated form may become quite hazardous when converted to powders and granules The U S Chemical Safety and Hazard Investigation Board is currently investigating dust explosions that occurred in 2003 at WestPharma CTA Acoustics and Hayes Lemmerz and is likely to recommend that companies that handle powders or whose operations produce dust pay more attention to understanding the hazards that may exist at their facility This new CCPS guidelines book will discuss the types of hazards that can occur in a wide range of process equipment and with a wide range of substances and will present measures to address these hazards

**Guidelines for Safe Handling of Powders and Bulk Solids** Stanley S. Grossel, 2005 Powders and bulk solids handled widely in the chemical pharmaceutical agriculture smelting and other industries present unique fire explosion and toxicity hazards Indeed substances which are practically inert in consolidated form may become quite hazardous when converted to powders and granules The U S Chemical Safety and Hazard Investigation Board is currently investigating dust explosions that occurred in 2003 at WestPharma CTA Acoustics and Hayes Lemmerz and is likely to recommend that companies that handle powders or whose operations produce dust pay more attention to understanding the hazards that may exist at their facility This new CCPS guidelines book will discuss the types of hazards that can occur in a wide range of process equipment and with a wide range of substances and will present measures to address these hazards

**Guidelines for Safe Handling of Powders and Bulk Solids**, 2004 **Guidelines for Integrating Process Safety into Engineering Projects** CCPS

(Center for Chemical Process Safety), 2018-12-11 There is much industry guidance on implementing engineering projects and a similar amount of guidance on Process Safety Management PSM However there is a gap in transferring the key deliverables from the engineering group to the operations group where PSM is implemented This book provides the engineering and process safety deliverables for each project phase along with the impacts to the project budget timeline and the safety and operability of the delivered equipment

Food Processing Technology P.J. Fellows, 2016-10-04 Food Processing Technology Principles and Practice Fourth Edition has been updated and extended to include the many developments that have taken place since the third edition was published The new edition includes an overview of the component subjects in food science and technology processing stages important aspects of food industry management not otherwise considered e g financial management marketing food laws and food industry regulation value chains the global food industry and overarching considerations e g environmental issues and sustainability In addition there are new chapters on industrial cooking heat removal storage and distribution along with updates on all the remaining chapters This updated edition consolidates the position of this foundational book as the best single volume introduction to food manufacturing

technologies available remaining as the most adopted standard text for many food science and technology courses Updated edition completely revised with new developments on all the processing stages and aspects of food industry management not otherwise considered e g financial management marketing food laws and food industry regulation and more Introduces a range of processing techniques that are used in food manufacturing Explains the key principles of each process including the equipment used and the effects of processing on micro organisms that contaminate foods Describes post processing operations including packaging and distribution logistics Includes extra textbook elements such as videos and calculations slides in addition to summaries of key points in each chapter

**Process Safety for Engineers** CCPS (Center for Chemical Process Safety),2022-05-03 Process Safety for Engineers Familiarizes an engineer new to process safety with the concept of process safety management In this significantly revised second edition of Process Safety for Engineers An Introduction CCPS delivers a comprehensive book showing how Process Safety concepts are used to reduce operational risks Students new engineers and others new to process safety will benefit from this book In this updated edition each chapter begins with a detailed incident case study provides steps that help address issues and contains problem sets which can be assigned to students The second edition covers Process Safety including an overview of CCPS Risk Based Process Safety Hazards specifically fire and explosion reactive chemical and toxicity Design considerations for hazard control including Hazard Identification and Risk Analysis Management of operational risk including management of change In addition the book presents how Process Safety performance is monitored and sustained The associated online resources are linked to the latest online CCPS resources and lectures

**Guidelines for Engineering Design for Process Safety** CCPS (Center for Chemical Process Safety),2012-11-07 This updated version of one of the most popular and widely used CCPS books provides plant design engineers facility operators and safety professionals with key information on selected topics of interest The book focuses on process safety issues in the design of chemical petrochemical and hydrocarbon processing facilities It discusses how to select designs that can prevent or mitigate the release of flammable or toxic materials which could lead to a fire explosion or environmental damage Key areas to be enhanced in the new edition include inherently safer design specifically concepts for design of inherently safer unit operations and Safety Instrumented Systems and Layer of Protection Analysis This book also provides an extensive bibliography to related publications and topic specific information as well as key information on failure modes and potential design solutions

**Emergency Planning** CCPS (Center for Chemical Process Safety),2010-08-26 Over 40 papers and posters that share the latest practices in emergency planning related to fixed chemical pharmaceutical LNG and petroleum facilities storage facilities transportation and security

**Guidelines for Mechanical Integrity Systems** CCPS (Center for Chemical Process Safety),2017-04-11 In recent years process safety management system compliance audits have revealed that organizations often have significant opportunities for improving their Mechanical Integrity programs As part of the Center for Chemical Process Safety s Guidelines series Guidelines for

Mechanical Integrity Systems provides practitioners a basic familiarity of mechanical integrity concepts and best practices. The book recommends efficient approaches for establishing a successful MI program.

**Guidelines for Inherently Safer Chemical Processes** CCPS (Center for Chemical Process Safety), 2019-10-11. Since the publication of the second edition, several United States jurisdictions have mandated consideration of inherently safer design for certain facilities. Notable examples are the inherently safer technology (IST) review requirement in the New Jersey Toxic Chemical Prevention Act (TCPA) and the Inherently Safer Systems Analysis (ISSA) required by the Contra Costa County California Industrial Safety Ordinance. More recently, similar requirements have been proposed at the U.S. Federal level in the pending EPA Risk Management Plan (RMP) revisions. Since the concept of inherently safer design applies globally with its origins in the United Kingdom, the book will apply globally. The new edition builds on the same philosophy as the first two editions but further clarifies the concept with recent research, practitioner observations, added examples, and industry methods and discussions of security and regulatory issues. *Inherently Safer Chemical Processes* presents a holistic approach to making the development, manufacture, and use of chemicals safer. The main goal of this book is to help guide the future state of chemical process evolution by illustrating and emphasizing the merits of integrating inherently safer design, process-related research, development, and design into a comprehensive process that balances safety, capital, and environmental concerns throughout the life cycle of the process. It discusses strategies of how to substitute more benign chemicals at the development stage, minimize risk in the transportation of chemicals, use safer processing methods at the manufacturing stage, and decommission a manufacturing plant so that what is left behind does not endanger the public or environment.

**Guidelines for Combustible Dust Hazard Analysis** CCPS (Center for Chemical Process Safety), 2017-04-26. This book describes how to conduct a Combustible Dust Hazard Analysis (CDHA) for processes handling combustible solids. The book explains how to do a dust hazard analysis by using either an approach based on compliance with existing consensus standards or by using a risk-based approach. Worked examples in the book help the user understand how to do a combustible dust hazards analysis.

**Guidelines for Initiating Events and Independent Protection Layers in Layer of Protection Analysis** CCPS (Center for Chemical Process Safety), 2015-02-03. The book is a guide for Layers of Protection Analysis (LOPA) practitioners. It explains the onion skin model and, in particular, how it relates to the use of LOPA and the need for non-safety instrumented independent protection layers. It provides specific guidance on Independent Protection Layers (IPLs) that are not Safety Instrumented Systems (SIS). Using the LOPA methodology, companies typically take credit for risk reductions accomplished through non-SIS alternatives, i.e., administrative procedures, equipment design, etc. It addresses issues such as how to ensure the effectiveness and maintain reliability for administrative controls or inherently safer passive concepts. This book will address how the fields of Human Reliability Analysis, Fault Tree Analysis, Inherent Safety Audits and Assessments, Maintenance, and Emergency Response relate to LOPA and SIS. The book will separate IPLs into categories such as the following: Inherent Safety eliminates a scenario or

fundamentally reduces a hazard Preventive Proactive prevents initiating event from occurring such as enhanced maintenance Preventive Active stops chain of events after initiating event occurs but before an incident has occurred such as high level in a tank shutting off the pump Mitigation active or passive minimizes impact once an incident has occurred such as closing block valves once LEL is detected in the dike active or the dike preventing contamination of groundwater passive      **Active**

**Pharmaceutical Ingredients** Stanley Nusim, 2016-04-19 To successfully bring an Active Pharmaceutical Ingredient API to market many steps must be followed to ensure compliance with governmental regulations This book is an unparalleled guide to the development manufacturing and regulation of the preparation and use of APIs globally This second edition brings readers up to date with the quality control regulations for APIs that have been added or amended since the first edition These updates help ensure that pharmaceutical professionals and drug manufacturers meet the established and required guidelines set forth by the US and international regulatory industries      *Guidelines for Asset Integrity Management* CCPS (Center for Chemical Process Safety), 2017-01-06 This book is an update and expansion of topics covered in *Guidelines for Mechanical Integrity Systems* 2006 The new book is consistent with Risk Based Process Safety and Life Cycle approaches and includes details on failure modes and mechanisms Also example testing and inspection programs is included for various types of equipment and systems Guidance and examples are provided for selecting and maintaining critical safety systems      **Dust**

**Explosion and Fire Prevention Handbook** Nicholas P. Cheremisinoff, 2014-06-27 Up to date and thorough coverage of the causes repercussions and prevention of dust explosions and fires by one of the most well respected environmental scientists and worker safety litigation specialists in the world This handy volume is a ready go to reference for the chemical engineer plant manager process engineer or chemist working in industrial settings where dust explosions could be a concern such as the process industries coal industry metal industry and others Though dust explosions have been around since the Earth first formed and they have been studied and written about since the 1500s they are still an ongoing concern and occur almost daily somewhere in the world from bakeries to fertilizer plants Dust explosions can have devastating consequences and recently there have been new industrial standards and guidelines that reflect safer more reasonable methods for dealing with materials to prevent dust explosions and resultant fires This book not only presents these new developments for engineers and managers it offers in depth coverage of the subject starting with a complete overview of dust how it forms when it is in danger of exploding and how this risk can be mitigated as well as a general overview of explosions and the environments that foster them Dust Explosion and Fire Prevention Handbook covers individual industries such as metal and coal offers an appendix that outlines best practices for preventing dust explosions and fire and how these risks can be systematically mitigated by these implementations and incorporates a handy glossary of terms for easy access not only for the veteran engineer or chemist but for the student or new hire This ready reference is one of the most useful texts that an engineer or chemist could have at their side With so many accidents still occurring in industry today this must have volume pinpoints the

most common sure fire ways for engineers scientists and chemists working with these hazardous materials to go about their daily business safely efficiently and profitably with no extraneous tables or theoretical treatises      **SFPE Handbook of Fire Protection Engineering** Morgan J. Hurley, Daniel T. Gottuk, John R. Hall Jr., Kazunori Harada, Erica D. Kuligowski, Milosh Puchovsky, José L. Torero, John M. Watts Jr., CHRISTOPHER J. WIECZOREK, 2015-10-07 Revised and significantly expanded the fifth edition of this classic work offers both new and substantially updated information As the definitive reference on fire protection engineering this book provides thorough treatment of the current best practices in fire protection engineering and performance based fire safety Over 130 eminent fire engineers and researchers contributed chapters to the book representing universities and professional organizations around the world It remains the indispensable source for reliable coverage of fire safety engineering fundamentals fire dynamics hazard calculations fire risk analysis modeling and more With seventeen new chapters and over 1 800 figures the this new edition contains Step by step equations that explain engineering calculations Comprehensive revision of the coverage of human behavior in fire including several new chapters on egress system design occupant evacuation scenarios combustion toxicity and data for human behavior analysis Revised fundamental chapters for a stronger sense of context Added chapters on fire protection system selection and design including selection of fire safety systems system activation and controls and CO2 extinguishing systems Recent advances in fire resistance design Addition of new chapters on industrial fire protection including vapor clouds effects of thermal radiation on people BLEVEs dust explosions and gas and vapor explosions New chapters on fire load density curtain walls wildland fires and vehicle tunnels Essential reference appendices on conversion factors thermophysical property data fuel properties and combustion data configuration factors and piping properties Three volume set not available separately      Particulate Products Henk G. Merkus, Gabriel M.H. Meesters, 2013-11-19 Particulate products make up around 80% of chemical products from all industry sectors Examples given in this book include the construction materials fine ceramics and concrete the delicacies chocolate and ice cream pharmaceutical powders medical inhalers and sun screen liquid and powder paints Size distribution and the shape of the particles provide for different functionalities in these products Some functions are general others specific General functions are powder flow and require at the typical particulate concentrations of these products that the particles cause adequate rheological behavior during processing and or for product performance Therefore this book addresses particle packing as well as its relation to powder flow and rheological behavior Moreover general relationships to particle size are discussed for e g color and sensorial aspects of particulate products Product specific functionalities are often relevant for comparable product groups Particle size distribution and shape provide for example the following functionalities dense particle packing in relation to sufficient strength is required in concrete construction ceramic objects and pharmaceutical tablets good sensorial properties mouthfeel to chocolate and ice cream effective dissolution flow and compression properties for pharmaceutical powders adequate hiding power and effective coloring of paints for protection

and the desired esthetical appeal of the objects adequate protection of our body against sun light by sunscreen effective particle transport and deposition to desired locations for medical inhalers and powder paints Adequate particle size distribution shape and porosity of particulate products have to be achieved in order to reach optimum product performance This requires adequate management of design and development as well as sufficient knowledge of the underlying principles of physics and chemistry Moreover flammability explosivity and other health hazards from powders during handling are taken into account This is necessary since great risks may be involved In all aspects the most relevant parameters of the size distribution and particle shape have to be selected In this book experts in the different product fields have contributed to the product chapters This provides optimum information on what particulate aspects are most relevant for behavior and performance within specified industrial products and how optimum results can be obtained It differs from other books in the way that the critical aspects of different products are reported so that similarities and differences can be identified We trust that this approach will lead to improved optimization in design development and quality of many particulate products

*Principles of Forensic Engineering Applied to Industrial Accidents* Luca Fiorentini, Luca Marmo, 2019-01-29 An introductory text on the investigation of industrial accidents Forensic engineering should be seen as a rigorous approach to the discovery of root causes that lead to an accident or near miss The approach should be suitable to identify both the immediate causes as well as the underlying factors that affected amplified or modified the events in terms of consequences evolution dynamics etc as well as the contribution of an eventual human error This book is a concise and introductory volume to the forensic engineering discipline which helps the reader to recognize the link among those important very specialized aspects of the same problem in the global strategy of learning from accidents or near misses The reader will benefit from a single point of access to this very large technical literature that can be only correctly understood with the right terms definitions and links in mind Keywords Presents simple real cases as well as giving an overview of more complex ones each of them investigated within the same framework Gives the readers the bibliography to access more in depth specific aspects Offers an overview of the most commonly used methodologies and techniques to investigate accidents including the evidence that should be collected to define the cause dynamics and responsibilities of an industrial accident as well as the most appropriate methods to collect and preserve the evidence through an appropriate chain of security *Principles of Forensic Engineering Applied to Industrial Accidents* is essential reading for researchers and practitioners in forensic engineering as well as graduate students in forensic engineering departments and other professionals **Dust Explosions**, 2019-06-25 *Methods in Chemical Process Safety* Volume Three addresses the most important challenges recent advancements and contributions in chemical process safety The work helps researchers and professionals obtain guidance on the selection and practice of chemical process safety methods Chapters in the book cover Experimental Methods Hazard Identification Risk Assessment Safety Measures Regulations Guidelines and Standards Emerging Unique Scenarios and more Users will find a



complete guide that presents tactics in process safety management that are now globally recognized as the primary approach for establishing a high level of safety in operations As process safety is now a disciplined framework for managing the integrity of operating systems and processes handling hazardous substances and because continued occurrence of major losses have had a significant impact on the industry s approaches to modern process safety this book is a must have for those in the industry

**Dust Explosion Dynamics** Russell A. Ogle, 2016-09-10 Dust Explosion Dynamics focuses on the combustion science that governs the behavior of the three primary hazards of combustible dust dust explosions flash fires and smoldering It explores the use of fundamental principles to evaluate the magnitude of combustible dust hazards in a variety of settings Models are developed to describe dust combustion phenomena using the principles of thermodynamics transport phenomena and chemical kinetics Simple tractable models are described first and compared with experimental data followed by more sophisticated models to help with future challenges Dr Ogle introduces the reader to just enough combustion science so that they may read interpret and use the scientific literature published on combustible dusts This introductory text is intended to be a practical guide to the application of combustible dust models suitable for both students and experienced engineers It will help you to describe the dynamics of explosions and fires involving dust and evaluate their consequences which in turn will help you prevent damage to property injury and loss of life from combustible dust accidents Demonstrates how the fundamental principles of combustion science can be applied to understand the ignition propagation and extinction of dust explosions Explores fundamental concepts through model building and comparisons with empirical data Provides detailed examples to give a thorough insight into the hazards of combustible dust as well as an introduction to relevant scientific literature

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