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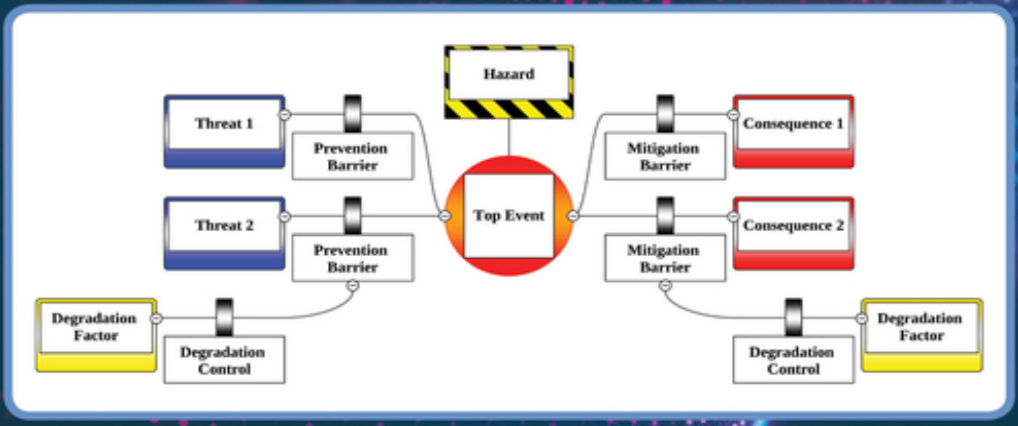
BOW TIES in RISK MANAGEMENT

A Concept Book for Process Safety



A CCPS CONCEPT BOOK

energy institute

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BOW TIES IN RISK MANAGEMENT

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This concept book is issued jointly with the Energy Institute. In EI publications, concept books are termed Research Reports in its series of technical publications. EI publications can be found at http://publishing.energyinst.org/.

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A Concept Book for Process Safety

CCPS in association with the Energy Institute

CENTER FOR CHEMICAL PROCESS SAFETY
OF THE
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PROJECT TEAM MEMBERS:

CCPS

Kiran Krishna	Shell	Project Team Chair
Timothy McGrath	ex Chevron	Project Team Vice-Chair
Americo Carvalho Neto	Braskem	
Umesh Dhake	CCPS Asia Manager	
Martin Johnson	BP	
Mark Manton	ABS Group	
Ron McLeod	Ron McLeod Ltd	
Darrin Miletello	Lyondell Basell	
Sudhir Phakey	Linde Gas	
Keith Serre	Nexen	
Ryan Supple	ConocoPhillips	

Thiruvaiyaru Venkateswaran	Reliance Industries	
Stephanie Wardle	Husky Energy	
Danny White	Ex-BHP Billiton	
Charles Cowley	CCPS Staff Consultant	Project Manager

Energy Institute

Mark Scanlon	Energy Institute	Project Team Co-Chair
Donald Smith	ENI	
Dennis Evers	Centrica	
Rob Miles	Hu-Tech	
Rob Saunders	Shell	

European Commission Joint Research Centre Major Accident Hazards Bureau

Maureen Wood
Zsuzsanna Gyenes

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Peer Reviewers:

San Burnett	BHP Billiton
Palani Chidambaram	Du Pont
Chris Devlin	Celanese
Scott Haney	Marathon Oil
Ed Janssen	Ed Janssen Risk Management Consulting
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Sam Daoudi	EI Process Safety Committee
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Sam Mannan	MKO Process Safety Center, Texas A&M University
Ian Travers	Ian Travers Ltd (ex Deputy Director Chemicals Regulation, HSE)
Mike Nicholas	Environment Agency
Mike Wardman	Health & Safety Laboratory (HSL)
Patrick Hudson	Independent Consultant, Emeritus Professor, Delft University

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INTRODUCTION

1.1 PURPOSE

The purpose of this concept book is to establish a set of practical advice on how to conduct bow tie analysis and develop useful bow tie diagrams for risk management. It describes the intended audience, gives directions on how to use the concept book and provides a basic introduction to the method, which is expanded in the following chapters. It explains the rationale for developing bow tie diagrams and how they fit into an overall risk management framework.

CCPS concept books address newer techniques in process safety that have not yet become accepted standard practice or where there is not yet industry consensus on approach. In EI publications, concept books are termed Research Reports in its series of technical publications. Concept books introduce these valuable tools in a simple and straightforward manner. CCPS and EI encourage the use of this concept book to aid the industry in developing better quality bow tie diagrams with a consistent methodology and preferred terminology for their use. Implementation of the methodology outlined in this CCPS / EI book should improve the quality of bow tie analysis and bow tie diagrams across an organization and industry.

1.2 SCOPE AND INTENDED AUDIENCE

This concept book provides practical advice on how to develop bow tie diagrams and in their use. This will help to:

- ensure consistent use of methodology and terminology;
- establish a valid approach to defining hazards, top events, threats, and consequences;
- establish criteria for barriers and degradation controls linked to degradation factors;
- identify common errors which may occur when constructing bow ties;
- provide a method to incorporate human and organizational factor issues in bow ties;
- provide guidance on how bow ties can be used for risk management purposes through the effective depiction of barriers;
- discuss basic and advanced uses of bow tie diagrams; and
- review an overall strategy for barrier management.

The intended audience for this book is primarily anyone involved with or responsible for managing process safety risks, although the concepts within the book are applicable to all bow tie risk management practices and not limited to process safety (e.g., for other safety and environmental applications and Enterprise Risk Management). It is designed for a wide audience, from beginners with little to no background in barrier management, to experienced professionals who may already be familiar with bow ties, their elements, the methodology, and their relation to risk management.

The origin of bow ties and their main use to date has been in managing process safety risks particularly relating to major accidents. They have been applied in the chemical / petrochemical and oil and gas industries as well as other industries (such as maritime, aviation, rail, mining, nuclear, and healthcare). However, the logic and approach described here may also be used to manage strategic risks, financial risks, risks of losing critical sales, etc. As these applications are less common, the examples in this book are focused on safety risks but also include human health, environmental impact, asset damage, and reputation loss.

Several software tools are available to aid in the development of the diagrams. The level of detail displayed using software tools can be complete or partial depending on the audience needs. This book does not endorse any particular software tool; however, Appendix A provides a summary of several widely available software tools known to the authors at the time of publishing.

1.3 ORGANIZATION OF THIS CONCEPT BOOK

This book is organized in a way that follows the logical flow of constructing bow ties and then conducting bow tie barrier analysis. Several examples are used to demonstrate this advice; however, these often only cover parts of a bow tie under discussion. More detailed, complete examples are found in Appendices B and C. The examples relate to the topics in each chapter and provide a story line concerning the development and use of bow ties. A summary of the content of each chapter is provided below.

Chapter 1 – Introduction

- Purpose and scope;
- Introduction to the bow tie concept;
- Linkage between bow ties, fault trees, and event trees.

Chapter 2 – The Bow Tie Model

- Define terminology and elements of the bow tie diagram;
- Illustrate robust and weak examples of bow tie elements;
- Define and discuss the types of barriers, including criteria for validity and quality.

Chapter 3 – Bow Tie Development

- Discuss the process of bow tie development including their initial development in team workshops;
- Discuss common errors and quality checks during development of bow tie diagrams.

Chapter 4 – Addressing Human Factors in Bow Tie Analysis

- Discuss how to include human and organizational factors in bow tie diagrams;
- Show how human factors can be addressed using a basic approach, but also introduce the concept of a multi-level bow tie which provides an extended analysis with greater utility, albeit with some complexity;
- Discuss metrics for human and organizational factors.

Chapter 5 – Basic Use of Bow Ties

- Discuss common uses of bow tie tools in analyzing barriers and identifying safety critical elements and tasks.

Chapter 6 – Management of Bow Ties

- Discuss use of bow ties as part of a barrier management strategy utilizing a lifecycle approach;
- Discuss links between bow ties and management system elements (e.g., Management of Change, maintenance, training, audits).

Chapter 7 – Additional Uses of Bow Ties

- Discuss the application of bow ties as a communication tool and to help demonstrate ALARP;
- Illustrate how bow ties are used to aid in decision making for various activities in an organization and for risk management;
- Show how real-time bow ties can interface with an organization's management system.

Appendices

- Appendix A – Software Tools; provides a table listing various software tools available to develop bow ties and their capabilities;
- Appendix B – Case Study for a pipeline; provides an example of a full bow tie with an emphasis on technical threats;
- Appendix C – Case Study for Multi-Level Bow Ties; provides an example bow tie incorporating human and organizational factors and demonstrating the concept of multi-level bow ties.