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EPSC

Guidelines for Managing Abnormal Situations

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Speaker Bio

- Roger Stokes – Principal Engineer CEng FIChemE
- 12 Years in Chemical Industry
  - Chlor-alkali / solvents resins / VCM / PVC
  - Design, process troubleshooting, plant management
- 23 Years in Insurance Industry
  - Investigating incidents and accidents in refineries, petrochemical / chemical
- 8 Years with BakerRisk
  - Incident Investigation
    - 2019 update to CCPS Book – Guidelines for Investigating Process Safety Incidents
  - Insurance Risk Engineering
  - PSM systems and audits
  - PHAs (Process Hazard Analysis), FHAs (Fire Hazard Analysis)
- IChemE Loss Prevention Bulletin Panel
  - Sharing learning from incidents

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About CCPS

- Center for Chemical Process Safety
- March 1985, in response to Bhopal, AIChE formed CCPS with seventeen charter member companies.

www.aiche.org/ccps

- *A collaborative effort to eliminate catastrophic process incidents by advancing state of the art technology and management practices, serving as the premier resource for information on process safety, supporting process safety in engineering, and promoting process safety as a key industry value*
- About 260 member companies including most of the world's leading chemical, petroleum, pharmaceutical, and related manufacturing companies.
- Over 100 books and products

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Acknowledgements – CCPS & Subcommittee

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Susan Behr	Braskem	Marcus Miller	TapRoot
Michelle Brown	FMC	Assem Saleh	Petro Rabigh
Eddie Dalton	BASF	Nicholas Sands	DuPont
Seshu Dharmavaram	Air Products	Bryant Sartor	AdvanSix
SP Garg	GAIL (India) Ltd	Bruce Spencer	Marathon Petroleum
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BakerRisk Project Team

Larry Bowler

Mike Broadribb

Mike Moosemiller

Duane Rehmeyer

Roger Stokes

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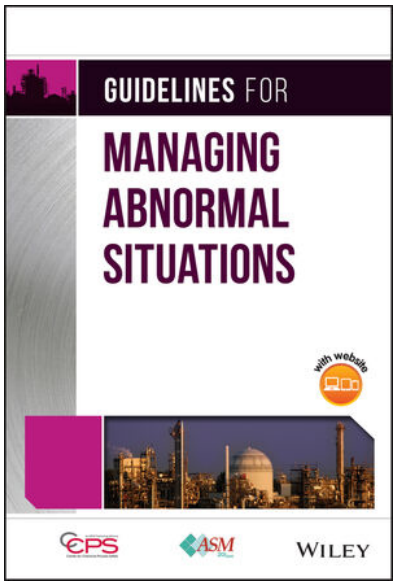
The Book !

What's Inside?

- Seven Chapters
- 234 pages
- 35 Embedded Case Studies
- 3 Detailed Case Studies
- 5 Interactive on-line Training Modules

Target Audience

- Operations Managers
- Process Safety Engineers
- Plant Engineers
- Process Control Engineers



Example - Milford Haven, 1994

View from south west showing fire at flare drum (photograph courtesy of the Western Mail and Echo Ltd)

- Release of ~ 20 tonnes of hydrocarbons
- Delayed ignition and explosion – ignition source 100m away
- 26 minor injuries on site (Sunday afternoon)
- Property damage 3km away
- Refinery damage ~ £48M
- HSE fines £200k

https://www.hse.gov.uk/comah/sragtech/casetexaco94.htm

Example - Milford Haven, 1994

- 0720: Thunderstorm ⇒ Small fire (not direct cause of main event)
- Electrical disturbances tripped feed to cracker (temporarily)
- Operators attempted to re-stablish conditions
  - But outlet valve from debutanizer stuck closed (not spotted by operators)
- Debutanizer filled up
  - Level gauge (DP) showed 79% but was actually >> 100% (calibrated for single fluid density between two specific points)
- Other distractions
  - Compressor trip, overpressure, manual venting to flare
- Flare knockout drum overfilled
- 1323: Rupture of 30" pipe downstream of KO drum at its weakest point due to overpressure, explosion, and fires

Book Chapters

- Chapter 1 – Introduction
- Chapter 2 – Process Safety and Managing Abnormal Situations
- Chapter 3 – Abnormal Situations and Process Plant Operations
- Chapter 4 – Education for Managing Abnormal Situations
- Chapter 5 – Tools and Methods for Managing Abnormal Situations
- Chapter 6 – Continuous Improvement for Managing Abnormal Situations
- Chapter 7 – Case Studies

Definitions of Abnormal Situation

- CCPS: A disturbance in an industrial process with which the basic process control system of the process cannot cope.
- ASMC: A disturbance or series of disturbances in a process that cause plant operations to deviate from their normal operating state. Abnormal situations extend, develop, and change over time in the dynamic process control environments increasing the complexity of the intervention requirements.

Business Case

- Consequences of failing to adequately manage them could range from/ to:
  - Minor product quality issue / reduction in process efficiency
  - Equipment deterioration
  - Loss of containment of hazardous substances due to overpressure or overfilling, and potentially leading to major events such as fire, explosion, toxic release, environmental damage, and fatalities
- Cost, fines
- Reputational damage (social media)
  - Philadelphia Energy Solutions (PES) refinery closure after loss of containment, fire, explosion, June 2019

Process Safety Management and Abnormal Situations

ABNORMAL SITUATION MANAGEMENT

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PROCESS SAFETY MANAGEMENT

- Hazard Identification and Risk Analysis
- Operating Procedures
- Training
- Competency
- Asset Integrity
- Process Safety Culture/Leadership.

IMPORTANCE OF TRAINING FOR ASM

- Understanding the Limits
- STOP WORK Authority ?

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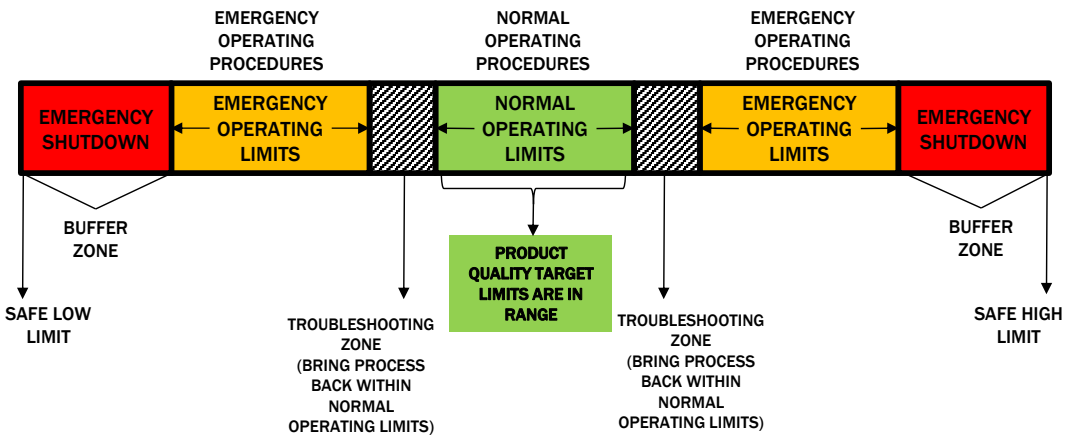
Operating Limits and Abnormal Situations



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Process Plant Operations

- Recognising and Managing Abnormal Situations *before* a major incident
- ASM Consortium key research areas:
  - Understanding Abnormal Situations
  - Organisational Roles, Responsibilities, and Work Processes
  - Knowledge and Skill Development
  - Communications
  - Procedures
  - Work Environment
  - Process Monitoring Control and Support Applications

Process Plant Operations - additional

- Instrumentation failures: Faulty valves, sensors, calibration errors, bypassed trips
- Energy blackouts: Backup supplies do not always function when required.

The China Syndrome

New/ Emerging Technologies

- Advanced Process Control, connected devices, machine learning, and artificial intelligence
  - Can add to the safe and reliable operation of a process.
- But might also cause confusion for operating teams
  - Human factors require detailed consideration when new systems are installed, as part of the management of change (MOC) process.
  - Systems may have inherent, unknown modes and patterns of failure.
- Design of the Human Machine Interface (HMI) is crucial
  - Ensure that operators maintain Situation (Situational) Awareness during complex deviations from normal operations
- Increasingly sophisticated systems
  - But operators may lose hands-on experience of managing the process during upsets
  - Unless practiced via specific training / process simulator

Education

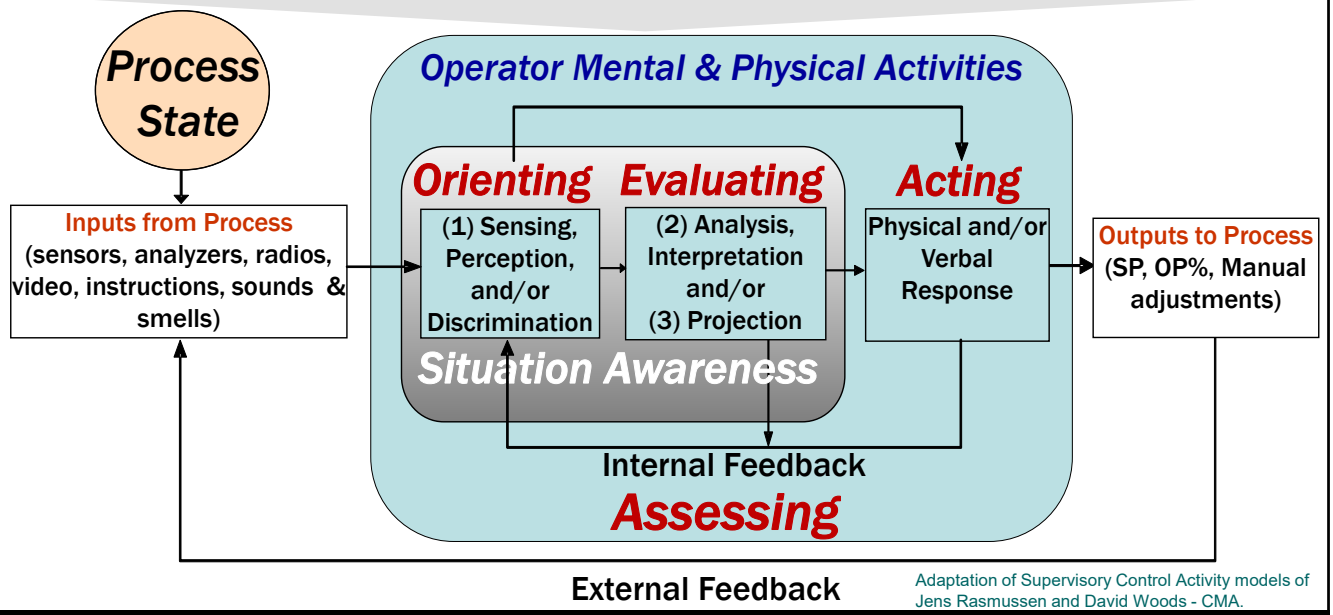
- Train the trainer – guidance, tools, and techniques
  - Toolbox talks, E-learning
  - Interactive desktop studies – learning from previous events inside/ outside the site / company / industry
- Digital twins / simulators
- Non-Technical Skills
  - From the aviation industry - Crew Resource Management (CRM)
  - Leadership techniques / effective management of resources plus cognitive skills required to gain and maintain situation awareness, particularly in stressful situations
- Don't forget the design engineers!
  - Consider inherently safer design
  - HAZID/ HAZOP/ HMI Design

Education

Operating personnel must have the competencies and skills to be able to:

- Identify the initiation of an abnormal situation
- Apply their mental model of the process
  - To understand the situation and formulate a plan to identify the appropriate action(s) that may be required.
- Calmly and adequately troubleshoot the cause of the abnormal situation
  - Either directly or in association with another member of staff / SME
- Understand process safety issues associated with making changes, shutting down, or isolating equipment (e.g., trip overrides)
- Restore the situation to normal or make further decisions such as whether to continue operating, reduce production rates, or to shut down the process.

Mental Model and Situation Awareness



Adaptation of Supervisory Control Activity models of Jens Rasmussen and David Woods - CMA.

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Tools and Methods

- Traditional tools
  - HAZID / HAZOP / LOPA/ FMEA / Bow Ties
  - Procedures – Standard, Transient, Emergency
- Process Control
  - Trend monitoring
  - Alarm management
  - Instrument condition monitoring, advanced diagnostics
- Ergonomics and Other Human Factors
  - HMI systems and graphics, ergonomics, non-technical skills (CRM)
- Learning from previous Abnormal Situation Incidents
- Exercises / drills

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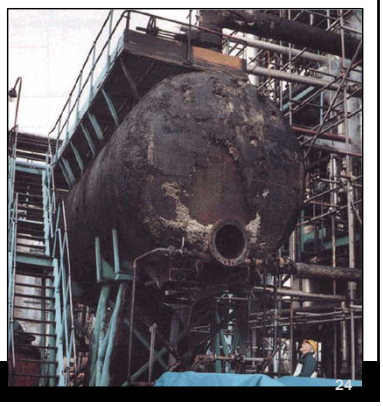
Continuous Improvement

- Measurement and Metrics
- Incident Investigation
- Auditing
- Management Review

Case Studies – in depth

Texaco Milford Haven Fire and Explosion

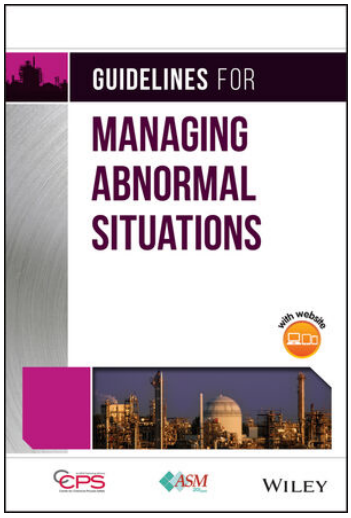
Hickson and Welch Fire



Summary

Guidelines for Managing Abnormal Situations

- Collaborative Effort Between CCPS, BakerRisk, and the ASM Consortium
- Demonstrates How ASM Connects to PSM and RBPS
- Emphasises Case Studies to Learn from Past Incidents
- Offers Exclusive and Challenging On-Line Training Modules



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Identify | Evaluate | Solve

ASM | CONSORTIUM

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Thank You for Listening

Questions?

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