

Process Safety Risk Assessment

Is there a better way?



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THE PROCESS SAFETY NETWORK



The EPSC logo features a central white circle containing the text 'EPSC' in large, bold, black letters, with 'THE PROCESS SAFETY NETWORK' in smaller black text below it. Further down, a paragraph describes the organization: 'EPSC, EUROPEAN PROCESS SAFETY CENTRE, is an international not for profit organization. It is founded in 1992 and provides an active network for members to work together on process safety.' The background is a blurred image of a metallic molecular structure with several overlapping circles in shades of green and blue.



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Process Safety Risk Assessment

Do we need a better way?

- ▶ Is our process safety performance good enough?
- ▶ Is safety still keeping us awake at night?
- ▶ Have we eliminated major incidents yet?



First, look at the
history...

History of Process Safety risk assessment

▶ HAZOP Study

The method is universal and works well...or does it?

Risk Assessment Consistency

- ▶ Ensuring consistent levels of risk control across multiple units, plants and facilities
 - Everywhere the same low level of residual risk
 - which starts with similar conclusions on the risks, meaning
 - Similar plants will have similar HAZOPS outcomes, which requires...
 - For any given facility, your HAZOP teams in China (for example) will come to the same conclusions as your teams in Germany
 - Do they?

HAZOP results across teams

- ▶ Isolated HAZOP teams come to quite different conclusions on scenarios and especially consequences
 - (international) review sessions or networks are organised around a limited number of super-specialists
 - Inadequately protected risks are found, over-engineering is discovered

- ▶ Why is HAZOP not more consistent?

HAZOP Method

- ▶ Multi-disciplinary team

- Expert study leader
- Engineer
- Operations staff
- Maintenance

Team is established based on need *and availability*

- ▶ Various methodologies

- Guide word etc

Team is expected to look creatively at what *could happen*

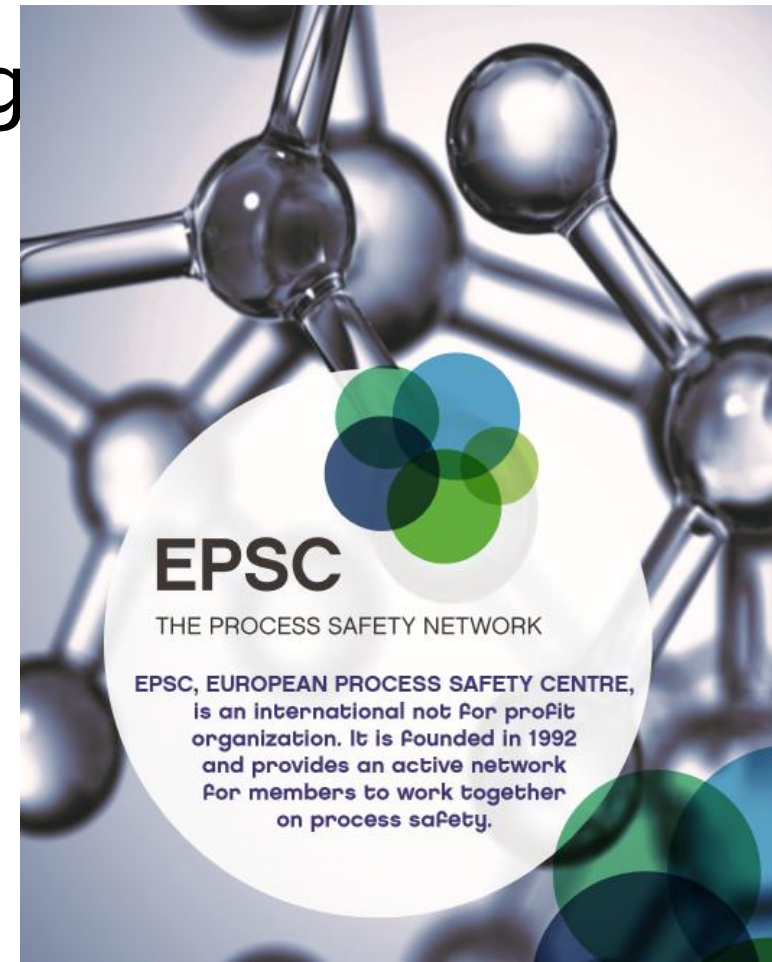
Why is creativity so important?

Creativity: why is it important?

- ▶ Creativity in the HAZOP teams allows us to
 - make up for missing or not found process data
 - Avoid reading and understanding an unmanageable amount of data
 - avoid applying lots of complex formulas
 - overcome lack of understanding
 - guess effects
- ▶ If equipment & process data is available, deviations are surely a matter of calculation?

Process Safety Innovation

- ▶ What about Industry 4.0?
- ▶ Can the HAZOP be automated?
 - Do away with all the multi-disciplinary meetings
 - No input facts, no output
 - same input, same output



RAST

- ▶ Risk Analysis Screening Tool
- ▶ Uses ‘basic’ scientific and engineering principles
- ▶ References public available information sources
- ▶ ‘Automated’ screening of process safety scenarios or a given unit operation



A screenshot of the RAST software interface displayed within a Microsoft Excel spreadsheet. The spreadsheet title is "Risk Analysis Screening Tool 1 - 1.XIS11". The interface includes logos for CCPS (An AIChE Technology Alliance) and EPSC (European Process Safety Centre). The main heading is "RAST Risk Analysis Screening Tools Version 1.0 Latest Revision Date 5/31/18". There are two buttons: "Go To Instructions >>" and "Go To Main Menu >>". A welcome message reads: "Welcome to RAST 1.0 (Risk Analysis Screening Tools). The RAST software and its associated CHEF documentation were developed through the collaborative efforts of volunteers from member companies of the Center for Chemical Process Safety (CCPS) and the European Process Safety Centre (EPSC). Special appreciation is extended to the Dow Chemical Company for donating RAST/CHEF for global use and for providing the resources to help modify the software and documentation such that companies can tailor the RAST software to meet their company-specific risk tolerance levels. It is sincerely hoped that companies using RAST and CHEF during their hazards evaluations and risks assessments will be able to improve their process safety performance." A disclaimer follows: "Disclaimer: It is sincerely hoped that the information presented in this document will lead to an even more impressive safety record for the entire industry; however, neither the American Institute of Chemical Engineers, the European Process Safety Centre, its consultants, CCPS Technical Steering Committee and Subcommittee members, EPSC members board, their employers, their employers officers and directors, nor The Dow Chemical Company, and its employees warrant or represent, expressly or by implication, the correctness or accuracy of the content of the information presented in this document. As between (1) American Institute of Chemical Engineers, its consultants, CCPS Technical Steering Committee and Subcommittee members, their employers, their employers officers and directors, and The Dow Chemical Company, and its employees, and (2) the user of this document, the user accepts any legal liability or responsibility whatsoever for the consequence of its use or misuse." A red notice states: "Please do not distribute this software freely to colleagues, as this software is subject to updates in the future through the CCPS/EPSC RAST User's Group pending potential improvements and when addressing program-related issues. If you have received this program without downloading from the CCPS Website, please do so that your User name can be entered into the RAST User database for future update communications. Thank you." The footer contains "Copyright © 2018 American Institute of Chemical Engineers and European Process Safety Center". The Excel status bar at the bottom shows "Normal View" and "Ready".

RAST for CCPS - CAI Example.xlsm

Ink Formulation Mixing Tank

Home Layout Tables Charts SmartArt Formulas Data Review

Edit Font Alignment Number Format Cells Themes

Paste Arial Narrow 8 abc Wrap Text General Conditional Formatting Styles Insert Delete Format Themes

G3

<< Go To Main Menu Update **Suggested Scenarios from the RAST Library** Go To Scenario Results >

Create User Scenario

HAZOP Node:
 Plant Section = 001100
 Equipment Type = Reactor/Crystallizer
 Equipment Tag = Ink Formulation Mixing Tank

HAZOP Design Intent
 Ink Formulation Mixing Tank is a Stirred Reactor/Crystallizer that operates at 40 C and 0.01 bar. The volume is 3000 gal with a design pressure of 0.1 bar. The maximum feed or flow rate is 50 gal/min.

Scenarios in gray were considered but are excluded for reason noted

LOPA Menu Filters: Scenarios with NO IPL's Required will NOT be reported.

Scenario Type	Scenario Comments	Parameters and Deviation	Initiating Event (Cause)	Initiating Event Description	Incident	Outcome	Potential Outcome / Tolerable Frequency Factors															
							Off-Site Toxic Release	On-Site Toxic Release	Indoor Toxic Release	Toxic Inflammation	Chemical Exposure	Flash Fire or Fireball	Vapor Cloud Explosion	Building Explosion	Equipment Explosion	Property Damage or Business Loss	Environmental Damage					
Drain or Vent Valve Open	Drain or Vent Valve left open following infrequent maintenance, purging or cleaning	Flow-Loss of Containment	Human Failure Action once per quarter or less	Operator leaves Drain or Vent Open following infrequent maintenance	Drain or Vent Leak	Flash Fire or Fireball							4									
Excessive Heat Input - Heat Transfer	Vapor Pressure plus pad gas exceeds Maximum Allowable Working Pressure or Relief Set Pressure at Ambient or Heating Media Temperature	Pressure-High	BPCS Instrument Loop Failure	Failure of Flow Control	Vapor Relief Vent - Heat Transfer	Flash Fire or Fireball, Building Explosion							5	6								
					Equipment Rupture at Saturation Temperature	Flash Fire or Fireball, Building Explosion, Equipment Explosion					5	6	3									
Excessive Heat Input - Mechanical	Vapor Pressure plus pad gas exceeds Maximum Allowable Working Pressure or Relief Set Pressure at Maximum Temperature from Mechanical Energy Input	Pressure-High	Human Failure Action once per quarter or less	Agitation or Pump Recirculation left running for extended time allowing slow temperature increase	Vapor Relief Vent - Mechanical Energy	Flash Fire or Fireball							3									
Excessive Heat Input - Pool Fire Exposure	Vapor Pressure exceeds Relief Set or Burst Pressure from Pool Fire Exposure	Pressure-High	IEF=2 as determined by Process Safety	Leak of Flammable Material or Material above its Flash Point which may ignite	Vapor Relief Vent - Fire	Indoor Toxic Release, Flash Fire or Fireball, Building Explosion				5			5	6								
					Equipment Rupture at Fire Conditions	Flash Fire or Fireball, Equipment Explosion					4		3									
Ignitable Headspace	Chemical is Flammable or Combustible: Maximum Operating, Mechanical Energy or Heating Media Temperature exceeds Flash Point less 5 C	Composition-Wrong Concentration	BPCS Instrument Loop Failure	Failure of Pressure or NonCombustible Atmosphere Control	Equipment Rupture - Deflagration	Flash Fire or Fireball, Equipment Explosion							4						3			
Mechanical Integrity Failure - Extremely Large	Largest Pipe or Nozzle Size less than Extremely Large Hole Size	Flow-Loss of Containment	IEF=4 as determined by Process Safety	Failure from corrosion, fatigue, etc.	Extremely Large Hole Size Leak	Flash Fire or Fireball							5									
Mechanical Integrity Failure - Medium	Mechanical Integrity Loss of Containment for Medium Hole Size	Flow-Loss of Containment	IEF=4 as determined by Process Safety	Failure from corrosion, fatigue, etc.	Medium Hole Size Leak	Flash Fire or Fireball							4									
Mechanical Integrity Failure - Very Large	Mechanical Integrity Loss of Containment for Very Large Hole Size	Flow-Loss of Containment	IEF=4 as determined by Process Safety	Failure from corrosion, fatigue, etc.	Very Large Hole Size Leak	Flash Fire or Fireball							5									
Mechanical Integrity Failure - Very Small	Mechanical Integrity Loss of Containment for Very Small Hole Size	Flow-Loss of Containment	IEF=3 as determined by Process Safety	Failure from corrosion, fatigue, etc.	Very Small Hole Size Leak	Flash Fire or Fireball							3									
Overfill, Overflow, or Backflow	Overfill or Backflow of liquid with spill rate equal to the feed rate to a maximum quantity of the available inventory minus Maximum Pad Gas Pressure Does Not Exceed the Maximum Allowable Working Pressure or Relief Set Pressure	Level-High or Flow-Backflow	BPCS Instrument Loop Failure	Failure of Level Indication with continued addition of material	Overfill Release	Flash Fire or Fireball							5									
					Equipment Rupture at Operating Temperature	Flash Fire or Fireball, Building Explosion, Equipment Explosion					5	6	3									
Excessive Pad Gas Pressure	Maximum Pad Gas Pressure Does Not Exceed the Maximum Allowable Working Pressure or Relief Set Pressure	Flow-High	Regulator Failure	Regulator Fails causing high flow or pressure	Criteria for Triggering Incidents Not Met																	
High Temperature Failure	Maximum Feed Temperature Does Not Exceed Temperature limits of Equipment	Temperature-High	BPCS Instrument Loop Failure	Failure of Temperature Control	Criteria for Triggering Incidents Not Met																	
Pad Gas Compression	Maximum Feed or Downstream Pressure does not exceed the Maximum Allowable Working Pressure or Relief Set Pressure	Pressure-High	BPCS Instrument Loop Failure	Failure of Pressure Control	Criteria for Triggering Incidents Not Met																	
Piping or Equipment Leak - Small	Motor below Vibration Power Limit for Potential for Vibration Fatigue Failure of Rotating Equipment	Flow-Loss of Containment	Mechanical Failure	Loss of Alignment or Equipment Support causing Vibration or Excessive Movement	Criteria for Triggering Incidents Not Met																	
Rotating Equipment Damage	Motor Power below Rotating Equipment Vibration or Damage Limit	Composition-Contaminants	Mechanical Failure	Breakage of rotating blade or internal parts due to alignment, wear, or fatigue	Criteria for Triggering Incidents Not Met																	
Seal Leak	No Agitator Seal indicated	Flow-Loss of Containment	Single Mechanical Seal Failure	Failure from corrosion, alignment, low flow, etc.	Mechanical Seal Failure above Liquid Level	Consequence Does Not Exceed Threshold Criteria for Continuing with LOPA																
Vacuum Damage	Rating for Full Vacuum Not Entered for Low Design Pressure Equipment	Pressure-Low	BPCS Instrument Loop Failure	Failure of Pressure Control	Criteria for Triggering Incidents Not Met																	

Scenario Type	Scenario Comments	Parameters and Deviation	Initiating Event (Cause)	Initiating Ev
Drain or Vent Valve Open	Drain or Vent Valve left open following infrequent maintenance, purging or cleaning	Flow-Loss of Containment	Human Failure Action once per quarter or less	Operator leaves Dra infrequen
Excessive Heat Input - Heat Transfer	Vapor Pressure plus pad gas exceeds Maximum Allowable Working Pressure or Relief Set Pressure at Ambient or Heating Media Temperature	Pressure-High	BPCS Instrument Loop Failure	Failure o
Excessive Heat Input - Mechanical	Vapor Pressure plus pad gas exceeds Maximum Allowable Working Pressure or Relief Set Pressure at Maximum Temperature from Mechanical Energy Input	Pressure-High	Human Failure Action once per quarter or less	Agitation or Pump Re extended time allowing
Excessive Heat Input - Pool Fire Exposure	Vapor Pressure exceeds Relief Set or Burst Pressure from Pool Fire Exposure	Pressure-High	IEF=2 as determined by Process Safety	Leak of Flammable M; Flash Point'
Ignitable Headspace	Chemical is Flammable or Combustible: Maximum Operating, Mechanical Energy or Heating Media Temperature exceeds Flash Point less 5 C	Composition-Wrong Concentration	BPCS Instrument Loop Failure	Failure of Pressu Atmosp
Mechanical Integrity Failure - Extremely Large	Largest Pipe or Nozzle Size less than Extremely Large Hole Size	Flow-Loss of Containment	IEF=4 as determined by Process Safety	Failure from co
Mechanical Integrity Failure - Medium	Mechanical Integrity Loss of Containment for Medium Hole Size	Flow-Loss of Containment	IEF=4 as determined by Process Safety	Failure from co
Mechanical Integrity Failure - Very Large	Mechanical Integrity Loss of Containment for Very Large Hole Size	Flow-Loss of Containment	IEF=4 as determined by Process Safety	Failure from co
Mechanical Integrity Failure - Very Small	Mechanical Integrity Loss of Containment for Very Small Hole Size	Flow-Loss of Containment	IEF=3 as determined by Process Safety	Failure from co

Incident	Outcome	Off-Site	On-Site	Indoor	To	Chem
Drain or Vent Leak	Flash Fire or Fireball					
Vapor Relief Vent - Heat Transfer	Flash Fire or Fireball, Building Explosion					
Equipment Rupture at Saturation Temperature	Flash Fire or Fireball, Building Explosion, Equipment Explosion					
Vapor Relief Vent - Mechanical Energy	Flash Fire or Fireball					

Towards better risk assessment

- ▶ Ongoing validation of results
 - reference point is existing multi-disciplinary HAZOP
 - already a powerful study normalisation tool
- ▶ Provides a starting point for and expert team
- ▶ Can be applied in the cyclic review process
 - genuinely new scenarios identified

Interested in joining the project?



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