Process Safety Risk Assessment

Is there a better way?

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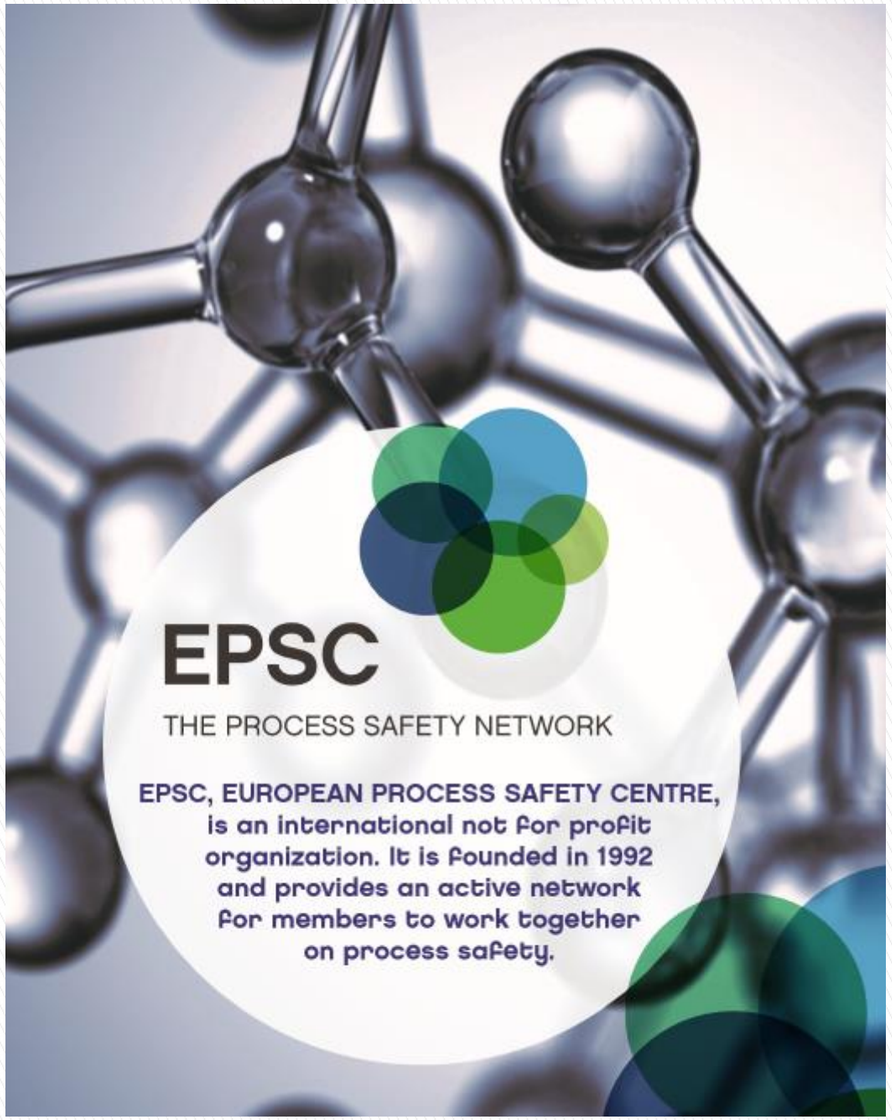
THE PROCESS SAFETY NETWORK



Theo Reindorp

theoreindorp@hotmail.com
www.EPSC.org

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?

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?

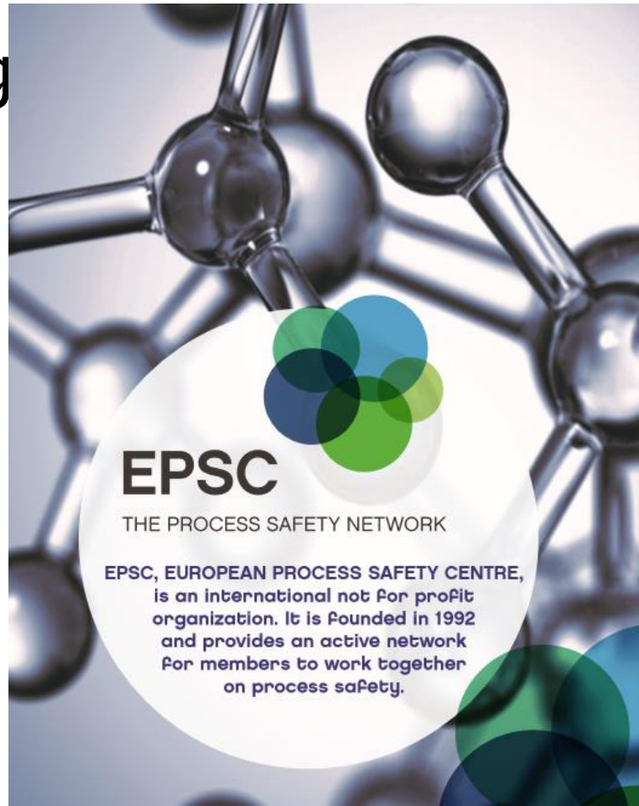
Creativity: why is it important?

- 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?

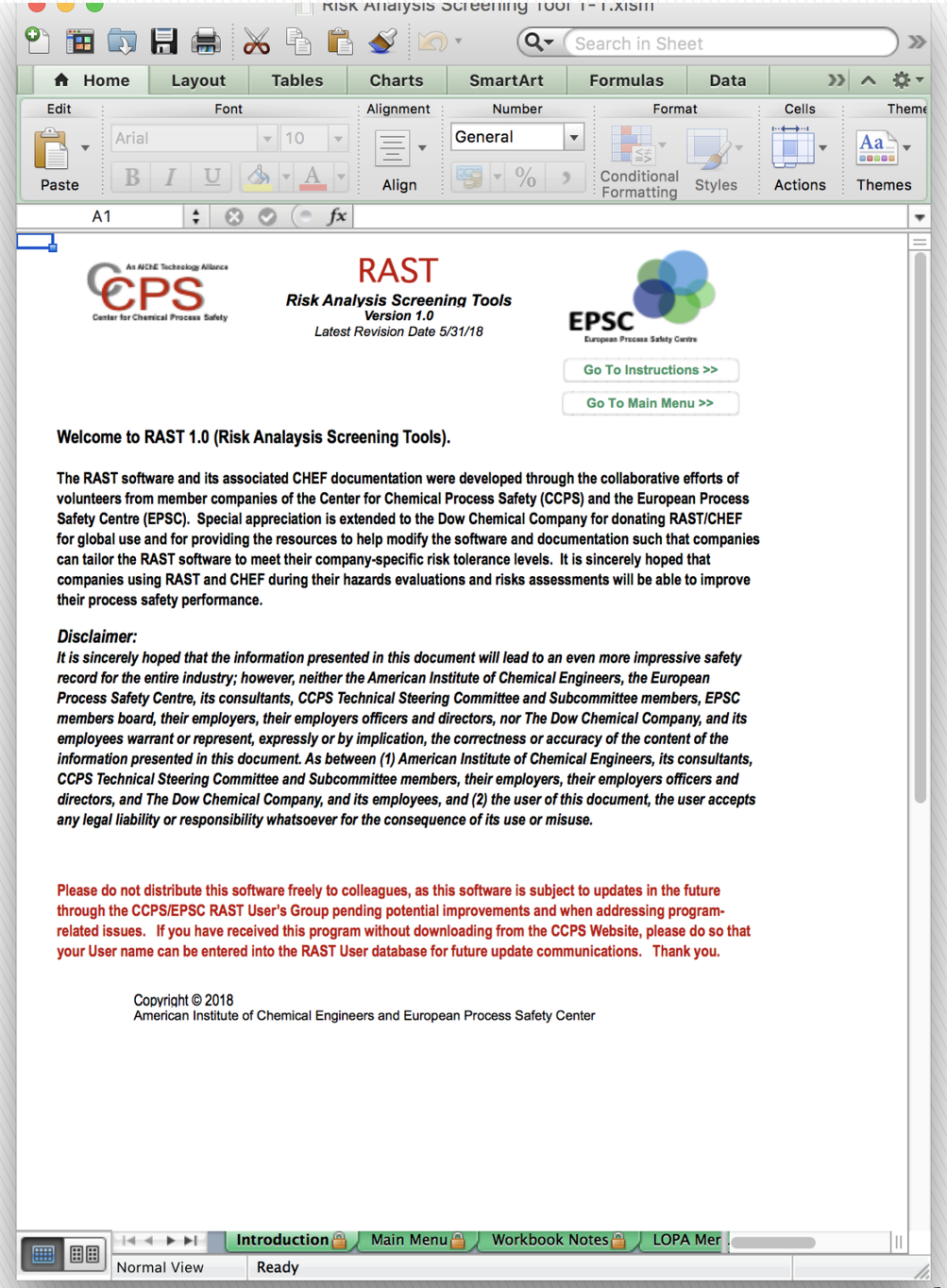
Process Safety Innovation

- What about Industry 4.0?
- Can the HAZOP be automated?
  - Do away with all the multi-disciplinary meeting
  - 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



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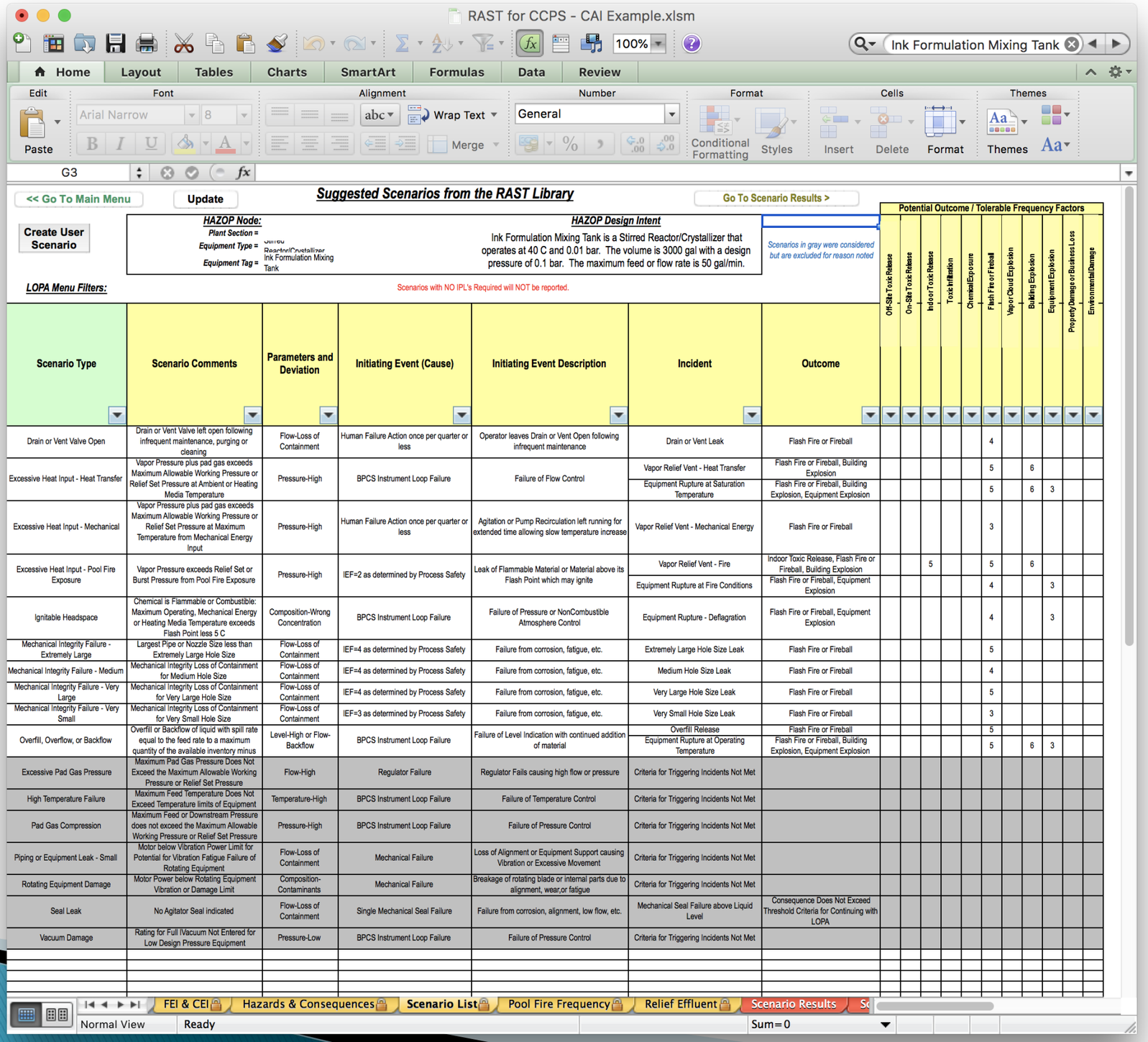
An AIChE Technology Alliance
CCPS
Center for Chemical Process Safety


RAST for CCPS - CAI Example.xlsm
Ink Formulation Mixing Tank
Home
Layout
Tables
Charts
SmartArt
Formulas
Data
Review
Paste
Wrap Text
Merge
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 =
Equipment Type = Stirred 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.
Potential Outcome / Tolerable Frequency Factors
Off-Site Toxic Release
On-Site Toxic Release
Indoor Toxic Release
Toxic Inflitration
Chemical Exposure
Flash Fire or Fireball
Vapor Cloud Explosion
Building Explosion
Equipment Explosion
Property Damage or Business Loss
Environmental Damage
Scenario Type
Scenario Comments
Parameters and Deviation
Initiating Event (Cause)
Initiating Event Description
Incident
Outcome
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
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
Equipment Rupture at Saturation Temperature
Flash Fire or Fireball, Building Explosion, Equipment Explosion
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
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
Equipment Rupture at Fire Conditions
Flash Fire or Fireball, Equipment Explosion
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
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
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
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
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
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
Level-High or Flow-Backflow
BPCS Instrument Loop Failure
Failure of Level Indication with continued addition of material
Overfill Release
Flash Fire or Fireball
Equipment Rupture at Operating Temperature
Flash Fire or Fireball, Building Explosion, Equipment Explosion
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
FEI & CEI
Hazards & Consequences
Scenario List
Pool Fire Frequency
Relief Effluent
Scenario Results
Normal View
Ready
Sum=0

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 Ma 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-Si	On-Si	Indo	To	Chei
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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Theo.Reindorp@homtail.com
office@epsc.be