

Flammable And Toxic Release Mitigation In High Hazard Facilities



JENSEN HUGHES

Advancing the Science of Safety



Dammam Conference

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Tim Shelton, PE is an experienced process engineer specializing in Process Safety, Risk Assessment, Technology Evaluation and Energy Utilization. His experience covers several industries including: oil and gas, steel making, power generation, pharmaceuticals and chemical. Mr. Shelton's career has an emphasis on safety-in-design, integration of vendor equipment at all levels of the engineering process, including site work and commissioning. His expertise includes Process Safety Management for major hazard facilities, Federal OSHA and EPA compliance and/or internal company standards.



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Learning Objectives

1. *What is Process Safety and its relation to Code Driven Building Safety*
2. *Awareness of HAZOP Methodology for Hazard Assessment*
3. *Awareness of Quantitative Risk Analysis (QRA)*

WHAT IS PROCESS SAFETY?

- **What its not.....**

- **Occupational Health**
 - Chronic exposure, ergonomics, impact injury
- **Environmental Safety**
 - Release to air, water, ground
- **Fire and Life Safety**
 - Built Environment

- **Process Safety Incidents.....**

- **Loss of Containment of hazardous materials from a production process or product storage**

- **With Immediate and catastrophic consequence**



WHAT IS PROCESS SAFETY?

- **Requires Design Engineers to:**
 - Understand and Control Risks
 - Fundamental understanding of Chemical and Physical Processes
 - Hazardous materials and hazardous Conditions

- Ask Three Questions...
 1. What can go wrong?
 2. How Bad could it be?
 3. How likely is it?



WHAT IS PROCESS SAFETY?

- You will know it when you see it.....



Caribbean Refinery Company, 2009



Deepwater Horizon, 2010



WHAT IS PROCESS SAFETY?

- You will know it when you see it.....



Buncefield UK, 2005

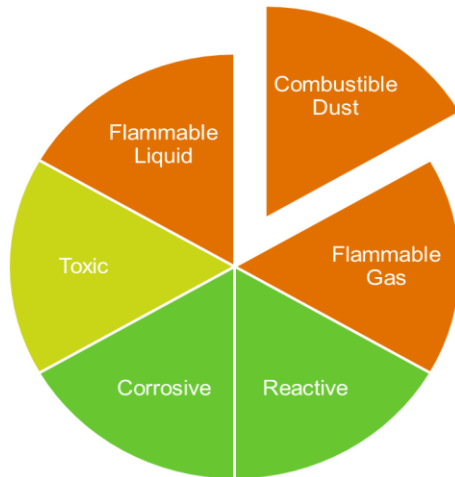


WHAT HAZARDS ARE INVOLVED

PROCESS SAFETY INCIDENTS

- Occupancies are inherently hazardous by the nature of hazardous materials, or hazardous conditions in storage or in the process.

HAZARDS EVALUATED

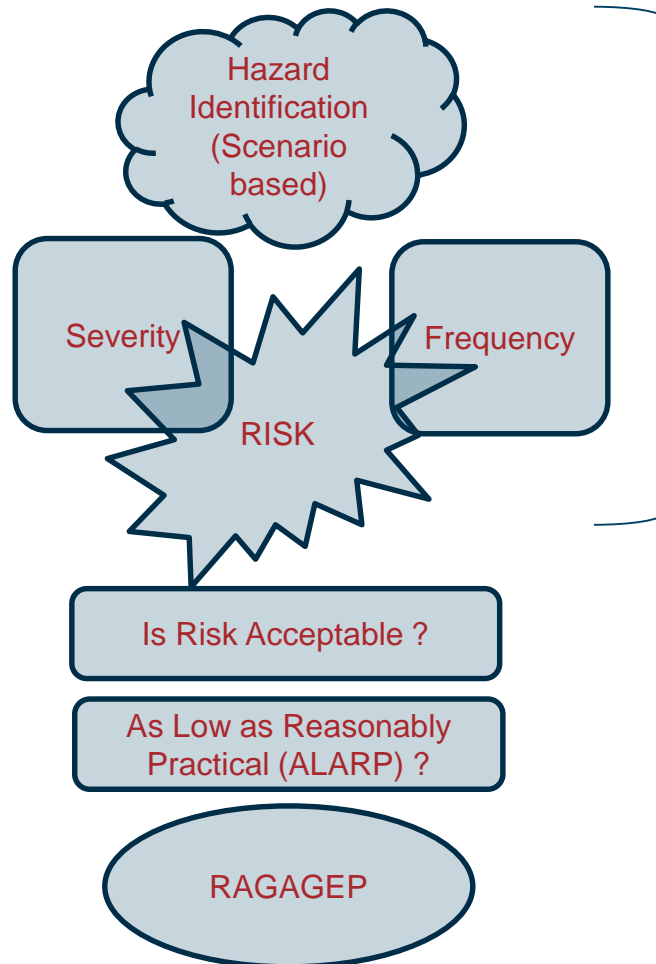


CONSEQUENCES EVALUATED



PROCESS SAFETY vs CODE CONSULTING

PROCESS SAFETY APPROACH



CODE BASED APPROACH

- Identify Hazardous Materials



- Quantities



- Occupancy



- Prescriptive Requirements



OR

- Performance Based Design



SAFETY DESIGN in BUILDINGS

WHAT DOES PROCESS SAFETY HAVE TO DO WITH BUILDINGS?

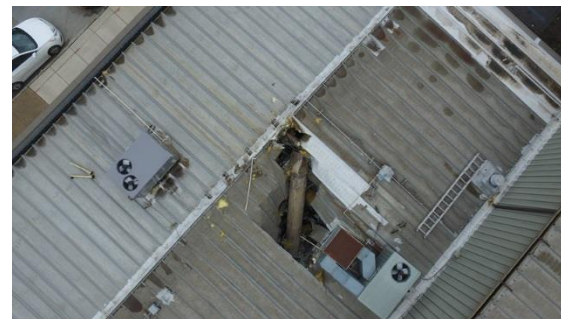
- Chemical Processes are installed inside buildings, adjacent to buildings
 - Laboratories
 - Batch chemical processes (polymerization)
 - Food (dust)
 - Pharmaceutical formulation
 - Solvent Extraction
- Building systems may involve inherent risks. Owners may adopt process safety approach (keep it on the pipe)
 - LP Steam
 - Nitrogen
 - Ethylene oxide
- Performance based justification relies on process safety techniques



SAFETY DESIGN in BUILDINGS

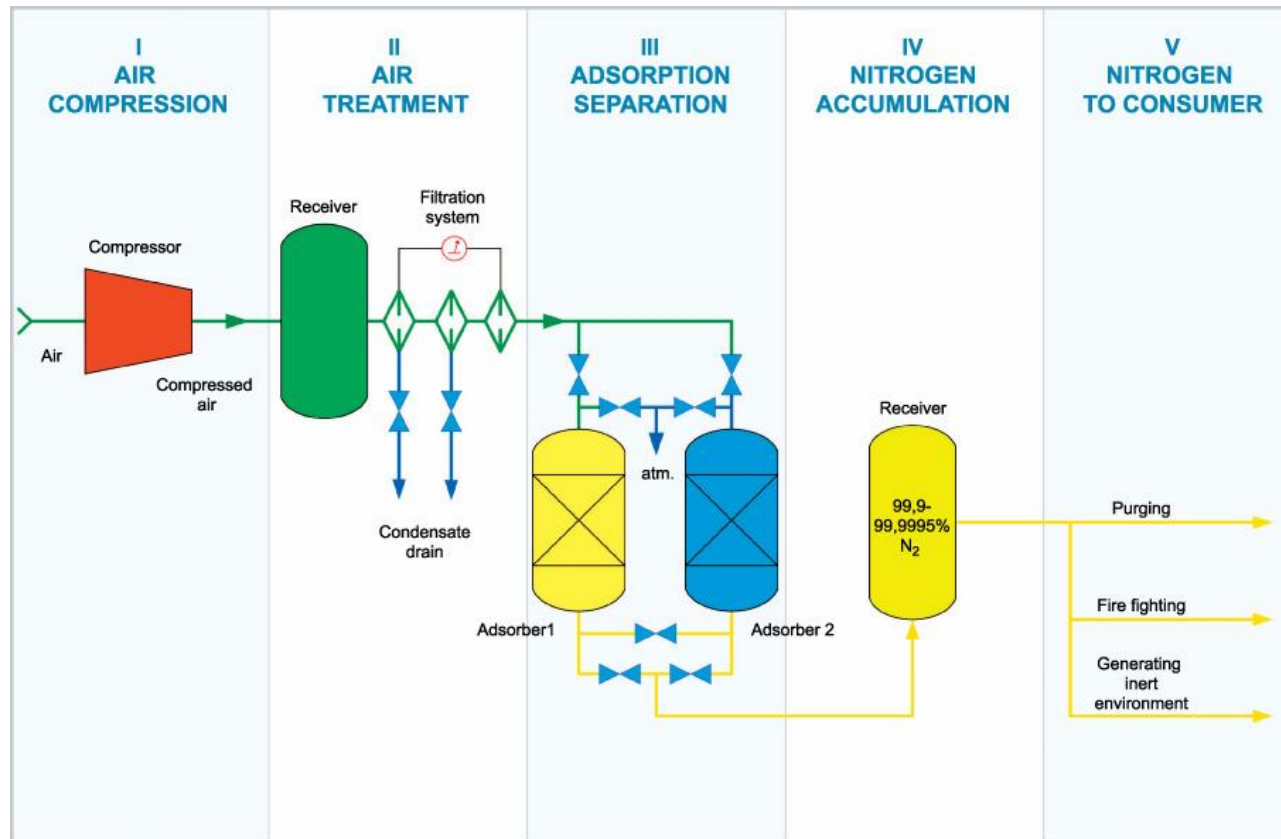
WHAT DOES PROCESS SAFETY HAVE TO DO WITH BUILDINGS?

- Texas Tech Laboratory Fire
- Didion Milling Dust Explosion
- Loy-Lange Pressure Vessel explosion
- NDK Crystal (overpressure)

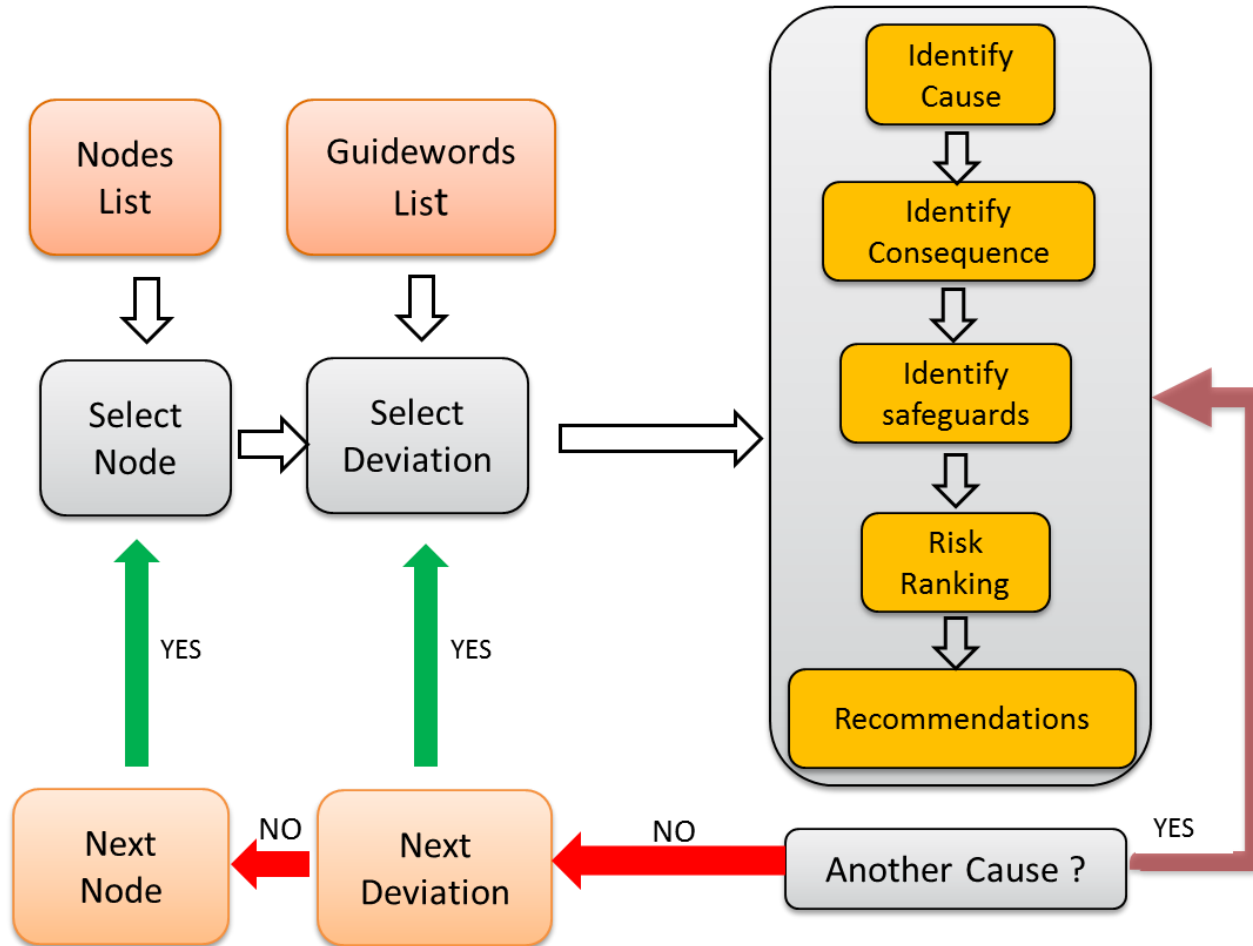


HAZOP METHODOLOGY

HAZOP – HAZards and OPerability Stepwise process evaluation with diverse team



HAZOP METHODOLOGY



HAZOP METHODOLOGY

Session: (2) 7/17/2017

Node: (3) Deaerator to Boiler

Drawings: PI70910080-3 - Deaerator to Boiler

Parameter: Flow

Revision:

Intention:

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
No	No Flow (to Boiler)	Failure of boiler feedwater pumps (x4) - power loss or single point of failure	Lose level in boiler; boiler disturbance; potential for boiler explosion	Emergency generator (for pumps) Low level shut off on boiler (low/low-low) High temperature shutoff FM-certified burner management system (BMS)	3	2	Med		Annual/weekly/daily PM schedule to maintain level indicators and controls Training of operators/maintenance personnel Identify key HSE safety elements	
More/High	More/High Flow (to Boiler)	Failure of boiler LCV	Feedwater pushed through into steam header; no hazardous consequences; potential equipment damage	High water cutoff Sight glass						

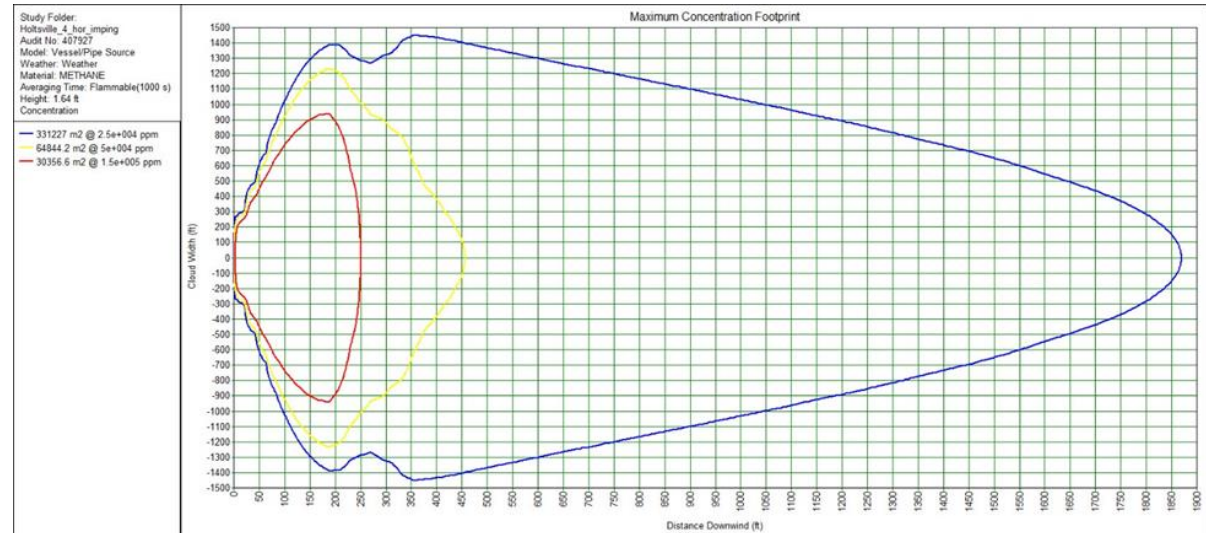


QUANTITATIVE RISK ANALYSIS

DETERMINE HAZARD DISTANCE FOR FLAMMABLE OR TOXIC GAS PLUME

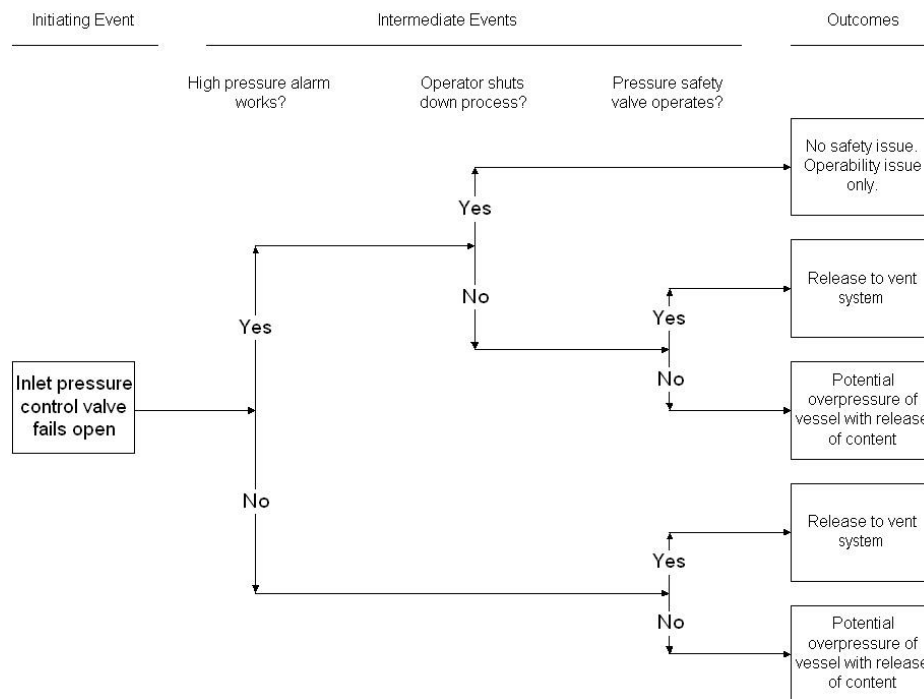
Dispersion models

- Standard industrial approach using Gaussian dispersion models (PHAST, ALOHA)
- Heavy gas models (DEGADIS, HEGADAS), and complex modeling utilizing CFD for toxic, explosive and asphyxiation hazards.



QUANTITATIVE RISK ANALYSIS

QUANTIFY THE LIKELIHOOD (FAULT TREE or LOGIC MODEL)



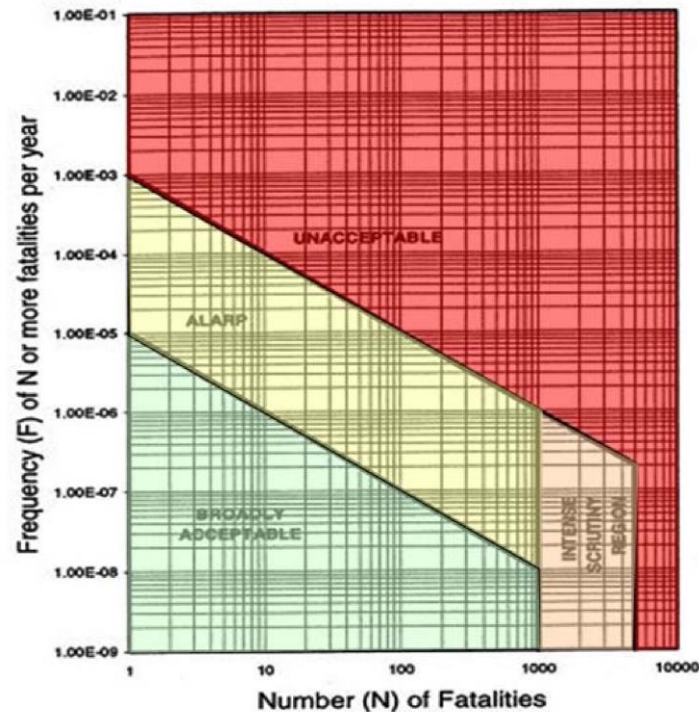
COMBINE FREQUENCY WITH CONSEQUENCE TO CREATE CONTOURS WHICH MAY INDICATE



QUANTITATIVE RISK ANALYSIS

COMBINE CONTOURS WITH MANNING AND POPULATION and OFF-SITE DATA

- Societal Risk correlates number of fatalities with frequency



SUMMARY

- Important for designers of industrial buildings to understand process safety
 - Improve acceptance of Risk
 - May assist in performance based design justification
- HAZOP Risk Assessment technique
 - Ensure sufficient controls are in place to prevent and mitigate loss of release from the process equipment
- Quantitative Risk Assessment
 - Fundamental tool to determine feasibility of project
 - Tools that will feed into building design criteria
 - Tools that will enable facility siting



QUESTIONS?



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