

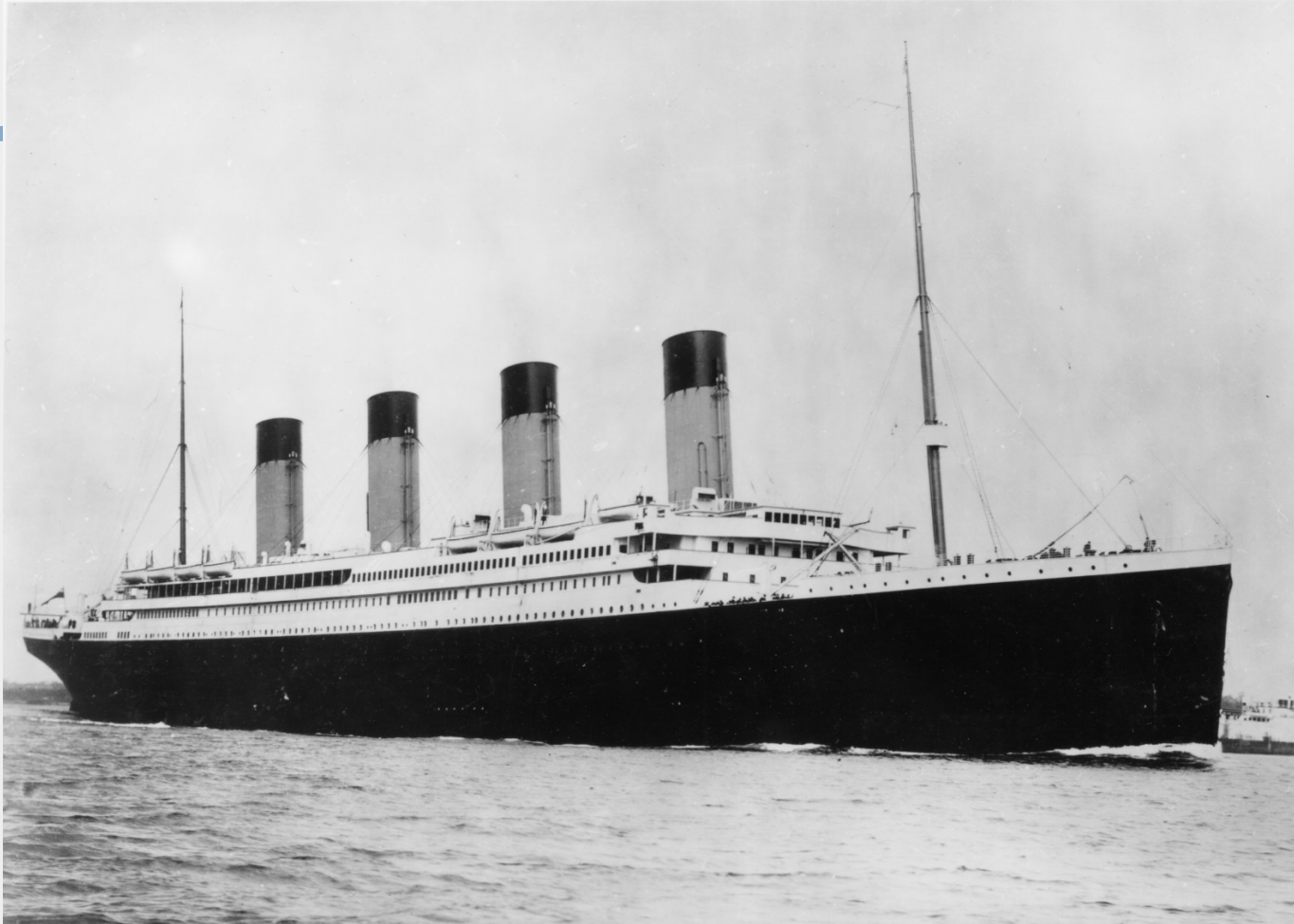
Approaching research and scale-up safety through process-oriented solutions

Harry J. Elston, Ph.D., CIH

Principal

Midwest Chemical Safety, LLC

“Compliance is not safety”



RMS Titanic, From Smithsonian Institute website

Why?

- Regulations cannot keep pace with innovation
 - Inherently Safer Technology is *still* not part of PSM (though recognized as early as 1978!)
 - Regulations stagnate because of political process; best practices are flexibly executed at corporate levels

Why?

- Regulations focus on hazard, not risk.
 - Hazard identification is easy
 - Risk requires understanding of a process

Failure of the Lab Standard

- The OSHA Lab Standard is a chemical ***exposure*** standard.
 - Focus is “hazard communication”
- It is silent about:
 - Pressure/Temperature considerations
 - Reactivity issues/Reaction considerations
 - Materials of construction, etc.

Controlling the Process = Controlling Safety

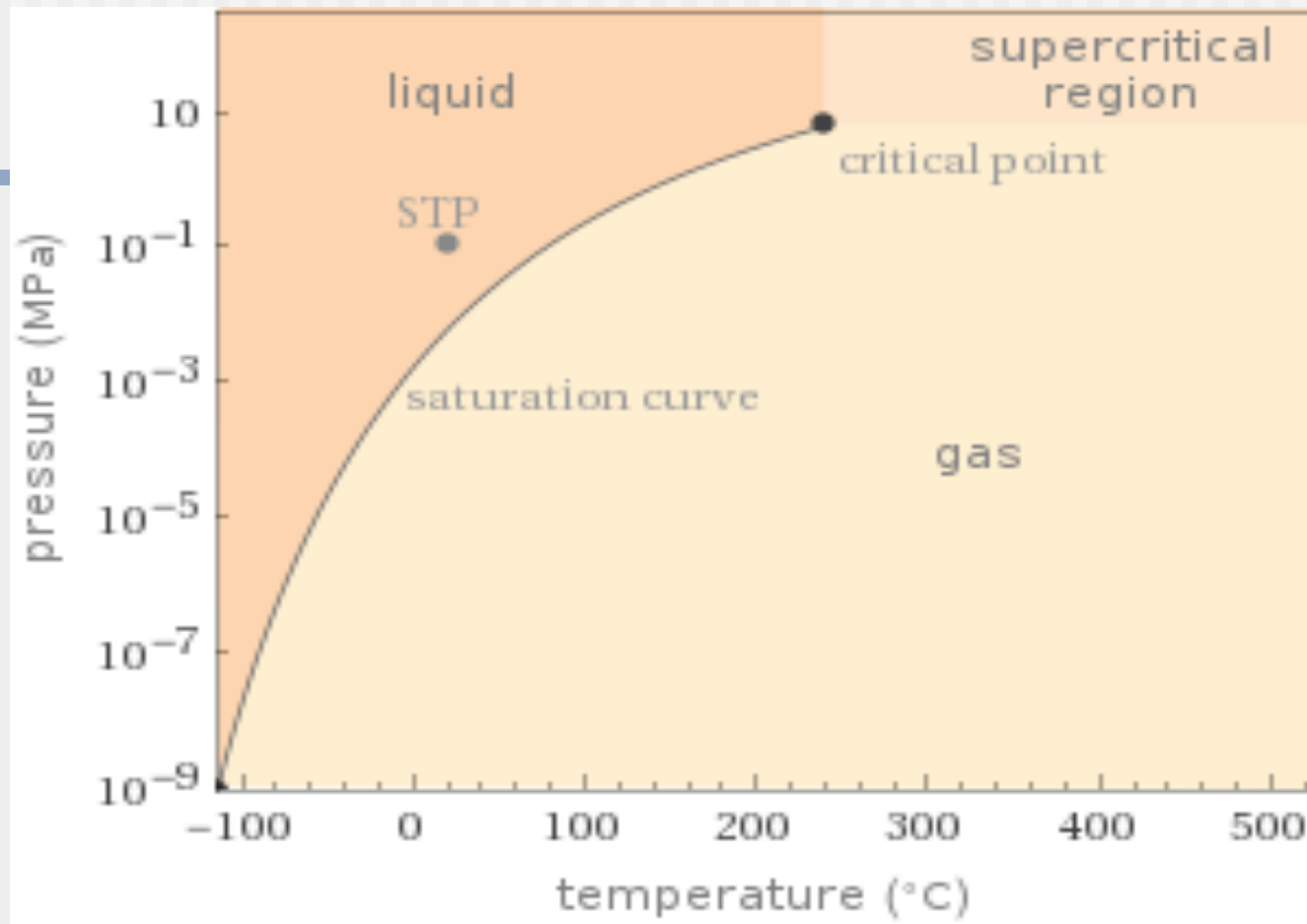
- What is needed
 - Chemical information
 - (Anticipated) Process Conditions
 - Out of normal/Emergency actions

Short comparison

- Reaction in ethanol as a supercritical fluid
 - Reaction in a Parr-like vessel
 - SOP not well established
 - Proposed reaction not particularly exothermic



Photo from Parr website



Ethanol P-T Diagram from calculated from Wolfram Alpha

“Lab Std” vs. Process Safety evaluation

Lab Standard method

- Chemical hazard information
 - Ethanol
 - Eye irritation (GHS 2A)
 - Flammable Liquid, FP = 14°C
 - AIT= 363°C
 - Using about 30 mL, 0.5 mol

Process Safety method

- Chemical hazard information
 - Ethanol
 - Same as Lab Standard, plus
 - $\Delta H(\text{Comb}) = -1370$ kJ/mol

“Lab Std” vs. Process Safety evaluation

Lab Standard method

- Process safety information
 - None

Process Safety method

- Process safety information
 - Reaction vessel
 - PR (burst disk) at 34 Mpa (5000 psi)
 - 314 SS
 - 750 mL capacity
 - New vessel, no pressure cycles

“Lab Std” vs. Process Safety evaluation

Lab Standard method

- Process safety information
 - None

Process Safety method

- Process safety information
 - Reaction information
 - Operate in SCF region of ethanol (otherwise silent on P/T limits)
 - SOP silent on vessel purge

“Lab Std” vs. Process Safety evaluation

Lab Standard method

- Safety analysis
 - Exposure and flammability control focused

Process Safety method

- Safety analysis
 - AIT ↓ as P ↑
 - Oxygen in RX?
 - Pressure transition of ignition in vessel (> 900 MPa)

“Lab Std” vs. Process Safety evaluation

Lab Standard method

- Safety analysis
 - Exposure and flammability control focused

Process Safety method

- Incident prevention
 - Inert vessel
 - In hood with shield
 - Tighter SOP would be nice
- What if?
 - PR disk relief will probably result in fire but contained in hood (deemed acceptable risk for experiment)

Summary

- Laboratories have similar risks as production/manufacturing
 - Incidents can be catastrophic
- Preventing incidents requires complete process information and evaluation.