INDORAMA VENTURES

Module 2A: Hazard Identification

Last Revised – June 2024

PS Bootcamp Modules

- ✓ Module 1: Introduction
- ✓ Module 2: Hazard Identification
- ❑ Module 3: Risk Matrix
- ❑ Module 4: Safeguards Concept
- ❑ Module 5: Explosion/Fire Protection
- ❑ Module 6: Management of Change
- ❑ Module 7: Incident Investigation
- ❑ Module 8: Facility Siting

Module 1: Introduction Agenda

Review and Understand:

What is a Hazard and its Importance

Where to Look for Hazards

Relevance of Process Safety Information

Keywords to Aid in Hazard Identification (HAZID)

Training Objectives

Be able to explain and apply Indorama's hazard identification methodology

Increase awareness major hazards in chemical processing facilities – spills, releases, loss of containment (LOC)

Complete a team exercise in Hazard Identification:

- Use the basic Keywords for Hazard Identification Checklist
- Identify the hazards of a process

Definition of Hazard

- Hazard: Potential source of harm, e.g.
  - a material with toxic or flammable properties or
  - a process with physical or mechanical capability to cause harm, such as operation at high temperature or high speed.
- The term “hazard” is used qualitatively.
- The nature or severity of the potential “harm” of a “hazard” sets the basis for quantitative analysis.

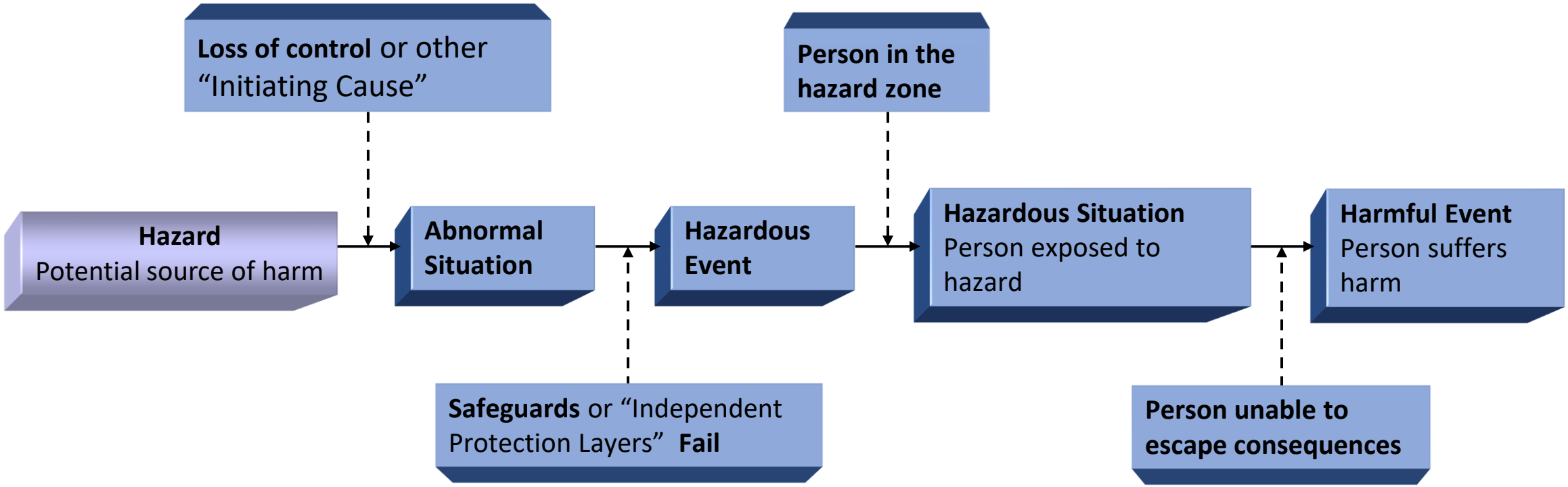
Hazard Identification References

- Process Descriptions, Process Flow Diagrams and Heat & Mass Balances, P&IDs
- Safety Data Sheets
- Reactive Chemistry Information
- Incident Investigations
- Maintenance Records and Failure Mechanisms
- Similar Unit PHAs and LOPAs
- Facility Siting Study
- Research and Development Papers
- Technology License Information
- EO User's Group Information
- Published References
  - Bretherick's Handbook of Reactive
  - Manufacturers' Product Stewardship Handling Guides

Escalation of Hazard

- Chemical Properties (Flammability, Toxicity, Reactivity, Corrosivity)
- Chemical Inventory
- Process Temperature
- Process Pressure
- Reactive Chemistry
- Level of Energy

Hazardous Event Scenario



Hazardous Event Scenario

An unplanned event or sequence of events that results in an undesirable consequence. Each scenario consists of at least two elements:

- **an initiating event (e.g., loss of control) that starts the chain of events, and**
- **a consequence (e.g., harm) that results if the chain of events continues without interruption. Defined without safeguards.**

What is Harm?

Harm:

- physical injury or damage to the health of people, or
- damage to property or the environment.

Harm is an element of the consequence of concern.

Pop Quiz #1

Question: Why is identifying hazards so important with respect to process safety?

Basic Process Safety Rule #1 – You can't control a Hazard that you haven't identified

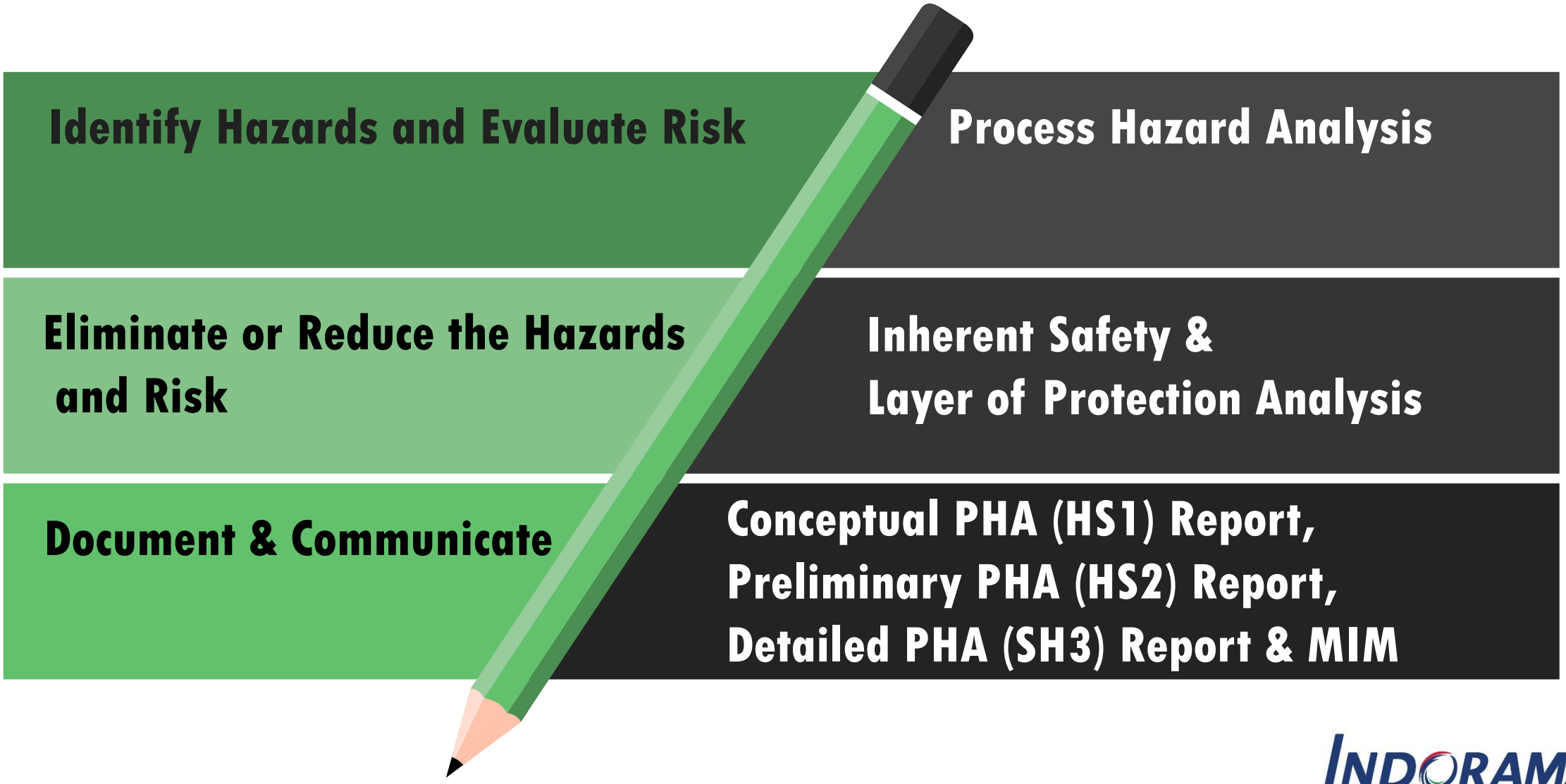
Four Steps of Process Safety

The Management of Hazards can be thought of as a 4-step process

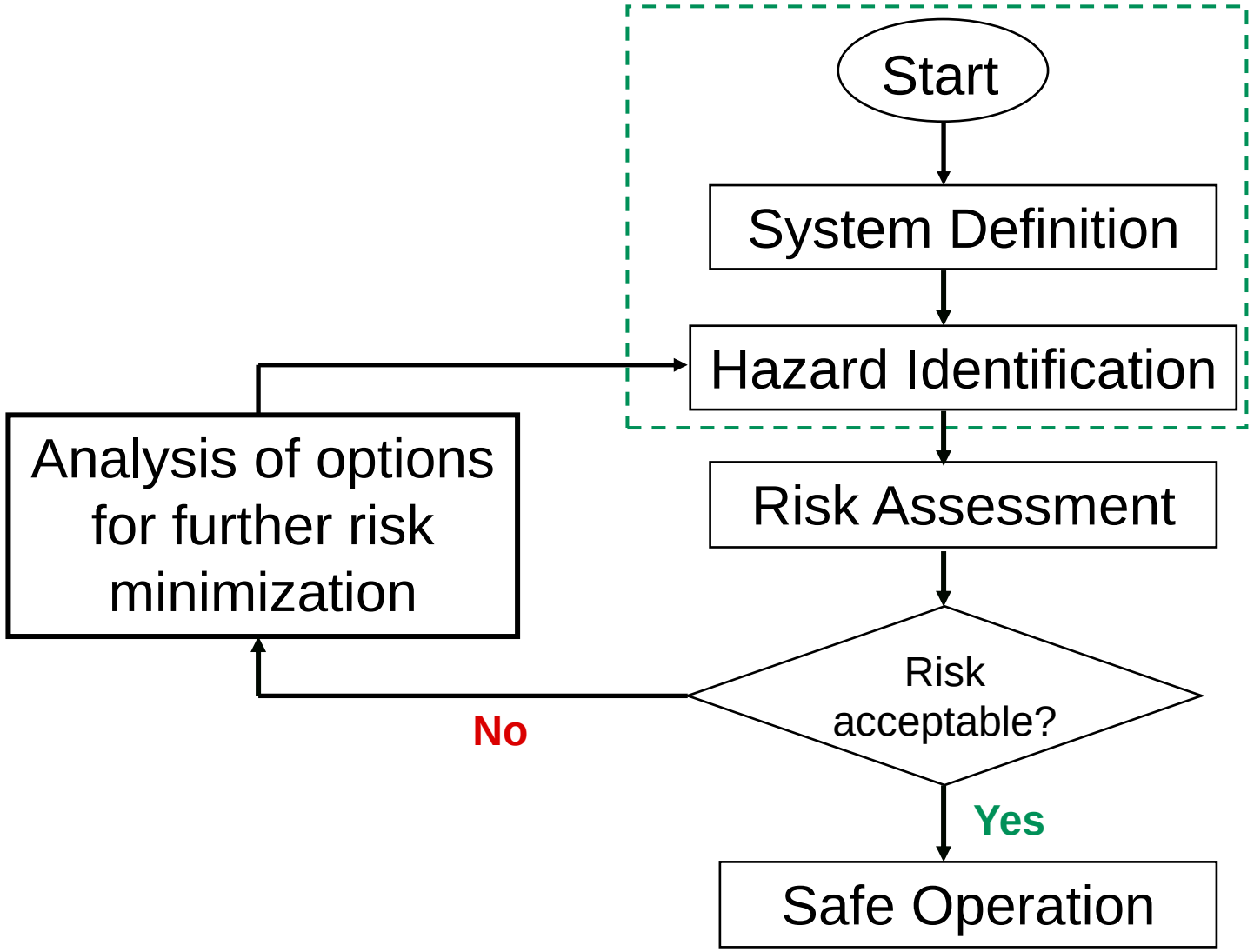
1. Identify the Hazards & Evaluate the Risks
2. Eliminate or Reduce the Hazards and Risks
3. Document & Communicate the Information
4. Manage the Hazards that Remain to Operate in a Safe Manner

Need to identify the hazards to manage them!!

Executing the First 3 Steps



Hazard Control Process



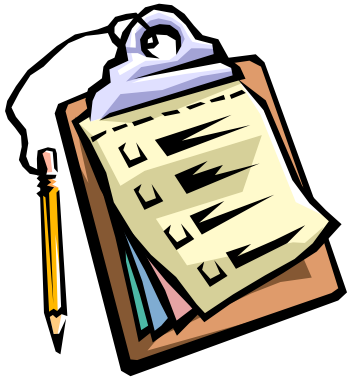
Step 1

Step 2
Step 3

Step 4

How to Accomplish Hazard Identification?

- Structured approach
- Systematic - Keywords or Guidewords
- Team effort
- Right participants
- Sit at the same table or meeting room
- Process safety information
- Document results
- Communicate results



Hazard Identification

- **Structured Hazard Identification with the Keywords Checklist, What-If Checklist or HAZOP Guidewords**

Team Based

Collective responsibility for decisions

Key Word Topics for Hazard Identification

- Basic Process Data
- Site Data
- Basis of Safety Design Concepts
- Explosion Protection
- Fire Protection
- Toxic Protection
- Environmental Protection

Basic Process Data HAZID Review
EHS-402 Process Safety Information

- Chemistry (desired, undesired, upset)
- Process Description (PFD's, P&ID's, safe upper/lower limits…)
- Material Hazards (raw materials, intermediates, products, wastes)
- Process Hazards (temp, press, reactivity, corrosion, start-up, …)
- Control of Process Hazards (engineered and administrative)
- Utility Issues (pressure/temp, emergency back-up, …)
- Atmospheric Process and Emergency Vent locations
- Leak sources
- Reverse or Misdirected Flow of Materials

Specific Hazards Discussion Points

Site Data

- Location
- Logistics
- Layout

Design Concepts

- Control of Material Hazards
- Special Criteria for Equipment/Piping/Controls
- Building/Structural Aspects
- Drainage / Spill Containment

Explosion Protection

- Primary Measures
- Secondary Measures
- Area Classification
- Design Measures

Fire Protection

- Buildings
- Structures
- Equipment
- Fire Fighting
- Fire Risk Assessment

Toxic Protection

- Detection
- Ventilation
- Shelter / Egress
- PPE

Environmental Protection

- Dispersion
- Drainage
- Operating Permit

Pop Quiz #2

Question:

When should the Keywords for Hazard Identification Checklist be used to identify hazards?

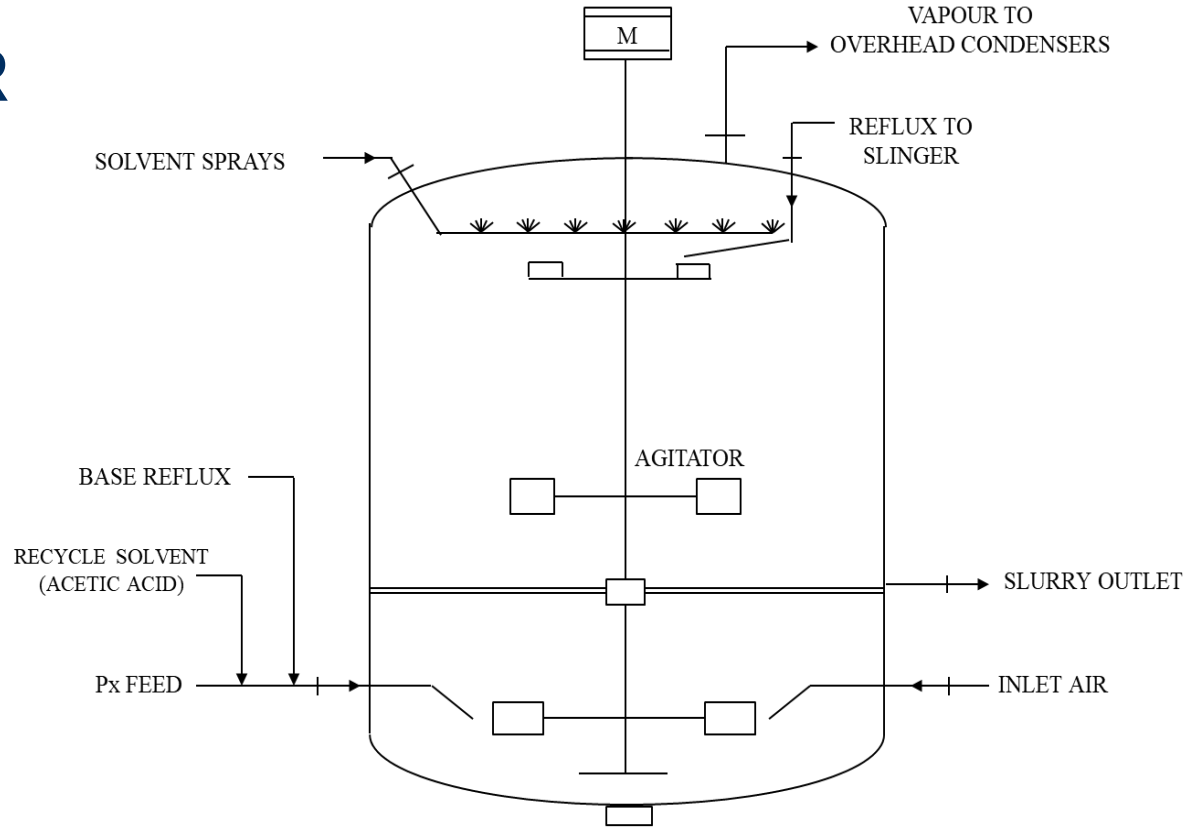
A. Prior to a Conceptual (HS1), Preliminary (HS2) and Detailed (HS3) PHA Review Meetings
B. When a plant change is made
C. At a PHA Review Meeting
D. During an incident investigation
E. A. & C.
F. All of the above
G. None of the above

Team Exercise #1

- **Okay, lets work together to identify Hazards Using Just the Discussion Topics Lists in Slides 18 and 19.**

Team Exercise #1 Process Flow Schematic

PTA OXIDATION REACTOR



Oxidation Reactor

PTA OXIDATION REACTOR

Chemistry (desired, undesired, upset)

Process Description (PFD's, P&ID's, …)

Material Hazards (RM's, intermediates, products, wastes)

Process Hazards (temp, press, corrosion, start-up, …)

Control of Process Hazards

Utility Issues (pressure/temp, emergency back-up, …)

Escape of Materials from Process Outlets (normal/emergency vents, where do they go)

Leakage of Materials

Reverse Flow of Materials

PTA OXIDATION REACTOR

Chemistry (desired, undesired, upset)

- Desired – Terephthalic Acid, Reaction above flammability limit (Fuel rich & Oxygen lean), Exothermic reaction
- Undesired – Operation in flammability limit, Side reaction due to impurities in raw material / operating conditions

  -- Loss of reaction due to accumulation of water (byproduct)

Process Description (PFD's, P&ID's, …)

Material Hazards (RM's, intermediates, products, wastes)

- P-xylene – Flammable, Toxic
- Acetic acid – Flammable, Toxic, Corrosive
- Methyl Acetate – Flammable, Toxic
- Methanol – Flammable, Toxic
- Offgas (Nitrogen rich) – Asphyxiant
- Terephthalic acid – Flammable (Dust)
- Catalyst – Toxic, Corrosive

Process Hazards (temp, press, corrosion, start-up, …)

- Low air flow / air pressure – Back flow of slurry in air line & risk of fire in air sparger.
- Low PX flow, Low temperature of Reactor, low Water draw off, G1-301 not running –> High Offgas O2-> Formation of flammable atmosphere.
- High Process air temperature – Fire hazard in sparger
- High CO2 in Offgas – Damage to reactor internals due to burning of reactor contents.
- High level in Reactor / High Offgas temperature – Carry over of acetic acid rich vapor in Offgas.
- Nucleonic source – Radiation hazard (Non-Process Hazard)

PTA OXIDATION REACTOR

Control of Process Hazards

- Trip & Interlock – To mitigate above hazards
- Nitrogen supply for purging – To prevent reverse flow in air sparger
- Emergency back-up power
- Nitrogen back up / Buffer tank for Instrument air

Utility Issues (pressure/temp, emergency back-up, …)

- Loss of Power, Instrument air, cooling water.

Escape of Materials from Process Outlets (normal/emergency vents, where do they go)

- High Offgas temperature – Carry over of acetic acid rich vapor in Offgas to HPCCU / conveying. (Normal route)
- Reactor overhead blocked outlet , External fire, loss of cooling in overhead exchanger -> Reactor overhead PSV pop-up – Carry over to emergency Relief scrubber. (Emergency vent)

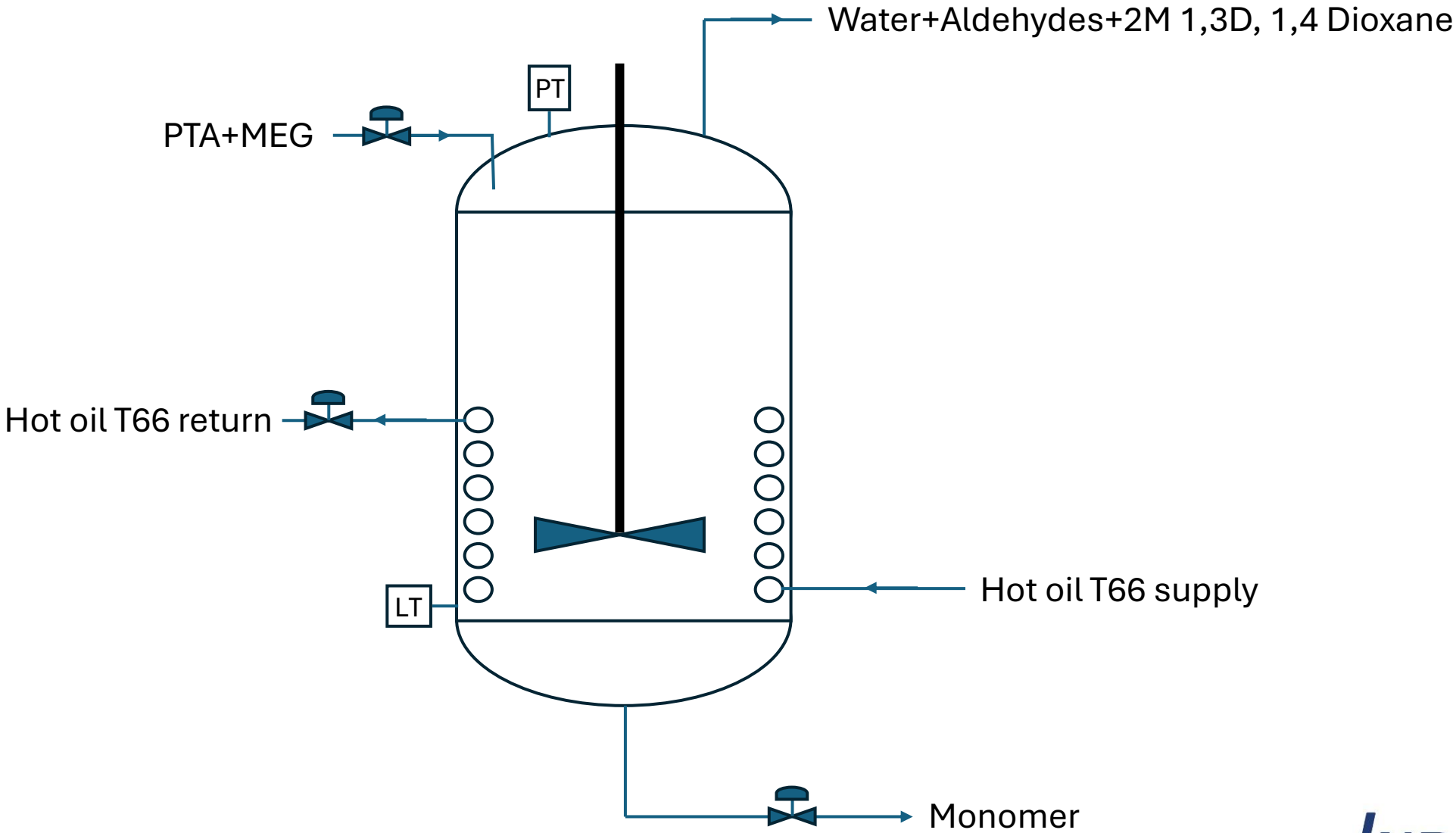
Leakage of Materials

- Flange leak, Corrosion / erosion in pipeline & equipment – Flammable & Toxic chemical release / External fire / vapor cloud explosion
- Mechanical seal leak – Release of toxic acid vapor to atmosphere / external fire / Vapor cloud explosion

Reverse Flow of Materials

- Reverse flow of Rx slurry to process air feed lines – Internal fire
- Reverse flow of vapor into top reflux line –> Increase in reactor pressure ->Relief valve popup-> Emission of Organics to environment

PET CP ESTERIFIER



PET CP ESTERIFIER

Chemistry (desired, undesired, upset)

Process Description (PFD's, P&ID's, …)

Material Hazards (RM's, intermediates, products, wastes)

Process Hazards (temp, press, corrosion, start-up, …)

Control of Process Hazards

Utility Issues (pressure/temp, emergency back-up, …)

Escape of Materials from Process Outlets (normal/emergency vents, where do they go)

Leakage of Materials

Reverse Flow of Materials

PET CP ESTERIFIER

Chemistry (desired, undesired, upset)

- Desired – PTA reaction with MEG (mildly Exothermic reaction)
- Undesired – Side reactions due to impurities in raw material / operating conditions

Process Description (PFD's, P&ID's, …)

Material Hazards (RM's, intermediates, products, wastes)

- PTA – Flammable Dust cloud in air,
- MEG – Mildly toxic, Combustible vapors, Marine pollutant
- Aldehydes – Flammable, Eye irritant, carcinogen
- 2 Methyl 1,3 Dioxolane - Highly flammable liquid & vapor, eye & skin irritant
- 1,4 Dioxane – Highly flammable liquid & vapor, eye irritant, carcinogen.
- Monomer - Stable

Process Hazards (temp, press, corrosion, start-up, …)

- High temperature (~285 degC)
- High turbulence (agitation or thermo-syphoning)
- Reaction under pressure (0.5 – 1.5 barg)
- Nucleonic source – Radiation hazard
- High level
- High / Low flow of PTA+MEG slurry to esterifier
- High HTM temperature

PET CP ESTERIFIER

Control of Process Hazards

- Trips & Interlocks – To mitigate above hazards
- Emergency back-up power
- Buffer tank for Instrument air/N2 back up

Utility Issues (pressure/temp, emergency back-up, …)

- Loss of Power, Instrument air, cooling water, HTM supply, Chilled water, DM water

Escape of Materials from Process Outlets (normal/emergency vents, where do they go)

- High temperature/Pressure may blow the RD /PSV and release the reaction mix to atmosphere (or safe location)
- Gas/Liquid separator (Esterifier EG seal pot) – Escape of Aldehydes to atmosphere

Leakage of Materials

- Flange leak, Corrosion / erosion in pipeline & equipment – Flammable & Toxic chemical release / External fire / vapor cloud explosion
- Pump/agitator Mechanical seal leak – Release of toxic vapor to atmosphere / external fire / Vapor cloud explosion

Reverse Flow of Materials

Knowledge Check

- **“Hazard” - Potential source of harm**
- **Basic Process Safety Rule #1 – You can’t control a Hazard that you haven’t identified.**
- **Indorama’s hazard identification approach includes:**
  - Use of a Keywords for Hazard Identification Checklist, Guidewords from IOD-EHS Standards, Conceptual Design (HS1) Checklist
  - A multi-disciplinary team of the right people
  - Documenting and communicating identified hazards
- **Hazard Identification is the foundation of Risk-Based Process Safety**

THANK YOU

Questions/Comments