Module 2B – Hazard Identification

Lasted 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 2B: Hazard Identification Agenda

Review and Understand:

Four Steps of Process Safety in IVL EHS Standards

Inherent Safety

Plant Safety Concepts

Training Objectives

Increase awareness and understanding of the hazard control process integrated into the IVL EHS process safety standards

Increase understanding of inherent safety

Introducing the definition and value of a safety concept

Encouraging development of plant and technology process safety concepts

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 in a Safe Manner

	Frequency Category								
	$\leq 10^{-6}$	$> 10^{-6}$ to 10^{-5}	$> 10^{-5}$ to 10^{-4}	$> 10^{-4}$ to 10^{-3}	$> 10^{-3}$ to 10^{-2}	$> 10^{-2}$ to 10^{-1}	$> 10^{-1}$ to 1	> 1	
Severity Category	1	2	3	4	5	6	7	8	
A	EHS-2	EHS-3	EHS-3	EHS-3	EHS-3	EHS-4	EHS-4	EHS-4	Facility Siting Scope
B	EHS-2	EHS-3	EHS-3	EHS-3	EHS-3	EHS-4	EHS-4	EHS-4	
C	EHS-2	EHS-2	EHS-3	EHS-3	EHS-3	EHS-4	EHS-4	EHS-4	
D	EHS-1	EHS-2	EHS-3	EHS-3	EHS-3	EHS-4	EHS-4	EHS-4	LOPA Scope
E	EHS-1	EHS-2	EHS-2	EHS-3	EHS-3	EHS-4	EHS-4	EHS-4	
F	EHS-1	EHS-1	EHS-2	EHS-2	EHS-3	EHS-3	EHS-3	EHS-4	
G	EHS-1	EHS-1	EHS-1	EHS-1	EHS-2	EHS-2	EHS-3	EHS-3	HazOp Scope
H	EHS-1	EHS-1	EHS-1	EHS-1	EHS-1	EHS-2	EHS-2	EHS-3	

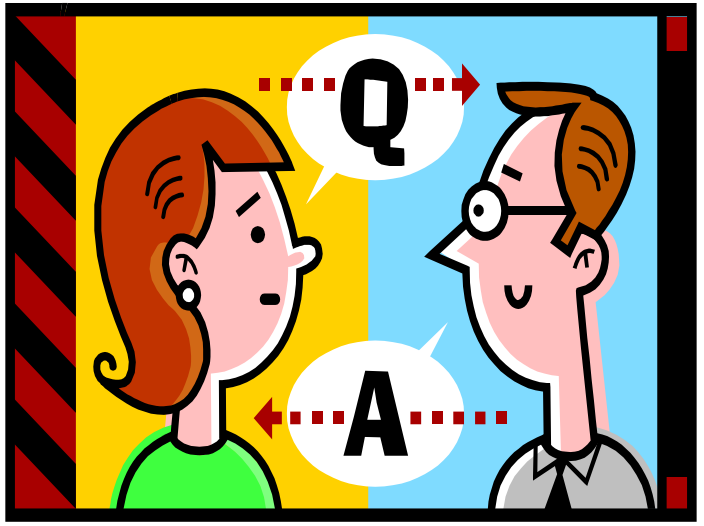
Manage the Hazards

IVL Process Safety Standards with the Four Steps of Process Safety

1. Process Hazard Analysis – IVL EHS-403
2. SIL Target Assessment – IVL EHS-406
3. Management of Change – IVL EHS-204 and IVL EHS-104
4. Pre-Startup Safety Review – IVL EHS-413
5. Incident Investigation – IVL EHS-106
6. Process Fire Safety Management – IVL EHS-210
7. Facility Siting – IVL EHS-407
8. Mechanical Integrity – Inspection & Testing – IVL EHS-415

Step 1. Identify and Evaluate

What are some ways (References, Methods and Tools) used to identify the hazards of our processes and define the potential consequences and inherent or “raw” risk without safeguards and mitigated risk with safeguards?

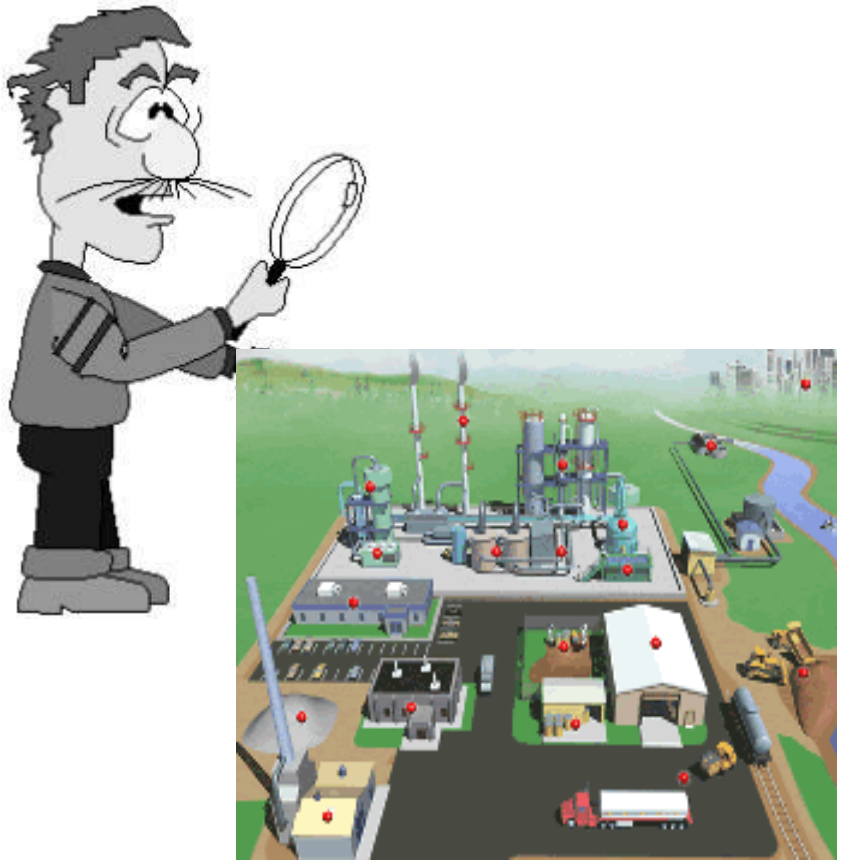


Process Hazard Analysis

A Process Hazard Analysis (PHA) is the generic term for any Hazard Identification & Evaluation

Typically, PHAs also include recommendations for the Control of Hazards

A PHA can take many forms (Not just a HAZOP) and be performed throughout the lifecycle of the plant



Process Hazard Analysis
IVL EHS-403 and IVL EHS-404

Hazard Identification Keyword Checklist
Conceptual PHA (Hazard Study 1 – HS1)
Preliminary PHA (Hazard Study 2 – HS2)
Detailed PHA (Hazard Study 3 – HS3)
Pre-Start Safety Review (Hazard Study 4 and 5 – HS4/HS5)
Post Project PHA (Hazard Study 6 – HS6)
Procedural PHA (PPHA)
Process Hazard Review (PHR)

Incident Investigation is a Form of PHA

An Accident or Incident can signal the presence of an Unknown or Inadequately controlled Hazard

Investigations uncover the true causes of the incident and the potential Hazards

Documentation and communication are key to prevent reoccurrence

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

Tools to Assist in HAZID in IVL EHS-403

Hazard Identification Keyword Checklist
Conceptual PHA (Hazard Study 1) Checklists
What-If Checklist Methodology
Hazard and Operability (HAZOP) Methodology with Guidewords
Facility Siting Checklist
Human Factor Checklist
Procedural PHA Guidewords
Preliminary (HS2) Guideword Lists

Also, for more quantitative look:
Aloha® Modeling Software – ALOHA Software | US EPA
CCPS Probability of Ignition Estimating Tool

Step 2. Eliminate or Reduce the Hazards and the Risks

What are some ways that we Eliminate and Reduce the Hazards that we have identified in our plants?

Eliminating or Reducing the Hazards – Inherent Safety

Inherent Design for Chemical Plants

Avoid a Hazard rather than Control it.

The Avoidance of Hazards has priority over control through safety measures or procedures.

Take Risk out of the Business!

Inherent Safety

Basis for safety that is a permanent and inseparable element

Low level of danger even if things go wrong

In contrast to safe systems resulting from inherently safer design

- **High degree of hazard controlled by protective systems**

Always preferred to “Avoid” instead of control hazards

- Minimize
- Substitute
- Moderate
- Simplify

Inherent Safety Principles

Minimize

- The amount of hazardous material inventory
- The number of hazardous operations

Substitute

- One material with another of less hazard
  - Clean with water and detergent rather than a flammable solvent

Moderate:

- Reduce the strength of an effect
  - Dilute material instead of concentrated
  - Cool material before transfer

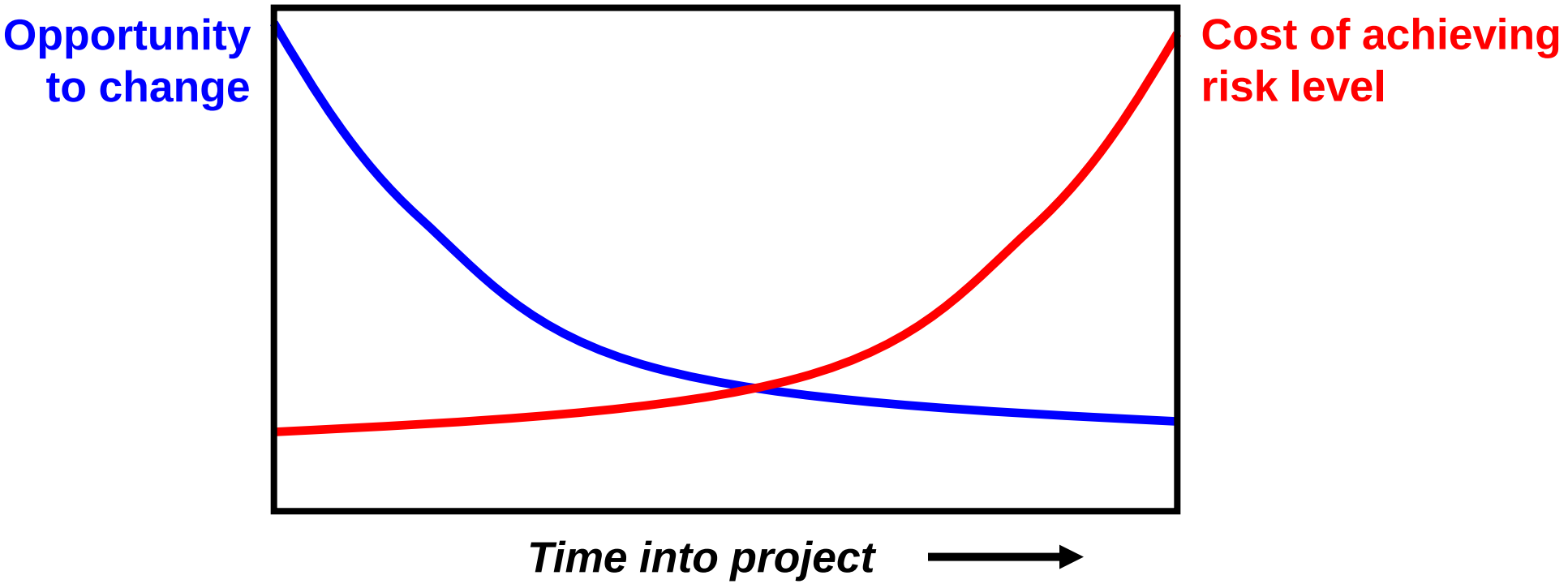
Simplify

- Design out problems -vs- adding complexity to deal with them
  - Design a vessel for the worst case P_{MAX} during an upset

Safer, Simpler, Cheaper…..

Inherent Safety - Do Early In Projects

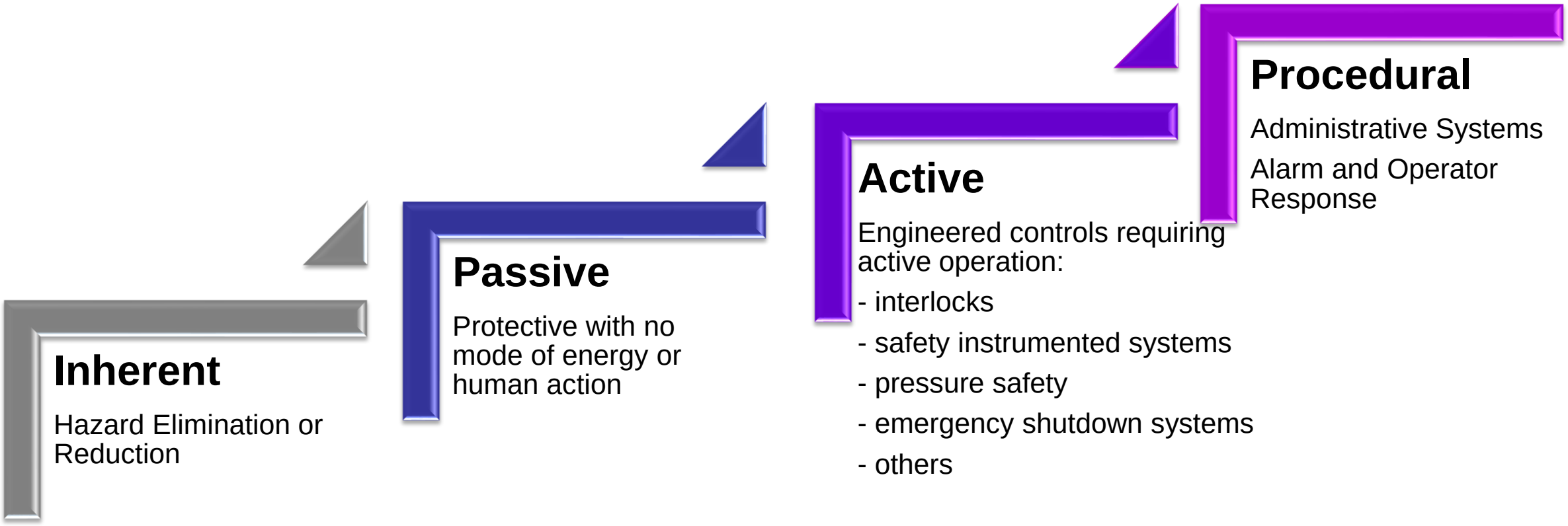
"An architect has two tools: an eraser and a sledgehammer"



OPPORTUNITIES ARE GREATEST EARLY ON

Reducing the Risk

Hierarchy of Controls



Hierarchy of Controls

Passive Control Measures:

Measures which have an immediate impact without relying on human, mechanical or electronic action (Proper Maintenance may be necessary)

Examples of Passive Controls:

- Pressure-Proof Design
- Dike / Containment system to mitigate spill effects
- Flow limitation via Design of Piping system
- Fire-Proofing of Structural Steel
- Blast Walls

Hierarchy of Controls

Active Control Measures:

Measures which rely on mechanical or electrical devices to take the proper action to control a hazard.

Examples of Active Controls:

- Pressure Safety Valve / Rupture Disk
- Check Valves
- High Temperature Interlocks with Block Valves
- Fire Sprinkler Systems
- Runaway Reaction Stopper Solutions

Hierarchy of Controls

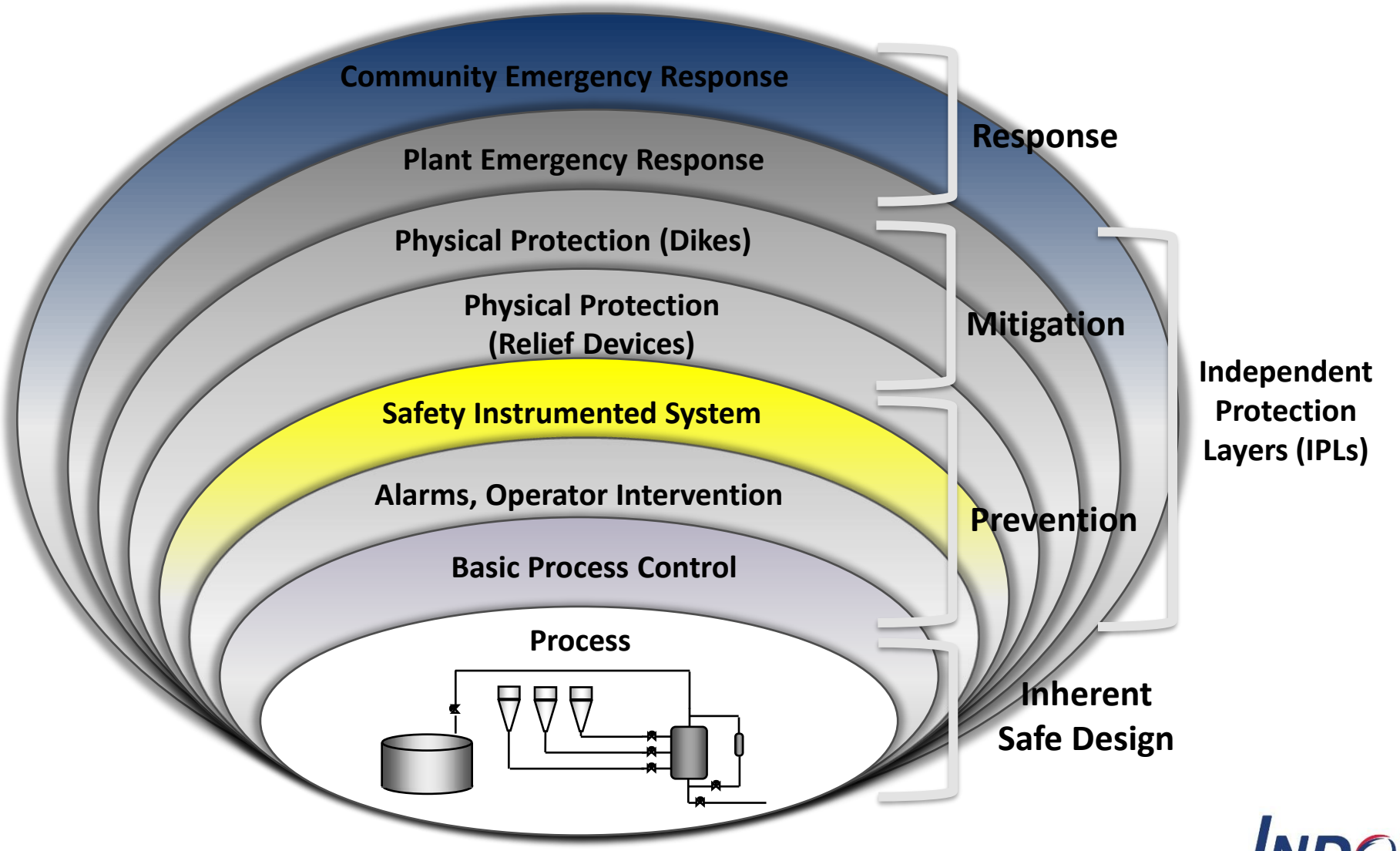
Administrative Control Measures:

Measures which involve the correct and timely actions of personnel to control a hazard.

Examples of Administrative Controls:

- Operating Procedures
- Training Programs
- Safe Work Permits
- Personal Protective Equipment
- Periodic Inspections / Walk-throughs

Layers of Protection for Fault Tolerant Hazard Control & Mitigation

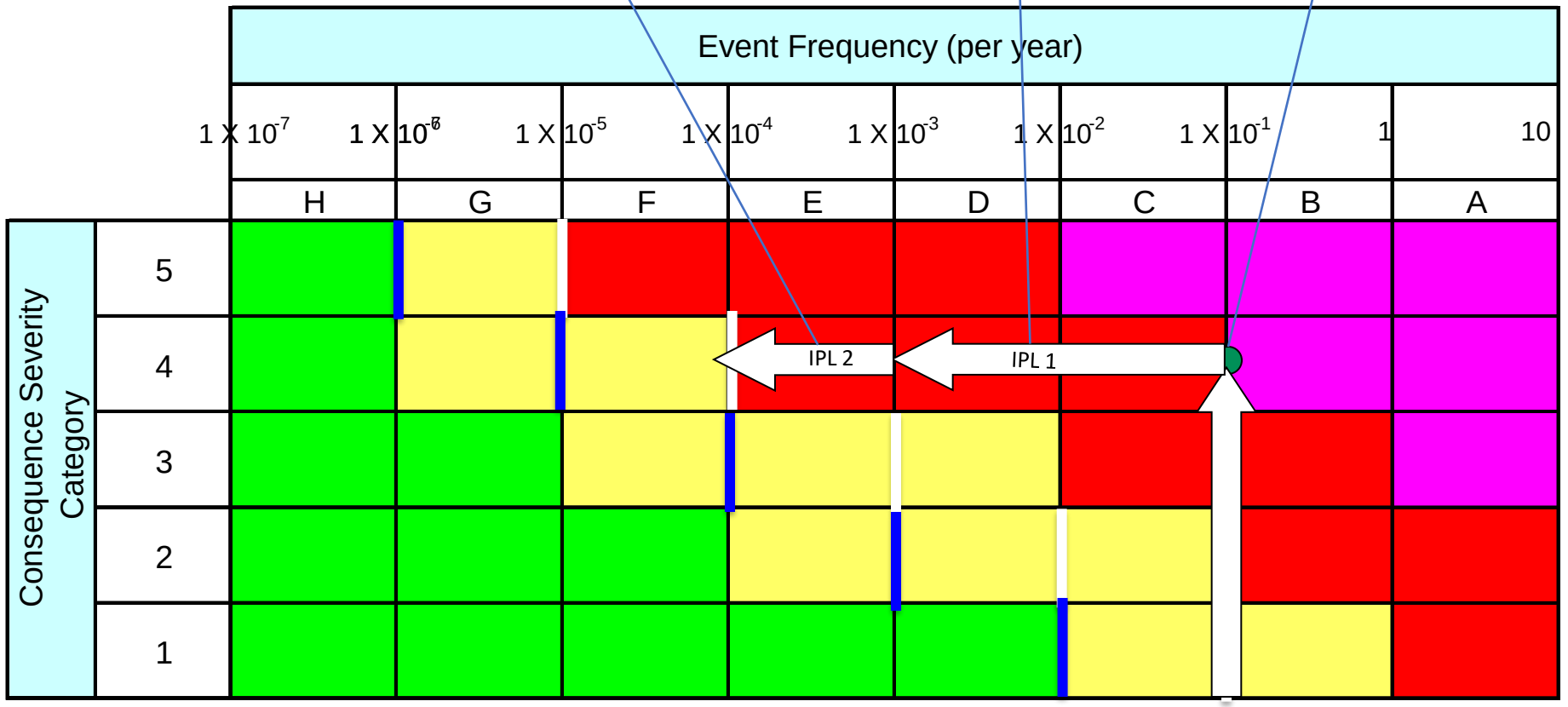


Risk Management

SIS IPL – High Pressure Trip of EO 0.1 PFD

Non-SIS IPL – Pressure Relief Device 0.01 PFD – Single Sized Adequately

Inherent Risk of the Process - No Safeguards (PHA) – BPCS Failure of Micromotion charging EO too fast – S4 0.1/yr [1/10 yrs]



EHS - 4	**Very High Risk Range**
EHS - 3	**High Risk Range**
EHS - 2	**Medium Risk Range**
EHS - 1	**Low Risk Range**

Step 3. Document and Communicate

What are some ways that we Document and Communicate Hazards and Controls to others in our organization, company, community, etc.?

Step 3. Document and Communicate

Key management practices of a Process Safety Management Program

1. Process Safety Information – IVL EHS-402
2. Process Hazard Analysis – IVL EHS-403
3. SIL Target Assessment Methodology – IVL EHS-406
4. Operating Procedures – IVL EHS-412
5. Training
6. Management of Change – IVL EHS-204 and IVL EHS-104
7. Incident Investigation – IVL EHS-106
8. Process Fire Safety Management – IVL EHS-210
9. Facility Siting – IVL EHS-407

Step 3. Document and Communicate

If I identify a Hazard, but I don't document it or communicate it, that Hazard is still unknown to others.

If we don't document our designs or discoveries, that information will soon be lost to the organization.

If we don't document and share our learnings from incidents and near misses, we are destined to have history repeat itself .

"Organizations have no memory" – T. Kletz

Plant Safety Concept

Safety Concept

Tool for documenting the hazards and the measures to manage the risk.

Simply stated, a Safety Concept documents:

identified hazards of a process

AND

measures for dealing with those hazards

Plant Safety Concept

Fundamentals

Sufficient Understanding of Materials and Reactions

Comprehensive Identification of Hazards

Design of Simple, Straightforward Plants Using all Feasible Possibilities for Inherent Safety

Establishment of Systematic Plant Safety Concepts

Plant Safety Concept

Fundamentals (cont)

Observation of Recognized Technical Guidelines, Codes and Standards

Use of Experience from Previous Events

Establishment of Well-balanced Plant Safety Concepts for Hazard Control

Examples of Safety Concepts

Ethylene Oxide Pump Safeguard Design

Nitrogen Purge Pocket Backflow Preventor

Alkoxylation Reactor Nitrogen Pad System to Control EO in Headspace

Ethylene Oxide Unloading Filter Media

Ethylene Brittle Frac Management

Ethylene Oxide Reaction Initiation Charge

PNO Boiler Study Comparison – Guidance for Fired Equipment

PHA/LOPA Documentation

Conceptual PHA (Hazard Study 1 – HS1) documents the Plant Basis of Safety Concept

Preliminary and Detailed PHA/LOPA Worksheets document the Unit Process Safety Concept

- Potential Hazards and their Consequences
- Safeguards or Independent Protection Layers
- Risk Inherent to the Process and “as is” managed with the Safeguards

When this documentation is very similar for multiple plants, a generalized Process Safety Concept can be developed.

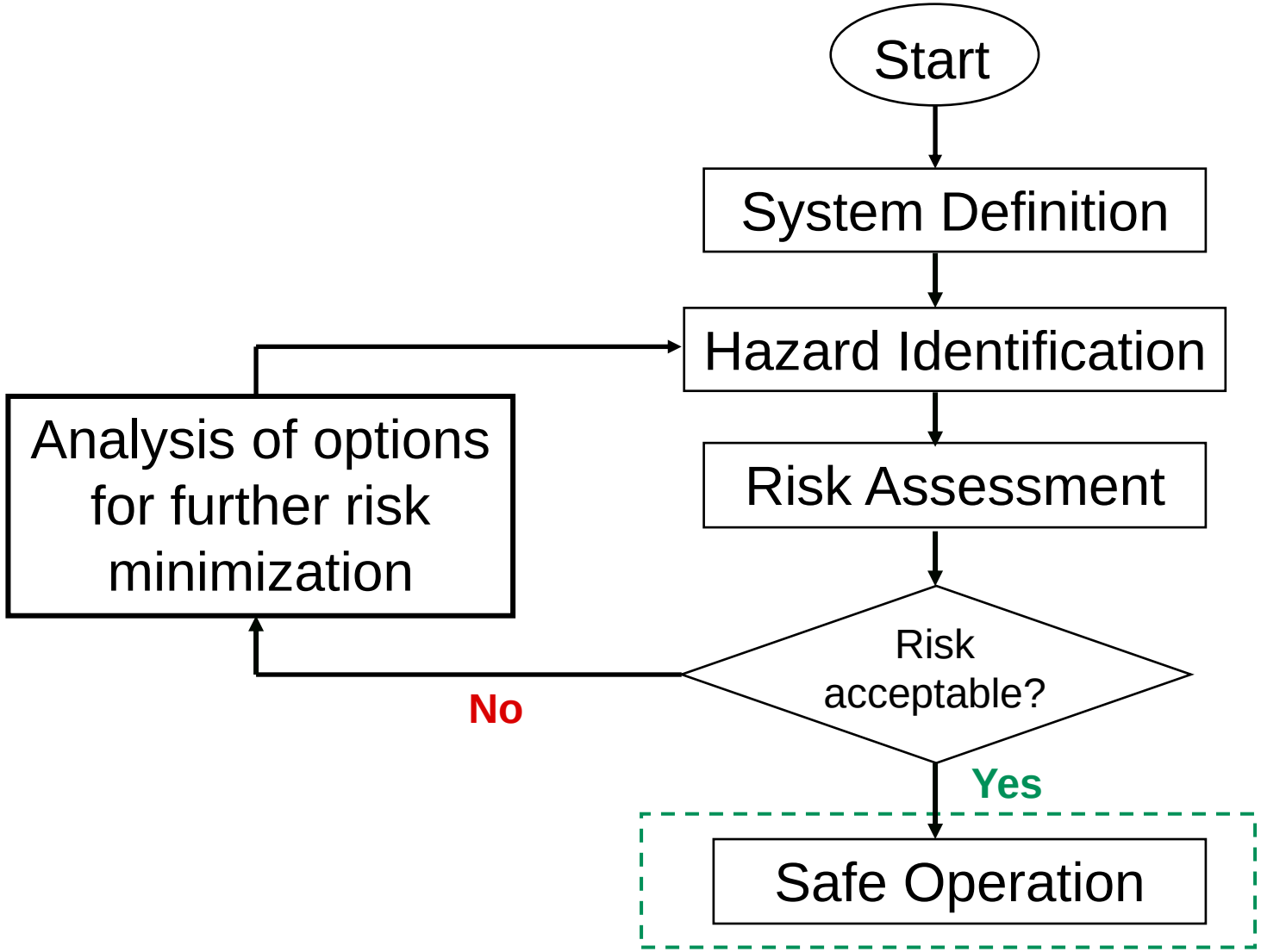
Step 4. Manage the Hazards that Remain in a Safe Manner

It is never possible to eliminate all risk.

Therefore, we must control the remaining risks…to operate safely

- Dikes or Blast Walls
- Safety Measures (ESDs, SIS, PSVs, etc.)
- Basic Process Control Systems (BPCS, Alarms, Interlocks)
- Operating Procedures
- Maintenance (corrective, preventative, etc.)
- Safe Work Permits (ex. Confined Space, LO/TO, Hot Work)
- PPE
- Fire Protection Systems
- Emergency Response
- Management of Change
- Training

Hazard Control Process



Step 1

Step 2
Step 3

Step 4

Takeaways

Question: What did you learn?

1. PHAs, Incident Investigations, Siting, MOCs are all forms of Hazard Identification and Control
2. The IVL EHS Standards and Practices are How we find Hazards. Evaluate risk, identify controls, document and communicate
3. There is a Hierarchy of Controls with Inherent Safety 1st
4. Repetitive PHAs with the same Controls are good Safety Concepts

Questions / Comments

Backup Slides

PSI Chemical

Chemicals Involved in the Process
Toxicity information
Permissible exposure limits
Physical data
Reactivity data (reactive chemistry)
Corrosivity data
Thermal and chemical stability
Hazardous effects of inadvertent mixing of different materials that could occur

PSI- Technology of the Process

Block flow diagram

Process Description (Batch Process full sequence descriptions)

Process Chemistry

Maximum Intended Inventories

Safe upper and lower design limits

- Pressures
- Temperatures
- Flows
- Compositions (intermediates, final products, etc.)

An evaluation of consequences of deviation

- From the above
- Especially those affecting safety and health
- But not omitting any others

PSI Equipment

Materials of construction
Piping and Instrumentation Diagrams
Electrical classification
Relief system design and design basis
Ventilation system design
Design codes and standards
Materials and energy balances
Safety systems and their function - Interlocks, detection, suppression, etc

Recognized and generally accepted good engineering practices
(RAGAGEP)

Procedure Requirements – Operating Steps/Phases

Steps for each operating phase
Initial startup
Normal operations
Temporary operations
Normal shutdown
Emergency shutdown

- Conditions requiring emergency shutdown
- Assignment of responsibility to qualified operators
  - ensure safe and timely execution

Emergency Operations
Startup following a turnaround
Startup following an emergency shutdown

Procedure Content – Safe Operating Limits

Operating Limits

- Maximum Intended Inventory
- Safe Upper and lower limits
  - Pressure
  - Temperature
  - Flow
  - Time (Duration)
- Consequences of deviation
- Steps required to avoid deviation
- Steps required to correct deviation

Procedure Content – Safety and Health Considerations

Materials/Chemicals

- Properties
- Hazards
- Precautions necessary to prevent exposure
  - Engineering controls,
  - Administrative controls,
  - Personal protective equipment;
- Control measures to be taken if exposure occurs
  - Physical contact
  - Airborne exposure

Procedure Content – Safety and Health Considerations

Control of hazardous chemical inventory

- Maximum Intended Inventory
- Storage
- Accountability

Quality control for raw materials

Special or unique hazards

Safety systems and their function