



Module 1: Introduction The Basics of Process Safety

Last Revised – June 2024



Process Safety 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 to Process Safety Agenda



Review and Understand:



What Process Safety is, what it includes and why its important



IVL Process Safety Organization and Management Systems

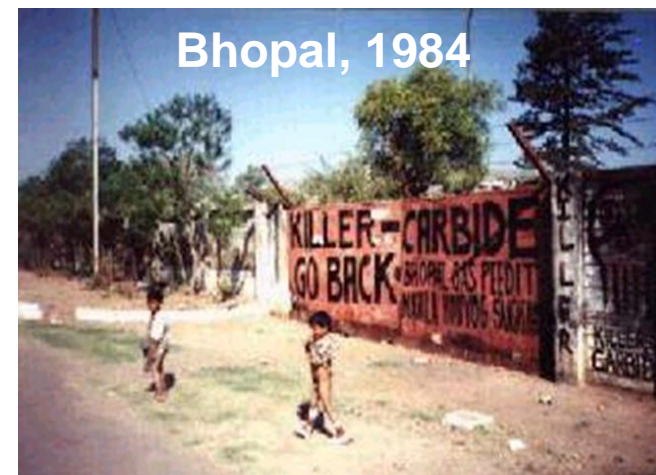


Commitment to Process Safety at all levels in the organization

What is Process Safety?

A discipline that focuses on the prevention of physical situations with the potential for human injury, damage to property, or damage to the environment through the release of chemical energy in the form of:

**Fire,
Explosion,
Toxicity, or
Corrosivity.**



Primary Elements of Process Safety Management

1. Employee Participation
2. Process Safety Information (PSI)
3. Process Hazard Analysis (PHA)
4. Operating Procedures
5. Training
6. Contractors
7. Pre-Startup Safety Review (PSSR)
8. Mechanical Integrity (MI)
9. Hot Work (Permits)
10. Management of Change (MOC)
11. Incident Investigation
12. Emergency Planning & Response
13. Compliance Audits
14. Trade Secrets



What is *Why* Process Safety?

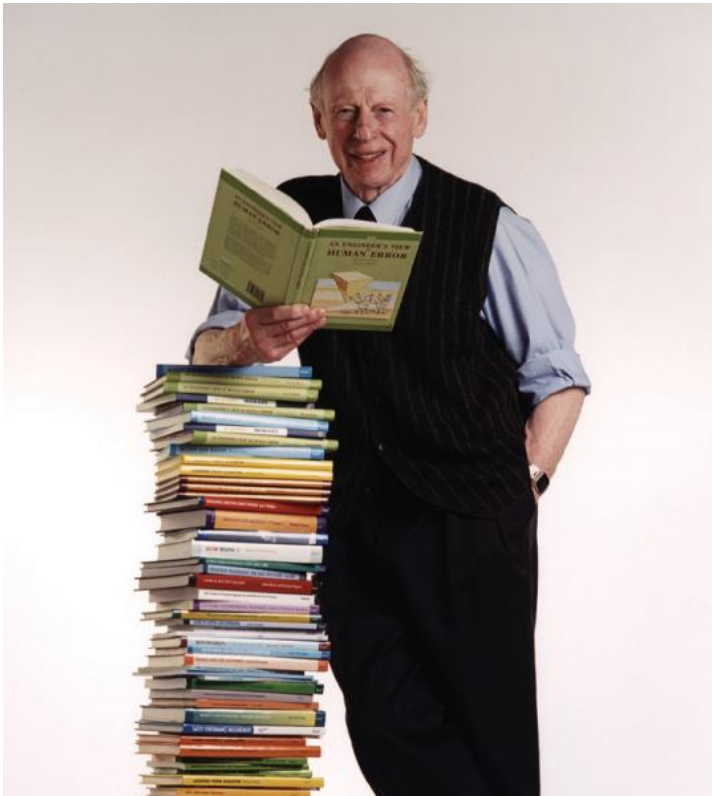
“Try to change situations, not people...”

Organizations have no memory, only people have memory.

If you think safety is expensive, try an accident.

People say that accidents are due to human error, which is like saying falls are due to gravity.

What You Don't Have Can't Leak



Why Indorama needs Process Safety Management

Warehouse Fire*



Exchanger Fire
Gasket Failure



Duct Fire
*Accumulation of
Material in Ducts*



Duct Fire & Explosion
Valve Position Failure



Furnace Fire
Tube Failure



Line Overpressure
Mechanical Integrity Failure



2019

2023



Explosion
Lightning



Equipment Fire
Structure Failure



Hot Glycol Splash
Failed Hazard Recognition



HTM Leak
Tube Failure

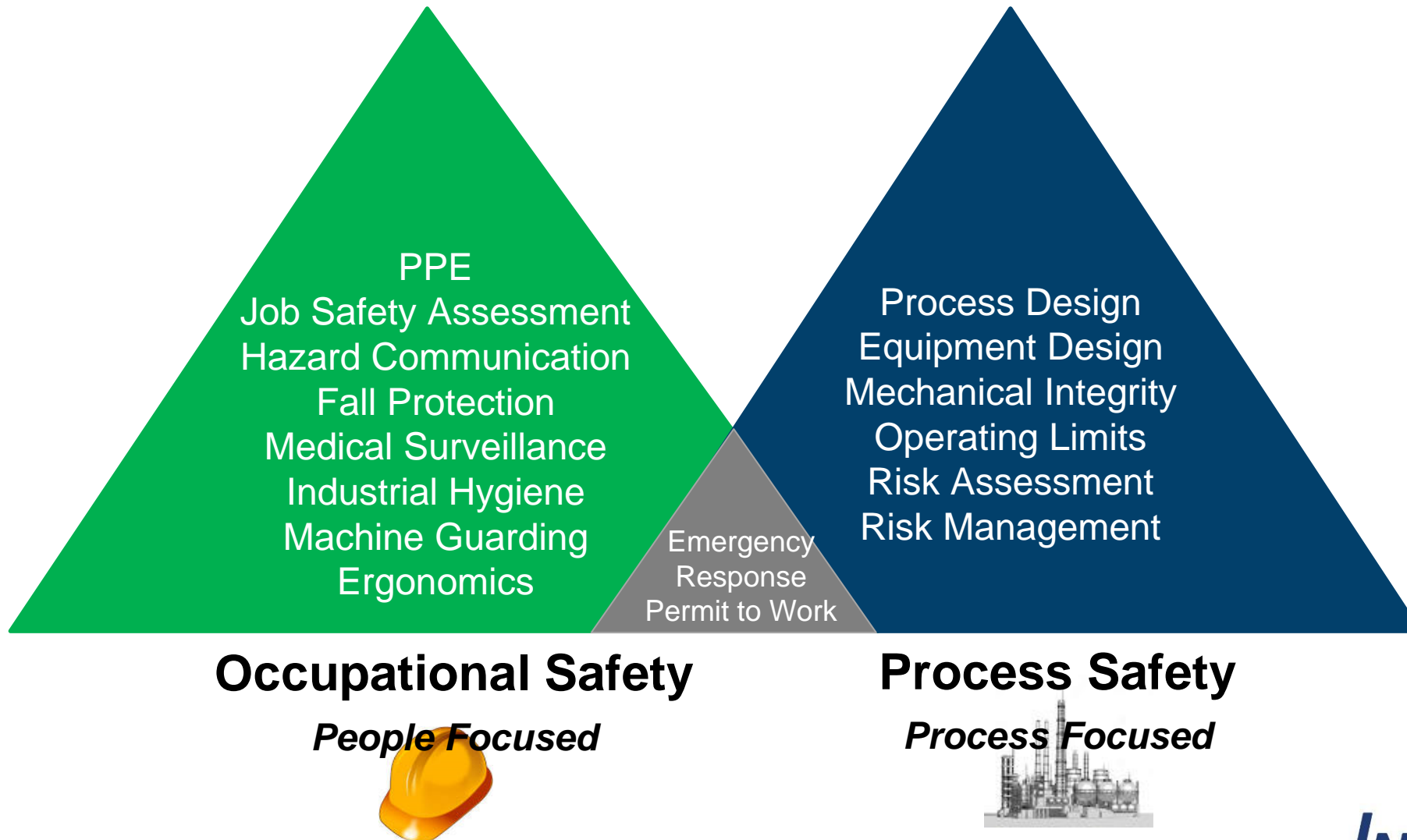


Furnace Explosion
Material in Plant Air

We are responsible.

In our pursuit of business growth and profitability we do things the right way – economically, socially, and environmentally. Furthermore, health and safety are non-negotiable.

Occupational Safety versus Process Safety



Accidents and Regulations



Flixborough 1974
28 deaths
Led to the HSWA and COMAH



Bhopal 1984
> 3,000 deaths
Led to the CCPS



Pasadena, TX 1989
23 deaths
Led to OSHA PSM



West, TX 2013
15 deaths
Led to Executive Order
and RMP update

1974

1976

1984

1988

1989

2005

2013

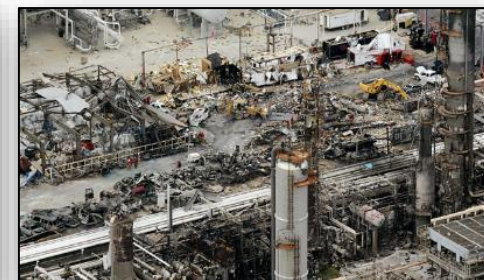
Seveso 1976
Dioxin release
Led to the Seveso
Directive



Piper Alpha 1988
167 deaths
Led to performance based
management systems



Texas City 2005
15 deaths
Led to API 755
(Worker Fatigue)



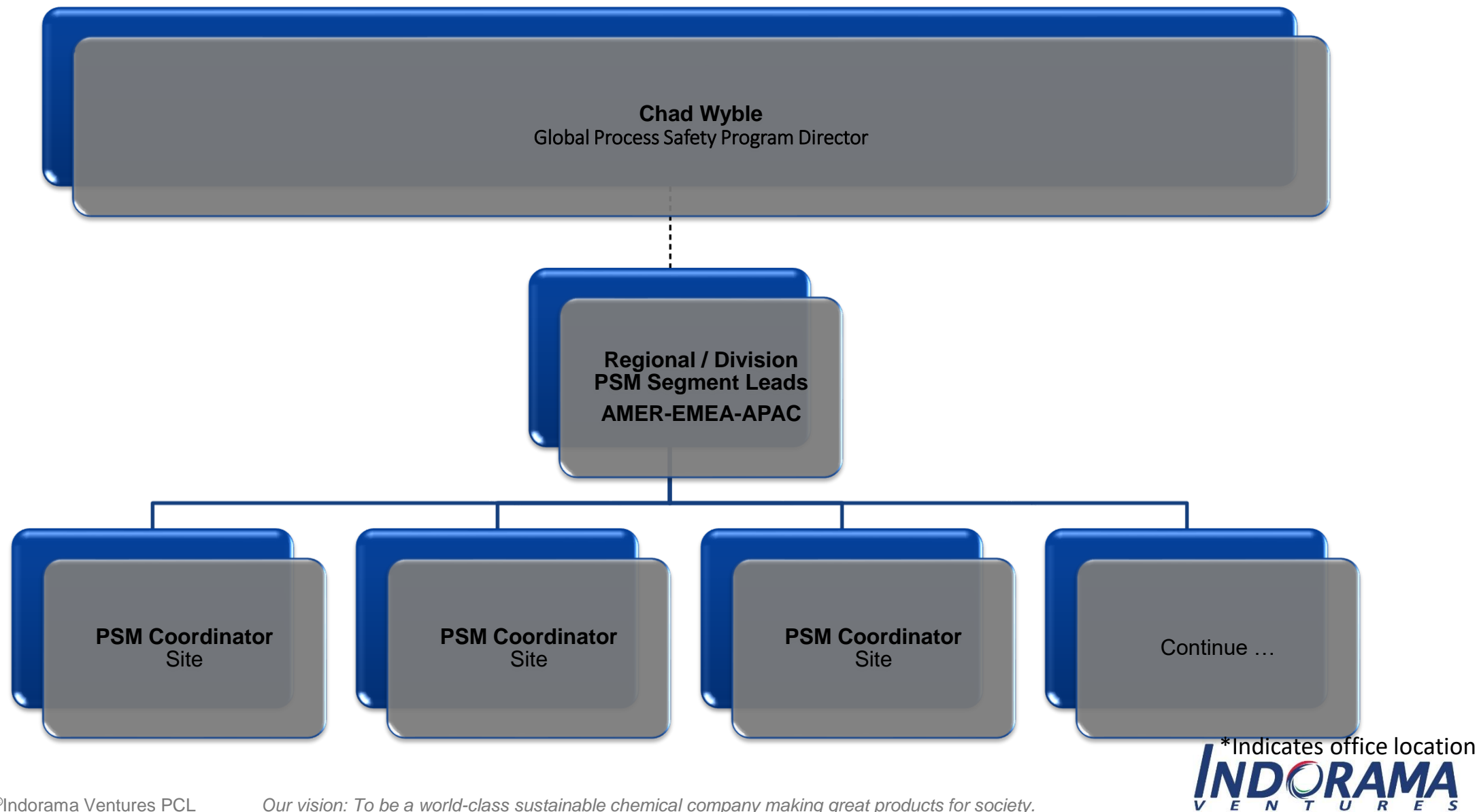
EHS Roles and Responsibilities (IVL-EHS-101)

ALL Indorama Ventures employees have ownership of EHS as an integral part of their job. EHS is not reserved for just the EHS professionals. **EVERYONE** is responsible.

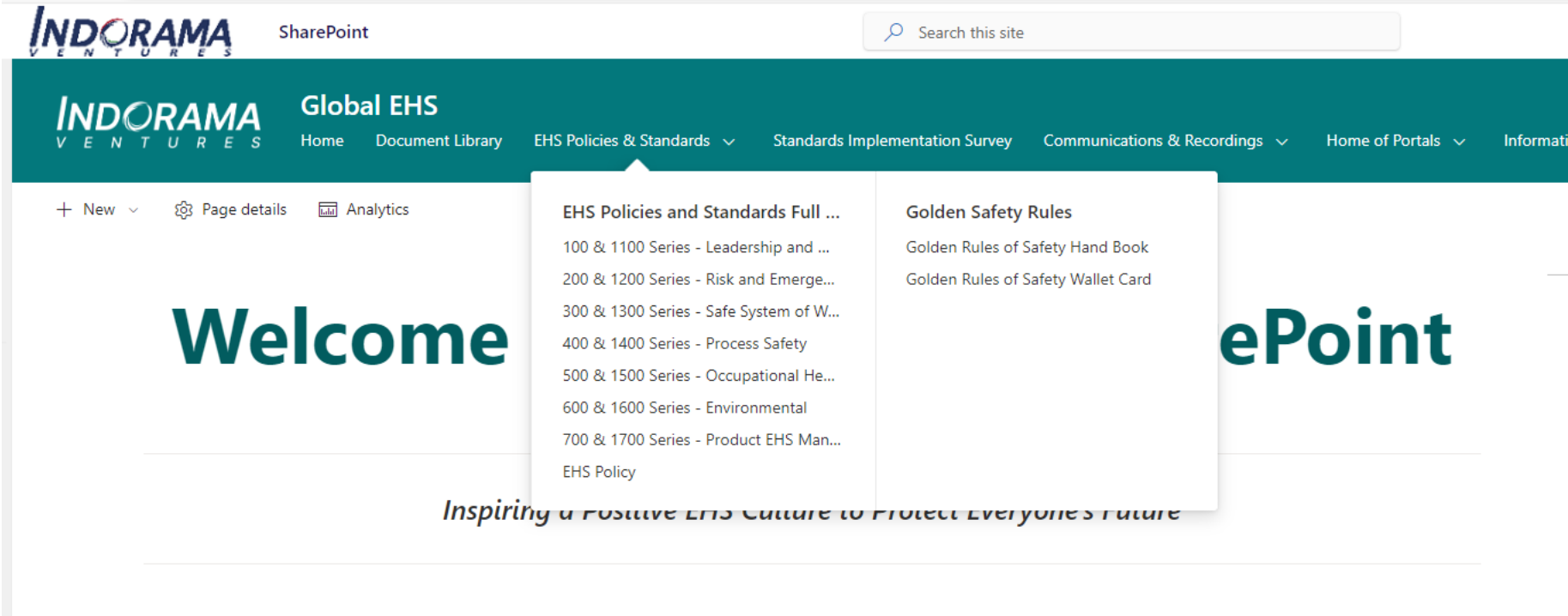
Employees are responsible and accountable to their respective Line Manager to take an active role in protecting and promoting EHS by:

- Identifying and being aware of EHS risks involved in their work,
- Participating in EHS meetings, facility EHS self-audits, and other company EHS programs and activities,
- Following procedures,
- Reporting any observed EHS hazards or lapses in EHS management system/programs, and
- Attending required EHS training.

IVL Process Safety Organization (Simplified)



IVL EHS Standards



IVL EHS Process Safety Subject Standards

No.	Title	No.	Title
IVL-EHS-104	Organizational Change Management	IVL-EHS-409	Design & Maintenance of Safety Instrumented Functions
IVL-EHS-204	Management of Change	IVL-EHS-410	Pressure Relief System Design
IVL-EHS-208	IVL Risk Management Standard and Matrix	IVL-EHS-411	Design Verification
IVL-EHS-402	Process Safety Information	IVL-EHS-412	Operating Procedures
IVL-EHS-403	Process Hazard Analysis	IVL-EHS-413	Pre-Startup Safety Review
IVL-EHS-405	IVL EHS Criticality Assessment	IVL-EHS-414	Alarm Management
IVL-EHS-406	Safety Integrity Level (SIL) Target Assessment Methodology	IVL-EHS-415	Mechanical Integrity
IVL-EHS-407	Facility Siting	IVL-EHS-417	Process Safety Management Applicability
IVL-EHS-408	Area Classification and Management		

NOTE: Procedures highlighted green will be covered in this module.

Related IVL EHS Standards

No.	Title
IVL-EHS-101	EHS Roles & Responsibilities
IVL-EHS-103	Selection and Management of Contractors
IVL-EHS-106	Incident Investigation
IVL-EHS-107	IVL Management of Recommendations/Actions
IVL-EHS-109	IVL EHS Metrics and Reporting
IVL-EHS-110	EHS Audit Program
IVL-EHS-112	EHS Regulatory Compliance
IVL-EHS-114	EHS Standard Variance Request
IVL-EHS-301	General Work Permits
IVL-EHS-302	Hot Work
IVL-EHS-303	Energy Isolation
IVL-EHS-304	Confined Space Entry

Integrated Process Safety Program

Management & Leadership

EHS 101 Roles & Responsibilities

Identify Hazards



Determine Safeguards



Design Safeguards



Operate & Maintain



System Effectiveness & Continuous Improvement

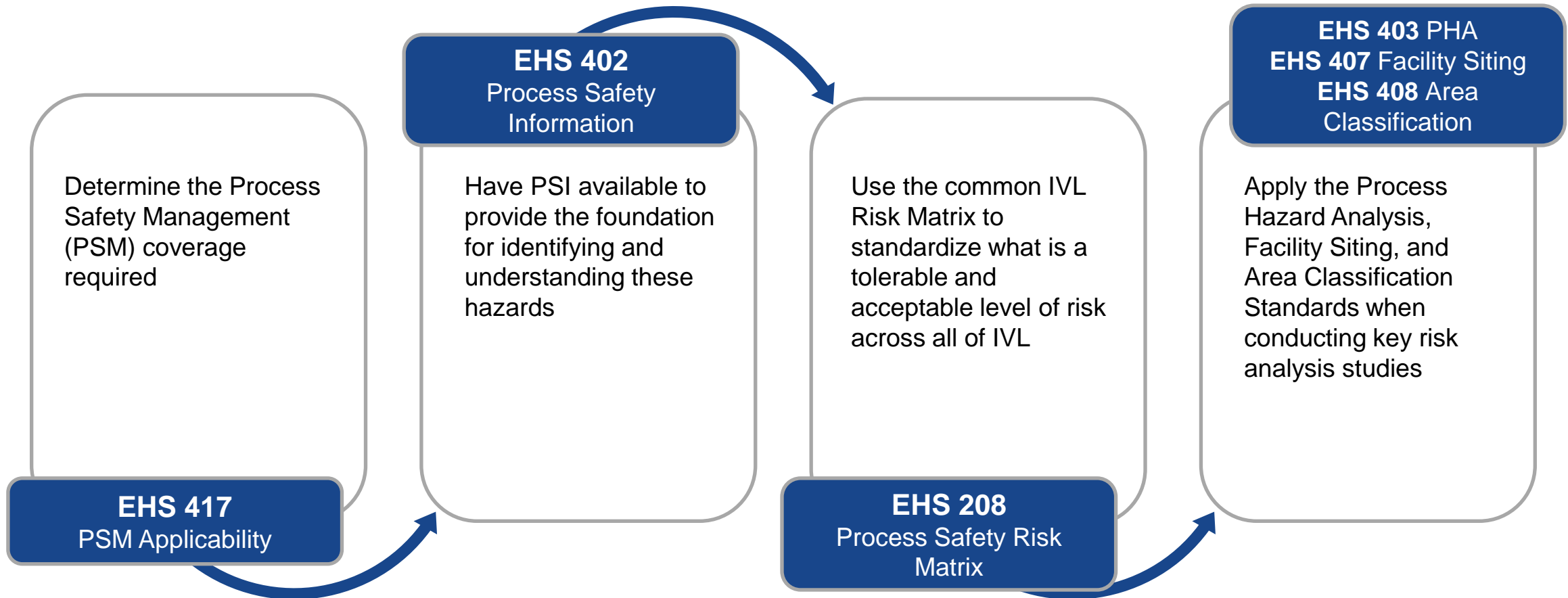
EHS 204 Management of Change (MOC)
EHS 104 Organizational Change Management (OCM)
EHS 413 Pre-Startup Safety Review (PSSR)

EHS 105/106 Incident Investigation
EHS 107 Management of Actions
EHS 109 EHS Metrics
EHS 110 EHS and PSM Audits

Integrated Process Safety Program



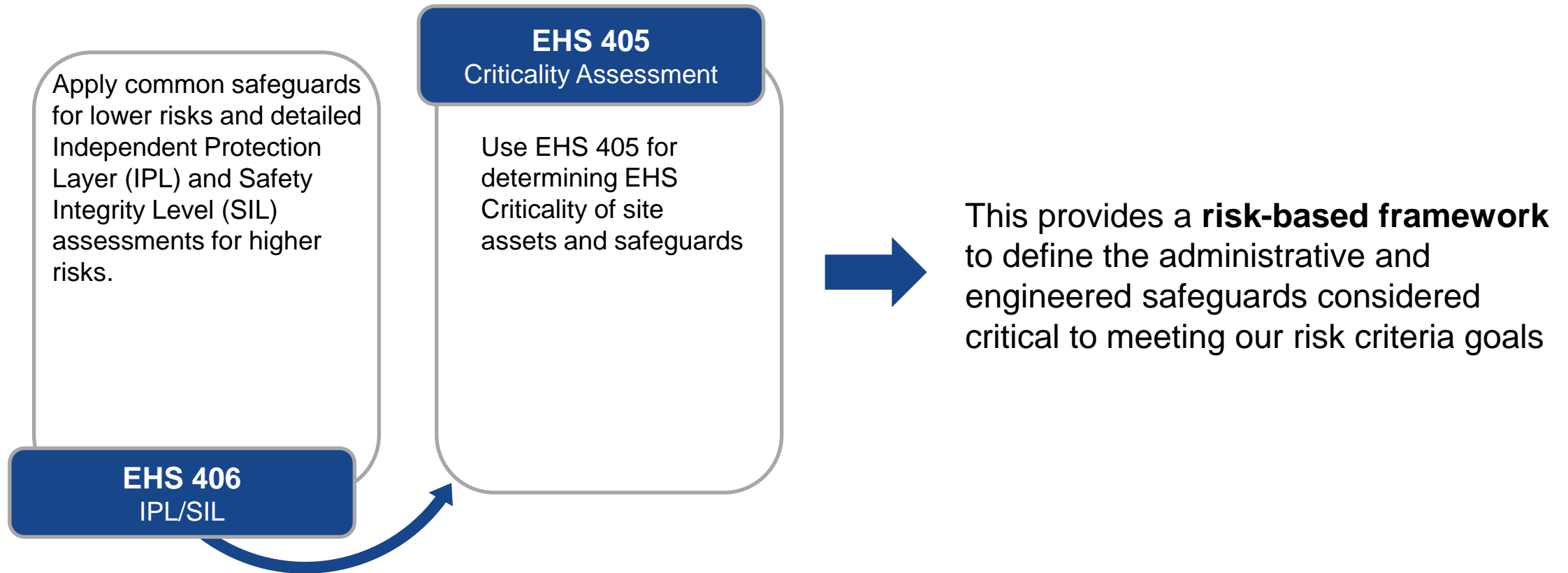
Identify Hazards



Integrated Process Safety Program



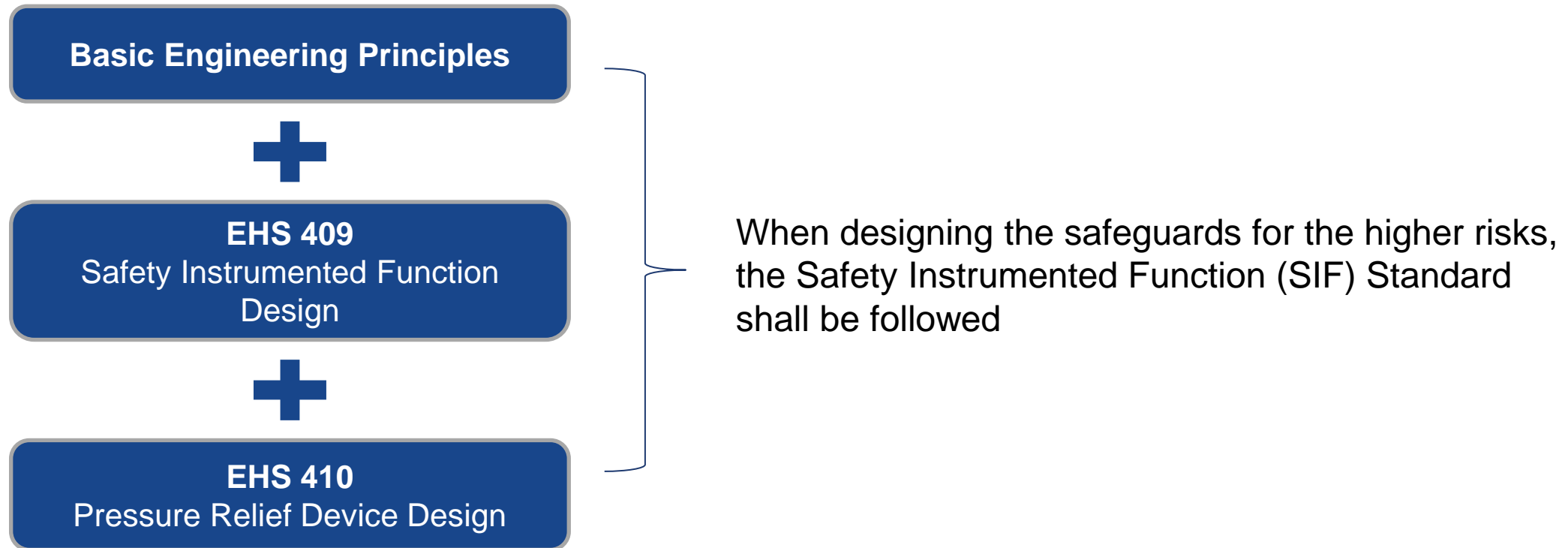
Determine Safeguards



Integrated Process Safety Program



Design Safeguards





Integrated Process Safety Program

Operate and Maintain

EHS 412
Operating Procedures (2024)

EHS 414
Alarm Management

EHS 415
Mechanical Integrity

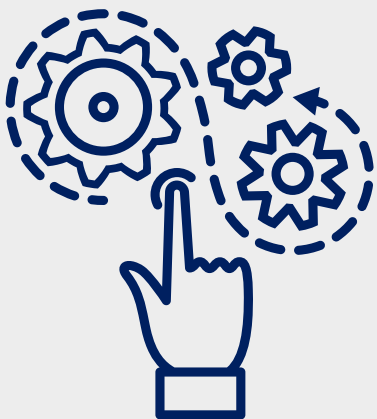
EHS 103
Management of Contractors

EHS 109
EHS Metrics

After designing the Safeguards, we have to make sure everything is being properly Operated and Maintained.

Several of our Process Safety procedures deal with Operations and Mechanical Integrity, and these are the areas that we can control.

EHS 417 Process Safety Management Applicability



Management System in place to ensure



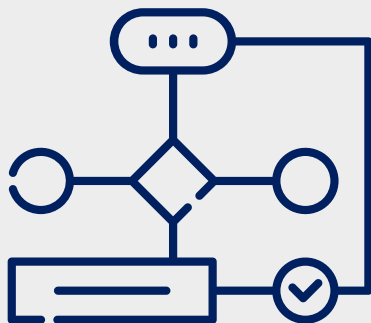
Identification of Process Hazards



Practices to Design and Maintain a Safe Site



Systems to minimize consequences of accidental releases



Establishes PSM evaluation criteria



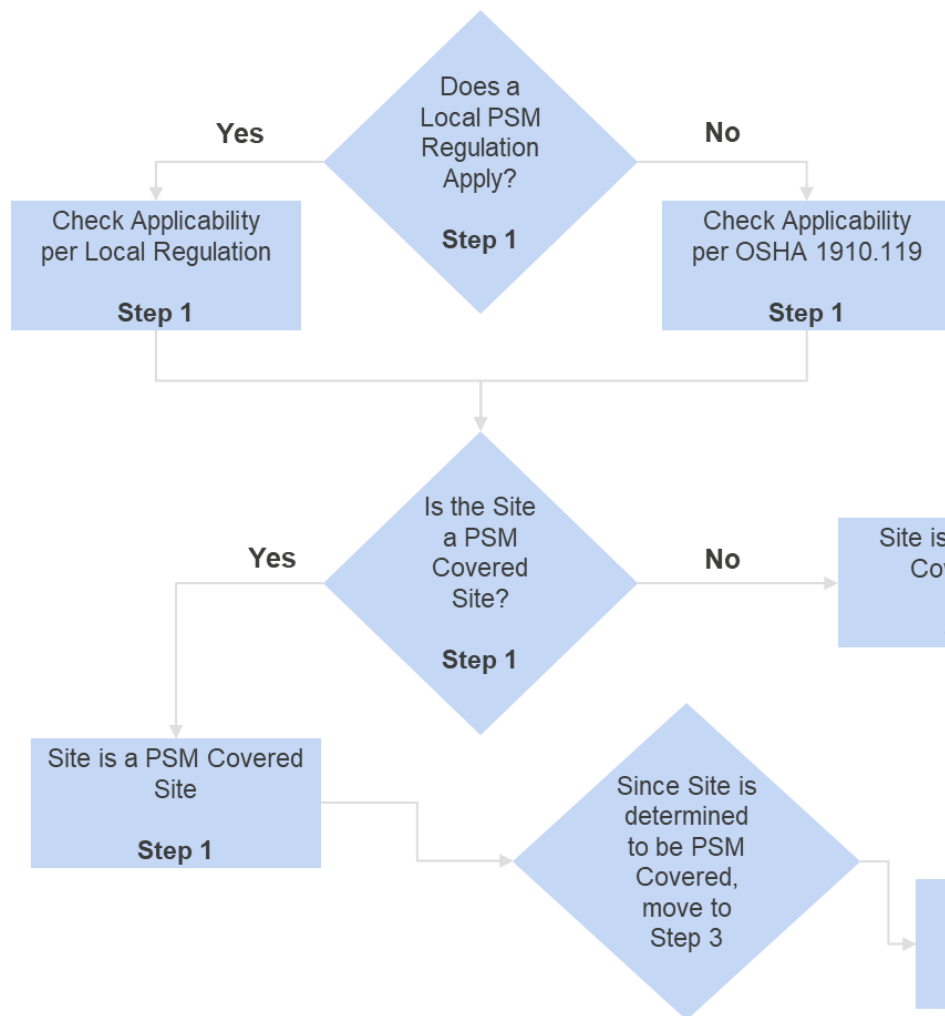
PSM Covered or Non-PSM



Potential High, Medium, or Low Process Safety Risk

EHS 417 Process Safety Management Applicability

PSM Applicability Decision Workflow



Question:

Does the site produce, process, handle or store any substances, including inert gases, which may as a result of a release potentially result in an event with Severity Category A through F due to the substance's toxicity, reactivity, flammability, volatility, corrosivity, temperature, pressure, or other process conditions?

These are Typical High Hazard Process Systems (HHPS)

- Boiler systems
- Heat Transfer Fluid systems
- Thermal Oxidizers
- Venting systems
- Reactors
- Hot polymer systems
- Extruders
- Hot pack systems
- Areas of combustible dust
- Caustic systems
- Distillation columns
- Etc.

EHS 417 Process Safety Management Applicability

STEP 1 PSM Applicability Decision Workflow

Site covered by OSHA 1910.110 PSM?

Based on inventory threshold of hazardous chemicals

Site covered by Local PSM Regulation?

Typically modelled after OSHA 1910.119

STEP 2

Does the site have High Hazard Process Operating Systems?

Boiler systems, heat transfer fluid systems, thermal oxidizers, venting systems, reactors, hot polymer systems, extruders, hot pack systems, areas of combustible dust, caustic systems, distillation columns, etc.

STEP 3

Identification as High, Medium, or Low Risk Site

Extent of Standards required to be followed

Relevant Process Safety Standards (Number, Section, Title & Requirements)

		PSM Covered or Non-PSM Covered Site?	PSM Covered	Non-PSM Covered With HHPS	Non-PSM Covered Without HHPS
		High Hazard Process System Present?	N/A	Yes	No
		IVL Site Process Safety Risk Hazard Ranking	High	Medium	Low
Relevant Process Safety Standards					
Standard Number	Leadership and Management of IVL EHS				
IVL EHS-101	EHS Roles & Responsibilities		Mandatory	Mandatory	Mandatory
IVL EHS-102	Agency Inspections and Investigations (to be issued at a future date)		Mandatory	Mandatory	Mandatory
IVL EHS-103	Selection and Management of Contractors		Mandatory	Mandatory	Mandatory
IVL EHS-104	Organizational Change Management		Mandatory	Mandatory	Mandatory
IVL EHS-105	Notification of Incidents		Mandatory	Mandatory	Mandatory
IVL EHS-106	Incident Investigation		Mandatory	Mandatory	Mandatory
IVL EHS-107	Management of Recommendations / Actions		Mandatory	Mandatory	Mandatory
IVL EHS-108	Improvement Plans (to be issued at a future date)		Mandatory	Mandatory	Mandatory
IVL EHS-109	EHS Metrics & Reporting		Mandatory	Mandatory	Mandatory
IVL EHS-110	Corporate Audit Program		Mandatory	Mandatory	Mandatory
IVL EHS-112	EHS Regulatory Compliance		Mandatory	Mandatory	Mandatory
IVL EHS-113	EHS Training & Competency (to be issued at a future date)		Mandatory	Mandatory	Mandatory
IVL EHS-114	EHS Standard Variance Request		Mandatory	Mandatory	Mandatory
IVL EHS-115	Insurance Recommendation Challenge		Mandatory	Mandatory	Mandatory
Risk and Emergency Management					
IVL EHS-203	Corporate and Business Crisis Management		Mandatory	Mandatory	Mandatory
IVL EHS-204	Management of Change (MOC)		Mandatory	Mandatory	Mandatory
IVL EHS-208	Risk Management Standard & Matrix		Mandatory	Mandatory	Mandatory
IVL EHS-210	Fire Risk Assessments (to be issued at a future date)		Mandatory	Mandatory	Mandatory
IVL EHS-211	Facility Security & Visitor Control (to be issued at a future date)		Mandatory	Mandatory	Mandatory
IVL EHS-212	Travel Health, Safety and Security (to be issued at a future date)		Mandatory	Mandatory	Mandatory
Safe Systems of Work					
IVL EHS-302	Hot Work		Mandatory	Mandatory	Mandatory

Revelant Process Safety Standards (Number, Section, Title & Requirements)

Process Safety				
IVL EHS-402	Process Safety Information	Mandatory	Mandatory	Mandatory
IVL EHS-403	Process Hazard Identification and Analysis	Mandatory	Mandatory HHPS	Recommended
IVL EHS-405	EHS Criticality Assessment	Mandatory	Mandatory HHPS	Recommended
IVL EHS-406	IPL/SIL Assessment Methodology	Mandatory	Mandatory HHPS	Recommended
IVL EHS-407	Facility Siting	Mandatory	Mandatory	Recommended
IVL EHS-408	Area Classification and Management (to be issued at a future date)	Mandatory	Mandatory	Mandatory
IVL EHS-409	Safety Instrumented Functions (Plant Trips) (to be issued at a future date)	Mandatory	Mandatory HHPS	Recommended
IVL EHS-410	Pressure Relief System Design (to be issued at a future date)	Mandatory	Mandatory	Mandatory
IVL EHS-412	Operating Procedures (to be issued at a future date)	Mandatory	Mandatory	Mandatory
IVL EHS-413	Pre-Start-Up Safety Review	Mandatory	Mandatory	Mandatory
IVL EHS-414	Alarm Management (to be issued at a future date)	Mandatory	Mandatory	Mandatory
IVL EHS-415	Mechanical Integrity (to be issued at a future date)	Mandatory	Mandatory	Mandatory
IVL EHS-417	IVL Process Safety Management Applicability	Mandatory	Mandatory	Mandatory
General Topics Covered Within the Standards				
Multiple*	Employee Participation	Mandatory	Mandatory	Mandatory
Within EHS-417	Trade Secrets	Mandatory	Mandatory	Mandatory

* Employee Participation requirements are covered in multiple IVL EHS Standards

Mandatory

Standard is required to be followed as written throughout the site

Mandatory HHPS

Standard is required to be followed as written when associated with a High Hazard Process System. It is recommended as a best practice for non-HHPS areas

Recommended

Suggested as a best practice for the site when applicable

Process Safety Information (IVL-EHS-402)

Application	Types of PSI	Documentation	Timing
<ul style="list-style-type: none">• Complete and accurate information related to process chemicals, process technology and process equipment is essential to an effective PSM program.• Safe Operation Envelope is defined by the assembly of the PSI.• PSI is integral to PHAs, Facility Siting, SIL Target Assessments, Maintenance, Training, Operating procedures, and Emergency Response.	<ul style="list-style-type: none">• Category 1: “Mandatory” for EHS Critical Equipment.• Category 2: “Mandatory” for Non-EHS Critical Equipment.• Category 3: “Valued” but not required.	<ul style="list-style-type: none">• Maintained current as controlled documents in a secure location by one or more PSI Custodians.• Maintained for the life of the asset.• Shared with and readily available to those employees who need to use it (operators, maintenance, contractors.)	<ul style="list-style-type: none">• PSI must be updated in accordance with the Management of Change procedure (IVL-EHS-204).• Gaps in Category 1 or Category 2 PSI documentation must be closed as soon as reasonably possible upon discovery.

Process Safety Information



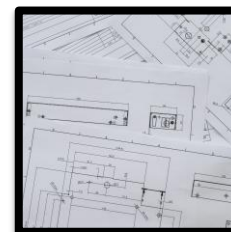
Process Chemicals

- Flammability, Toxicity, Corrosivity, Reactivity
- Intended/Unintended Chemistry - Reactivity with Materials of Construction, Other Chemicals
- Physical Properties - Flash Point, Boiling Point, Vapor Pressure, Density, etc.



Process Technology

- Block Flow Diagram
- Process Chemistry
- Maximum Intended Inventory
- Operating Conditions
- Safe Upper and Lower Limits of Process Variables



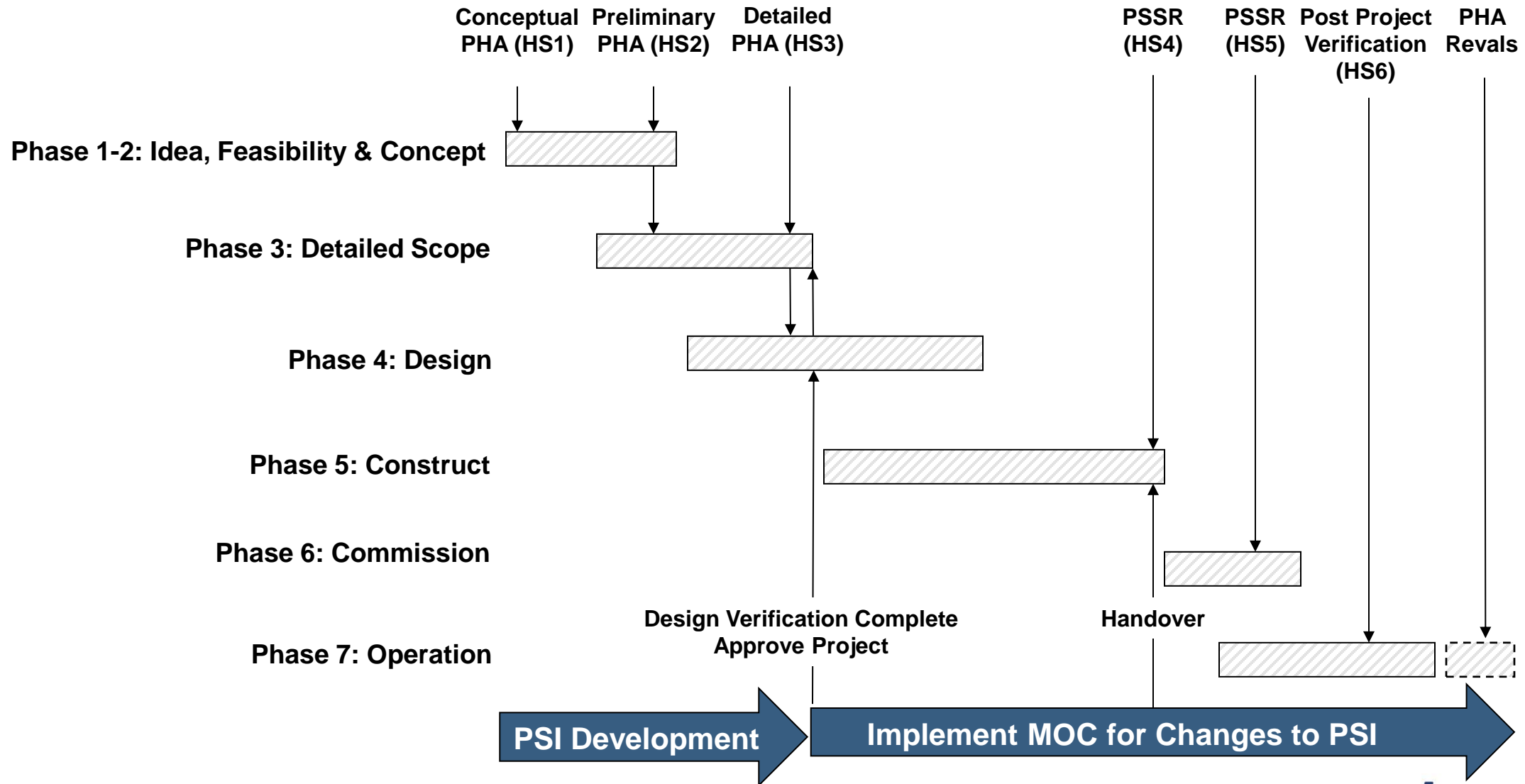
Process Equipment

- Materials of Construction
- Piping & Instrumentation Diagrams (P&IDs)
- Electrical Classification / Drawings
- Relief System Design and Basis
- Ventilation System Design
- Control Strategy
- Material and Energy Balances
- Safety Systems

Process Hazard Analysis (IVL-EHS-403)

Application	PHA Triggers	Types of PHAs (Six Step Process)	Timing
<ul style="list-style-type: none">• Defines a formal methodology for conducting PHAs• ‘How-to’ for performing approved methodologies• Defines Study Leader responsibilities• PHA Revalidation requirements	<ul style="list-style-type: none">• New designs• Newly acquired facilities• MOC Hazard Level 3 modifications• A major incident per EHS-106	<ul style="list-style-type: none">• Conceptual PHA (HS1)• Preliminary PHA (HS2)• Detailed PHA (HS3) (What-if, HAZOP, FMEA, & Procedural PHA)• PSSR Parts 1 and 2 (HS4/HS5) (EHS-413)• Post Project Verification (HS6)	<ul style="list-style-type: none">• For newly acquired facilities, HS1/HS2 in place no later than 12 months after the purchase• For existing systems, HS1 performed prior to completing a baseline or revalidation PHA• Existing PHA <u>revalidated every 5 years</u>

Risk Assessment Timing



Difference between Hazard and Risk

HAZARD

Potential
source of
harm

VS.

RISK

How likely it is that a
hazard will cause
harm

Harm is defined as the physical injury or damage to the
health of people or the environment

Hazard vs. Risk Example

Is flying in an airplane hazardous?

HAZARD

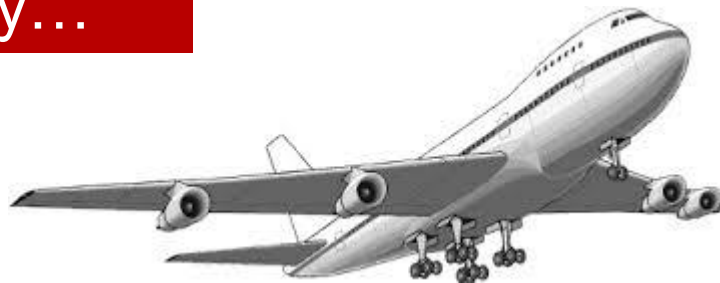
High hazard with the
potential consequence of
a crash/fire
Severity Category A
Multiple fatalities

But we still fly...

VS.

RISK

The airlines have gone to
great lengths to
implement safeguards.
The risk and frequency
are low.



IVL Risk Matrix

	Frequency Category							
	>10 ⁻⁷ to 10 ⁻⁶ /yr	>10 ⁻⁶ to 10 ⁻⁵ /yr	>10 ⁻⁵ to 10 ⁻⁴ /yr	>10 ⁻⁴ to 10 ⁻³ /yr	>10 ⁻³ to 10 ⁻² /yr	>10 ⁻² to 10 ⁻¹ /yr	>10 ⁻¹ to 1/yr	>1/yr
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
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
E	EHS-1	EHS-2	EHS-2	EHS-3	EHS-3	EHS-3	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-2	EHS-2	EHS-2	EHS-3	EHS-3
H	EHS-1	EHS-1	EHS-1	EHS-1	EHS-1	EHS-2	EHS-2	EHS-3

Goal: Move down and across the matrix by reducing risk

EHS-4 Very High Risk Range (Unacceptable Region – Immediate risk reduction required)
 EHS-3 High Risk Range (Intolerable Region – Schedule risk reductions for implementation)
 EHS-2 Medium Risk Range (Tolerable Region – Acceptable if further risk reduction is impracticable)
 EHS-1 Low Risk Range (Broadly Acceptable Region – No further risk reduction necessary)

IVL Risk Matrix for Process Safety Activities

Severity Category	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	
	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-3	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-2	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	

Mechanical Integrity (IVL EHS-415)

Application

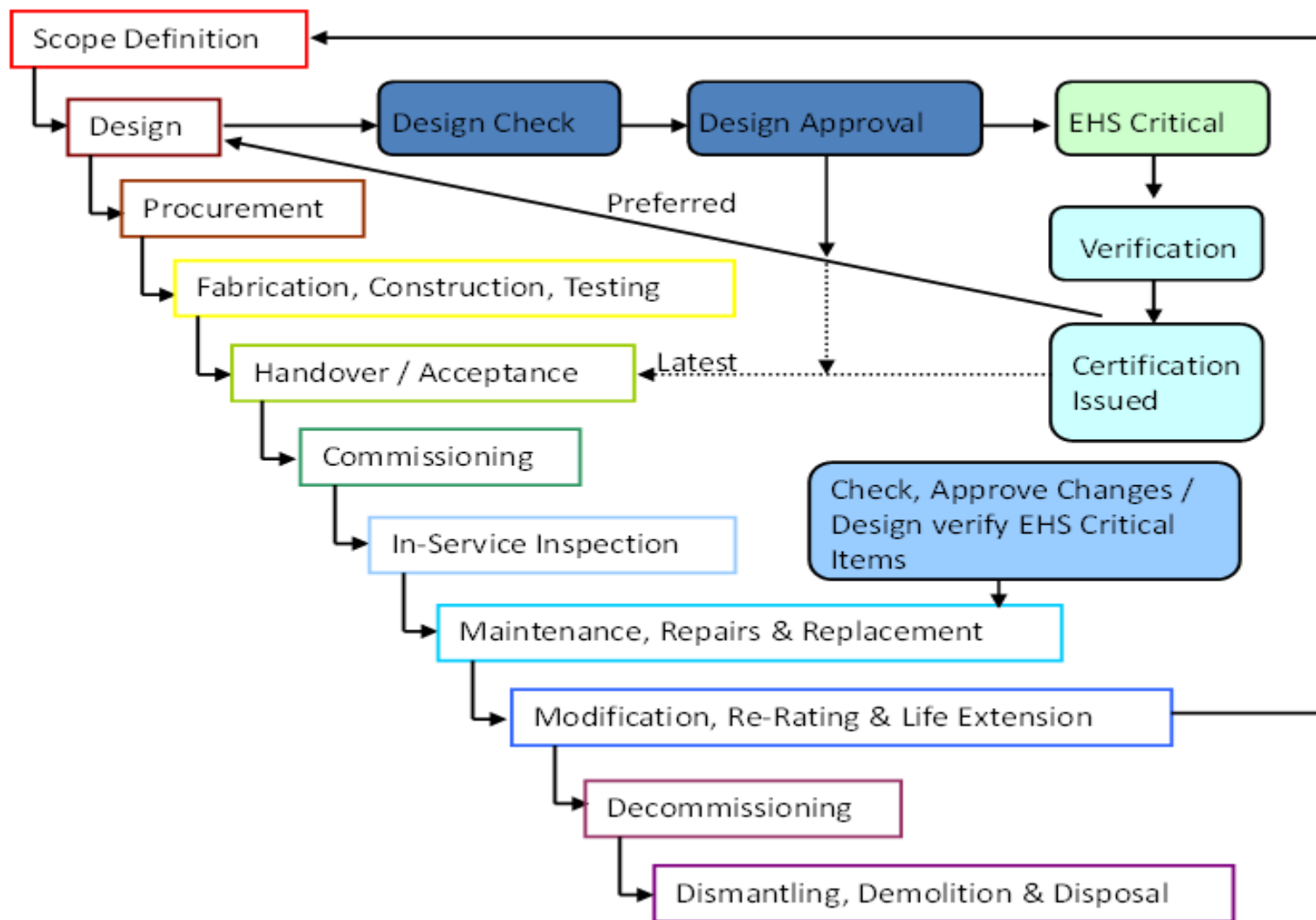
- Minimum requirements for design, selection, manufacture, installation, operation, inspection and maintenance of process equipment
- Develop a written maintenance strategy, including an Inspection Schedule and approach for the covered equipment
- Develop detailed maintenance procedures for all assets, including spares
- Only properly skilled personnel are allowed to install, repair and test MI covered equipment

Equipment Types

- Includes both EHS Critical and Non-EHS Critical equipment, systems and structure whose failure could lead to a release of harmful quantities of hazardous materials, including:
 - Pressure vessels
 - Storage tanks
 - Rotating equipment
 - Piping systems
 - Relief and vent systems and devices
 - Emergency shutdown
 - Fire protection
 - Controls
 - Hazard mitigation devices and systems
 - Structures, civil structures

Documentation

- Obtain appropriate design, test and certification documentation from equipment fabricators/vendors to demonstrate compliance with design specifications
- Document, record and maintain equipment history, including all inspection, test and maintenance records, for the life of the asset
- Document operability assessments for equipment found to be deficient



Management of Change (IVL EHS-204)

Application

- Ensure all changes to a process are properly reviewed
- Hazards introduced by the change are identified, analyzed, and controlled prior to starting or resuming a process

Types of MOCs

- Standard
- Replacement-in-Kind (RIK)
- PSI Change
- Procedure Change
- Organizational Change Management (OCM)(IVL-EHS-104)
- Inspection Deferral
- Leak Repair
- Permanent
- Temporary
- Emergency

Timing

- Temporary Changes:
 - Initial period cannot exceed 180 days
 - Can be extended once for 180 days; but not to exceed one full year in total duration
- Emergency Changes require a documented MOC within 72 hours of approval

IVL EHS Process Safety Standards Recap

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Module 1: Knowledge Check



Questions / Comments

