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# CPSS\_Improvement of IPL in Unloading Operations of Haz. Mat

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# Agenda

- **Introduction ~ 10 mins**
  - Independent Protection Layer (IPL), Requirements & Pitfalls
  - Selection of IPLs & Decision basis in Risk Analysis
- **Unloading Operation of Hazardous Materials**
  - IPL in Liquid Overfill of Storage Tank ~ 10 mins
  - IPL in ISO Tanker collapse ~ 10 mins
- **IPL Operability Audit Requirements ~ 10 mins**
  - Control System Interlocks / Safety Instrument Functions
  - Pressure Relief devices
  - Passive Safeguards
  - Safeguard Management

# Independent Protection Layer, Requirements & Pitfalls

- **Independent Protection Layers (IPLs)** are control measures that can prevent the initiating event from propagating to a Unwanted event that is independent from the causes of the scenario and from other safeguards
  - IPLs must be 'effective' which includes their response time, which must be compatible with the speed of development of the scenario
  - IPLs should be 'reliable' that is measured by its Probability of Failure in demand and its reliability depends on components, design, installation, use, maintenance, periodical check
  - IPLs are 'auditable' in terms of proof test procedure, initial verification of conformity, proof test intervals, record of each proof test performed, results obtained and its corrective actions taken
- **Pitfalls - Demand Mode**
  - Low demand Mode – If the demand is less than once/year
  - High demand/Continuous Mode – If the demand is more than once/year

note : Incorrect application of 'demand modes' may result in underestimate/overestimate risk

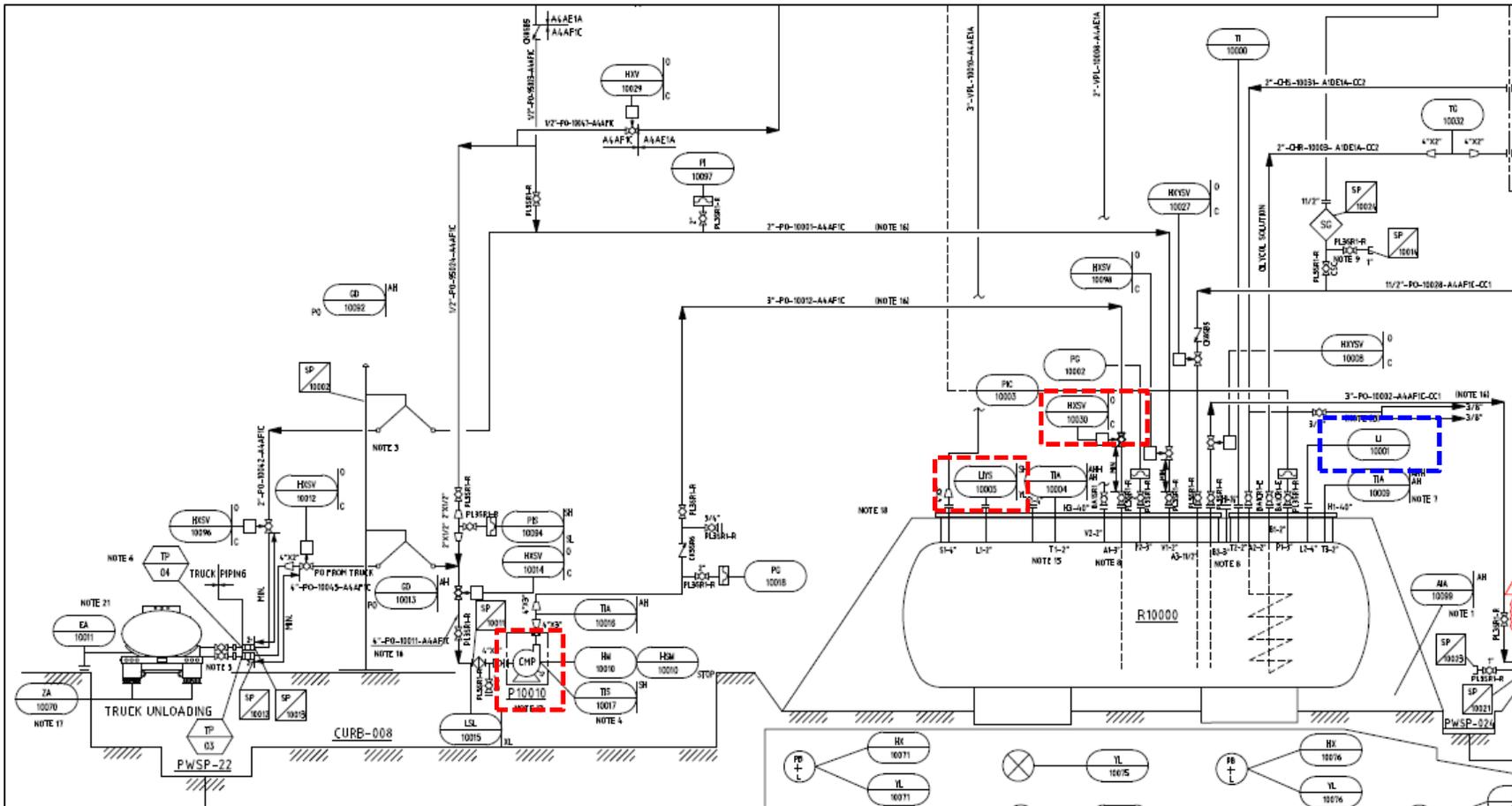
# Selection of IPLs & Decision Basis in Risk Analysis

- **Layers of Protection** --- Active, Passive, human, material, preventive or protective
  - Criteria : Independence, Reliability & Effectiveness (response time)
- **Safeguards that are considered IPLs in Layers of Protection**
  - Human Safeguard (w/out Instrumented Function)
  - Human Safeguard (with Instrumented Alarm & Action, HIF)
  - Control System Interlocks (BPCSIF)
  - Safety Instrumented Functions (SIF)
  - Pressure Relief Devices (PSVs, rupture discs)
  - Protective Devices (Gas Detectors, Deluge Systems)
- **Safeguards that are not considered IPLs In Layers of Protection**
  - Training & Certification
  - Standard/Safe Operating Procedures
  - Maintenance, Normal Testing & Inspection
  - Communication & Safety Signs
  - Fire Protection (**note** : its availability & effectiveness may be affected by fire/explosion)
- **Taking into account active IPLs**
  - Existing Installations (Identify & rate the active safeguards)
  - Projects (Identify the required RRCs of the safeguard to reduce risk to acceptable level)
    - Preventive IPLs (reduces probability,  $rP = pP + \frac{1}{2} \sum RRCs$ , reliability based on PFD)
    - Protective IPLs (reduces severity of event, reliability based on PFD, RRC-2 max)

# IPL-1\_ISO Tanker Unloading to Storage Tank

- **Operation** : Unloading of hazardous material from ISO Tanker to Storage Tank
- **Basic Process Control** :
  - Operator would assess for enough space inside the storage tank through LI-10001 & decides to unload ISO Tanker
- **Initiating Event/s or Causes of Error** :
  - Human Error : Operator error of wrongly noticing/reading the level transmitted in LI-10001  
(Or)
  - Instrument error : LI-10001 fails low (actual high)
- **Sequence of Events, Effects & Consequences** :
  - Overfill the Storage tank, overflow to scrubber or from top of tank to secondary containment
    - If material flammable + presence of ignition source, Fire & Explosion (Physical Hazards)
    - If material not flammable + presence of operator, corrosive or toxic effects (Health Hazards)
- **Independent Protection Layer/s:**
  - LIS-10005 SH : 90% installed in storage tank to stop Unloading Pump, close HXV (SIF, SIL-2)

# IPL-1\_ISO Tanker Unloading to Storage Tank



# Risk Reduction Measures\_IPL-1

PROBABILITY <input type="checkbox"/> for a one-year observation period			RISK LEVEL				
Qualitative	Value <sup>(1)</sup>	Level					
Highly probable (≈ Once a year)	1	1	3	2	1	1	1
≈ Once every 10 years	10 <sup>-1</sup>	1 – 2	3	2	1	1	1
Probable (≈ Once every 100 years)	10 <sup>-2</sup>	2	3	3	2	1	1
≈ Once every 1,000 years	10 <sup>-3</sup>	2 – 3	3	3	2	1	1
Improbable (≈ Once every 10,000 years)	10 <sup>-4</sup>	3	3	3	3	2	1
≈ Once every 100,000 years	10 <sup>-5</sup>	3 – 4	3	3	3	2	1
Extremely improbable (≈ Once every million years)	10 <sup>-6</sup>	4	3	3	3	3	3

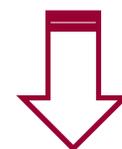
  

SEVERITY <input type="checkbox"/>		L Low	M Medium	H High	C Catastrophic	D Disastrous
Human consequences		Minor injury, first aid	Serious reversible injury	Serious irreversible injury, including one or more potential fatalities	From ≈ 10 people exposed to lethal effects <sup>(2)</sup> or from ≈ 100 people exposed to irreversible effects	From ≈ 100 people exposed to lethal effects <sup>(2)</sup> or from ≈ 1000 people exposed to irreversible effects
Environmental consequences		Minor reversible damage within the site	Minor reversible damage within or outside the site	Serious reversible damage within or outside the site	Serious medium lasting (less than 10 years) damage within or outside the site	Serious long lasting (more than 10 years) damage within or outside the site

(1) The indicated value corresponds to the center of the probability range (except for 1). The limit value between two levels of probability is  $3.16 \times 10^{-n}$ .

(2) Threshold values for lethal effects are the lower values between local regulatory values and thresholds associated to 1% of mortality.

Risk level 1 = Unacceptable  
Risk level 2 = Intermediate  
Risk level 3 = Acceptable



RRC-2 (SIL-2)



Identify another IPL or increase to SIL-3?

 Unacceptable Risk

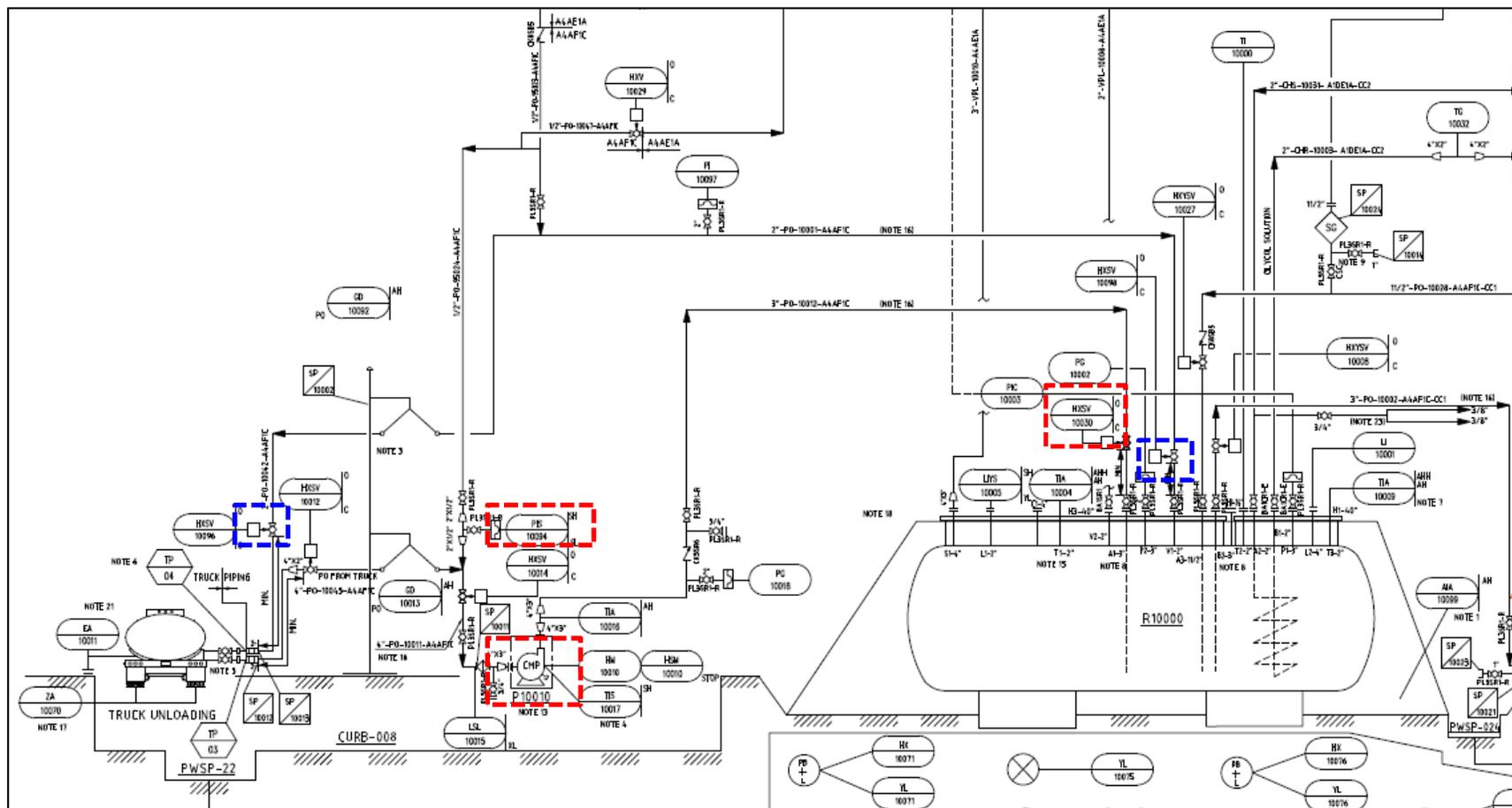
 Intermediate Risk

 Acceptable Risk

# IPL-2\_ISO Tanker Unloading to Storage Tank

- **Operation** : Unloading of hazardous material from ISO Tanker to Storage Tank
- **Basic Process Control** :
  - Operator to connect Vapor return line from Storage Tank to ISO Tanker connected and Open manual & on/off valves
- **Initiating Event/s or Causes of Error** :
  - Human Error : Operator error forgets to connect vapor return line or open valves  
(Or)
  - Instrument error : HXVs fails close (feedback error in DCS, Unloading continuous)
- **Sequence of Events, Effects & Consequences** :
  - ISO Tanker would reach very low pressure upon continuous unloading/sucking by pump, considering ISO tanker is not rated for vacuum, may lead to collapse of ISO Tanker and loss/release of hazardous material to containment
    - If material flammable + presence of ignition source, Fire & Explosion (Physical Hazards)
    - If material not flammable + presence of operator, corrosive or toxic effects (Health Hazards)
- **Independent Protection Layer/s:**
  - PIS10094 SL : 0.4 barg installed in Liquid line to stop Unloading Pump, close HXV (SIF, SIL-2)

# IPL-2\_ISO Tanker Unloading to Storage Tank



# Risk Reduction Measures\_IPL-2

PROBABILITY <input type="checkbox"/> for a one-year observation period			RISK LEVEL				
Qualitative	Value <sup>(1)</sup>	Level					
Highly probable (≈ Once a year)	1	1	3	2	1	1	1
≈ Once every 10 years	10 <sup>-1</sup>	1 – 2	3	2	1	1	1
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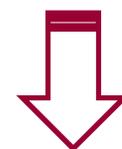
  

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RRC-2 (SIL-2)



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 Unacceptable Risk

 Intermediate Risk

 Acceptable Risk

# IPL Operability Audit Requirements

- **Control System Interlocks / Safety Instrument Functions**
  - Physically Exist
  - Sensors and actuators used 'proven in use'
  - Threshold value set same as in risk analysis report
  - Access to the threshold is protected
  - Periodically tested & Test frequency complies with functional specification requirement
- **Pressure Relief Devices**
  - Physically Exist
  - Installed w/out any shut-off valve (in case of valve, complies with good practice)
  - Inspected at regular intervals
  - Opening pressure same as in risk analysis report
  - Sized for the scenario
- **Passive Safeguards**
  - Physically Exist
  - Inspected regularly & Inspection frequency complies with plant inspection plan
  - Sized for scenario
- **Safeguard (IPL) Management**
  - Cause & Effect matrix is up-to-date
  - Categorized as 'Safety Critical' for purchasing & service provider
  - By-passing of Safeguard is recorded

# Questions & Answers...

