1st Chemical Process Safety Sharing (CPSS)

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Misunderstanding of Overpressure Scenarios Protection by Relief Valves

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Queries of Overpressure Scenarios

- ***W***hat is a relation between Layer of Protection Analysis (LOPA) and Relief Load Scenarios Consideration?
- ***H***ow to identify whether the relief load scenarios is applicable or not?
- ***W***hat is a difference between control valve failure and instrument air failure?
- ***I***s a relief valve required for every pressure vessel?
- ***S***hould a liquid overfilling scenario be considered for vessel or column?

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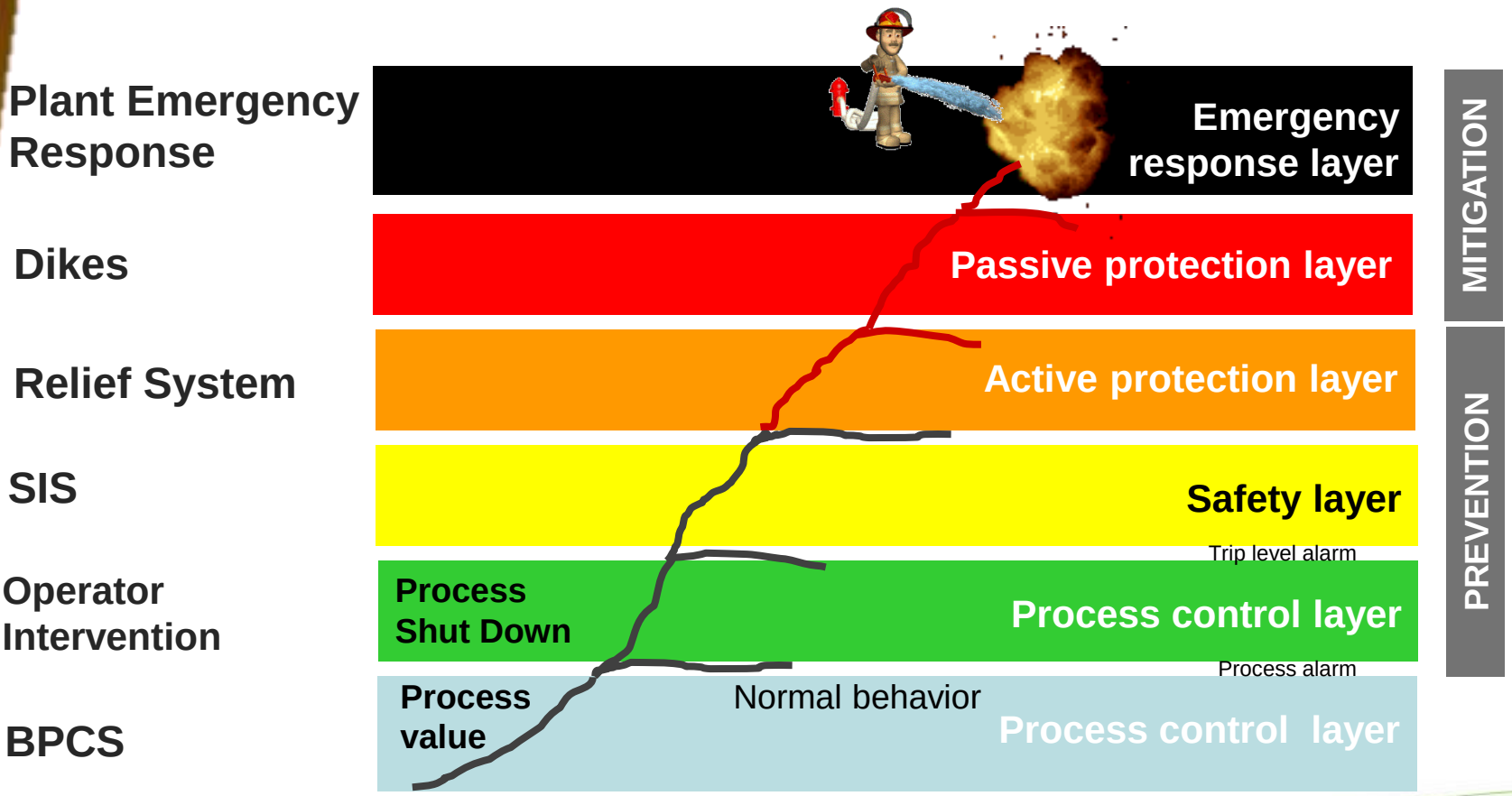
What is a relation between Layer of Protection Analysis (LOPA) and Relief Load Scenarios Consideration?

Layer of Protection Analysis (LOPA)

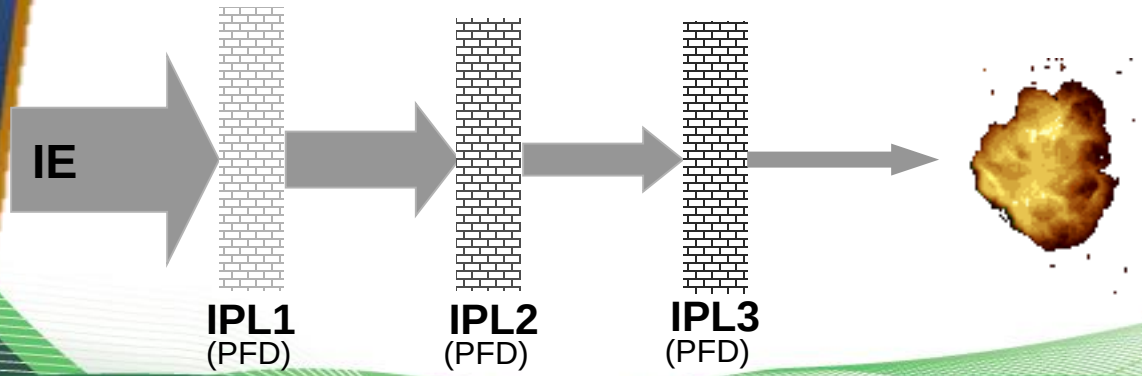


SIS maintains process variable within prescribed limited

BPCS maintains process variable and initiates actions when required

What is Layer of Protection Analysis?

- Semi-quantitative for analysing hazard and risk that is following a qualitative risk tool such as HAZOP
- The initiating event (IE) starts the chain of events that leads to the unwanted event or impact
- It can be prevented by or more protection layers known as Independent Protection Layers (IPL's) in reducing the likelihood or severity of an undesirable event
- And end up with comparing the resulting frequency to As Low As Tolerable Risk Frequency (ALARF)



PFD = Probability Failure on Demand
IPL= Independent Protection Layer

Relief Load Scenarios

- Relied load scenarios shall be considered without credit of BPC response.
- High-integrity protection system (HIPS) is able to eliminate *a particular overpressure scenario.*
- *To provide system overpressure protection where a relief device is ineffective.*

Example of LOPA

1) Initial Event (IE) : BCP Failure ➔ Frequency = 10^{-1}

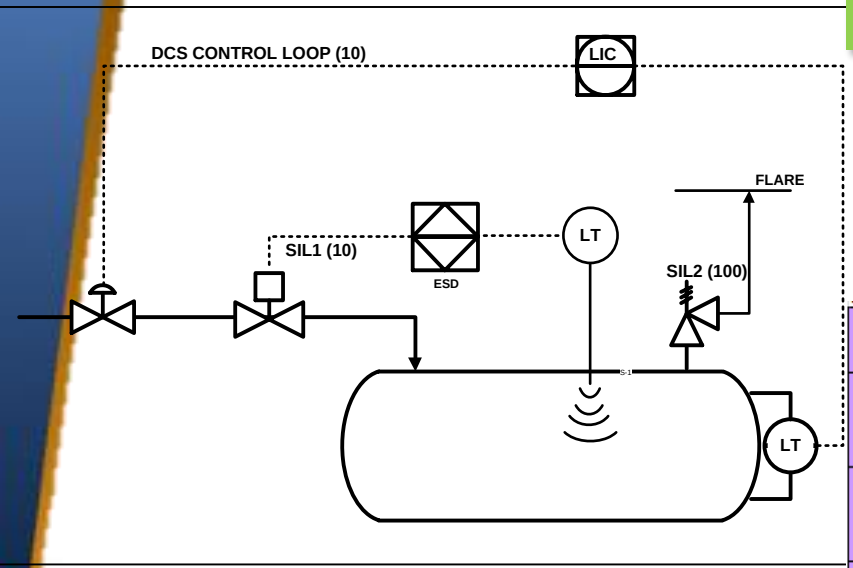
2) Evaluate Consequence ➔ High Effect = C4

3) Frequency VS Consequence ➔ Risk I

4) Target ALARF : Risk Must Be III

5) IPL1 : SIF *(PFD = 10^{-1})*

6) IPL2 : PSV *(PFD = 10^{-2})*



DESCRIPTION	Frequency (events per year	Frequency Category					
Very Likely to Occur	> 1 to 10^{-1}	F-1	IV	II	II	I	I
Likely to occur at least once in the lifetime of the process	10^{-1} to 10^{-2}	F-2	IV	III	II	II	I
Unlikely to occur in the lifetime of the process, but possible	10^{-2} to 10^{-3}	F-3	IV	IV	III	II	I
Very unlikely - not expected	10^{-3} to 10^{-4}	F-4	IV	IV	IV	III	II
Extremely unlikely - not realistacally expected to occur	10^{-4} to 10^{-5}	F-5	IV	IV	IV	IV	III
	CONSEQUENCE CATEGORY		C-1	C-2	C-3	C-4	C-5

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How to identify whether the relief load scenarios is applicable or not?

Relief Load Scenarios Consideration

Prior to determine relief load scenarios, the following

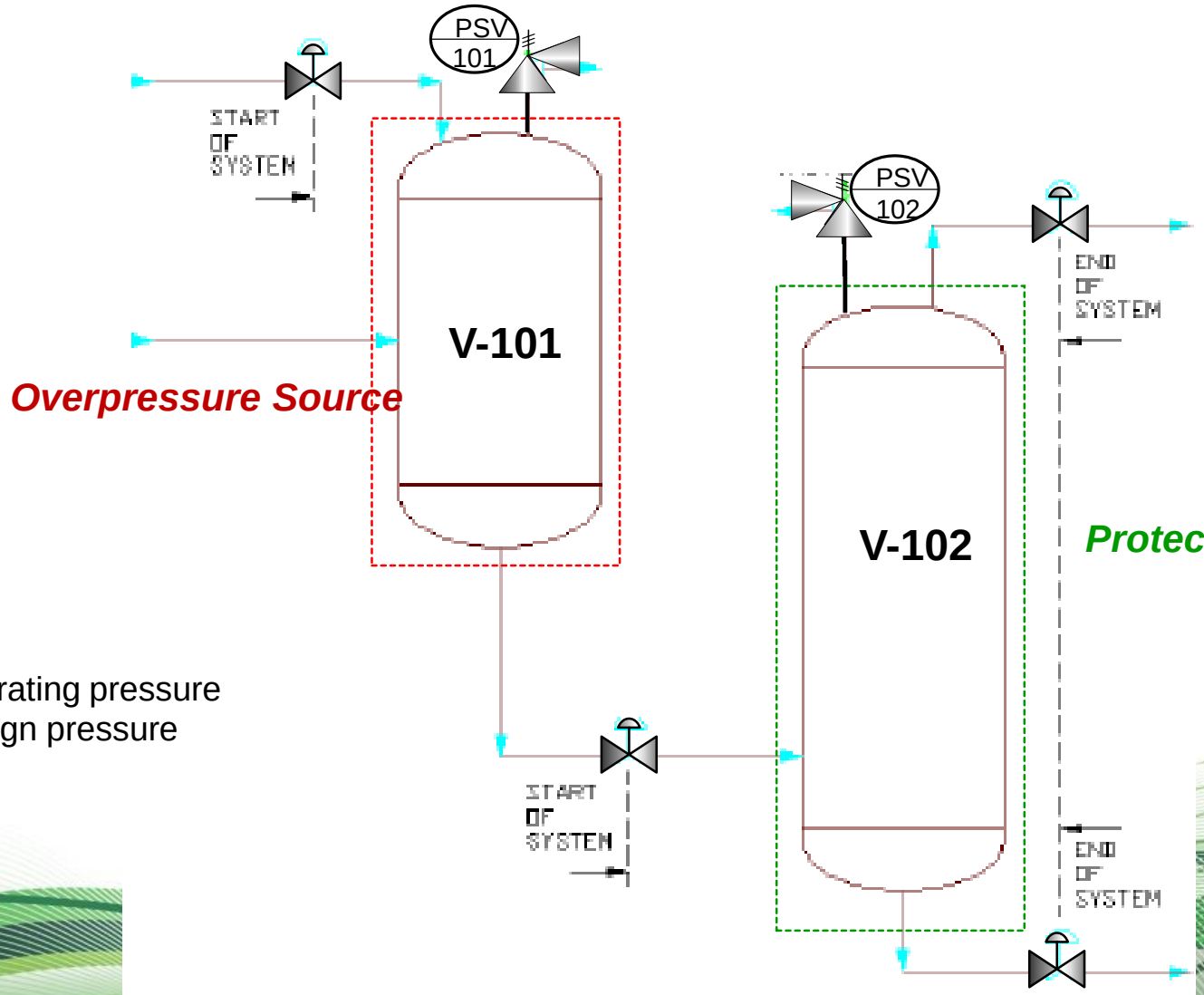
- What is the protected equipment?
- What is the overpressure source?

Identify the protect equipment and overpressure source by establishing the system boundary with system sketch.

Overpressure Sources

- ***Direct*** higher pressure sources than the design pressure of the protected equipment.
- ***Inadvertent*** heat input such as heat exchanger.
- ***External*** fire or thermal radiation.

Relief Load Scenarios Consideration

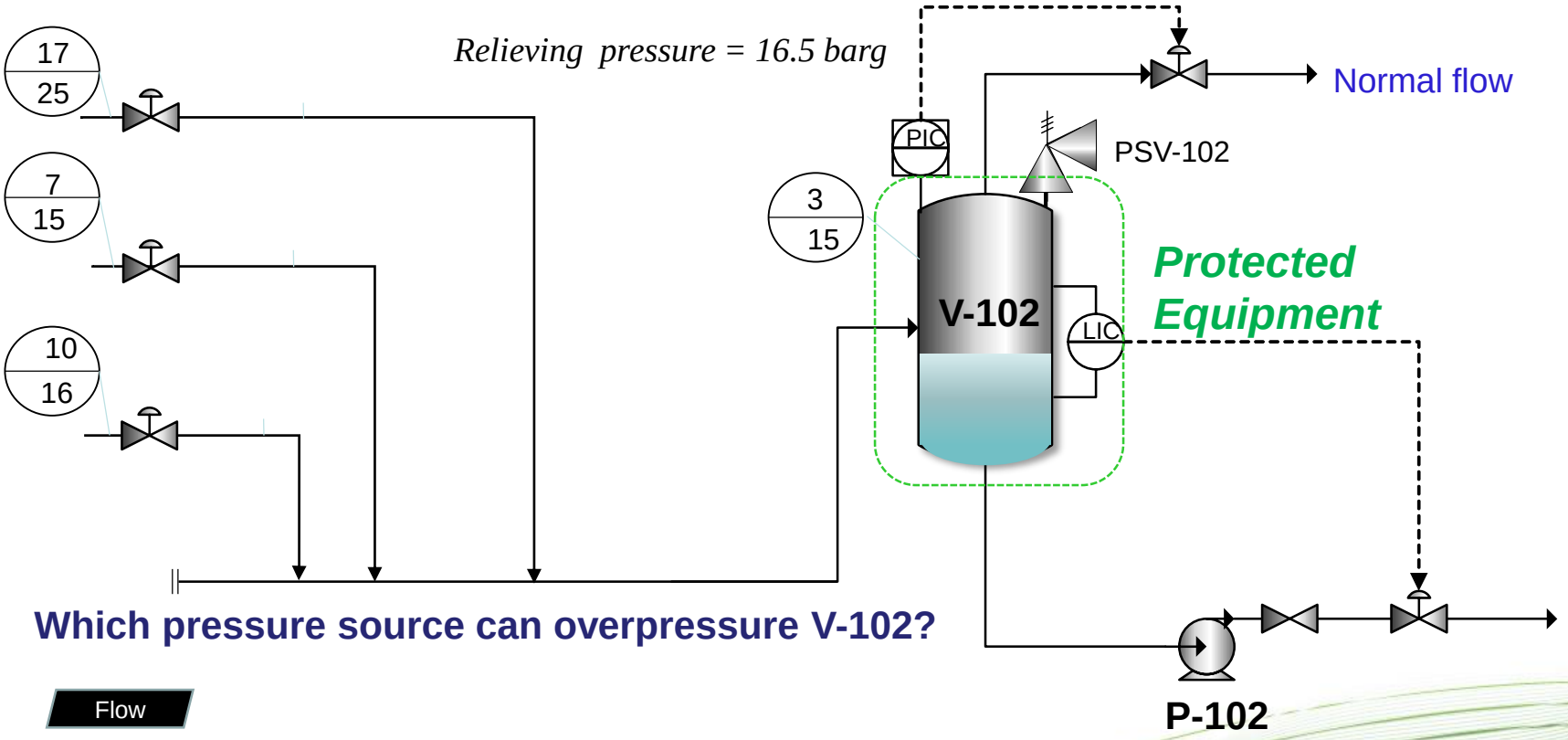


= Operating pressure
= Design pressure

Relief Load Scenarios Consideration

Example

Multiple sources of overpressure from inlets



Which pressure source can overpressure V-102?

Flow

Max operating pressure barg

Design pressure barg

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What is a difference between control valve failure and instrument air failure?

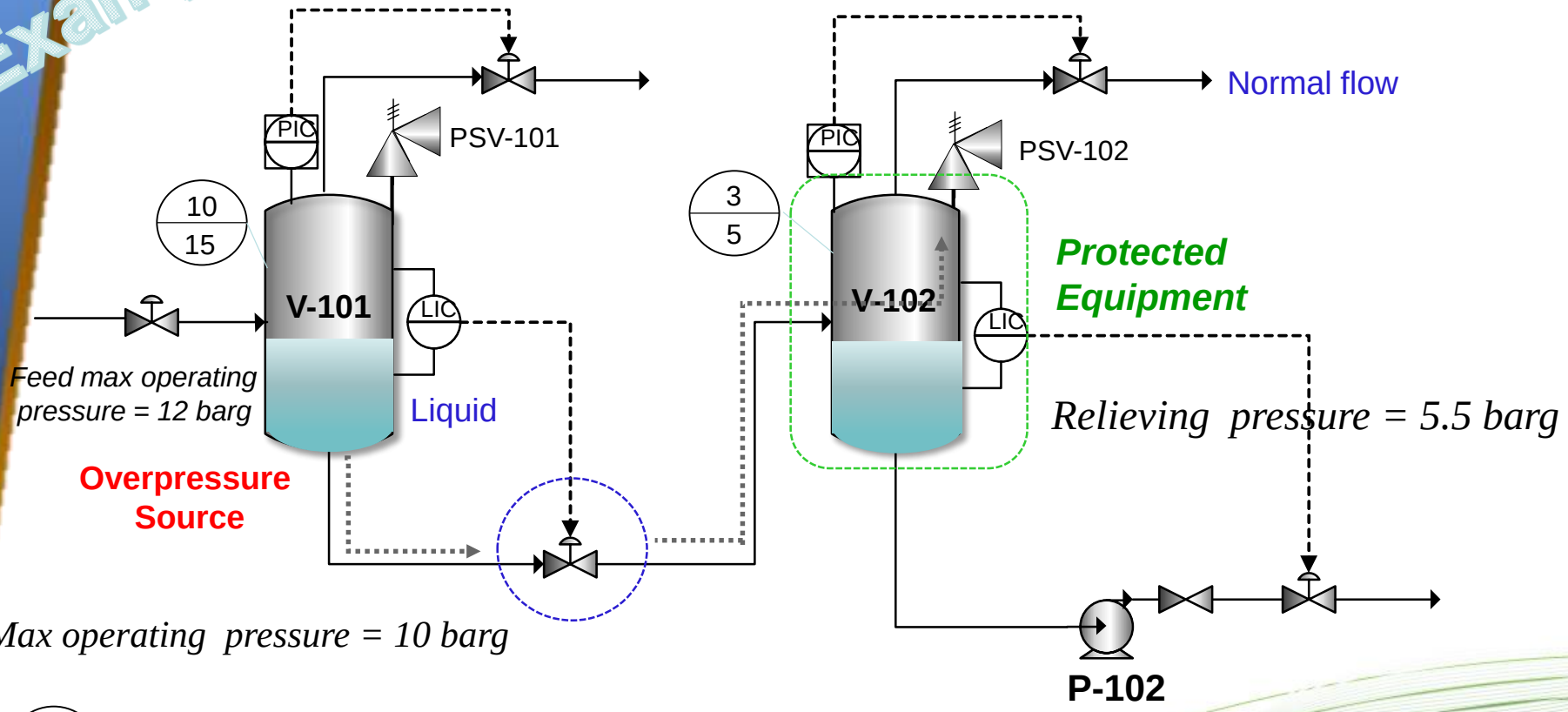
Control Valve Failure

- *"When the transmission signal or operating medium to a final element fails, the control valve devices should be assume either a fully open or fully close position."*

- *Credit of BPC to decrease relief load shall not be considered. Other BPCs shall be considered as normal operation.*

Control Valve Failure

Example



Max operating pressure barg

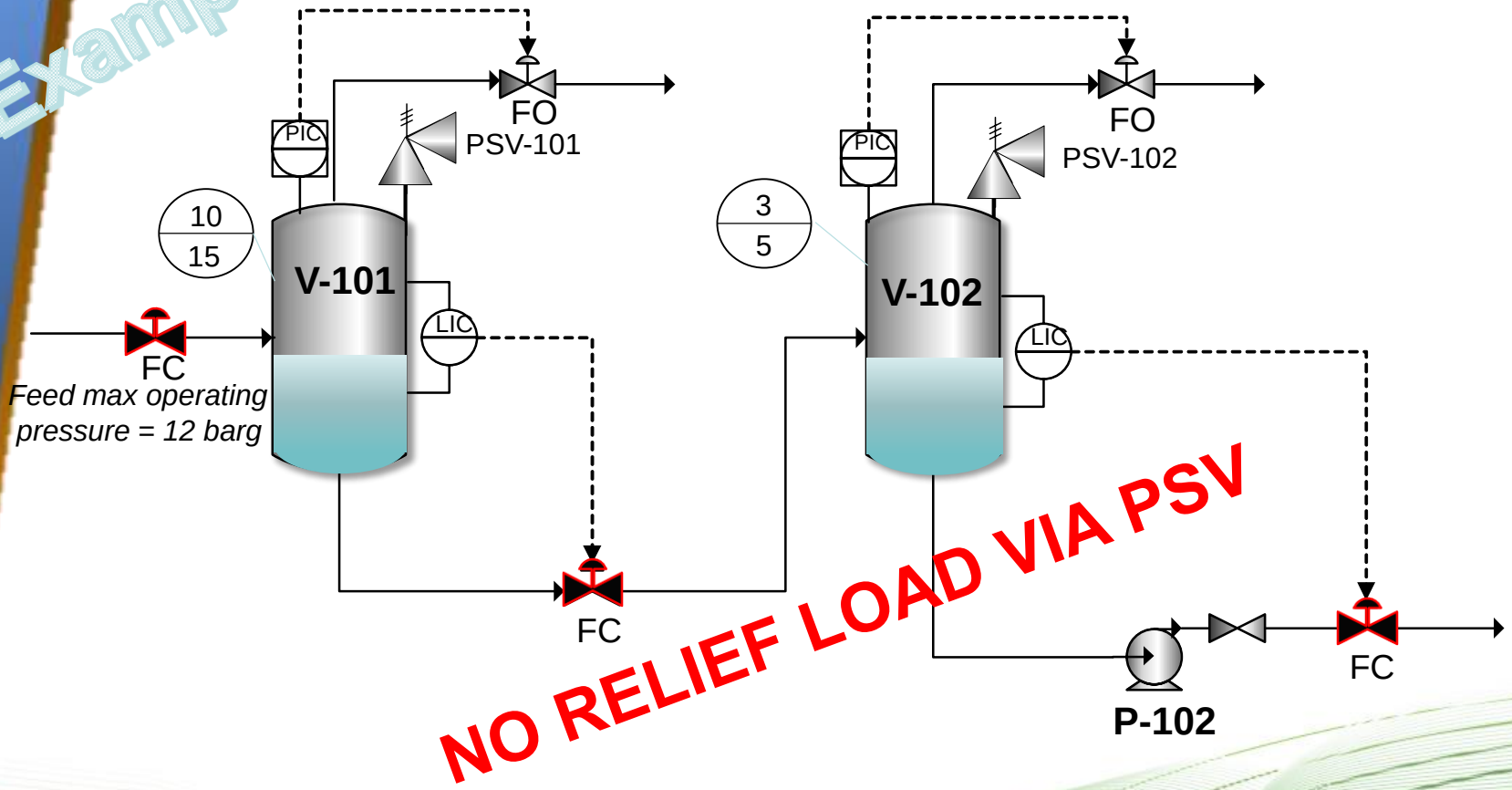
Design pressure barg

Instrument air failure

- Relief load results from simultaneous loss of instrument power to all instruments.
- This means loss of instrument power + failure of any UPS supply.
- All the control valves would then do to their IA failure position (FO or FC).

Instrument air failure

Example



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Is a relief valve required for every pressure vessel?

Location of Reliefs

- **All vessels** need reliefs, including reactors, storage tanks, towers, and drums.
- **Any break class** of pressure rating due to reduction of pressure.
- **Blocked-in sections of cool liquid-filled** lines that are exposed to heat (such as the sun) or hot fluid in a heat exchanger need reliefs
- **Positive displacement pumps, compressors, and turbines** need reliefs on the discharge side
- **Storage vessels need pressure and vacuum reliefs** to protect against pumping-in or out of a blocked-in vessel or against a vacuum by condensation

Fire Case

"Pressure vessel which is equipped with U-stamp shall be protected by PSV with at least fire case".

Figure by www.steelalloy.com

ASME Section VIII U-1 (h), U-1(j)

The following criteria will exclude a vessel as being considered an ASME Section VIII

- Vessel rated for less than 15 psig
- Vessel diameter < 6" (152mm).

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***S*hould a liquid overfilling scenario be considered for vessel or column?**

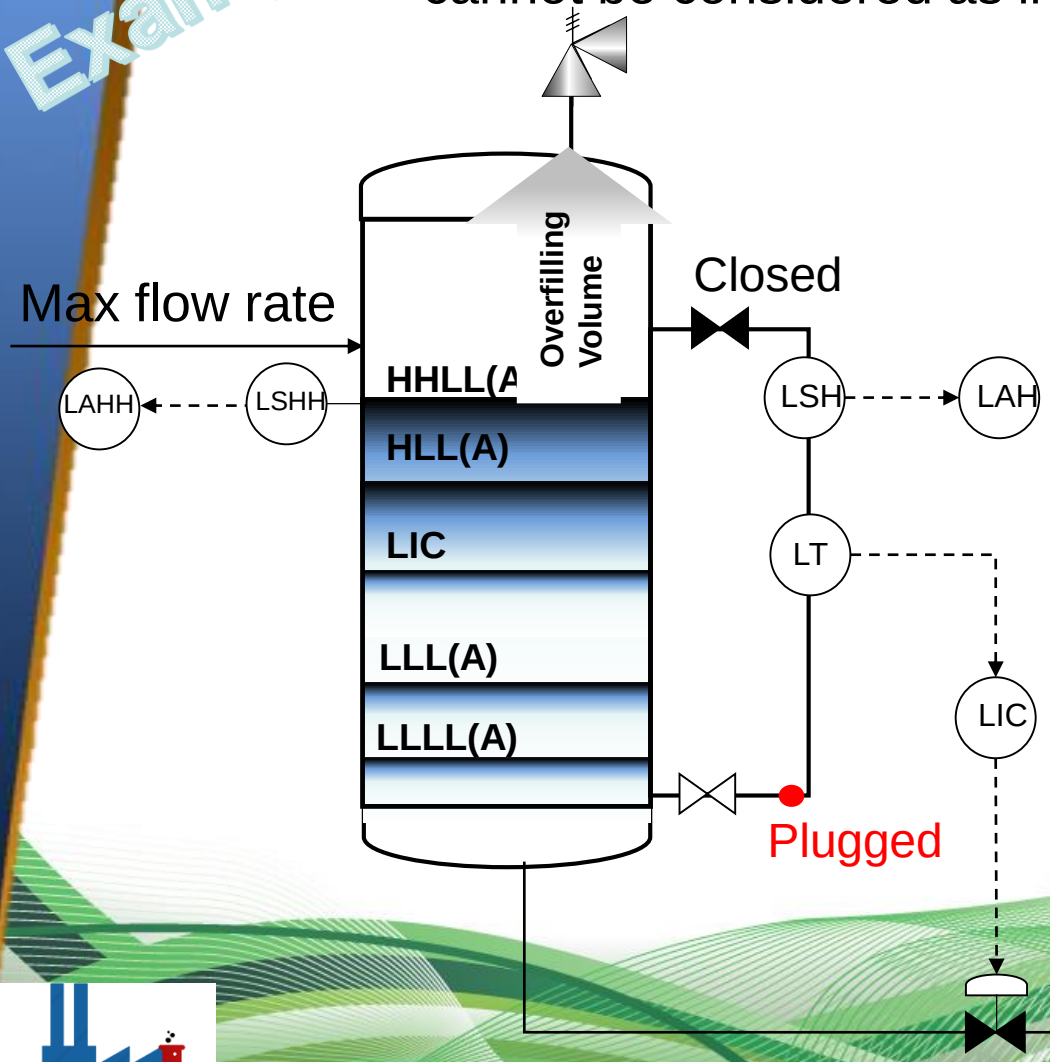
Overfilling

- Overfilling case is a consequence of block outlet case at liquid side.
- Consider a maximum possible flow rate to the vessel.
- Check overfilling time in the vessel against an operator intervention (10-30 mins depending on complexity).
- An alarm must be independent of the possible cause of failure.

Overfilling

Example

An alarm (LAH) using the same level bridle or transmitter cannot be considered as independent notification of the rising level.



Alarm NOT Independent

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