Results from the EPSC work group “HAZOP efficiency”

OR

The search in for the lost time and money

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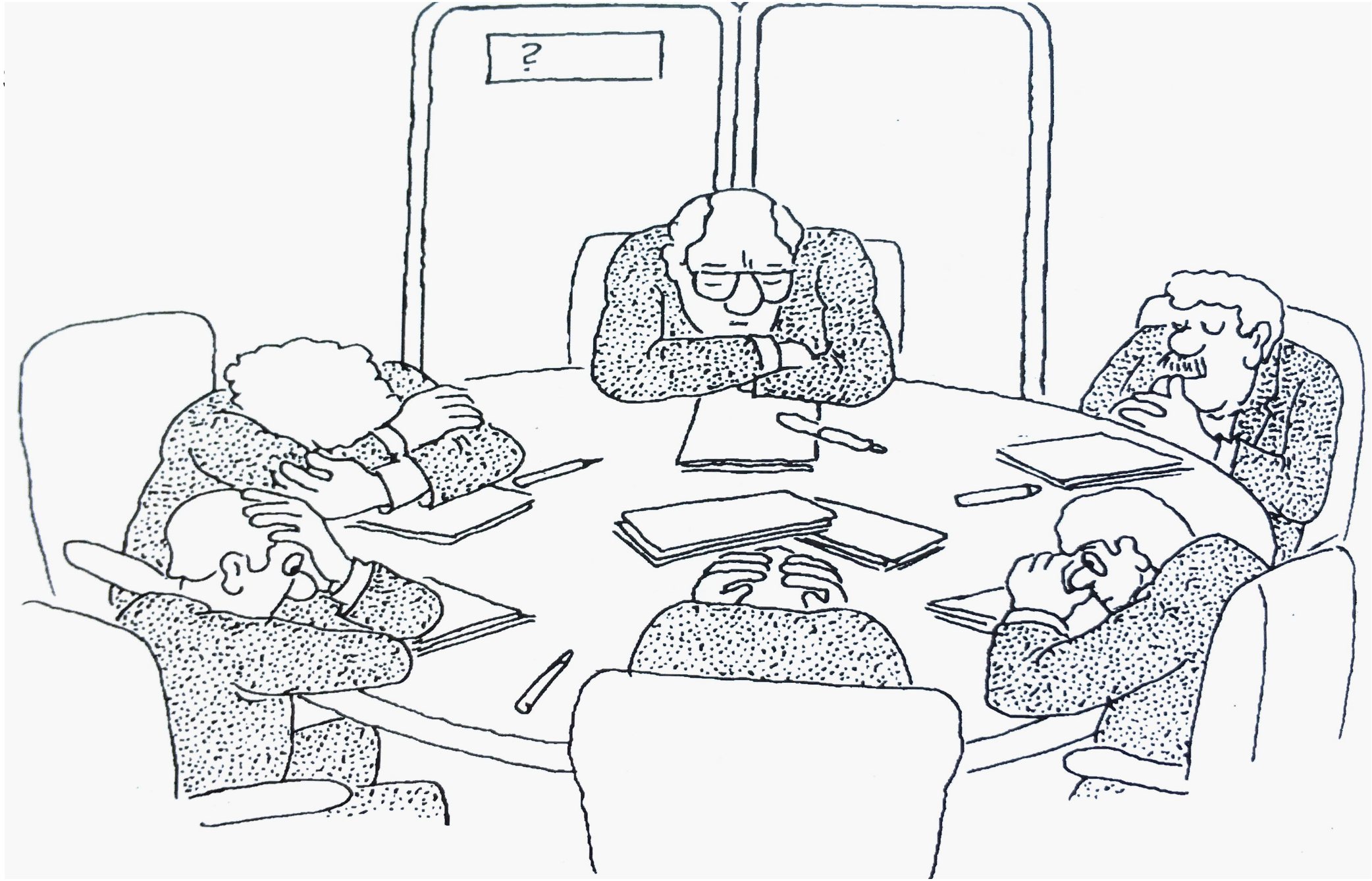

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Comm
Zero

Preparing and execution of a HAZOP

MEANS,

WE NEED TO DEAL WITH CONFLICTS!

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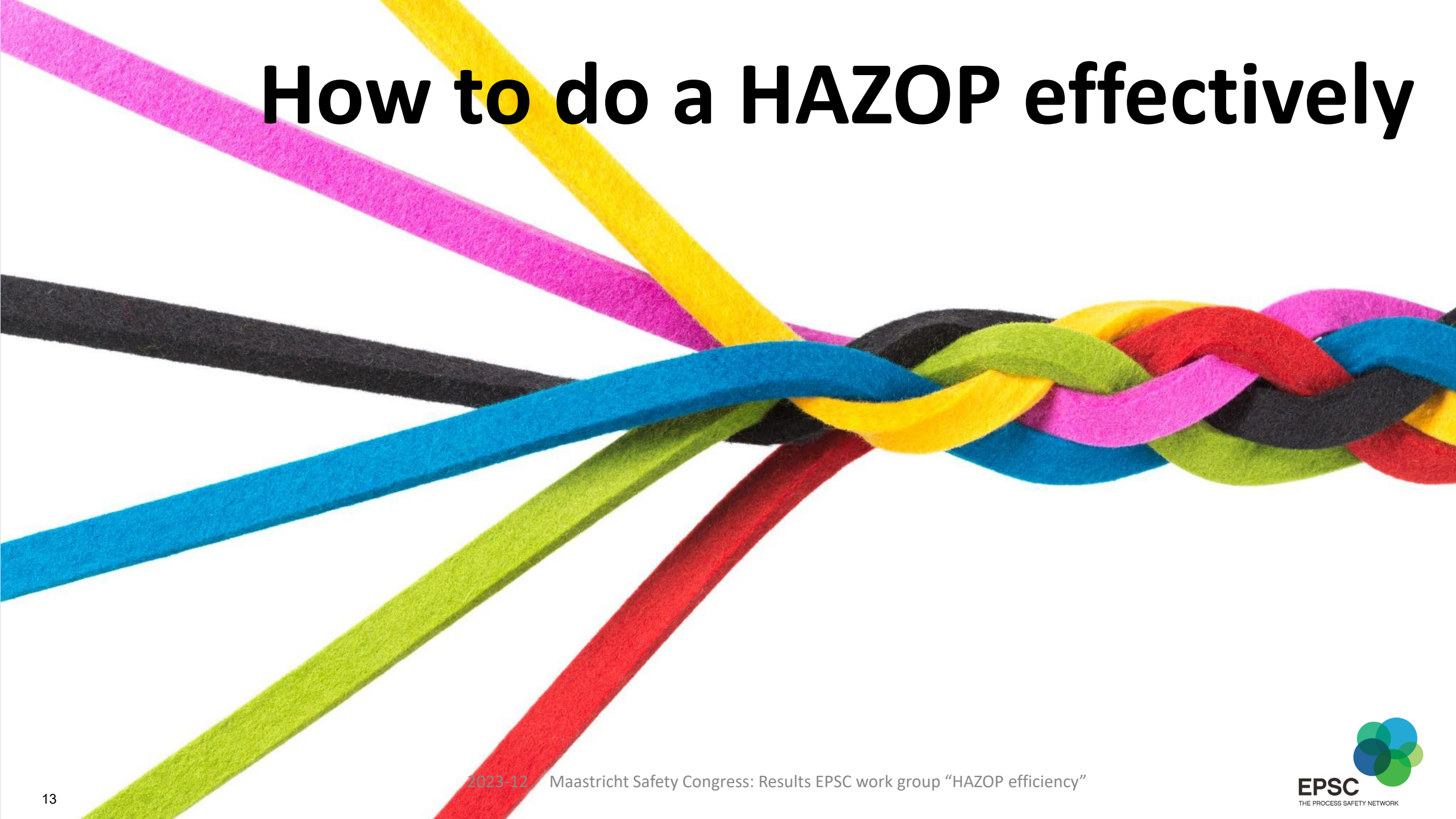
EPSC HAZOP Readiness Checklist

Preparation aspect	Not ready (1 point)	Score 1-5	Fully ready (5 points)	i
HAZOP defenition				
Charter / ToR (terms of reference)	No charter/ ToR	4	Clear Charter, agreed and signed	2
Sponsor	Leadership not aware / interested in PHA	5	Strong leadership support, sponsor identified	4
Scope	not identified	4	All P&ID's to be reviewed are identified	3
Required Time	no clue		good estimation, nr of required days identified	3
HAZOP schedule	no clue		Days identified and marked in Calendars (acceptable hours/days, back-up)	3
Vendor package	no understanding nor data of vendor package		Supplier joining; Package unit data well available	1
Utilities	not defined	3	Utilities descibed on P&ID, part of scope. Emergency procedures on Utility loss available	2
Process data				
P&ID quality / availablity	P&ID over 25 years old; MOC's not included; not all available	5	P&ID's as built, including safety instrumented functions	9
PSV data	No design scenario's and data of PSV's are available		Revlief scenarios / design data of PSV's are available [API 521]	
Equipment design data	Pressure and Temperature rating of equipment not understood	4	Design data well available and understood by the team	4
Chemicals	Chemicals / Chemical hazards unknown	5	All Chemicals and their hazards known and described	4

HAZOP Team				
HAZOP Leader	No skilled leader	5	Experienced leader, great skills to lead the team, good understanding of the process	7
Scribe	No scribe identified		Experienced scribe that understands the documentation tool	2
Operation	No person from operation involved, or just a trainee added	4	Experienced operation person with over 10 years experience in the unit	6
Process	no process engineer	5	Senior process engineer	6
Mechanical	maintenance / inspection not involved	4	maintenance experience and knowledge well available: design, maintenance findings	4
Automation	Automation (E&I) not involved		Sufficient automation (E&I) knowledge available: alarms, interlocks, plant trips	2
HAZOP execution preparation				
Node selection	No nodes identified	5	Logic Nodes identified and shown with colors on P&ID, for all participants	5
Guide words	No guide word list available	4	Suitable guide word list for the PHA prepared	2
Special client HAZOP requirements	Not understood		Understood and can be met	1
Documentation tool	not prepared	3	Electronic documentation system identified, good skills and tool pre-filled where applicable	3
Standard scenario's	not identified		standard scenario's identified per equipment	3
Standard consequences	not identified		severity of consequences of typical scenarios predetermined.	2
Risk Criteria	not identified	4	Useful risk matrix available that is well understood by the participants	3

Topic	Readiness		Qualification		
Defenition	89%		HAZOP Ready	80% or better	Good HAZOP sessions and outcome expected
Process Data	95%		Prepared	Below 80%	HAZOP can be done, some effciency is missing
HAZOP Team	88%		Insufficient	Below 60%	HAZOP not efficient
HAZOP execution	83%		Do not start	Below 40%	Other processes to bo done first

How to do a HAZOP effectively




Master
Skilled
Learner
Amateur
Novice

Does the scenario lead to a “LOPC”?

YES / NO

Process Safety Performance Indicators for the Refining and Petrochemical Industries

ANSI/API RECOMMENDED PRACTICE 754
THIRD EDITION, AUGUST 2021

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VCE (Vapour Cloud Explosion) possible				
Cat.	**Size of release**	**Type of release**	**Location of release**	**Remarks - examples**
4	Large	Catastrophic failure of vessel or process pipe		LPG storage tanks, BLEVE, Vapour cloud explosions with major overpressure, H2S explosion Opening of LPG storage tank safety relief valve to atmosphere. Other large LPG or gasoline releases like overfilling of gasoline storage tank.
3	Medium	Catastrophic failure of smaller equipment or pipe	In congested process installations or near areas where there are people or traffic (congestion increases overpressure effect)	
		Not from catastrophic failure but from leakage to atmosphere		
2	Medium	Catastrophic failure of smaller equipment or pipe	Neither near process installations nor near areas where there are people of traffic (Open space)	
		Not from catastrophic failure but from leakage to atmosphere		
1	Small	Limited release in quantity and time		Small leakage through packing. Sample point. Thermal safety valve.

Type	Large, kg (10 x PSE1)	Medium, kg (PSE1)	Small, kg (PSE2)
Hydrogen or hydrogen rich refinery circulation gas (REF hydrogen) (Note that this deviates from PSE-classification) **(Note: If medium size hydrogen leak happens is enclosed space such as compressor hall, LOC category is increased to LOC4.** **If small hydrogen leak happens is enclosed space such as compressor hall, LOC category is increased to LOC3.)**	Over 100	10-100	Below 10
Flammable Gases (LPG, fuel gas, non hydrogen rich gases) and Liquids with boiling point, ≤ 35 °C and flash point < 23 °C (e.g. gasoline etc) (CLP flammable liquid category 1) NOTE: If process temperature is above auto ignition temperature and consequence is an immediate fire, table 2A&B shall be used also for category 1 flammable substances.	5 000	500	50
Liquids with boiling point > 35 °C and flash point < 23 °C (e.g crude oil) (CLP flammable liquid category 2) NOTE: If process temperature is above auto ignition temperature and consequence is an immediate fire, table 2A&B shall be used also for category 2 flammable substances.	10 000	1 000	100
Ethanol, Methanol, ETBE, MTBE (CLP flammable liquid category 2)	10 000	1 000	100
Flammable liquids with flash point between 23 °C - 40 °C (e.g. JET or equal) (CLP flammable liquid category 3) Liquids with flash point between 40 °C - 60 °C (CLP flammable liquid category 3) and operated significantly above flash point but below AIT (e.g. middle distillates like diesel at elevated temperatures about 150 °C but below AIT -> VCE risk due to capability to form vapour cloud) NOTE: Liquids with flash point between 40 °C - 60 °C (CLP flammable liquid category 3) and operated at temperatures below flash point -> use Table 2A&B	20 000	2 000	200

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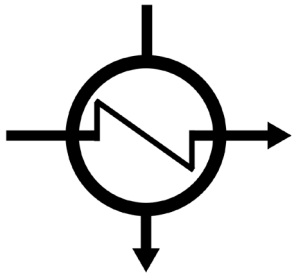
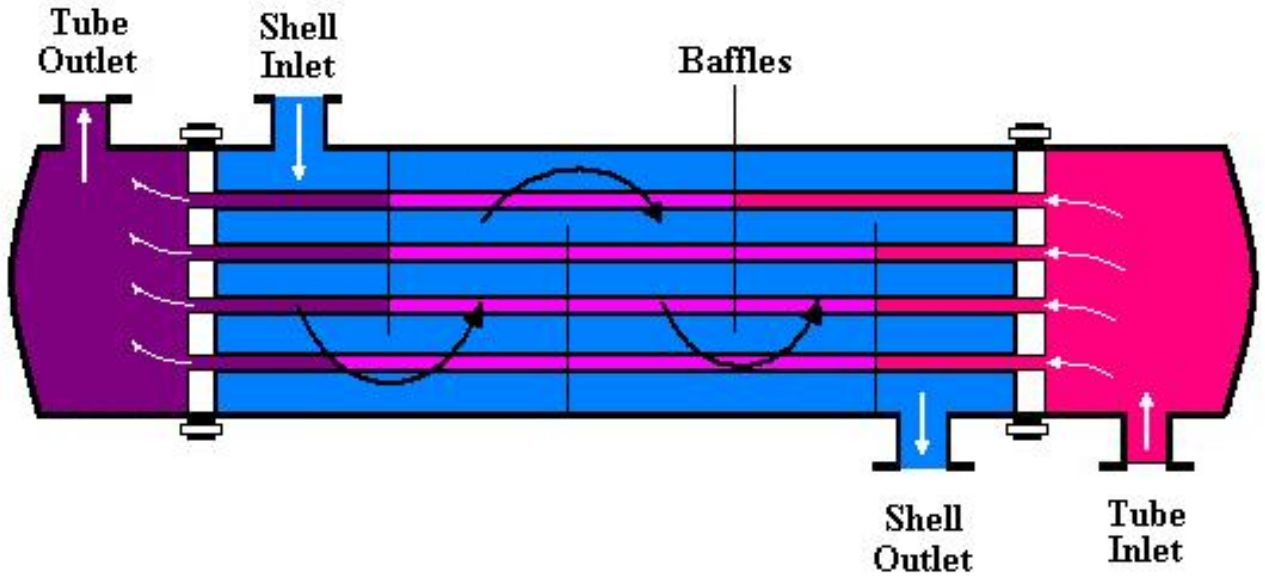
Heat Exchanger





Scenarios to consider

- Tube leak small (corrosion pinhole) → contamination → …
- Full tube rupture (low probability [1]) → Pressure exchange
- "Blocked in" at start-up → high pressure
- Fouling & corrosion
- Large temperature exceedance due to control loop failure

Measures to consider

Detection (e.g. HC detector at the cooling tower)

Pressure protection low pressure side (PSV)

TRV to release liquid

Cooling water / Boiler water control

Robust design allowing temperature deviations

[1] This is a low frequency scenario when leak before rupture with detection, or good design

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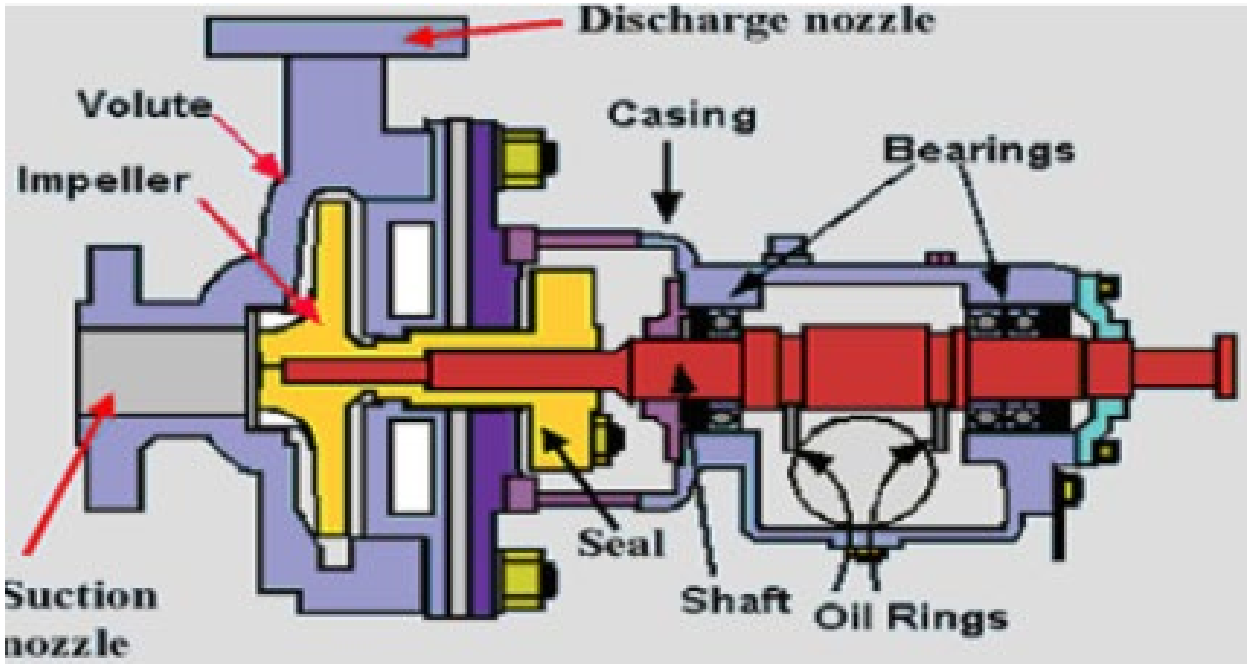
Centrifugal pump



Scenarios to consider

- Low flow / suction blocked → Cavitation → Seal damage & leak
- Bearing damage → vibrations → seal leakage and worse
- Discharge blocked → overheated product → leakage → fire
- Damaged seal
- Large leak near pump

Measures to consider

Low flow alarm, second containment, gas detection

Shaft position control, vibration analysis, operator rounds

second containment, gas detection

Double mechanical seal, avoid very high rpm

Emergency isolation (ESV)

Remark: Magnetic driven pumps are more sensitive to solids, not sensitive to seal leakage

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Package Unit – Vendor package

Some Examples

- Nitrogen storage and gas supply
- Ammonia cooling unit
- Compressor
- Dosing system
- Auxiliaries: hot oil / steam
- Water treatment
- Boiler / Heater

Aspects

- Is the potential hazard identified (chemical releases)?
- Is a Recognized Design applied (e.g. according a standard)?
- Has a HAZOP been performed by the vendor?
- Are the IPL's identified and maintained?
- Is a P&ID available, is maintenance responsibility defined, are SOP available for operation?
- Is the vendor a recognized specialist?

➢ Validate interface: flow, pressure, temperature exchanges bringing equipment out of design

➢ Consider to invite the vendor to do a joined HAZOP to clarify residual hazards (depending on complexity and severity of potential consequence)

➢ Spot check on HAZOP of the vendor

➢ Is the protection of the Package Unit appropriate vs the hazard of the process unit

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