



Reliable. Sustainable. Resourceful.

Implementation of Process Safety Fundamentals (PSF)

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Content



- Introduction Vynova Group
- What are "Process Safety Fundamentals?"
- Implementation of "Process Safety Fundamentals" at Vynova
- Examples
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A leading European PVC and chlor-alkali company



Strong regional presence

Production network of 7 manufacturing sites, strategically located in key European markets.



Committed employees

Over 1,275 employees in manufacturing, supply chain, sales & marketing and support services.



Broad product range

Product portfolio that includes PVC, KOH and other potassium derivatives, NaOH and sodium hypochlorite.



Solid financial performance

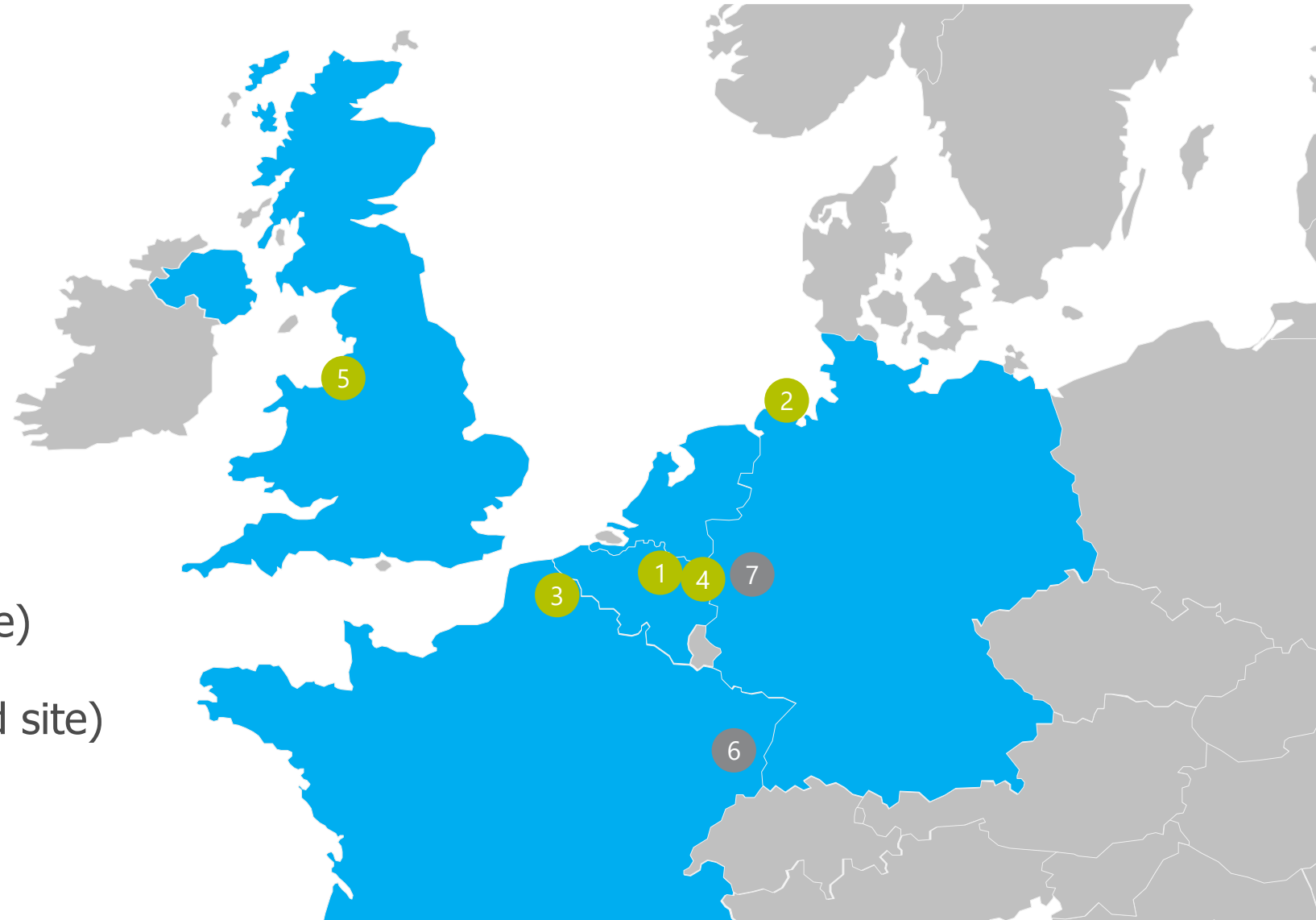
Founded in 2015, we have grown to generate sales of 1 billion euros in 2023. Our profitability enables us to pursue ambitious growth opportunities.



Production network in five countries

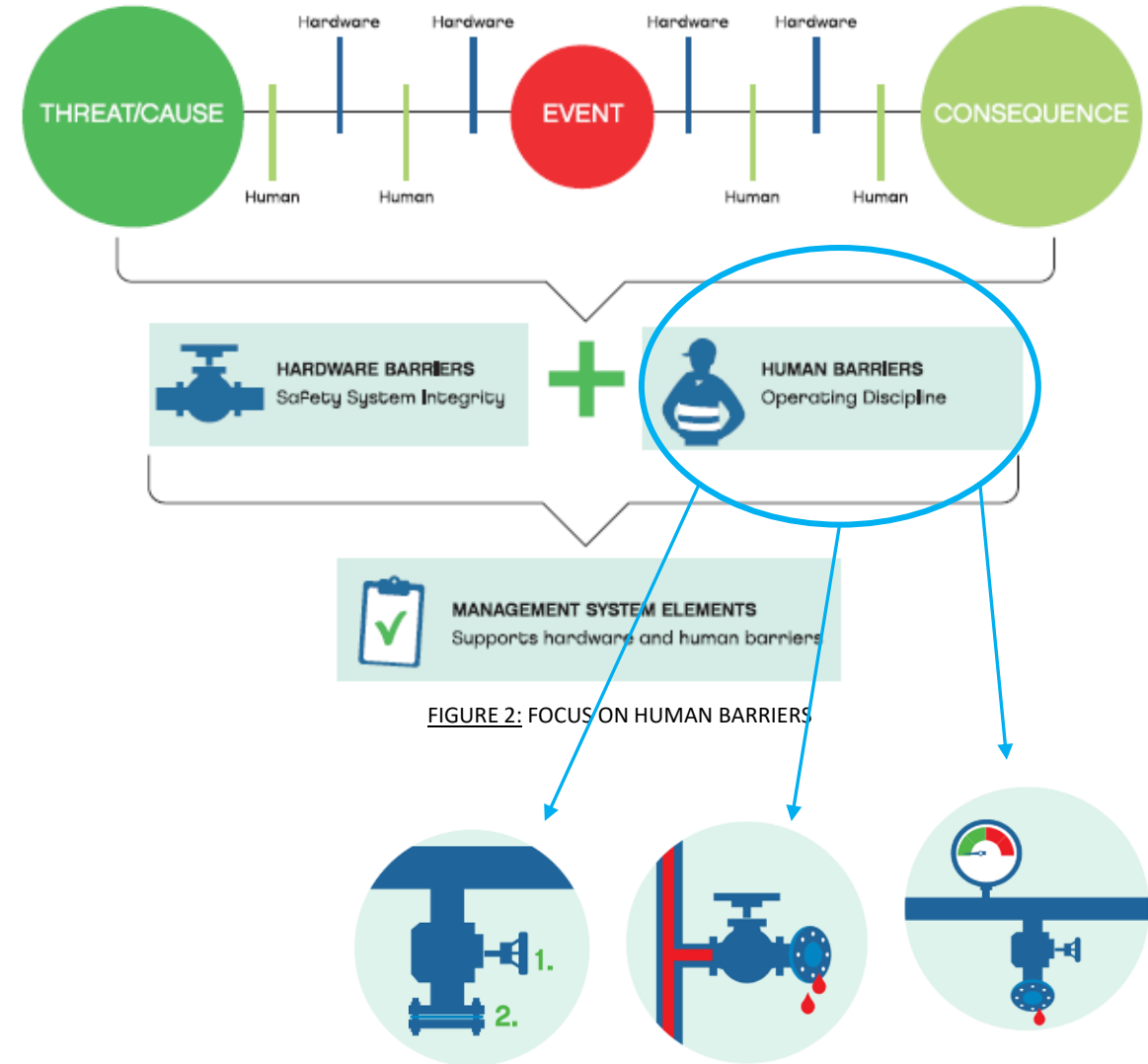


- 1 Tessengerlo - Belgium
- 2 Wilhelmshaven - Germany
- 3 Mazingarbe - France
- 4 Beek - Netherlands
- 5 Runcorn - UK
- 6 Thann - France (affiliated site)
- 7 Lülisdorf - Germany (affiliated site)



Human Barriers & Process Safety Fundamentals

- To avoid chemical releases in process plants so called “**barriers**” are identified. Barriers can be
 - hardware,
 - human or
 - organizational
- Process Safety Fundamentals (PSFs) focusing on preventive and mitigating **human barriers**,
 - operating discipline principles that need to be respected rigorously to avoid process safety incidents and accidents.
- **PSFs were developed by major oil & gas companies** like Shell or Total and implemented with good results
 - Number of LoC-incidents caused by breach of human barriers decreased significantly!



What are 'PROCESS SAFETY FUNDAMENTALS'?



■ Process Safety Fundamentals:

- **Basic principles** to support frontline workers, supervisors and operational management
- **Attention** to situations that could lead to a release of a hazardous chemical
- **Emphasize** existing good practices to prevent such PS events.
- PSFs mention **several typical critical aspects** that are not easy to do well and that have resulted multiple serious incidents.
- **PSF can be used** very well **in addition** to the existing process safety management systems, no replacement of existing safety management systems
- **Increase understanding on the items** that often go wrong in the field

■ PSF do not include new safe operation principles, but

- Address well known basic principles
- Present and visualize in a way that front line workers get a better understanding of process safety in their day-to-day activities.
- Do not conflict with existing Audit Protocols (10 Vynova Process Safety Principles) or the Life Saving Rules!

PROCESS SAFETY FUNDAMENTALS & LIFE SAVING RULES



■ **Process Safety Fundamentals** are intended as a **complement to the Life Saving Rules**

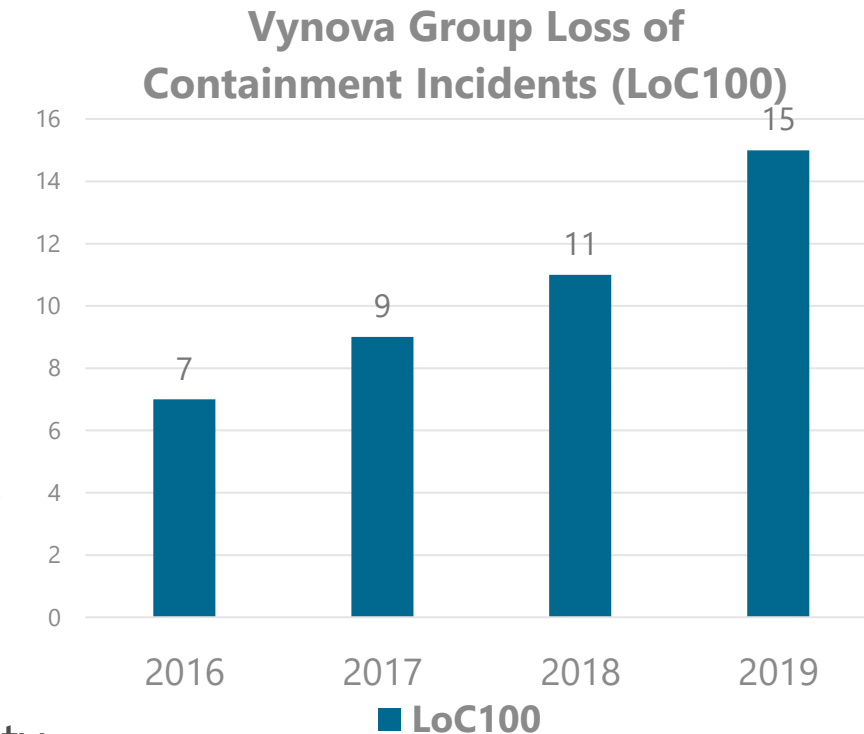
- Context of the use of the PSF is quite different from the intent of Life Saving Rules.
- Combining them in a single list is not recommended; see comparison below:

OBJECTIVE	LIFE SAVING RULES	PROCESS SAFETY FUNDAMENTALS
HSE DOMAIN	Reduce number of injuries/fatalities	Avoid loss of containment of chemicals with potentially serious consequences for people, environment and assets.
TARGET	Behaviors in occupational safety	Behaviors in operations involving hazardous chemicals
TARGET POPULATION	All	Operation teams on hazardous sites (process operators, supervisors, operational management, contractors, maintenance technicians)
NATURE AND APPLICABILITY	Simple rules that are easy to understand and apply in all circumstances	More complex principles that cannot always be fully applied (e.g. in case of design issues)
IMPLEMENTATION	Non-negotiable set of requirements (Life Saving Rules / Golden Rules)	The aim is to identify situations that are not in line with the Process Safety Fundamentals and to start a discussion on how to proceed, while avoiding uncontrolled initiatives "to get the job done"

Background & Starting Point of PSF-implementation



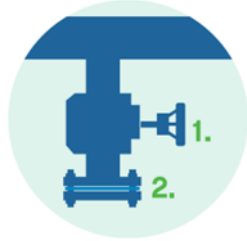
- **Vynova Process Safety Performance** not on good level after foundation of the company in 2015!
- Increasing number of process safety incidents 2016 to 2019!
- **PSE performance not at 'top quartile level'**; PSER above average of EPSC members*
 - PSER** Vynova 2019 = 12.8
 - Average PSER of EPSC members = 1.7
- **Human Operation** was the main cause for Vynova PS incidents (62% in 2020)
- Several **severe Process Safety HiPo-incidents** in 2019 - 2021
- Further **need for improvement** to avoid a serious Process Safety Events!
- Decision was made to **implement Process Safety Fundamentals** for Vynova Group, based on EPSC PSF!



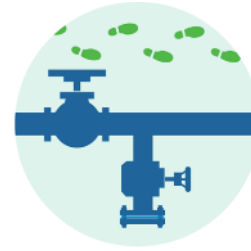
*EPSC = European Process Safety Center
** PSER based on 1 Mio working hours

Examples for Incidents related to PSF

Double Isolation



Walk the Line



■ Release of 25t NaOH32% via drain valve of tank

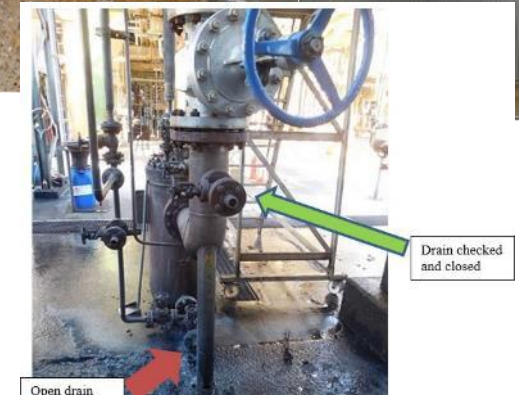
- Open drain valve & missing blind

■ Product release and fire at furnace filter

- Release via open drain valve
- No formal double-check procedure in place

■ Release of 500kg cracking gas

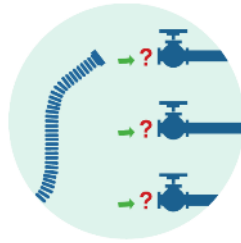
- After drying, hose was removed, but no blind was installed
- Walk the line failed, open end was not detected



Manual valve open with no blind

Examples for Incidents related to PSF

Control (Un)loading



Report deficiencies on Safety Critical Equipment



■ Release of VCM during railcar loading

- Railcars moved during loading

■ Spill of 300 kg FeCl₃ during transport IBC

- Plastic of the IBC becomes more brittle with time.
- Forklift driver with too much speed

■ Caustic Soda leakage during loading of tank

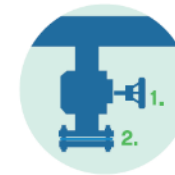
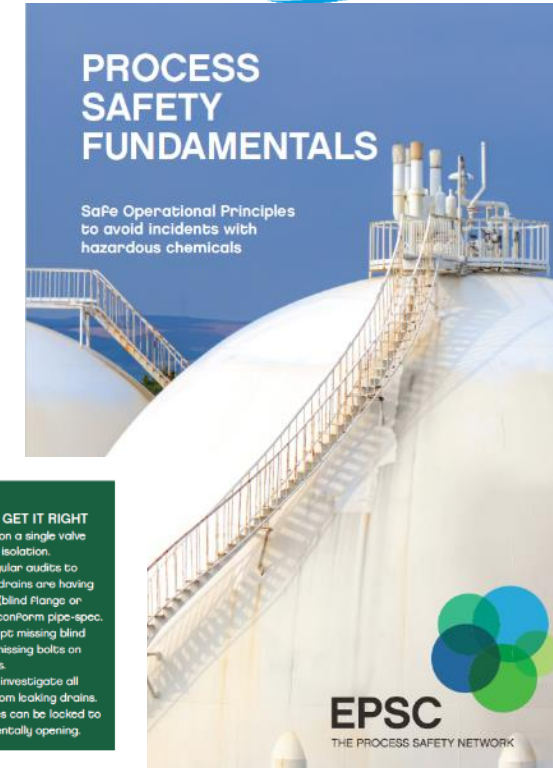
- Caustic Soda filling line blocked towards tank due to miscommunication, flushing nozzle was open
- Walk the line failed, open end was not detected



EPSC Working Group Process Safety Fundamentals



- **EPSC Working Group** Process Safety Fundamentals started in 2019
- Active participation in this Working Group by Vynova
- Elaboration of EPSC **18 Process Safety Fundamentals**
- Publication of **Booklet** on EPSC Process Safety Fundamentals
- For each PSF **specific pictograms** developed
- **Guidance Cards** for each PSF



APPLY DOUBLE ISOLATION

Hazards

Spill of (hazardous) material can occur when a barrier (like a valve) fails and no second barrier is in place.

When important

During routine and special operations: draining & sampling, (un-)loading activities, utility connections.

Challenges in the Field

- Older plant design often do not provide a double barrier.
- Blind Flanges not put back after maintenance work.
- Blind Flanges not installed with bolts & missing end-caps.
- Importance of "primary containment" not understood.
- Valve handles that can be opened accidentally.

OPTIONS TO GET IT RIGHT

- Do not rely on a single valve for positive isolation.
- Execute regular audits to check that drains are having an end-cap (blind flange or screw cap) conform pipe-spec.
- Do not accept missing blind flanges or missing bolts on blind flanges.
- Report and investigate all incidents from leaking drains.
- Valve handles can be locked to avoid accidentally opening.



Implementation Plan for Vynova

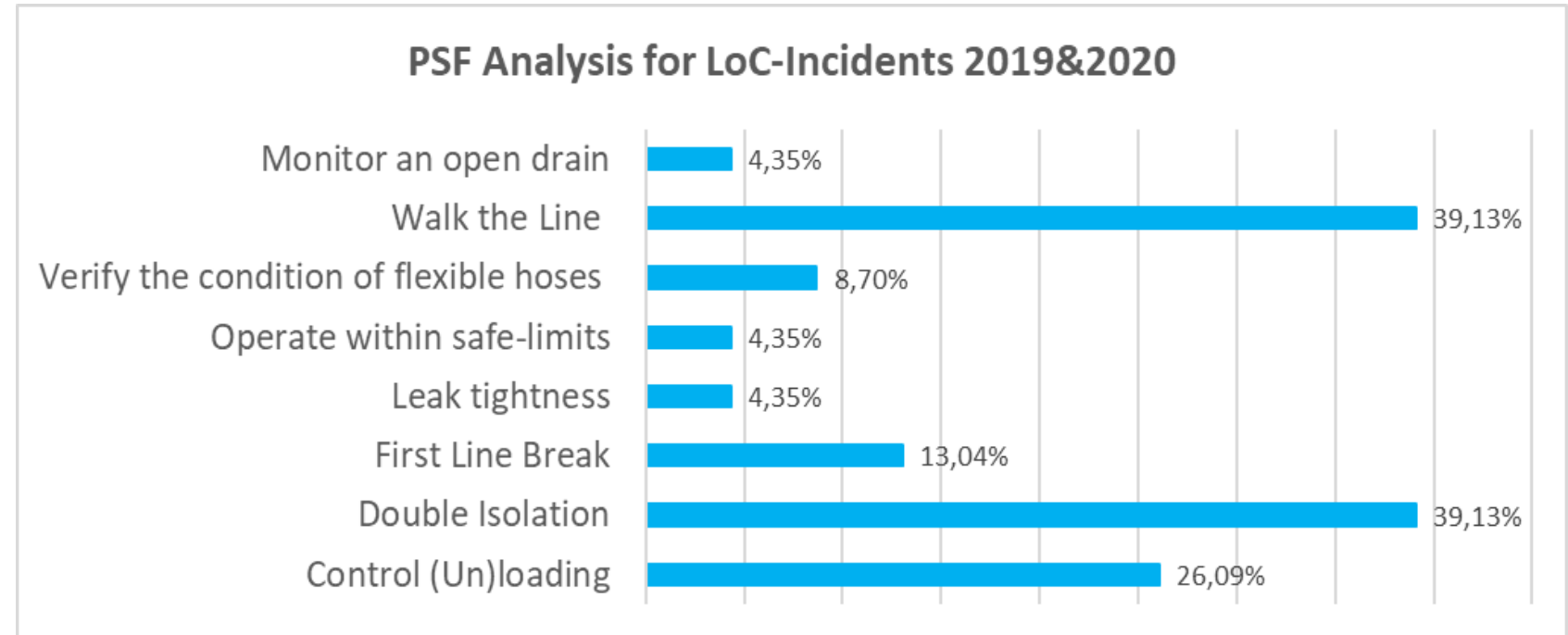


- Set-up a **project group for implementation** PSF in Vynova
 - HSE/PS-experts of all sites participating
- **Selection of relevant PSF** for Vynova by the members of project group
 1. Analysis of PS incidents of last years
 2. Definition and alignment on the major issues & items
 3. On basis of this analysis, selection of relevant PSF for Vynova Group
- Define and execute the **implementation program**
 1. Define the required tools for an implementation of the selected PSFs:
 - a) Vynova Policy or Guideline on PSFs
 - b) Information and Training package for roll-out of PSFs, e.g.
 - c) Methods which should be used for roll-out
- **Local Implementation**
 - Define per site on basis of Vynova PSFs the most important PSFs for local implementation (Site SHE Manager)

Selection of relevant PSF for Vynova



■ Analysis of all LoC-incidents 2019 & 2020



■ Main issues identified:

- Walk the line
- Double Isolation
- Control (Un)loading
- First Line Break (empty & de-energize)
- Flexible hoses

Selection of relevant PSF for Vynova



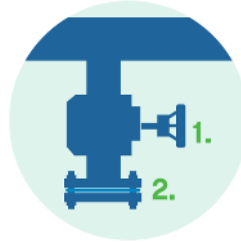
- For the selection, a **poll** was done; each site could propose the 8 most relevant PSF
- From the **incidents of the years before**, some further items identified:
 - Connection of utility system to the process
 - System override (bypassing)
 - Avoid working behind single valve
- **Decision: Define 7 PSF**, similar to existing 7 Life Saving Rules.
- **Not selected “Manage overrides of safety critical systems”** -> Already covered by Life Saving Rule “Safety critical Devices/interlocks must not be disabled or overridden without authorization.”
- **“Flexible Hoses” not selected** as just before a specific Group Guideline was published on this item!

Ranking	PSF:	%
1	Apply Double Isolation	12,73%
2	Empty and De-energize before Line-breaking	12,73%
3	Walk the line	12,73%
4	Avoid working behind a single valve	10,91%
5	Verify the condition of flexible hoses	10,91%
6	Manage Overrides of Safety Critical Systems	10,91%
7	Stay out of the Line of Fire	5,45%
8	Report deficiencies on Safety Critical Equipment	5,45%
9	Operate within safe limits	5,45%
10	Control (Un)loading	3,64%
11	Control utility systems connected to a process	3,64%
12	Monitor an open drain	3,64%
13	Verify leak tightness after maintenance work	1,82%

7 Vynova Process Safety Fundamentals



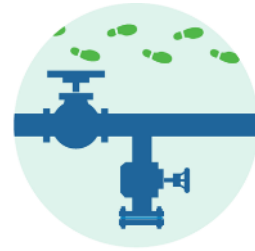
1. Apply Double Isolation



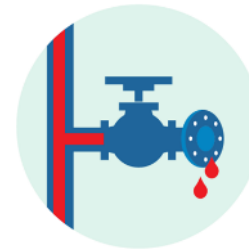
2. Empty and De-energize before Line-breaking



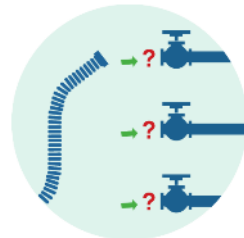
3. Walk the line



4. Avoid working behind a single valve



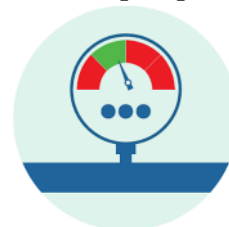
5. Control (Un)loading



6. Report deficiencies on Safety Critical Equipment



7. Operate within safe limits



Implementation Program

- For the implementation, the **following documents** were elaborated:
 - a) Vynova Policy Process Safety Fundamentals
 - b) Vynova Booklet with additional information about the PSF
 - c) Vynova PSF Training slide pack
 - d) PSF Posters & Guidance Cards
 - e) Translations of all tools to local languages
- **Further training material** including more digital tools (videos, gamification) in preparation
- **Additional information** and training material of EPSC or other companies made available on central SHE Cascade SharePoint
- Vynova PSFs were **published end of November 2021**



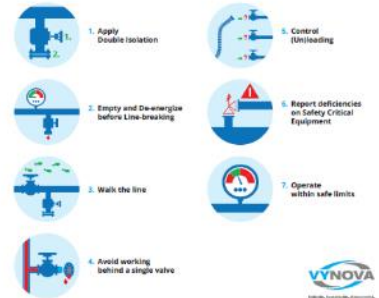
PROCESS SAFETY FUNDAMENTALS

Safe Operational Principles to avoid incidents with hazardous chemicals



PROCESS SAFETY FUNDAMENTALS

Safe Operational Principles to avoid incidents with hazardous chemicals



Training & Roll-out of PSF

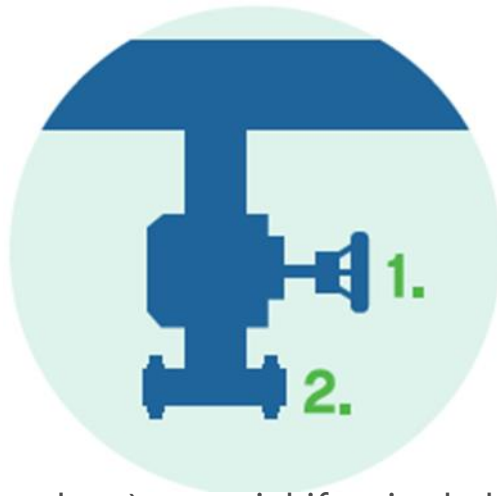


- **Training Slide Deck** prepared and translated, sessions started in Q1/ 2022!
 - See examples on the following slides!

- **Roll-out Program:**
 - Make Vynova PSF visible on site (use & provide posters, PSF booklet, guidance cards)
 - Organisation of toolbox meetings / training sessions for the relevant employees and contractors
 - Information cascaded down to shopfloor level
 - Completion of 1st wave training at all sites -> end of Q2/2022
 - Integration of PSF to the Process Safety Audit Program (see separate slide)
 - For all relevant incidents & events -> Refer to the affected PSF!

- **Improvement Ideas:**
 - Training videos (either cartoons or better with own employees) with concrete examples useful
 - Develop more interactive tools like gaming to further improve the mindset of employees!

Apply Double Isolation



Hazards:

- Spill of (hazardous) material if a single barrier starts leaking and no 2nd barrier is in place.
- Spill can lead to major release of flammable or toxic product if not directly detected
- No barrier is 100% reliable

When is this important:

- Everywhere in the plant where we handle hazardous chemicals; especially draining points and loading and unloading activities

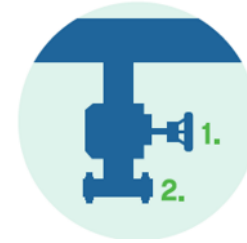
Possible challenges in the field:

- Older plant design often do not provide a double barrier
- Blinds often not re-mounted after maintenance work
- Blinds & caps installed not with all bolts
- Importance of “primary containment” not understood
- Valve handles can be opened accidentally

Options to get it right:

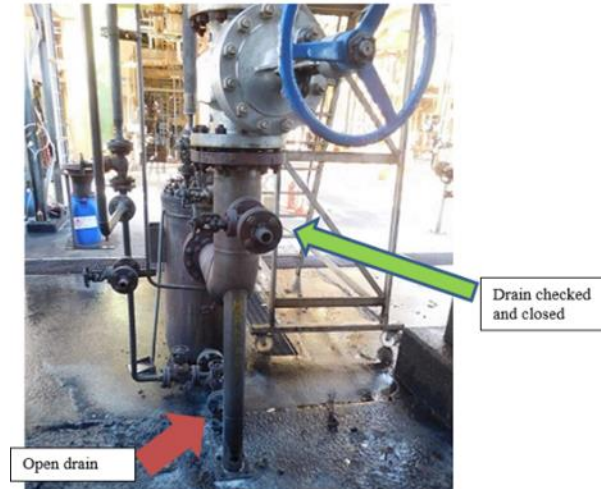
- Do not rely on a single barrier like a valve (one flange is sufficient)
- Execute regular audits to check that drains are having an end-cap (flange or screw cap) conform pipe-spec
- Do not accept missing blinds or missing bolts on blinds
- Report and investigate all incidents from leaking drains
- Assure valve design allows placement of the endcap (with the need of putting the valve handle in a partly open position)
- Valve handles can be locked to avoid accidentally opening

Apply Double Isolation - Incident examples Vynova



■ Fire furnace filter MVC2 (TES; 06/08/2020)

- What:
 - Product released via open drain valve when taking a filter into service
 - The mixture almost immediately ignited, resulting in a fire.
- Why:
 - Open drain valve -> no second isolation!
 - Open ends were an accepted working method; inadequate procedure
 - No formal checks for routine production tasks.



■ VCM release after replacement of a valve (WHV; 16/09/2015)

- What:
 - Release of 5 t VCM from a rundown vessel via open 2"-handvalve
- Why:
 - Closed shut-down-valve of VCM vessel opened by mistake while system was still purged with N2 and open to atmosphere
 - No second barrier (isolation plate or valve) in place!



Example for a PROCESS SAFETY FUNDAMENTAL

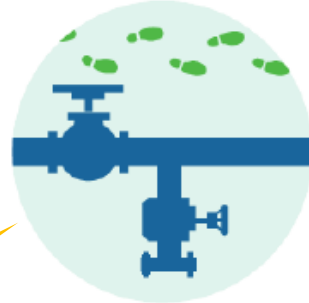


For each PSF a Guidance Card with supporting information available

Pictogram to illustrate the issue

Description of relevant hazards

3. WALK THE LINE



HAZARDS:

- Spills of (hazardous) materials or inadvertent mixing occur when the transfer line is not ready for operation due to open ended lines, wrong valve or tank line-up, or improper tightened flanges.

WHEN IS THIS IMPORTANT:

- After each change in set-up of a transfer line, e.g. start-up after shut-down, isolating equipment, change of equipment, maintenance work

POSSIBLE CHALLENGES IN THE FIELD:

- Transfers occurring around shift change-over
- Busy with other things
- Bad weather, low visibility at night
- Pipelines or valve position that are not easily to see
- Bad accessibility

OPTIONS TO GET IT RIGHT:

- Validate a correct line-up (valves, tanks, pumps), before starting the pump / transfer
- Perform a check, after pump start, to detect leaking drains, hoses, flanges and pump seals
- Use P&IDs during line check
- Label equipment in the field, like valves, pipelines and pumps to help with the field check
- Validate the transfer by checking the levels of the tanks and compare these with pump flow speed. Take action upon deviation

What you need to do to manage the issue

Situations and tasks where this PSF is relevant

Frequently reported challenges in real life

Example for WWL with link to PSE!

LOC 100 – release of 7,3t NaOH32% CCU ELY3

Tessengerlo 12/01/2023

What?

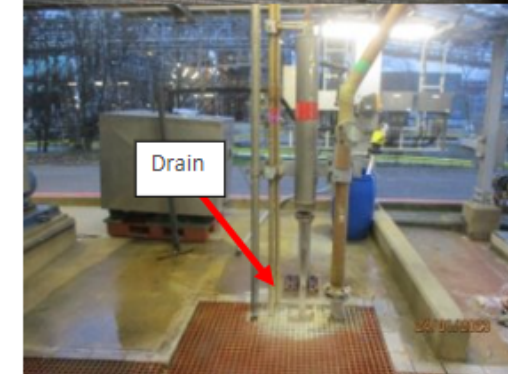
- A short shutdown of ELY3 was planned, starting 12/01 at 3am
- 11/01 at 11h00, **the SD procedure was ready** and explained to the operators in a toolbox.
- 11/01 in the afternoon the decision was taken to do **an extra urgent repair** at the evaporation section of ELY3 during SD.
- **The CCU of ELY3** was put back into operation **on 12/01 at 18h.**
- At 18h11, **NaOH32%** started to flow out via an **open drain valve** and fixed pipe **to the process sewer**. No risk involved.
- At 18u55 the drain is closed when operator **noticed a decrease of the level of the Catholyte tank**.
- A total amount of **7,3 tons of NaOH** is released via the drain to the process sewer and wastewater treatment of the site

Why?

- The short shutdown was planned, but **the repair work at the CCU was not included in the instruction**. 11/01 In the afternoon, the production engineer prepared a P&ID, indicating how to secure the evaporation section (no written instruction was prepared)
- In the field there was **no indication with hazard cards, also no isolation list was used** - > The shut down procedure was used instead of an isolation list. But only the P&ID was available
- The shift that did the normalization, was not the same shift that secured the installation. The shift that did the normalization **did not use the P&ID**.
- **Walk the line and the 4-eye principle** was not applied in a correct way.

Lessons?!

- **A written SD procedure + isolation plan is recommended for every SD/TAR**
- When extra repair works are included in a SD not covered by the initial isolation plan of SD-procedure, using **an isolation list for this part of the installation is mandatory**.
- When lining up the installation : Check all available info, **use a procedure or isolation list executing, walk the line and apply the 4-eye principle**
- **Review/intensify replacement program for piping** at the ely plant.
- Evaluate how to deal with drains with fixed outlet piping to sewers or other safe locations. **No double isolation possible (with blind).**



Compromised Safety principles

BSP1, BSP3, BSP5 and BSP9



12

01

23

Integration of PSF into EHS Audit Program



PROCESS SAFETY

10 principles

1. The asset operating manager is responsible for its overall integrity.
2. The asset engineers are responsible for maintaining the asset and protective systems integrity.
3. The responsibilities in the organisation for defining and maintaining the correct operating envelopes must be clear.
4. Operating procedures and envelopes must be observed. Deviations must be reported and investigated.
5. Any changes must be properly risk assessed and subjected to MOC procedures.
6. Process hazards are systematically identified, risk assessed, reviewed and managed.
7. All assets must be subject to periodic inspection designed to ensure their integrity and the reliability of their protective systems.
8. Operations must always place the safe operation or shutdown of the asset ahead of production.
9. When in doubt the asset must always be taken to its safest state.
10. We have emergency plans based on assessed risks which are regularly tested.



- Vynova is following the „**20 Safety Principles**“ (originally developed by INEOS)
- The **20 Safety Principles** are divided into
 - 10 Behaviour Safety Principles
 - 10 Process Safety Principles
- For both categories, a **comprehensive audit questionnaire** is in place which is for each site audited every 3 years via `Cross-Site Audits`
- A new **Process Safety Principle 11 “Process Safety Fundamentals”** with additional questions was developed to take the opportunity to check compliance with the PSF-requirement during the PS-Audit.
 - Good experience with these new requirements in the audit protocol
 - Several weak points could be identified, and mitigating actions defined

PS# 11 Additional questions to check PS-Best-Practices.

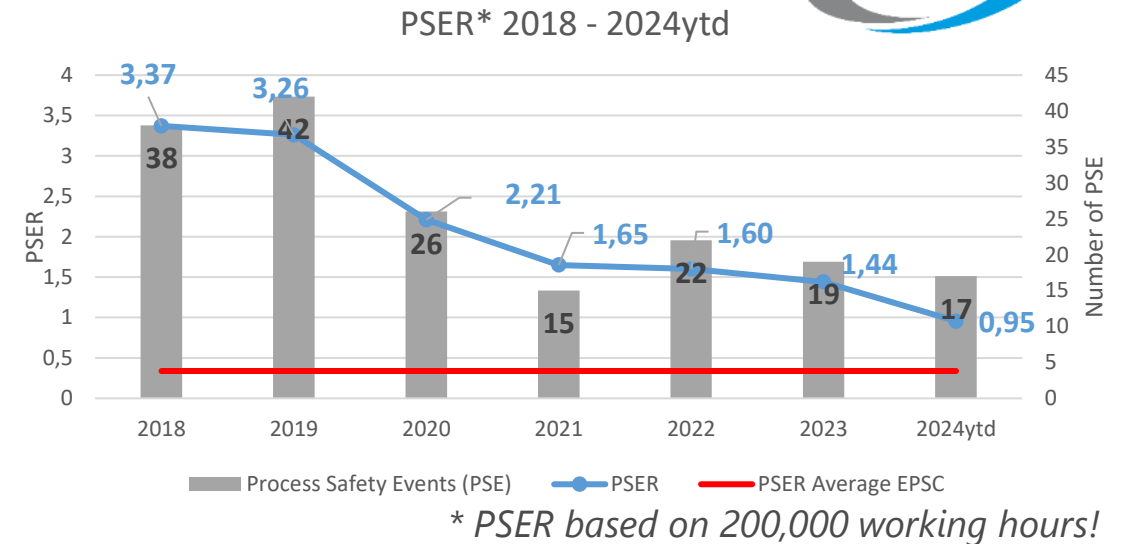


	0 – 25%	25 – 50%	50 – 75%	75 – 100%
<p>PS 11.1 Double Isolation:</p> <ul style="list-style-type: none"> Is the principle of double isolation applied on the site? Is this principle clearly stated in site procedures for safe isolation and part of the plant design? In case of non-existing double isolation is there a procedure in place to execute a detailed risk assessment? <p>Technical</p>	<ul style="list-style-type: none"> No double isolation in the plant, only single barrier concept is in place. No blinds & caps installed No risk assessment 	<ul style="list-style-type: none"> Double isolation is partially available in the plant but not for all equipment. Blinds & caps are used for the majority of drains and openings Some blinds & caps installed without using the full number of bolts 	<ul style="list-style-type: none"> Double isolation is available in the plant for most of the equipment. Blinds & caps are used for most drains and openings Blinds & caps are installed across the full number of bolts Some audits are available to check correct use of blind & caps. Resorting and investigation of all incidents from leaking drains Risk assessment process in place. 	<ul style="list-style-type: none"> Double isolation is available in the plant for all relevant equipment. Blinds & caps are used for all drains and openings and correctly mounted Regular audits to check correct use of blind & caps. High number of incident reports from leaking drains Risk assessment procedure available and widely used if needed
<p>PS 11.2 Opening of equipment:</p> <ul style="list-style-type: none"> Is there a clear instruction/work method available on site for the opening of piping or equipment which contains hazardous material? Does the instruction contain an isolation plan, LOTO, LMRH before starting, etc.? <p>Technical</p>	<ul style="list-style-type: none"> No site procedure for opening of piping or equipment available. No isolation plans and other tools are used for openings of equipment 	<ul style="list-style-type: none"> Site procedure for opening of piping or equipment available but only used for "high risk" openings Isolation plans are in use but no systematic check of completion. 	<ul style="list-style-type: none"> Site procedure for opening of piping or equipment is followed for all openings of equipment which contains hazardous material Check the completion of the isolation plan by an independent operator before signing PSI Selection of suitable PPE is part of site procedure 	<ul style="list-style-type: none"> Site procedure followed for all openings of equipment which contains hazardous material Completion check of isolation plan by an independent operator before signing PSI LMRHA by the mechanic or contractor, before opening as part of the procedure Isolation plan is adjusted after changes

First Results of PSE-Implementation

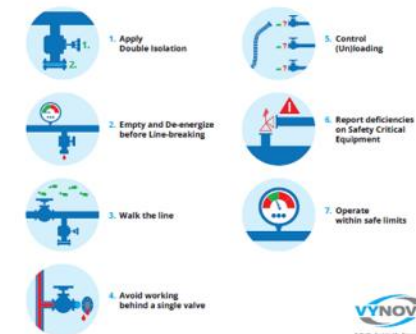


- Overall, we see a **decreasing PSE Rate!**
- Reduction of „**operational**“ **caused PSE**
- **More attention** of employees and contractors
- Some sites had still the „old approach“ that loss of primary containment is not worth to report
- Some **interesting discussion and improvement potential identified** during the PS-Audits on new topics of PS 11 “Process Safety Fundamentals”!
- But still too many PSE, some work to do



PROCESS SAFETY FUNDAMENTALS

Safe Operational Principles to avoid incidents with hazardous chemicals:



Tipps & Tricks for Roll-Out



- **Explain difference to “Life Saving Rules”** and other systems!
 - PSF different to “Life Saving Rules”, sanctions are not in focus!
 - PSF should more trigger the discussion if we are faced with risky situation
- **Link each PSF to real examples** of incidents & accidents
 - Essential to gain acceptance and understanding
- **Use pictures** and (if available) videos & gaming tools
 - Still, some work to do
- For investigation reports and presentations, **make the link to new Process Safety-Events:**
 - Refer to relevant PSF
 - Elaborate statistics / graphs on affected and most relevant PSF
- **Integrate the Process Safety Fundamentals** into other existing systems (e.g. EHS Audits)

Summary

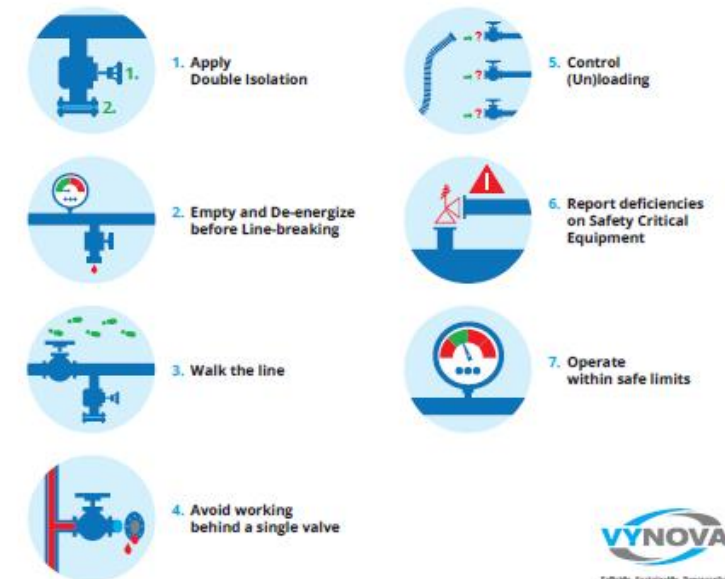


- **'Process Safety Fundamentals'** (PSF) are a powerful tool to strengthen operational excellence and the 'human barrier' in process safety which is widely used in the chemical industry
- The 'Process Safety Fundamentals' are **basic principles** which should support frontline workers, supervisors and operational management
- **Goal:** Reduce the number of loss of containment incidents by following these basic principles
- A Vynova working group with all sites represented has selected **7 Vynova PSF**
- **Vynova PSF Policy** and more detailed **PSF booklet** elaborated for the implementation
- **Further training material** including more digital tools (videos, gamification) **in preparation**
- First **positive results** in reducing the number of Process Safety Events caused by operational issues!



PROCESS SAFETY FUNDAMENTALS

Safe Operational Principles to avoid incidents with hazardous chemicals



Questions?



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