From Incident Statistics to Driving Incident Reduction

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- **Dr. Bob van Woezik, dsm-firmenich**

ProSafeX
Process Safety Excellence

dsm-firmenich

Dr. Hans V. Schwarz

35 years experience in Chemical Industry

Sustainability Consulting 2016-

Dir. Business Developmt, 2020-2023

Owner, Process Safety Services company, Germany, 2019-

- **VP Process Safety BASF SE, Ludwigshafen, Germany**
  - **Global chief expert Process Safety 2017-2019**
  - **Global head of Process Safety 2010-2016**
- VP Technology and supply chain, PU Division, 2003-2010, Brussels, Belgium
- Project Executive New TDI plant project, 1999-2003, Geismar, US
- TDI, MDI, Polyols Production & Technology, various roles, 1991-1999, Belgium & US
- R&D Manager high pressure pilot plants,
  R&D Chemist new chemical processes, 1986-91, Ludwigshafen, Germany

PHD in Physical Chemistry, Heidelberg University, Germany, 1986

Board Member EPSC

Panel Member *Loss Prevention Bulletin* (LPB)

Appointed Member PROCESSNET EINE INITIATIVE VON DECHEMA UND VDI-GVC

Dr.Ir. Bob van Woezik MTD

Education
Chemical Technology Twente University, the Netherlands
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1999 AkzoNobel Functional Chemicals, global manufacturer of Chelates, Micronutrients, Organic peroxides, Metal alkyls
Functions: Process Engineer; Maintenance & Project manager; HSES&Q manager; BG Process Safety program manager

2015 OCI Fertilizers, global manufacturer of Methanol, Ammonia, Nitric Acid, Ammonium Nitrate
Function: Corporate Process Safety & Occupational safety manager

2018 – Now: DSM/dsm-firmenich, global manufacturer Perfumery, Taste & Texture, Nutrition products
Function: Director GOE Process Safety
- Process Safety Expert
- Process Safety Lead Premix Operation (60 plants)

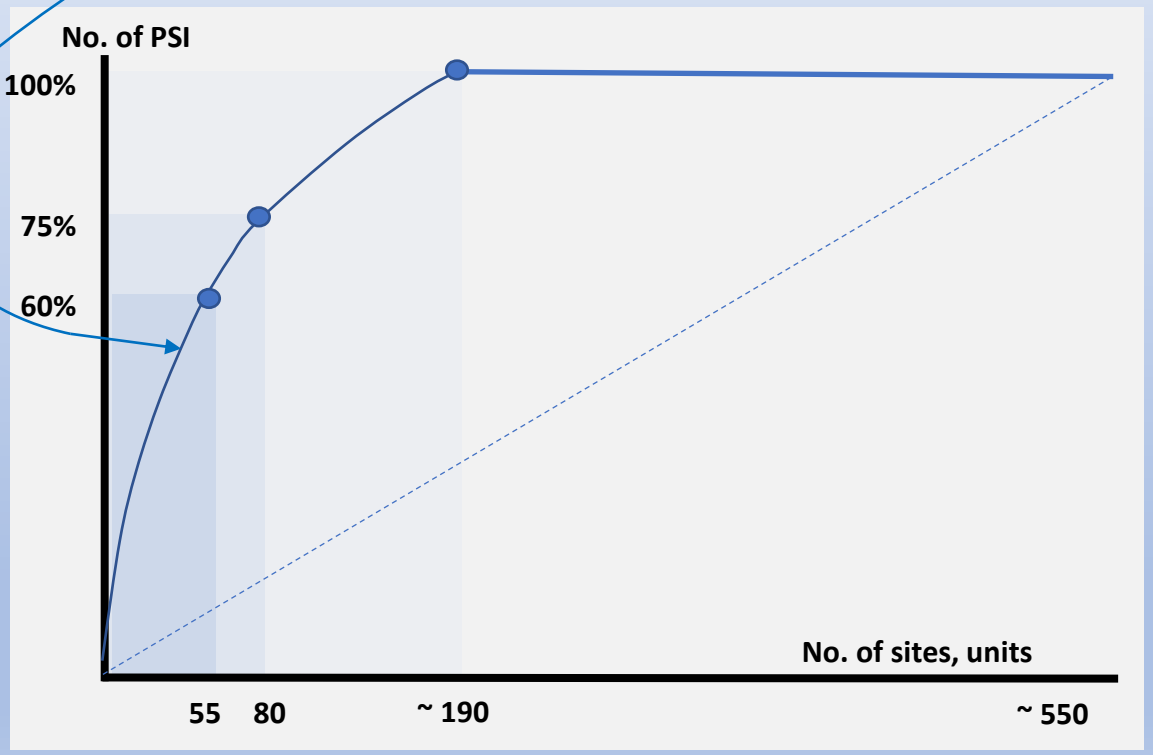
Measuring Incident Performance and acting on it

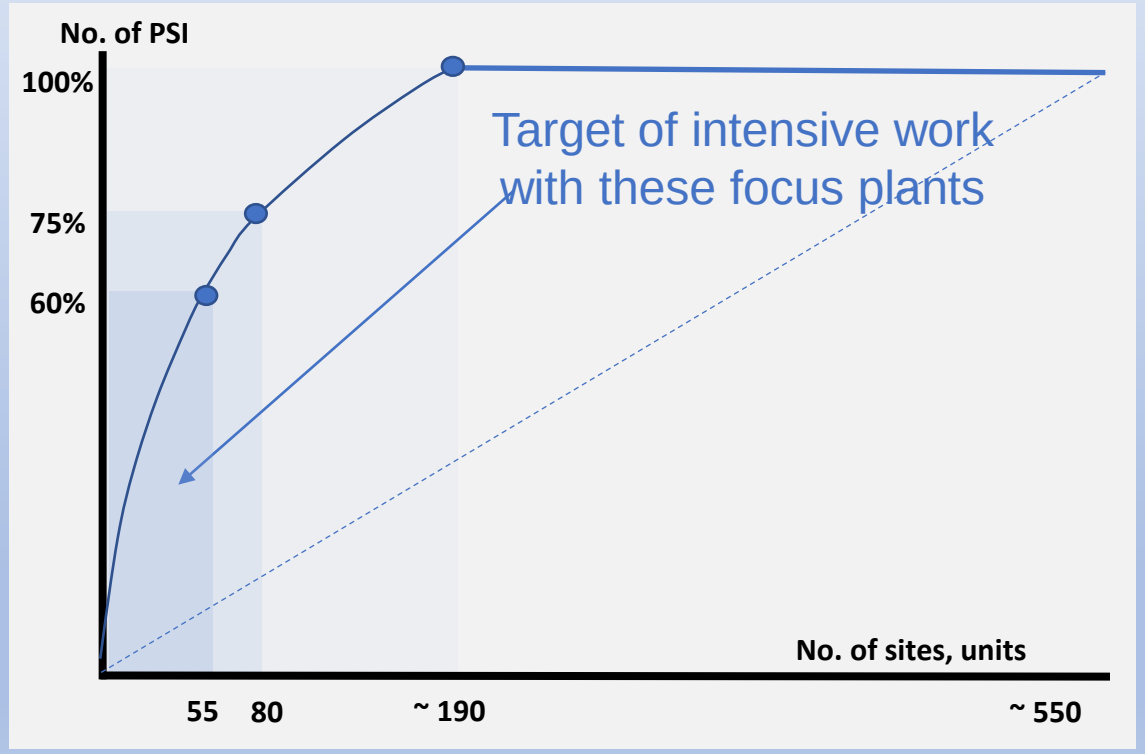
- Lagging KPIs were successfully introduced since 2010 in many companies
- Companies discussed here use the **PSI definition of ICCA/CEFIC/VCI**
  - Releases (Haz.Mat. >100kg, highly toxic >5 kg); Fire/Explosion; Injury/fatality; Environmental damage; Evacuation
- In order to derive **focus areas** for improvements from analysing PSI cause statistics, at BASF yearly in-depth analyses were performed 2012 – 2018
  - Comparing Sites, Regions
  - Common themes in incidents
  - Frequency of direct and root causes
  - Frequency and causes of incidents with high potential (e.g. flammable/toxic gas clouds)
- Based on the learnings, **‚Incident Reduction Initiatives‘** were performed with Focus plants

Pareto Distribution of Incidents

- **Remarkable Observation in all regions and sites:**

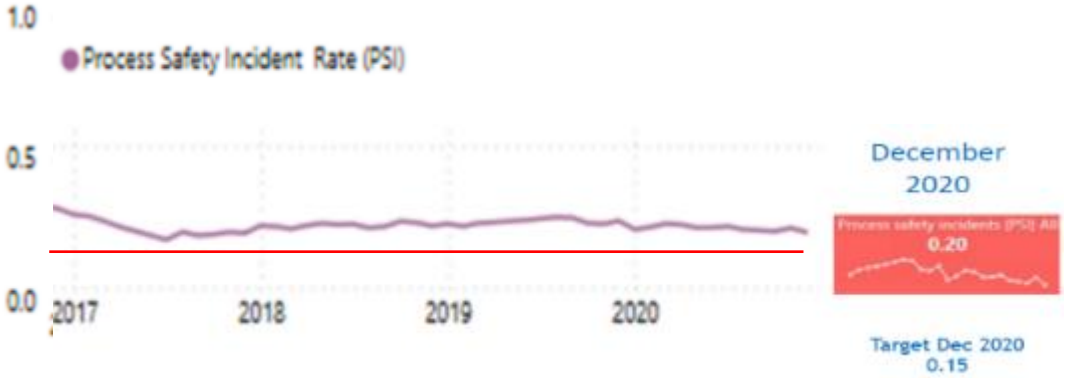
  > 50% of all Process Safety Incidents occur in ~10% of the plants



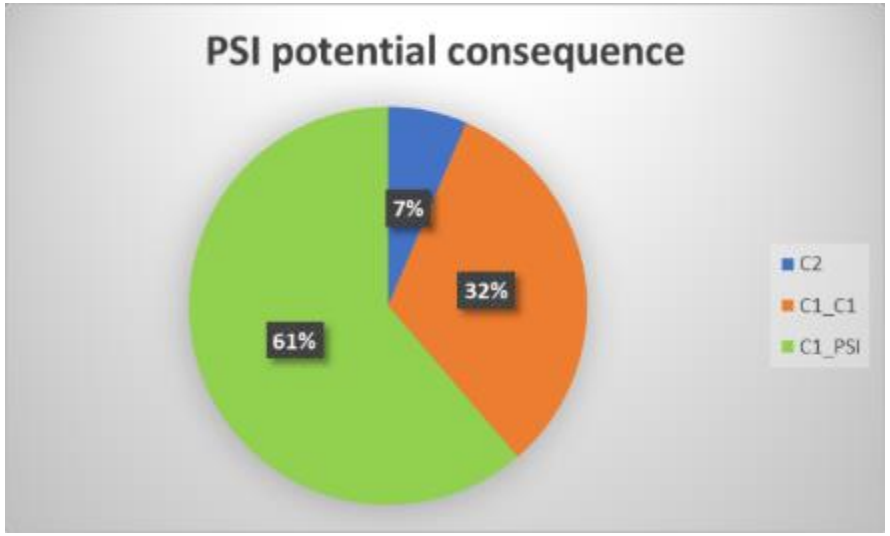


PSI performance

PSI improvement
- Over the years, the PSI rate DSM was plateauing
- Several BG actions, but no improvements visible
- In 2020 started to structurally improve the PSI rate



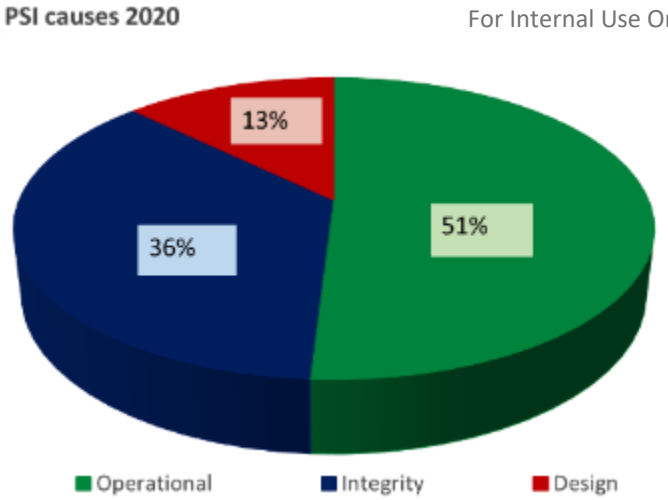
PSIs
- We use definition Cefic-ICCA
- PSIs do not always have PS potential
  - 7% PSI have serious potential ≥ C2 (fire/explosion, fatalities, environmental disasters)
  - >90% of PSIs are spills/leaks, limited SHE consequence, max C1 (FA, MTC, no environmental effect)
- PSIs were mainly LOPC exceeding the threshold value



➔ Better HAZOP will not significantly improve our PSI rate

➔ We need a 2-pronged approach: PSI serious, and PSI spills

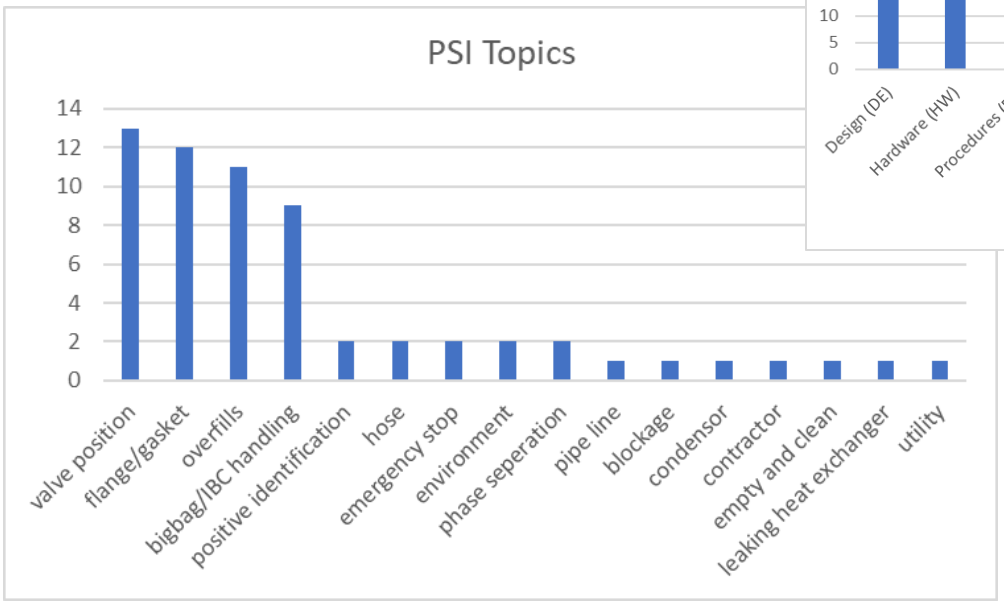
PSI Analysis

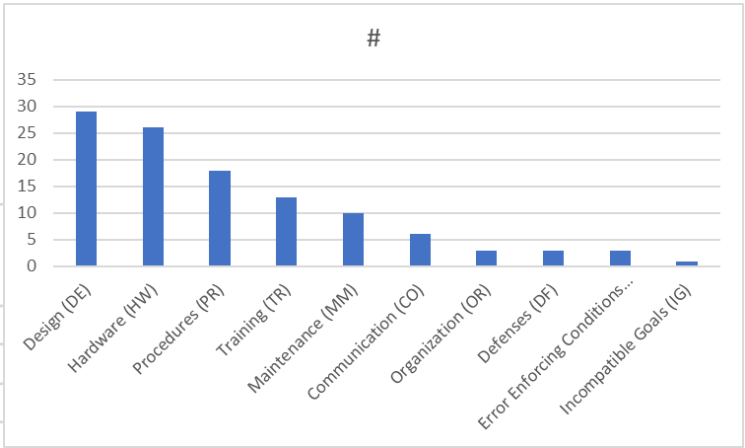


Analysis
- Started analyzing all PSIs: Operational/Integrity/Design; Basic Risk Factors; Risk assessment methods used, etc.
- Not found to be practical. Too high level, too big, academic approach

PSI improvement topics
- Categorizing in practical topics, technical objects
- Easy to improve, including the technical and behavior components
- Pareto analysis identified 4 main topics:
  - Wrong Valve position
  - Flange management
  - Overfills
  - BigBag/IBC handling

➔ We need to develop a specific tool for each indentified topic (SAT)





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Identify Valve Positions

Problem

Manual valve left in the wrong position after maintenance, start-up, cleaning, etc. can cause incidents

Solution

- Make it easier to spot a valve in wrong position.
  Colour code for manual valve handles, e.g.
  green for normally open and
  red for normally closed
- **Tag numbers** at manual valves that correspond to procedures and P&ID
- Add a label to the valve in case of a special operation that requires a position different from normal

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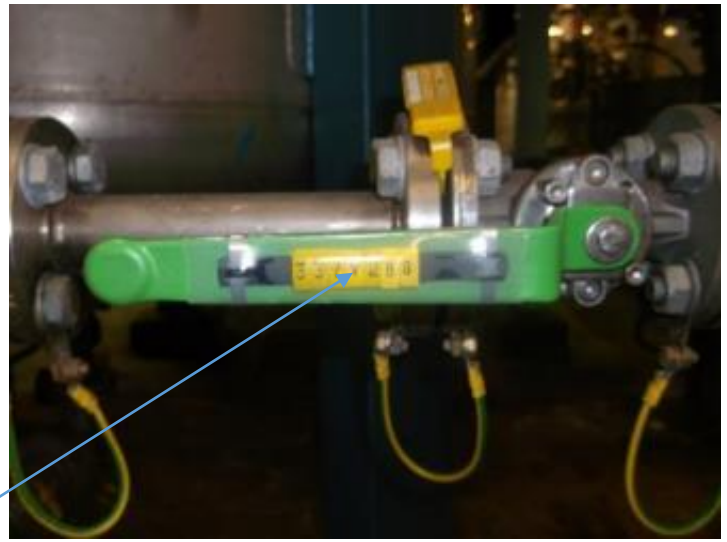
Colour coded and tagged valves (examples):



Normally Open: Green

Normally Closed: Red

Useful Practises, sorted by Type of Incident or Equipment

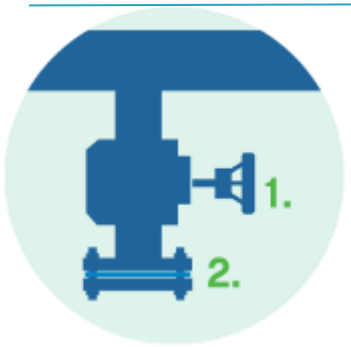
- Manual valve position
- Flange leak
- Overfills
- Breaking off small nozzles
- Wrong equipment (opened)
- Equipment which invite human error
- Wrong material or chemical
- Hose issues
- Plant isolation issues
- Interlock issues
- Loading, unloading
- Organizational practices
- Competency related

Link:
https://epsc.be/Activity/Completed+Working+Groups/_/Human%20Performance%20Best%20Practice%20slides.pdf

EPSC

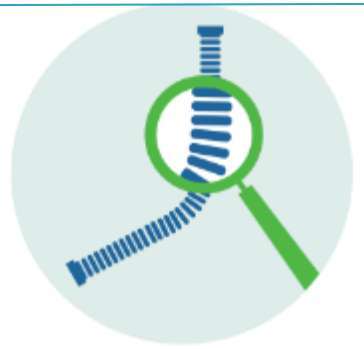
Process Safety Fundamentals

EPSC

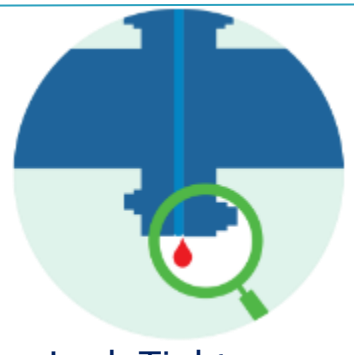


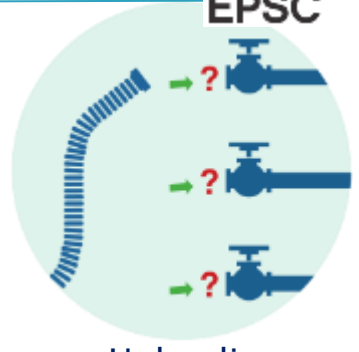
Double Isolation


First Line Break


Flexible Hoses


Furnace Burners


Leak Tightness



Unloading


Open Drain


Operating Limits

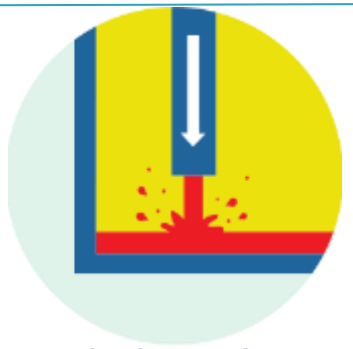
Overrides

Plugged Equipment

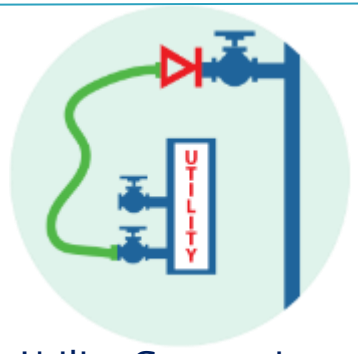

Critical Equipment


Reporting


Run Away Reaction


Splash Loading


Line of Fire



Utility Connections


Walk the Line


Single valve

Link: EPSC – European Process Safety Centre – PS Fundamentals

SAT approach

Just Sharing the good practices is not enough:
First you need to make the practices assessable

Development of SATs
- SAT (Self Assessment Tool): Questionnaire linking to practices
- Working groups, with experts and site people
- Collected useful practices from DSM and industry
- Covers the whole life cycle

Typical chapters:
- Management Procedure / Instruction
- Knowledge and skills
- Design
- Maintain & operate

SAT in practice
- Developed 4 types of SATs and Piloted in 2021
- Assessment done by site, circa 4 hrs each by multidisciplinary teams

	Emmen	Freeport	Village Neuf	Heerlen
Implemented	7%	14%	46%	21%
Partly implemented	68%	46%	50%	39%
Not implemented	25%	39%	4%	39%

Gap assessment result (28 questions)

PSI Focus sites Program

PSI Focus sites Program
- PSI focus sites were selected based on PSI rate
- Best to have about 6-8 sites, a mix of old and new ones
- Annually reviewed: stay – celebrate – new

Senior Management commitment
- Philosophy: Zero Spill mindset
- New sites receive Invitation letter from CEO

Learning platform
- Connect Sites with similar issues
- Analyzing their own PSI and LOPCs from last 3 years
- Monthly calls sharing good practice by one of the sites
- Learn and make it your own: “Double isolation” or “Manual valve position” became: “Hunt for single barriers”, “Orange caps”
- Connect to existing initiatives

Conclusions from the initiatives with ‚focus plants'

- **~ 60 - 70% Reduction of PSI** in the ‚active' year of the initiative 2015, 2016, 2017

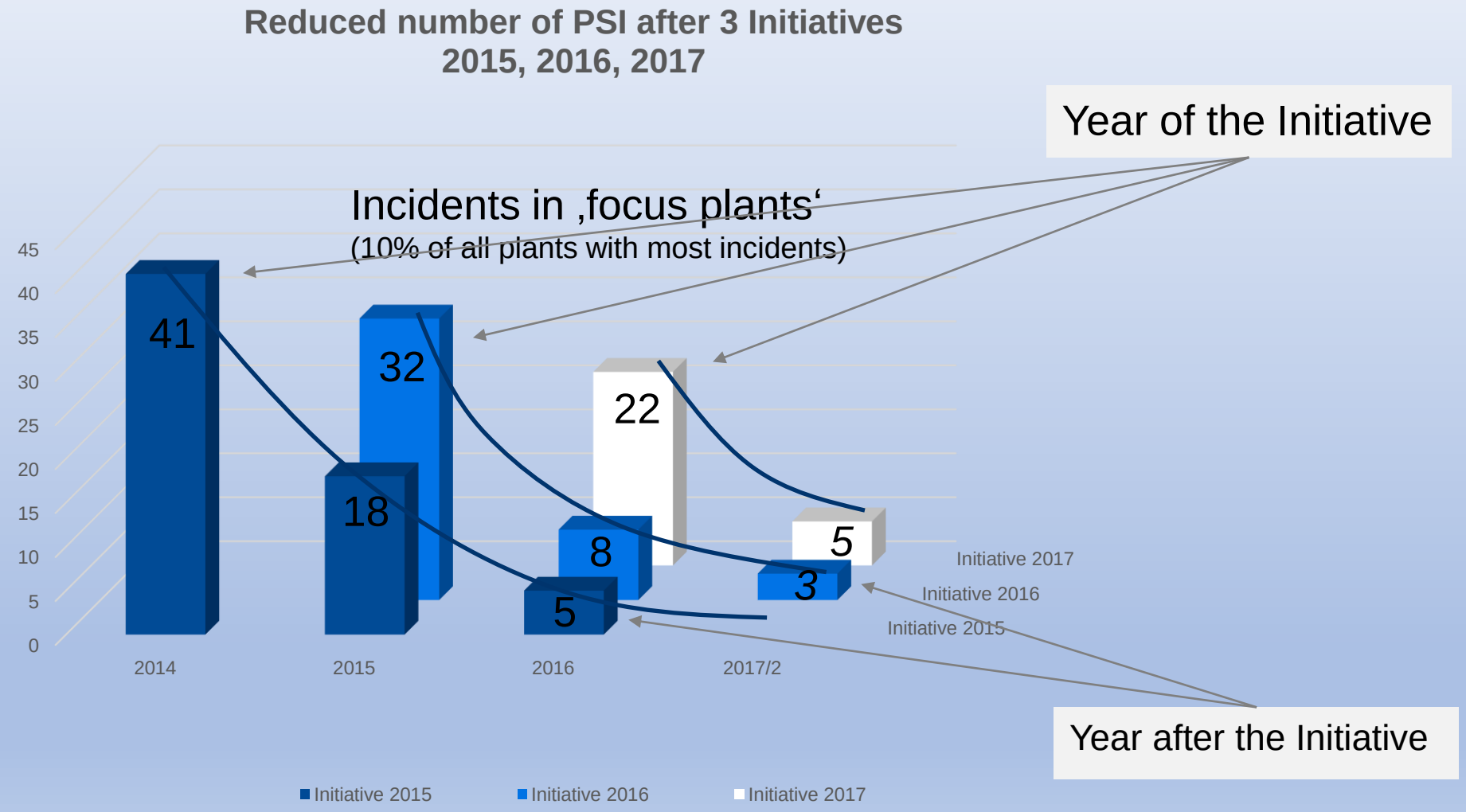
- **Additional ~ 50 - 60% Reduction of PSI** in the year after the active initiative
  → Improvement continues after the year of the active program

➔ Overall **PSI Reduction of ~ 85 - 90% in the focus plants** after 2 years

Key was the experience exchange between plants

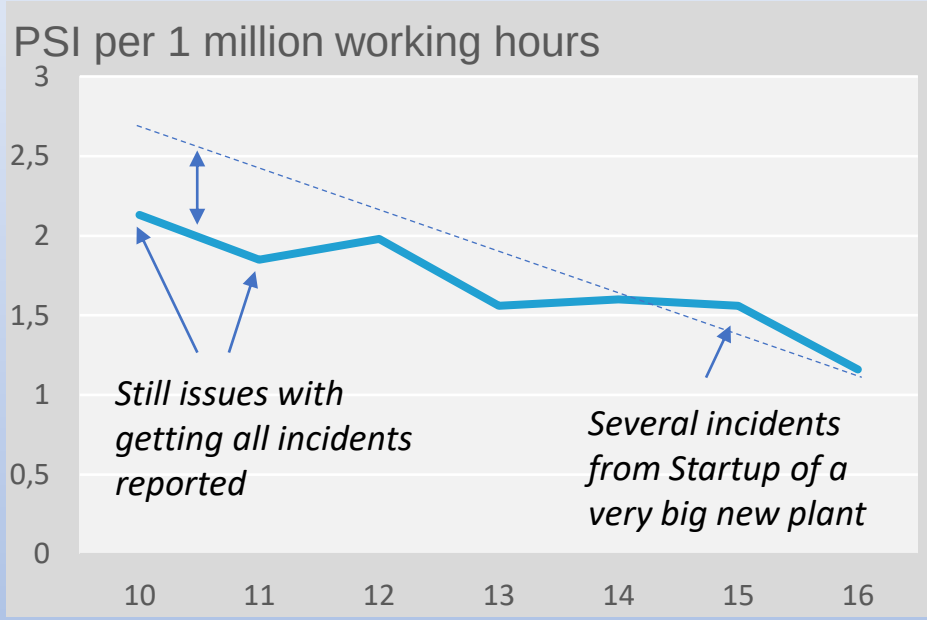
- The approach was less successfull in other regions, where plants were not as intensive in plant-to-plant contact for experience exchange

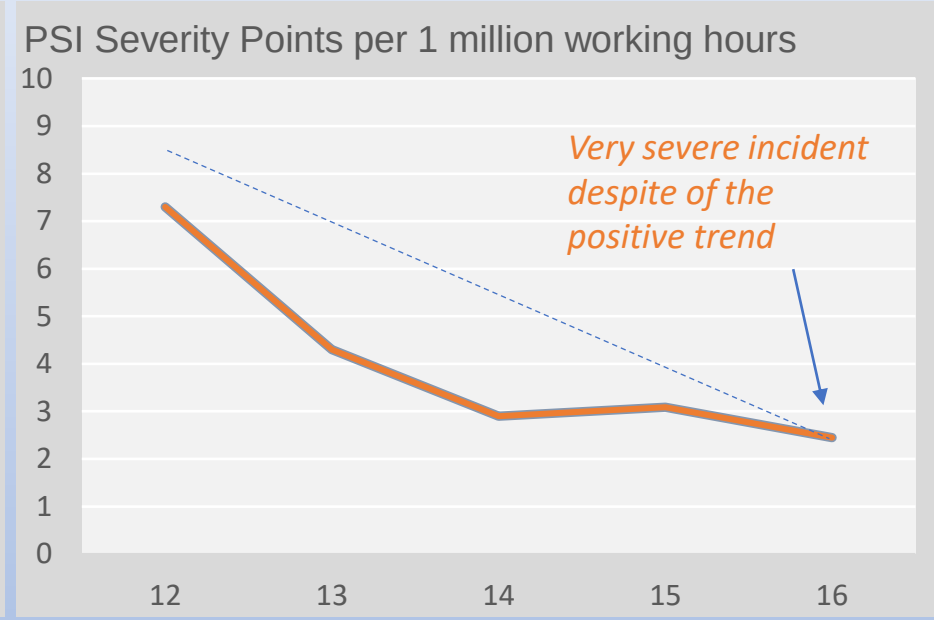
Making use of the un-equal distribution of incidents



Overall result

- Over a 5 year period (2012 – 2016) 40% less incidents, 70% less severity





- Success factor: Intensive work with ‘focus plants’ identified in the analysis
- Issues: - Operating errors
  - Errors during maintenance work/ work under work permit

PSI reduction results

Performance Monitoring
- Monitoring PSI reduction for PSI focus sites
- Do not expect big improvement during the first 1-2 year
- Average annual improvement Focus sites of -45%
- Program results are visible in company PSI performance by -25%

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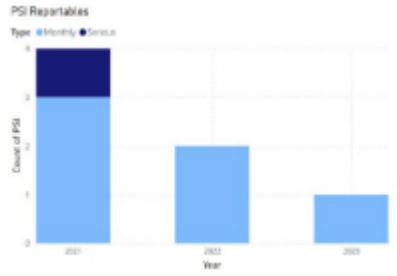
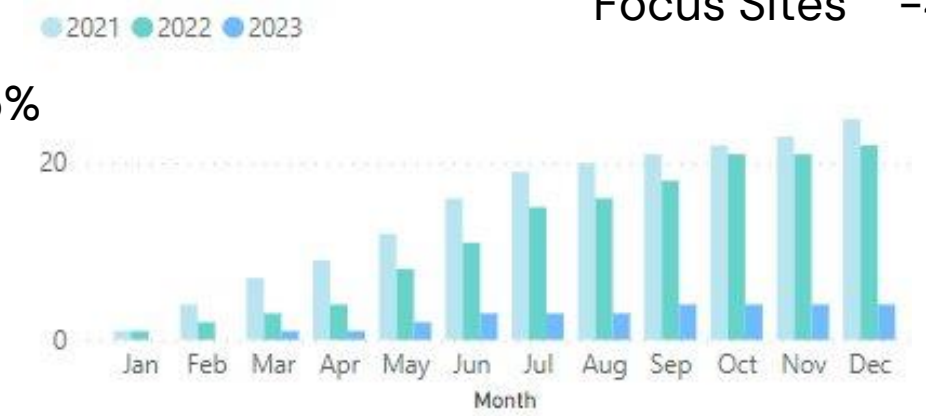
- Analysis 2023 for dsm-firmenich: Same issues.
- Flange leaks / Overfills / BigBag-IBC handling / Open drains
- New topics: Pump leaks / Hose leaks: New SATs to be developed?

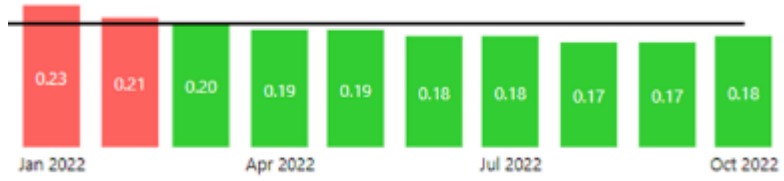
Individual Site



Focus Sites -45%



Company -25%



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Learnings from 2 companies

Successfully Driving Incident Reduction requires:

- A zero-spill mindset with commitment from senior Management
- A focus site program: only for sites that have PSIs
- Utilize useful practices from Industry. Hands-on, practical approach
- Provide a learning platform and make it your own
  - Engaging sites by doing their own analysis and find good practices
  - Encouraging direct discussions and workshops between plants/sites with similar issues

SAT example – PSI SAT Flange Management

A. Score in column 1 (Implementation) whether the detailed step, to your opinion:
Is carried out correctly (Green), Can be improved (Yellow) or Needs to be improved (Red).
B. Indicate in column 2 the present bottleneck when a step can and/or needs to be improved.
C. Ideas about how to solve the bottleneck can be indicated in column 3.
D. Finally, report any remarks about a step in column 4.
E. In column 5 you'll find additional information
F. Column 6 provides links to "Good Practices"

Chapters
-Procedure/Instructions
-Knowledge & Skills
-Design
-Maintenance
-Operation
-Analyze & Improve

Implemented	1
Partly implemented	2
Not implemented	3

Step	Description	Detail	1 Implementation	2 Bottleneck(s)	3 Possible action to deal with bottleneck	4 Remarks	NR.	5 Additional description for inspiration	6 Reference example material
1	Flange Management Procedure / Instruction	1.1 Do you have a Flange Management procedure/instruction at your site?	1				1	Site has an up-to-date Flange Management procedure, which is part of a the site management system including review cycle.	
		1.2 Does the procedure/instruction cover all the "Flange" life cycle activities (Design, construct, operate, maintain, improve, dismantle)	2				2	The consecutive life cycle phases are described in the document, or links/references to other documents describing this phase are provided (e.g. Plant Specbook for design phase).	Example_Dalry Bolted joint procedure.pdf Example Dalry Bolted procedure.pdf
		1.3 Are the responsibilities clearly defined in the procedure/instruction	3				3	Site responsibilities are defined and described in the procedure. Responsibilities are defined related to knowledge, design, maintenance, operate, improve/management review.	Dalry Bolted joint procedure_section 4
		1.4 Does the procedure/instruction describe/determine what are critical flanges?					4	Critical flanges are defined. For critical flanges specific competence, tools, work procedure may be required. This is defined in the procedure. Critical flanges are flanges which likely lead to a monthly PSI based quantity and/or toxicity (see PSI flow chart)	Dalry Bolted joint procedure_section 3
2	Knowledge and skills of Flange Management	2.1 Are all relevant people (SHE, operations, maintenance including contractors and improve) at your site aware of the existence of the procedure/instruction, are they trained and do they know the content?					5	The flange management procedure is part of the site management system and describes how relevant roles/people are being regularly informed/trained on the existence/application of the procedure (e.g. online or information sessions). These awareness/training sessions also serve to verify that participants understand the content and evidence is documented. External service providers should assure and document that their people are formally trained as per the site procedure.	
		2.2 Are those who are working on flanges practical trained and does the site have evidence of the fullfilment of the required competence?					6	The site has defined in the Flange Management procedure who may work on flanges and what qualification is required. Next to knowledge of the procedure (previous question), practical training is provided to the relevant roles/persons. This is valid for own staff (operators, maintenance) and external service providers. A certification which demonstrates evidence of capability on working with flanges is available (e.g. certain levels: certificate for working on critical flanges). Remark: Many external trainings are available that provide flange integrity management according to EN1591-4. e.g. 2 day flange training including certification.	Example Flange training.pdf
		2.3 pro cor flar					7	People are aware of the Flange management procedure and always us (There procedu embedd checks applied correctly.	

Chapters

Requirement Question

Score

gaps

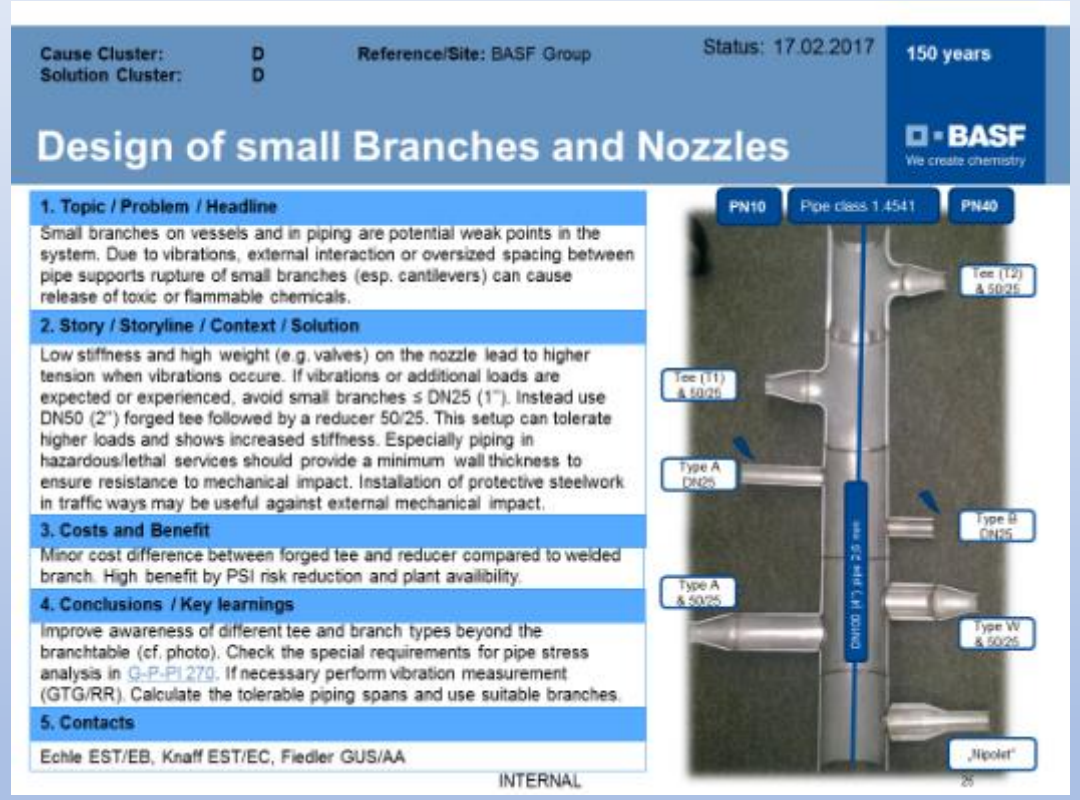
action

Description of what is expected

Example material e.g. procedure, training provider, maintenance instruction

Transferrable ‚best practises‘

- **Many of the improvements were ‚transferrable‘ to other plants**
- **Catalogue of successfull practises**
  - Transferrable ‚successfull practises‘, are captured on 1 slide for each, with
    - simple description,
    - foto & contact information
  - Used company wide



- The ‚Catalogue of successfull practises‘ became a global success in BASF.
- **It became the basis of the even broader ‚EPSC best practises‘**