Useful Practises of Process Safety Incident prevention

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October 2016: BASF‘s worst incident in decades

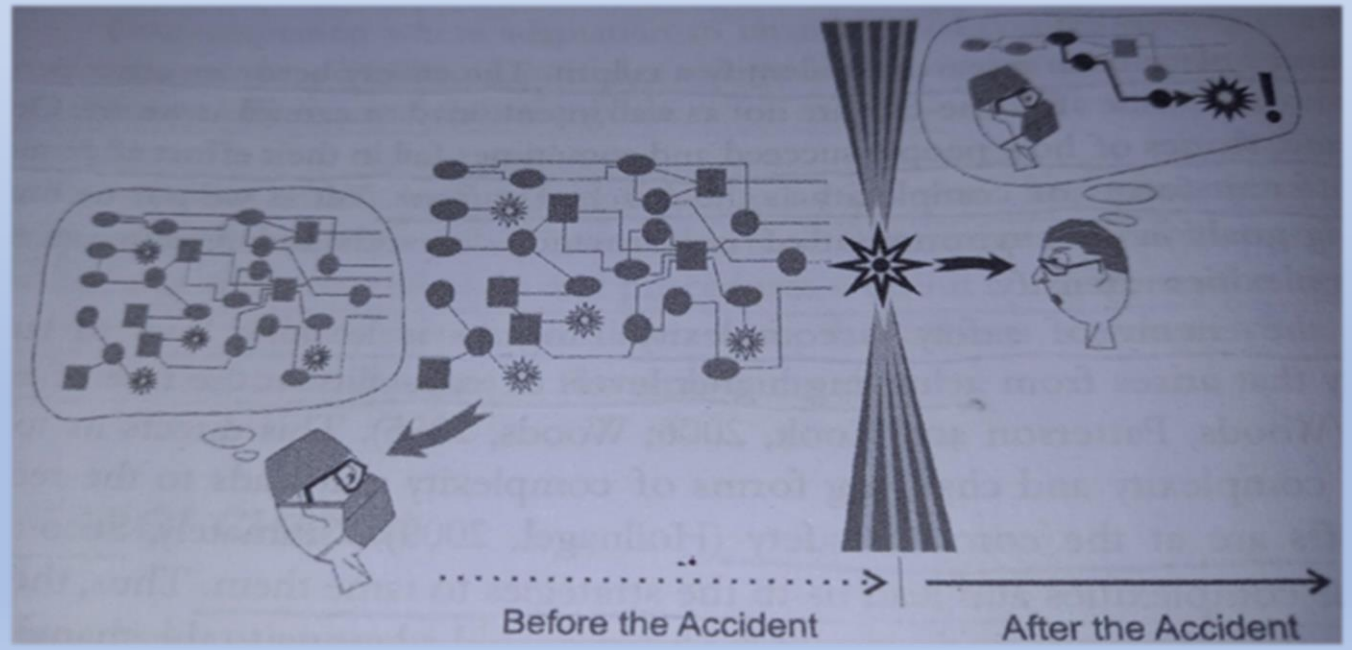
- Cut in the wrong pipeline, with ignition, puts neighboring Ethylene pipeline under fire,
  - Explosion of Ethylene pipeline (80 bar, supercritical Ethylene)
    - 5 Fatalities, 7 severely injured

Before the incident

After the incident

Human error

- Unsafe acts result from (inevitable) compromises in a complex environment
  (1990s, 2000s, Woods, Dekker, Hollnagel)
- In hindsight, accidents often look like incomprehensible mistakes of individuals.
  That view ignores, how a process is ‘normally’ executed.
  Seen from the end (the accident), the cause appears to be ‘simple’.



Behind Human Error, 2010, Woods, Dekker, Cook, Johannson, Sarter

Practical approach

- How can we help the worker to avoid such mistakes ?

Practical approach

- How can we help the worker to avoid such mistakes ?

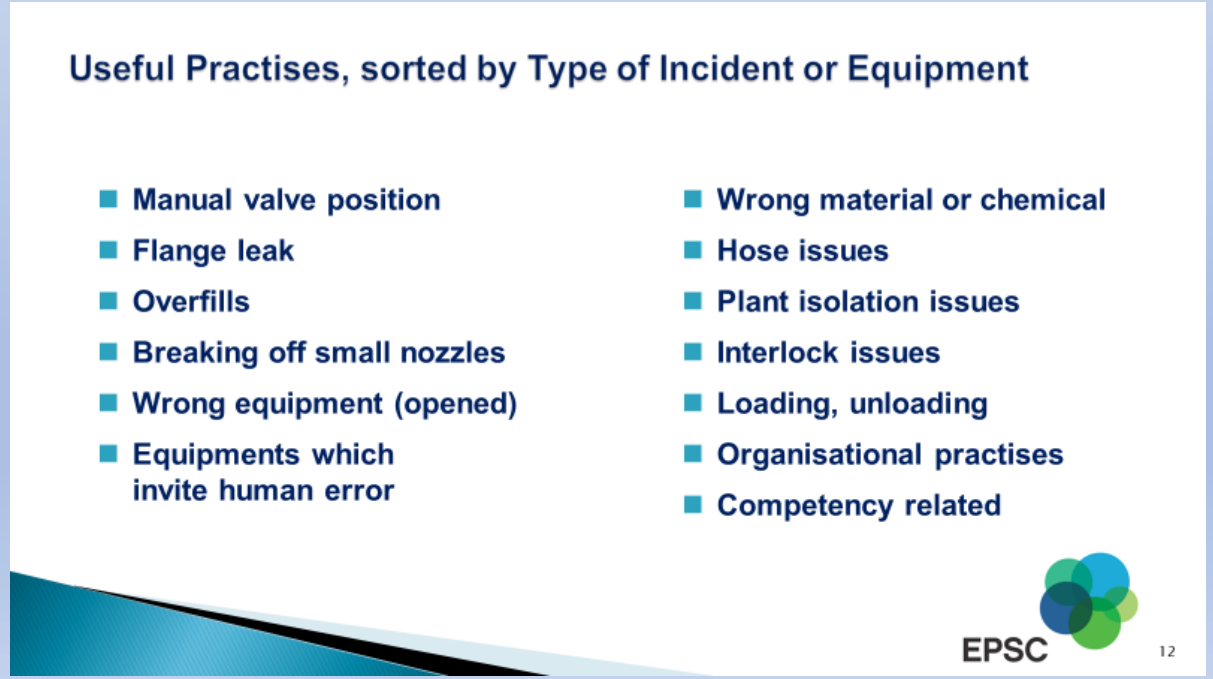
1 : marking the pipeline

2: Tape marking the cutting point

3: Date and signatures

EPSC Useful Practises of Incident Avoidance

- Based on an approach of BASF
- Broadened by an **EPSC working group** of Chemical, Pharma, Oil&Gas companies & made company independent
- Catalogue of ~50 useful practices (each company can expand this)
- Approach benefits from strong ‘bottom up’ participation of operators



Source: EPSC Presentation Köln, 2019

Useful Practises, sorted by Type of Incident or Equipment

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

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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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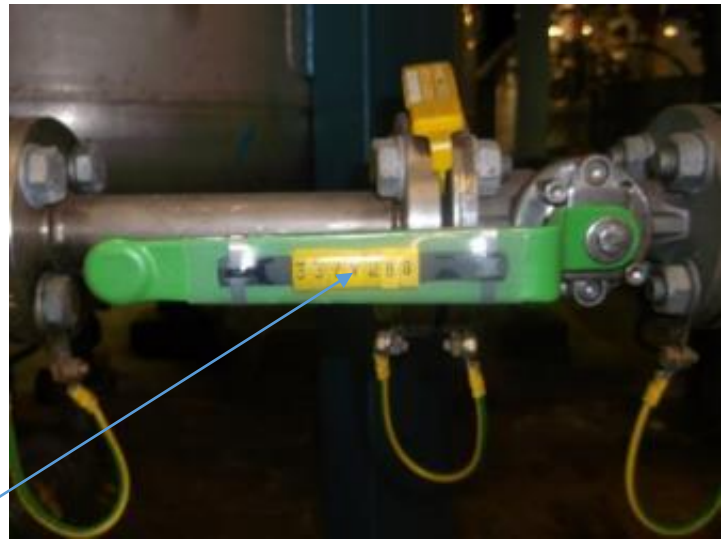
Colour coded and tagged valves (examples):



Normally Open: Green

Normally Closed: Red

Valve position

LOTO to assure valve position

Problem

Especially after repairs, turnarounds and washout or purging procedures, **valves are left open**, leading to the release of a chemical

Solution

Applying **Lock-out /Tag-out (LOTO)** system will help to ensure that no valves, openings or devices are left in the incorrect position

Sign-off each item on the LOTO checklist

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Lock-out /Tag-out cards (examples):

Mechanical locks (example):

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Flange 4 step Label

Flange

Problem

Flanges can leak if certain steps are forgotten or not well executed

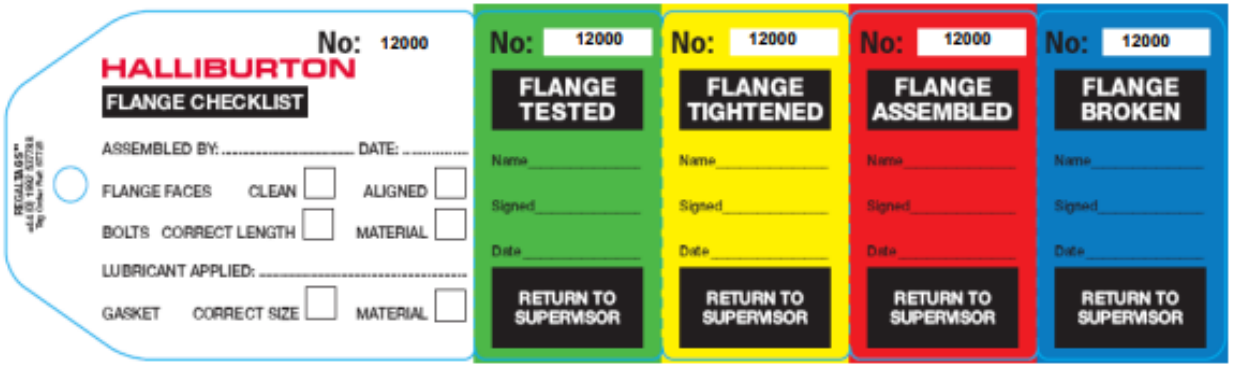
Story

Companies / Contractors use a 3 or **4 folded label** that indicates the critical steps and bolt tension. At each step a part of the label is removed and given back to the foreman or to production

Solution:

Use a label at flanges that need to be opened, so that the critical **steps can be validated, step by step**. The label is made of strong and water resistant material. Each part can be torn off, after completion.

Four folded flange label, attached to flanges before opening. From outside: 1 Broken, 2 Assembled, 3 Tightened at set tension, 4 Leak test performed



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Personalization of Flanges

Flange

Problem

Leaking flanges because **bolts not tightened** with the correct torque, **or missing**;
or the **flange seal face** damaged,
or **gaskets** not suitable or incorrectly installed.

Story

Make the Craftsman, who assembles the flange, **'sign' his work**. Instill sense of responsibility for the correct installation.

Solution:

All flanges get seals or **labels with a personal identifier for employee / contractor** worker who assembles the flange, + for the person who ensures the tightness of the flange (seal quality). + technical information, e.g. type & material of gasket
Modern version: **QR code**

Flanges identified by lead seal system:

QR code identification:

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Flange

Tightness of large flanges

Problem

Large flanges leaking due to different torques on the bolts

Solution

Use of **bolts with force indicator** or use of **hydraulic torque tensioning tool** during flange assembly.

Tightness test with e.g. nitrogen, gradually increase the nitrogen pressure and perform check with an adequate leak detection substance (e.g. spray) or pressure hold test

Tightness check (examples):

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Removal of gearbox or actuator from valves

Problem

During removal of an inoperable gearbox on a plug valve, the operator **mistakenly removed critical bolts** securing the pressure-retaining component of the valve. The valve came apart and released the process fluid.

Solution

Evaluate human factors associated with equipment design and apply the hierarchy of controls e.g. **improve design to mitigate identified hazards**

Establish detailed and accurate written procedures and provide training to ensure workers know the hazards and how the plug valve gearbox should be disassembled safely.

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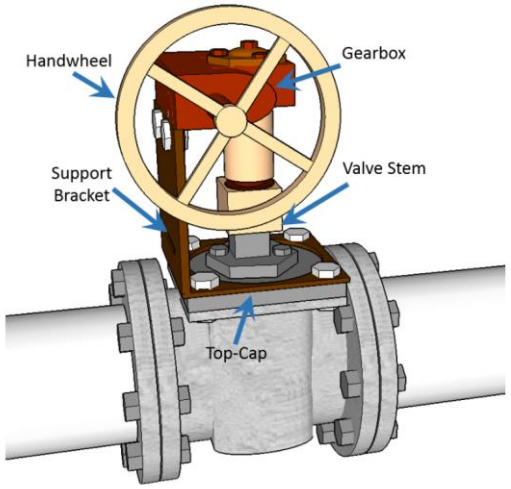
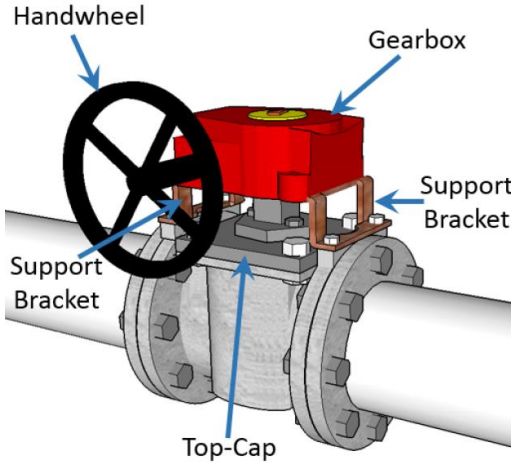
Different design



By design, removing the gearbox did not require removing the four vertical bolts that secured the pressure-retaining top-cap



Improved design, showing how gearbox connects to all four dedicated attachment points on the valve flanges that are not pressure-retaining parts.

Reference: CSB see https://www.csb.gov/

Rupture disk installation

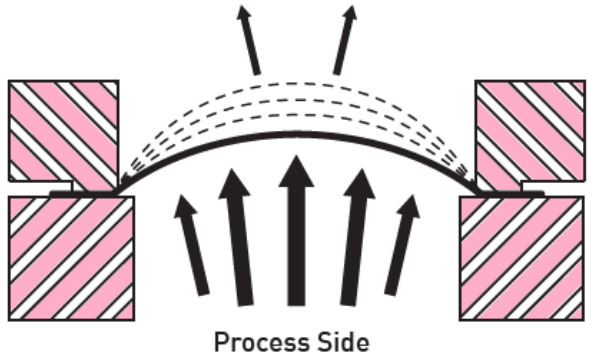
Poka Yoke

Problem:

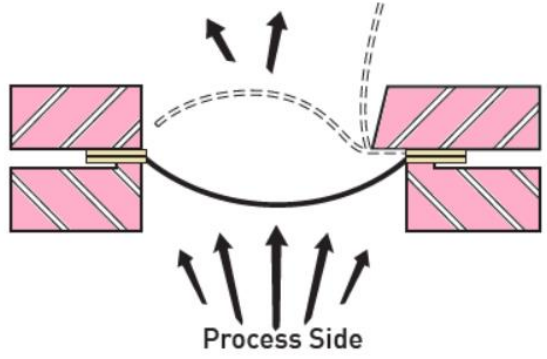
Rupture disks can be of the type "Forward-acting" or "Reverse-acting". Depending on the type, the dome must be placed upwards or downwards. **Installing a rupture disc upside down, is an easy mistake**, that changes the bursting pressure, and may result in tank rupture before the rupture disk breaks.

Solution:

- 1 Use **disk holders that only allow the right installation** (Poka Yoke).
- 2 If not available: Always check the **flow direction indicator** on the rupture disc, and have an independent verification by 4-eye principle to confirm correct installation.

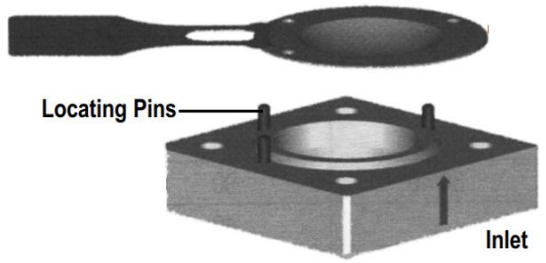


Forward-acting (Tension loaded) type Rupture DisK



Reverse-acting(Compression loaded) Type Rupture Disk

1 Disk holder with locating pins to assure right installation



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Indication of flow direction

Bob van Woezik DSM

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Protection of Interlocks

Interlock

Problem

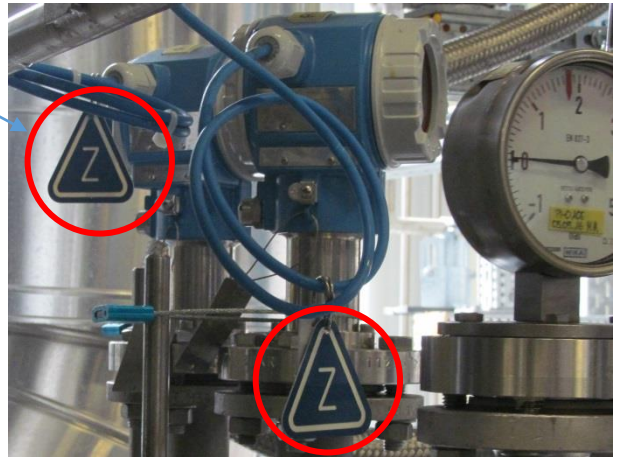
Safety interlocks are sometimes **deactivated** (unintentionally, or intentionally to solve production issues) during operation **without proper permission**. Accidents can result.

Solution

- Make Safety interlocks visible e.g.: label in the field, on documents, P+IDs and DCS-screens.
- Avoid easy bypassing by technical means, e.g. use **key cards or passwords** for DCS-systems or locks at operation panels.
- **Enforce the rule,** to work on safety interlocks **never** without a specific authorization/Permit to Work

Key card to protect access to SIS

Labeling of Safety Interlock Instrumentation



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Right Location

Marker for Line Cutting

Problem

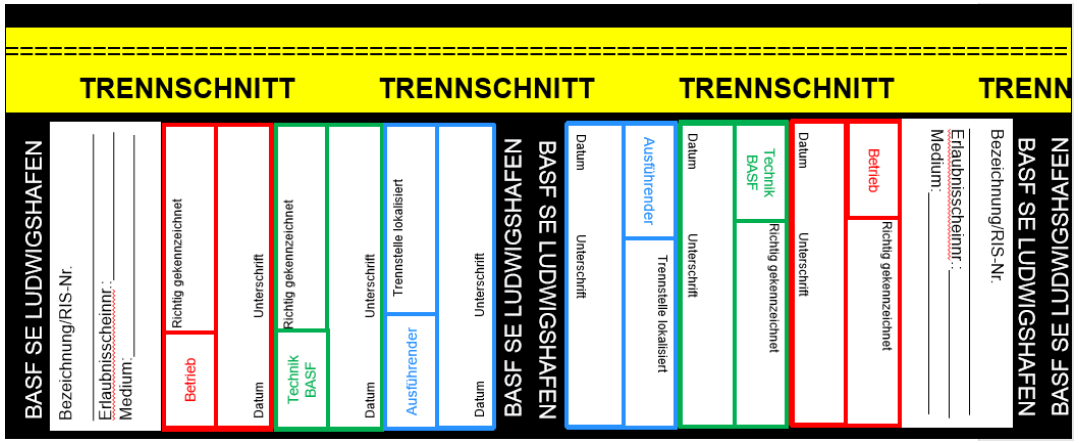
Cutting into the wrong pipe during technical changes, or maintenance work. Avoid consequences of a single human failure.

Solution

Before a line cutting task, a risk assessment is needed.
Critical pipe cut location to be marked with adhesive tape.
Note on the tape the work permit number, signature of plant supervisor, date of work.

Clearly identified and marked pipeline

Example of an identification adhesive tape



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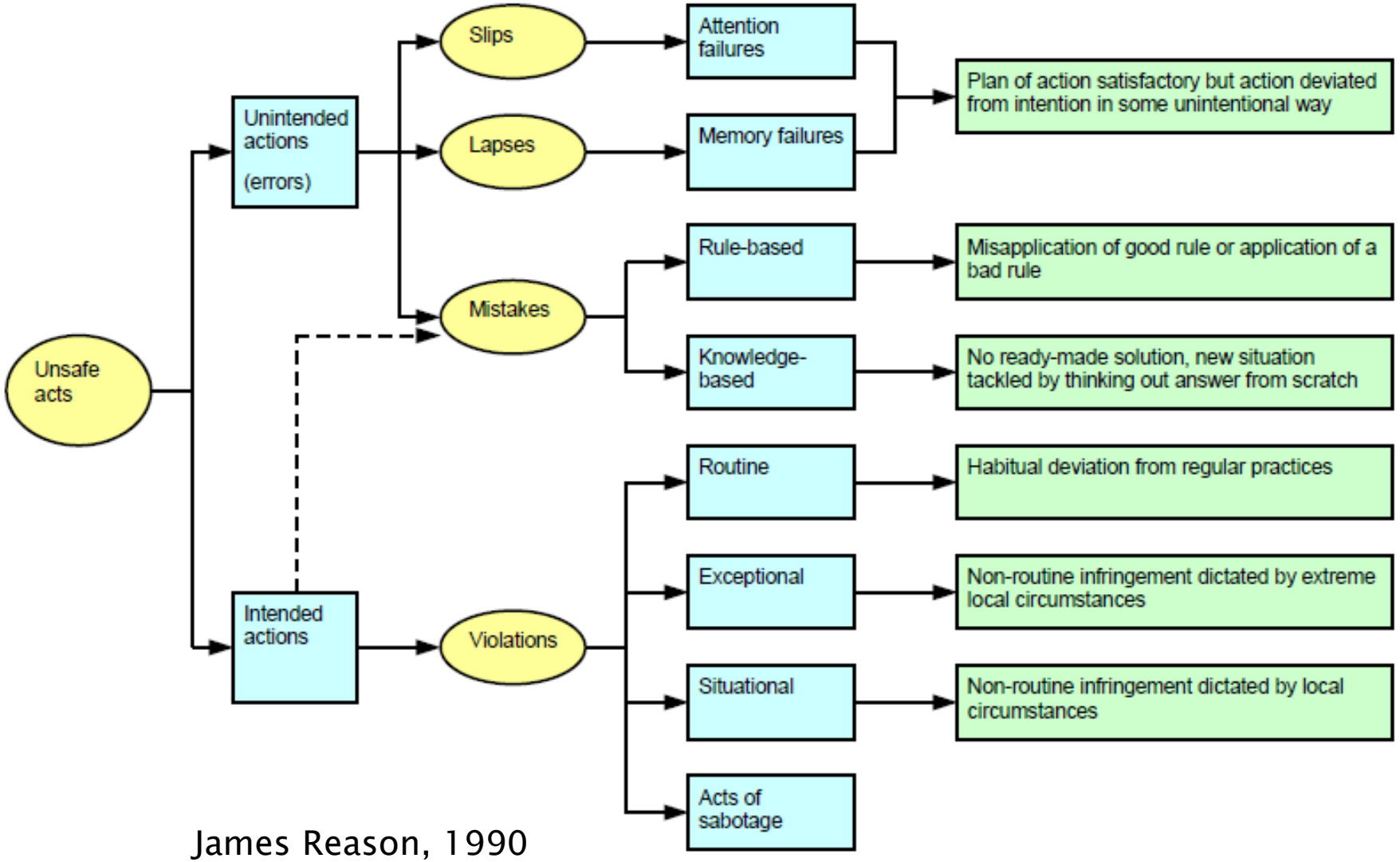
How to get started

- Start in a plant with ‘more than usual’ incidents
- Analyze your PSIs: are there common circumstances ?
- Let operators and/or maintenance technicians pick 1 or 2 ‘useful practices’, and implement with their help
- Repeat with another useful practice

- The catalogue of the useful practices can be found on www.epsc.be

Backups

Classification of Human Errors (HSE, UK)



James Reason, 1990

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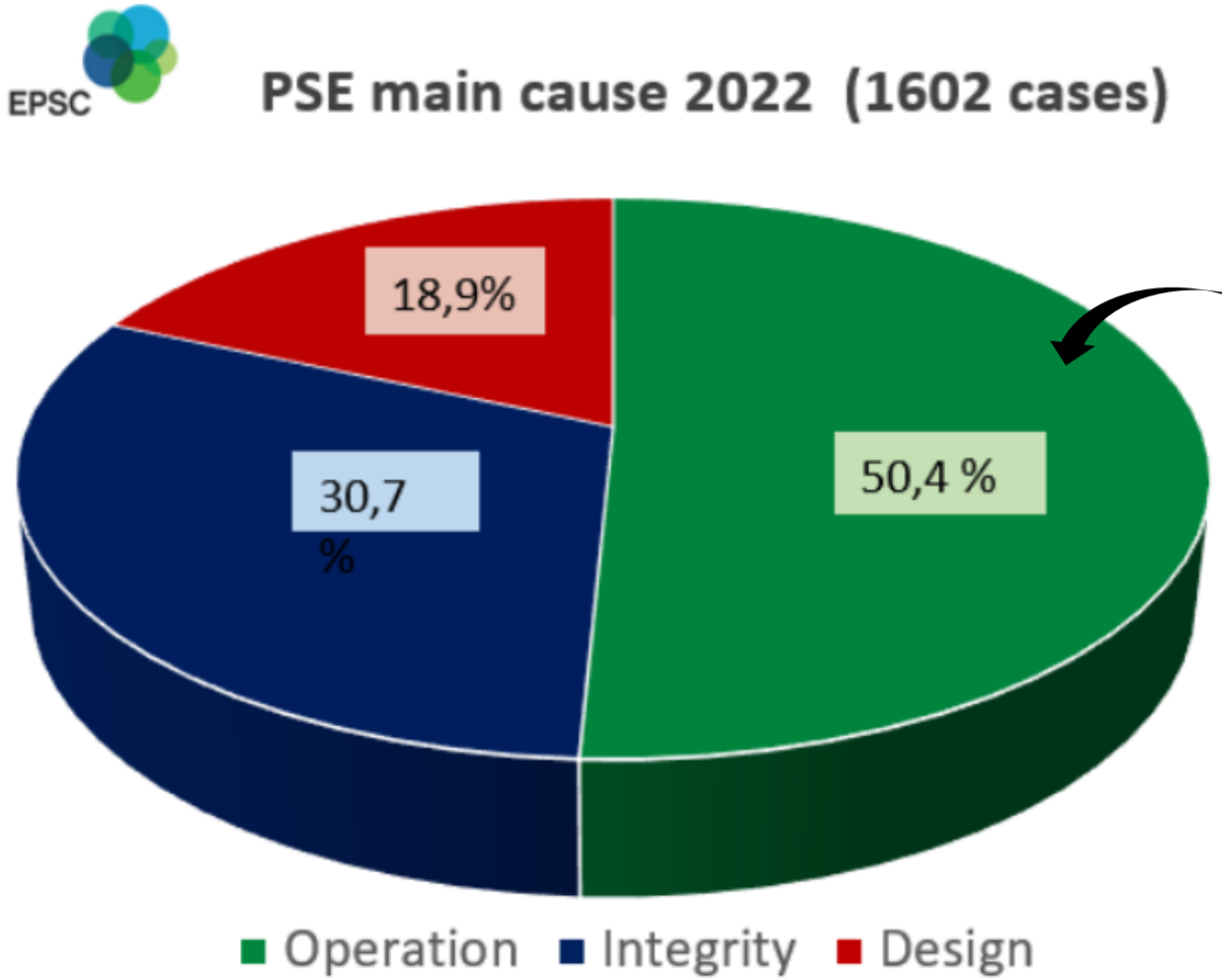
EPSC Benchmarking of Process Safety Incidents



Most PSI occurr during operation or maintenance

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Technical overfill protection

Problem

Overflowing tanks or vessels, when filling is manually controlled by operator, without overfill protection.

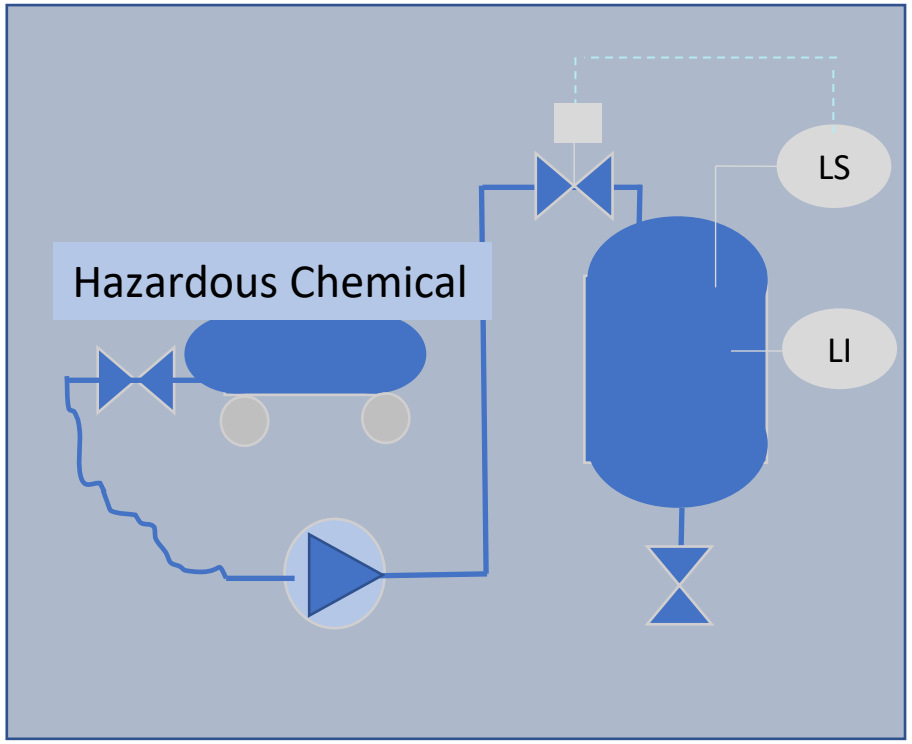
Hazardous materials handled in tanks without overfill interlock, relying on operator to stop filling at high level

Solution

Tanks with hazardous materials should **have level gauge and high level interlock**, which stops the feed on level high.

High level interlock in adequate reliability class.

Overfill



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