16th Chemical Process Safety Sharing (CPSS)

Journey of Functional Safety in SCGC

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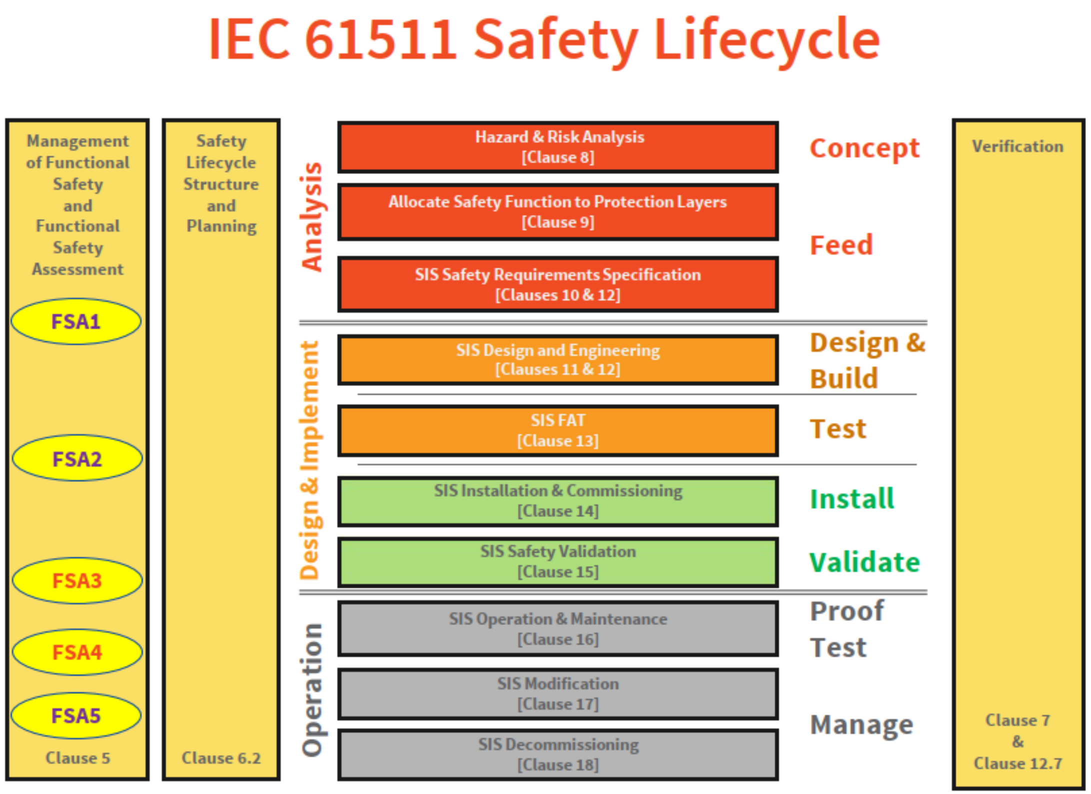
Background

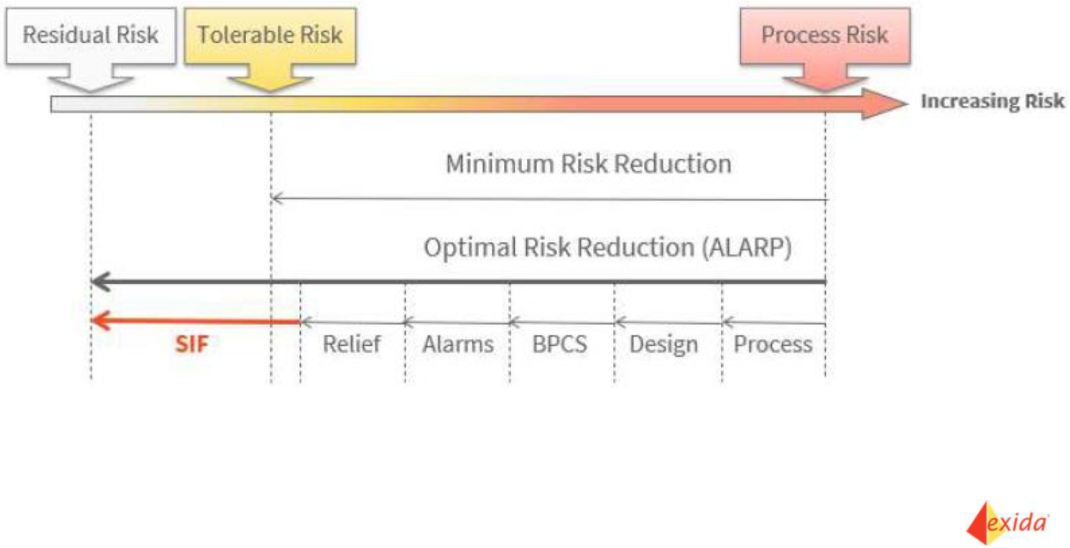
Lessons learnt from incidents take us to review & revisit what we did and find gaps to improve

Strengthen PHA quality and ensure Major Hazard Incident Prevention with the effectiveness of interlock evaluation, design, operation and maintenance

Functional Safety

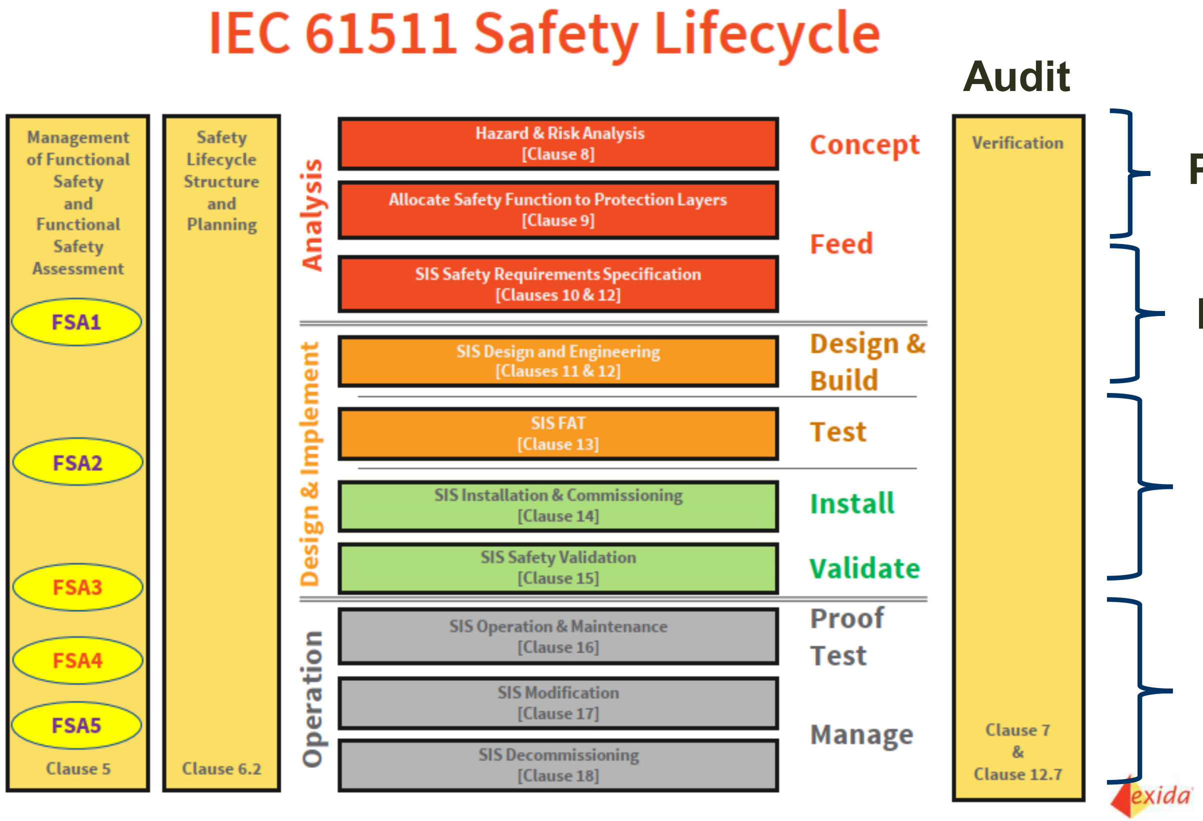
"Part of the overall safety relating to the process and the BPCS which depends on the correct functioning of the SIS and other protection layers" **IEC 61511:2016 Part1**





Strengthen PSM with Functional Safety

Mapping PSM vs Safety Life Cycle (IEC 61511)



PHA

PSI

PSI/PSSR/CSM

SOP/SWP/MOC/PHA/MIQA /CSM/Training/PSI

Strengthen PSM with Functional Safety

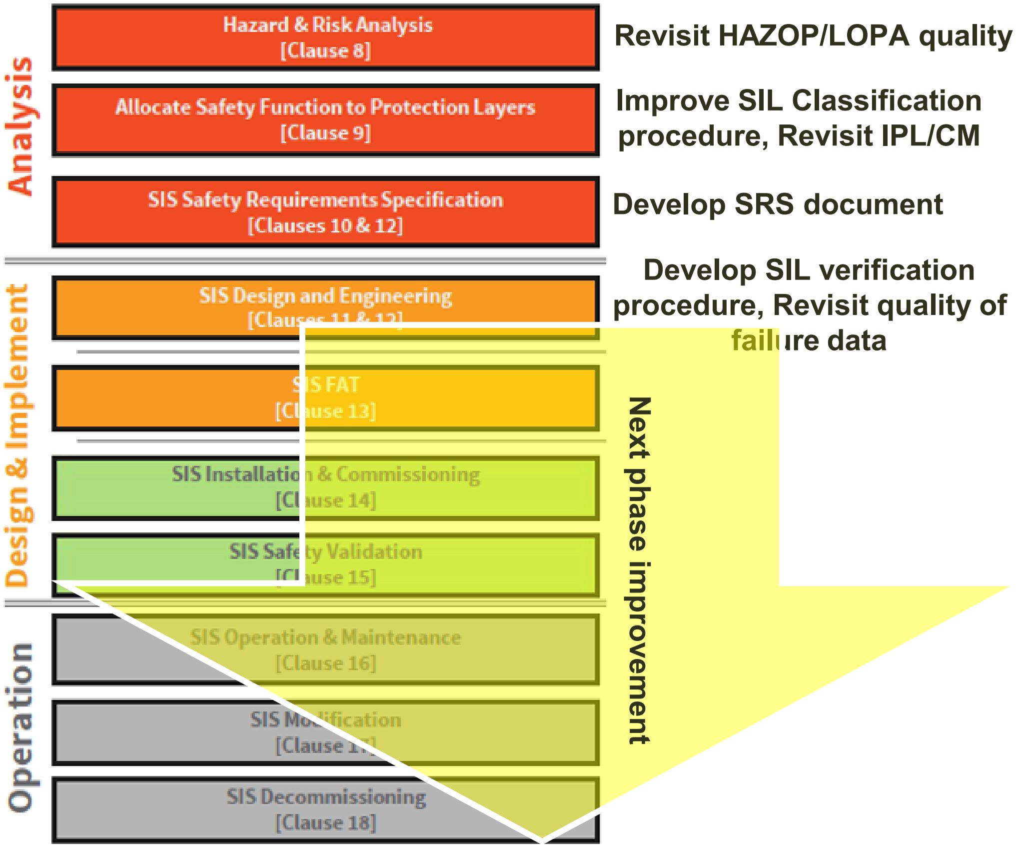
Review existing PHA practice

10 Steps of PHA

1. **Planning and Preparing**
2. **Hazards Identification**
3. **Consequence Analysis**
4. **Process Hazards Evaluation**
   - What If
   - HAZOP / LOPA
5. **Other Considerations**
   - Human Factors
   - Facility Siting
   - Inherently Safer Process
   - Interlock Evaluation
6. **Risk Assessment**
7. **Recommendations**
8. **Documentation**
9. **Management Response**
10. **Communication and Tracking**

SCG

What we're improving

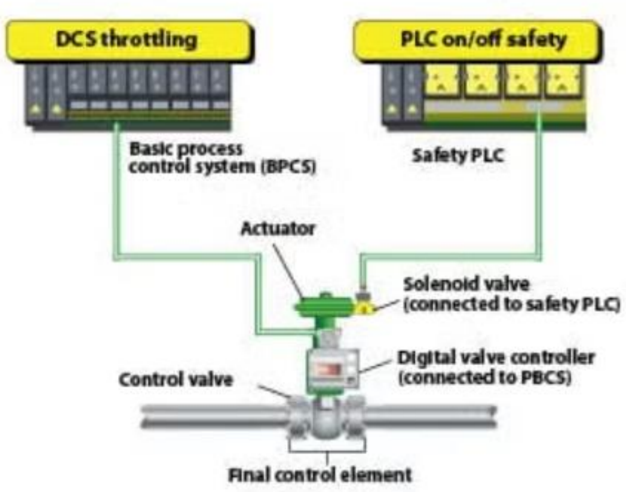


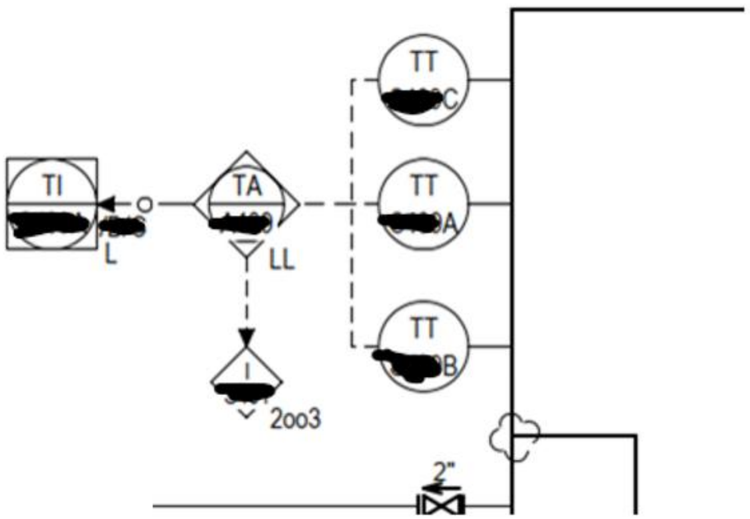
- Revisit HAZOP/LOPA quality
- Improve SIL Classification procedure, Revisit IPL/CM
- Develop SRS document
- Develop SIL verification procedure, Revisit quality of failure data

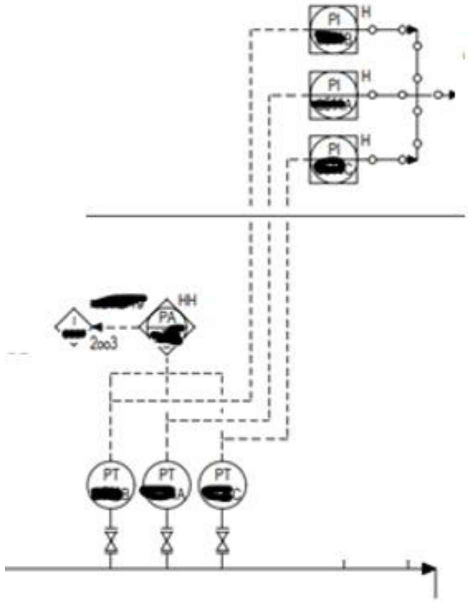
Functional Safety Improvement to prevent Major Hazard

Revisit HAZOP/LOPA, IPL quality

- Review IPL credit in case of sharing any component between SIS & BPCS







Functional Safety Improvement to prevent Major Hazard

Revisit HAZOP/LOPA, IPL quality

- Unreliable measuring devices e.g. level, temperature, pressure switches will not be IPL credited if no testing evidence.
- Review process design/calculation used in IPL (e.g. sizing PSV for which scenario)
- Review impacted from the consequence with process design (e.g. overpressure, cold temperature, surge against pipe class)
- Consider corrosion impact in case of prolong operation
- Encourage to record as note in worksheet in case of no cause identified, low consequence impact e.g. happen in short period.
- For alarm & operator response, ensure operator has enough time to take action.

Functional Safety Improvement to prevent Major Hazard

Develop Safety Requirement Specification (SRS) document

- Clearly identified the SIF design intent
- Visualize via Reliability Block Diagram
- Indicate the characteristic of SIF and its elements
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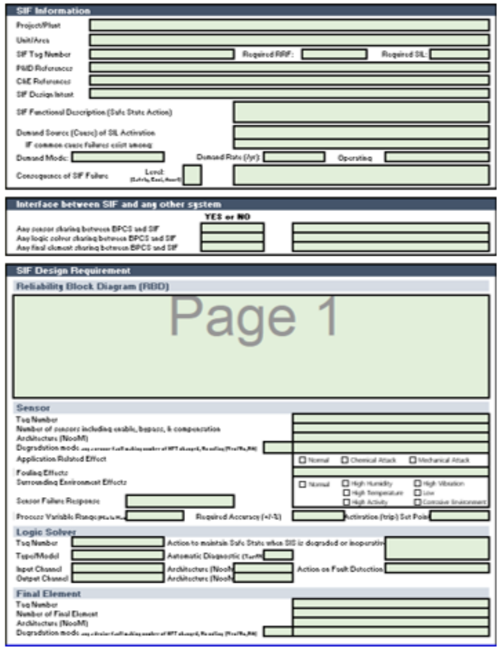
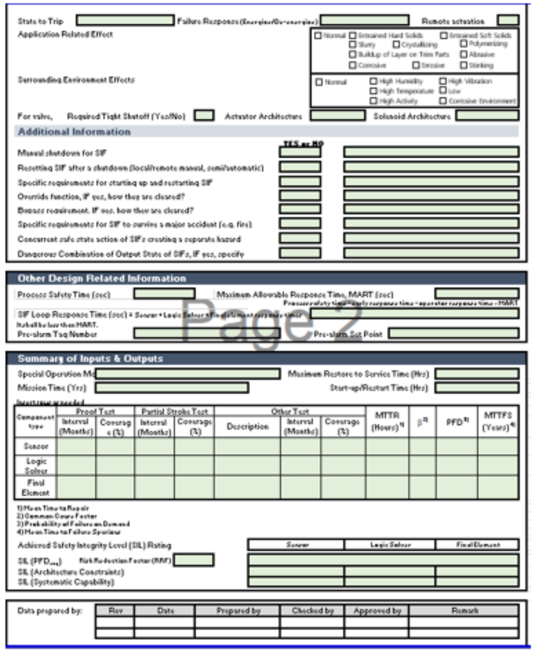
- Indicate necessary parameters of test to be used in SIL Verification
- Indicate the SIL target and SIL Verification result

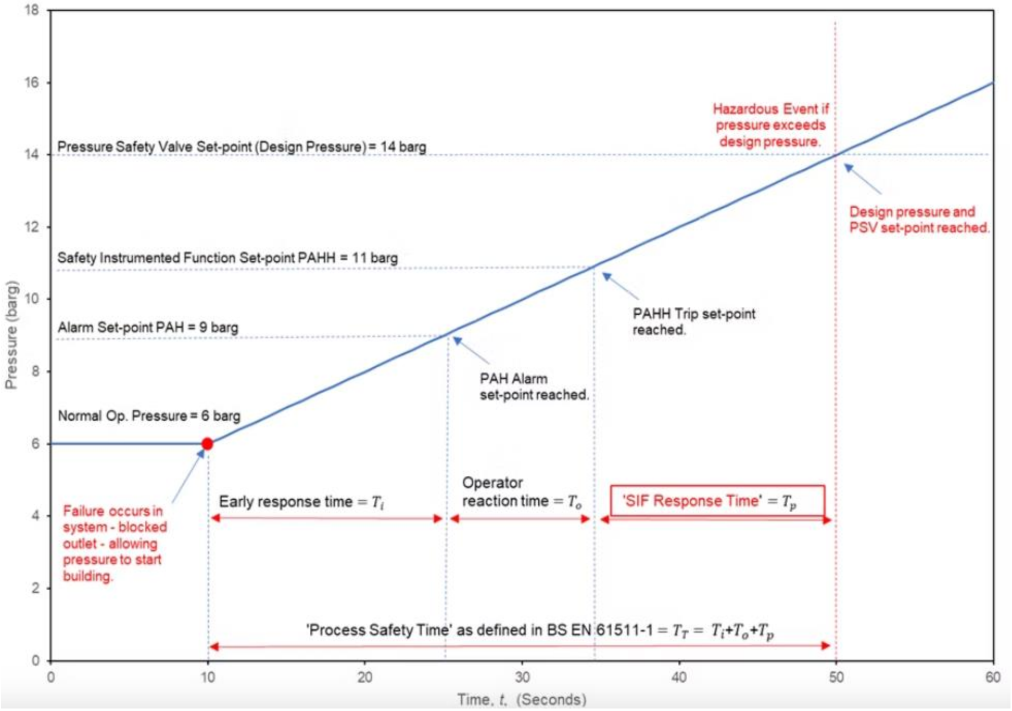




Functional Safety Improvement to prevent Major Hazard

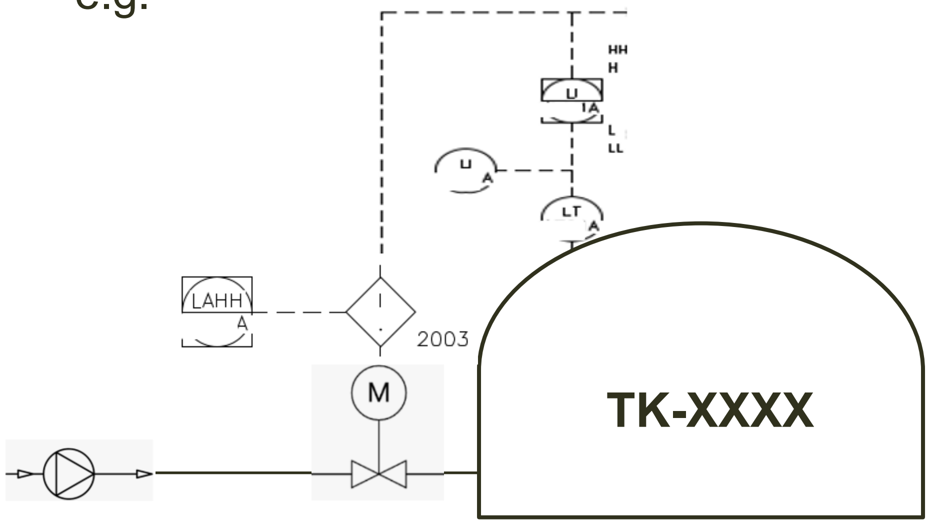
Develop Safety Requirement Specification (SRS) document

- **Assess SIF response time VS process safety time**



https://www.ors-consulting.com/difference-between-the-process-safety-time-and-the-sif-response-time

e.g.



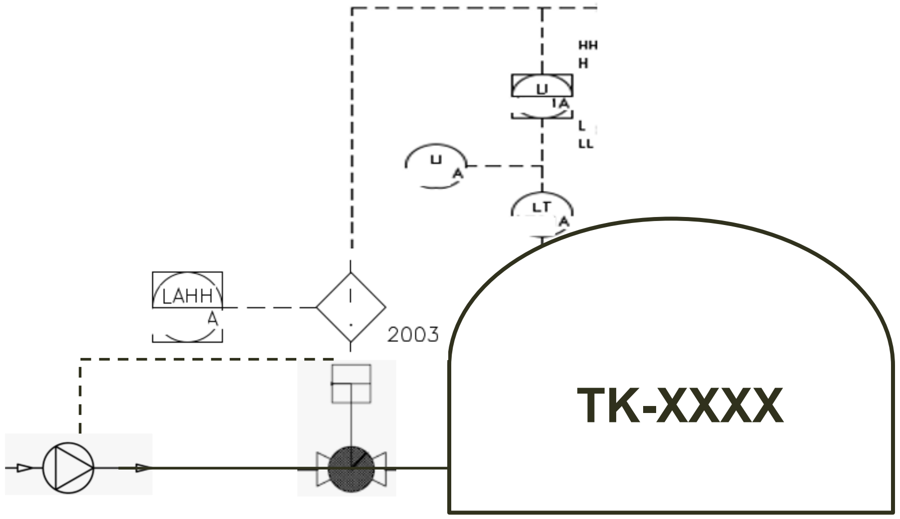
Change MOV to XV valve to reduce closure time in case of level high high

Functional Safety Improvement to prevent Major Hazard

Develop Safety Requirement Specification (SRS) document

- **Review concurrent safe state hazard**

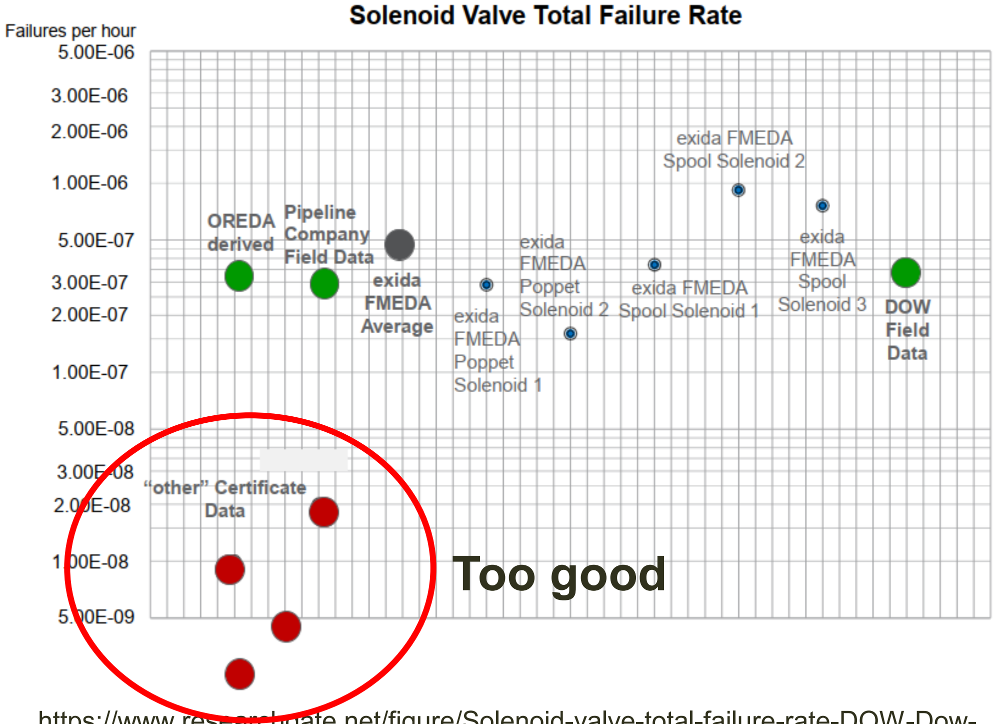
Safe state function of SIF will not create a new hazard (collateral hazard)



Functional Safety Improvement to prevent Major Hazard

Develop procedure to control SIL Verification quality

- **Review & Screen failure rate data of hardware**



Too good

https://www.researchgate.net/figure/Solenoid-valve-total-failure-rate-DOW-Dow-chemical-field-data-FMEDA-failure-modes_fig5_351947208

IEC 61508 Failure Rates in FIT*

Application/Device/Configuration	λSD	λSU	λDD	λDU
Full Stroke, Clean Service	0	0	0	396
Tight Shut-Off, Clean Service	0	0	0	1185
Open on Trip, Clean Service	0	135	0	261
Full Stroke with PVST, Clean Service	0	0	131	265
Tight Shut-Off with PVST, Clean Service	0	0	131	1054
Open on Trip with PVST, Clean Service	134	1	131	130
Full Stroke, Severe Service	0	0	0	719
Tight Shut-Off, Severe Service	0	0	0	2244
Open on Trip, Severe Service	0	257	0	462
Full Stroke with PVST, Severe Service	0	0	226	493
Tight Shut-Off with PVST, Severe Service	0	0	226	2018
Open on Trip with PVST, Severe Service	254	2	226	236

PTI period ?

Functional Safety Improvement to prevent Major Hazard

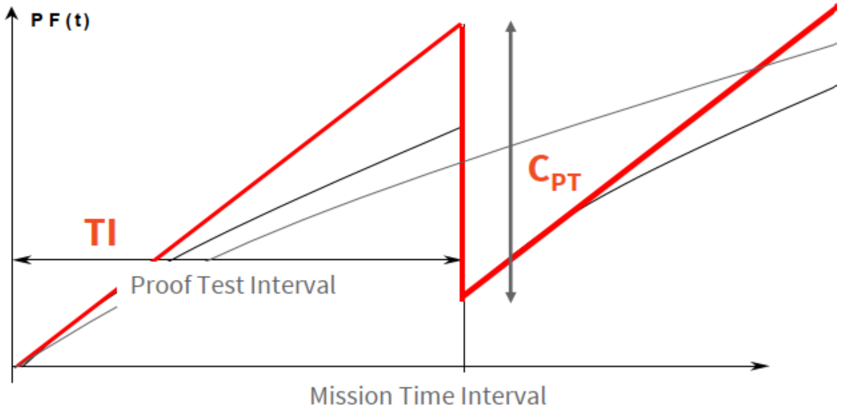
Develop procedure to control SIL Verification quality

- **How to claim % prove test coverage not too optimistic**

Ensure to follow the proof test instruction in safety manual

If no data? How to define? Liaise with vendor/manufacture

e.g. Valve Overhaul and Full Test –> PTC = 99% Is it reasonable?



Safety Manual

Device-Specific Values

Probability of Dangerous Failure on Demand	PFD_{spec}	2,12 E-04
Confidence Level	1-α	95 %
Safe Failure Fraction (see note)	SFF	68 %
Hardware Fault Tolerance	HFT	0
Diagnostic Coverage	DC	0 %
Type of Sub System		Type A
Mode of Operation		Low Demand
Proof Test Coverage	PTC	85 %

5. Operation

5.1 Recommended proof test

The purpose of proof testing is to detect failures of the complete final element subsystem. Neles recommends the following proof test procedure:

- Conduct an initial visual inspection. Check that there are no unauthorized modifications to the SIS valve assembly. Verify that there is no observable deterioration in the SIS valve such as pneumatic leaks, visible damage, or impurities on the SIS valve.
- Bypass the SIS valve if full stroke could cause an unnecessary process shutdown.
- Perform the safety action (full stroke), preferably using the system. Verify that the SIS valve achieves safe position within the required time specified by the application. Verify also the shutoff tightness for tightness critical applications. Note that a tightness measurement might require removing the valve from the pipeline. If the valve must be removed from the pipeline, verify proper full stroke operation after re-installation.
- Restore the SIS valve to it's normal position.
- Conduct a final visual inspection. Check that the SIS valve is in the normal position, and verify that all accessories are operating according the specification for the SIS valve normal operation. Inspect visually that there is no observable deterioration of the SIS valve.
- Record all results and observations into the corresponding database with necessary audit trail information.
- Remove the SIS valve bypassing, if used.

The Challenge and Way Forward

Human Errors & Mistake

Competency gaps

Lean Manpower

How AI tool assist and control quality of work

AILY

Gemini

NotebookLM

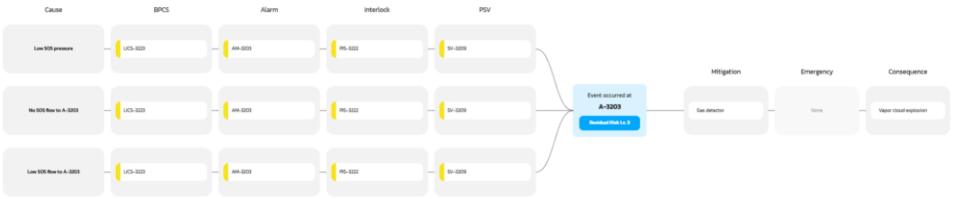
Unidentified Hidden risks

We sit on the uncertainty → random failure

DRS by REPCO NEX

Lack of linkage & integration

How to live monitoring interlock health check



Thank you for your attention