10. SIF Design - Exercise

GAS DETECTOR FUNCTIONAL SAFETY

OVERVIEW COURSE

Institute of Instrumentation Control and Automation

SIF Design - Exercise

Design a SIF to meet the requirements we defined in the Safety Requirements Specification in Module 6 (repeated on next slide).

1. On the diagram below (slide 4), sketch up a SIF to meet these requirements.

2. What is the minimum HFT required for each subsystem?

3. What factors could result in requiring more components than required by this HFT?

4. Using the data on slide 6, calculate the PFD_{avg} for the detector(s), valve(s) and the entire SIF.

5. Does this meet the required SIL? If not, what should we do?

6. Make the necessary changes and then recalculate the PFD_{avg}. Does the SIF now meet the required SIL?

7. What are the criteria required to select the SIF components?

Case Study – SRS for oxygen SIF

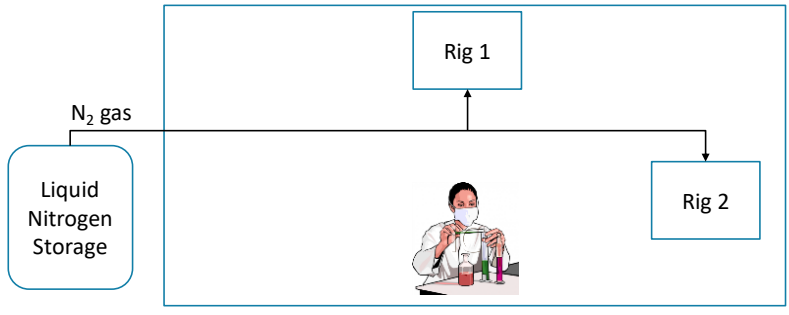
SIF ID:	01
Name:	Laboratory low ambient oxygen
Protects against:	Possible asphyxiation; single fatality
Likely cause(s):	Nitrogen leak and ventilation failure
SIF Function:	When oxygen concentration falls below 17% isolate nitrogen supply by closing shut-off valves
Other protection:	Evacuation alarm actuated with SIF Ventilation system
Required SIL:	SIL 2
Time between demands:	1 to 10y
Operating Mode:	Low demand
Other requirements:	. . .
References:	. . .

Case Study – Nitrogen use in laboratory

A laboratory uses nitrogen for several experimental rigs; the nitrogen is piped as a vapour from a central liquid nitrogen storage vessel.

One person normally works in the laboratory when Nitrogen is in use.

We will use this case study for the rest of the course.



Required HFT – IEC 61511 Ed. 2

IEC 61511-1 2016 (Ed. 2) 9.2.7 Table 6

Required HFT based on SIL & Mode only

SIL	Mode	Minimum required HFT
1	Any	0
2	Low demand	0
2	High demand or continuous	1
3	Any	1
4	Any	2

IEC 61511 Ed.2 requirements:

- reliability data confidence level must be 70%
- programmable devices must have Diagnostic Coverage > 60%

Reference Information

Reliability data λ_{DU}:

- Detector: 0.0667 /y including control unit (gas to relay output)
- Valve: 0.0167 /y

Test Interval:

- 1 year

β factor:

- 5%

Equations:

1oo1 $PFD_{avg} = \lambda_{DU}\ TI\ /2$

1oo2 $PFD_{avg} = (\lambda_{DU}\ TI)^2/3 + \beta\ \lambda_{DU}\ TI\ /2$

2oo3 $PFD_{avg} = (\lambda_{DU}\ TI)^2 + \beta\ \lambda_{DU}\ TI\ /2$

Safety Integrity Level vs. PFD_{avg}

SIL	Risk Reduction Factor (RRF)	Probability of Failure on Demand (PFD_{avg})	Safety Availability
4	> 10,000	$\geq 10^{-5}$ < 10^{-4}	> 99.99%
3	> 1,000 ≤ 10,000	$\geq 10^{-4}$ < 10^{-3}	> 99.9 ≤ 99.99%
2	> 100 ≤ 1,000	$\geq 10^{-3}$ < 10^{-2}	> 99 ≤ 99.9%
1	> 10 ≤ 100	$\geq 10^{-2}$ < 10^{-1}	> 90 ≤ 99%
BPCS*	≤ 10	$\geq 10^{-1}$	≤ 90%
	$= 1 / PFD_{avg}$	$= 1 / RRF$	$= 100(1 - PFD_{avg})$

Used to specify SIL required

Used to specify SIL achieved

* Basic Process Control System

For Low Demand Mode SIFs only

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Summary

Exercise to design a SIF

Designing a SIF

Answers are in Module 13 Case Study

Questions?