What Process Engineers Should Know About Functional Safety

IChemE Irish Members Group & Engineers Ireland, August 2025

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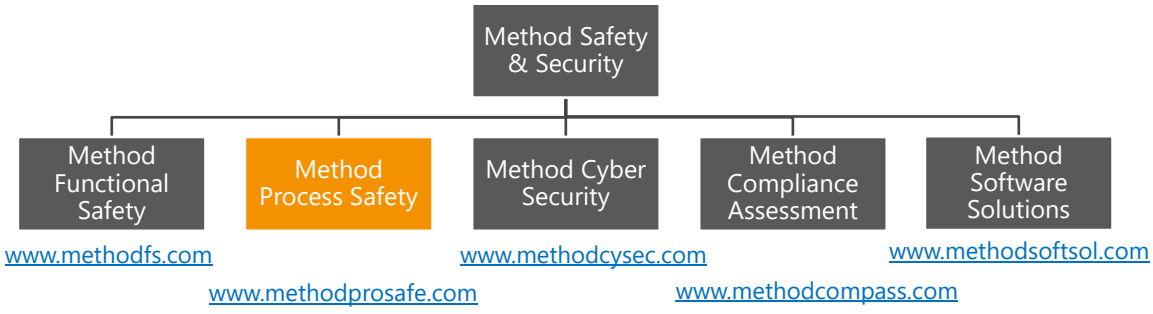
Who We Are:

=Method are functional safety and process safety consultants and trainers.



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What is Process Safety?

Safety:

- "Freedom from risk which is not tolerable" – IEC61511

Process Safety (CCPS definition):

- Process safety deals with the prevention and control of incidents that have the potential to release hazardous materials or energy.
- Such incidents can cause toxic effects, fire or explosion and could ultimately result in serious injuries, property damage, lost production and environmental impact.

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What is Functional Safety?

"Part of the overall safety relating to the process & the BPCS which depends on the correct functioning of the SIS & other protection layers" - IEC61511

So functional safety is a key thing we do in order to achieve overall process safety, i.e. freedom from intolerable risk.

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Basic Process Control System (BPCS)

- The main purpose of the BPCS is to provide continuous control of the process.
- The BPCS is the main plant DCS or PLC/SCADA system.

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The Functional Safety Standards

IEC61508 – "Functional safety of electrical/electronic/programmable electronic safety-related systems"

This is the "basic safety standard" from which others are derived.

IEC61511 is a version of IEC61508 which has been simplified for the process industries

IEC62061
Machinery Safety

IEC61513
Nuclear Safety

IEC61511
The Process Industries

ISO 26262
automotive software

Etc!

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The Legal Status of IEC61511

- The Health & Safety at Work Act requires you to reduce risk "so far as is reasonably practicable".
- This means you must have systems in place to assess and manage risk.
- IEC61511 is "Recognised as Good Practice" by the HSE for achieving functional safety.
  - Its use is not mandatory, but in practice, it is the easiest (only?) way to demonstrate compliance.

Safety Instrumented Functions (SIFs)

- A protection layer whose objective is to achieve or maintain a safe state of the process when a specific dangerous event occurs.
- Each SIF will have a sensor, a logic solver and a final element.

SENSOR
(input)

LOGIC SOLVER
(makes a decision)

FINAL ELEMENT
(output – takes action)

- These must operate **independently** from the BPCS

Safety PLC photo credit www.hima.com

Safety Instrumented Functions (SIFs)

- Each SIF will have a calculated **reliability**, called a **Safety Integrity Level** (SIL)

SIL	Probability of Failure on Demand (PFDavg)		Risk Reduction Factor (RRF)	
	From	From	To	To
1	0.1	0.01	10	100
2	0.01	0.001	100	1,000
3	0.001	0.0001	1,000	10,000
4	0.0001	0.00001	10,000	100,000

← Works at least 9 times out of 10

← Works at least 99 times out of 100

Etc.....

- We usually use LOPA (layer of protection analysis) to decide what SIL is required

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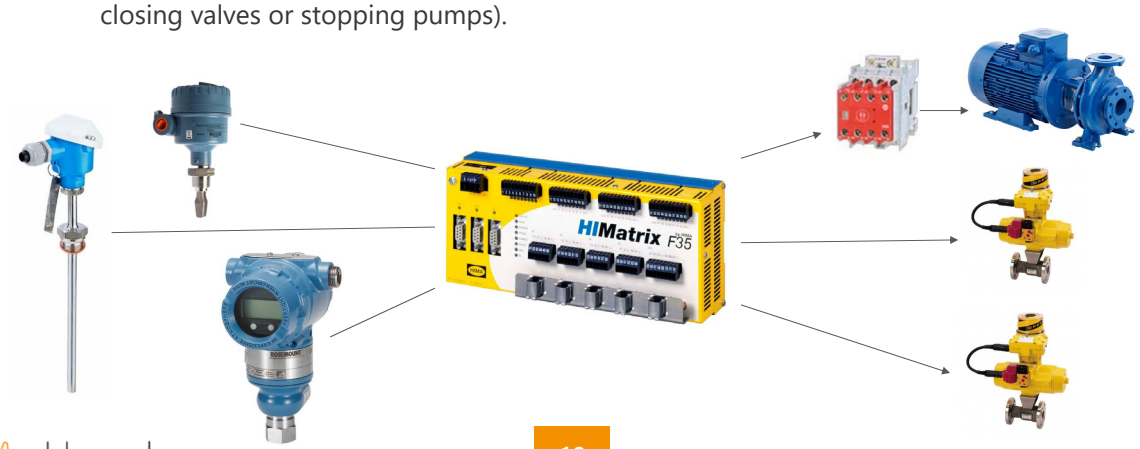
Safety Instrumented System (SIS)

- An independent system, whose function is only to maintain safety.
- **A SIS is usually made up of several SIFs**
- The SIS usually remains passive until there is a process upset that the BPCS does not or cannot deal with, and then acts to bring the process to a safe state (e.g. by closing valves or stopping pumps).



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Instrument photo credit www.emerson.com

The Functional Safety Lifecycle

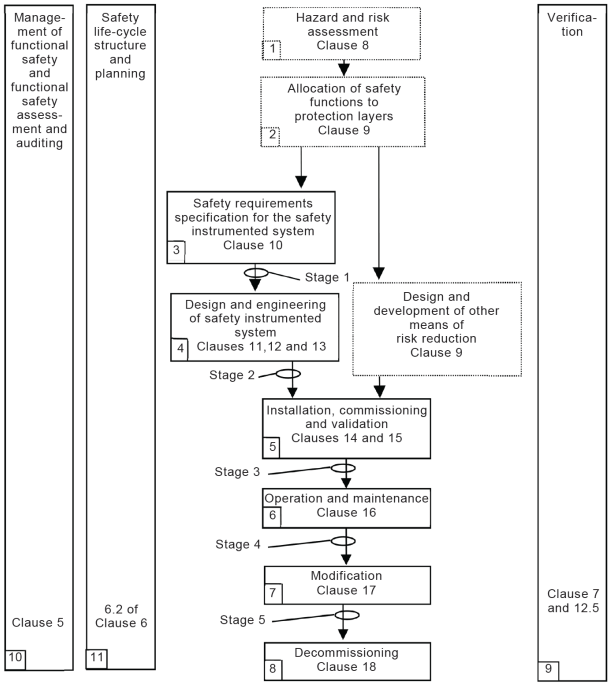

Diagram from
PD IEC TR 61511-0 Fig 1

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The Real Basics

1) Assess your risks
2) Decide what safety functions you need (if any)
3) Design and implement them
4) Keep them well maintained
5) Ensure everything is:
   - Managed well, in accordance with the standard
   - Done by competent people
   - Checked by competent people

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The Role of Process Engineers

- Process engineers have a key role in carrying out hazard & risk assessment (usually using HazOp), and "allocation" (usually using LOPA).
  - It's usually Process Safety Engineers who lead these studies.
- Process engineers must work with ECI engineers to define the SIS
  - Our knowledge of process operation and process hazards is vital in getting this right.

The Role of Process Engineers

SENSOR
(input)

LOGIC SOLVER
(makes a decision)

FINAL ELEMENT
(output – takes action)

ECI Engineers' SIF Description:

"The purpose of this SIF is to close valve X if the temperature goes above 100°C"

The Role of Process Engineers

SENSOR
(input)

LOGIC SOLVER
(makes a decision)

FINAL ELEMENT
(output – takes action)

Process Engineers' SIF Description:

"The purpose of this SIF is to prevent an unventable runaway reaction leading to vessel rupture and up to two fatalities, by closing thermal oil valve X if a malfunction of the BPCS causes the temperature inside the vessel to approach the runaway onset temperature of 120°C"

Defining Safety Instrumented Functions:

A useful acronym is "SLATS":	**Example:**
○ **S**ensing	Measure the reactor temperature using TT01
○ **L**ogic	If TT01 > 100°C THEN
○ **A**ctuate	Close valve x to stop the thermal oil flow
○ **T**iming	Within 30 seconds
○ **S**afety integrity (SIL)	And do it to SIL 1 reliability with a PFD of 0.05

Some Things to be Aware of

- Chemical industry SIFs are generally “low demand mode”
  - i.e. we expect them to operate less than **once** per year.
  - If your SIFs are activating more often than that, it is important that you investigate why and fix the underlying process.

Some Things to be Aware of

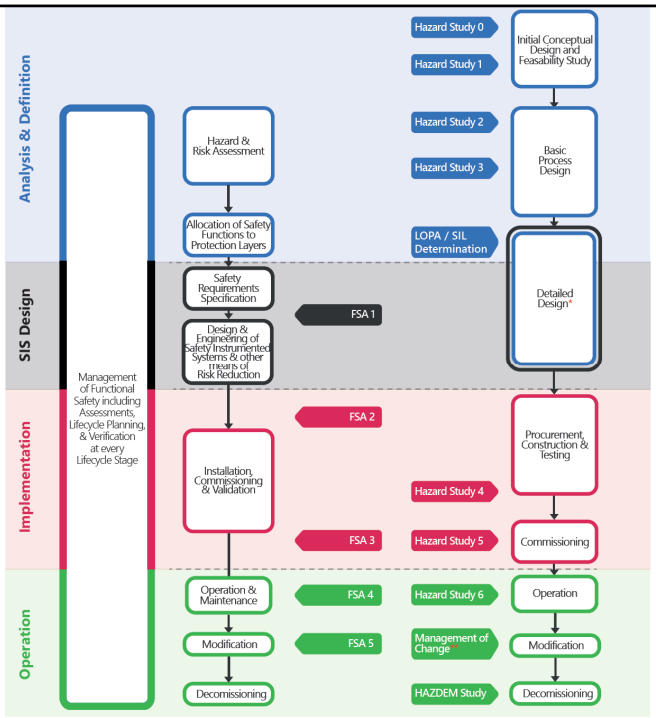
- HazOp and LOPA are functional safety lifecycle stages, so they need functional safety management (FSM)

  To be compliant……
  - Plan what you’re doing in advance
  - Ensure everybody is trained and competent
  - Ensure everything is independently verified (checked)

Tying the PS and FS Lifecycles Together:

Activities:
- **Analysis and Definition**
- **SIS Design**
- **Implementation**
- **Operation**

* It is also usual for the hazard study 3 to be reviewed and revised during the detailed design phase, especially for large projects.
** Management of change (MOC) usually includes a review of the Hazard Study 3 (HazOp). However, depending on the change being made, other hazard studies may also have to be revised.



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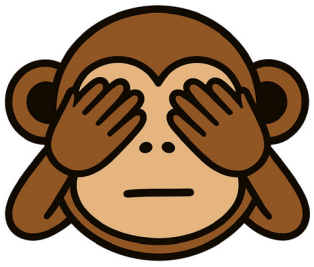
SHAMELESS PLUG ALERT!



Relevant Method Training Courses

=Method Hazard Study Leaders & Team Members Courses

=Method LOPA Leaders Course

=Method TÜV Certified Functional Safety Training Course and Examination in IEC61508 or IEC61511

=Method Process Safety Management Training Course

=Method "Achieving ALARP" Training Course

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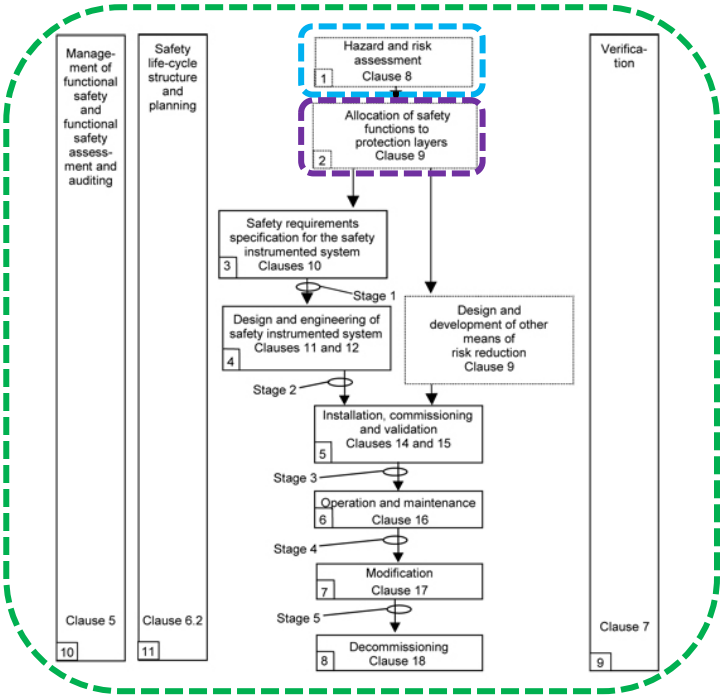

QR Code for IChemE Survey:

What Process Engineers should know about Functional Safety - 19th Aug 25

Link for Details of Training Courses:

Process Safety:

https://www.methodprosafe.com

Functional Safety:

https://www.methodfs.com