



## I&E Systems Pty Ltd

### Functional Safety Engineer (TÜV Rheinland)

### Training and Certification

#### Objective

I&E Systems' Functional Safety Engineering course provides the underpinning knowledge that is essential for engineers applying safety instrumented systems (SIS) in the process sector.

I&E Systems is an engineering consultancy specialising in systems engineering and systems integration. We bridge the gap between plant owners and the system suppliers. We work with the end-users from the initial early design concept right through design and implementation and on into long term support for operations, maintenance and modifications.

This **FS Engineer (TÜV Rheinland)** course is aimed specifically at engineers who work for:

- Engineering companies in the design, installation and commissioning of SIS
- 'End-user' companies who own and/or operate process plant.

It is not intended for engineers involved in the design of internal hardware for logic solver systems or for the design of field device components by OEMs. It is designed to provide candidates with a holistic view of the entire safety lifecycle from the user's perspective.

The course puts a strong emphasis on systematic integrity: Avoiding avoidable failures. These failures are primarily due to human error in the specification, design, installation, operation and maintenance of SIS. It also emphasises the importance of user-centred architectural design for safety instrumented systems.

#### The Standards

The course has been designed to provide the underpinning knowledge for competence as required by IEC 61511 and IEC 61508. It also supports the units of competence defined in the Institution of Engineering and Technology '*Competence Criteria for Safety-related System Practitioners*'.

#### New Course Material in 2019

The course material has been extensively revised for 2019. The course is still primarily based on IEC 61511 (2016) and IEC 61508 (2010) but new material has been added to briefly introduce the machinery safety standards AS 4024 (ISO 13849) and IEC 62061.

Some limited guidance is now included on safeguarding based on IEC 61508 for machines such as conveyors, stackers, loaders and unloaders. The focus is on protection against hazards that can cause fatalities and on safeguarding systems that include programmable devices. The course does not deal with factory automation safety or safety for machines such as lathes, forges and guillotines.

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Those types of machines rely on relatively simple interlocks based on ISO 13849 rather than using the principles of IEC 61508.

Throughout the course comparisons are now made between the IEC 61511 and the approach taken by ISO 13849 and IEC 62061.

The other significant change is that throughout the course emphasis has been added on the wide variability in failure rates that are achieved in practice and on the factors that influence system performance. A new session has been added on 'Performance management'. Emphasis has also been added on the importance of architectural design in ensuring that the performance targets are feasible.

### Course Structure

The course is presented over 4 days and includes classroom exercises. The exam is held on the 5<sup>th</sup> day, after a tutorial and review session in the morning. The 5<sup>th</sup> day is optional for candidates not intending to complete the exam.

Candidates will be provided with a set of homework exercises to do in their own time. The exercises will be reviewed in tutorial sessions at the beginning of each day of the course.

	Day 1	Day 2	Day 3	Day 4	Day 5
Session 1	Introduction	SIL determination	Exercises	Exercises	Review
Session 2	Risk management	Exercises	Quantification of random failure	Safety requirements	
Session 3	SIS Standards	Systematic integrity	Exercises	System detail design	Examination
Session 4	Machinery safety	FS Management	Architectural design	Operation and maintenance	
Session 5	SIL concepts	Quality management	Fault tolerance	Performance management	
Session 6	Failure modes	Verification and validation	Design patterns	Audit and assessment	
Session 7	SIL determination	Review	Review	Review	

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## Assessment

Underpinning knowledge will be assessed in a 3 part exam:

- Part 1: Multiple choice questions, 50 questions assessing knowledge (worth 50%) and 20 calculation questions (worth 20%)
- Part 2: Written answer questions, 10 questions on functional safety principles (30%)

To complete the exam typically takes around 3 to 4 hours. The fastest students complete it within 1.5 hours.

Candidates wishing to apply for the FS Engineer (TÜV Rheinland) certificate need to complete an eligibility requirements form before attending the course. The following requirements have to be met to qualify for this certificate:

- A minimum of 3 to 5 years' experience in the field of functional safety
- University degree (Master's or Bachelor's degree in Engineering) or equivalent engineer level responsibilities status certified by employer
- A score of at least 75% in the exam.

Over the past few years the average score in the exam on this course has been 88%. Only 3% of candidates have failed to meet the pass mark. Candidates that do not yet meet the grade may have a second attempt within a few weeks' time and will receive additional coaching.

Candidates who have not yet gained at least 3 years of experience in functional safety may still participate in the training as well as the exam.

If an inexperienced candidate successfully completes the exam TÜV Rheinland will hold the application form and assessment results on file. Once the candidate can demonstrate the necessary 3 years of business experience in the area of functional safety TÜV Rheinland will issue the FS Engineer certificate. There is no need for the candidate to retake the exam.

## Course Outline

- Introduction: What is 'Functional Safety'?
  - Regulatory framework
  - SIFs for risk reduction
  - Random and systematic failures
- Risk management principles, tolerable risk, ALARP
- Standards – history and structure
- Machinery safety - a comparison between IEC 62061, ISO 13849, IEC 61511 and IEC 61508
- SIS fundamentals:
  - Conceptual design,
  - SIFs and SIF allocation,
  - Continuous mode and demand mode
  - Introduction to hardware fault tolerance
  - Factors that influence failure rates

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- Failure modes
  - Unrevealed and dangerous failures
  - How to distinguish random failures from systematic failures
  - Failure rate data
  - Safe failure fraction and diagnostic coverage
  - Basic principles in estimating probability of failure
- SIL determination
- Systematic integrity
  - Probability of human error
  - Systematic capability,
  - Techniques and measures
- Functional safety management
- Quality management
- Verification and validation
- Quantification of failure rates and the main drivers influencing probability of failure
- System architectural design
  - Operability
  - Maintainability
  - Testability
  - Separation between protection layers
  - Separation between safety and non-safety
- Fault tolerance – achieving a balance between safety and the cost of downtime
- Design patterns – developing conceptual designs to enable performance in risk reduction
- Safety Requirements Specification
- System detailed design – documentation and traceability
- Operations and maintenance
  - Operations planning and management
  - Proof testing
  - Maintenance, inspection and testing
  - Issues and performance management
  - Modification management
  - Documentation
- Performance management – maintaining risk reduction performance targets
- Audit and assessment – closing the loop, demonstrating due diligence

### Course Cost

The cost for each candidate on the full 5 day course is AUD 4,100 +GST. This includes course materials and the FS Engineer (TÜV Rheinland) certificate.

The cost per candidate for the 4 day course without the exam is AUD 3,400 + GST.

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## Course Schedule

Scheduled presentations of this course are listed on the I&E Systems website at <http://www.iesystems.com.au/training/>

Contact [mirek@iesystems.com.au](mailto:mirek@iesystems.com.au) to register or for further details.

## Presenter

Mirek Generowicz is the Principal Consultant at I&E Systems, a company that specialises in control and safeguarding systems for the process industries. He first started working with functional safety systems in 1986. Mirek has worked in engineering management roles since 1992, focusing particularly on design integrity and quality management.

Mirek specialises in independent functional safety assessment and audit for end-users. Since 2004 he has carried out more than 40 functional safety audits and/or assessments for a wide variety of major SIS applications around the world. He was accredited by TÜV Rheinland as a FS Engineer in 2005, as a FS Expert in 2012 and as a FS Senior Expert in 2014.