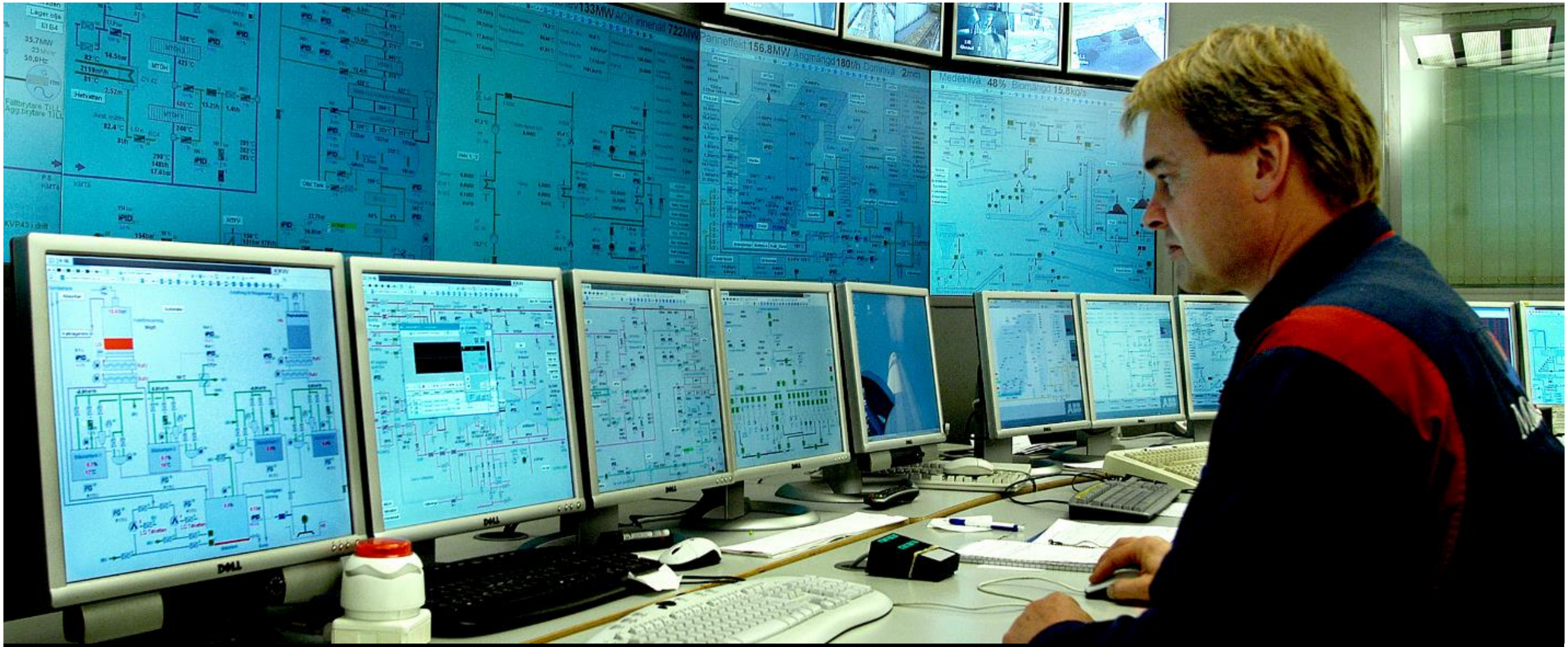

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Introduction to IEC61508 and Functional Safety

Why have Functional Safety Systems?

To prevent risk to people, environment and business

HOW ?

- **By good management safety and quality systems**
- **Design to standards / best practices**
- **Using competent resources to deliver**

WHAT HAPPENS IF THESE GO WRONG ?

Have You Been Asked This?

'Regulator'

"How can you demonstrate that you are safe?"

Safety Issues for End User / Operators

- How do you demonstrate that your operations are ‘safe’?
- How do you demonstrate that your equipment is ‘safe’?
- How do you demonstrate that your safety and protective systems protect against your hazards?

You can answer these questions by demonstrating compliance with Industry Safety Standards

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

What is IEC61508?

- An international standard relating to the Functional Safety of electrical / electronic / programmable electronic safety related systems
  - Mainly concerned with E/E/PE safety-related systems whose failure could have an impact on the safety of persons and/or the environment
  - Could also be used to specify any E/E/PE system used for the protection of equipment or product

- It is an industry best practice standard to enable you to reduce the risk of a hazardous event to a tolerable level

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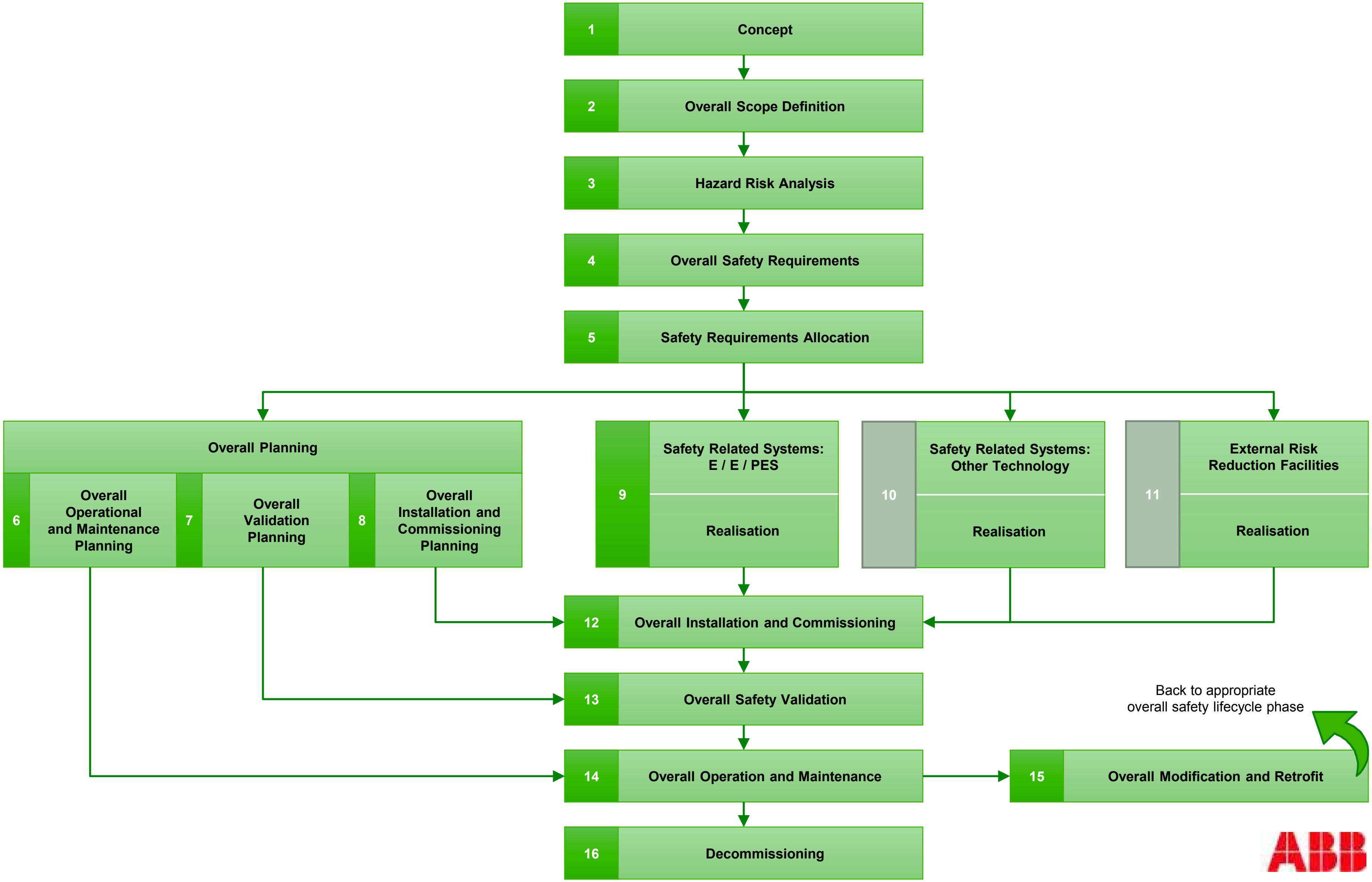
Features of IEC61508

- Generic Standard which may be applied by all Sector variants (machinery, process plant, medical, rail)
- International standard - end users and suppliers operate internationally
- Guidance on use of Electrical, Electronic and Programmable Electronic Systems which perform safety functions
- Comprehensive approach involving concepts of Safety Lifecycle and all elements of protective system
- Risk-based approach leading to determination of Safety Integrity Levels (S.I.Ls) - measures proportionate to the risk reduction required
- Considers the entire Safety Critical Loop
- Aims to facilitate improvements in both safety and economic performance through effective use of the (PES) technology

Overall Safety Lifecycle in IEC 61508



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Why this lifecycle ?

- Maps directly to the normal work pattern of the project in a ‘cradle-to-grave’ process.
- Maps directly to asset life cycle
- Seen by the Regulatory Authorities as industry best practice
- Can be used in any business, any sector.
- Applies to all aspects of the end user supply chain relationship
- Will be used to demonstrate regulatory compliance
- Generates efficiencies in ‘cost of safety’
  - Common terminology
  - Defined document / responsibility interfaces throughout the supply chain
  - Common practices

Summary of the Key Messages in IEC 61508

Safety Management System

- Life cycle
- Planning
- Assessing compliance
- Supply chain

Technical Requirements

- Choice of technologies
- Assessment of risk
- Specifications of function & integrity level

Competencies

- Roles & responsibilities
- Skills & training

Benefits of a Safety Management System

- A defensible method of managing risks
- Coherent approach to the whole subject
- Facilitates specification, design and purchase
- Allows self regulation

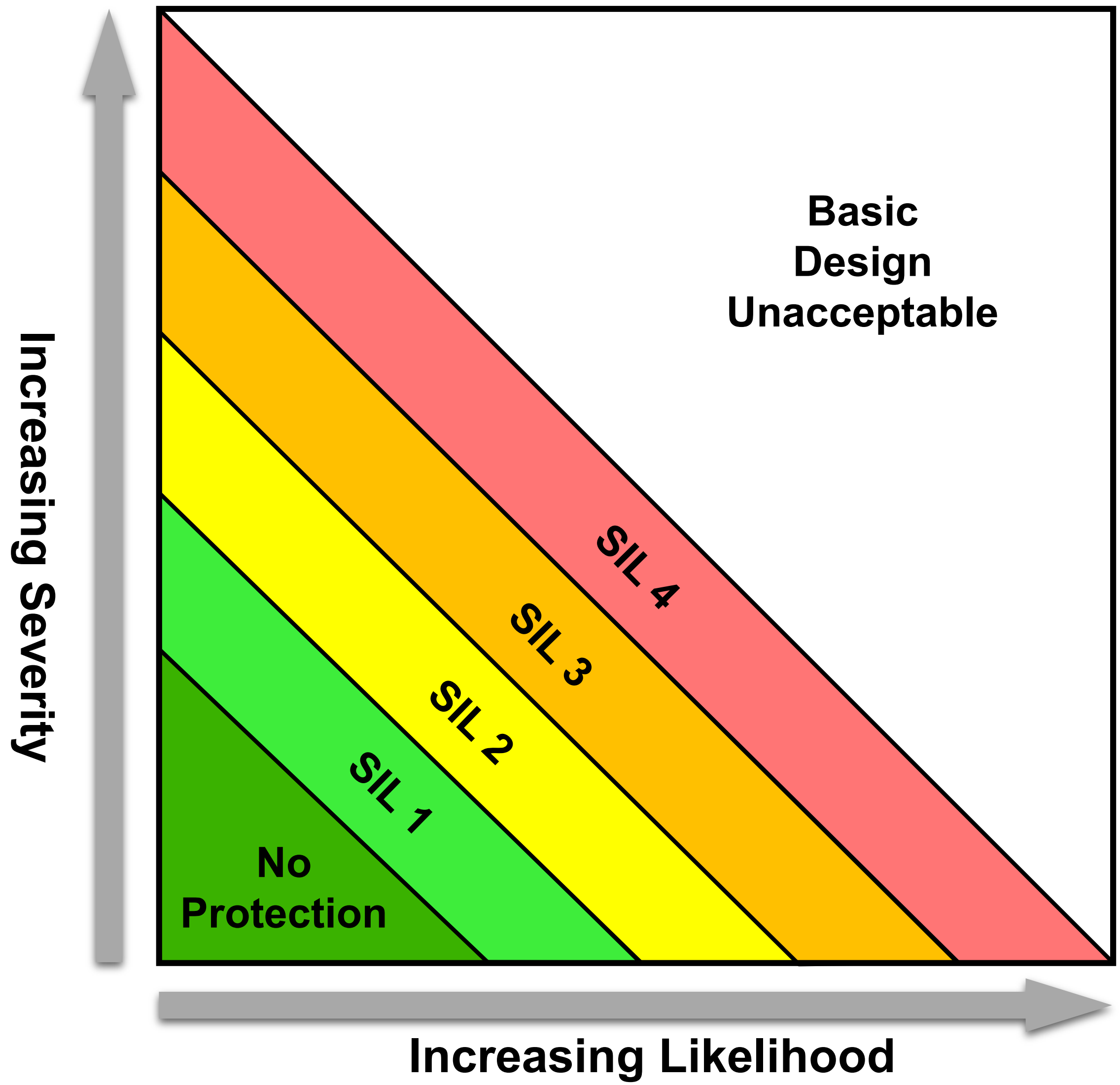
What is Risk?

- The probable rate of occurrence of a hazard causing harm

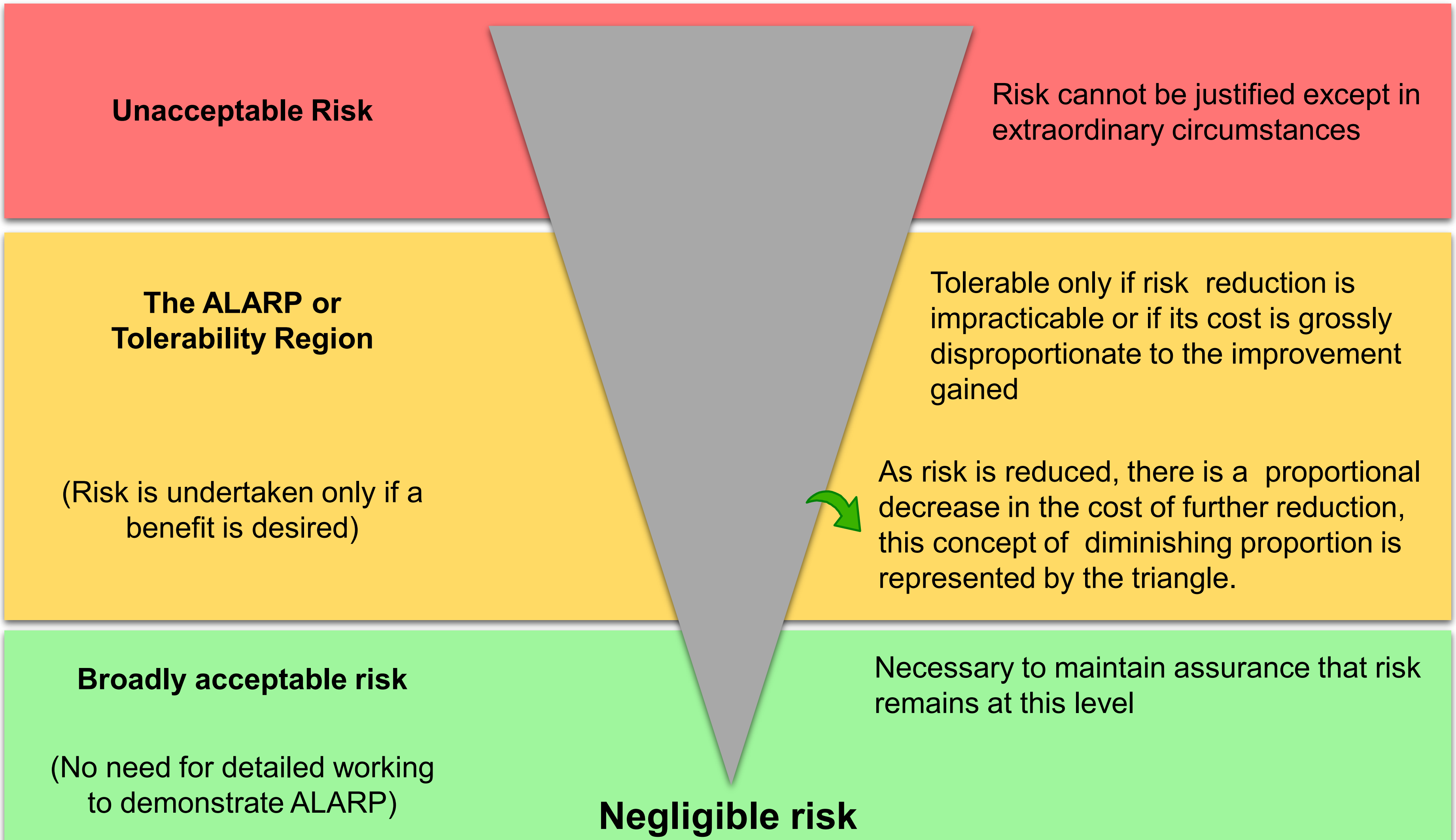
AND

- the degree of severity of the harm
  - Qualitatively - Words
  - Quantitatively - Figures

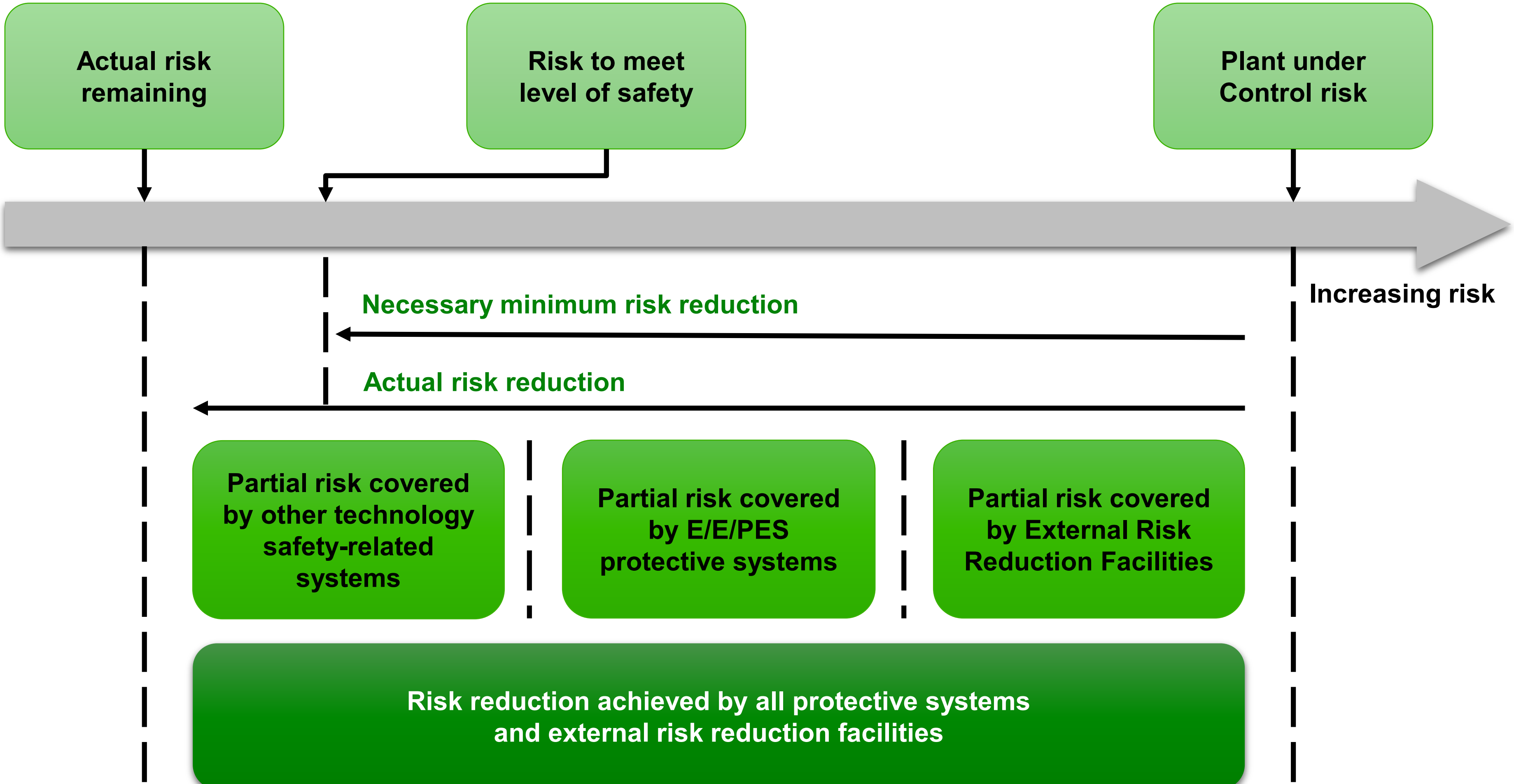
Risk and Determination of Safety Integrity Levels



Levels of Risk and ALARP



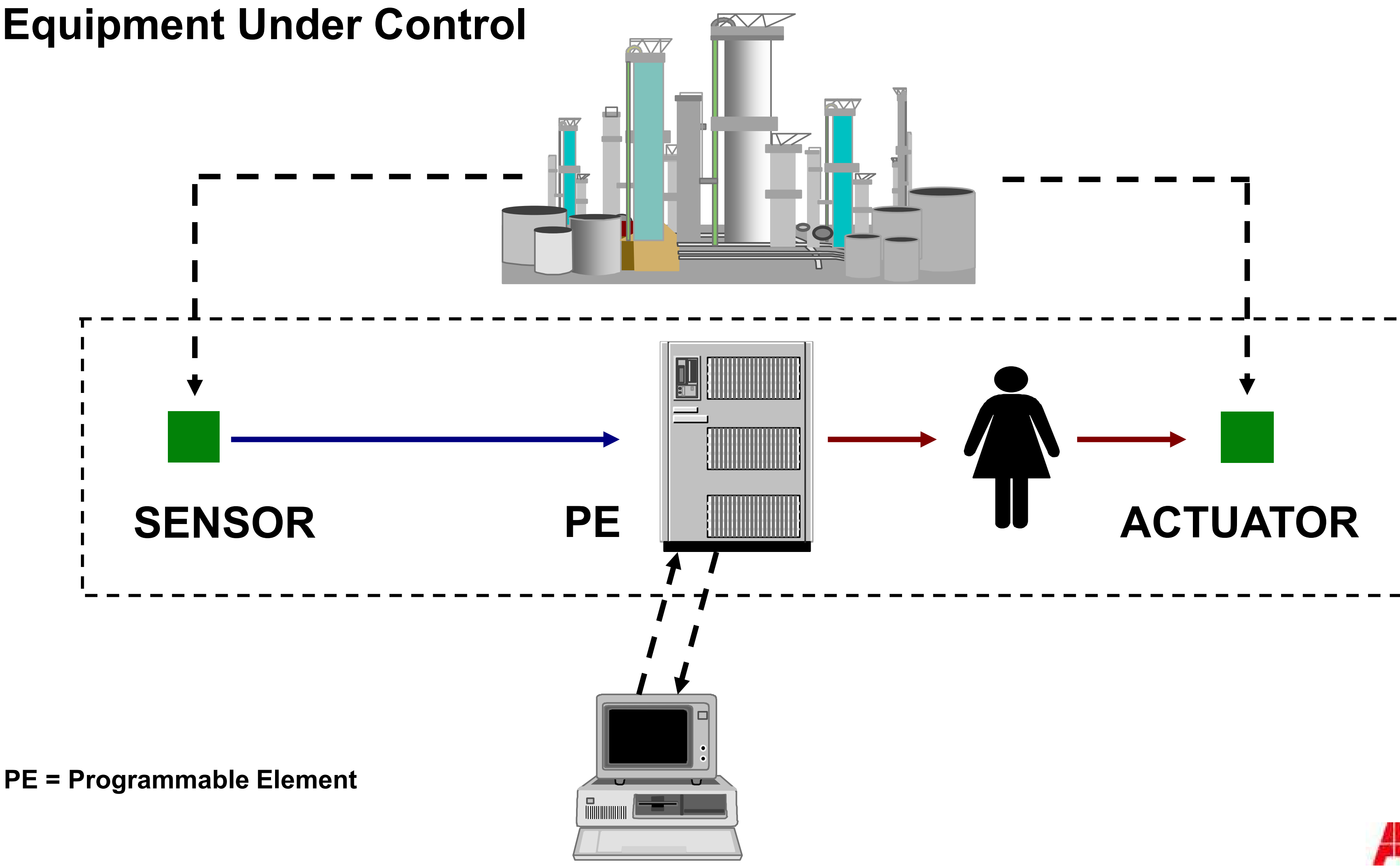
Risk reduction: General concepts



Technologies Under Consideration

- Electrical
  - Electro-mechanical / relays / interlocks
- Electronic
  - Solid state electronics
- Programmable Electronic Systems
  - Programmable Logic Controllers (PLC’s);
  - Microprocessor based systems
  - Distributed Control Systems
  - Other computer based devices
    - **(“smart” sensors / transmitters / actuators)**

Extent of a E/E/PE safety-related system



PE = Programmable Element

Example method of calculating a Target Safety Integrity Level

- Hazard studies and HAZOPs
- Evaluate possible consequences
- Establish tolerable frequencies vs ALARP
- Build event chain
- Estimate demand rates
- Define protection required
- Specify required Safety Integrity Level

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Risk Reduction Requirements

Safety Integrity Level	Risk Reduction
1	10 - 100
2	100 - 1,000
3	1,000 - 10,000
4	10,000 - 100,000

Reliability, Failure Rate and Availability at each level

	Reliability	Probability of failure on demand	Trip Unavailable (per year)
SIL 1	90% - 99%	0.1 to 0.01	876 to 87.6hrs
SIL 2	99% - 99.9%	0.01 to 0.001	87.6 to 8.76hrs
SIL 3	99.9% - 99.99%	0.001 to 0.0001	8.76hrs to 52.6 mins
SIL 4	99.99% - 99.999%	0.0001 to 0.00001	52.6 mins to 5.3 mins

Protective System Technology

SIL 1	Standard components, single channel or twin non-diverse channels
SIL 2	Standard components, 1 out of 2 or 2 out of 3, possible need for some diversity. Allowance for common-cause failures needed
SIL 3	Multiple channel with diversity on sensing and actuation. Common-cause failures a major consideration. Should rarely be required in process industry
SIL 4	Specialist design. Should never be required in the Process Industry

Protective System Design, Test and Maintenance Requirements

SIL 1

Relatively inexpensive to design, build and maintain
Test interval unlikely to be less than 3 months

SIL 2

Moderately expensive to design, build and maintain
Test interval unlikely to be more than 3 months

SIL 3

Expensive to design, build and maintain
Test interval likely to be 1 month

SIL 4

Extremely expensive to design, build and maintain
Test interval as for SIL 3 (diminishing returns below 1 month)

IEC 61508 - ownership of phases

PRE-DESIGN
(Phases 1 to 5)

End user / operator

DESIGN AND INSTALLATION
(Phases 6 to 13)

Engineering Contractors / Equipment Supplier

OPERATION
(Phases 14 to 16)

End user / operator

Pre-Design: Phases 1 - 5

1. Concept
2. Overall Scope Definition
3. Hazard Risk Analysis
4. Overall Safety Requirements
5. Safety Requirements Allocation

Can you demonstrate that you have identified all your hazards? (→ 3 Hazard Risk Analysis)

Can you demonstrate that you are using adequate and correct methods of hazard protection? (→ 4 Overall Safety Requirements, 5 Safety Requirements Allocation)

Design & Implementation : Phases 6 - 13

How do you ensure competencies for all these activities?

Overall Planning

- **6** Overall Operational and Maintenance Planning
- **7** Overall Validation Planning
- **8** Overall Installation and Commissioning Planning

Can you demonstrate that you pass the necessary information into these activities?

- **9** Safety Related Systems: E / E / PES — Realisation
- **10** Safety Related Systems: Other Technology — Realisation
- **11** External Risk Reduction Facilities — Realisation

- **12** Overall Installation and Commissioning
- **13** Overall Safety Validation

Can you demonstrate that all necessary information has been passed to you from these activities?

Operation : Phases 14 - 16

14 **Overall Operation and Maintenance**

Can you demonstrate that you maintain / test / analyse your protective systems correctly?

15 **Overall Modification and Retrofit**

Can you demonstrate that you are in control of your modification process?

16 **Decommissioning**

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IEC 61508 - Three Phases for Protective Functions

Set the Target SIL	**PRE-DESIGN (Phases 1 to 5)**	End user / operator
Designed SIL	**DESIGN AND INSTALLATION (Phases 6 to 13)**	Engineering Contractors / Equipment Supplier
Demonstrate Achieved = Design = Target	**OPERATION (Phases 14 to 16)**	End user / operator

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IEC 61508 Responsibilities: End Users / Operators

- Functional Safety Specification Requirements
  - Contribution from all Safety Function Technologies and Risk Reduction Methods
  - Target SIL for the E/E/PES contribution
- Overall Responsibility for the Management of Functional Safety
- Functional Safety Plan at the outset of the work - Identification of Functional Safety Assessments for the project duration
- Overall Validation and Verification
- Commissioning and acceptance
- Operations and Maintenance
- Modification and Retrofit

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