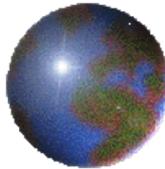


# *Safety Instrumented Systems*

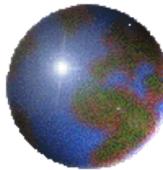
ANGELA E. SUMMERS, PH.D., P.E.  
SIS-TECH Solutions, LLC

**We're Proven-in-Use.**



# *Terminology*

- Critical Control Systems
- Safety Shutdown Systems
- Protective Instrumented Systems
- Equipment Protection Systems
- Emergency Shutdown Systems
- Safety Critical Systems
- Interlocks
- Safety Instrumented Systems



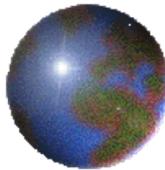
# *What is a Safety Instrumented System (SIS)?*

- An SIS is designed to:



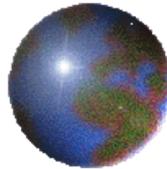
- respond to conditions in the plant which may be hazardous in themselves or,
- if no action was taken, could eventually give rise to a hazard, and
- to respond to these conditions by taking defined actions that either prevent the hazard or mitigate the hazard consequences.

- Input ----- Logic Solver ----- Output



## *Examples of Safety Instrumented Systems*

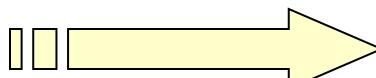
- High fuel gas pressure furnace initiates shutdown of main fuel gas valves.
- High reactor temperature initiates fail open action of coolant valve.
- High column pressure initiates fail open action of pressure vent valve.



OSHA & EPA

Process Safety Management

SIF included here



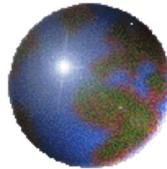
Emergency Shutdown  
Systems, Control, Relief  
Systems

Written Internal  
Guidelines

Mentor/Engineering  
Practices

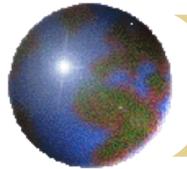
Industry Codes  
& Standards

**GOOD ENGINEERING PRACTICE**



## *Standards Bodies that Define Good Engineering Practice for Safety Instrumented Systems*

- ISA, Instrumentation Systems and Automation Society
- IEC, International Electrotechnical Commission



***Other standards and guidelines must be integrated with SIS standards!***

**NFPA**

**ISA 84.01-2003**

**API**

**IEC 61508**

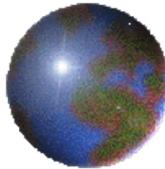
**ASME**

**IEC 61511**

**Boiler Codes**

**ISO**

**AICHE  
Books**



## ***Safety Instrumented System Standards***

### **IEC 61508 - “Functional Safety: Safety Related Systems”**

Current version released 1999

Under revision for next release 2005

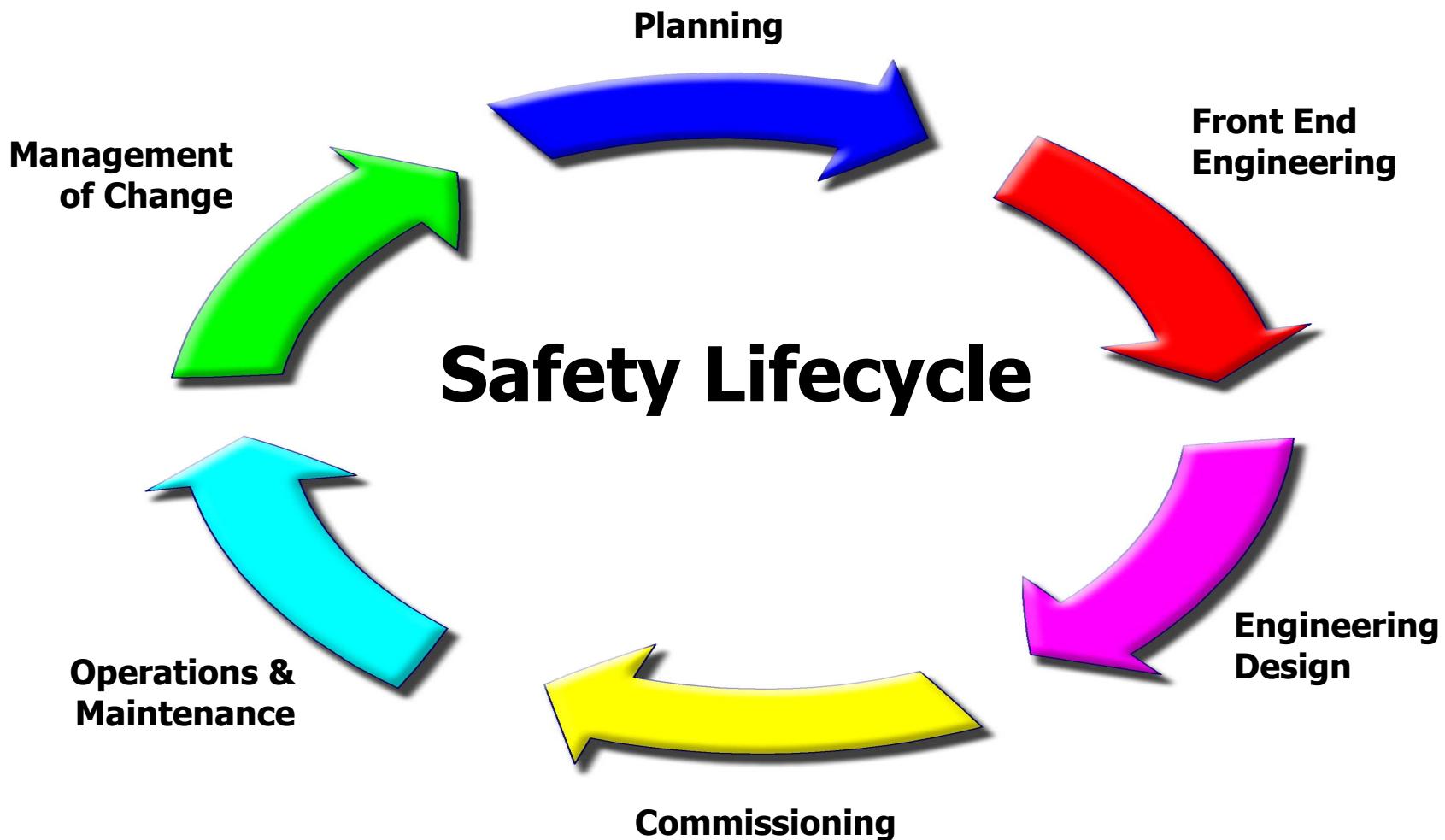
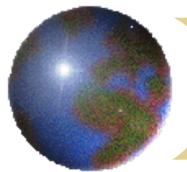
### **IEC 61511 - “Functional Safety: Safety Instrumented Systems for the Process Industry Sector”**

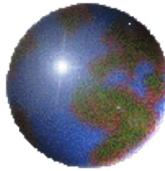
Published 2003

### **ISA 84.01-2003 - “Functional Safety: Safety Instrumented Systems for the Process Industry Sector”**

Identical to IEC 61511 with inclusion of grandfather clause

To be published October 2003



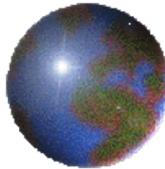


## *Manage risk - People*



- Identify role of individual or departments
  - Who is assigned to project?
  - What are their roles?
- Document competency of individuals and departments
  - Does anyone need more training?
  - Who will mentor inexperienced engineers?
  - Who will review and approve?

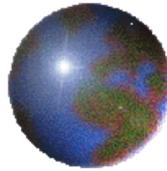
**This is good project management.**



## *Manage risk – Procedures*

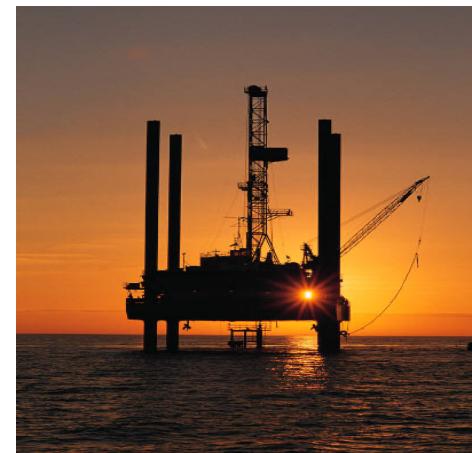
- Define when the following will take place:
  - Verifications,
  - Audits, and
  - Validation.
- Require procedures for evaluating the performance of the SIS after it has been installed
  - Performance audits and
  - Tracking failures rates.

**This is good quality control.**



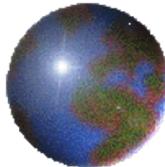
## *Assess risk and mitigate it*

- Will talk about the “how to” later
- The assessment results in the assignment of Safety Integrity Level



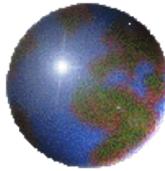
# ***Safety Integrity Level***

<b>SIL</b>	<b>PF<sub>avg</sub></b>	<b>Risk Reduction</b>	<b>Availability (%)</b>
<b>4</b>	<b><math>10^{-4}</math> to <math>10^{-5}</math></b>	<b>10,000 to 100,000</b>	<b>99.99 to 99.999</b>
<b>3</b>	<b><math>10^{-3}</math> to <math>10^{-4}</math></b>	<b>1,000 to 10,000</b>	<b>99.9 to 99.99</b>
<b>2</b>	<b><math>10^{-2}</math> to <math>10^{-3}</math></b>	<b>100 to 1,000</b>	<b>99 to 99.9</b>
<b>1</b>	<b><math>10^{-1}</math> to <math>10^{-2}</math></b>	<b>10 to 100</b>	<b>90 to 99</b>



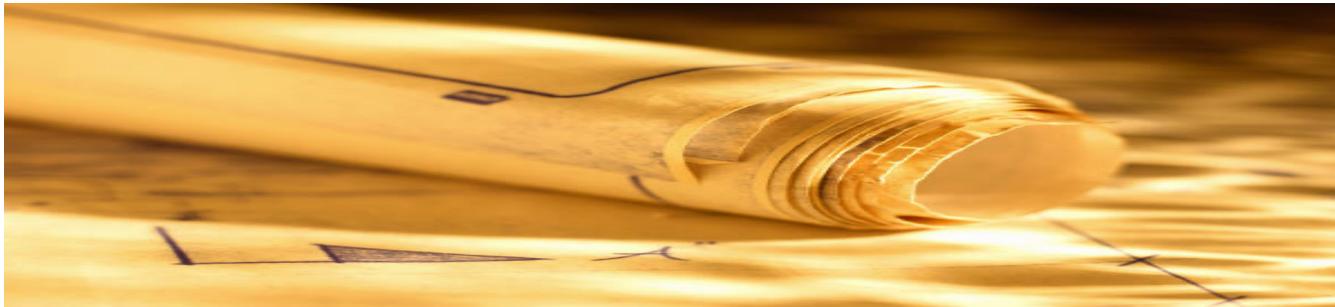
- Let's talk about Risk.
- What is your wager?
- How many times do you place the wager each year?
- What are your odds of losing your wager?

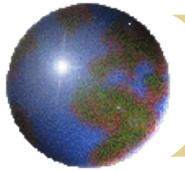




## *Design SIF*

- Justify selection of devices
- Document the safety requirements specification
- Design SIFs to achieve Safety Integrity Level.





# *Prove it*

## ● Verify

- Safety Integrity Level
- Fault tolerance

## ● Commissioning

- Install SIFs per design documents

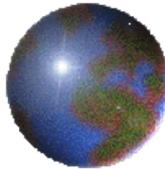
## ● Functional safety assessment

- Make sure all documents are in place and all hazards analysis items are addressed.

## ● Validation

- Test SIFs to ensure that they have desired functionality





## *Maintain it*

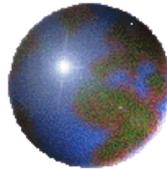


### ❖ Operation, maintenance and testing

- Use diagnostics and testing to maintain performance
- Create and maintain procedure to support these activities
- Train personnel on procedures

### ❖ Management of change

- Monitor changes to SIS that might affect SIL



## ***Audit it***

- Includes design and procedures
- Define frequency of audits
- Determine the degree of independence of auditing activity
- Document audit
- Define follow-up activities



