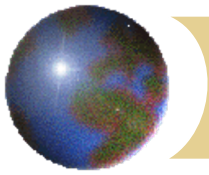


# *Safety Instrumented Systems*

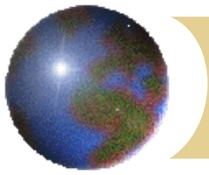
ANGELA E. SUMMERS, PH.D., P.E.  
SIS-TECH Solutions, LLC

**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



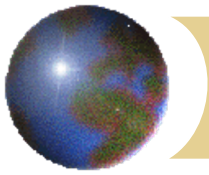
## *What is a Safety Instrumented System (SIS)?*

✚ An SIS is designed to:



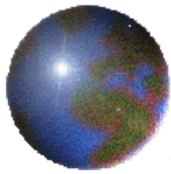
- ✚ respond to conditions in the plant which may be hazardous in themselves or,
- ✚ if no action was taken, could eventually give rise to a hazard, and
- ✚ to respond to these conditions by taking defined actions that either prevent the hazard or mitigate the hazard consequences.

✚ Input ---- Logic Solver ---- Output

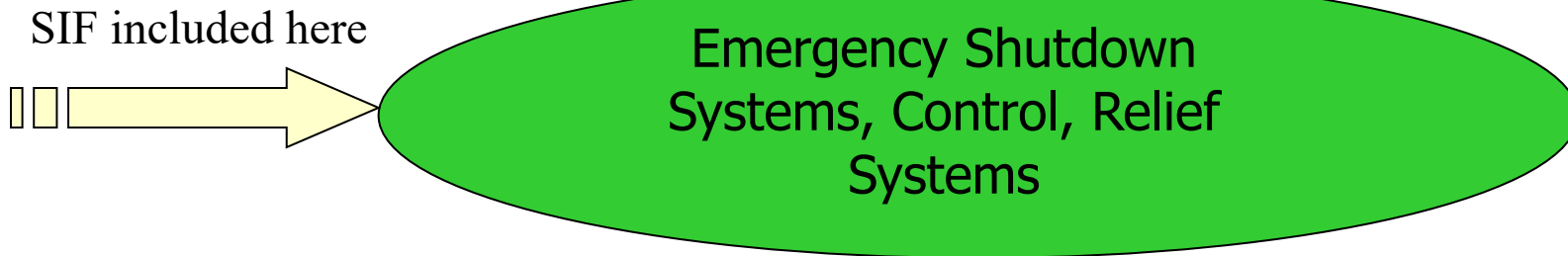


## *Examples of Safety Instrumented Systems*

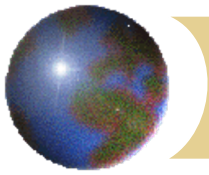
- ⊕ High fuel gas pressure furnace initiates shutdown of main fuel gas valves.
- ⊕ High reactor temperature initiates fail open action of coolant valve.
- ⊕ High column pressure initiates fail open action of pressure vent valve.



**OSHA & EPA**  
**Process Safety Management**

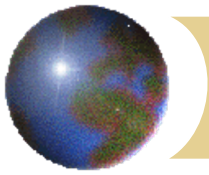


<b>Written Internal Guidelines</b>	<b>Mentor/Engineering Practices</b>	<b>Industry Codes &amp; Standards</b>
<b>GOOD ENGINEERING PRACTICE</b>		



## *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**

**API**

**ISA 84.01-2003**

**IEC 61508**

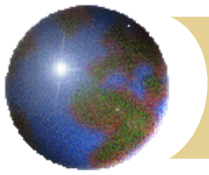
**ASME**

**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"**

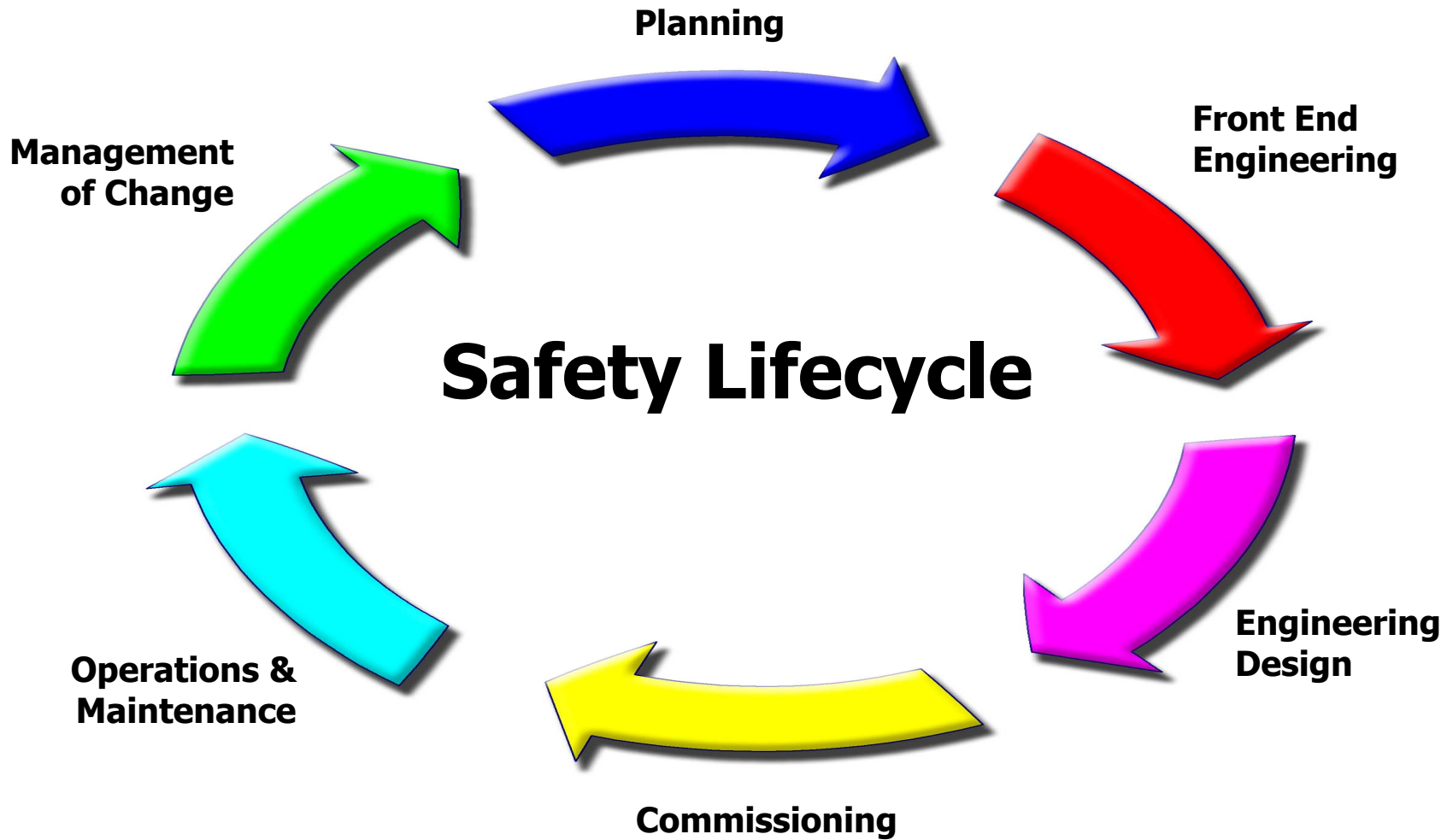
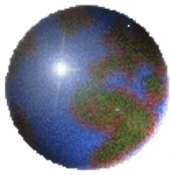
Published 2003

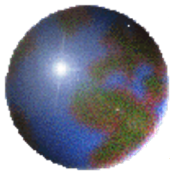
### **ISA 84.01-2003 - "Functional Safety: Safety Instrumented Systems for the Process Industry Sector"**

Identical to IEC 61511 with inclusion of grandfather clause

To be published October 2003





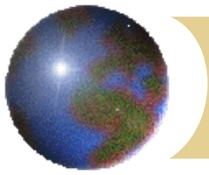


## *Manage risk - People*



- ❖ 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?

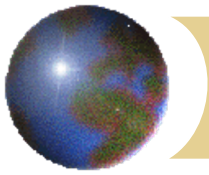
**This is good project management.**



## *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.**



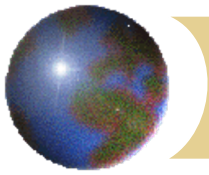
# *Assess risk and mitigate it*

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



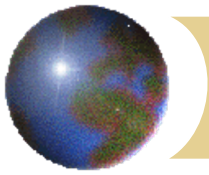
## *Safety Integrity Level*

<b>SIL</b>	<b>PFDavg</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>



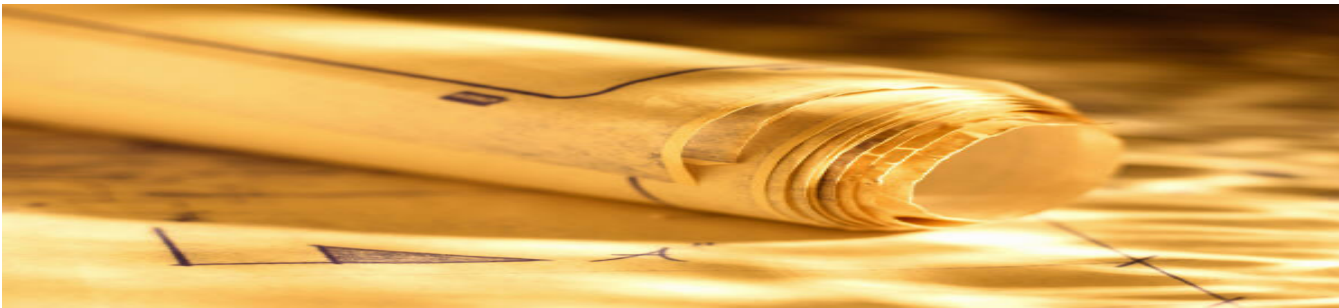
- ✚ Let's talk about Risk.
- ✚ What is your wager?
- ✚ How many times do you place the wager each year?
- ✚ What are your odds of losing your wager?



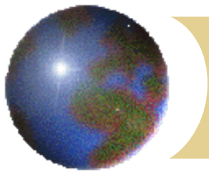


## *Design SIF*

- ✚ 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

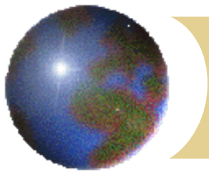
- ⊕ Make sure all documents are in place and all hazards analysis items are addressed.

### ⊕ Validation

- ⊕ Test SIFs to ensure that they have desired functionality







## *Maintain it*

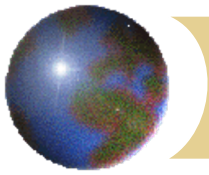


### ✚ Operation, maintenance and testing

- ▣ 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



