SmartPlant Instrumentation and ANSI/ISA-84.00.01-2004 SIS

Fluor's SmartPlant Implementation Initiative

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Engineering Automation Practices

- Fluor uses SmartPlant Instrumentation (SPI) to automate the Engineering, Procurement and Construction activities as applied to Petrochemical Projects
- The deliverables from SPI are also used by Owner Operators for Operations and Maintenance of the Plant Control Systems and Instrument Networks

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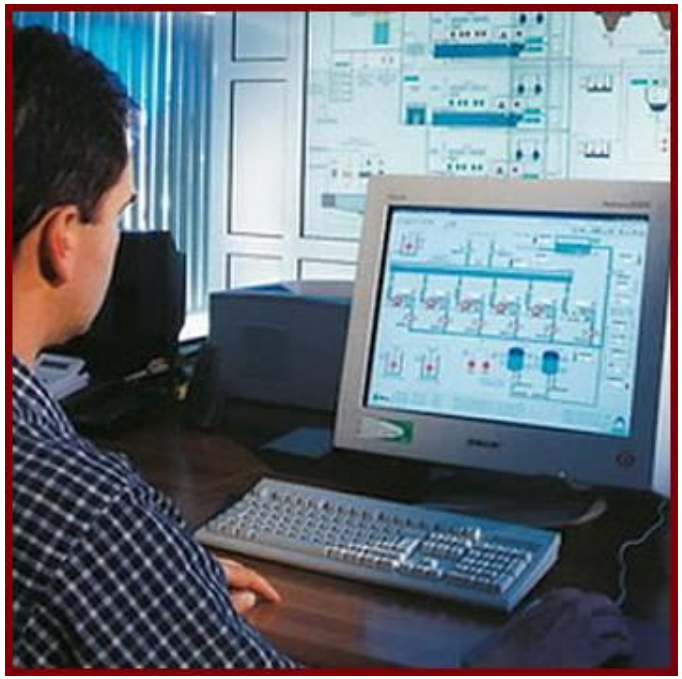
Computer Automated Engineering

- SPI is well suited to document the Basic Process Control Systems (BPCS) but are also used to document other Instrument networks such as Safety Instrumented Systems (SIS)
- When developing SIS using SPI must assure compliance with certain U.S. and International Practices, Standards and Certifications



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Functional Safety Standards

- U.S. Companies must adhere to OSHA 1910.119 for Process Safety Management (PSM)
- ISA S84 committee created the ISAISA 84.01-1996 standard to supplement PSM for Instrumentation
- Lacking an International standard for Safety – The International Electrotechnical Commission (IEC) developed IEC 61511 in 1998 defining Safety Instrumented Systems

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Functional SIS Standards

- ISA S84 committee adopted the IEC 61511-1 Mod standard in 2004 creating ANSI/ISA-84.00.01-2004
- This ISA standard was more comprehensive and covered the complete management of SIS
  - These standards called for Safety Instrumented Systems to be designed to automatically respond to potentially dangerous process conditions and take preprogrammed action to mitigate or avoid a dangerous condition

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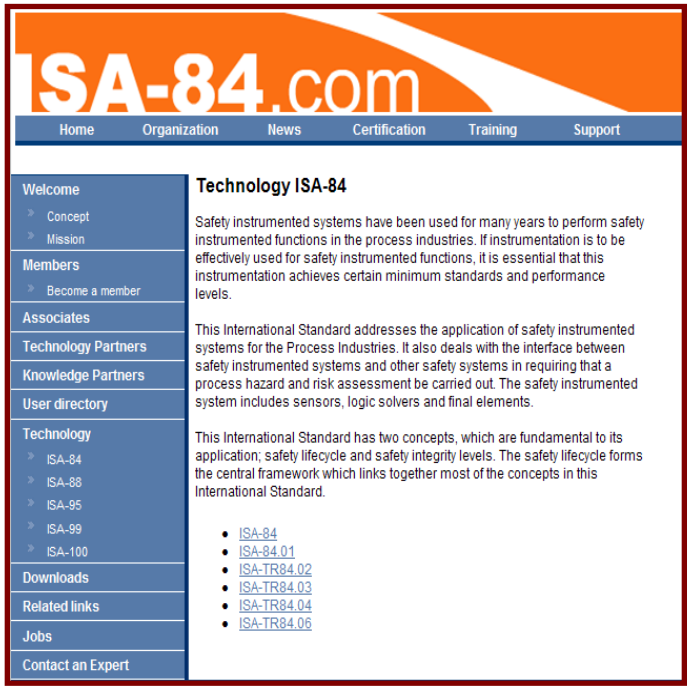
Functional SIS Standards

- The safety-related portion of the Plant Control Systems configuration must remain in place for the lifecycle of the plant including decommissioning
- Provides a framework for establishing Safety Integrity Levels (SIL) and hardware fault tolerances
- Defines the preparation of information and procedures concerning software needed by the user for the operation and maintenance of the SIS



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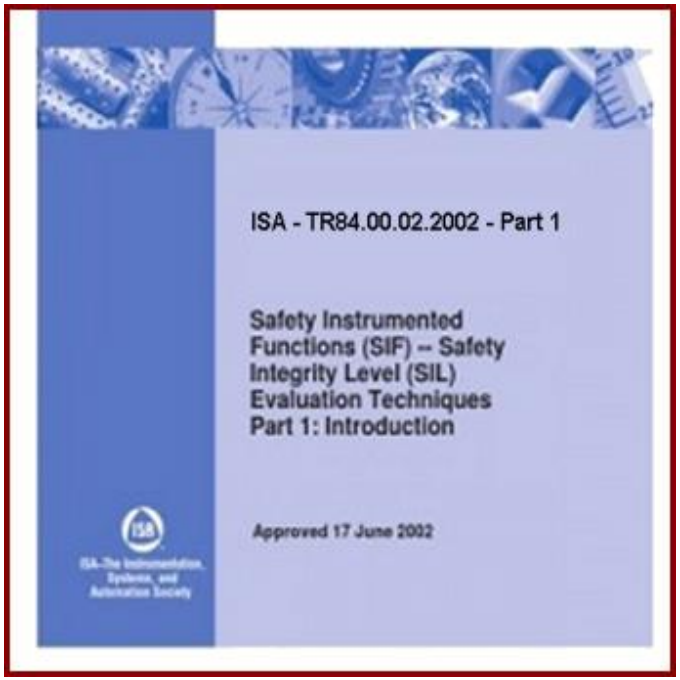
Functional SIS Standards

- Requires the SIS system be composed of a separate and independent combination of sensors, logic solvers, final elements, and support systems
- Defines the selection of SIS hardware by “Proven in use” or “Compliance with IEC 61508”
- Defined procedures to be used for uniquely identifying all constituent parts of a SIS (hardware and software)

See ANSI/ISA-5.1-2009



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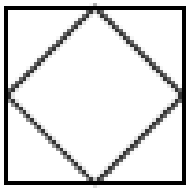
SIS Identification Standard

- **ANSI/ISA-5.1-2009 Instrument Symbols & Identification**
  - 'Diamond-in-square' will depict either (a) alternate control system choice or (b) Safety Instrumented System (SIS)



  - Variable Modifier safety [S] shall not be used to identify Safety Instrumented Systems and Components (E.G. PSV-)
  - Variable Modifier [Z] is used to identify the components of Safety Instrumented Systems (E.G. PZV-)

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Manufactures Standards for SIS

- IEC 61508 defines a set of standards for "Functional safety of Electrical, Electronic and Programmable Electronic (E/E/PE) safety-related systems"
  1. General Requirements
  2. Equipment Compliance
  3. Software Compliance
  4. SIL Definitions
  5. SIL Examples
  6. Guidelines
  7. Overview

Manufactures Standards for SIS

- Manufactures switched from hard wired safety systems to safety PLC's and safety networks:
  - Reduced Risk of Process Operator Error
  - Heightened Flexibility of Configuration
  - Lower Installed Equipment Costs
  - Functional Safety Certification to ensure that the product includes sufficient Functional Safety protection according to the required Safety Integrity Levels (SIL)

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Computer Aided Engineering (CAE)

- "*The safety-related portion of the Plant Control Systems configuration must remain in place for the lifecycle of the plant*" ~ ANSI/ISA-84.00.01
- CAE Control Systems Data now exists throughout the lifecycle of the Plant
- Owner Operator Retention:
  - Instrument Indexes
  - Instrument Data Sheets
  - Instrument Calibration Data
  - Loop Wiring Drawings / Data
  - Critical Alarm Lists

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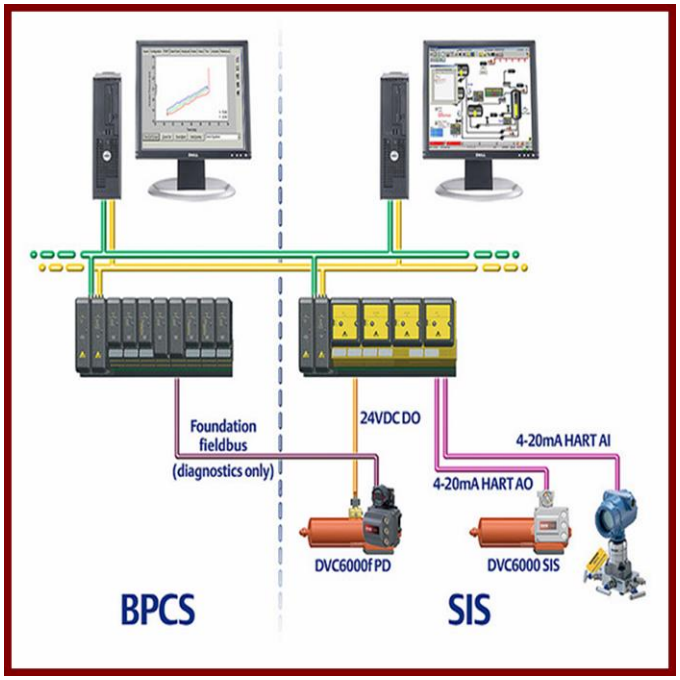
SIS fit to CAE and SPI

- ANSI/ISA-84.00.01-2004 created the need to document safety networks with CAE systems:
  - Safety Interlock (or Instrumented) Systems (SIS)
  - Burner Management Systems (BMS)
  - Fire and Gas Systems (F&G)
  - Shutdown Systems (ESD)
- Typical Documentation:
  - Safety Device Indexes
  - Safety Device Data Sheets
  - Safety Device Calibration Data
  - Safety Maintenance Data



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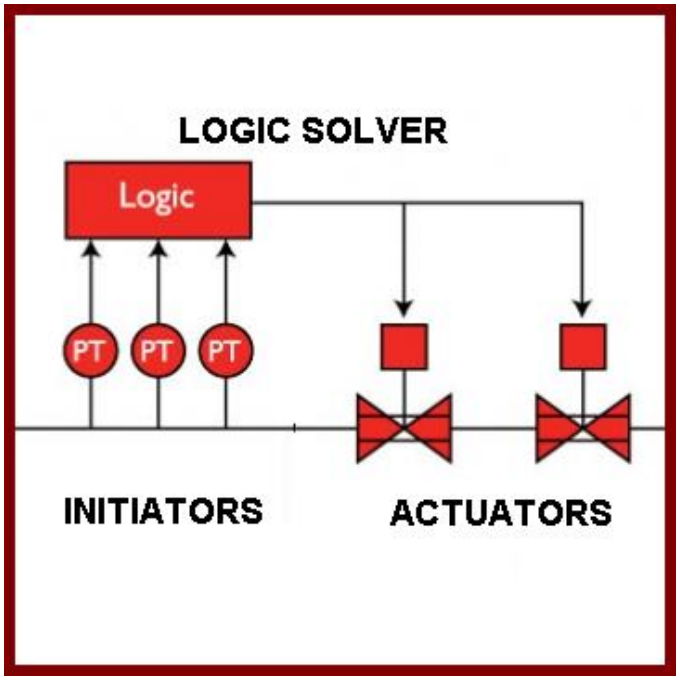
Basic Parts of a SIS

- **Initiators** - Primary Sensing Elements
- **Logic Solver** - Programmable Logic Controllers
- **Actuators** - Final Control Elements

- Each SIS part must have appropriate certification, testing and documentation to maintain the integrity of the safety network



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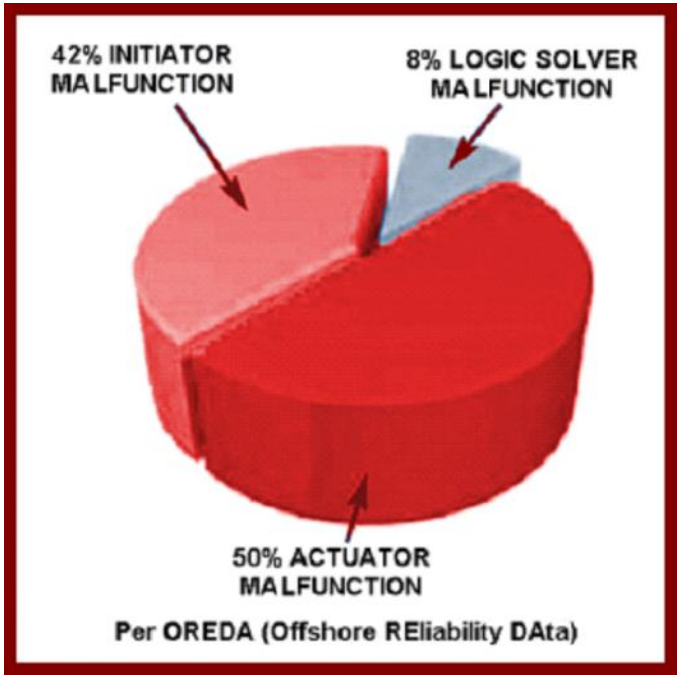
Reliability factors for SIS

- The most common areas of Failure (92%) are the Initiators and Actuators and their associated physical wiring systems
- The Initiators and Actuators are also the two areas that SPI interface with the SIS for Specification, Data Management, Wiring Documentation and Equipment Maintenance



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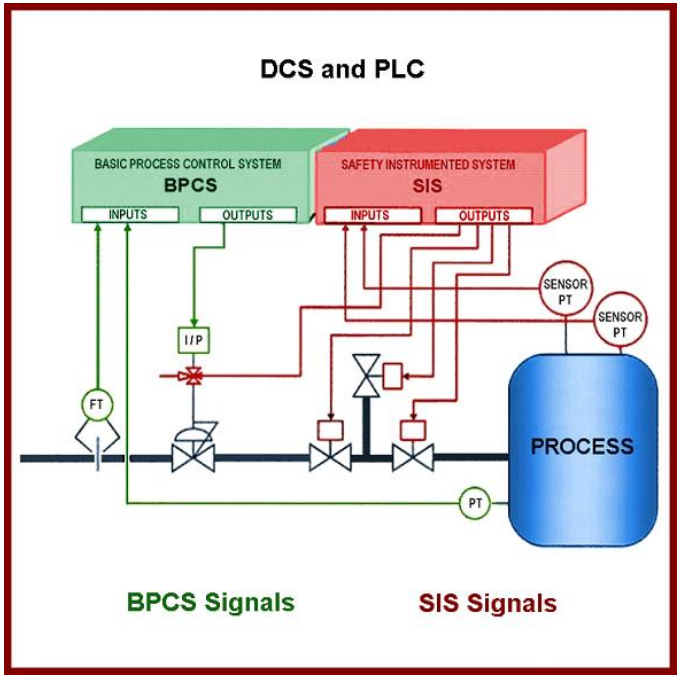
BPCS compared to SIS

- Typical SIS System Requirements
  - Signals are connected to a dedicated Isolated PLC
  - Multiple block and bleed Control Valve Configurations
  - Partial stroke testing to Improve the Probability of Failure on Demand (PFD) thus increasing the SIL
  - Discrete I/O vs. Analog (2oo3)
  - Redundant I/O & Wiring (2oo3)
  - Power supplied from redundant UPS sources or COPS (Critical Operations Power Systems)



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SIS Index Data Requirements

- User Defined Fields and Tables for Safety Data
- Additional Index Data for SIS Systems:
  - Unique Tag Identifiers for SIS Instrument Devices
  - Instrument System Identifiers
  - Power Requirements
  - Code Requirements
  - Maintenance Cycles
  - Interlock Numbers
  - SIS SIL Ratings

Note the “Z” Character in the Tag Number denoting SIS Tags per ANSI/ISA-5.1-2009

Tag Number	I/O System	Maintenance Cycle	Interlock Number
101-FI -003 -G	DCS		
101-FT -003 -G	DCS		
101-FV -003 -G	DCS		
101-FZT -2002-A	SIS	1 Year	I-20
101-FZT -2002-B	SIS	1 Year	I-20
101-FZT -2002-C	SIS	1 Year	I-20
101-FV -2002	DCS	6 Months	
101-FZY -2002	SIS	6 Months	I-20
101-ZZSC -2002	SIS	1 Year	I-20
101-ZZSO -2002	SIS	1 Year	I-20
101-FZT -2003-A	SIS	1 Year	I-20
101-FZT -2003-B	SIS	1 Year	I-20
101-FZT -2003-C	SIS	1 Year	I-20
101-FV -2003	DCS	6 Months	
101-FZY -2003	SIS	6 Months	I-20
101-ZZSC -2003	SIS	1 Year	I-20
101-ZZSO -2003	SIS	1 Year	I-20

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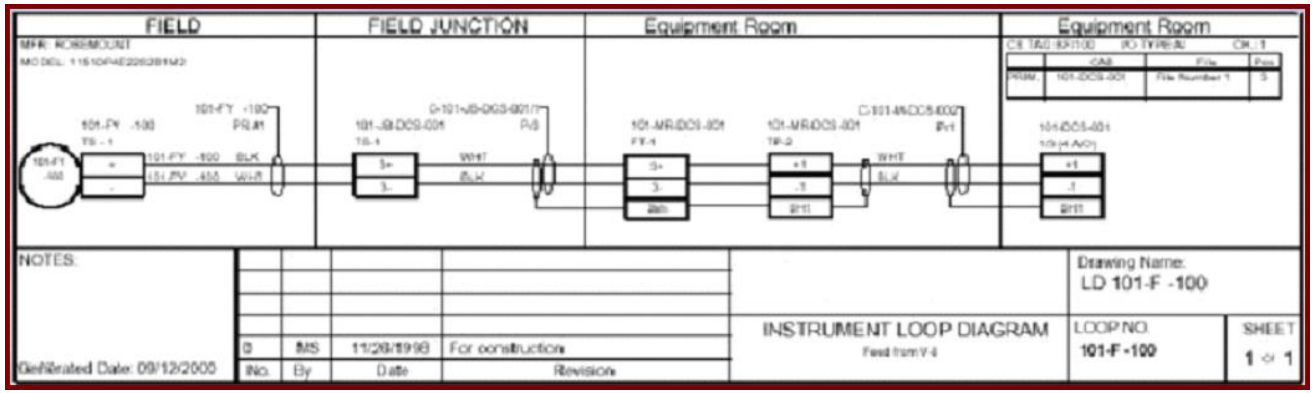
SIS Spec Sheet Requirements

- Additional Spec Sheet Data for SIS:
  - Safety Integrity Level Ratings
  - Testing Requirements
  - Certifications and Approvals
  - Redundancy or Conditioning Requirements
  - Special Notes for Design Engineering
  - Partial Stroke Testing Requirements (for Valves)
  - Cross references to Safety Documents

4	Detector Type	EMI Shielding Hz	Infrared Point HC Gas Detector	Yes
5	Safety Integrity Level	Approvals	IEC 61508 (SIL Level 2)	ATEX
6	Area Classification		Zone 2 CENELEC	
7	Output	Range	4-20 mA	0 - 100% LEL
8	Gas to be Detected - LPG		BUTANE/PROPANE	

SIS Wiring Requirements

- Issues When Wiring SIS:
  - PLC redundant power distribution uses common bus
  - Physical separation between SIS and BPCS wiring
  - Minimize terminals and connections as points of failure
  - Special colors, markings and labels for Safety Systems
  - May need ladder wiring diagrams instead of Loops
  - Need for Cause & Effect or Logic Diagrams
  - Special Power distribution diagrams for UPS or COPS



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Are Existing SIS Grandfathered?

- S84.01-2004 Part 1 Clause 1y is considered the "grandfather clause" and states the following:
  - "For existing SIS designed and constructed in accordance with codes, standards, or practices prior to the issuance of this standard (e.g. ANSI/ISA 84.01-1996), the owner/operator shall determine and document that the equipment is designed, maintained, inspected, tested, and operating in a safe manner."
- This exception is only for facilities built prior to 2004
- The EPC has no control over Operations after turnover
- This clause was specifically requested by OSHA and has been strictly enforced after catastrophic events when "Current Engineering Practices and Standards" were not followed by the EPC or Owner Operator

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Questions?

> *. . . When purchasing real estate the three most important selection criteria are location, location, location. When purchasing a Safety Instrumented System, the three most important selection criteria are diagnostics, diagnostics, diagnostics.*