

# SmartPlant Instrumentation and ANSI/ISA-84.00.01-2004 SIS

Fluor's SmartPlant  
Implementation  
Initiative



**FLUOR**<sup>®</sup>

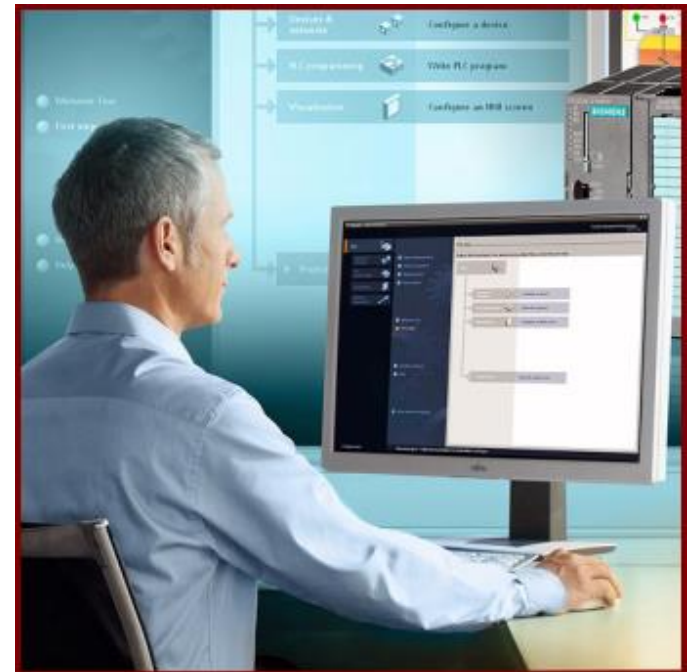
© 2013 Fluor. All Rights Reserved.

By: John Dressel

# Engineering Automation Practices



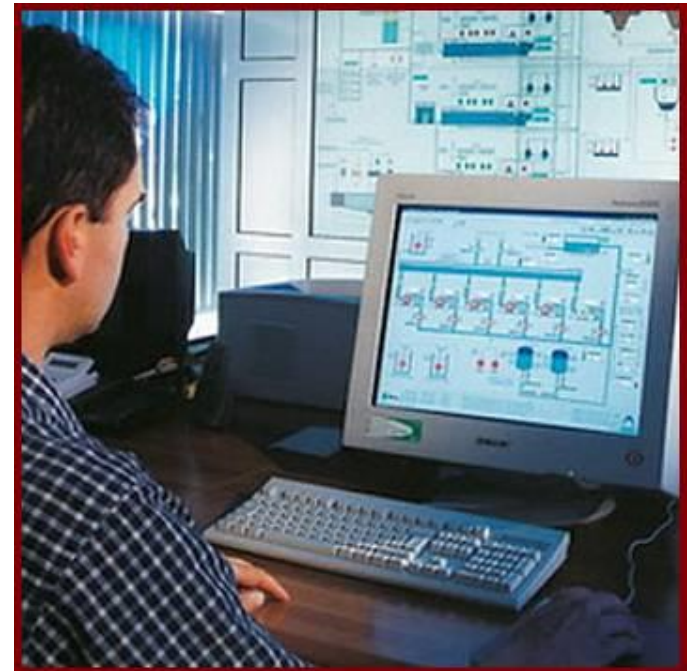
- ◆ Fluor uses SmartPlant Instrumentation (SPI) to automate the Engineering, Procurement and Construction activities as applied to Petrochemical Projects
- ◆ The deliverables from SPI are also used by Owner Operators for Operations and Maintenance of the Plant Control Systems and Instrument Networks



# 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



# 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



# 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

IEC  
FUNCTIONAL SAFETY ZONE

ABOUT THE IEC | IEC IN ACTION | CONFORMITY ASSESSMENT | STANDARDS DEVELOPMENT | FOR MEMBERS AND EXPERTS | WEB STORE SEARCH

IEC 61511, Functional safety: Safety instrumented systems for the process industry sector

- ▶ Introduction
- ▶ IEC 61511-1 Framework, definitions, system, hardware and software requirements
- ▶ IEC 61511-2 Guidelines in the application of IEC 61511-1 – Informative
- ▶ IEC 61511-3 Guidance for the determination of safety integrity levels – Informative
- ▶ Publication status

**Introduction**

Safety instrumented systems have been used for many years to perform safety instrumented functions in the process industries. If instrumentation is to be effectively used for safety instrumented functions, it is essential that this instrumentation achieves certain minimum standards and performance.

This international standard addresses the application of safety instrumented systems for the process industries. It also requires a process hazards and risk assessment to be carried out to enable the specification for safety instrumented systems to be derived. Other safety systems are only considered so that their contribution can be taken into account when considering the performance requirements for the safety instrumented systems. The safety instrumented system includes all components and subsystems necessary to carry out the safety instrumented function from sensor(s) to final element(s).

This international standard has two concepts which are fundamental to its application, safety lifecycle and safety integrity levels.

This international standard addresses safety instrumented systems which are based on the use of electronic/programmable electronic technology. Where other technologies are used for logic solvers, the basic principles of this standard should be applied. This standard also addresses the safety instrumented system sensors and final elements regardless of the technology used. This international standard is process industry specific within the framework of IEC 61508 (see annex A of IEC 61511-1).

This international standard sets out an approach for safety lifecycle activities to achieve these minimum standards. This approach has been adopted in order that a rational and consistent technical policy is used.

INDEX OF QUESTIONS

- ▶ A Scope
- ▶ B Position in international standards framework
- ▶ C Regional issues and technical interpretation
- ▶ D Complying with the standard

▶ E Key concepts

- ▶ F Hazard and risk analysis
- ▶ Feedback
- ▶ Copyright for this zone

WHAT IS RELATED

- ▶ Horizontal committees and functions
- ▶ Information on a Technical Committee
- ▶ Publications and work in progress

SEARCH THE SITE

WEB STORE

Search & buy standards

# Functional SIS Standards



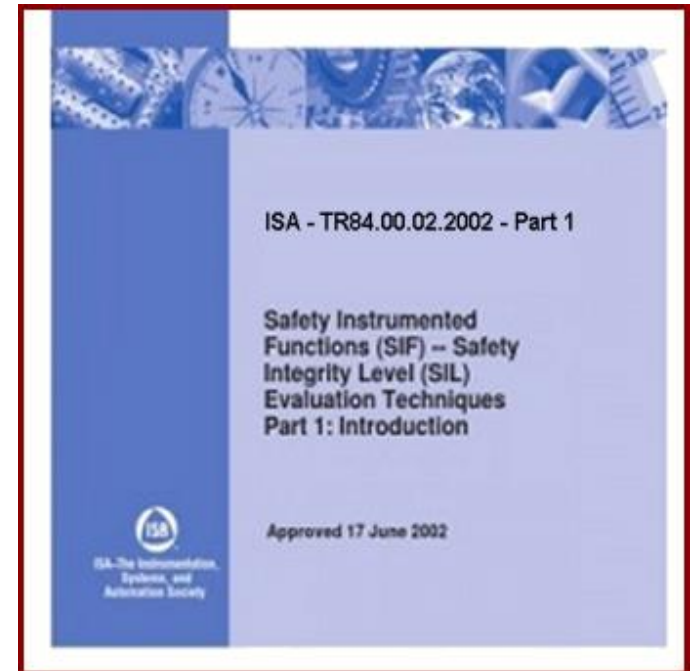
- The safety-related portion of the Plant Control Systems configuration must remain in place for the lifecycle of the plant including decommissioning
- Provides a framework for establishing Safety Integrity Levels (SIL) and hardware fault tolerances
- Defines the preparation of information and procedures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

The screenshot shows the ISA-84.com website. The header features the logo 'ISA-84.com' in white on an orange background. Below the logo is a navigation bar with links for Home, Organization, News, Certification, Training, and Support. The main content area is divided into two columns. The left column contains a 'Welcome' section with sub-links for Concept and Mission, a 'Members' section with a 'Become a member' link, 'Associates', 'Technology Partners', 'Knowledge Partners', and 'User directory'. The 'Technology' section lists ISA-84, ISA-88, ISA-95, ISA-99, and ISA-100. Below this are 'Downloads', 'Related links', 'Jobs', and 'Contact an Expert'. The right column is titled 'Technology ISA-84' and contains introductory text about safety instrumented systems, followed by a list of standards: ISA-84, ISA-84.01, ISA-TR84.02, ISA-TR84.03, ISA-TR84.04, and ISA-TR84.06.

# 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

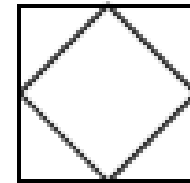


# SIS Identification Standard

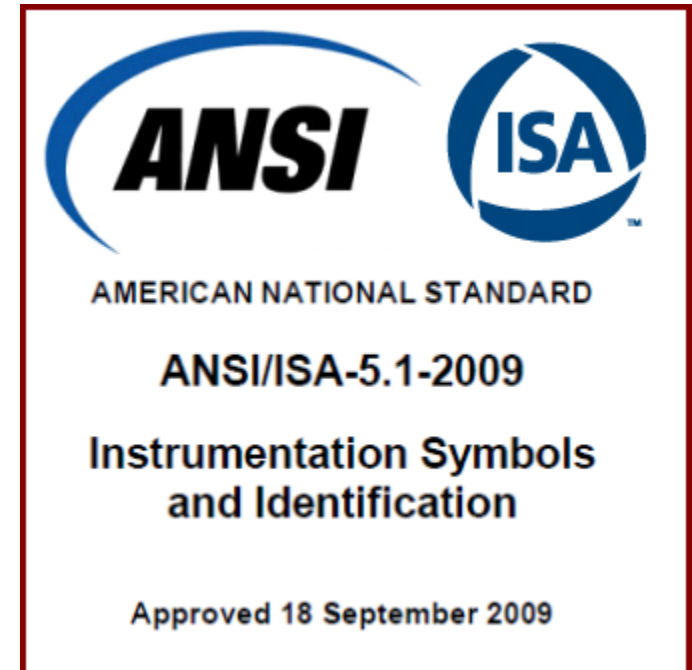


## ◆ ANSI/ISA-5.1-2009 Instrument Symbols & Identification

- ‘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-)





# 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)



# Computer Aided Engineering (CAE)

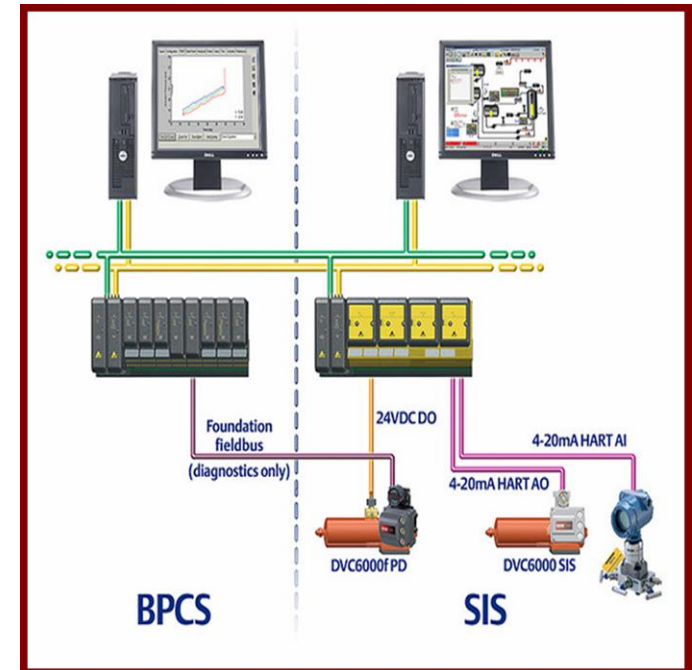


- *“The safety-related portion of the Plant Control Systems configuration must remain in place for the lifecycle of the plant” ~ ANSI/ISA-84.00.01*
- CAE Control Systems Data now exists throughout the lifecycle of the Plant
- Owner Operator Retention:
  - Instrument Indexes
  - Instrument Data Sheets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



# SIS fit to CAE and SPI

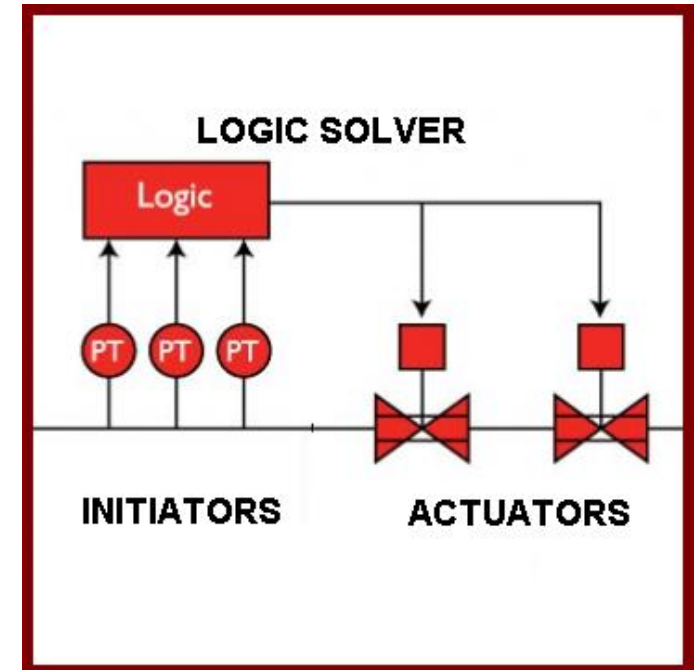
- ◆ ANSI/ISA-84.00.01-2004 created the need to document safety networks with CAE systems:
  - Safety Interlock (or Instrumented) Systems (SIS)
  - Burner Management Systems (BMS)
  - Fire and Gas Systems (F&G)
  - Shutdown Systems (ESD)
- ◆ Typical Documentation:
  - Safety Device Indexes
  - Safety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



# Basic Parts of a SIS



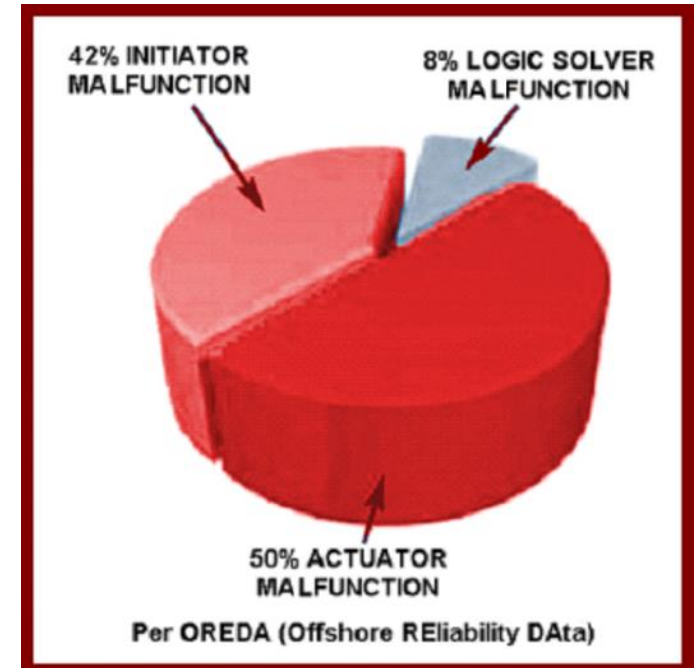
- ◆ **Initiators** - Primary Sensing Elements
- ◆ **Logic Solver** - Programmable Logic Controllers
- ◆ **Actuators** - Final Control Elements
- Each SIS part must have appropriate certification, testing and documentation to maintain the integrity of the safety network



# Reliability factors for SIS

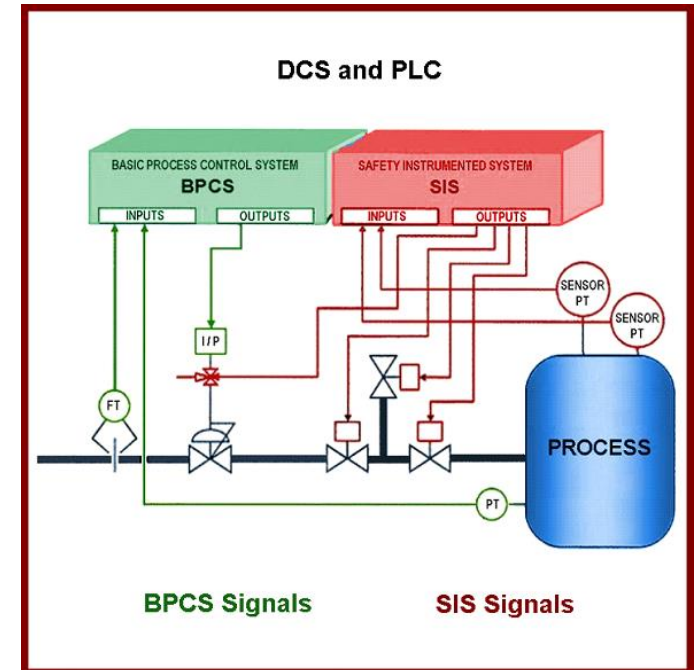


- The most common areas of Failure (92%) are the Initiators and Actuators and their associated physical wiring systems
- The Initiators and Actuators are also the two areas that SPI interface with the SIS for Specification, Data Management, Wiring Documentation and Equipment Maintenance



# 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 (2003)
  - Redundant I/O & Wiring (2003)
  - Power supplied from redundant UPS sources or COPS (Critical Operations Power Systems)



# 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



# SIS Spec Sheet Requirements



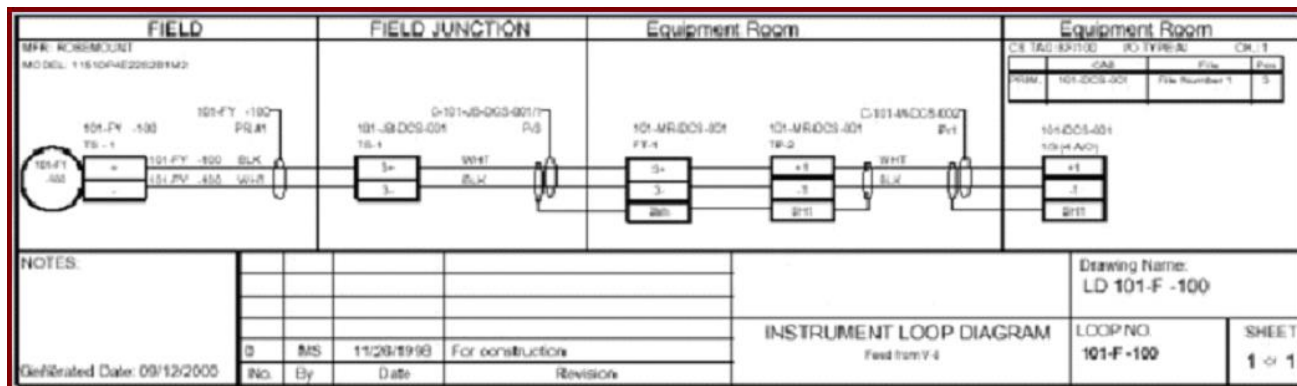
- ◆ Additional Spec Sheet Data for SIS:
  - Safety Integrity Level Ratings
  - Testing Requirements
  - Certifications and Approvals
  - Redundancy or Conditioning Requirements
  - Special Notes for Design Engineering
  - Partial Stroke Testing Requirements (for Valves)
  - Cross references to Safety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



# 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



# 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**.*