Training Program:

Safety Instrumented Systems & Emergency Shutdown

INTRODUCTION:

Thousands of process plants all over the world use Safety Instrumented Systems (SIS for short), to protect people, equipment and the environment from catastrophe. During recent years, various countries and regions have made it mandatory to use these systems, to prevent accidents and mishaps. Unfortunately however, knowledge about Safety Instrumented Systems is perceived by many people to be a hidden art that only a few chosen people know (or are capable of knowing), which is just not true. Any professional who has work experience and / or qualifies to work in the process industries can easily learn all about Safety Instrumented Systems. Until now, however, there were few cost-effective resources that a person who wanted to know more about SIS in detail could refer to. Let us take a look at these now. These resources were mainly of three types; books on the subject, some online training courses and "free white papers" that one could find on the internet. The books are quite excellent, but you require to read, understand and digest, at least three of them (to gain a complete knowledge on the subject) that can be used in your work. This requires a lot of time that many people today simply cannot spare. Many online training courses are available, but they are mere copies and summaries of materials in the books and/or power point presentations of long gone seminars in a new avatar. The topics in the white papers and other documents is pretty good, but it ranges from the very basics to the very complex and everything in between. Reading and understanding it is like trying to drink a glassful of water from a fire hose. Theoretically possible but practically impossible. But now, there is an alternative-it is the newest e-learning course from Abhisam Software. This course on Safety Instrumented Systems is designed to make the learning experience comfortable and easy. Everything is explained in easy to understand terms, with plenty of graphics, interactive simulations and worked problems. Everything that you need to know about Safety Instrumented Systems, put together, in an easily digestible form, stripped of all the complexity, but still useful to impart skills to you that you can actually use in your work. To

reiterate once again, this course is NOT a rehashed power point presentation. It is a full fledged e-learning course with interactive animations, simulations, graphics and text. It also has many worked out example problems, to help understand the logic behind designing and operation of Safety Instrumented Systems.

COURSE OUTLINE:

- Introduction to Safety Instrumented Systems (SIS for short)
- Hazards, Risks & their analysis
- Failures & Reliability
- Safety Integrity Level
- SIS Standards
- SIS in practice
- SIS Testing & Maintenance
- Detailed course contents
- MODULE 1- Introduction to SIS
- What are Safety Instrumented Systems?
- Basic Ideas about SIS
- Functional Safety
- Instrumented Systems & Safety Instrumented Systems
- BPCS
- BPCS and SIS
- Safety Instrumented Function
- Safety Instrumented Function-2
- Safety Instrumented Function-3
- Emergency Shutdown Systems
- Need for a separate SIS

- Simulation exercise
- Learnings from the exercise
- Typical architecture
- Integrated BPCS & SIS
- Integrated BPCS & SIS-2
- Differences between BPCS & SIS
- MODULE 2-Hazards, Risks & their analysis
- Hazards & Risks
- Types of hazards- Fire & Explosions
- Types of hazards-Toxic Material
- The Safety Lifecycle
- Steps in analysis
- Preliminary Hazard Analysis
- HAZOP
- HAZAN
- Consequence Analysis
- Risk
- Risk graph
- Risk Reduction
- Risk Reduction-2
- The ALARP principle
- Risk Reduction in process plants
- Risk Reduction explained
- Risk reduction using an SIF
- Risk reduction using an SIF
- Layers of Protection
- Layers of Protection in the process industries
- Preventive & Mitigative layers
- Safety Requirement Specification

- Safety Requirement Specification-2
- Diversity
- MODULE 3-Failures & Reliability
- Failures
- Types of failures
- Types of failures-2
- Types of failures-3
- Dangerous & Safe failures
- Dangerous & Safe failures
- Safe Failure Fraction
- SFF Pie Chart
- Proof Test Interval
- Diagnostic Coverage
- Common Cause Failures
- Common Cause Failures-2
- CCF Example
- Diversity
- Reliability
- Failure Rate
- MTTF
- MTTR
- MTBF
- Failure Data
- Software Reliability & fault injection
- Reliability Block Diagrams
- Reliability Block Diagrams-2
- Reliability Block Diagrams-3
- Redundancy and Reliability
- Fault Tree Analysis

- Fault Tree Analysis Example- 1
- FTA and RBD
- Fault Tree Analysis Example-2
- Fault Tree Analysis Example-2
- Fault Tree Analysis-Probabilities
- Event Trees
- Event Tree Components
- Event Tree Analysis Example
- Fail-Safe and Fail Danger modes
- FMEA
- FMEDA
- FMEDA report
- How to use the FMEDA report
- Example FMEDA report
- Redundancy
- Redundancy and Voting
- Voting Systems 1oo1
- Voting Systems 1oo2
- Voting Systems 1oo2D
- Voting Systems 2oo2
- Voting Systems 2oo3
- Spurious Trips
- Concept of Demand
- Demand in a plant
- Low Demand & High Demand
- PFD
- MODULE 4-Safety Integrity Level
- Introduction to Safety Integrity Level
- What SIL is not

- Is SIL applicable to me?
- SIL 1 to SIL 4
- SIL for Demand Mode
- SIL for Demand Mode-Example
- SIL for Continuous/High Demand Mode
- The SIL process
- Common SIL questions
- Common SIL questions-2
- Target SIL-Qualitative & Quantitative methods
- Risk Reduction Factor-1
- Risk Reduction Factor-2
- Safety Availability and PFDavg
- SIL calculation Example
- SIL calculation Example
- SIL calculation Example (contd)
- SIL calculation Example (contd)
- SIL Calculation example-(modification)
- SIL Calculation example-additional layers
- SIL Calculation example-caution
- Consequence Only Method
- Hazard Matrix Method
- Hazard Matrix Method- (contd)
- Hazard Matrix Method-Example
- Risk Parameter Graph-1
- Risk Parameter Graph-2
- Risk Parameter Graph-3
- Calibrated Risk Graph-1
- Calibrated Risk Graph-2
- LOPA method

- Conducting a LOPA
- More about LOPA
- LOPA Example
- LOPA Example contd
- LOPA Example contd 2
- LOPA Example contd 3
- Target SIL & SIL verification
- SIF design process
- PFD of simple loop
- SIL verification example-1
- SIL verification example-2
- SIL verification for complex loops
- Markov Modeling-1
- Markov Modeling-2
- Markov Modeling-3
- Markov Modeling-4
- Simplified Equations
- Use of Simplified Equations-Example
- Architectural Constraints
- Architectural Constraints IEC 61508
- Hardware Fault Tolerance-IEC61508
- Hardware Fault Tolerance (contd)
- Architectural Constraints-Example
- Hardware Fault Tolerance-IEC61511
- Hardware Fault Tolerance example
- Conclusion
- MODULE 5-SIS Standards
- Introduction to Standards in SIS
- AK 1 to AK 8

- IEC Standards
- IEC 61508
- E/E/PE systems
- IEC 61508-Safety Life Cycle
- IEC 61511-Basics
- Relationship between IEC 61508 & IEC 61511
- ISA S84 Background
- ISA S84 Differences
- Where to get standards
- What standards apply to me?
- MODULE 6- SIS in practice
- Components of the Safety Loop
- Types of logic Solvers
- Hardwired logic solvers-Trip amplifiers
- Hardwired logic solvers-Gates
- Safety Relays-Electromechanical
- Safety Relays-Electromechanical-2
- Safety Relays-Electromechanical-3
- Safety Relays-Electromechanical-4
- Safety Relays-Electronic
- Safety Relays-Electronic-2
- Programmable Logic Solvers
- Safety PLCs & General Purpose PLCs
- Fault Diagnostics
- Safety PLCs- Inputs
- Safety PLCs-Processors
- Safety PLCs- Outputs
- Safety PLCs-Software
- Safety PLCs-Software-2

- Safety PLCs-Software-Design
- Safety PLCs-Voting architecture
- Safety PLCs-TMR
- Safety PLCs-QMR
- Safety PLCs-Interface to BPCS
- Safety Networks-1
- Safety Networks-2
- HIPPS
- MODULE 7-SIS Testing & Maintenance
- Need for testing
- Testing-Example
- Breakup of failures
- Testing the components of a SIS
- Testing Sensors & Transmitters
- Testing Logic Solvers
- Testing valves
- Valve Testing-Bypass method
- Partial Stroke Testing
- Partial Stroke Testing-ISA method
- Valve Testing- Mechanical Stoppers
- Valve Testing-Smart Positioner method
- PST-Advantages & Disadvantages
- Testing and PFDavg
- Conclusion