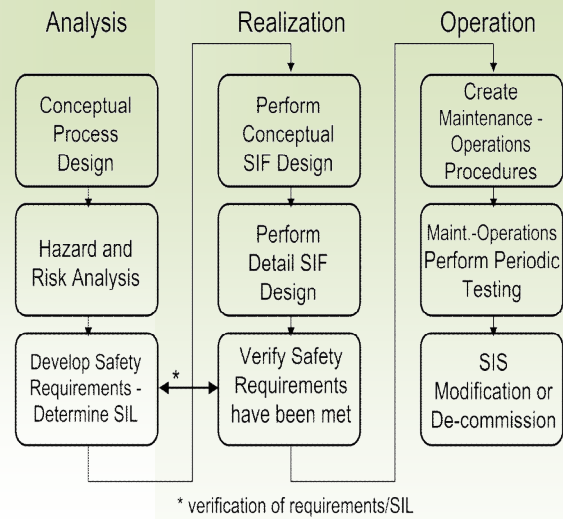


Safety Life Cycle Services: Safety Instrumented System



Functional Safety Services

Process industry is exposed to risks like fire, explosion, injuries and accidents etc causing fatalities and monetary losses. 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 levels. Safety Instrument System (SIS) is one of the most important layers of protection against accidents & hazards, in a chemical process industry. Occupational Safety and Health Administration, USA warrants that the design and implementation of safety system meet good engineering practice. Safety Performance criteria for SIS should be defined by Safety Integrity Levels (SIL). The determination of Safety Integrity Level required for the SIS will help verification of configuration of SIS to meet or exceed the required SIL and in turn the reliability of the system.

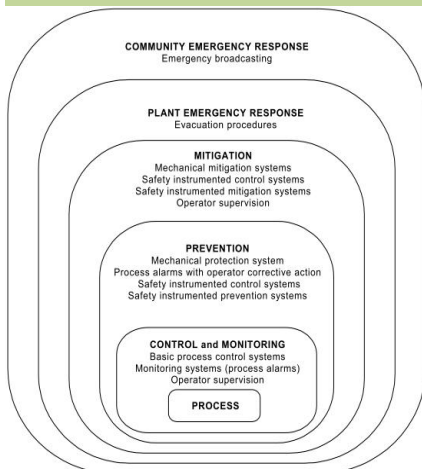
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What we can offer

Chola MS Risk is a pioneer of many specialized services and is one of leading service provider of consulting services in domains related to Safety, Health & Environment. The organization has services in following domains: Process Safety & Fire Risk Management; Environment/Energy Consulting Services; Electrical/Construction Safety Services; Logistics Risk Management.

Chola MS Risk offers safety life cycle services for process industry. It includes HAZOP, QRA, PHSER, SIL Determination study using Layer of Protection Analysis, Risk Graph technique etc, Safety Requirement Specification, SIL Verification Study, Functional Safety Assessment Study and SIL Validation.



Layer of Protection Analysis

SIL Determination

"SIL" (Safety Integrity Level) classification is performed to establish a "fit for purpose" design of (instrumented) safety measures, which are able to mitigate hazards with respect to safety, environmental consequences and economic loss.

It is also "fit for purpose" in the sense that robustness (i.e. redundancy of sensing and/or final elements) of the safety measure is validated against operational losses caused by spurious trips. The SIL Determination will be performed by a multi-disciplinary team

knowledgeable of the design being evaluated, and IEC61508 / IEC61511 standards. The team will consist of people qualified to review the chemical process, identify potential process hazards, and recommend actions be taken to minimize risks.

Chola MS Risk will facilitate the team through the LOPA or Risk Graph to allocate SIL for a SIF. SIL determination is done

- ❖ To allocate safety functions to protection layers;
- ❖ Determine the required safety instrumented functions;
- ❖ Determine, for each safety instrumented function, the associated safety integrity level.

A SIS is defined as a system composed of sensors, logic solvers and final elements designed for the purpose of: 1. Automatically taking an process to a safe state when specified conditions are violated; 2. Permit a process to move forward in a safe manner 3. To mitigate the consequences

Credentials

- ⇒ Cholamandalam MS Risk Services Ltd. is joint venture of the diversified US \$ 3.14 billion Indian business conglomerate, *Murugappa Group, India and Mitsui Sumitomo Insurance group, Japan* one of the largest insurance groups in the world and biggest in Asia.
- ⇒ Chola MS Risk is an ISO 9001:2008 certified company
- ⇒ Team of qualified Functional Safety specialists who are Trained by CFSE, EXIDA and Functional Safety Engineers, certified by TUV, Germany
- ⇒ CMSRSL uses exSILentia, Integrated Safety Life Cycle suite of EXIDA
- ⇒ Usage of PHA PRO software version 8.0 and PHAST Risk 6.6 developed by DNV
- ⇒ Executed close to 2500 Safety & Environment related Risk Assessment consulting assignments across domestic & International markets for last 15 years
- ⇒ Chola MS Risk has been accorded approval of "Organization as Safety Auditor" by DGFASLI, Govt of India to conduct safety audit studies in India; this is the First institution to get such recognition.
- ⇒ Certified "Environment Impact Assessment" organisation by NABET EIA Accreditation committee, a constituent of Quality Council of India
- ⇒ Exposure to more than 100 different clients which includes Oil & Gas,

Safety Requirement Specification

The objective is to specify the requirements for the safety instrumented function.

- ❖ to define the safe state of the process for each identified safety instrumented function;
- ❖ the assumed sources of demand and demand rate on the safety instrumented function;
- ❖ requirement for proof-test intervals;
- ❖ response time requirements for the SIS to bring the process to a safe state;
- ❖ the safety integrity level and mode of operation (demand/continuous) for each safety instrumented function;
- ❖ a description of SIS process measurements and their trip points;
- ❖ requirements relating to energize or de-energize to trip;
- ❖ requirements for resetting the SIS after a shutdown;
- ❖ maximum allowable spurious trip rate; etc as per IEC 61511.

Transmitter Logic Solver Valve

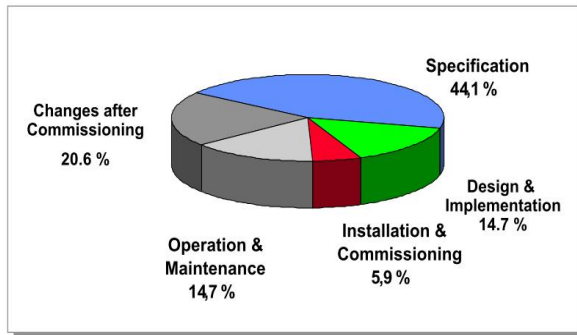


$$PFD_{AVG} = \sum PFD_{SE} + \sum PFD_{LS} + \sum PFD_{FE}$$

Where;

- PFD_{SE} is the probability of failure on demand of a sensor or input interface element
- PFD_{LS} is the probability of failure on demand of a logic system element, and
- PFD_{FE} is the probability of failure on demand of an output interface element or final element

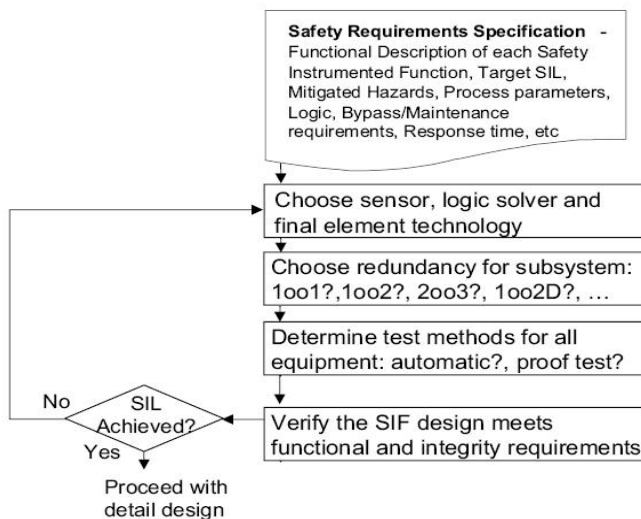
Primary Cause of Control System Failure



Note: based on 34 investigated incidents in the UK : "Out of Control", HSE

SIL Verification

SIL verification is a key step in the conceptual design process of SIF. After the preparation of Safety Requirement Specification based on SIL Assessment exercise the SIF subsystem (sensor, logic solver, final element) technology is chosen. Subsequently the redundancy for sub system (like 1oo1, 1oo2, 2oo3 etc) is decided. Test methods for all equipment (automatic, proof test etc) are determined. The SIF design is verified whether it meets functional and integrity requirements. The flow chart of conceptual design process is given below for



SIL Validation

The objective of the requirements of this stage is to validate, through inspection and testing, that the installed and commissioned safety instrumented system and its associated safety instrumented functions achieve the requirements as stated in the safety requirement specification. Some of the check include, Verify that SIS performs under normal and abnormal operating modes as defined in SRS; Confirm that adverse interaction between basic process control system (BPCS) and other connected systems do not affect the SIS; Confirm that the sensors, logic solvers, and final elements perform as defined in the SRS; Verify that proof test intervals are documented in maintenance procedures etc.

Functional Safety Assessment

- ❖ To ensure that the hazards arising from the process and its associated equipment are properly controlled
- ❖ To ensure that the dangerous failure rates of the safety instrumented system are in accordance with those assumed during the design
- ❖ To ensure that the recommendations from HAZOP and other safety related studies that applies to safety instrumented system have been implemented or resolved
- ❖ To ensure that the Safety instrumented system is designed, constructed and installed in accordance SRS
- ❖ To ensure that Safety, operating, maintenance and emergency procedures pertaining to the Safety instrumented system are in place
- ❖ To ensure the validation planning are appropriate and validation activities have been completed
- ❖ To verify if appropriate information about the SIS is provided for employees through training

Stages for FSA

To carry out functional safety assessment activities at the following stages

- ❖ Stage 1 - After the hazard and risk assessment has been carried out, the required protection layers have been identified and the safety requirement specification has been developed.
- ❖ Stage 2 - After the safety instrumented system has been designed.
- ❖ Stage 3 - After the installation, pre-commissioning and final validation of the safety instrumented system has been completed and operation and maintenance procedures have been developed.
- ❖ Stage 4 - After gaining experience in operating and maintenance.
- ❖ Stage 5 - After modification and prior to decommissioning of a safety instrumented system.

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*We partner with clients in managing
their risks to protect business, society
and environment*

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www.cholarisk.com



Codes and Standards

- IEC 61511: Functional safety - Safety instrumented systems for the process industry sector - Part 1,2 & 3.
- IEC 61508: Functional safety of electrical/electronic/programmable electronic safety-related systems- Part 1,2,3,4,5 & 6
- Layer of Protection Analysis: Simplified Process Risk Assessment – Centre for Chemical Process Safety (CCPS)
- Reliability Data for Safety Instrumented System – PDS Data Hand Book (SINTEF)
- Offshore Reliability Data Handbook (OREDA)
- Safety Equipment Reliability Handbook (SERH)

SIL Studies Carried out by CMSRS in the recent past

Project Name	Client
SIL Assessment, SRS & Verification Study for Effluent Water Injection Phase-1 & Sea Water Injection Phase-2, Kuwait Oil Company, Kuwait.	Petrofac, Sharjah
SIL Assessment, Safety Requirement Specification, SIL verification studies for Installation of Fuel gas & gas oil pipelines and pumping station from MAA to Azzour & Shuaiba Power Station, Kuwait Oil Company, Kuwait	Petrofac, Sharjah
SIL Assessment study for IOCL Paradip Refinery	Callidus Technologies by Honeywell.
SIL Assessment Studies Generic FEED for wellhead platform-Dragon oil Turkmenistan Ltd.	Saipem India Projects Limited, Chennai
SIL Assessment for EPIC of Gas Sweetening Facilities at Mesaieed & Dukhan, Qatar Petroleum,	Petrofac, Sharjah
SIL Assessment and Verification for BS-160, Kuwait Oil Company	Saipem-Italy, Kuwait Oil Company.
SIL Assessment and Verification for the contract no. 39084: 40" Gas Pipeline from BS131 to LPG plant at MAA	Petrofac Sharjah – Kuwait Oil Company.
SIL Study/ Functional Safety Assessment of Processing Facility and Gas Compressor Project, TEG, REG, Krechba, IGS In Salah Gas, Algeria	(British Petroleum and Statoil Joint Venture) - Petrofac Sharjah
Safety Integrity Level Assessment Report for Improvement and Modification of Power Distribution System in GC 23, North Kuwait, Kuwait Oil Company	Oil & Gas Engineering W.L.L., Kuwait
SIL Assessment study for Karan utilities & Co-Generation Project	Aramco Overseas Company - Petrofac, Sharjah
Safety Integrity Level Assessment Report for Upgrading of Medium Crude Oil Incoming Manifold at GC-27, Kuwait Oil Company, Kuwait.	Kuwait Oil Company.
Safety Integrity Level Assessment and Verification Studies for 120 MBOPD early production facility for Ratqa and Abdali – North Kuwait, Kuwait Oil Company	Kuwait Oil Company.
Safety Integrity Level Assessment for Replacement of ESDV/AOV/Shutdown Control valves at BS 140 & BS 150, Kuwait Oil Company	Kuwait Oil Company.
SIL Study for improvement to ESD Systems at South Kuwait GC-3, GC-4, GC-6, GC-7, GC-8, GC-21 Kuwait Oil Company.	Kuwait Oil Company.
SIL Study for Renovation of waste water treatment facilities at Al Khafji Joint Operations, Kingdom of Saudi Arabia	Al Khafji Joint Operations
SIL Study for Field Development Plan, Phase 1, Oil & Gas sector, Off shore Project, at Al Khafji Joint Operations, Kingdom of Saudi Arabia	Al Khafji Joint Operations
SIL Study for improvement to ESD Systems at GC-17, GC-27 & GC-28 and isolation capabilities, at GC-27 and GC-28 in West Kuwait.	Kuwait Oil Company.
SIL Study for Lower Flares Pilot Project	Kuwait Oil Company.
SIL Study for HIPPS of 20" Crude oil pipeline from TL3 to Doha Power Station – Kuwait Oil Company	Kuwait Oil Company.
SIL Assessment for HIPPS of 120 MBOPD Early Production Facility for RATQA & ABDALI- North Kuwait	Kuwait Oil Company.
SIL Assessment/ Verification for Modification of Fire and Gas Detection System in GC-17	Kuwait Oil Company.