

Vertigo – Technical Data

SIS Design Basis Software

The Kenexis Vertigo™ safety instrumented system design basis management software provides an all-in-one software solution to the design of SIS in accordance with IEC 61511 /ISA 84. The software provides users with a powerful enterprise solution for developing conceptual designs, documenting/tracking design changes, and maintaining design documentation throughout the life of the system.

Server Hardware Specifications

Vertigo is built on cloud based architecture to create a multi-site multi-user global enterprise software experience. The core of the application framework are Kenexis' powerful server computers that run the application code and store data. Servers are maintained on Kenexis cloud based systems.

Server Operating System:	Windows Server - 2013
Database Engine:	Microsoft SQL Server – Latest Version
Web Server Engine:	Microsoft Internet Information Services – Latest Version
Server Hardware:	Multi-Core Multi-threaded High Performance Processor Array
Data Storage:	RAID Multi-Drive
Availability:	>99% Guaranteed
Data Backup:	Daily – Offsite; 30 days of backup available; Offsite Annual backup maintained for 5 years

Client Requirements

Users of Vertigo access Kenexis' powerful server architecture through their own client devices through a simple web browser. Effigy can be accessed by almost any computer, in almost any location – worldwide, at any time. This allows diverse work teams across the globe to seamlessly work together regardless of time zone or computer system.

Client Device Types:	Computers (and laptops), Tablet Computers, Smart Phones
Supported Operating Systems:	Windows, Mac OS, Linux, iOS, Android, Windows Phone
Supported Web Browsers¹:	Internet Explorer, Chrome, Firefox, Safari
Connectivity:	Any variety of internet connectivity

¹ Some more advanced features, are only supported by the most recent version of a browser. Otherwise, Kenexis supports the past three versions of each browser listed.

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Client Accounts

Kenexis is robust enterprise software, but it has the flexibility to allow organizations and individual users to set up accounts to meet their own needs.

Account Types:

Professional – Named User – This account is accessed from the Kenexis Public Server (shared application code and database). Only the single named user associated with the account is licensed to access the software and associated data. Professional Accounts are available in Annual or Project (60 day) durations.

Professional – Simultaneous User - This account is accessed from the Kenexis Public Server (shared application code and database). Unlimited users from a single organization are licensed to access the software and associated data, but only the specified number (minimum of two) can access the application simultaneously. Professional Accounts are available in Annual or Project (60 day) durations.

Operating Enterprise – This account can be accessed from the Kenexis Public Server (shared application code and database), but a dedicated server or dedicated node is recommended. Unlimited users from a single organization are licensed to access the software and associated data with no limit on the number of simultaneous users. Operating Enterprise Accounts are available in annual duration and licensing is based on the number of tags in the database.

Private Node:

As an option, any user or group of users, can obtain a private node. The private node is operating by the same powerful Kenexis server system that operates the public server, but in a private node the group maintains a separate set of application code and a separate database for results storage. Private nodes can also be customized with custom graphics and custom URL for access.

Private Server:

As an option, any user or group of users, can obtain a private server. The private server allows for complete physical and functional separation from any other users of the Kenexis instrumented safeguard suite. This option provides for a completely separate and dedicated computer system for the user group.

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Handling Multiple Project

Vertigo, through the KISS project manager, allows for the creation, manipulation, and management of an unlimited number of project.

Project Types:	Vertigo – Safety Integrity Level Verification and SRS Effigy – Fire and Gas Mapping (Sold Separately) Audit – Audit and Assessment Database (Sold Separately)
Tracked Project Data:	Study Name, Study Type, Study Facility, Study Owner (User Name and Full Name), Date Modified, Current Revision
Project Actions:	Load Study, Copy Study, Delete Study, Baseline Study (Set Revision), Import Study ²

Data Libraries

Vertigo contains data libraries that allow for fast and accurate modeling of a wide variety of safety instrumented function configurations. Kenexis has compiled data for most safety instrumented system equipment vendors

Available Libraries:	Process Connections, Sensor Interface Devices, Sensors, Logic Solvers, Final Element Interface Devices, Final Elements
Equipment Attributes:	Failure Rate (Overall), Safe Failure Percentage, Diagnostic Coverage (Dangerous), Diagnostic Coverage (Safe), Device Type (A or B), Process Parameter Measured Data Trace Reference, Hardware Fault Tolerance, Maximum SIL Capability
Equipment Data Source:	Vendor Literature or Kenexis Analysis of publicly available databases supplemented by Kenexis analysis and confidential sources of failure statistics for process industry facilities
Equipment Vendors Included:	ABB, ASCO, Bentley Nevada, Berthold, CCC, Delta Controls, Detronics, Draeger, Drexelbrook, Emerson, Endress+Hauser, Fire Sentry, Fireye, Fisher, HIMA, Kidde, Krohne, K-TEK, Magnetrol, Masoneilan, Maxon, Mokveld, MTS, Micro Motion, MSA, Moore Industries, Neles, Pepperl+Fuchs, Phoenix Contact, Ronan, Rockwell, Rosemount, Siemens, Sierra Monitor, Smar, Triconex, United Electric, Vega, Wandfluh, Watlow, WIKA, Yamatake, Yokogawa, Zellweger, <i>Other vendors and makes can be added within minutes upon submittal of IEC 61508 Part 2&3 certification report style testing results</i>

² Importing of complete studies can be performed from an export file generated by Vertigo or other KISS applications. The import file will be an .xlsx file with database data. Export/Import files allow transfer of data amount multiple different servers.

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Tag	IPF Description	IPF Type	Selected SIL	Sensors Tag	Sensors Voting	Input Group Logic	Final Elements Tag	Final Elements Voting	Output Group Logic	IPF Notes
USC-101A	High Pressure Separator (V-101) High-High Pressure Closes Inlet Valve	SIF	SIL 2	PT-101D (HIGH)	1oo1	1oo1	SDV-101 (CLOSE)	1oo1	1oo1	These transmitters are used with MDT output to the DCS ...
USC-101B	High Pressure Separator (V-101) Low-Low Pressure Closes Inlet Valve	SIF	SIL 1	PT-101D (LOW)	1oo1	1oo1	SDV-101 (CLOSE)	1oo1	1oo1	
USC-101C	High Pressure Separator (V-101) High-High Level Closes Inlet Valve	SIF	No SIL	LT-101B (HIGH)	1oo1	1oo1	SDV-101 (CLOSE)	1oo1	1oo1	
USC-101D	High Pressure Separator (V-101) Low-Low Level Closes Liquid Outlet Valve	SIF	SIL 1	LT-101B (LOW)	1oo1	1oo1	SDV-102A (CLOSE)	1oo1	1oo1	
USC-102A	Low Pressure Separator (V-102) High-High Pressure Closes Inlet Valve	SIF	SIL 1	PT-102B (HIGH)	1oo1	1oo1	SDV-102A (CLOSE)	1oo1	1oo1	
USC-102B	Low Pressure Separator (V-102) Low-Low Pressure Closes Inlet Valve	SIF	SIL 1	LT-102B (LOW)	1oo1	1oo1	SDV-102A (CLOSE)	1oo1	1oo1	
USC-102C	Low Pressure Separator (V-102) High-High Level Closes Inlet Valve	SIF	SIL 2	LT-102B (HIGH)	1oo1	1oo1	SDV-102A (CLOSE)	1oo1	1oo1	
USC-102D	Low Pressure Separator (V-102) Low-Low Level Closes Liquid Outlet Valve	SIF	No SIL	LT-102B (LOW)	1oo1	1oo1	SDV-102B (CLOSE)	1oo1	1oo1	
USC-102E	Low Pressure Separator (V-102) Low-Low Level Stops Pump	SIF	SIL 2	LT-102B (LOW)	1oo1	1oo1	P-103-M (STOP)	1oo1	1oo1	
USC-103A	Export Pump (P-103) Low-Low Discharge Flow Closes Anti Backflow Valve	SIF	SIL 2	FT-103B (LOW)	1oo1	1oo1	SDV-103 (CLOSE)	1oo1	1oo1	

Instrumented Protective Function List (SIF List)

Vertigo defines all of the instrumented functions that are included in an SIS design basis in the IPF List. The IPF list allows for the definition of each function in terms of inputs, outputs, voting logic, and logic solver. This page also allows for access to more detailed information on each function and the ability to delete or edit functions.

ITEM	TAG	IPF DESCRIPTION	IPF TYPE	SELECTED SIL	SENSORS TAG	SENSORS VOTING	INPUT GROUP LOGIC	FINAL ELEMENTS TAG	FINAL ELEMENTS VOTING	OUTPUT GROUP LOGIC	IPF NOTES
01	USC-101A	High Pressure Separator (V-101) High-High Pressure Closes Inlet Valve	SIF	No SIL	PT-101D (HIGH)	1oo1	1oo1	SDV-101 (CLOSE)	1oo1	1oo1	
02	USC-101B	High Pressure Separator (V-101) Low-Low Pressure Closes Inlet Valve	SIF	SIL 1	PT-101D (LOW)	1oo1	1oo1	SDV-101 (CLOSE)	1oo1	1oo1	
03	USC-101C	High Pressure Separator (V-101) High-High Level Closes Inlet Valve	SIF	No SIL	LT-101B (HIGH)	1oo1	1oo1	SDV-101 (CLOSE)	1oo1	1oo1	
04	USC-101D	High Pressure Separator (V-101) Low-Low Level Closes Liquid Outlet	SIF	SIL 1	LT-101B (LOW)	1oo1	1oo1	SDV-102A (CLOSE)	1oo1	1oo1	

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Drawing List

The user records information about drawings that are referenced by the SIS design basis study, including drawing number, revision, and description. In addition, the ability to create a link to an external database that contains the drawing is available.

DRAWING NUMBER	REV	DESCRIPTION	LINK
D254.001	1	Process Flow Diagram - Gas Production Facility	https://onedrive.live.com/redir?resid=307C878ABBBF4372193348&authkey=1AEh7T118U0GcY&thint=file%2cpdf
D254.002-01	1	Legend Sheet - Gas Production Facility	https://onedrive.live.com/redir?resid=307C878ABBBF4372193308&authkey=1ALgJIKy_Wuz-Ze&thint=file%2cpdf
D254.002-02	1	High Pressure Separator - Gas Production Facility	https://onedrive.live.com/redir?resid=307C878ABBBF4372193338&authkey=1ANdP67nNS77aE&thint=file%2cpdf
D254.002-03	1	Low Pressure Separator - Gas Production Facility	https://onedrive.live.com/redir?resid=307C878ABBBF4372193318&authkey=1AMr_qjcmVv&thint=file%2cpdf
D254.002-04	1	Pipeline Pump - Gas Production Facility	https://onedrive.live.com/redir?resid=307C878ABBBF4372193358&authkey=1AED2EFs&thint=file%2cpdf

Instrumented Protective Function Groups

Vertigo collects and arranges SIS design basis information in terms of Instrumented Protective Function (IPF) Groups. An IPF Group is a collection of functions that are all related, usually as the result of serving a single piece of major process equipment. The IPF Group is used to sort and order instrumentation in the safety requirements specifications and cause and effect diagrams.

TAG	DESCRIPTION
USC-101	High Pressure Separator
USC-102	Low Pressure Separator
USC-103	Export Pump
USC-104	Export Compressor
USC-105	Liquid Export Pipeline

Instrument Type Data

Vertigo contains an extensive library of SIS equipment that includes the failure rate data required for SIL verification. Each study contains an instrument type list where data can be imported from the main libraries. The instrument type data is stored at the study level to ensure that any changes in the master library will not alter the validated and certified results for a particular study. This also allows custom device types to be built and utilized in specific projects.

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Process Connection	Sensor Interface	Sensor Type	Logic Solver Type	Final Element Interface	Final Element Type								
+ Add Custom Component + Add From Library Refresh													
TYPE	DESCRIPTION	PRIOR USE	FAILURE % (PER HOUR)	% SAFE	% DANGER	LAMSD	LAMDU	LAMCD	LAMDU	ARCHD	PROCD	DATAREF	DATABA
service													
Vibration Probe	Vibration Probe - Generic	<input type="checkbox"/>	1.50E+50.0 %	0.0 %	0.0 %	0.00E0	7.50E-	0.00E0	7.50E-	A	Vibratk	N/A	3.01
Level Transmitter - Generic	Generic Level Transmitter - Displacer type - Configured for Low Trip - (Displacement Low and High signal (<4 mA & >20 mA) PLC Diagnostics)	<input type="checkbox"/>	3.00E+3.3 %	100.0 %	57.0 %	9.90E-	0.00E0	1.65E-	1.25E-	A	Level	1.412	3.01
Pressure Transmitter - Generic (H Trip / Diag /	Generic Pressure Transmitter - Either Differential Pressure or Gauge Pressure type -	<input type="checkbox"/>	1.50E+10.0 %	100.0 %	56.0 %	1.50E-	0.00E0	7.50E-	5.94E-	B	Pressu	1.111	3.01

Instrument List

Vertigo allows input of a list of instruments that are utilized in a study. The instruments are only contained once in the instrument list, and then can be utilized in multiple different SIF.

Sensor	Logic Solver	Final Element				
+ Add new record Refresh						
TAG	DESCRIPTION	TYPE	SENSOR VOTING	TEST INTERVAL (MONTHS)	PFD	STR
PT-106B (LOW)		Pressure Transmitter - Generic (Lo Trip / Diag / Clean)	1oo1	12	2.63E-3	9.00E-7
TT-104 (HIGH)		Temperature Sensor - Generic Thermocouple - General	1oo1	12	1.10E-3	4.75E-6

Facility Overlay: All equipment items and detectors are drawn on top of the facility overlay graphic to provide context.

Instrument List – Sensor

In the instrument list, information required for performance calculations and details for safety requirements specifications are entered and edited, and results on an instrument by instrument basis are presented.

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FT-103B (LOW) Export Pump Discharge Pressure Transmitter - Generic (Lo Trip / Diag / Clean) 1001 12 2.63E-3 9.00E-7

Failure Component	Factor(s)	PFD Contrib	STR Contrib
Dangerous Undetected	MTTR (Hours) 72	2.63E-3	
Spurious Failure			0.00E0
<input type="checkbox"/> Include Common Cause	Beta Factor	0.00E0	0.00E0
<input checked="" type="checkbox"/> Detected Failure	Diagnostic Interval (Hours)	0.00E0	9.00E-7
<input type="checkbox"/> Online Testing	Test Duration (Hours)	0.00E0	
<input type="checkbox"/> Imperfect Testing	Test Coverage	0.00E0	
	Useful Life (years)		
TOTALS		2.63E-3	9.00E-7

Calculations	Details
Trip Type	LL
Trip Setting	20
EU High	0
EU Low	100
Units	GPM
Trip Setting Tolerance	1
Element Response Time	0.3
Input Type	AI
Data Reference	D254 002-04
IPF Group	USC-103
Data Sheet Reference	PT-103 Spec
Startup Override & Timer	Auto-Bypass / Auto-Reset
Bypass Tag	HS-FT103B-BYP
Action on Failure	Vote to Trip
Safety Manual	
Safety Critical	<input checked="" type="checkbox"/>

- Type:** Selection of the instrument type from the instrument type database.
- Description:** Service description for the instrument.
- Voting:** Selection of the voting arrangement for the instrument – 1001, 1002, 2002, 2003
- Testing Interval:** The duration, in months, in between manual function tests for this instrument.
- Process Connection:** The instrument type for the process connection (selection)
- Tabular Results:** The instrument type for up to two different sensor interface devices like IS barriers
- Common Cause Flag:** Selection that determines whether common cause failure contribution is calculated. If true, input of common cause beta factor is required.
- Detected Failure Flag:** Selection that determines whether a detected failure automatically results in movement of the process to a safe state, or continued process operation with bad process variable alarm. If not true, input of diagnostic test interval is required.
- Online Testing:** Selection that determines whether the contribution of unavailability due to instrument bypassing during online testing is calculated. If true, a test duration is required.
- Imperfect Testing:** Selection that determines whether the contribution of unreliability due to imperfect manual testing is calculated. If true, a manual proof test coverage factor and instrument useful life duration is required.
- Trip Type:** Selection of the type of trip activation – LL, L, H, or HH
- Trip Setting:** The set point for the trip in engineering units
- EU High/Low/Units:** Engineering unit range for the instrument including high, low, and units.
- Element Response Time:** The time duration in which the instrument is expected to response to a demand.
- Input Type:** Type of electrical input the device provides to the logic solver – analog input (AI), digital input (DI)
- Data Reference:** Selection for the drawing in the drawing list where this instrument is contained.
- IPF Group:** Selection for which IPF from the IPF list that this instrument is associated with.
- Data Sheet Reference:** Selection for the document in the document list where that is the data sheet for this instrument.

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- Startup Override & Timer:** Data specifying the type of startup overrides or startup timers that are required for this instrument
- Bypass Tag:** Tag number information for the bypass for the instrument
- Safety Manual:** Selection for the document in the document list where that is the safety manual for this instrument.
- Safety Critical:** Flag indicating whether or not this instrument is safety critical.

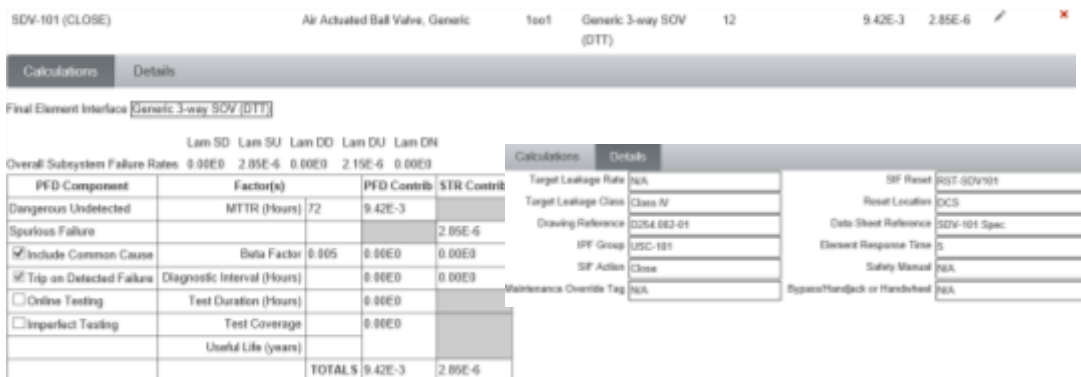
Instrument List – Logic Solver



- Type:** Selection of the instrument type from the instrument type database.
- Test Interval:** The duration, in months, in between manual function tests for this instrument.
- Element Response Time:** The time duration in which the instrument is expected to respond to a demand.
- Description:** Service description for the instrument.
- Safety Manual:** Selection for the document in the document list where that is the safety manual for this instrument.

Instrument List – Final Element

The final element instrument data collected for final elements is similar to that collected for sensors. Additional information for SRS development is also collected.



- Target Leakage Rate:** Specified maximum leakage rate for valve used as SIF final element
- Target Leakage Class:** Specified leakage class for valve used as SIF final element
- Drawing Reference:** Selection for the drawing in the drawing list where this instrument is contained.

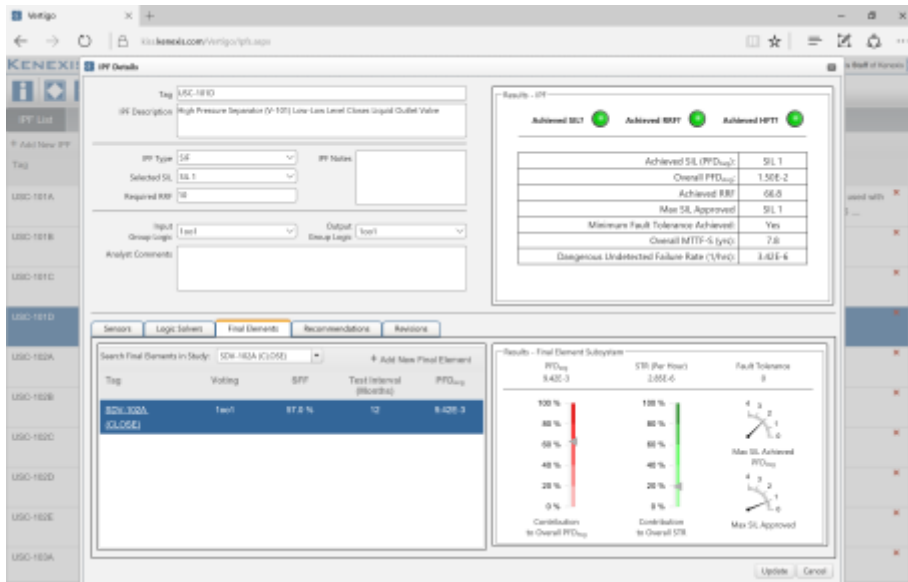
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IPF Group:	Selection for which IPF from the IPF list that this instrument is associated with
SIF Action:	Action taken by the final element to move the process to a safe state
Maintenance Override Tag:	Tag number for maintenance override switch for the final element
SIF Reset:	Tag number for reset switch for the final element
Reset Location:	Location of the reset switch
Data Sheet Reference:	Selection for the document in the document list where that is the data sheet for this instrument
Element Response Time:	The time duration in which the instrument is expected to response to a demand.
Safety Manual:	Selection for the document in the document list where that is the safety manual for this instrument.
Bypass/Handjack/Handwheel:	Specification of a manual means of operating or bypassing an SIS valve.

SIL Verification Results

Vertigo provides SIL verification and conceptual design review results. This includes the achieved SIL along with a host of other metrics supporting the verification of achieved SIL.



Achieved SIL (PFD):	Safety integrity level achieved by the design only considering the average probability of failure on demand calculation.
Overall PFDavg:	The overall average probability of failure on demand achieved by the SIF considering the sensor, logic solver, and final element subsystems. Performance of the individual subsystems can be viewed in their respective tabs.
Achieved RRF:	Risk reduction factor (1/PFD) achieved by the safety instrumented function.

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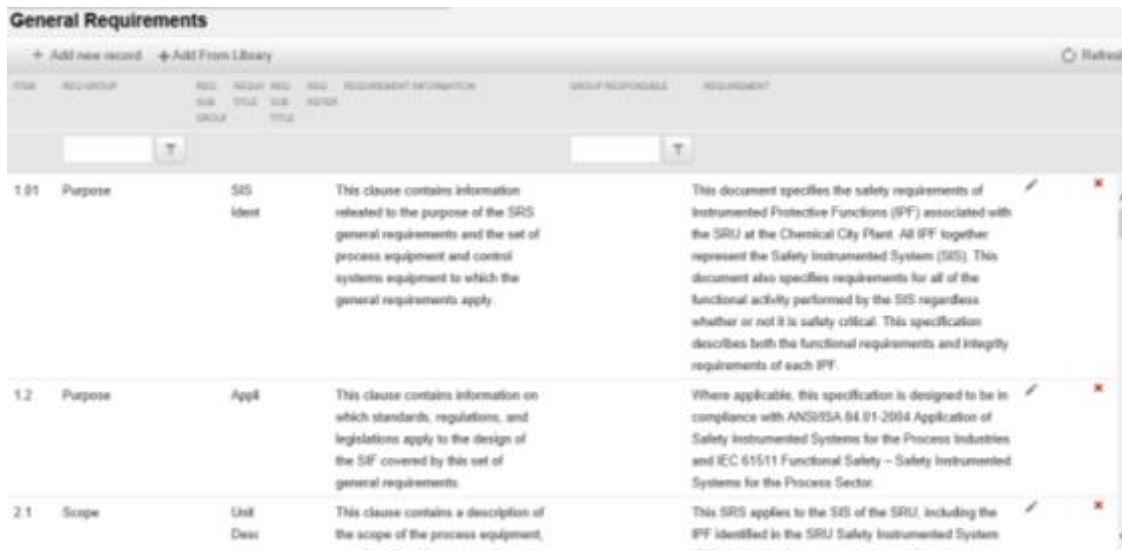
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- Max SIL Approved:** The maximum SIL that the SIF is approved for use in considering both the probability of failure on demand and architectural constraints (i.ee, minimum fault tolerance).
- Min Fault Tolerance Achieved:** Flag indicating whether or not the required minimum fault tolerance for the SIF has been achieved. Calculation performed in accordance with IEC61511 tables and IEC 61508 tables, least restrictive result utilized.
- Overall MTTF(S):** The overall mean time to fail safe for the SIF, consider all subsystems.
- Dangerous Undetected Failure Rate:** Rate of dangerous undetected failures of the SIF. This figure would be utilized if the SIF were a continuous mode SIF.

More information is available on other tabs including calculations details for the sensor subsystem, logic solver subsystem, and final element subsystem, along with SRS details that are related to the SIF, and a tracking of revisions for the SIF.

Safety Requirements Specifications

In addition to the safety requirements specification fields associated with individual instruments and individual SIF, Vertigo includes the capability of specification of general requirements and notes, along with the development of cause and effect diagrams to demonstrate system logic.



ID	REQ GROUP	REQ TITLE	REQ DESC	REQUIREMENT INFORMATION	GROUP RESPONSIBLE	REQUIREMENT
1.01	Purpose	SIS Ident	This clause contains information related to the purpose of the SRS general requirements and the set of process equipment and control systems equipment to which the general requirements apply.			This document specifies the safety requirements of Instrumented Protective Functions (IPF) associated with the SRU of the Chemical City Plant. All IPF together represent the Safety Instrumented System (SIS). This document also specifies requirements for all of the functional activity performed by the SIS regardless whether or not it is safety critical. This specification describes both the functional requirements and integrity requirements of each IPF.
1.2	Purpose	Appl	This clause contains information on which standards, regulations, and legislations apply to the design of the SIF covered by this set of general requirements.			Where applicable, this specification is designed to be in compliance with ANSIISA 84.81-2004 Application of Safety Instrumented Systems for the Process Industries and IEC 61511 Functional Safety – Safety Instrumented Systems for the Process Sector.
2.1	Scope	Unit Desc	This clause contains a description of the scope of the process equipment, control systems equipment, and other related equipment.			This SRS applies to the SIS of the SRU, including the IPF identified in the SRU Safety Instrumented System (SIS) design. This document also specifies the safety requirements of the IPF.

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			Voting	1001
			Description	High Pressure Separator Inlet
			Tag	SDV-101 (CLOSE)
Tag	Description	Voting	SC	<input checked="" type="checkbox"/>
LT-101B (HIGH)	High Pressure Separator	1001	<input checked="" type="checkbox"/>	<input type="checkbox"/>
LT-101B (LOW)	High Pressure Separator	1001	<input checked="" type="checkbox"/>	<input type="checkbox"/>
PT-101D (HIGH)	High Pressure Separator	1001	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Validation

Vertigo has been extensively validated to demonstrate that the results presented are accurate. The validation includes traceability of all equations and calculation methods back to standards body documents describing calculation requirements, manual calculations of all steps in the calculation process for all potential variations in all parameters affecting the calculations.

About Kenexis

Kenexis is an independent engineering consulting firm headquartered in Columbus, Ohio. For more information, www.Kenexis.com.