Device ID – Data Sheets

The Device ID is used on the protective function sheet for selecting the device for the analysis. It should be made as descriptive as possible, but is limited to five characters. The Device Type field allows an extended description of the device to be shown on the datasheet (45 characters). If additional notes are required, these can be entered in the Notes field at the bottom of the datasheet. Notes area can be used to list the boundary of the device, exclusions, comments, data source, etc.

Figure 9. 8 Device information - Data Sheet

Click Delete to abort entry.

Device Entry – Data Sheet

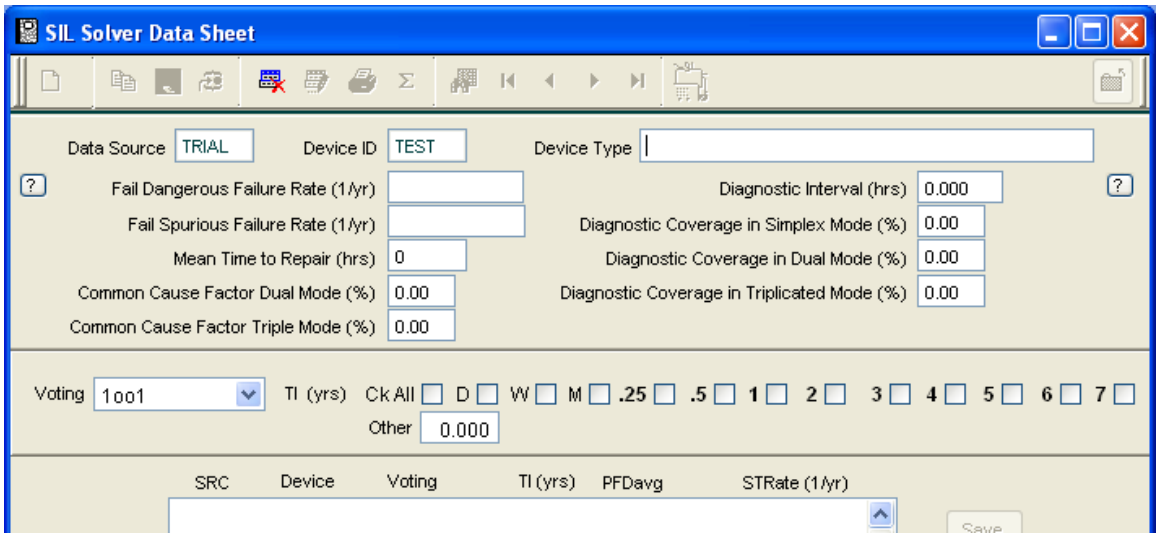


Figure 9. 9 Data Entry Input Boxes - Data Sheet

The data is entered into the data entry fields as follows:

Fail dangerous failure rate per year--This is the total dangerous failure rate for the device and is a required entry. The units are in failures per year. The value should be entered in exponential format.

Fail spurious failure rate per year--This is the total safe + dangerous detected failure rate for the device and is a required entry. The units are in failures per year. The value should be entered in exponential format.

Warning: Always enter the failure rates in exponential format. If other formats are used, the software will default the field value to 0.

Mean time to repair (hours)--This is the MTTR assumed in the safety requirements specification for the device. The units are in hours. The value should be entered in number format.

Common Cause Factor Dual Mode--This is the beta factor for a dual redundant subsystem. The system expects the value to be a percentage, so a beta factor of 2% would be entered as 2.0.

Common Cause Factor Triple Mode--This is the beta factor for a triple redundant subsystem. The system expects the value to be a percentage, so a beta factor of 2% would be entered as 2.0.

Diagnostic Interval (hours)--This is the time interval between automatic on-line diagnostic tests. The units are in hours. The value should be entered in number format. For example, a deviated transmitter can be detected and alarmed within a couple of scans. However, safe operation requires that the operator acknowledge the fault and institute alternative safe operating procedures. The diagnostic interval is generally considered to at least two minutes.

Diagnostic Coverage in Simplex Mode--This is the diagnostic coverage present for a single device. In many cases, the failure rate data provided in the published literature already take into account the diagnostics contained within the device itself. Consequently, this diagnostic coverage is generally limited to some type of external diagnostics, e.g., partial stroke testing. The system expects the value to be a percentage, e.g. 40% would be entered as 40.

Diagnostic Coverage in Dual Mode--This is the diagnostic coverage present due to the comparison of dual redundant devices. The system expects the value to be a percentage, e.g. 80% would be entered as 80.

Diagnostic Coverage in Triplicated Mode--This is the diagnostic coverage present due to the comparison of triple redundant devices. The system expects the value to be a percentage, e.g. 80% would be entered as 80.

Architecture and test interval instructions continue after the Copy Device Sheet option.

Copy Device Sheet Option

Copy options allows user to start with data and notes from an existing device data sheet and make modifications to describe the new device.

Use the search function to find a device similar to the device to be added. Once the device has been selected with a double click, *Click* Copy Device Sheet.

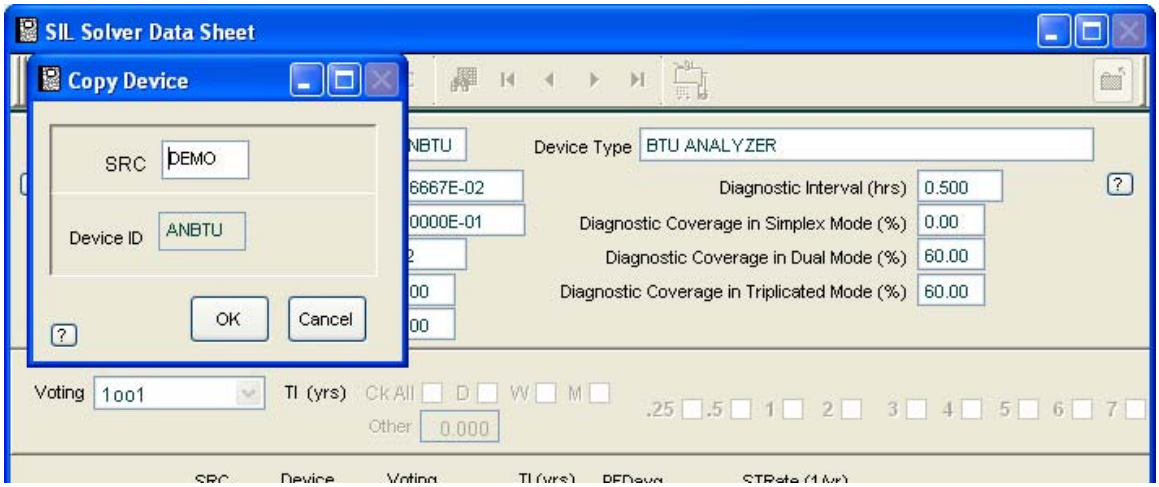


Figure 9. 10 Copy Device Sheet

The data source is tagged with the Project Start Customer ID (SRC), however, it can be changed to a generic name for the company projects. *Click* OK.

Make the changes required to describe the new device's functionality. Refer to the data entry definitions above and Edit Data in Existing User Created Data Sheet below as needed for the changes.

Following steps apply to both New and Copy Data Sheets Option.

Architecture and Test Intervals – Data Sheets

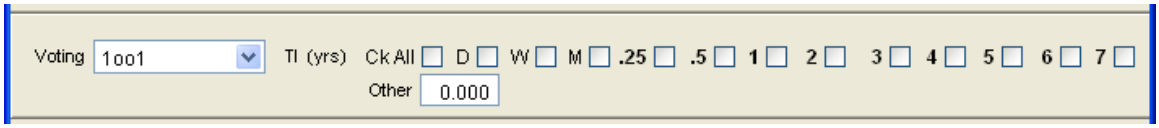


Figure 9. 11 Voting Drop down and Check boxes for Test interval Selection

The voting is selected using a drop down. The architectures are as follows:

1oo1
1oo1D
1oo2
1oo2D
2oo2
2oo2D
1oo3
1oo3D
2oo3
2oo3D
3oo3
3oo3D

Each voting architecture corresponds to an equation provided in Section 12.

Test Interval – Data Sheets

SIL Solver® includes twelve pre-designated test intervals. *Click* the Ck All to select all the test intervals. Individual test intervals may be selected by checking the box next to the desired test interval. If other test intervals are desired, these can be entered in number format in the Other field.

Add Voting Architectures and Test Intervals to Data Sheets

The Save button will not become active until a voting architecture is selected. *Click* Save. The device data, voting architecture, and test interval calculations will be performed. The PFD_{AVG} and spurious trip rate numbers are then displayed in the data sheet list.

For more architectures or test intervals, repeat the previous steps. The results are always sorted by architecture followed by test interval.

No calculations will be performed if the fail dangerous and fail spurious failure rates are not entered.

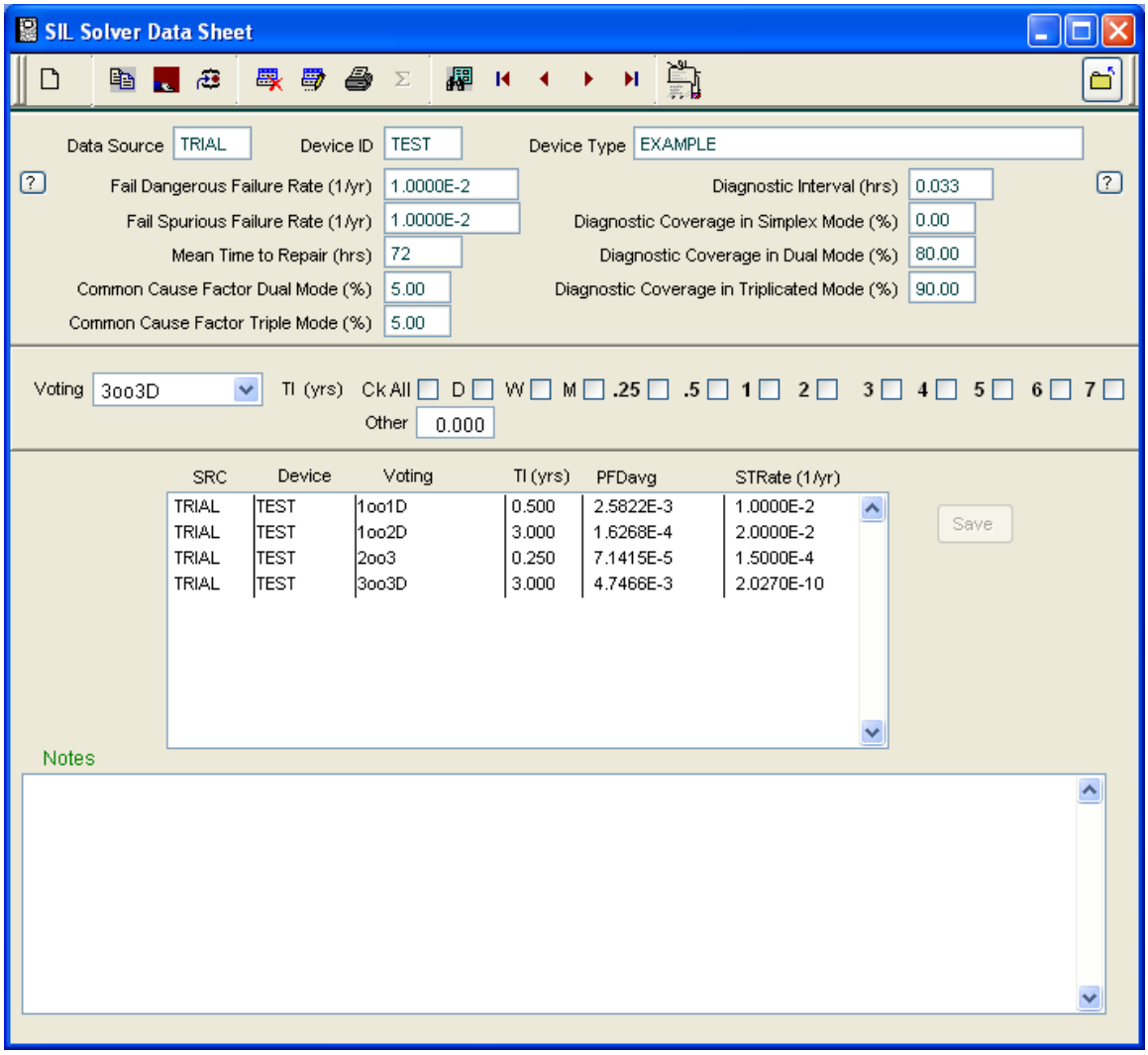


Figure 9. 12 Example Entry into Data sheet

Delete Device User Entered Data Sheet – Tool bar

From the tool bar, *Click* Delete. You will receive a confirmation to continue.

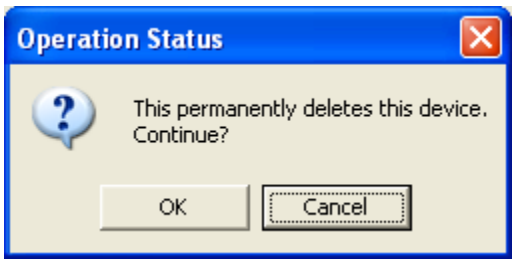


Figure 9. 13 Confirmation to Continue

Click Ok to remove the device sheet. *Click* Cancel to abort the delete process.

Delete Testing Interval - Options: Data Sheet menu

From the device list, *Click* on Device. *Right Click*. From the Data sheet menu, *Click* Delete.

There is no confirmation or warning. There is no "undo." Once deleted, the data line will need to be re-created.

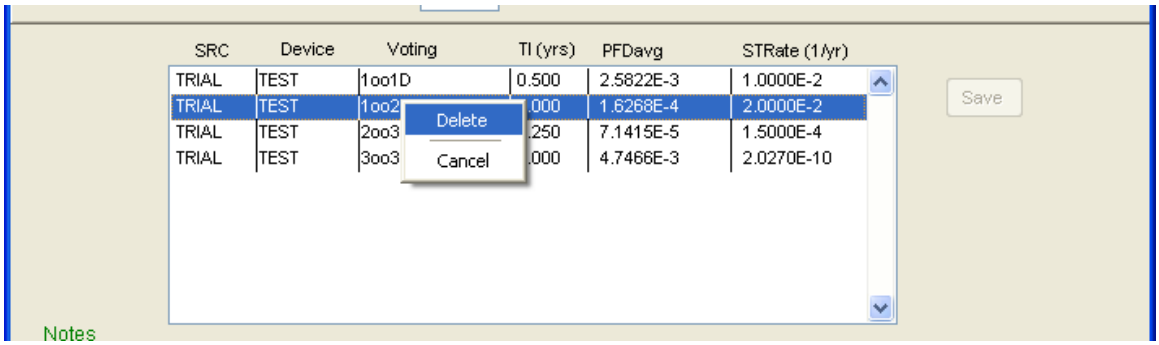


Figure 9. 14 Detail showing Delete action – Options: Data Sheet menu

Edit Data in Existing User Created Data Sheet – Tool bar

Once you have built a user data sheet, you may need to change assumptions made in the data entry area. Use the arrows to page through the database or *Click* Search. *Locate* your Device ID. *Double Click*. Now that your device is in view, *Click* Edit. Next, go to the field that you want to change. Change the value of the field using the appropriate format.

Click Recalculate to update the data sheet list results. The Save will not be enabled. Any change to device entry does not require a SAVE.

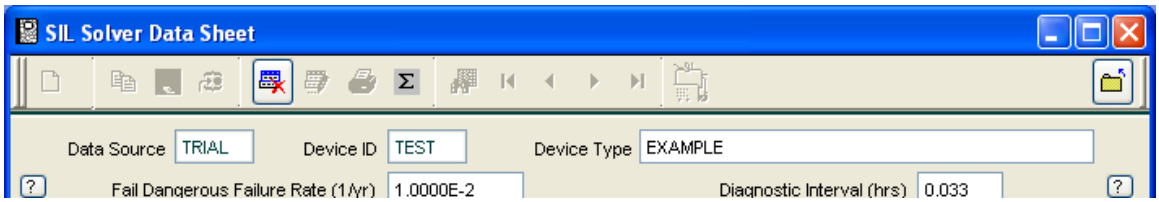


Figure 9. 15 After Clicking Edit, delete or recalculate available

Note: If you have added this device sheet to a project, the prior device information within the project will remain. The project data sheet is not updated with any change to a SIL Solver® Device Sheet.

Until you click the Recalculate button after data modifications, the testing interval information will not be updated. However, if you also added a Test Interval, the save will be enabled. *Click* Save. The re-calculation will occurred in the Save procedure. The testing interval information would be updated.

Sharing User Created Data Sheets

Data sheets are exported and imported through the icons on the device data sheet screen.

To Export

Click Choose Data Sheets For Copying To Share Tables

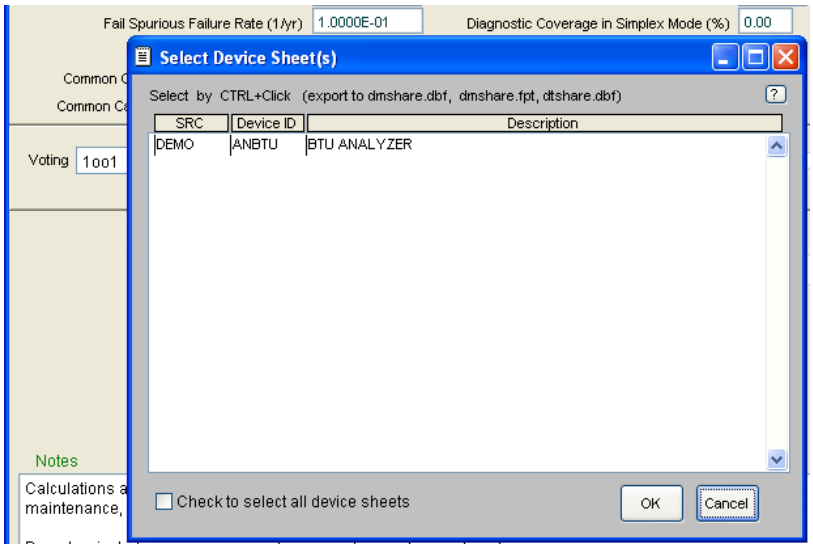


Figure 9. 16 Click on to Select an Individual Devices

If more than one device is to be shared, *click* Check to select all device sheets.

Click OK

Figure 9. 17 Locate or Create the Folder for Storing the Exported Devices

Note: Default export folder is \Share_Data

Click Make New Folder. Name the folder and make the location easy to find. *Click* OK. The files are now ready to be shared. Send folder as a zip file to the recipient if sharing by email.

To Import

If files have been shared in zip format, unzip first. Only tables with the dmshare.* or dm.* will be considered for import.

Click Import Data Sheets From Share Tables

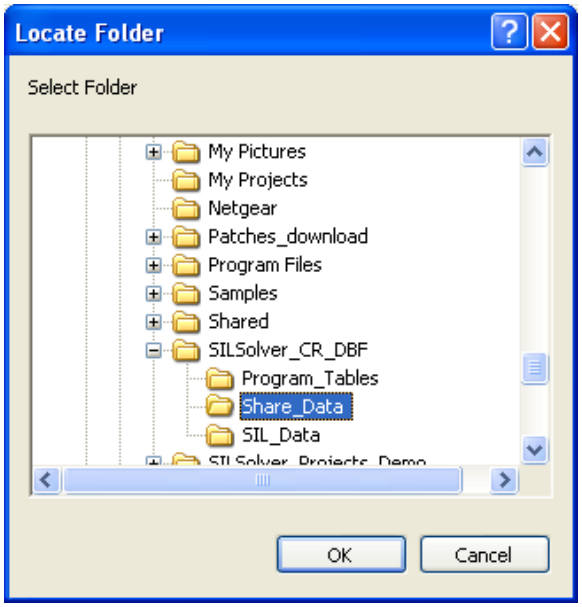


Figure 9. 18 Select Folder that Contains the Import Tables

Navigate to the location of the folder containing the data sheets to be imported. *Click* OK. The files have been imported and are ready to use. If a device exists in the device data table, it will not be imported. If you had wanted the device on the import tables, you could delete your data device and import again.

Print Data Sheets – Tool bar

From the toolbar, Click Print. A printing device options will be displayed.

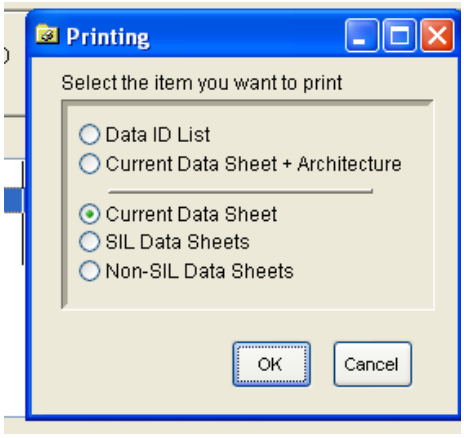


Figure 9. 19 Printing device options - Individual Device Reports

- Data ID List is a complete listing of devices and abbreviations in SIL Solver® database including user devices.

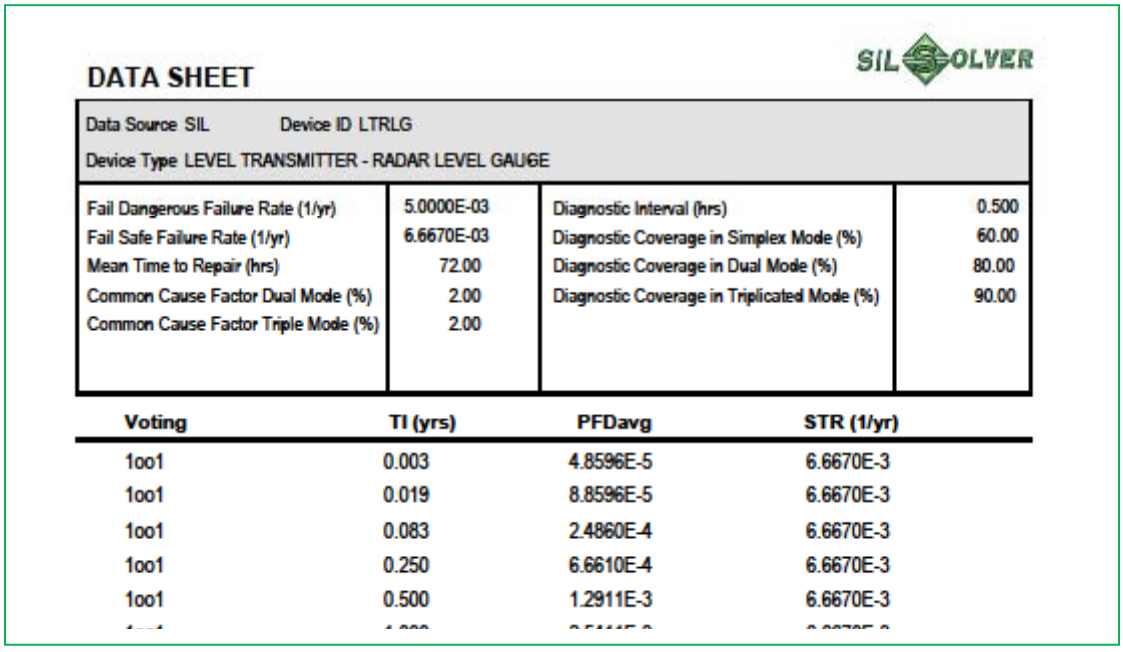
DATA ID LIST

Data Source	Device ID	Device Type
SIL	ALANN	ALARM ANNUNCIATOR
SIL	ANCLR	CHLORINE ANALYZER
SIL	ANCMO	CARBON MONOXIDE ANALYZER
SIL	ANCO2	CARBON DIOXIDE ANALYZER
SIL	ANCON	CONDUCTIVITY ANALYZER
SIL	ANDO2	DISSOLVED OXYGEN ANALYZER
SIL	ANH2S	HYDROGEN SULFIDE ANALYZER
SIL	ANHCT	HYDROCARBON ANALYZER-CATALYTIC
SIL	ANHIR	HYDROCARBON ANALYZER-INFRARED

Figure 9. 20 Example: Data ID List

Current Datasheet + Architecture.

- This report includes all available voting architecture and device notes at the end of the report.



DATA SHEET

Data Source SIL Device ID LTRLG

Device Type LEVEL TRANSMITTER - RADAR LEVEL GAUGE

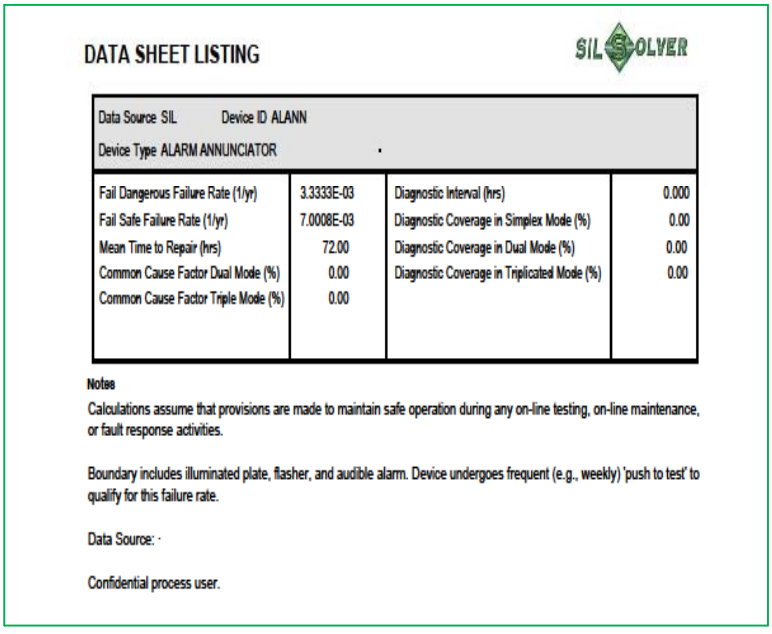
Fail Dangerous Failure Rate (1/yr)	5.0000E-03	Diagnostic Interval (hrs)	0.500
Fail Safe Failure Rate (1/yr)	6.6670E-03	Diagnostic Coverage in Simplex Mode (%)	60.00
Mean Time to Repair (hrs)	72.00	Diagnostic Coverage in Dual Mode (%)	80.00
Common Cause Factor Dual Mode (%)	2.00	Diagnostic Coverage in Triplicated Mode (%)	90.00
Common Cause Factor Triple Mode (%)	2.00		

Voting	TI (yrs)	PFDavg	STR (1/yr)
1oo1	0.003	4.8596E-5	6.6670E-3
1oo1	0.019	8.8596E-5	6.6670E-3
1oo1	0.083	2.4860E-4	6.6670E-3
1oo1	0.250	6.6610E-4	6.6670E-3
1oo1	0.500	1.2911E-3	6.6670E-3

Figure 9. 21 Example: Individual Device Datasheet with Architecture

Current Datasheet

- This report is the same as the previous report minus the Architecture.



DATA SHEET LISTING

Data Source SIL Device ID ALANN

Device Type ALARM ANNUNCIATOR

Fail Dangerous Failure Rate (1/yr)	3.3333E-03	Diagnostic Interval (hrs)	0.000
Fail Safe Failure Rate (1/yr)	7.0008E-03	Diagnostic Coverage in Simplex Mode (%)	0.00
Mean Time to Repair (hrs)	72.00	Diagnostic Coverage in Dual Mode (%)	0.00
Common Cause Factor Dual Mode (%)	0.00	Diagnostic Coverage in Triplicated Mode (%)	0.00
Common Cause Factor Triple Mode (%)	0.00		

Notes

Calculations assume that provisions are made to maintain safe operation during any on-line testing, on-line maintenance, or fault response activities.

Boundary includes illuminated plate, flasher, and audible alarm. Device undergoes frequent (e.g., weekly) 'push to test' to qualify for this failure rate.

Data Source: ·

Confidential process user.

Figure 9. 22 · Example: Current Datasheet w/o Architecture

All SIL Datasheets.

- This report is identical to Current Datasheet report for all original devices in SIL Solver® database.

All User Datasheets

This report is identical to Current Datasheet report for devices added by user to the SIL Solver® database.

Revision Level – Tool bar

Even though the Device Sheet database revision level may not be altered by users, for hard copy documentation users may print this information. From the tool bar, *Click* Revision Level.

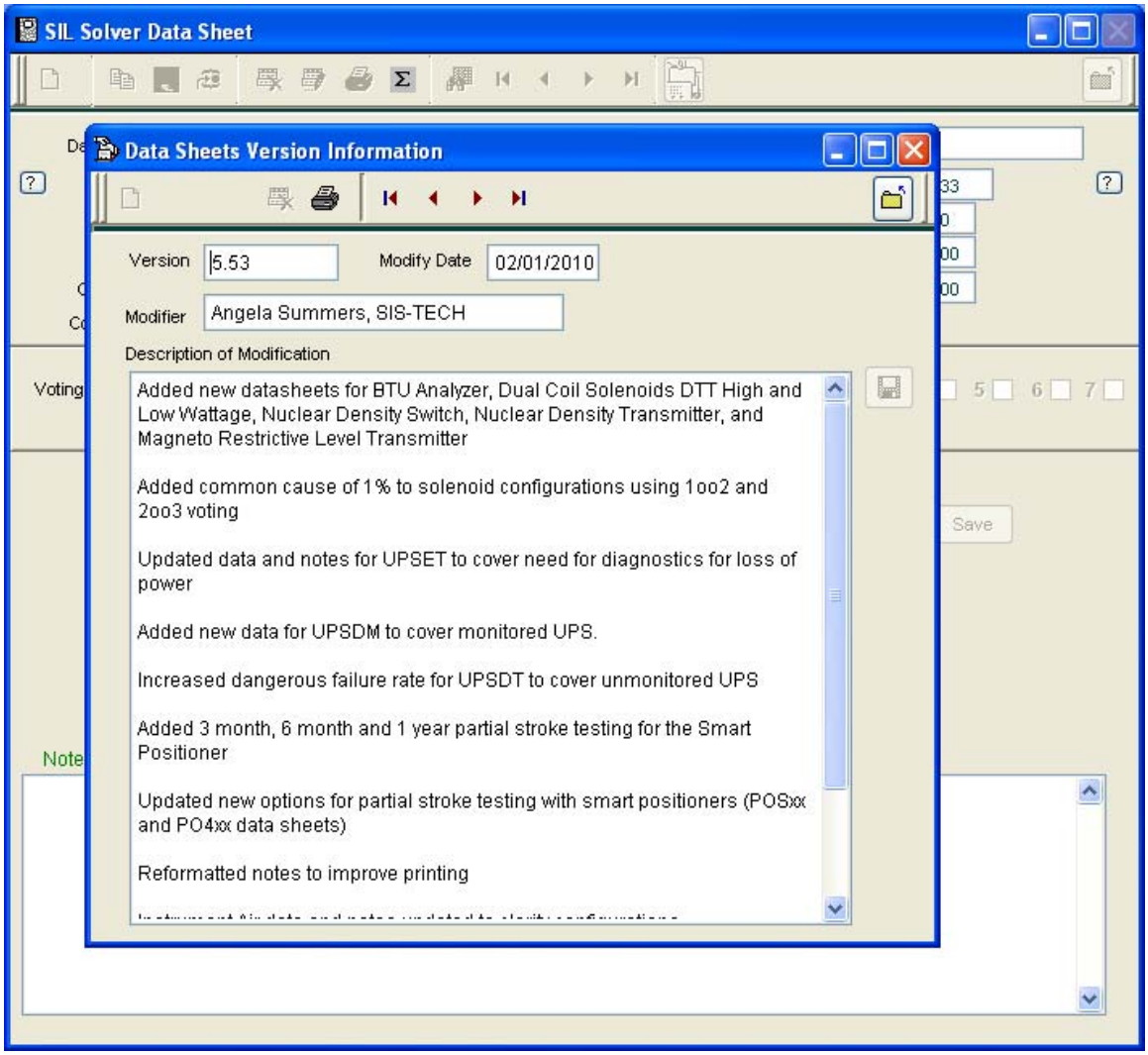


Figure 9. 23 Data Sheets Version Information

Click Print. Report not shown.

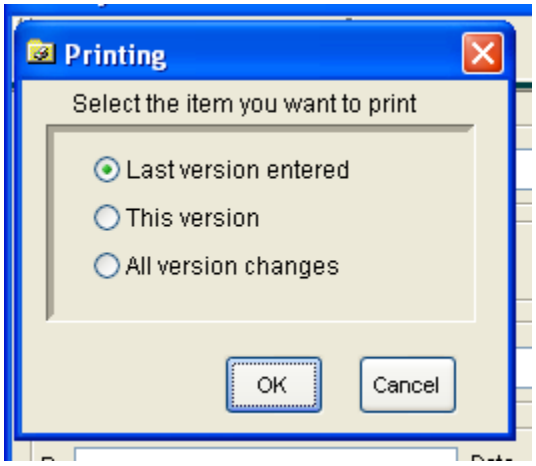


Figure 9. 24 Print Data Sheets Version Information

Last version entered: This information will print on the Protective Function Revision level reports.

This version: Will print the record you are editing/viewing when choosing print.

All Version changes: Will print all records contained in the table.

Close Data Sheets - Tool bar

To close and return to where you selected Data Sheets: the Project Start or Protective Function, or Go to Data Sheet. *Click* Close or the red X in the upper right hand corner.

LOGIC SOLVER SHEET

Data Sheets allows you to open the device sheets, logic solver sheets, and support system sheets databases. You may access the data sheets by selecting the Go to the device sheet from the right click menu in the Inputs and Action (1-5) tabs.

From the Project Start or from the Protective Function screen, *Click* Data Sheets. From the Data sheets menu, *Click* Logic Solver Sheets.

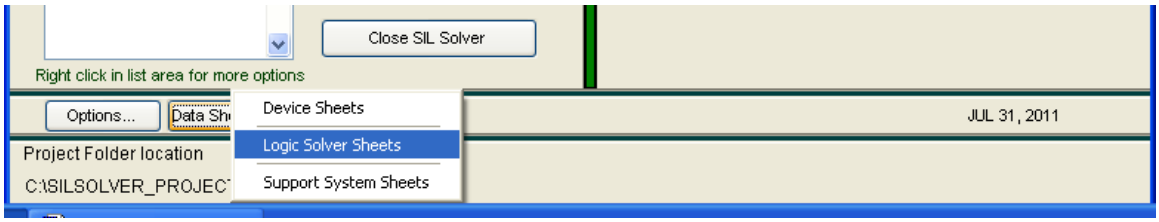


Figure 9. 25 Project Start Data Sheet Access - Options: Data sheets menu

From this screen, you can view the default datasheets, which are tagged as data source SIL, or any device sheets that you have entered into the database. This Logic Solver sheet includes a toolbar with icons defined in Section 3. Remember tool tips are available on the icons by running your mouse over them.

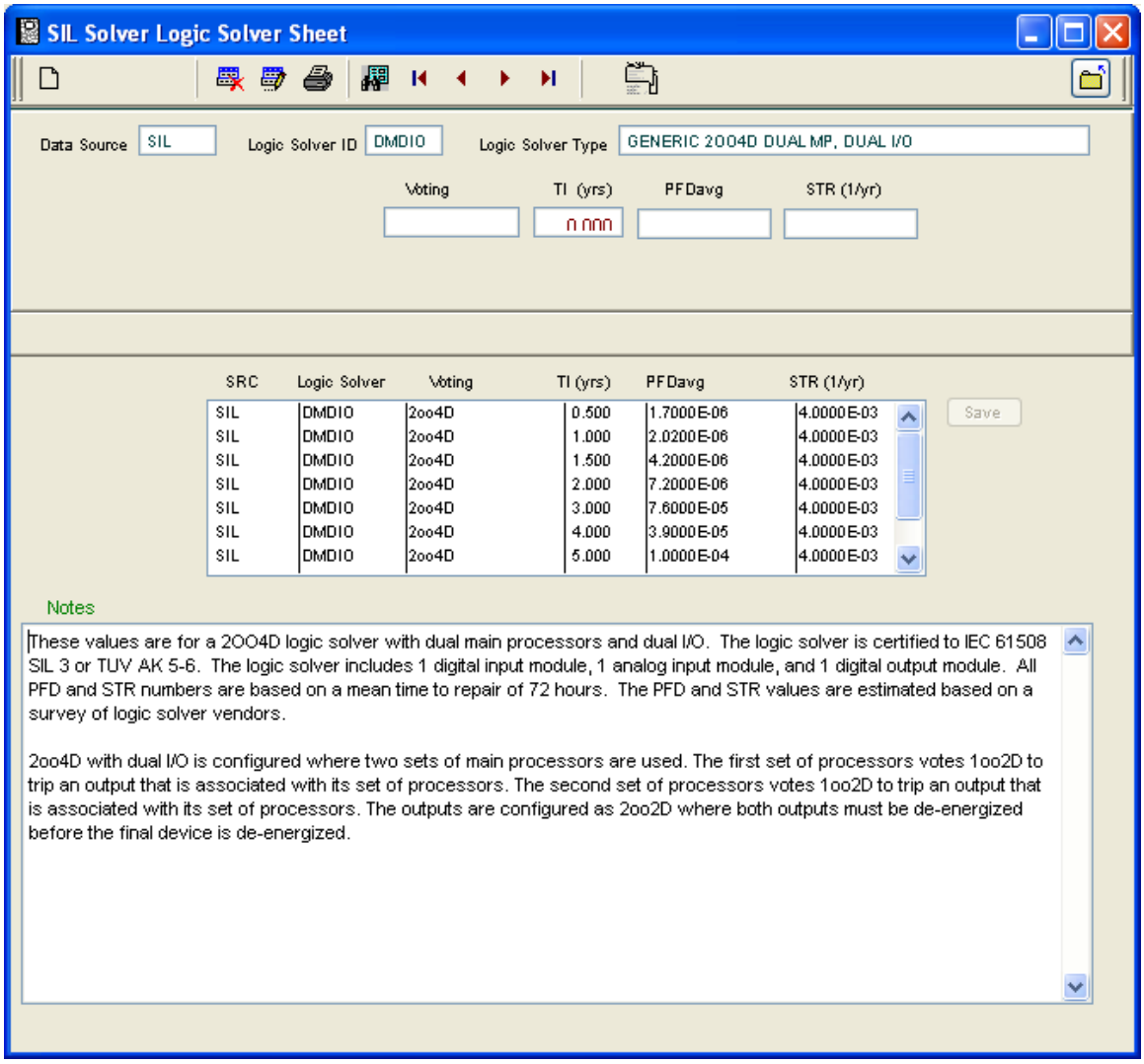


Figure 9. 26 Logic Solver Sheet View

Searching for a Device ID - Tool bar

From the toolbar, *Click* Search. When the Search window opens, D*ouble Click* on data sheet to retrieve. Or from the toolbar, *Click* Arrows to go to the next Logic Solver device in the database.

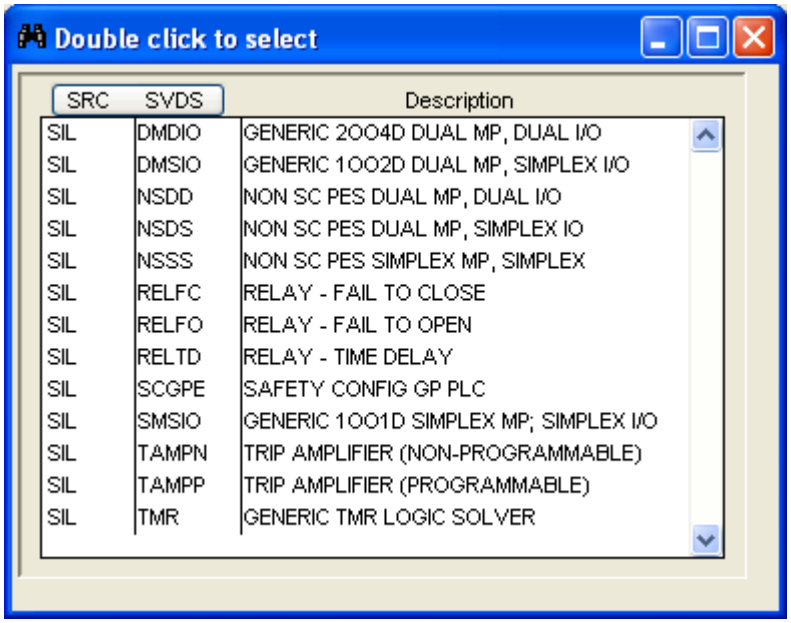


Figure 9. 27 Logic Solver Search

Notes area can be used to list the boundary of the device, exclusions, comments, data source, etc.

New – Tool bar

The Device ID is used on the protective function Logic Solver Tab for device selection. The Device ID should be made as descriptive as possible, but is limited to 5 characters. Characters in excess of 5 will be truncated. The Device ID field allows an extended description of the device to be shown on the datasheet. If additional notes are required, these can be entered in the Notes field at the bottom of the datasheet.

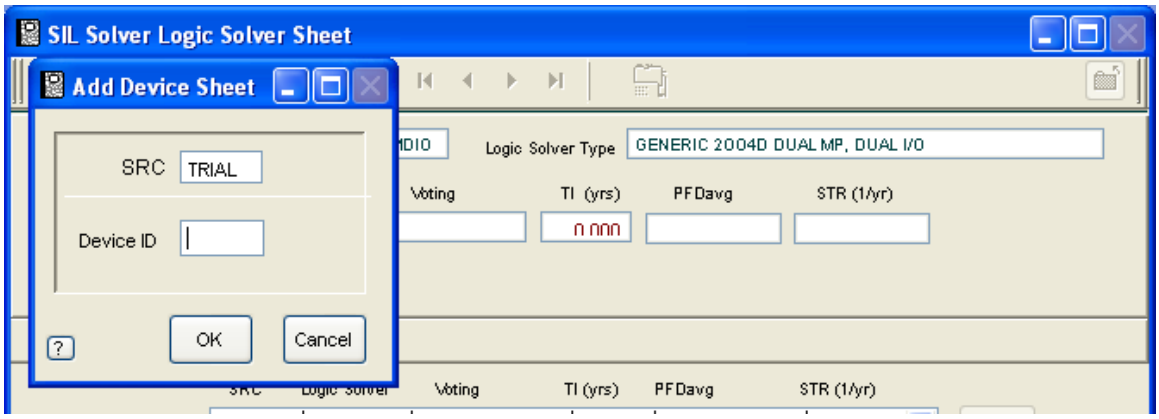


Figure 9. 28 New Device Detail - Logic Solver tool bar

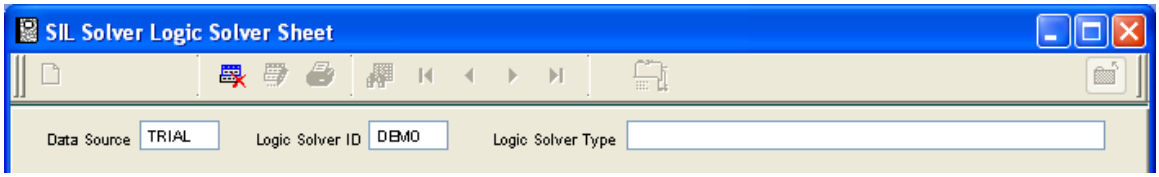


Figure 9. 29 Detail of Logic Solver ID information

The data is entered into the data entry fields as follows:

Voting--the architecture of the logic solver.

PFD_{AVG}--the average probability to fail on demand. The value should be entered in exponential format.

Spurious trip rate per year--This is the spurious failure rate for the logic solver. The units are in failures per year. The value should be entered in exponential format.

Warning: Always enter the failure rates in exponential format. If other formats are used, the software will default the field value to 0.

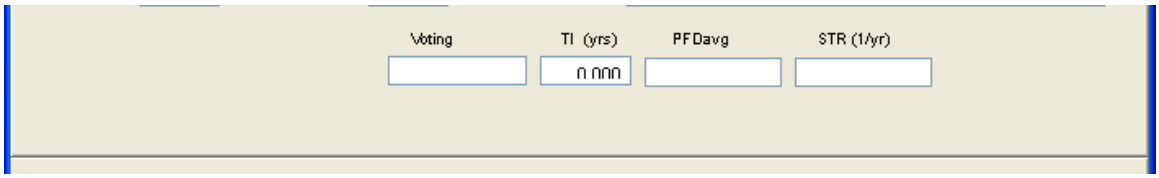


Figure 9. 30 Detail of Logic Solver Data Entry

Add Voting Architectures Or Test Intervals

The Save is not active until an entry is made in the voting architecture field. For more architectures or test intervals, repeat the previous steps. The results are always sorted by architecture followed by test interval.

Warning: The Save button will not become active until the voting architecture is entered.

Delete Device – User Entered Logic Solver Sheet

From the tool bar, *Click* Delete. You will receive a confirmation to continue.

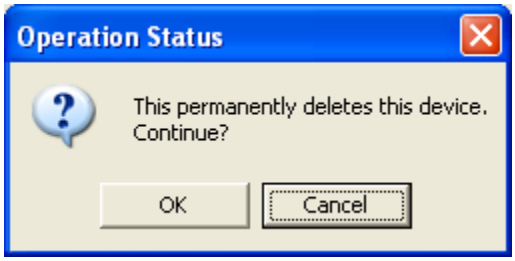


Figure 9. 31 Confirmation to Continue

Click Ok to remove the device sheet. *Click* Cancel to abort the delete process.

Delete Testing Interval - Options: Logic Solver menu

From the Logic Solver list, *Click* on Device. *Right Click*. From the Logic Solver menu, *Click* Delete.

There is no confirmation or warning. There is no "undo." Once deleted, the data line will need to be re-created.

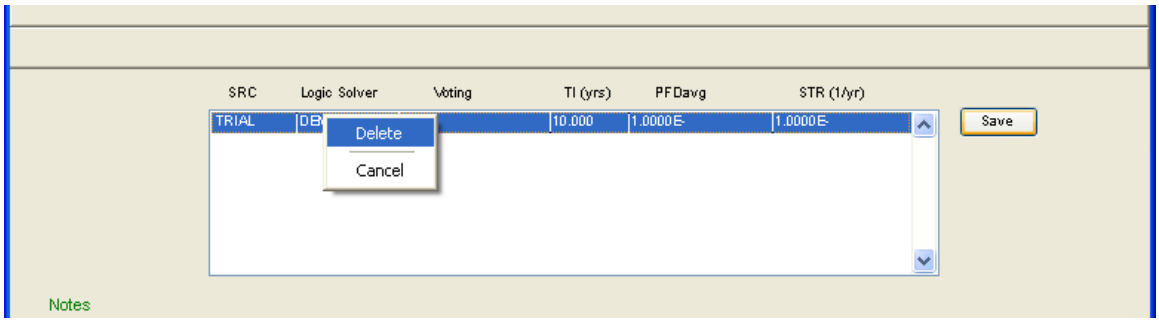


Figure 9. 32 Detail showing Delete action – Options: Logic Solver menu

Print – Tool bar

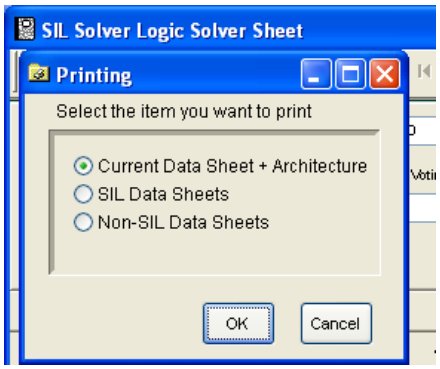
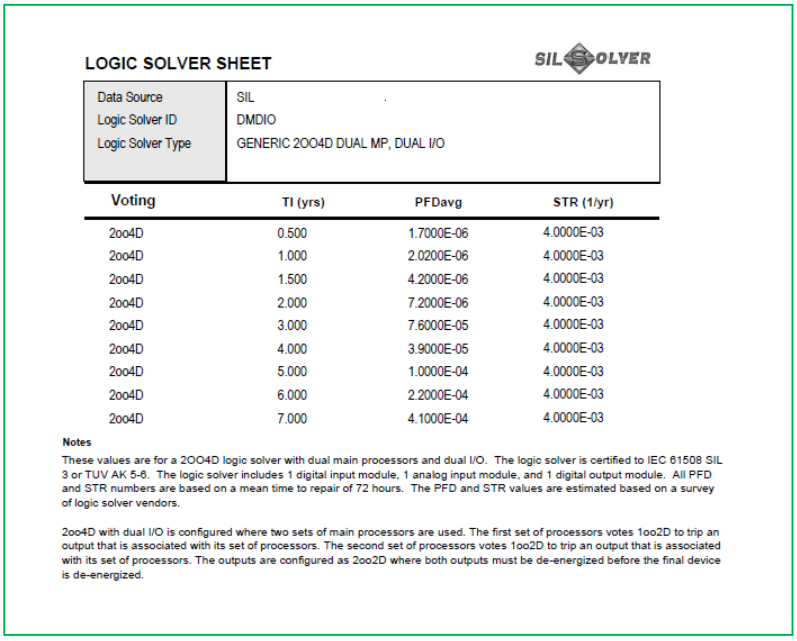


Figure 9. 33 Reports Available Options



LOGIC SOLVER SHEET

Data Source	SIL
Logic Solver ID	DMDIO
Logic Solver Type	GENERIC 2OO4D DUAL MP, DUAL I/O

Voting	TI (yrs)	PFDavg	STR (1/yr)
2oo4D	0.500	1.7000E-06	4.0000E-03
2oo4D	1.000	2.0200E-06	4.0000E-03
2oo4D	1.500	4.2000E-06	4.0000E-03
2oo4D	2.000	7.2000E-06	4.0000E-03
2oo4D	3.000	7.6000E-05	4.0000E-03
2oo4D	4.000	3.9000E-05	4.0000E-03
2oo4D	5.000	1.0000E-04	4.0000E-03
2oo4D	6.000	2.2000E-04	4.0000E-03
2oo4D	7.000	4.1000E-04	4.0000E-03

Notes

These values are for a 2OO4D logic solver with dual main processors and dual I/O. The logic solver is certified to IEC 61508 SIL 3 or TUV AK 5-6. The logic solver includes 1 digital input module, 1 analog input module, and 1 digital output module. All PFD and STR numbers are based on a mean time to repair of 72 hours. The PFD and STR values are estimated based on a survey of logic solver vendors.

2oo4D with dual I/O is configured where two sets of main processors are used. The first set of processors votes 1oo2D to trip an output that is associated with its set of processors. The second set of processors votes 1oo2D to trip an output that is associated with its set of processors. The outputs are configured as 2oo2D where both outputs must be de-energized before the final device is de-energized.

Figure 9. 34 Print Options Current Data Sheet + Architecture

The report format for all SIL Data Sheet report is same as above. When User Data Sheets report is chosen, it is only user's entered data that will be printed. None of the "SIL" devices will be included in the report.

Revision Level – Tool bar

Even though the Logic Solver Sheets database revision level may not be altered by users, for hard copy documentation users may print this information. From the tool bar, *Click* Revision Level.

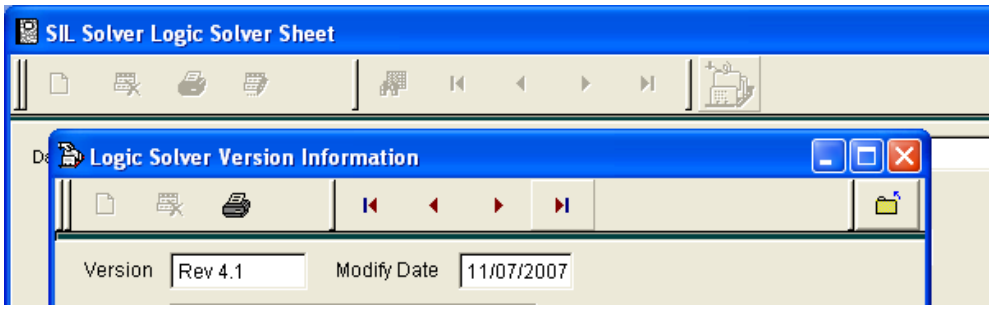


Figure 9. 35 Logic Solver Version Information

Click Print. Report not shown.

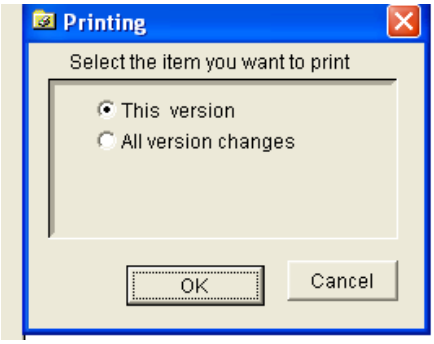


Figure 9. 36 Print Logic Solver Sheets Version Information

This version: Will print the record you are editing/viewing when choosing print.

All Version changes: Will print all records contained in the table.

Close - Tool bar

To close and return to where you selected Data Sheets: the Project Start or Protective Function, *Click* Close or the red X in the upper right hand corner.

SUPPORT SYSTEM SHEET

Data Sheets allows you to open the device sheets, logic solver sheets, and support system sheets databases. When you select Support System Sheets, the support system datasheet will open. Access screen includes a toolbar with icons defined in Section 3. You also may use the Go to the device sheet from Inputs and Action (1-5) to access the sheets.

From the Project Start, or from the Protective Function screen, *Click* Data Sheets. From the Data sheets menu, *Click* Support System Sheets.

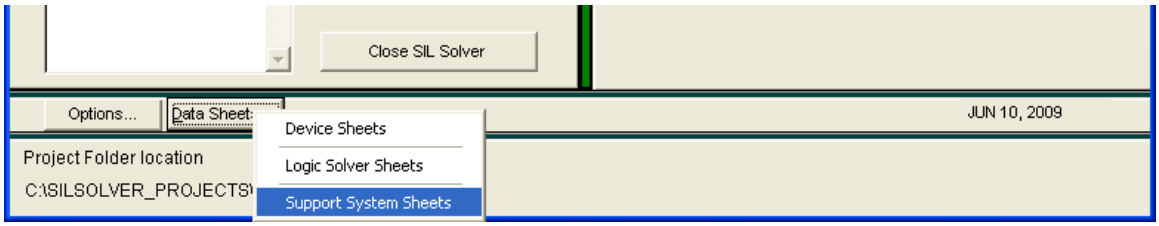


Figure 9. 37 Project Start Data Sheet Access - Options: Data sheets menu

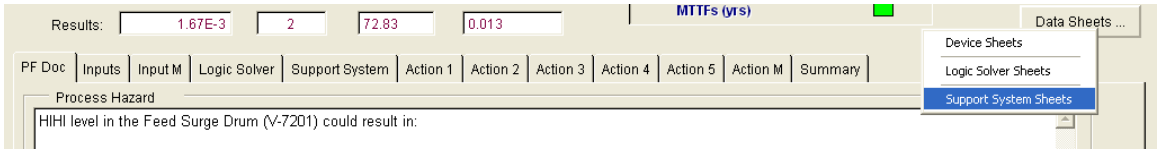


Figure 9. 38 Protective Function Data Sheet Access – Options: Data sheets menu

From this screen, you can view the default datasheets, which are tagged as data source SIL, or any device sheets that you have entered into the database. This Support System sheet includes a toolbar with icons defined in Section 3. Remember tool tips are available on the icons by running your mouse over them.

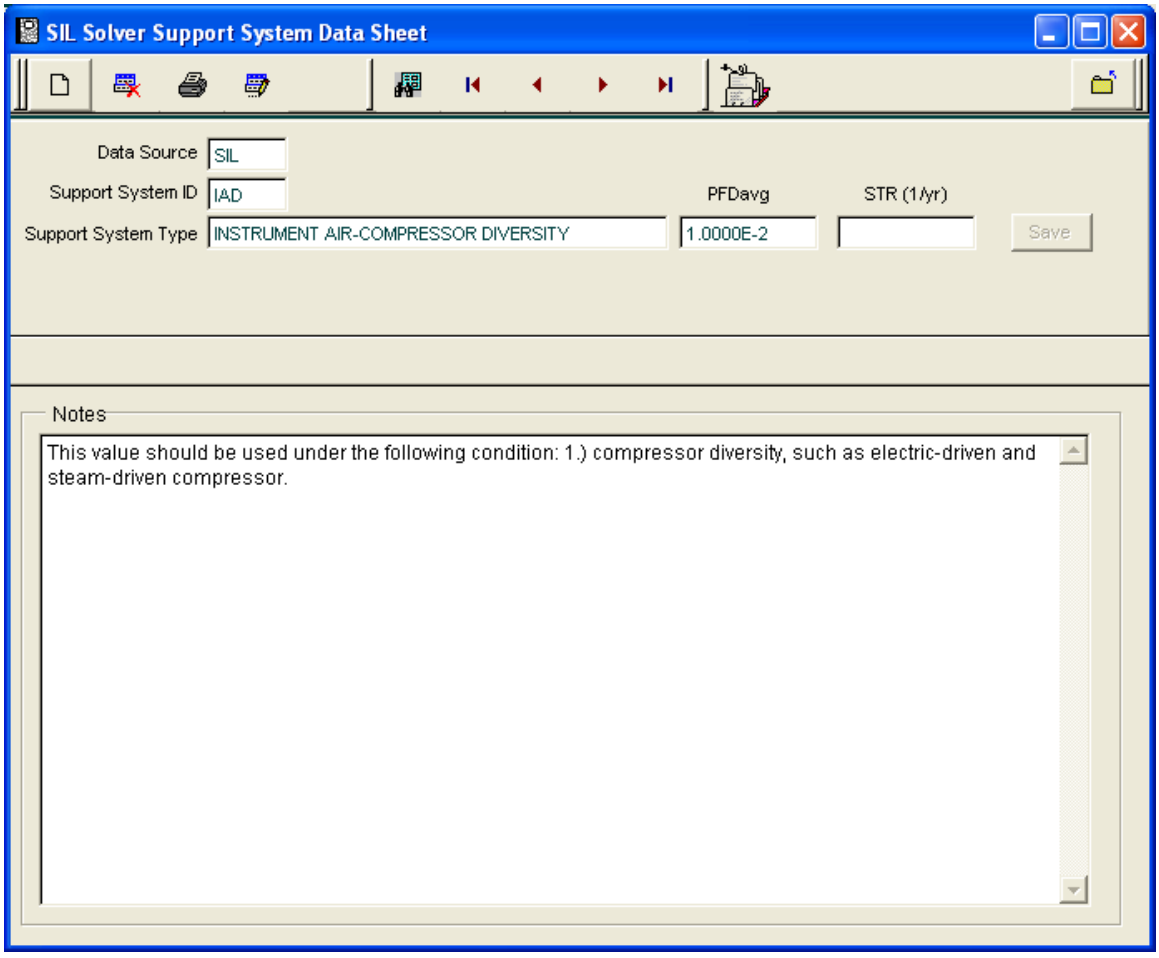


Figure 9. 39 Support System Sheet View

New Device – Tool bar

The Device ID is used on the protective function Support System Tab for device selection. The Device ID should be made as descriptive as possible, but is limited to 5 characters. Characters in excess of 5 will be truncated. The Device ID field allows an extended description of the device to be shown on the datasheet. If additional notes are required, these can be entered in the notes field at the bottom of the datasheet.

.

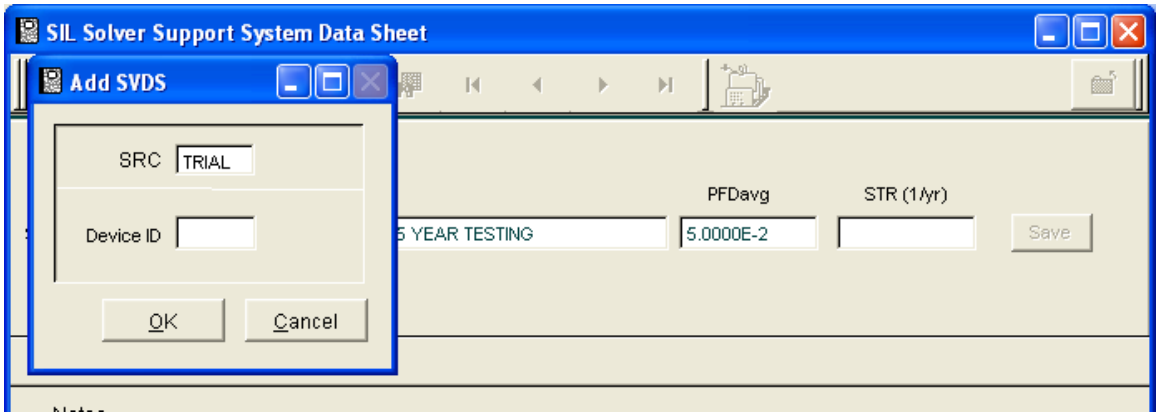


Figure 9. 40 New Device Detail - Support System tool bar

The data is entered into the data entry fields as follows:

PFD_{AVG}--the average probability to fail on demand. The value should be entered in exponential format.

Spurious trip rate per year--This is the spurious failure rate for the logic solver. The units are in failures per year. The value should be entered in exponential format.

Warning: Always enter the PFD_{AVG} and Spurious Trip Rate in exponential format. If other formats are use, the software will default the field value to 0.

Delete Device – User Entered Support System Sheet

From the tool bar, *Click* Delete. You will receive a confirmation to continue.

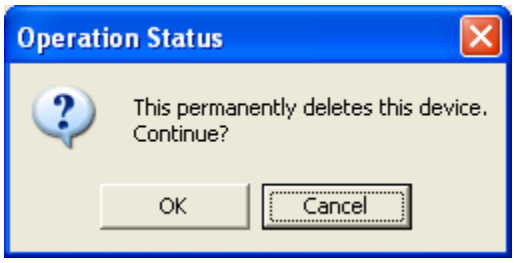


Figure 9. 41 Confirmation to Continue

Click Ok to remove the device sheet. *Click* Cancel to abort the delete process.

Print – Tool bar

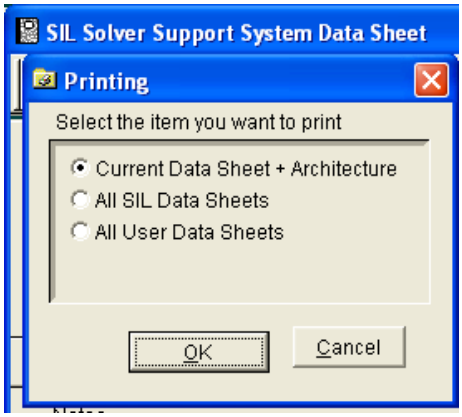
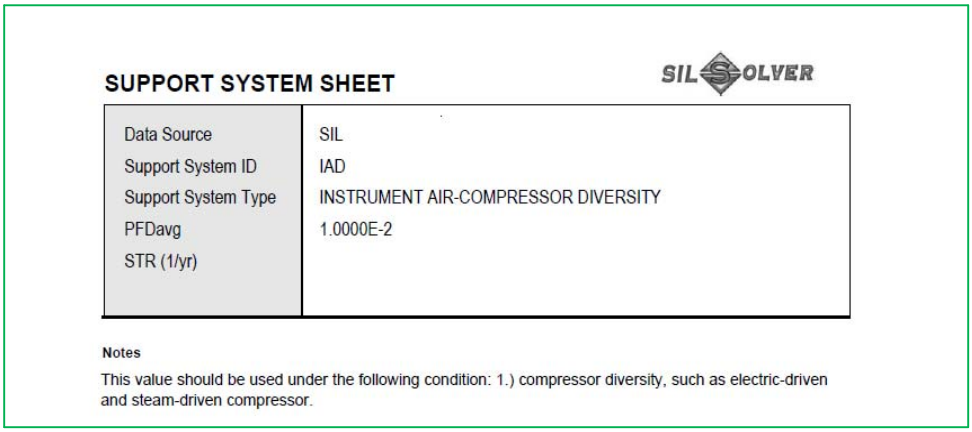


Figure 9. 42 Reports Available Options



SUPPORT SYSTEM SHEET

Data Source	SIL
Support System ID	IAD
Support System Type	INSTRUMENT AIR-COMPRESSOR DIVERSITY
PFDavg	1.0000E-2
STR (1/yr)	

Notes

This value should be used under the following condition: 1.) compressor diversity, such as electric-driven and steam-driven compressor.

Figure 9. 43 Print Options Current Data Sheet + Architecture

All SIL Data Sheet report is same as above. All User Data Sheets are only the sheets that not "SIL."

Revision Level – Tool bar

Even though the Support System Sheets database revision level may not be altered by users, for hard copy documentation users may print this information. From the tool bar, *Click* Revision Level.

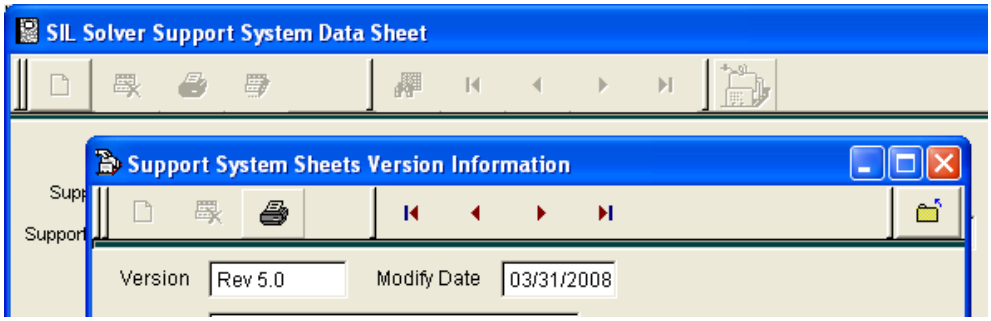


Figure 9. 44 Support System Version Information

Click Print. Report not shown.

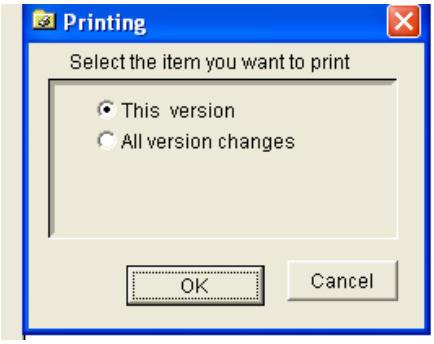


Figure 9. 45 Print Data Sheets Version Information

This version: Will print the record you are editing/viewing when choosing print.

All Version changes: Will print all records contained in the table.

Click OK.

Close the Support System Sheets

To close and return to where you selected Data Sheets: the Project Start or Protective Function, *Click* Close or the X in the upper right hand corner

SECTION 10 PROTECTIVE FUNCTION/PROJECT DOCUMENTATION

Documentation of both the Project and the individual Protective Functions may be completed at any time. Options are provided to support revision tracking at the Project and Protective Function level. When you print you will have the ability to choose which information is displayed in the report footer.

PF Revision Level Documentation

The user is provided two points to enter this information for convenience purposes. The data only needs to be entered in once. From the Protective Function side of the start screen click the PF **revision level** button. When this button is selected a revision control form opens and any modifications can be described with new revision noted. This revision level button opens the same database as the PF **revision level** button on the Summary Tab.

Click PF Revision Level

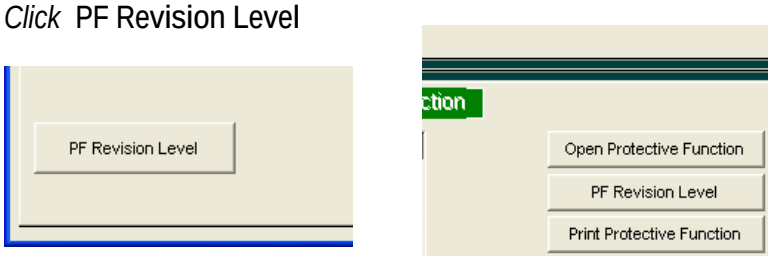


Figure 10. 1 From protective function Summary Tab or From Project Start

New – Tool bar

You can add as many revisions as you need. The latest revision will be the one printed. If you want to add a new revision, from the toolbar, *Click* New. Blank input boxes will display for editing.

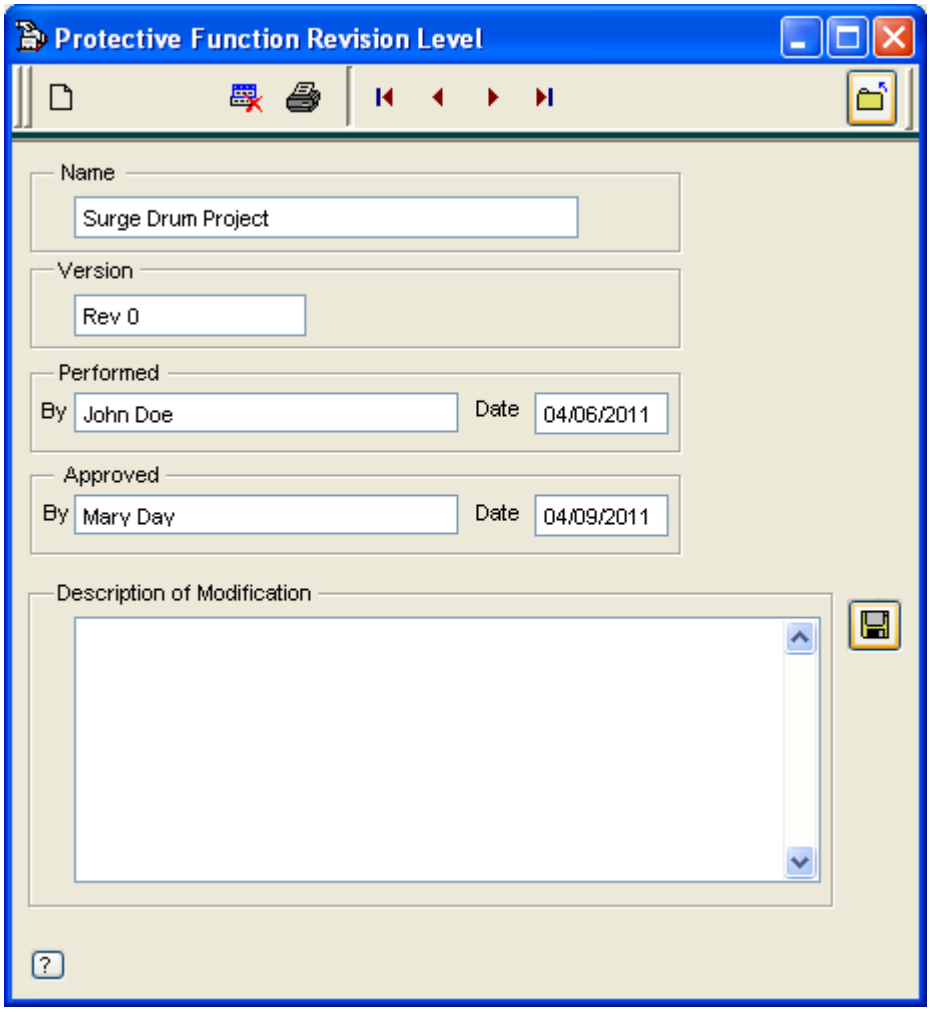


Figure 10. 2 Protective Function Revision Level Completed

Click Save.

Delete – Tool bar

Click Delete . Version will delete without a warning or confirmation. There is no undo.

Print – Tool bar

Click Print . Report not shown.

Last version entered: This information will print on the Protective Function Revision level reports.

This version: Will print the record you are editing when choosing print.

All Version changes: Will print all records contained in the table.

Close – Tool bar

To close and return the Project Start, *Click* Close or the red X in the upper right hand corner

Project Revision Level Documentation

Prior to printing a project, complete the Project Revision Level documentation. The project documentation can be skipped until needed for the printing of reports.

Figure 10. 3 Project Revision

From the project list, *Click* the Project processing. *Click* Project Revision Level.

New – Tool bar

Type the project information into the input boxes. *Click* Save. You will choose if the project information or the protective function will print on the report.

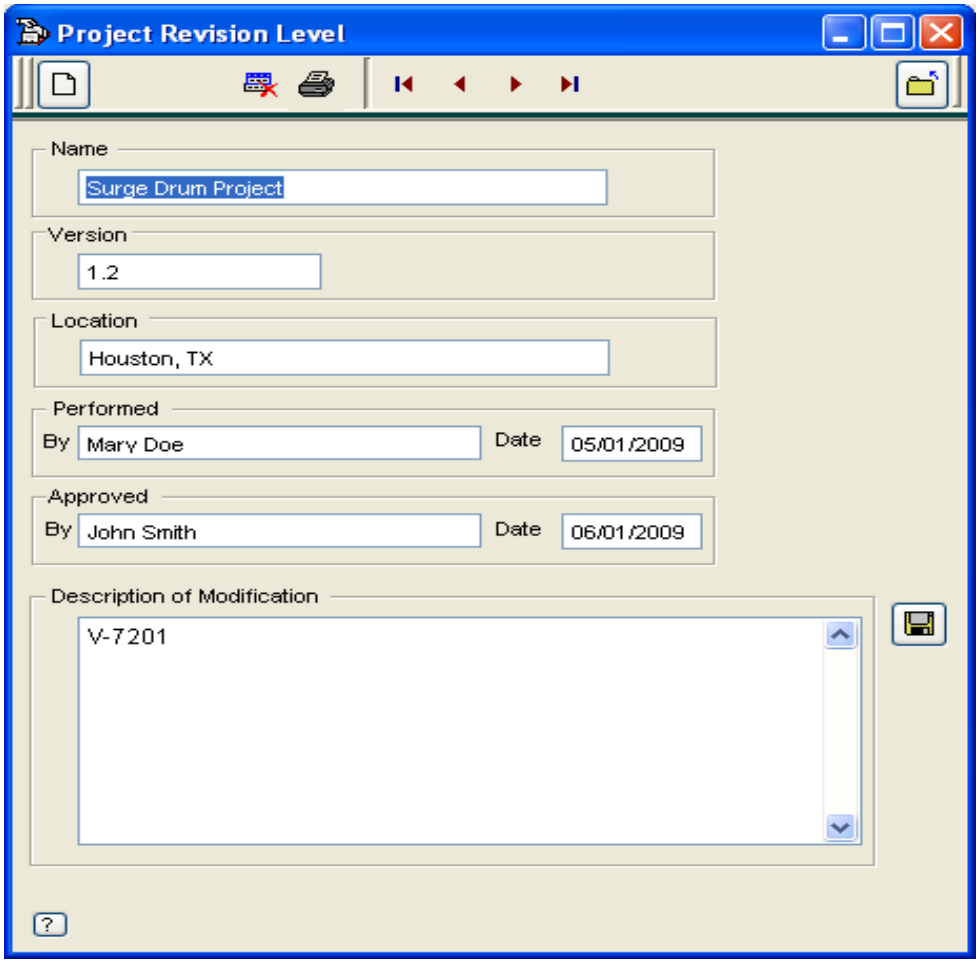


Figure 10. 4 Project Documentation Screen

Click Save.

Delete – Tool bar

Click Delete . Version will delete without a warning or confirmation. There is no undo.

Print – Tool bar

Click Print . Report not shown.

Last version entered: This information will print on the Project Revision level reports.

This version: Will print the record you are editing when choosing print.

All Version changes: Will print all records contained in the table.

Close – Tool bar

To close and return the Project Start, *Click* Close or the red X in the upper right hand corner

SECTION 11 REPORTS IN SIL SOLVER®

Reports may be generated on a Project level or a Protective Function level. The main difference is the scope of the data. The project reports print all the protective function connected the project. The protective function level prints only that protective function processing within the project. The guide will show you how to use the print at project level. Refer to these instructions when printing at protective function level.

From the Project Start, *Click* on the Project you wish to print, *Click* Print Project.

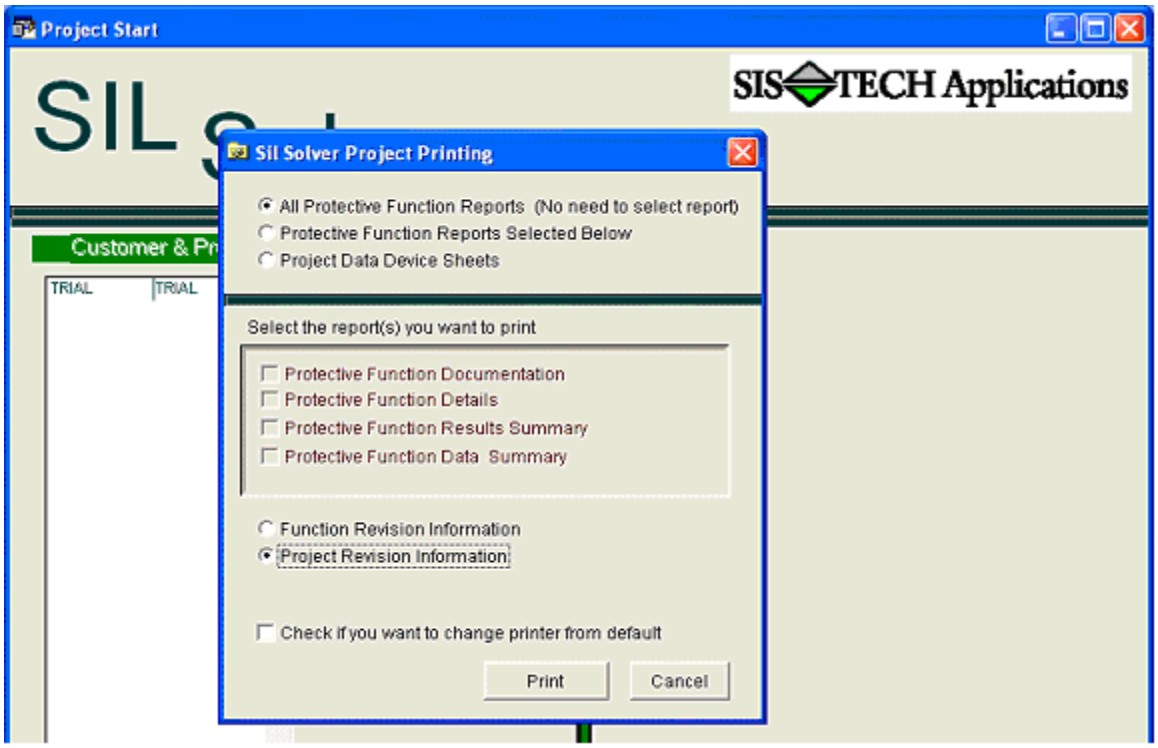


Figure 11. 1 Project and Protective Function Reports Available Options

Report Printing for Project

The default is All Protective Function Reports and Function Revision information. If you are printing at the project level, you may want the Project Revision information to print. Make sure you have updated the project revision information database.

Click Project Revision information. If you want the protective function revision information to print leave the default.

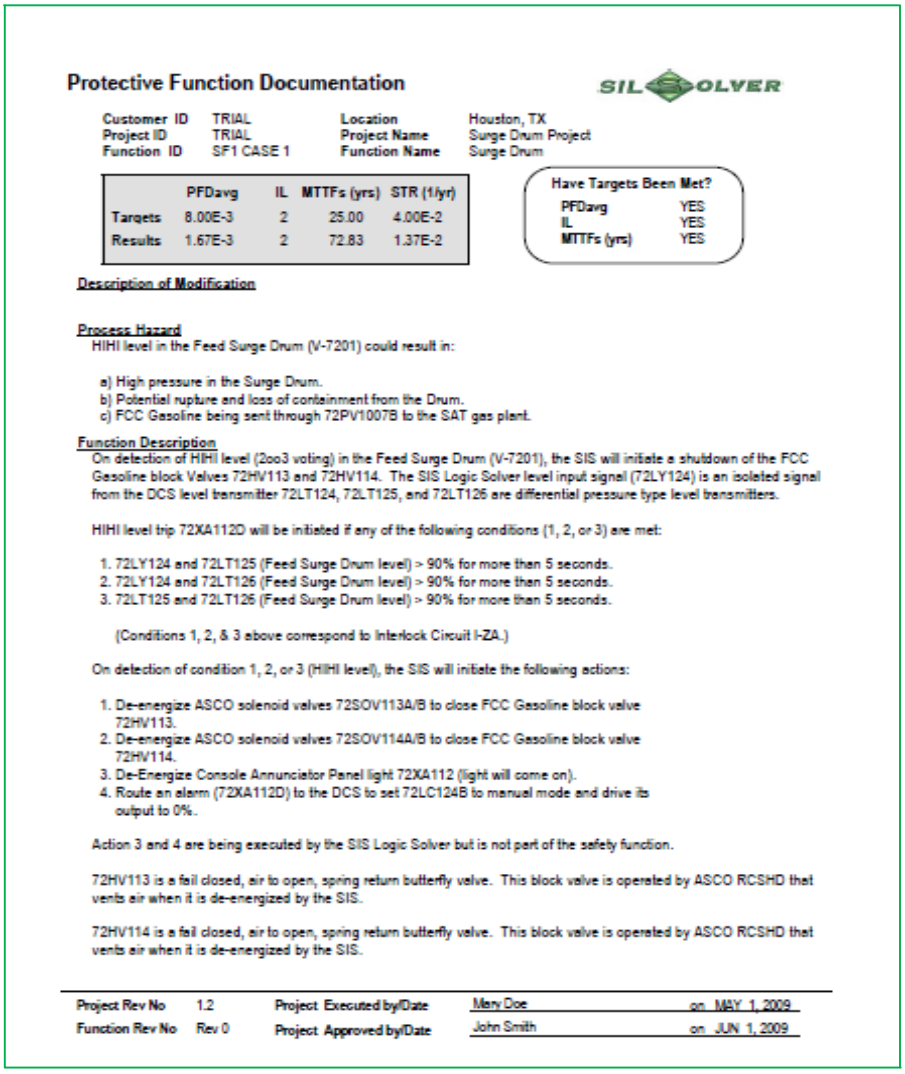
The All Protective Function Reports includes all four of the Protective Function Reports listed under the Select the reports you want to print. *Click* Protective Function Reports to enable the user to choose any combination of the individual reports.

Report Details for Project and Protective Function Levels

The four Protective Function Reports that may be printed all at once or individually selected are as follows:

Protective Functions Documentation

- This report has header information about the project the information entered into the PF Doc tab of the Protective Function, chosen project or the Protective Function current revision level, executed person\date and approval person\date.



Protective Function Documentation

SILSOLVER

Customer ID	TRIAL	Location	Houston, TX	
Project ID	TRIAL	Project Name	Surge Drum Project	
Function ID	SF1 CASE 1	Function Name	Surge Drum	

	PFDavg	IL	MTTFs (yrs)	STR (1/yr)
Targets	8.00E-3	2	25.00	4.00E-2
Results	1.67E-3	2	72.83	1.37E-2

Have Targets Been Met?

PFDavg	YES
IL	YES
MTTFs (yrs)	YES

Description of Modification

Process Hazard

HIHI level in the Feed Surge Drum (V-7201) could result in:

a) High pressure in the Surge Drum.
b) Potential rupture and loss of containment from the Drum.
c) FCC Gasoline being sent through 72PV1007B to the SAT gas plant.

Function Description

On detection of HIHI level (2oo3 voting) in the Feed Surge Drum (V-7201), the SIS will initiate a shutdown of the FCC Gasoline block Valves 72HV113 and 72HV114. The SIS Logic Solver level input signal (72LY124) is an isolated signal from the DCS level transmitter 72LT124, 72LT125, and 72LT126 are differential pressure type level transmitters.

HIHI level trip 72XA112D will be initiated if any of the following conditions (1, 2, or 3) are met:

1. 72LY124 and 72LT125 (Feed Surge Drum level) > 90% for more than 5 seconds.
2. 72LY124 and 72LT126 (Feed Surge Drum level) > 90% for more than 5 seconds.
3. 72LT125 and 72LT126 (Feed Surge Drum level) > 90% for more than 5 seconds.

(Conditions 1, 2, & 3 above correspond to Interlock Circuit I-ZA.)

On detection of condition 1, 2, or 3 (HIHI level), the SIS will initiate the following actions:

1. De-energize ASCO solenoid valves 72SOV113A/B to close FCC Gasoline block valve 72HV113.
2. De-energize ASCO solenoid valves 72SOV114A/B to close FCC Gasoline block valve 72HV114.
3. De-Energize Console Annunciator Panel light 72XA112 (light will come on).
4. Route an alarm (72XA112D) to the DCS to set 72LC124B to manual mode and drive its output to 0%.

Action 3 and 4 are being executed by the SIS Logic Solver but is not part of the safety function.

72HV113 is a fail closed, air to open, spring return butterfly valve. This block valve is operated by ASCO RCSHD that vents air when it is de-energized by the SIS.

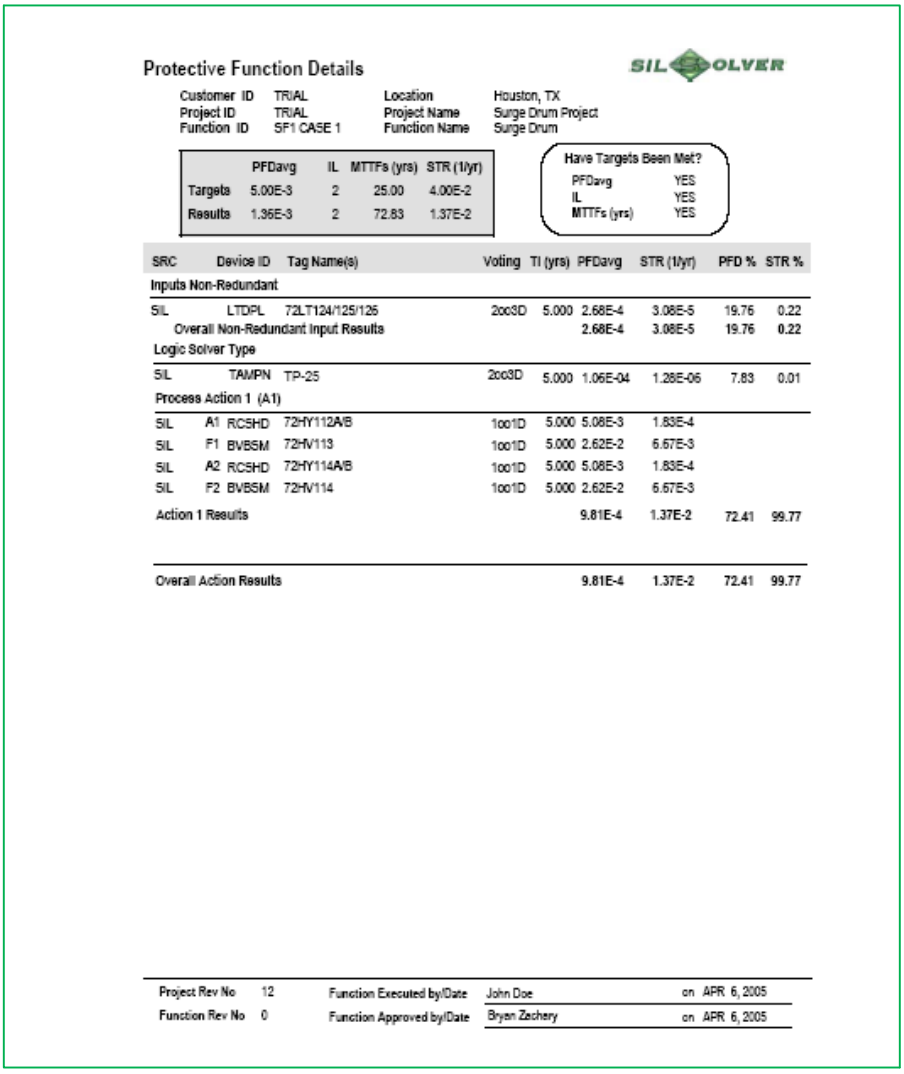
72HV114 is a fail closed, air to open, spring return butterfly valve. This block valve is operated by ASCO RCSHD that vents air when it is de-energized by the SIS.

Project Rev No	1.2	Project Executed by/Date	Mary Doe	on MAY 1, 2009
Function Rev No	Rev 0	Project Approved by/Date	John Smith	on JUN 1, 2009

Figure 11. 2 Protective Function Documentation Tab

Protective Function Details

- This report has header information about the project; the information entered into tabs Inputs through Action M (including devices, voting architecture, testing intervals, PFDavg and STR) of all devices in the Protective Function, the Project and the Protective Function current revision level, executed person\date and approval person\date.



Protective Function Details

Customer ID TRIAL Location Houston, TX
Project ID TRIAL Project Name Surge Drum Project
Function ID SF1 CASE 1 Function Name Surge Drum

	PFDavg	IL	MTTFs (yrs)	STR (1/yr)
Targets	5.00E-3	2	25.00	4.00E-2
Results	1.36E-3	2	72.83	1.37E-2

Have Targets Been Met?
PFDavg YES
IL YES
MTTFs (yrs) YES

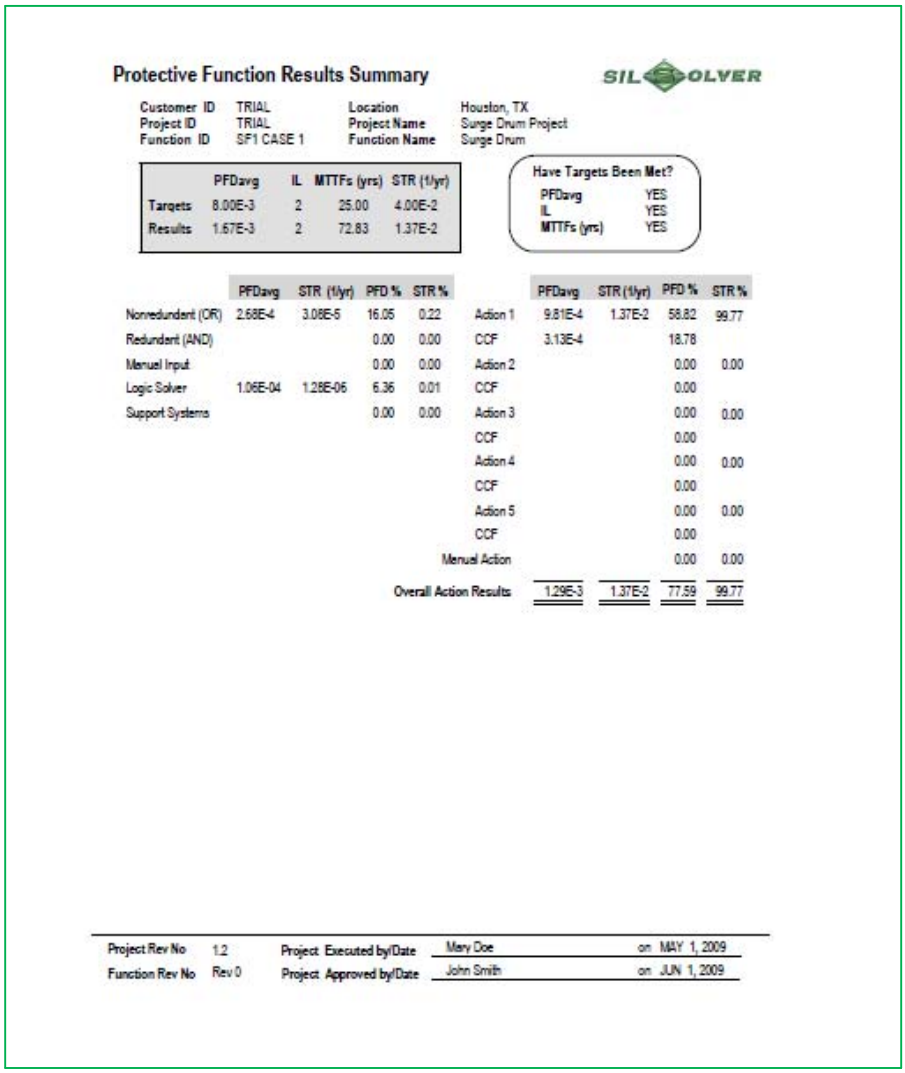
SRC	Device ID	Tag Name(s)	Voting	TI (yrs)	PFDavg	STR (1/yr)	PFD %	STR %
Inputs Non-Redundant								
SIL	LTDPL	72LT124/125/126	2oo3D	5.000	2.68E-4	3.08E-5	19.76	0.22
Overall Non-Redundant Input Results					2.68E-4	3.08E-5	19.76	0.22
Logic Solver Type								
SIL	TAMPN	TP-25	2oo3D	5.000	1.06E-04	1.28E-06	7.83	0.01
Process Action 1 (A1)								
SIL	A1 RCSHD	72HY112A/B	1oo1D	5.000	5.08E-3	1.83E-4		
SIL	F1 BVBSM	72HV113	1oo1D	5.000	2.62E-2	6.67E-3		
SIL	A2 RCSHD	72HY114A/B	1oo1D	5.000	5.08E-3	1.83E-4		
SIL	F2 BVBSM	72HV114	1oo1D	5.000	2.62E-2	6.67E-3		
Action 1 Results					9.81E-4	1.37E-2	72.41	99.77
Overall Action Results					9.81E-4	1.37E-2	72.41	99.77

Project Rev No 12 Function Executed by/Date John Doe on APR 6, 2005
Function Rev No 0 Function Approved by/Date Bryan Zachery on APR 6, 2005

Figure 11. 3 Protective Function Details Report Example

Protective Function Results Summary

- This report has header information about the project, the information reported in Protective Function Summary tab. The Project and the Protective Function current revision level, the Project or the Protective Function executed person\date and approval person\date.



Protective Function Results Summary

SIL SOLVER

Customer ID	TRIAL	Location	Houston, TX
Project ID	TRIAL	Project Name	Surge Drum Project
Function ID	SF1 CASE 1	Function Name	Surge Drum

	PFDavg	IL	MTTFs (yrs)	STR (1/yr)
Targets	8.00E-3	2	25.00	4.00E-2
Results	1.67E-3	2	72.83	1.37E-2

Have Targets Been Met?	
PFDavg	YES
IL	YES
MTTFs (yrs)	YES

	PFDavg	STR (1/yr)	PFD %	STR %
Nonredundant (OR)	2.68E-4	3.08E-5	16.05	0.22
Redundant (AND)			0.00	0.00
Manuel Input			0.00	0.00
Logic Solver	1.06E-04	1.28E-06	6.36	0.01
Support Systems			0.00	0.00

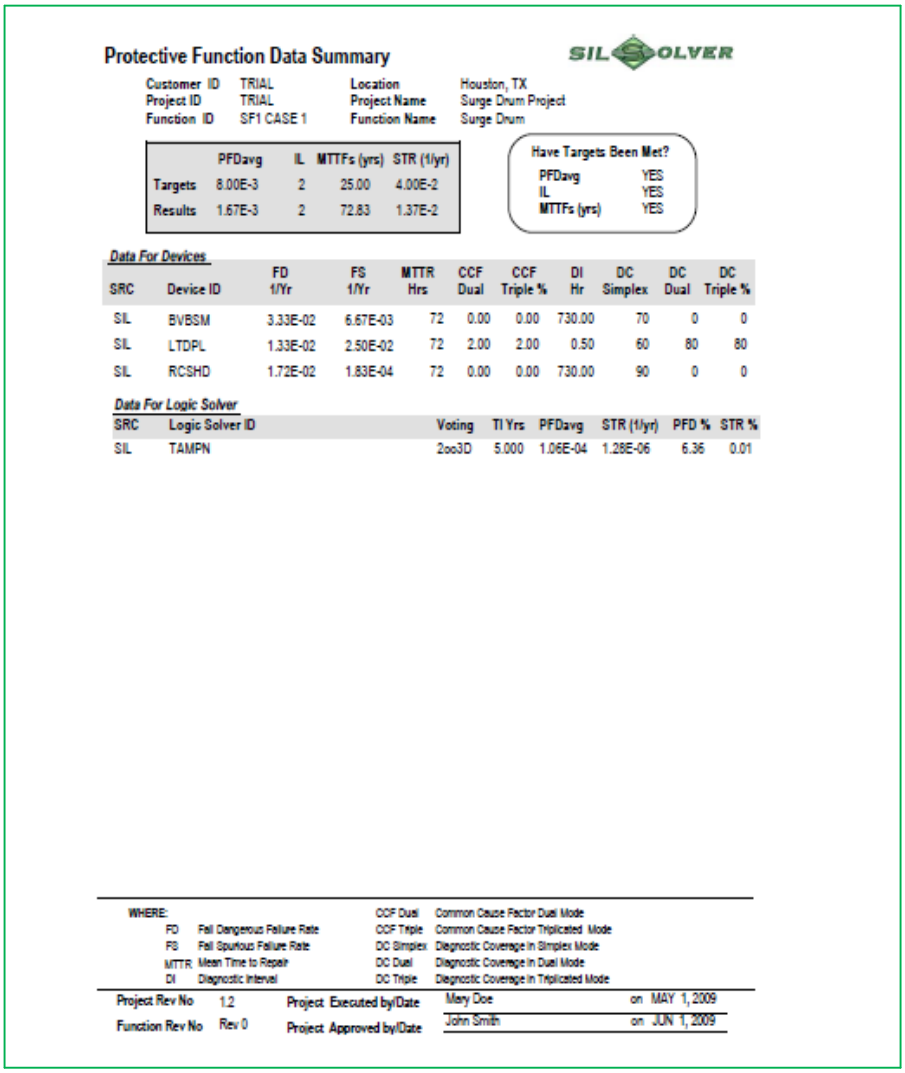
	PFDavg	STR (1/yr)	PFD %	STR %
Action 1	9.81E-4	1.37E-2	58.82	99.77
CCF	3.13E-4		18.78	
Action 2			0.00	0.00
CCF			0.00	
Action 3			0.00	0.00
CCF			0.00	
Action 4			0.00	0.00
CCF			0.00	
Action 5			0.00	0.00
CCF			0.00	
Manuel Action			0.00	0.00
Overall Action Results	1.29E-3	1.37E-2	77.59	99.77

Project Rev No	1.2	Project Executed by/Date	Mary Doe	on MAY 1, 2009
Function Rev No	Rev 0	Project Approved by/Date	John Smith	on JUN 1, 2009

Figure 11. 4 Protective Function Results Summary Example

Protective Function Data Summary

- This report has header information about the project, the device information including failure rate data used in SIL Solver calculations. The Project and the Protective Function current revision level, the Project or the Protective Function executed person\date and approval person\date.



Protective Function Data Summary

Customer ID	TRIAL	Location	Houston, TX
Project ID	TRIAL	Project Name	Surge Drum Project
Function ID	SF1 CASE 1	Function Name	Surge Drum

	PFDavg	IL	MTTFs (yrs)	STR (1/yr)
Targets	8.00E-3	2	25.00	4.00E-2
Results	1.67E-3	2	72.83	1.37E-2

Have Targets Been Met?	
PFDavg	YES
IL	YES
MTTFs (yrs)	YES

Data For Devices

SRC	Device ID	FD 1/Yr	FS 1/Yr	MTTR Hrs	CCF Dual	CCF Triple %	DI Hr	DC Simplex	DC Dual	DC Triple %
SIL	BVBSM	3.33E-02	6.67E-03	72	0.00	0.00	730.00	70	0	0
SIL	LTDPL	1.33E-02	2.50E-02	72	2.00	2.00	0.50	60	80	80
SIL	RCSHD	1.72E-02	1.83E-04	72	0.00	0.00	730.00	90	0	0

Data For Logic Solver

SRC	Logic Solver ID	Voting	TI Yrs	PFDavg	STR (1/yr)	PFD %	STR %
SIL	TAMPN	2oo3D	5.000	1.06E-04	1.28E-06	6.36	0.01

WHERE:

FD	Fail Dangerous Failure Rate	CCF Dual	Common Cause Factor Dual Mode
FS	Fail Spurious Failure Rate	CCF Triple	Common Cause Factor Triplicated Mode
MTTR	Mean Time to Repair	DC Simplex	Diagnostic Coverage in Simplex Mode
DI	Diagnostic Interval	DC Dual	Diagnostic Coverage in Dual Mode
		DC Triple	Diagnostic Coverage in Triplicated Mode

Project Rev No	1.2	Project Executed by/Date	Mary Doe	on MAY 1, 2009
Function Rev No	Rev 0	Project Approved by/Date	John Smith	on JUN 1, 2009

Figure 11. 5 Protective Function Data Summary Example

Project Data Device Sheets

This report will print information on each unique device that is used in the project. This report is available only at the Project level. If you check this report at protective function level, you will receive a message.

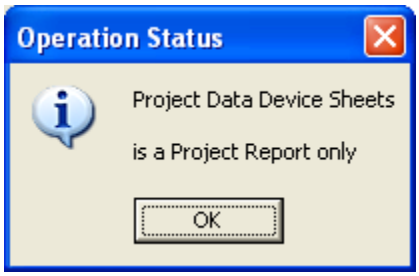


Figure 11. 6 Project Data Device Sheets chosen at PF level

Project Level Device Report

- Project Device Datasheets. This report includes a header with project information, a datasheet for each device used in the Project including all information from the Protective Function datasheet and the datasheet notes. The description includes the reference sources for the rates. Project Datasheets will only include the devices that are within the current revision of Protective Functions and will only print them once regardless of how many times a device is used with in the project.

Protective Function Data Summary

SIL SOLVER

Customer ID	TRIAL
Project ID	TRIAL
Data Source	SIL
Device ID	BVBSM
Device Type	BLOCK VALVE-BUTTERFLY-FTC-PS MONTH
Fail Dangerous Failure Rate (1/yr)	3.3330E-02
Fail Safe Failure Rate (1/yr)	6.6670E-03
Mean Time to Repair (hrs)	72.00
Common Cause Factor Dual Mode (%)	0.00
Common Cause Factor Triple Mode (%)	0.00
Diagnostic Interval (hrs)	730.00
Diagnostic Coverage in Simplex Mode (%)	70.00
Diagnostic Coverage in Dual Mode (%)	0.00
Diagnostic Coverage in Triplicated Mode (%)	0.00

Notes

Calculations assume that provisions are made to maintain safe operation during any on-line testing, on-line maintenance, or fault response activities.

Spring return, pneumatically-operated butterfly valve, operating in a standby (dormant) mode of operation.

Safe state specified is fail closed. Valve closes when air is removed from actuator.

The solenoid failure rate is NOT INCLUDED in the above calculation. The appropriate voting architecture should be listed separately as the actuating device on the SIL Verification Sheet.

Partial stroke involves movement of the valve from the full open position, which is confirmed using limit switches, position transmitters, or visual confirmation.

Calculation assumes that the valve is not bypassed or mechanically limited during the test, so that the fail-safe condition can be achieved if a process demand occurs during the test.

Calculation assumes that the partial stroke test is performed using equipment and instrumentation that provide a positive confirmation that the valve is returned to the fully operational state after completion of partial stroke testing. Calculation assumes that a full-stroke test of the valve is performed at the specified testing interval.

Data Source: + Compilation of the following data sources:

OREDA: "Offshore Reliability Data Handbook,ö 3rd Edition, Det Norske Veritas Industri Norge as DNV Technica, Norway, 1997.

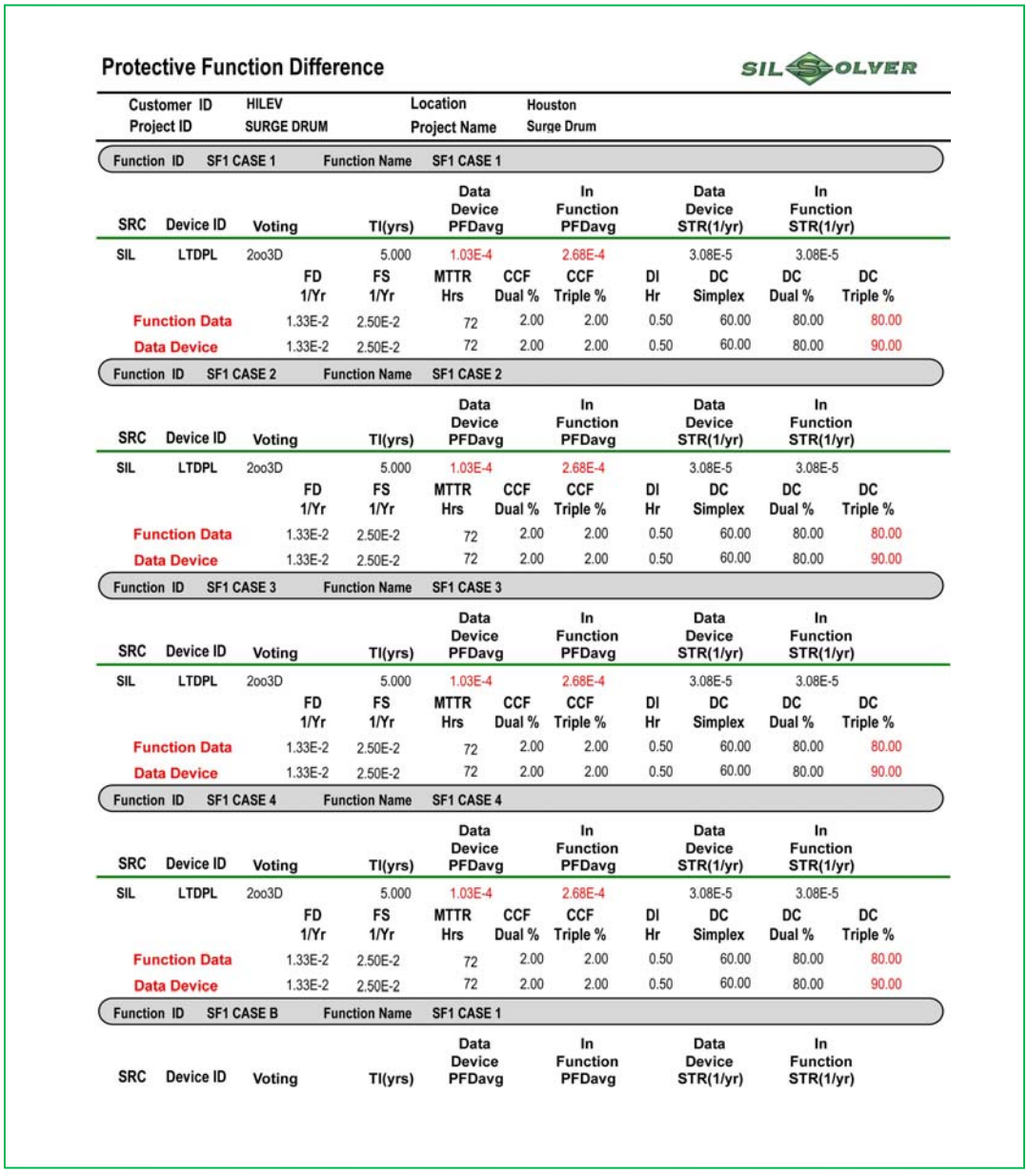
OREDA: "Offshore Reliability Data Handbook,ö 4th Edition, Det Norske Veritas Industri Norge as DNV Technica, Norway, 2002.

Figure 11. 7 Project Datasheets Example

Difference Report

This report can be run at function level or project level.

Over the course of time the failure rate of devices can change based on new field performance data. A project created in a previous version of SIL Solver may contain data that has been revised. When using the newer version you will have access to the new data that may be different. This report will list the devices that have changed with the associated old and new data highlighted; it will also list any user created data sheets have been used in the project. When a device exists in the project that does not exist in the SIL Solver database it is identified only.



Protective Function Difference

Customer ID	HILEV	Location	Houston
Project ID	SURGE DRUM	Project Name	Surge Drum

Function ID SF1 CASE 1 **Function Name** SF1 CASE 1

SRC	Device ID	Voting	TI(yrs)	Data Device PFDavg	In Function PFDavg	Data Device STR(1/yr)	In Function STR(1/yr)
SIL	LTDPL	2oo3D	5.000	1.03E-4	2.68E-4	3.08E-5	3.08E-5

	FD 1/Yr	FS 1/Yr	MTTR Hrs	CCF Dual %	CCF Triple %	DI Hr	DC Simplex	DC Dual %	DC Triple %
Function Data	1.33E-2	2.50E-2	72	2.00	2.00	0.50	60.00	80.00	80.00
Data Device	1.33E-2	2.50E-2	72	2.00	2.00	0.50	60.00	80.00	90.00

Function ID SF1 CASE 2 **Function Name** SF1 CASE 2

SRC	Device ID	Voting	TI(yrs)	Data Device PFDavg	In Function PFDavg	Data Device STR(1/yr)	In Function STR(1/yr)
SIL	LTDPL	2oo3D	5.000	1.03E-4	2.68E-4	3.08E-5	3.08E-5

	FD 1/Yr	FS 1/Yr	MTTR Hrs	CCF Dual %	CCF Triple %	DI Hr	DC Simplex	DC Dual %	DC Triple %
Function Data	1.33E-2	2.50E-2	72	2.00	2.00	0.50	60.00	80.00	80.00
Data Device	1.33E-2	2.50E-2	72	2.00	2.00	0.50	60.00	80.00	90.00

Function ID SF1 CASE 3 **Function Name** SF1 CASE 3

SRC	Device ID	Voting	TI(yrs)	Data Device PFDavg	In Function PFDavg	Data Device STR(1/yr)	In Function STR(1/yr)
SIL	LTDPL	2oo3D	5.000	1.03E-4	2.68E-4	3.08E-5	3.08E-5

	FD 1/Yr	FS 1/Yr	MTTR Hrs	CCF Dual %	CCF Triple %	DI Hr	DC Simplex	DC Dual %	DC Triple %
Function Data	1.33E-2	2.50E-2	72	2.00	2.00	0.50	60.00	80.00	80.00
Data Device	1.33E-2	2.50E-2	72	2.00	2.00	0.50	60.00	80.00	90.00

Function ID SF1 CASE 4 **Function Name** SF1 CASE 4

SRC	Device ID	Voting	TI(yrs)	Data Device PFDavg	In Function PFDavg	Data Device STR(1/yr)	In Function STR(1/yr)
SIL	LTDPL	2oo3D	5.000	1.03E-4	2.68E-4	3.08E-5	3.08E-5

	FD 1/Yr	FS 1/Yr	MTTR Hrs	CCF Dual %	CCF Triple %	DI Hr	DC Simplex	DC Dual %	DC Triple %
Function Data	1.33E-2	2.50E-2	72	2.00	2.00	0.50	60.00	80.00	80.00
Data Device	1.33E-2	2.50E-2	72	2.00	2.00	0.50	60.00	80.00	90.00

Function ID SF1 CASE B **Function Name** SF1 CASE 1

SRC	Device ID	Voting	TI(yrs)	Data Device PFDavg	In Function PFDavg	Data Device STR(1/yr)	In Function STR(1/yr)

Page Numbers in SIL Solver Reports

Reports from SIL Solver do not include page numbers. To add page numbers save report as a PDF, then using a program such as Adobe Acrobat's Add header & footer tool, insert page numbers using the header tab and reducing the top margin to .4 to align numbers with title.

SECTION 12 INTRODUCTION TO SIL SOLVER® MATHEMATICS

SIL Solver® utilizes reliability block diagrams with fault tree equations to calculate the probability to fail on demand (PFD_{AVG}) and the MTTFspurious of the protective instrumented function (PIF).

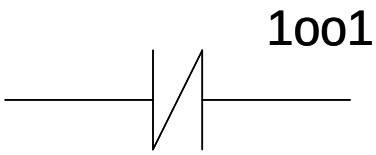
The reliability block diagram technique involves determining the PFD_{AVG} for the field sensors (FS), logic solver (LS), final elements (FE), and support systems (SS). The field sensors are the inputs required to detect the hazardous condition. The logic solver accepts these inputs and generates correct outputs that change the state of the final elements in order to mitigate the hazardous condition. The support systems are those systems that are required for successful functioning of the PIF. If the valves are air-to-move, the instrument air supply must be analyzed. If the PIF is energize-to-trip, the power supply must be considered as part of the PIF. The PFD_{AVG} for the inputs and outputs is calculated based on the architecture of each subsystem and utilizes assumed data for the dangerous failure rate (λD), test interval (TI), diagnostic coverage (DC), and mean time to repair (MTTR). Once the individual PFDs for each input, logic solver, output and support system are known, these PFDs are summed for the PFD_{PIF}.

$PFD_{PIF} = \Sigma PFD_{FS} + \Sigma PFD_{LS} + \Sigma PFD_{FE} + \Sigma PFD_{SS}$

The spurious trip rate (STR) for the inputs and outputs is calculated using the architecture of each subsystem and assumed data for the spurious failure rate (λ^{SP}) and mean time to repair (MTTR). Once the individual STR for each input, logic solver, and output are known, these STR values are summed for the STR_{PIF}.

$$STR_{PIF} = \sum STR_{FS} + \sum STR_{LS} + \sum STR_{FE} + \sum STR_{SS}$$

1oo1



Simplex devices are used to implement many protective instrumented functions. The 1oo1 equation shown below is used to model simplex devices when no external diagnostic coverage is provided in the PIF design. The SIL Solver® software uses the architecture description “1oo1” to represent this equation.

$$PFD_{avg} = \frac{\lambda^D * TI}{2} + \lambda^D * MTTR$$

$$MTTF^{SP} = \frac{1}{\lambda^{SP}}$$

The PIF design may utilize diagnostic coverage to improve the on-line detection of dangerous faults. The 1oo1 equation shown below is used to model simplex devices when external diagnostic coverage is provided in the PIF design. The SIL Solver® software uses the architecture description "1oo1D" to represent this equation.

The diagnostic interval (DI) is incorporated into the equation to allow modeling of diagnostic routines that occur at an extended interval. For example, this equation can be used to model the partial stroke test of a block valve. The diagnostic interval would be the partial stroke test interval. The test interval would be the full functional test interval. The diagnostic coverage that is provided by the specific partial stroke testing equipment would be determined using failure modes and effects analysis.

$$PFD_{avg} = \frac{(1-DC) * \lambda^D * TI}{2} + \frac{DC * \lambda^D * DI}{2} + \lambda^D * MTTR$$

$$MTTF^{SP} = \frac{1}{\lambda^{SP}}$$

1oo2

Dual redundant devices in a 1oo2 architecture are often used when fail safe operation is critical. The 1oo2 equation shown below is used to model dual devices when no external diagnostic coverage is provided in the PIF design. The SIL Solver® software uses the architecture description "1oo2" to represent this equation.

$$PFD_{avg} = \left[\frac{(1-\beta)*\lambda^{D}*TI}{2} + (1-\beta)*\lambda^{D}*MTTR\right]^{2} + \left[\frac{\beta*\lambda^{D}*TI}{2} + \beta*\lambda^{D}*MTTR\right]$$

$$MTTF^{SP} = \frac{1}{2*\lambda^{SP}}$$

The PIF design may utilize diagnostic coverage to improve the on-line detection of dangerous faults. The 1oo2 equation shown below is used to model dual devices when external diagnostic coverage is provided in the PIF design. The diagnostic interval (DI) is incorporated into the equation to allow modeling of diagnostic routines that occur at an extended interval. For small diagnostic intervals, the contribution of the terms containing DI is generally negligible. The SIL Solver® software uses the architecture description "1oo2D" to represent this equation.

The 1oo2D equation is used to model 1oo2 voting devices where only one device must function correctly for the safe state to be achieved and external diagnostic coverage is provided in the PIF design. For example, external diagnostic coverage may be provided by comparing the analog signals of two transmitters and issuing a deviation alarm on unacceptable deviation.

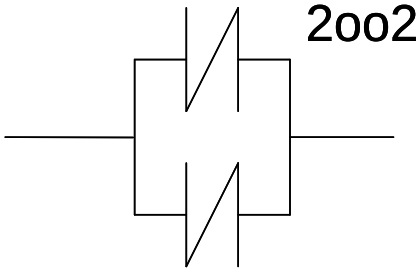
This equation should not be used for dual redundancy that normally operates in a 2oo2 mode and on detection of fault converts to a 1oo1 architecture. While this redundancy is marketed as "1oo2D," the failure models are actually 2oo2D (see 2oo2 section).

$$PFD_{avg} = \left[\frac{(1-DC)*(1-\beta)*\lambda^{D}*TI}{2} + \frac{DC*(1-\beta)*\lambda^{D}*DI}{2} + (1-\beta)*\lambda^{D}*MTTR\right]^{2} +$$

$$\left[\frac{(1-DC)*\beta*\lambda^{D}*TI}{2} + \frac{DC*\beta*\lambda^{D}*DI}{2} + \beta*\lambda^{D}*MTTR\right]$$

$$MTTF^{SP} = \frac{1}{2*\lambda^{SP}}$$

2oo2



Dual redundant devices in a 2oo2 architecture are often used when fail reliable operation is important. The 2oo2 equation shown below is used to model dual devices when no external diagnostic coverage is provided in the PIF design. The SIL Solver® software uses the architecture description "2oo2" to represent this equation.

$$PFD_{avg} = 2 * \left[\frac{\lambda^D * TI}{2} + \lambda^D * MTTR \right]$$

$$MTTF^{SP} = \frac{1}{2 * \lambda^{SP} * \lambda^{SP} * TI}$$

The PIF design may utilize diagnostic coverage to improve the on-line detection of dangerous faults. The 2oo2 equation shown below is used to model dual devices when external diagnostic coverage is provided in the PIF design. The diagnostic interval (DI) is incorporated into the equation to allow modeling of diagnostic routines that occur at an extended interval. For small diagnostic intervals, the contribution of the terms containing DI is generally negligible. The SIL Solver® software uses the architecture description "2oo2D" to represent this equation.

The 2oo2D equation is used to model 2oo2 voting devices where both devices must function correctly for the safe state to be achieved and external diagnostic coverage is provided in the PIF design. For example, external diagnostic coverage may be provided by comparing the analog signals of two transmitters and issuing a deviation alarm on unacceptable deviation.

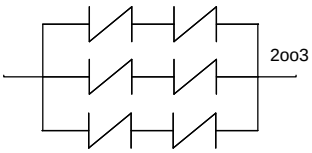
This equation should be used for dual redundancy that normally operates in a 2oo2 mode and on detection of fault converts to a 1oo1 architecture. While this redundancy is marketed as "1oo2D," the failure models are actually 2oo2D.

$$PFD_{avg} = 2 * \left[\frac{(1 - DC) * \lambda^D * TI}{2} + \frac{DC * \lambda^D * DI}{2} + \lambda^D * MTTR \right]$$

$$MTTF^{SP} = \frac{1}{2 * \lambda^{SP} * \lambda^{SP} * MTTR}$$

2oo3

Triplicated, redundant devices in a 2oo3 architecture are often used when fail safe operation is important, but on-stream reliability is also important. In 2oo3 voting, two of the devices must fail dangerously in order for the safety system to fail on demand. From a reliability perspective, it also requires the failure of two devices spuriously in order for the PIF to spuriously trip. The 2oo3 equation shown below is used to model triplicated devices when no external diagnostic coverage is provided in the PIF design. The SIL Solver® software uses the architecture description "2oo3" to represent this equation.



$$PFD_{avg} = 3 * \left[\frac{(1-\beta) * \lambda^D * TI}{2} + (1-\beta) * \lambda^D * MTTR \right]^2 + \left[\frac{\beta * \lambda^D * TI}{2} + \beta * \lambda^D * MTTR \right]$$

$$MTTF^{SP} = \frac{1}{6 * \lambda^{SP} * \lambda^{SP} * TI}$$

2oo3D

The PIF design may utilize diagnostic coverage to improve the on-line detection of dangerous faults. The 2oo3 equation shown below is used to model triplicated devices when external diagnostic coverage is provided in the PIF design. The diagnostic interval (DI) is incorporated into the equation to allow modeling of diagnostic routines that occur at an extended interval. For small diagnostic intervals, the contribution of the terms containing DI is generally negligible. The SIL Solver® software uses the architecture description "2oo3D" to represent this equation.

The 2oo3D equation is used to model 2oo3 voting devices where two of the three devices must function correctly for the safe state to be achieved and external diagnostic coverage is provided in the PIF design. For example, external diagnostic coverage may be provided by comparing the analog signals of three transmitters and issuing a deviation alarm on unacceptable deviation.

$$PFD_{avg} = 3 * \left[\frac{(1-DC) * (1-\beta) * \lambda^D * TI}{2} + \frac{DC * (1-\beta) * \lambda^D * DI}{2} + (1-\beta) * \lambda^D * MTTR \right]^2 +$$

$$\left[\frac{(1-DC) * \beta * \lambda^D * TI}{2} + \frac{DC * \beta * \lambda^D * DI}{2} + \beta * \lambda^D * MTTR \right]$$

$$MTTF^{SP} = \frac{1}{6 * \lambda^{SP} * \lambda^{SP} * MTTR}$$

1oo3

Triplicated redundant devices in a 1oo3 architecture are sometimes used when fail safe operation is absolutely critical. The 1oo3 equation shown below is used to model triplicated devices when no external diagnostic coverage is provided in the PIF design. The SIL Solver® software uses the architecture description "1oo3" to represent this equation.

$$PFD_{avg} = \left[\frac{(1-\beta)*\lambda^{D}*TI}{2} + (1-\beta)*\lambda^{D}*MTTR\right]^{3} + \left[\frac{\beta*\lambda^{D}*TI}{2} + \beta*\lambda^{D}*MTTR\right]$$

$$MTTF^{SP} = \frac{1}{3*\lambda^{SP}}$$

1oo3D

The PIF design may utilize diagnostic coverage to improve the on-line detection of dangerous faults. The 1oo3 equation shown below is used to model triplicated devices when external diagnostic coverage is provided in the PIF design. The diagnostic interval (DI) is incorporated into the equation to allow modeling of diagnostic routines that occur at an extended interval. For small diagnostic intervals, the contribution of the terms containing DI is generally negligible. The SIL Solver® software uses the architecture description "1oo3D" to represent this equation.

The 1oo3D equation is used to model 1oo3 voting devices where only one device must function correctly for the safe state to be achieved and external diagnostic coverage is provided in the PIF design. For example, external diagnostic coverage may be provided by comparing the analog signals of three transmitters and issuing a deviation alarm on unacceptable deviation.

$$PFD_{avg} = \left[\frac{(1-DC)*(1-\beta)*\lambda^{D}*TI}{2} + \frac{DC*(1-\beta)*\lambda^{D}*DI}{2} + (1-\beta)*\lambda^{D}*MTTR\right]^{3} +$$

$$\left[\frac{(1-DC)*\beta*\lambda^{D}*TI}{2} + \frac{DC*\beta*\lambda^{D}*DI}{2} + \beta*\lambda^{D}*MTTR\right]$$

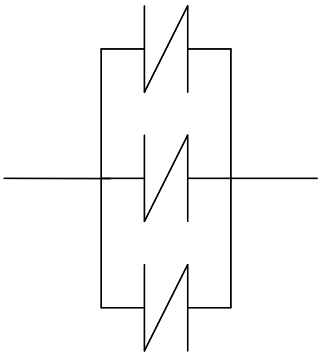
$$MTTF^{SP} = \frac{1}{3*\lambda^{SP}}$$

3oo3

Triplicated, redundant devices in a 3oo3 architecture are sometimes used when on-line operation is extremely critical. The 3oo3 equation shown below is used to model triplicated devices when no external diagnostic coverage is provided in the PIF design. The SIL Solver® software uses the architecture description "3oo3" to represent this equation.

$$PFD_{avg} = 3 * \left[\frac{\lambda^D * TI}{2} + \lambda^D * MTTR \right]$$

$$MTTF^{SP} = \frac{1}{3 * \lambda^{SP} * \lambda^{SP} * \lambda^{SP} * TI * TI}$$



3oo3D

The PIF design may utilize diagnostic coverage to improve the on-line detection of dangerous faults. The 3oo3 equation shown below is used to model triplicated devices when external diagnostic coverage is provided in the PIF design. The diagnostic interval (DI) is incorporated into the equation to allow modeling of diagnostic routines that occur at an extended interval. For small diagnostic intervals, the contribution of the terms containing DI is generally negligible. The SIL Solver® software uses the architecture description "3oo3D" to represent this equation.

The 3oo3D equation is used to model 3oo3 voting devices where all devices must function correctly for the safe state to be achieved and external diagnostic coverage is provided in the PIF design. For example, external diagnostic coverage may be provided by comparing the analog signals of three transmitters and issuing a deviation alarm on unacceptable deviation.

$$PFD_{avg} = 3 * \left[\frac{(1 - DC) * \lambda^D * TI}{2} + \frac{DC * \lambda^D * DI}{2} + \lambda^D * MTTR \right]$$

$$MTTF^{SP} = \frac{1}{3 * \lambda^{SP} * \lambda^{SP} * \lambda^{SP} * MTTR * MTTR}$$

SECTION 13 DEVICE ID

Device ID	Device Description
ALANN	ALARM ANNUNCIATOR
ANCLR	CHLORINE ANALYZER
ANCMO	CARBON MONOXIDE ANALYZER
ANCO2	CARBON DIOXIDE ANALYZER
ANCON	CONDUCTIVITY ANALYZER
ANDO2	DISSOLVED OXYGEN ANALYZER
ANH2S	HYDROGEN SULFIDE ANALYZER
ANHCT	HYDROCARBON ANALYZER-CATALYTIC
ANHIR	HYDROCARBON ANALYZER-INFRARED
ANNOX	NITROGEN OXIDE ANALYZER
ANOXY	OXYGEN ANALYZER
ANPH	PH ANALYZER
BNACC	BENTLY NEVADA ACCELERATION MONITOR
BNOVS	BENTLY NEVADA OVERSPEED MONITOR
BNRDM	BENTLY NEVADA ROD DROP MONITOR
BNTEM	BENTLY NEVADA TEMPERATURE MONITOR
BNTPM	BENTLY NEVADA THRUST POSITION MONITOR
BNVEL	BENTLY NEVADA VELOCITY MONITOR
BNVM	BENTLY NEVADA VIBRATION MONITOR
BVBSM	BLOCK VALVE – BUTTERFLY-FTC-PS-MONTH
BVBUC	BLOCK VALVE-BUTTERFLY-FTC
BVBUO	BLOCK VALVE-BUTERFLY-FTO
BVDAC	BLOCK VALVE-DOUBLE ACTING-SEE NOTES
BVFCC	BLOCK VALVE-BALL-FTC-CLEAN
BVFCD	BLOCK VALVE-BALL-FTC-DIRTY
BVFOC	BLOCK VALVE-BALL-FTO-CLEAN
BVFOD	BLOCK VALVE-BALL-FTO-DIRTY
BVGLC	BLOCK VALVE-GLOBE-FTC
BVGLM	BLOCK VALVE-GLOBE-FTC-PS MONTH
BVGLO	BLOCK VALVE-GLOBE-FTO
BVGTC	BLOCK VALVE-GATE-FTC
BVGTM	BLOCK VALVE-GATE-FTC-PS MONTH
BVGTO	BLOCK VALVE-GATE-FTO
BVSAC	BLOCK VALVE-BALL-FTC-PS ANNUAL-CLEAN
BVSAD	BLOCK VALVE-BALL-FTC-PS ANNUAL-DIRTY
BVSBC	BLOCK VALVE-BALL-FTC-PS BIANNUAL-CLEAN
BVSBD	BLOCK VALVE-BALL-FTC-PS BIANNUAL-DIRTY
BVSFC	BLOCK VALVE-BALL-FTC-FREQ STROKE-CLEAN
BVSFD	BLOCK VALVE-BALL-FTC-FREQ STROKE-DIRTY
BVSMC	BLOCK VALVE-BALL-FTC-PS MONTH-CLEAN
BVSMD	BLOCK VALVE-BALL-FTC-PS MONTH-DIRTY
BVSQC	BLOCK VALVE-BALL-FTC-PS QUARTER-CLEAN
BVSQD	BLOCK VALVE-BALL-FTC-PS QUARTER-DIRTY
BVSWC	BLOCK VALVE-BALL-FTC-PS WEEKLY-CLEAN

Device ID	Device Description
BVSWD	BLOCK VALVE-BALL-PS WEEKLY-DIRTY
CBC+2	CIRCUIT BREAKER 220V-440V FAIL TO CLOSE
CBC+4	CIRCUIT BREAKER >440V FAIL TO CLOSE
CBC-2	CIRCUIT BREAKER <220 VOLT FAIL TO CLOSE
CBO+2	CIRCUIT BREAKER 200V-440V FAIL TO OPEN
CBO+4	CIRCUIT BREAKER >440V FAIL TO OPEN
CBO-2	CIRCUIT BREAKER <220 VOLT FAIL TO OPEN
CONAX	AUXILIARY CONTACT
CSTPD	COMPRESSOR STOP - DTT
CSTPE	COMPRESSOR STOP – ETT- NOT MONITORED
CSTPM	COMPRESSOR STOP – ETT- MONITORED
CSTRT	COMP – START
CURSW	CURRENT SWITCH
CURTR	CURRENT TRANSMITTER
CVBAC	CONTROL VALVE-BALL-SPR RTN-FTC
CVBAO	CONTROL VALVE-BALL-SPR RTN-FTO
CVBUC	CONTROL VALVE-BUTTERFLY-SPRING RTN-FTC
CVBUO	CONTROL VALVE-BUTTERFLY-SPRING RTN-FTO
CVFS	CONTROL VALVE-FTC-FREQUENT STROKE
CVGLC	GLOBE VALVE-GLOBE-SPRING-RTN-FTC
CVGLO	CONTROL VALVE-GLOBE-SPRING RTN-FTO
CVGTC	CONTROL VALVE-GATE-SPRING RTN-FTC
CVGTO	CONTROL VALVE-GATE-SPRING RTN-FTO
DPTR	DIFFERENTIAL PRESSURE TRANSMITTER
EHCON	ELECTRICAL TO HYDRAULIC CONTROLLER
EMSOL	ELECTROMECHANICAL SPRING OPERATED VALVE
FGDFT	FLAME GAS DETECTOR – FLAME TEMPERATURE
FROD	FLAME ROD
FSCOM	COMBINATION UV/IR FLAME SCANNER
FSIR	INFRARED FLAME SCANNER
FSUV	ULTRAVIOLET FLAME SCANNER
FSWNS	FLOW SWITCH – NORMAL SERVICE
FTDP	FLOW TRANSMITTER – DIFFERENTIAL PRESSURE
FTMAG	FLOW TRANSMITTER – MAGNETIC
FTMFM	FLOW TRANSMITTER – MASS FLOW METER
FTPD	FLOW TRANSMITTER – POSITIVE DISPLACEMENT
FTTM	FLOW TRANSMITTER – TURBINE METER
FTULT	FLOW TRANSMITTER-ULTRASONIC
FTVS	FLOW TRANSMITTER – VORTEX SHEDDING
FUSE	FUSES (<1000V)
HCDCT	HYDROCARBON DETECTOR-CATALYTIC
HCDIR	HYDROCARBON DETECTOR-IR
HNDSW	HAND SWITCH
HVCMC	HYDRAULIC VLV-PS TEST-MONTHLY-CLEAN
HVCMD	HYDRAULIC VLV-PS TEST MONTHLY-DIRTY
HVFCC	HYDRAULIC VLV-SPRING RTN-FTC-CLEAN
HVFCD	HYDRAULIC VLV-SPRING RTN-FTC-DIRTY
HVFOC	HYDRAULIC VLV-SPRING RTN-FTO-CLEAN

Device ID	Device Description
HVFOD	HYDRAULIC VLV-SPRING RTN-FTO-DIRTY
IADR1	INSTRUMENT AIR – DIVERSITY/RECEIVER
IADR2	INSTRUMENT AIR – DIVERSITY/MONITORED RECEIVER
IADVM	INSTRUMENT AIR – COMPRESSOR DIVERSITY
IAMRM	INSTRUMENT AIR – MONITORED RECEIVER
IANDM	INSTRUMENT AIR – NO DIVERSITY
IARCM	INSTRUMENT AIR – WITH RECEIVER
IPCON	I/P CONVERTER
LDMON	LOAD MONITOR WITH ANALOG OUTPUT <50HP
LSVIB	LEVEL SWITCH – VIBRATING
LSWNS	LEVEL SWITCH – NORMAL SERVICE
LTCAP	LEVEL TRANSMITTER – CAPACITANCE
LTDIS	LEVEL TRANSMITTER – DISPLACEMENT
LTDPL	LEVEL TRANSMITTER – LIQUID FILLED DP
LTDPR	LEVEL TRANSMITTER – REMOTE SEALED DP
LTNUC	LEVEL TRANSMITTER – NUCLEAR
LTRLG	LEVEL TRANSMITTER – RADAR LEVEL GAUGE
LTSVG	LEVEL – SERVO GAUGE
LTULT	LEVEL TRANSMITTER – ULTRASONIC
MCNTD	MOTOR CONTACTOR – DTT
MCNTE	MOTOR CONTACTOR – ETT – NOT MONITORED
MCNTM	MOTOR CONTACTOR – ETT – MONITORED
MOVFC	MOTOR OPERATED VALVE-FAIL TO CLOSE
MOVFO	MOTOR OPERATED VALVE - FAIL TO OPEN
PBUTN	PUSH BUTTON
PCONT	PNEUMATIC CONTROLLER
PFTRN	PNEUMATIC FLOW TRANSMITTER
PLTDP	PNEUMATIC LEVEL TRANSMITTER - DIFF PRESS
PLTDS	PNEUMATIC LEVEL TRANSMITTER - DISPLACEMENT
PLTRN	PNEUMATIC LEVEL TRANSMITTER
POSSD	SMART POSITIONER - ON/OFF
POSSM	SMART POSITIONER - CONTINUOUS MODULATING
POSSP	SMART POSITIONER-ON/OFF-MONTHLY PARTIAL TEST
POSSW	POSITION SWITCH
POSTR	POSITION TRANSMITTER
PPOSM	PNEUMATIC POSITIONER-MODULATING
PPOSO	PNEUMATIC POSITIONER-ON/OFF
PPOST	PNEUMATIC POSITIONER - UNSPECIFIED
PPSW	PNEUMATIC PRESSURE SWITCH
PPTRN	PNEUMATIC PRESSURE TRANSMITTER
PRC+2	PROTECTIVE RELAY 220V-440V FAIL TO CLOSE
PRC+4	PROTECTIVE RELAY >440V FAIL TO CLOSE
PRC-2	PROTECTIVE RELAY <220V FAIL TO CLOSE
PRO+2	PROTECTIVE RELAY 220V-440V FAIL TO OPEN
PRO+4	PROTECTIVE RELAY >440V FAIL TO OPEN
PRO-2	PROTECTIVE RELAY <220V FAIL TO OPEN
PRXSW	PROXIMITY SWITCH
PSOV	PNEUMATIC SOLENOID VALVE

Device ID	Device Description
PSTPD	PUMP STOP – DTT
PSTPE	PUMP STOP – ETT- NOT MONITORED
PSTPM	PUMP STOP – ETT- MONITORED
PSTRT	PUMP START
PSWNS	PRESSURE SWITCH - NORMAL SERVICE
PTRAN	PRESSURE TRANSMITTER
PTTRN	PNEUMATIC TEMPERATURE TRANSMITTER
QVDTT	QUICK VENT - DE-ENERGIZING TO TRIP
RCS2	RCS-2002D MODE NO DIAGNOSTICS
RCS2D	RCS-2002D MODE MONTHLY DIAGNOSTICS
RCSH	RCS-1OO1HS MODE NO DIAGNOSTICS
RCSH3	RCS-1001HS – 3 MONTH DIAGNOSTICS
RCSH6	RCS-1001HS – 6 MONTH DIAGNOSTICS
RCSHD	RCS-1OO1HS MODE MONTHLY DIAGNOSTICS
RELFC	RELAY - FAIL TO CLOSE
RELFO	RELAY - FAIL TO OPEN
RELTD	RELAY - TIME DELAY
RPMTR	RPM TRANSMITTER
RTDHS	RTD - HIGH STRESS ENVIRONMENT
RTDLS	RTD - LOW STRESS ENVIRONMENT
RVFCC	RISING STEM-GENERIC-FTC
RVSAD	RISING STEM GENERIC-PST-ANNUAL
RVSBD	RISING STEM GENERIC-PST-BIANNUAL
RVSMD	RISING STEM GENERIC-PST-MONTHLY
RVSQD	RISING STEM GENERIC-PST-QUARTERLY
RVSWD	RISING STEM GENERIC-PST-WEEKLY
SISOL	SIGNAL ISOLATOR
SPDSW	SPEED SWITCH
SVDFS	SOLENOID VALVE DTT FREQUENT STROKE
SVDHW	SOLENOID VALVE DTT HIGH WATTAGE
SVDLW	SOLENOID VALVE DTT LOW WATTAGE
SVENM	SOLENOID VALVE - ETT - NOT MONITORED
SVETM	SOLENOID VALVE - ETT - MONITORED
TAMPN	TRIP AMPLIFIER (NON-PROGRAMMABLE)
TAMPP	TRIP AMPLIFIER (PROGRAMMABLE)
THMHS	THERMOCOUPLE - HIGH STRESS ENVIRONMENT
THMLS	THERMOCOUPLE - LOW STRESS ENVIRONMENT
TSECC	TEMPERATURE SWITCH-ELECTRICAL
TSMCC	TEMPERATURE SWITCH-MECHANICAL
TTRAN	TEMPERATURE TRANSMITTER
TTRHS	TEMPERATURE TRANS/RTD HIGH STRESS
TTRLS	TEMPERATURE TRANS/RTD LOW STRESS
TTTHS	TEMPERATURE TRANS/THERMOCOUPLE HIGH STRESS
TTTLS	TEMPERATURE TRANS/THEROMCOUPLE LOW STRESS
UPSDT	UPS - POWER SUPPLY - DTT
UPSET	UPS - POWER SUPPLY - ETT
VARSD	VARIABLE SPEED DRIVE STOP

SECTION 14 TROUBLESHOOTING GUIDE

PROBLEM	TIP
Error message at initial startup of SIL Solver®. Cannot find file MSVCR70.dll	Due to the various Windows versions, the installer occasionally has difficulty in locating a file required for program operation. On the initial startup, SIL Solver® will display a message related to its inability to locate a file named "MSVCR70.dll." To correct this error, simply use Microsoft Explorer to locate "MSVCR70.dll." Then, COPY this file to the SIL Solver® installation folder. If the default installation location was chosen, the file should be placed under C:\Program Files\SILSOLVER.
Data in protective function sheet keeps showing zero	You are not using exponential format: X.XXE-XX.
Data in datasheet displays zero event though I entered a number	You are not using exponential format: X.XXE-XX.
Changed data in datasheet, but the values in the table did not update	You did not *Click* Recalculate.
Cannot add devices under the input screen for the protective function	You have not selected a device and/or voting architecture
Cannot add devices under the output screen for the protective function	You have not selected a device and/or voting architecture
Cannot add logic solver under the logic screen of the protective function	You have not entered architecture for the logic solver.
Cannot modify the database	You are attempting to edit default data under the protective function screen. This is not permitted.
Message appears "A password required to edit datasheets. Do you know the password?"	This message indicates that you are attempting to modify the default database. This password is not provided to SIL Solver® users to ensure the integrity of the database. You are allowed to add or modify your personal datasheets only.
SILSolver may crash with Windows 7 display in extend mode when using drag to maximize feature.	When configured for extended displays, SIL Solver® is not compatible with the "drag to maximize" operation to maximize the display across the screen in Windows 7. When configured for extended display, users should select the maximize button on the SIL Solver application rather than drag the application to the top of the screen to maximize the display across the monitor.

SECTION 15 END-USER SITE LICENSE AGREEMENT

This End-User License Agreement (the "License") is a legal agreement for the SIS-TECH Applications, LLP's ("SIS-TECH Applications") software product, which includes computer software and may include associated media, printed materials, "online" or electronic documentation, databases, calculation algorithms, and related materials known collectively herein as "SIL Solver®."

BY INSTALLING, COPYING OR OTHERWISE USING SIL SOLVER®, THE CONSUMER ("End-User") AGREES TO BE BOUND BY THE TERMS OF THIS LICENSE. The End-User must indicate his/her agreement to be bound by the terms of the License by pressing the "I ACCEPT" button on SIL Solver® installation program, or else End-User will not be able to install SIL Solver®. If the End-User does not agree to the terms of the License, he/she may not install or use SIL Solver®. End-User may, within 30 days of initial purchase of a copy of SIL Solver®, return the entire copy of SIL Solver® (including all computer media, packaging and documentation) to SIS-TECH Applications or to a SIS-TECH Applications' authorized representative for a refund of the amount paid for SIL Solver®, in which event End-User rights under this License are immediately terminated.

End-User must represent and warrant to SIS-TECH Applications that he/she has the capacity and authority to enter into this License on his/her own behalf, as well as on behalf of the owner of the computer on which SIL Solver® is being installed. For the purposes of this License, the owner of the computer is the individual or entity that has legal title to the computer or that has the possessory interest in the computer if it is leased or loaned by the actual title owner.

Therefore, subject to the following terms and conditions, SIS-TECH Applications grants to End User a non-transferable (except as otherwise provided herein), non-exclusive license ("License") to use SIL Solver® only as indicated below.

ARTICLE 1: GENERAL COPYING RESTRICTIONS. End-User shall make copies of SIL Solver® only to the extent necessary to utilize SIL Solver®. Unauthorized copying of SIL Solver® (including any modification of SIL Solver® or merger with other applications or software) and the acquisition and use of unauthorized copies of SIL Solver® is expressly prohibited by law, and may be subject to both severe criminal and civil penalties for which End User may be liable for fines, damages, and attorney's fees. Violators will be prosecuted to the maximum extent possible. SIS-TECH Applications has the right to terminate this License and to take legal action if the terms of this License are violated.

ARTICLE 2: ARCHIVAL COPIES. End-User may make up to two (2) archival back-up copies of SIL Solver® diskettes, but only if such copies are for End-User's personal use within the scope of this License.

ARTICLE 3: PROPRIETARY RIGHT OF SIL SOLVER®. The SIS-TECH Applications logo, software, manuals, documentation, and other support materials comprising or supplied with SIL Solver® are owned by SIS-TECH Applications as trade secrets and/or proprietary information, and except as set forth herein, shall not be copied, lent, transferred, or otherwise disclosed without the

prior written consent of SIS-TECH Applications. Except to the extent that such restriction is unenforceable under local law, End-User may not reverse engineer, decompile, or disassemble SIL Solver®, which is licensed as a single product, and its component parts may not be separated for use on more than one computer. You may not modify, amend, or create derivative works of SIL Solver®.

ARTICLE 4: CUSTOMER SERVICE. End-User shall obtain customer service directly from SIS-TECH Applications or its authorized distributor unless such service becomes unavailable.

ARTICLE 5: TERMINATION OF END USER LICENSE. If any of the terms and conditions of this License is broken by End-User, in addition to all other legal rights and remedies, SIS-TECH Applications may terminate this License. Otherwise, the license granted herein shall be perpetual. Upon termination, End-User shall use its reasonable efforts to return SIL Solver® to SIS-TECH Applications, including copies thereof, whether modified, merged, or included with other software. SIS-TECH Applications understands that End-User's backup and archival and storage procedures may create copies of the SIL Solver® that cannot reasonably be removed from archival storage. The provisions of this License, which protect the proprietary rights of SIS-TECH Applications, shall continue in force after termination for a term of three (3) years.

ARTICLE 6: GOVERNING LAW. When entered into in the United States, this License shall be interpreted in accordance with the laws of the State of Texas. Otherwise, this License will be interpreted in accordance with the laws of the United States or such other law as may be required to protect the legitimate interests of SIS-TECH Applications.

ARTICLE 7: ASSIGNABILITY AND SUBLICENSES. End-User shall have no authority under this License to assign or sublicense the rights granted hereunder, except that End-User may assign and/or sublicense this License to any entity that acquires substantially all of the assets to which the License pertains. Except as otherwise provided herein, any assignment of the License is void. Notwithstanding the foregoing, SIL Solver® may be incorporated as a component of a larger system of software for resale by another software manufacturer. In the event of such resale under this Article 7, the terms and conditions of this License which protect SIL Solver® shall be incorporated in documents governing resale in such fashion as shall be necessary to protect the interests of SIS-TECH Applications hereunder. For purposes of this License, any such original software manufacturer shall be considered an End-User bound hereunder.

ARTICLE 8: FEE. The license fee due under this License shall be comprised of the price paid by End-User for SIL Solver®. This license fee shall entitle End-User to technical support and upgrades for a term of one (1) -year from the point of shipment of SIL Solver® to End-User. At the end of one (1)–year, End-User may extend technical support and upgrades on an annual basis for an additional fee.

ARTICLE 9: COMPLETE AGREEMENT. This License constitutes the entire agreement between SIS-TECH Applications and End-User.

ARTICLE 10: EXPORT REGULATIONS. End-User agrees that it will not, directly or indirectly, export or transmit any SIS-TECH Applications products covered by this License to any country to which such export or transmission is restricted by applicable regulations or statutes of the United

States or any agency thereof, without the prior written consent of the Office of Export Administration of the U.S. Department of Commerce, Washington, D.C. 20230 and of any other required governmental agency.

ARTICLE 11: SEVERABILITY. In the event that any provision hereof shall violate or be unenforceable under any applicable statute, ordinance, or rule of law of any jurisdiction, such provision shall be deemed null and void to the extent of such violation or unenforceability without invalidating such provision in any other jurisdiction and without invalidating any other provision hereof.

SECTION 16 DISCLAIMER OF SOFTWARE WARRANTIES AND LIABILITIES

1. SIS-TECH APPLICATIONS' SIL SOLVER® IS DISTRIBUTED AND LICENSED "AS IS." ALL WARRANTIES, EITHER EXPRESSED OR IMPLIED, ARE DISCLAIMED AS TO QUALITY, PERFORMANCE, OR MERCHANTABILITY, WHETHER EXPRESSED, IMPLIED OR STATUTORY, HIDDEN DEFECTS, OR FITNESS FOR ANY PARTICULAR PURPOSE. SIS-TECH APPLICATIONS MAKES NO REPRESENTATIONS ABOUT THE SUITABILITY OF THE INFORMATION CONTAINED IN THE DOCUMENTS AND RELATED GRAPHICS PUBLISHED AS PART OF SIL SOLVER® FOR ANY PURPOSE. END USER BEARS THE ENTIRE RISK RELATING TO THE ITS USE OF THE PRODUCT.

IN NO EVENT WILL SIS-TECH APPLICATIONS BE LIABLE FOR ANY SPECIAL, DIRECT, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OR ANY DAMAGES WHATSOEVER RESULTING FROM THE LOSS OF USE, DATA OR PROFITS, WHETHER IN AN ACTION OF CONTRACT, NEGLIGENCE OR OTHER TORTUOUS ACTION, ARISING OUT OF OR IN CONNECTION WITH THE USE OR PERFORMANCE OF SIL SOLVER®. SIS-TECH APPLICATIONS DOES NOT WARRANT THAT THE OPERATION OF SIL SOLVER® WILL BE UNINTERRUPTED OR ERROR FREE.

HEREIN. SIS-TECH APPLICATIONS AND/OR ITS DESIGNATED DISTRIBUTORS MAY MAKE IMPROVEMENTS AND/OR CHANGES IN SIL SOLVER® DESCRIBED HEREIN AT ANY TIME.

IN ANY CASE, SIS-TECH APPLICATIONS' ENTIRE LIABILITY UNDER ANY PROVISION OF THIS LICENSE SHALL BE LIMITED TO THE GREATER OF THE AMOUNT ACTUALLY PAID FOR SIL SOLVER® OR US$50.00.

2. Limited Warranty. SIS-TECH Applications warrants the diskettes to be free of defects in materials and workmanship under normal use for ninety (90) days after purchase. During the 90-day period, a defective diskette may be returned upon authorization by SIS-TECH Applications to SIS-TECH Applications or an authorized SIS-TECH Applications distributor identified by SIS-TECH Applications and it will be replaced without charge. Replacement of a diskette is the sole remedy in the event of a defect. This warranty gives specific legal rights. There may be other rights, which vary from state to state.

Notwithstanding anything to the contrary herein, SIS-TECH Applications warrants that End-User's use of the SIL Solver® will not infringe any intellectual property rights of third parties. Notwithstanding anything to the contrary herein, if any suit, action, or claim is made by a third party that End-User's use of the SIL Solver® constitutes infringement of any intellectual property right owned by a third party, and the SIL Solver® is used by End-User in accordance with this License, then SIS-TECH Applications will indemnify and hold End-User harmless, with respect to any such action, claim, or suit, and will undertake or have undertaken, at its expense, the legal defense or negotiations for settlement of such suit or action.

The limited warrant related to defective diskettes is void if failure of SIL Solver® has resulted from accident, abuse, misapplication, use of SIL Solver® other than as described in the documentation issued by SIS-TECH Applications, use of SIL Solver® in combination with other software products that are not described as being compatible in the documentation issued by SIS-TECH Applications, or the End-User breaches the terms of this License.

End-User's exclusive remedy for any breach of the Limited Warranty related to defective diskettes is for End-User to give notice of the breach to SIS-TECH Applications, a copy of the purchase order, and a description of the alleged breach, and then, at SIS-TECH Applications' option, SIS-TECH Applications shall either: (a) return the price End-User paid for SIL Solver® (at which time End-User rights under this License are deemed terminated); or (b) repair or replace SIL Solver®. The Limited Warranty period for any replacement of defective diskettes will be extended for the remainder of the original warranty period or thirty (30) days after the replacement product is delivered to End-User, whichever is longer. End-User remedies described in this paragraph are exclusive remedies related to defective diskettes, and shall not be deemed to fail of their essential purpose so long as SIS-TECH Applications is willing to repair or replace SIL Solver® or return the price that was paid for SIL Solver®.

SECTION 17 MAINTENANCE AGREEMENT

1. ADDRESSES AND COMMUNICATIONS

SIS-TECH Applications, LLP
12621 Featherwood, Suite 120
Houston, TX 77034
Tel: 281-922-8324
Email: info@SIS-TECH.com

2. DEFINITIONS

Agreement	Terms and Conditions of the SIS-TECH Applications Maintenance and Priority Support Program.
Discrepancy	A defect in the distribution media or a material difference between the operation of the Maintained Software and the description of the operation of the Maintained Software as provided in current end-user documentation provided for the Maintained Software by SIS-TECH Applications.
Error	A demonstrable instance of incorrect operation of the software that impacts Licensee's ability to use the functionality described in the documentation.
Error Correction	A solution generated in the form of a patch or software version that corrects the error without causing additional problems or a correction or clarification of the software documentation.
Maintained Software	The registered copy of the SIS-TECH Applications' SIL Solver® Product. If the Licensee of the Maintained Software is a corporation or other entity, the "user" as used in this Agreement refers to that corporation or entity.
Patch	A fix to a program error
Support Contact	The person authorized to communicate with SIS-TECH Applications to request and receive the Maintenance Services. The Support Contact may be an end user, an employee, or an agent or consultant of the company. The Support Contact should be knowledgeable about how the Maintained Software is being used and about the computer/operating system on which the Maintained Software is executed.

3. APPLICABILITY OF SIS-TECH APPLICATIONS SOFTWARE LICENSE AGREEMENT

Please read these terms and conditions carefully as they constitute the entirety of the customer's agreement relating to the SIS-TECH Applications corporation. This Agreement and all subject software, documentation, and media are subject to the terms and conditions of the SIS-TECH Applications End-User Software License Agreement that exists between the end-user and SIS-TECH Applications, including the Disclaimer of Warranty and Limitation of Liability.

4. MAJOR UPGRADE RELEASE

The SIS-TECH Applications release of a major upgrade of the Maintained Software will contain a new set of software and may contain replacements for all or some of the existing documentation set. There is no pre-determined timeframe for major upgrade release. If this Maintenance Agreement is still in effect, SIS-TECH Applications will provide the major upgrade without additional charge. If the supported Maintained Software is no longer covered by a Maintenance Agreement, the end-user will be required to purchase the desired upgrade.

5. FIXES TO REPORTED DISCREPANCIES

In response to a confirmed Discrepancy in the Maintained Software, SIS-TECH Applications shall use reasonable efforts to provide, on an as-needed basis and at its sole discretion, a Correction in the form of a workaround, support release, update disk, immediate correction disk or electronic transfer equivalent, component replacement, patch, major upgrade release, or other suitable form. When provided under this Agreement, such Correction will be provided without additional charge. SIS-TECH Applications reserves the right to discontinue Maintenance Services without notice on a past workaround, support release, update disk, immediate correction disk, or electronic transfer equivalent, component replacement, patch, or other form of Correction after a subsequent major upgrade release, support release, or update disk or electronic transfer equivalent containing a Correction of the Discrepancy is available.

6. ACCESS TO SIS-TECH APPLICATIONS PRODUCT SUPPORT STAFF

SIS-TECH Applications Product Support Staff are available via email to give the end-user assistance and advice on SIS-TECH Applications products or to receive Discrepancy reports, during normal working hours at our main office listed above. We may allocate the end-user support request based on availability of staff and experience to a named individual at our discretion. If the Product Support Staff are not available for immediate response, they will respond as soon as reasonably possible. The end-user may also use regular or overnight delivery services or telephone once assigned to a named individual to communicate with our Product Support Staff.

7. SOFTWARE NOT COVERED BY THIS AGREEMENT

Altered or modified Maintained Software.

Any combination of Maintained Software and other software not covered by this Agreement.

A Release of Maintained Software for which Maintenance Services has been discontinued.

Discrepancies caused by end-user negligence or fault.

Discrepancies resulting from hardware malfunction.

Discrepancies that do not significantly impair or affect the operation of the Maintained Software.

Maintained Software used on a computer or operating system other than that specified by the end-user and accepted by SIS-TECH Applications on the Maintenance Registration Form.

8. END-USER RESPONSIBILITIES

End-user agrees to report all suspected Discrepancies through the Support Contact to the SIS-TECH Applications Product Support Staff. Reports will include a description sufficient for SIS-TECH Applications Product Support Staff to reproduce the suspected Discrepancy. Failure to provide an adequate description may cause delays in responding to the Discrepancy.

End-user agrees to use reasonable efforts to assist SIS-TECH Applications in its efforts to find Corrections to confirmed Discrepancies reported by the end-user. End-user agrees to install and use the newest release or change disk for the Maintained Software sent to end-user by SIS-TECH Applications within thirty (30) days of receipt. In all contacts with SIS-TECH Applications Product Support, end-user agrees to provide the product serial number given to end-user by SIS-TECH Applications, along with end-user name and the name and address of the company or Support Contact contracted for the maintenance.

9. ADDITIONAL SERVICES AND CHARGES

SIS-TECH Applications may offer additional services such as training and consulting under separate agreements. Such services can be performed at a site and time mutually agreeable. These services are normally charged on a time-and-materials basis including expenses and are subject to availability.

SIS-TECH Applications reserves the right to charge for services outside of the range of normal support services. Services considered outside of the range of normal support services are (1) debugging application coding errors in a customer's application; (2) debugging problems in non-SIS-TECH Applications supported products or in combinations of SIS-TECH Applications supported and non-supported products where the problem occurs in the non-SIS-TECH Applications product; and (3) other cases where it is judged highly likely that the suspected problem is not the responsibility of SIS-TECH Applications Software.

When a situation occurs where a reported problem is likely to fall outside of the range of supported services, end-user will be advised of the potential of incurring charges to have SIS-TECH Applications work on the problem. An estimate of the cost of the additional services will be prepared and delivered to the end-user, by appropriate means, for approval and agreement. Should SIS-TECH Applications determine that the problem is indeed caused by a supported product, no charges will be incurred. However, if it is proven that the problem is not the responsibility of SIS-TECH Applications, the end-user will be charged for the time spent at the rates specified in the estimate/service agreement. Should the end-user not agree that the requested service falls out of the bounds of supported services, SIS-TECH Applications sales

person will be your representative at SIS-TECH Applications to mediate the issue for you. SIS-TECH Applications, upon prior notice, reserves the right to charge for unusual or excessive support person time or telephone expenses in connection with the Maintenance Services provided under this Agreement. Reasonable shipping, handling, media, and user documentation charges in connection with the provision of the upgrades and service shall be payable by the end-user.

10. PAYMENT

The annual Maintenance Fee must be paid prior to expiration of the current Maintenance Agreement period. The Maintenance Fee is as determined in the SIS-TECH Applications Software Price List as of the Maintenance Expiration date. SIS-TECH Applications is not responsible for notifying the end-user of the impending Maintenance Agreement Expiration Date. It is the end-user's responsibility to exercise the option to renew maintenance prior to the Maintenance Expiration Date. To register for a further year of maintenance under this Agreement, simply pay the current maintenance fee prior to the Maintenance Expiration Date and the end-user will continue to receive maintenance services. If the Maintenance Agreement expires, the end-user must purchase an upgrade to the current version of the product in order to register for a new maintenance period. All extended maintenance agreements are for a minimum term of one year and are non-refundable. The term of this Agreement will commence on the date of purchase and shall continue for a period of one calendar year.

11. TERMS AND TERMINATION

This agreement will be effective and services provided hereunder will commence as of the completion of SIS-TECH Applications 1) acceptance of payment of the appropriate Maintenance Fee or initial product purchase with Maintenance; 2) registration of this Agreement on receipt of the Maintenance Registration Form; and 3) ascertaining proof of proper license for the Software designated on the Maintenance Registration Form. The services provided hereunder will cease on the last business day of the month of the Maintenance Period that is one year from the commencement of services under this Agreement. The Maintenance Period commences as determined by SIS-TECH Applications as of the date of product purchase with maintenance, maintenance renewal, or maintenance commencement, as appropriate. SIS-TECH Applications may change the Maintenance Fee without notice, which fee shall become effective upon renewal of this Agreement. This Agreement will remain in effect unless terminated upon fifteen (15) days written notice by either party by reason of any violation of the terms and conditions of this Agreement. The extended maintenance agreement entitles the holder to the following benefits for the period of the agreement:

The option to upgrade to the latest release version available of the product(s) the maintenance agreement Covers without additional charge. Such upgrades will be subject to the terms and conditions of the license Agreement of the upgraded version of the product. Upgrades only apply to new versions of the product on the same platform as the licensed software covered by the maintenance agreement.

Access to extended email technical support by a Support Contact or End-user for the duration of the agreement, subject to provisions listed below.

SIS-TECH Applications will undertake commercially reasonable efforts to provide technical assistance under this agreement, but cannot guarantee that any or all of customer's inquiries will be solved, that any response will be error-free, or that all response time goals will be met. SIS-TECH Applications, from time to time, discontinues products and versions, discontinues support of selected products and versions, or discontinues or modifies any or all support services. The services provided are "as-is" without warranty of any kind. SIS-TECH Applications does not warrant that the services provided will meet customer's requirements, that the services will result in error-free solutions, or that defects in any licensed Software can be corrected. Furthermore, SIS-TECH Applications does not warrant or make any representations regarding the use or the results of the services in terms of correctness, accuracy, reliability, or otherwise.

No oral or written information or advice given by SIS-TECH Applications or its authorized representatives shall create a warranty or in any way increase the scope of this warranty. To the maximum extent permitted by applicable law, SIS-TECH Applications further disclaims all warranties, including without limitation any implied warranties of merchantability, fitness for a particular purpose, title and non-infringement. The entire risk arising out of the use or performance of the services remains with customer. To the maximum extent permitted by applicable law, in no event shall SIS-TECH Applications or its affiliates be liable for any consequential, incidental, direct, indirect, special, punitive, or other damages whatsoever (including, without limitation, damages for loss of business profits, business interruption, loss of business information, or other pecuniary loss) arising as a result of providing services or the use of or inability to use the services, even if SIS-TECH Applications has been advised of the possibility of such damages. Because some states or jurisdictions do not allow the exclusion or limitation of liability for consequential or incidental damages, the above limitation may not apply in certain circumstances. Notwithstanding anything contained herein, in no event shall SIS-TECH Applications be liable to customer for any claim in tort, contract, equity, or otherwise arising in connection with this agreement exceeding in the aggregate the amount paid for services. SIS-TECH Applications grants customer a non-exclusive license to use the support given hereunder (and any information and other proprietary material included therein) to the extent such use would be permitted in the SIS-TECH Applications End-User License Agreement that applies to the SIS-TECH Applications product(s) to which extended maintenance pertains. This is the full and final agreement between the customer and SIS-TECH Applications relating to extended maintenance and supersedes any promises, representations or agreements relating to the subject of this agreement, including without limitations, any agreements offered by any other persons. The acceptance of any Purchase Order placed by customer is expressly made conditional on customer's assent to the terms set forth herein, and not those contained in customer's purchase order or any other business form. SIS-TECH Applications reserves the right to withdraw maintenance services on any or all Maintained Software or other products, and to alter the prices, terms, and conditions of the Maintenance Program, in advance of any maintenance renewal. Any such withdrawal or alterations will amend the Maintenance Program between the end-user and SIS-TECH Applications as of the next renewal date.

12. MISCELLANEOUS

The end-user may not assign this Agreement to a third party without the prior written consent of SIS-TECH Applications. This Agreement and the SIS-TECH Applications End User Software License Agreement shall be the only Agreements between SIS-TECH Applications and the end-user with respect to the Maintained Software. These agreements cannot be modified except in

writing and with the approval of both parties. These Agreements supersede all prior agreements, oral or written, relating to the Maintained Software. The laws of the state of Texas shall govern the validity of these agreements, the construction of their terms, and the interpretation of the rights and duties of the parties.

APPENDIX 1 INSTALLATION FUNDAMENTALS

This section provides hardware, software, and security requirements and installation instructions. It contains the following sections:

Hardware and Software Requirements

Installing SIL Solver®

The remaining sections of this guide describe SIL Solver® and how you can use it to analyze components, subsystems, and PIFs.

Hardware, Software And Security Requirements

SIL Solver® has the following hardware and software requirements:

- A Microsoft or Mac Parallels operating system personal computer, 64MB of memory recommended
- Microsoft Windows 7, 2000, NT, Millennium, or XP. Mac OS X 10.6 Snow Leopard or OS X 10.7 Lion
- Full administrative rights during installation. Read, write, and modify rights on the default folders are required during normal use of SIL Solver®.

Installation of SIL Solver®

SIL Solver® is compatible with the install and uninstall utility included in Microsoft Windows or Mac Parallels operating systems. The default program directory is C:\Program Files\SILSolver. The installation directory may be changed during the software installation.

SIL Solver® creates two folders on the "C" drive. These folders are C:\SILSolver_projects and C:\SILSolver_CR_Dbf. C:\SILSolver_projects is the default folder for project created. This folder can be moved or multiples of project's folders can be created.

C:\SILSolver_CR_Dbf contains the Crystal Reports needed to print reports, SIL Solver® Guide, and SIL Solver® Version Changes.

These folders can NOT be moved. The C:\SILSolver_CR_Dbf contains subfolders:

- SIL_Data contains the SIL Solver® device data tables.
- Program_Tables contains the Crystal Reports temporary databases are created so read/write, and modify rights is essential for the correct operation of SIL Solver®.

- Share_Data contains the device data tables exported for sharing.

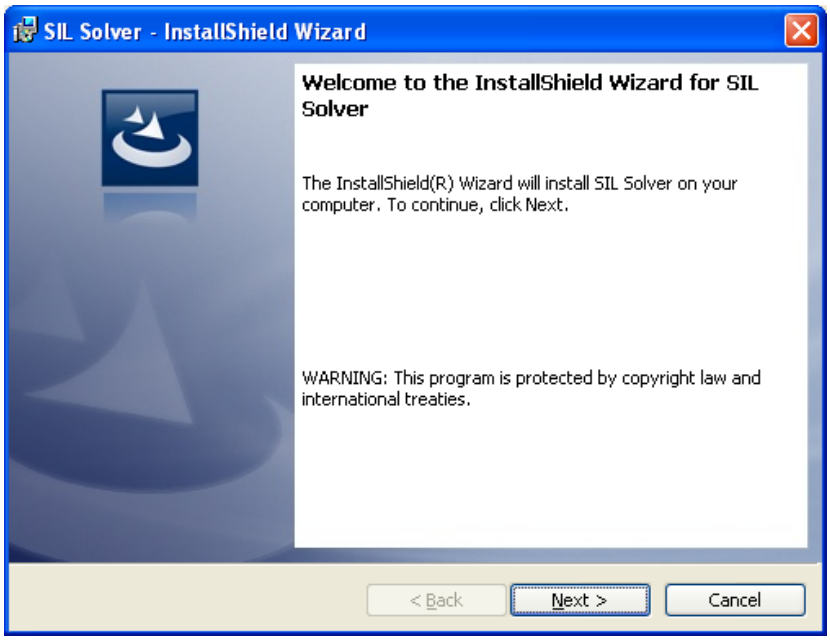
Although the specific steps for installing SIL Solver® may vary depending on the type of installation that is performed, the installation should follow these same general steps.

WARNINGS TO READ BEFORE YOU BEGIN

1. Read all instructions carefully.
2. Close all programs prior to installation.
3. Prior to installing the program, make sure that you have the necessary administrative rights to do so.

Download the Setup.exe from the file sharing link. Navigate to the download save location and double click the setup.exe file. The SIL Solver® install shield wizard will open. *Click* the "next" button to advance through the screens.

The welcome screen for the Install Shield Wizard.



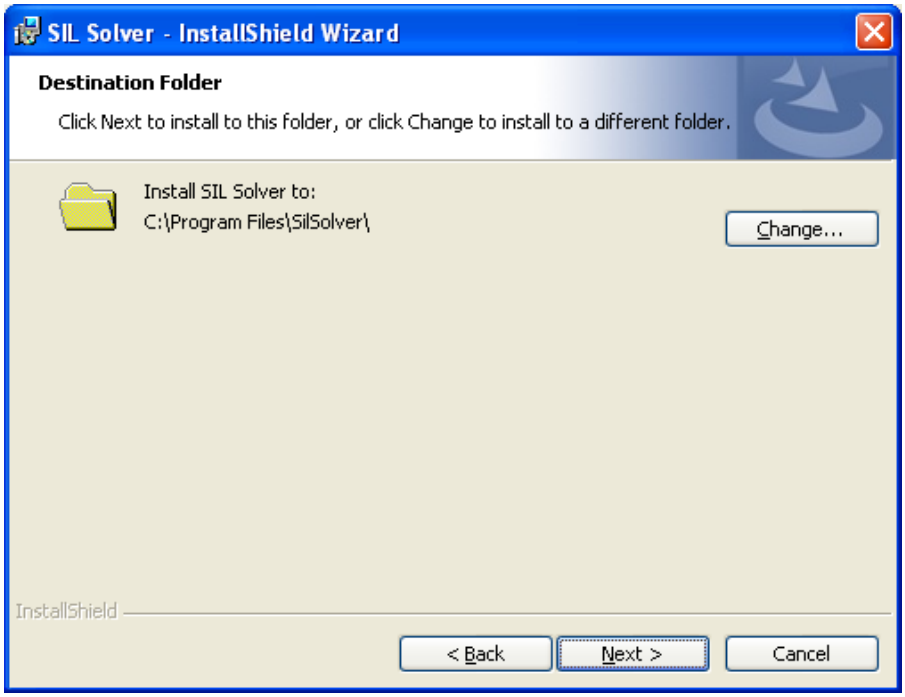
Appendix 1. 1 Installation wizard welcome screen

Read the end-user license agreement carefully. The end-user license is provided in "End-User Site License Agreement" section for your convenience. If you accept the terms, check

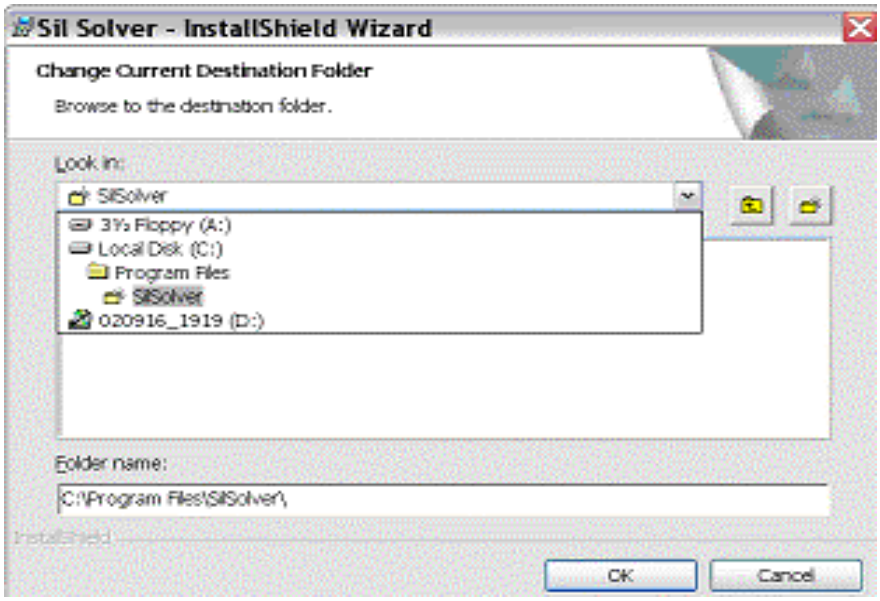
the “I accept the terms in the license agreement. If you do not accept the terms, SIL Solver® will not install.

Appendix 1. 2 End-User License Agreement

The installation default location is C:\Program Files\SILSolver. The installation location can be changed to any designated location by *Click*ing Change… You can select any destination location. Warning: Problems have occurred with mirrored drives. Some SIL Solver® features, such as rename and delete project, have not work properly when using a mirrored drive.

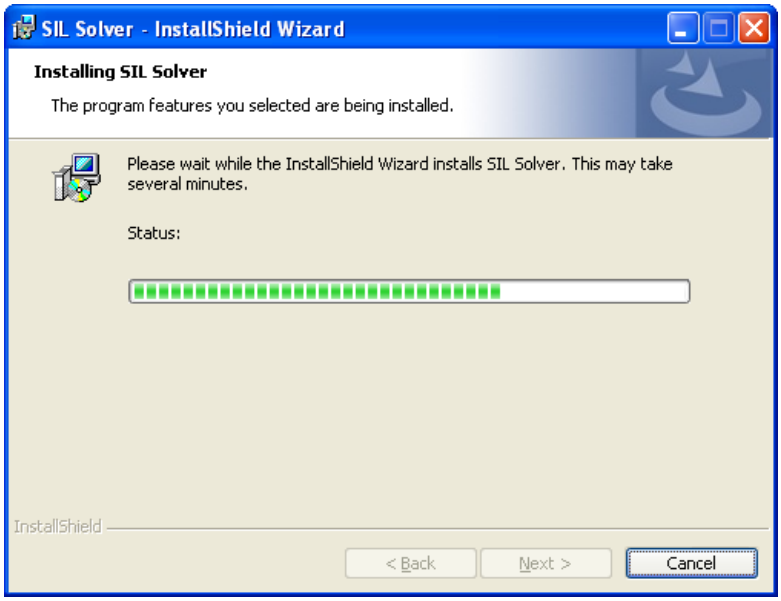


Appendix 1. 3 Install wizard destination folder

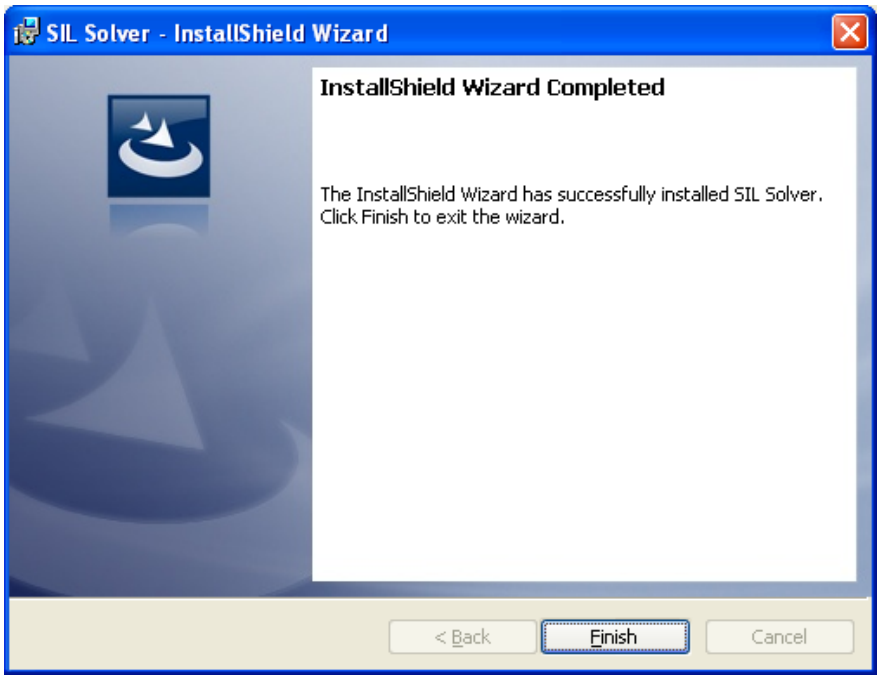


Appendix 1. 4 Changing the destination folder

Once the destination folder is selected, the software installation will commence.



Appendix 1. 5 Installation is occurring



Appendix 1. 6 Install wizard is complete

During installation, on some systems, the installer will display a dimmed CANCEL pop-up screen for approximately 60 seconds. During this period, the installer is verifying the registry. This action is considered normal and CANCEL should not be selected unless there are other indications that there are problems with the installation.

Windows 7 only, additional steps

On the root of the local C drive SIL Solver® 6.0 creates two folders: “C:\SILSolver_CR_Dbf” and “C:\SILSolver_Projects” as shown on Figure 1. For to SIL Solver® 6.0 to function properly, a SIL Solver ® users must have Full permission to these two folders. Instructions are shown for Windows 7 OS.

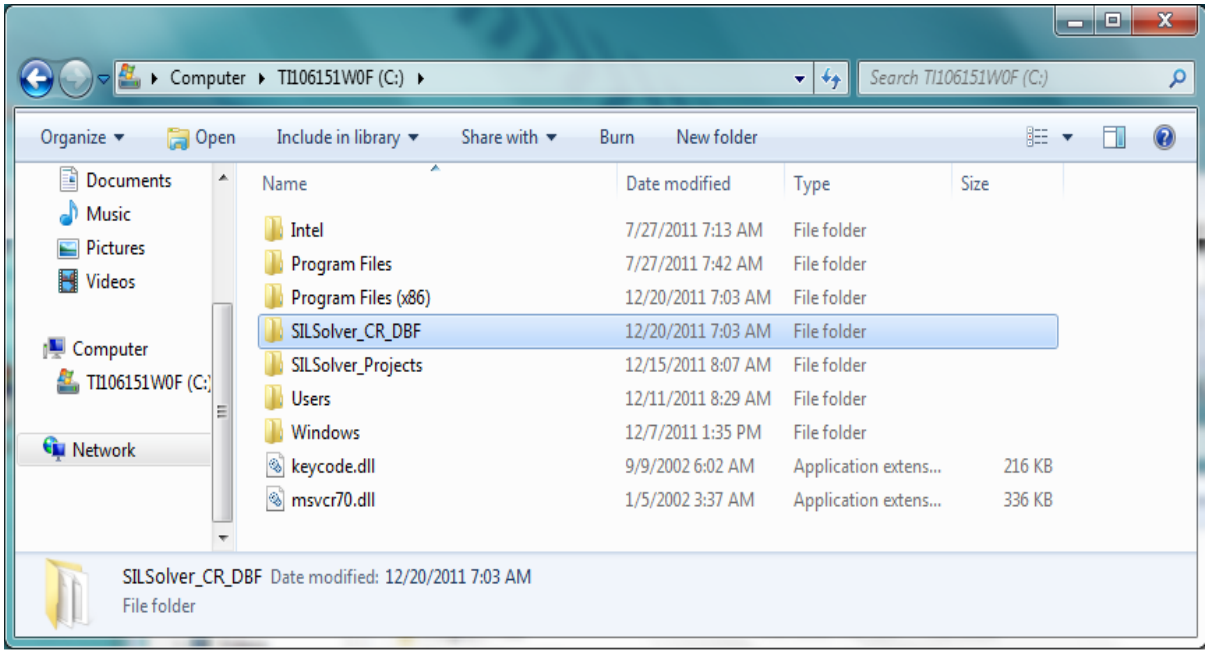


Figure 1 Windows Explorer View of SIL Solver® Working Tables' folders

You can view and change security permissions for folders by completing the following steps:

1. In Windows Explorer, *right-click* the folder you want to work with ("C:\SILSolver_CR_Dbf" or "C:\SILSolver_Projects").

2. From the pop-up menu, select Properties, and then in the Properties dialog box click the Security tab, as shown on Figure 2.

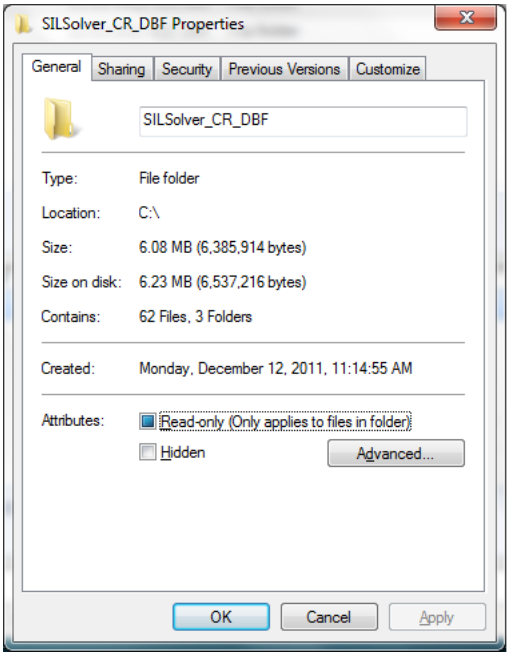


Figure 2 View of Folder after Installation. Note: The Read-only attribute.

3. *Click* Advanced, and then *click* the Security/Permission tab, as shown on Figure 3.

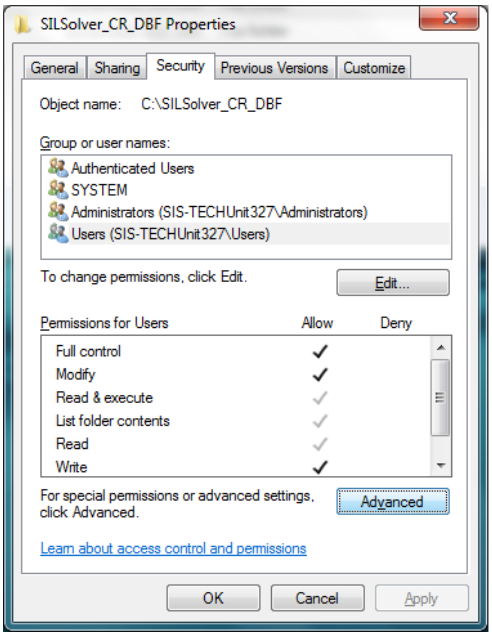


Figure 3 Security/Permissions for User

4. *Click* the User group, and then *click* the Change Permission button, as shown in Figure 4.

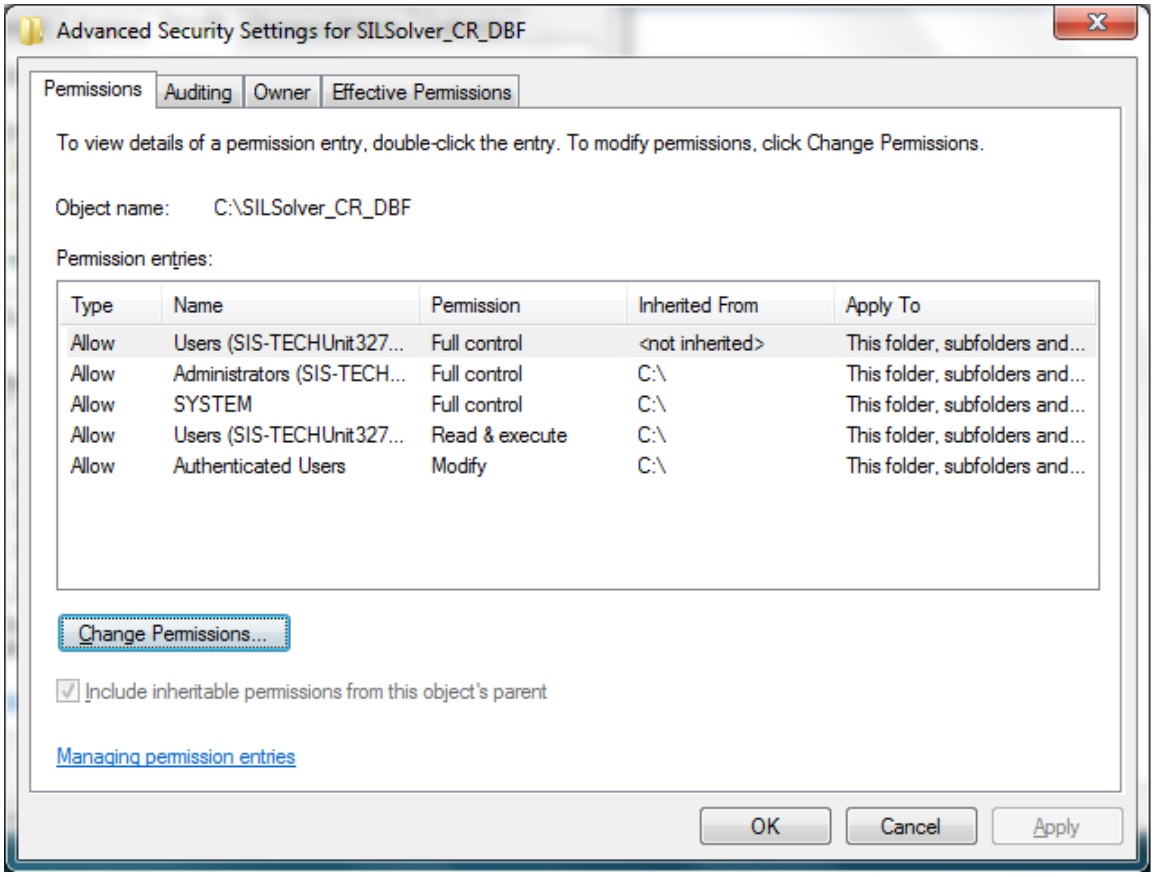


Figure 4 Permissions Changed.

5. From the Object dialog box, Select the Name of the User or User Group, select from the dropdown Apply list “This Folder, subfolders and files” and then select the Allow full control Checkbox.

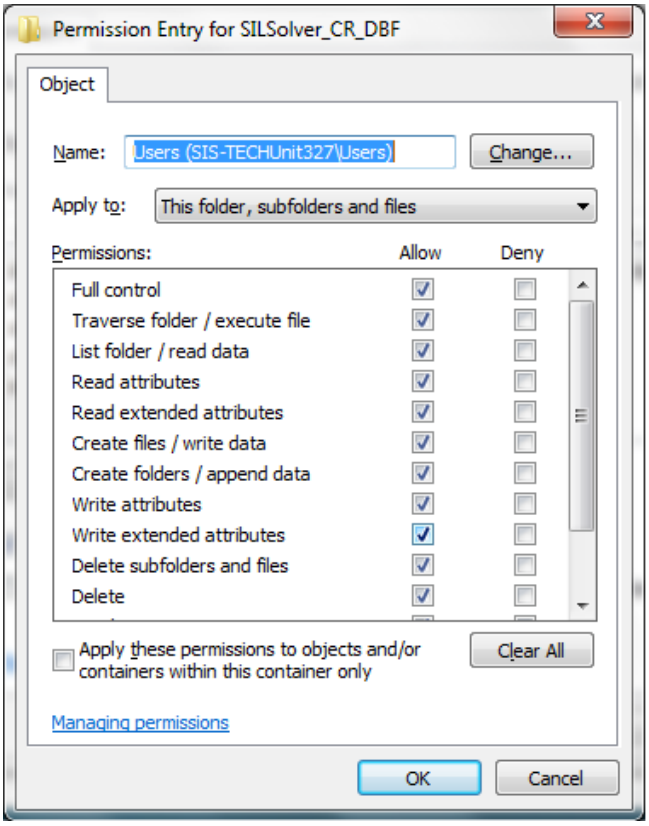


Figure 5 Apply Permission

6. *Click* OK, and then *click* Apply and OK on the last two screens that remained open.

Note: Repeat the Steps 1 – 6 for the second folder.