SIL Solver® Enterprise
Rev 1.2.0
User Instructions

SIS-TECH Solutions, LP

We're Proven-in-Use®

Welcome

- Welcome to SIL Solver® Enterprise.
- This presentation is sectioned to make it easier to navigate. You can collapse the slides to the sections using the tool bar.

- **If you need assistance or would like to provide us with feedback, contact:**
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SIS TECH

SIL Solver®

We are Proven in Use

- More than 100 companies have chosen SIL Solver® for their functional safety verification since 2002

We Build upon Field Experience

- The built-in SIL Solver® database uses field failure data as a basis, reflecting real-world device performance

We are Internationally Recognized

- SIL Solver® uses internationally recognized methods for PFD and STR calculation
- SIL Solver® is used by companies worldwide

User Instructions
Table of Contents

1. LOGGING IN

- Licensing
- Assigning username and password for new user
- Logging in

Licensing

- SIL Solver® is licensed software
  - Each enterprise license includes one administrator account and two user licenses
  - Additional user licenses can be purchased

- To request a quote for a new license, contact SIS-TECH at:

  http://sis-tech.com/applications/sil-solver

Assigning username and password to new user

- Assignment/re-assignment of usernames and passwords is performed through the administrator account of the purchasing company

Logging In:
User Name and Password

Purchasing companies will have their own server locations

For training classes, in any web browser go to, http://silsolver.sis-tech2.com/

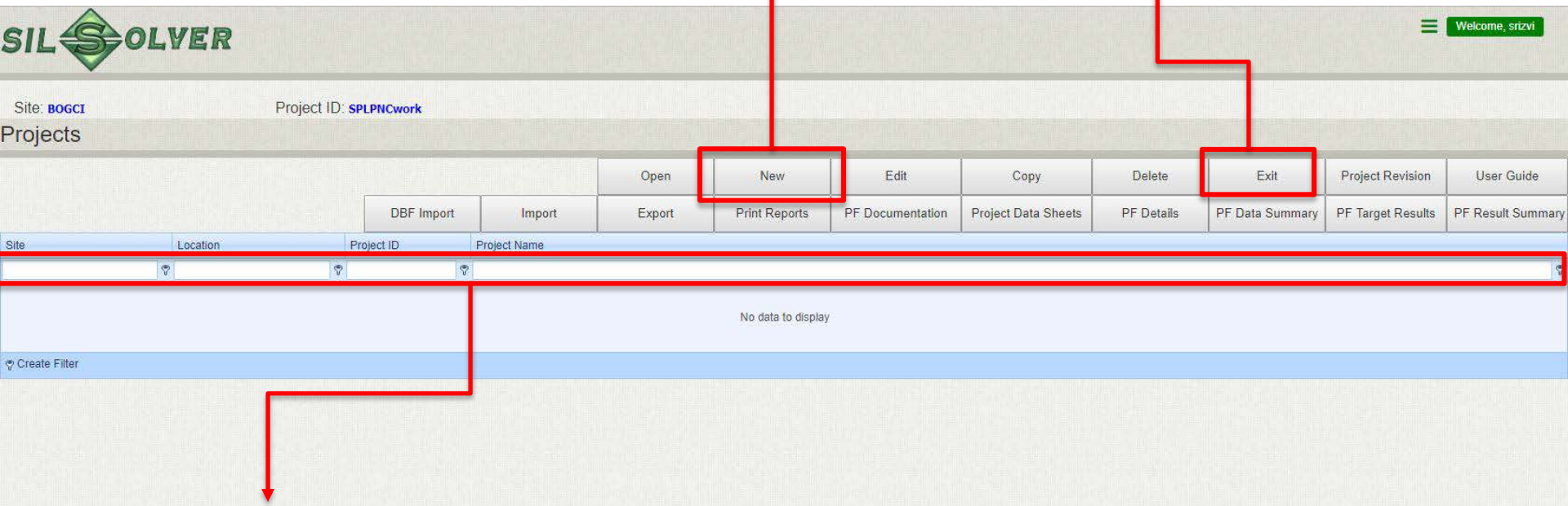
Log in with your assigned User name and Password

2. CREATING A NEW PROJECT

- Setting up the project information
- Creating a safety function
- Copying a safety function
- Editing a safety function

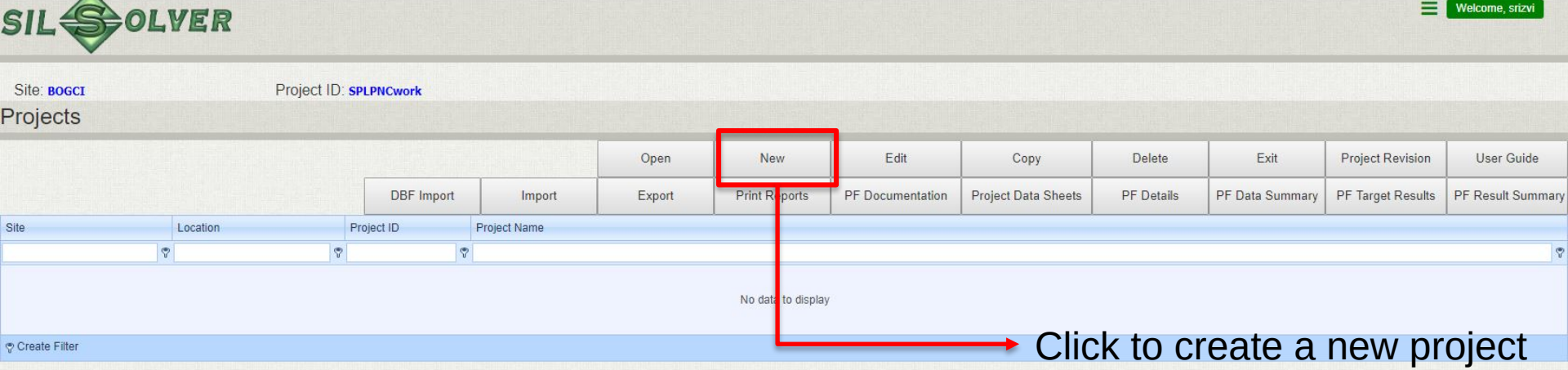
Starting a new project

Exit the software



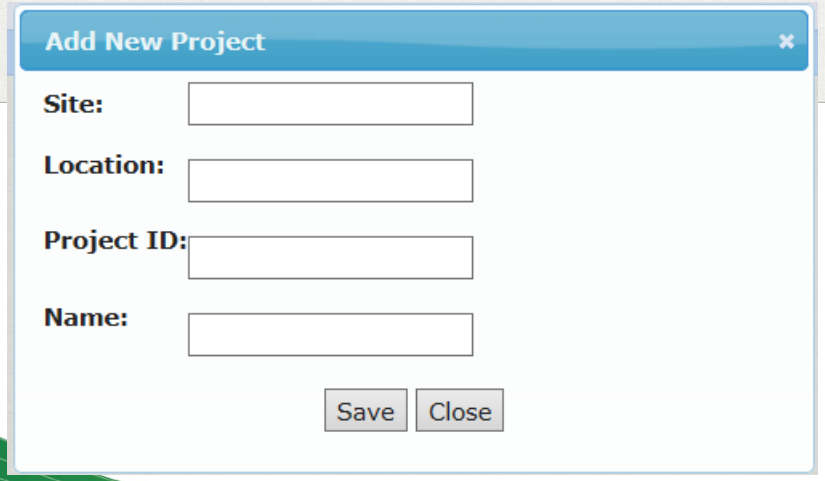
Project List

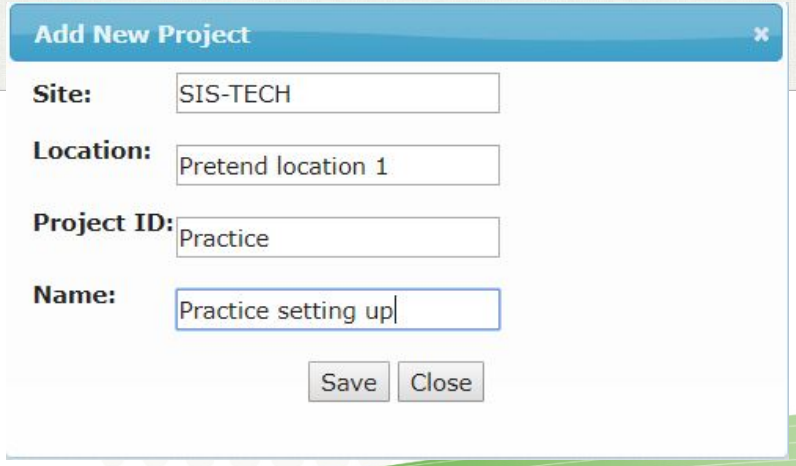
Filters may be useful to users with long project lists



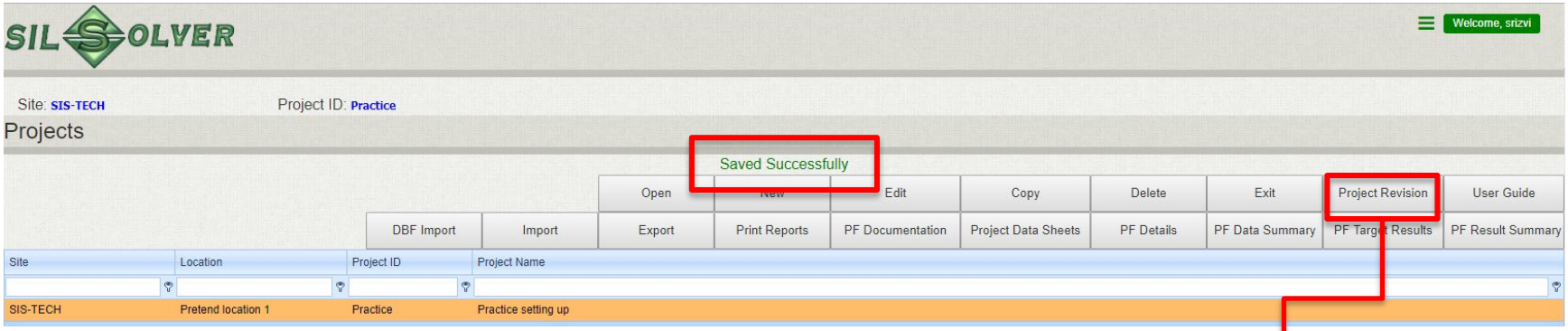
Click to create a new project

The window below pops up, type in relevant information and click “Save”

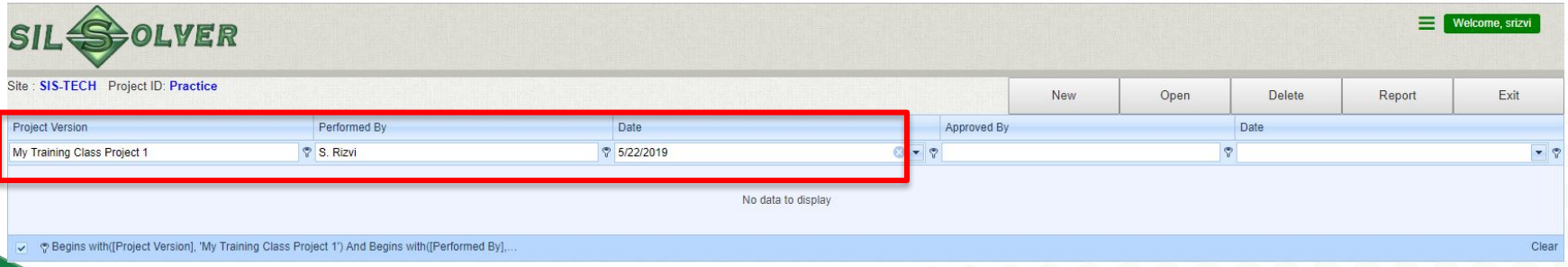




Success!



Set initial project revision information



Steps for adding a safety function

1. Obtain functional description from Hazard and Risk Analysis (H&RA) documentation
2. Open Project
3. Select new function and enter function identification fields
4. Enter performance targets
5. Enter function architecture through GUI interface and populating the architecture with devices
6. Perform calculation
7. Re-iterate with design modifications if necessary to get successful design

Example SIF

Information from H&RA and related process requirement specification (PRS) information

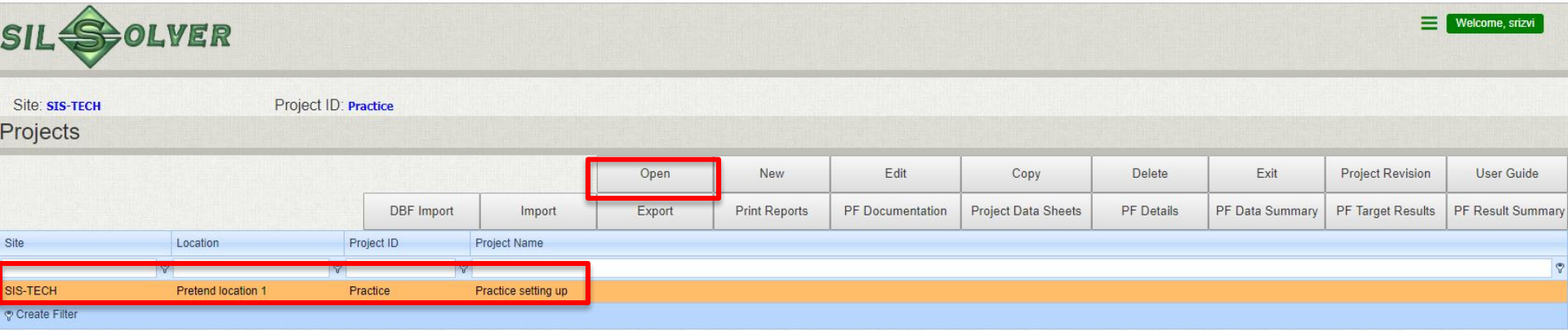
- SIF 01
- SIL-1 (20% design margin)
- Low Demand mode
- Spurious trip target = 20 yrs
- Desired test interval = 5 yrs
- V-101 High DP (2oo3,DP-101A/B/C) trip closes XV-101A and XV-101B (1oo2) ball valves spring loaded to the closed position, each with a single ETT solenoid (XY-101A and XY-101B)
- Power supply is monitored and is tested at 5 yr interval
- Existing logic solver (SIS-A) is safety configured system with 1oo2D CPU and simplex I/O

Opening the project

Start from Project home page

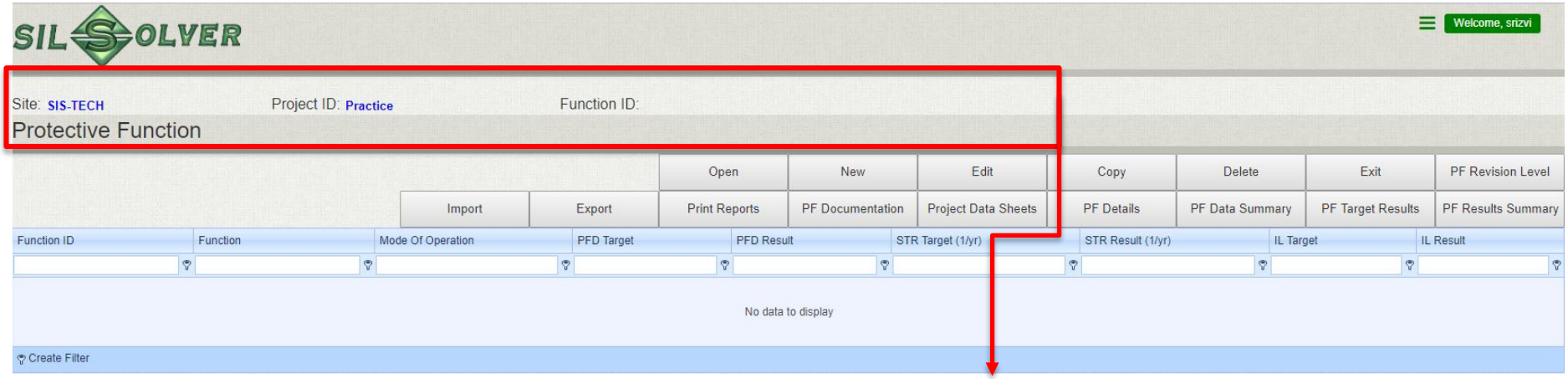
Select the Project by left-click (first project in list is selected by default)

Click Open



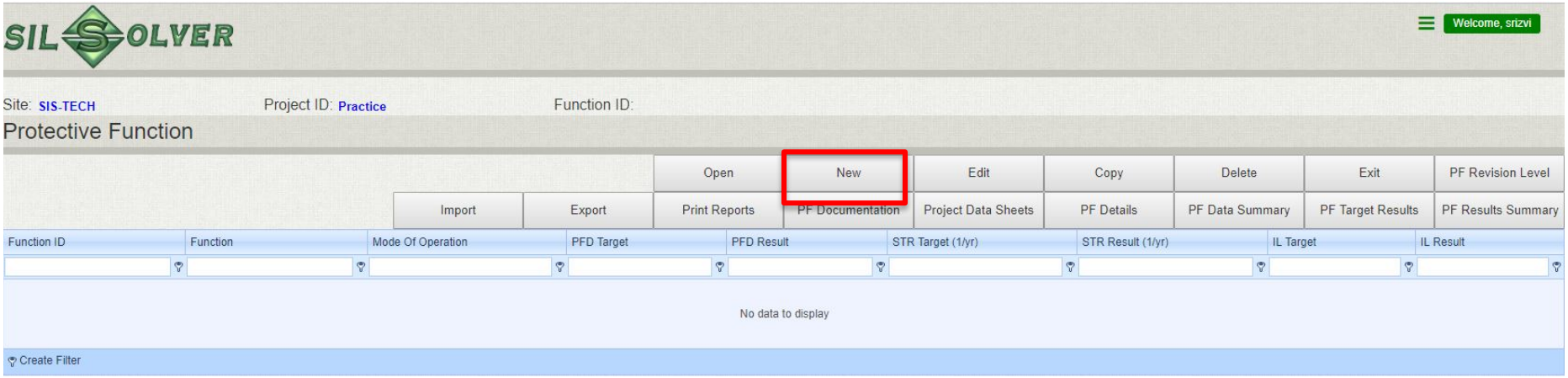
Protective Function Level

- The layout is the same as the main page with list of projects except that on the project level, we have the project information listed and do NOT have the DBF import function

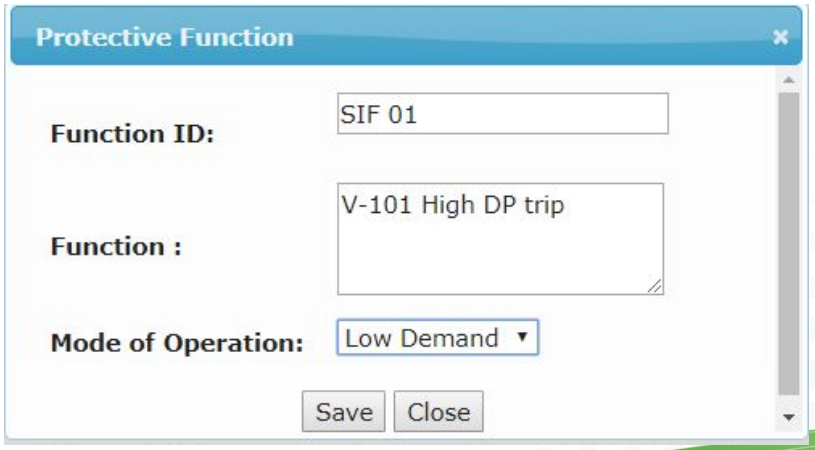


Project information.

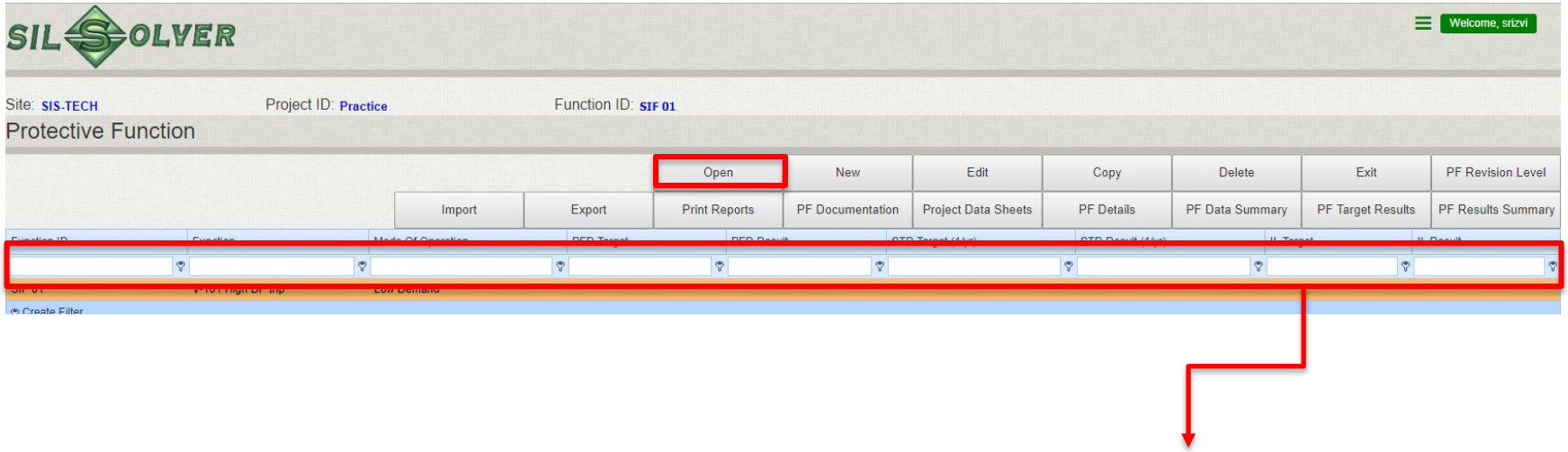
Start a new safety function



- Enter ID, brief version of H&RA description, Mode of Operation, and Save



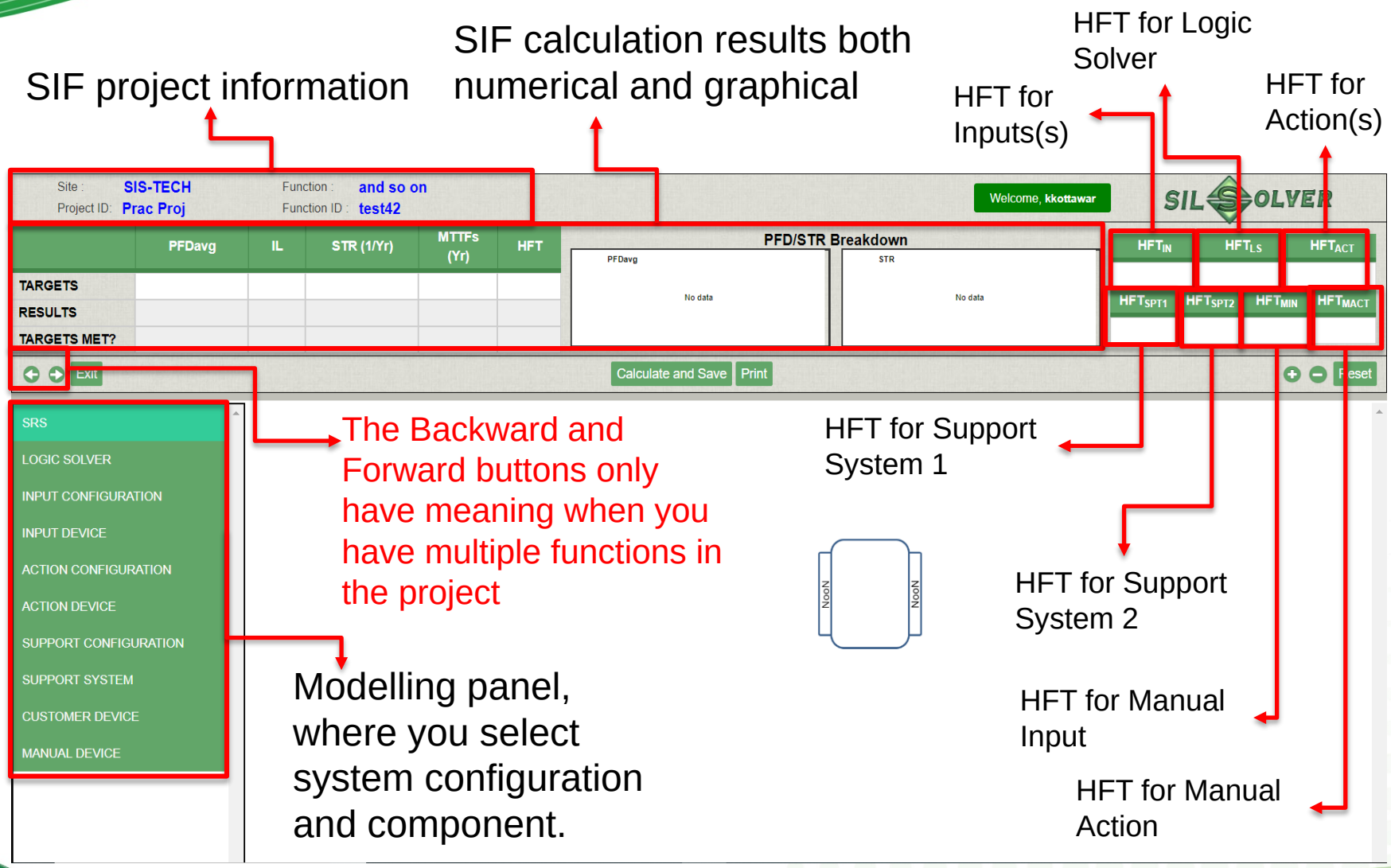
Success!



- Select function and click Open to begin configuring SIF

Fields for filtering can be useful for projects with long lists of protective functions

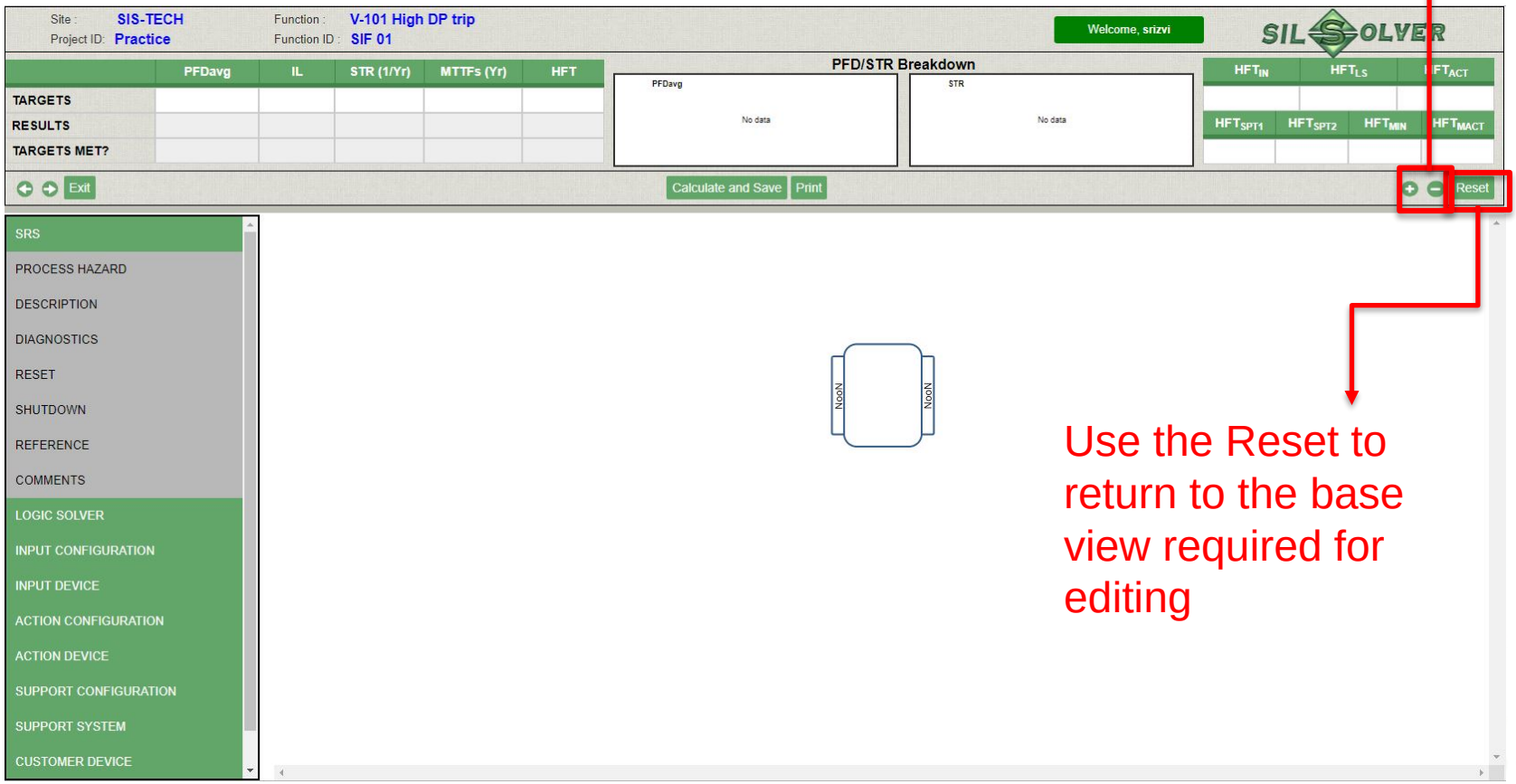
Function GUI Interface



Zooming

Use the + and – buttons to zoom in and out on the figure

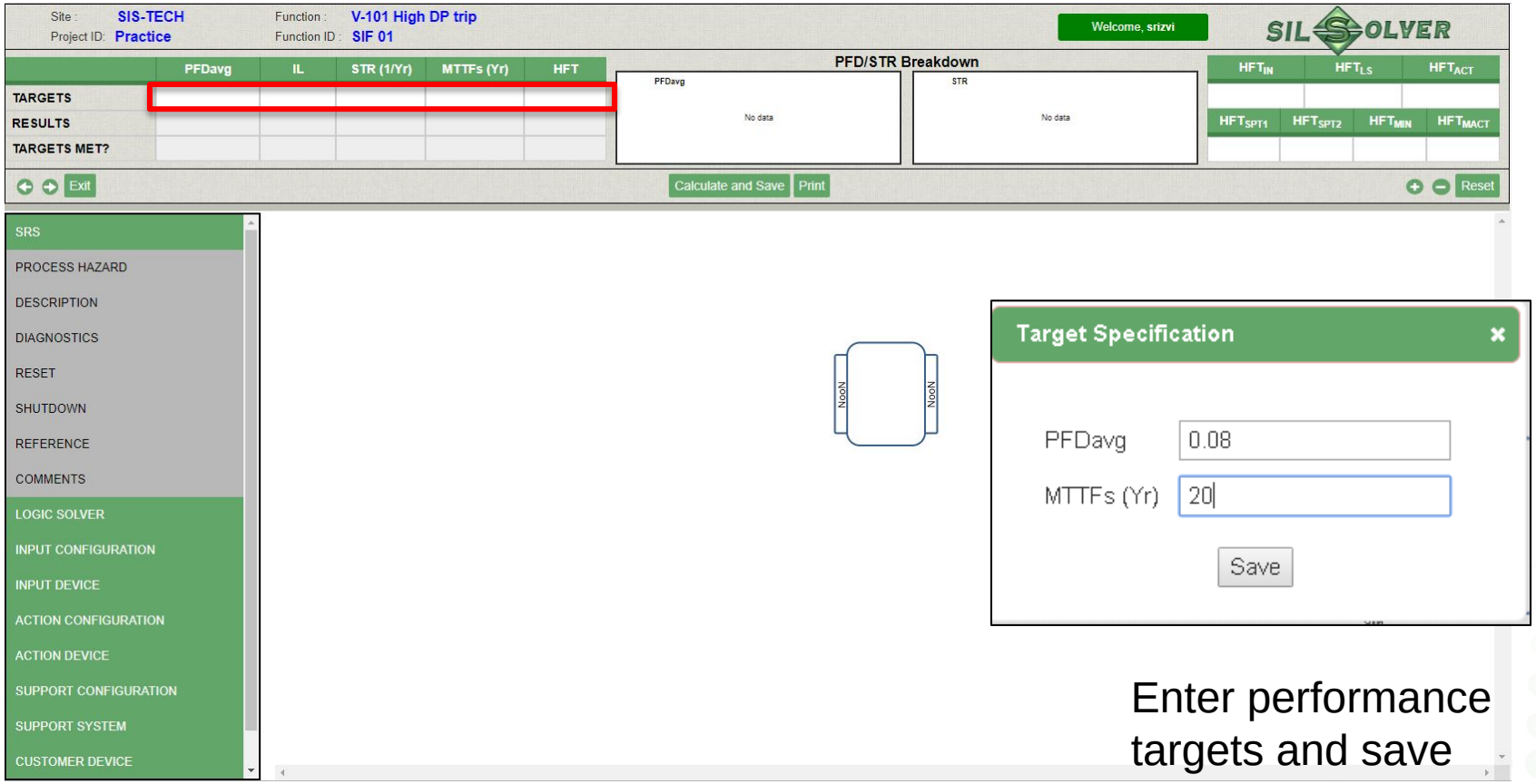
You cannot interact with certain features in a zoomed state



Use the Reset to return to the base view required for editing

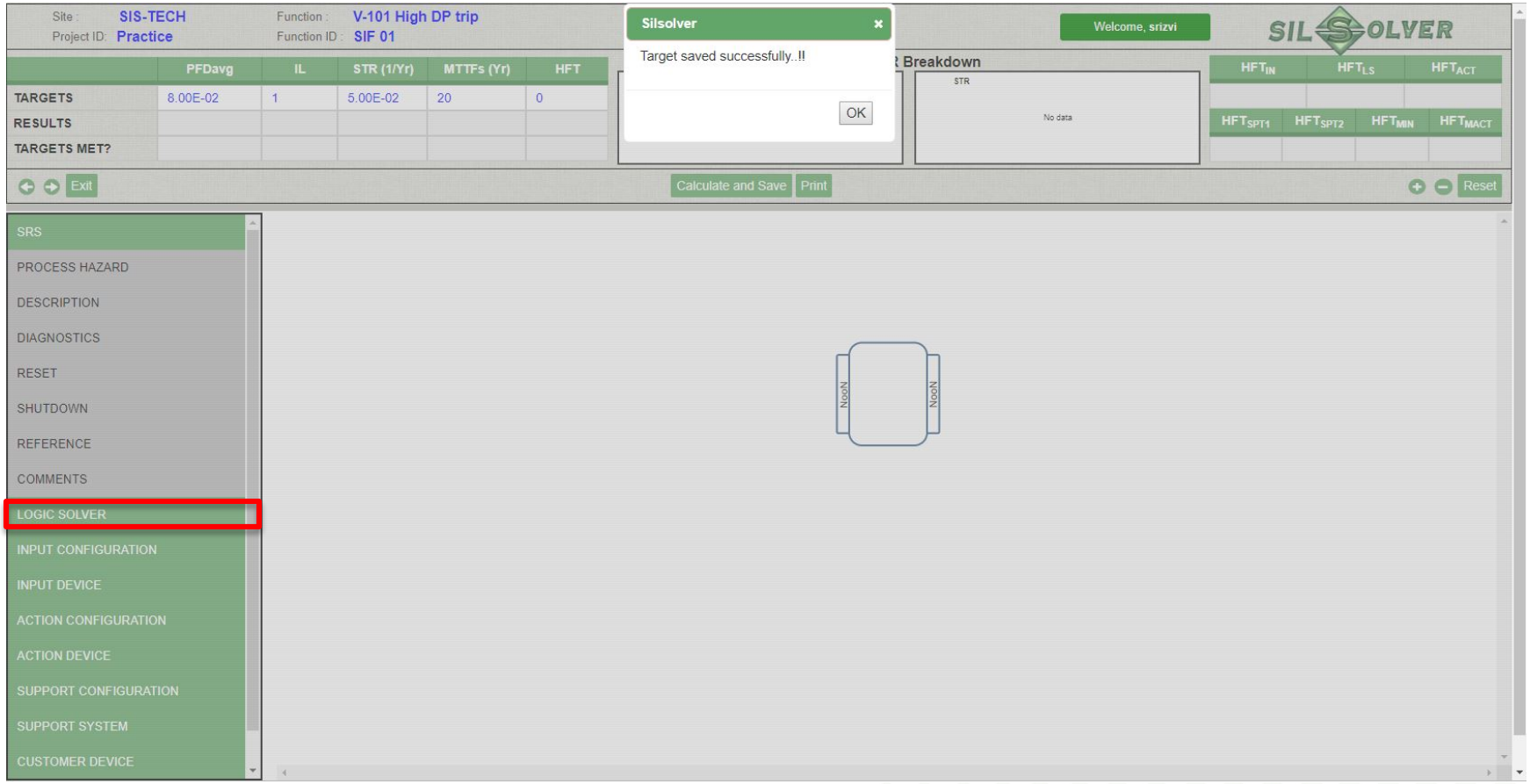
Entering Performance Targets

Click any cell in Targets row of table to open dialog box



Enter performance targets and save

Success!



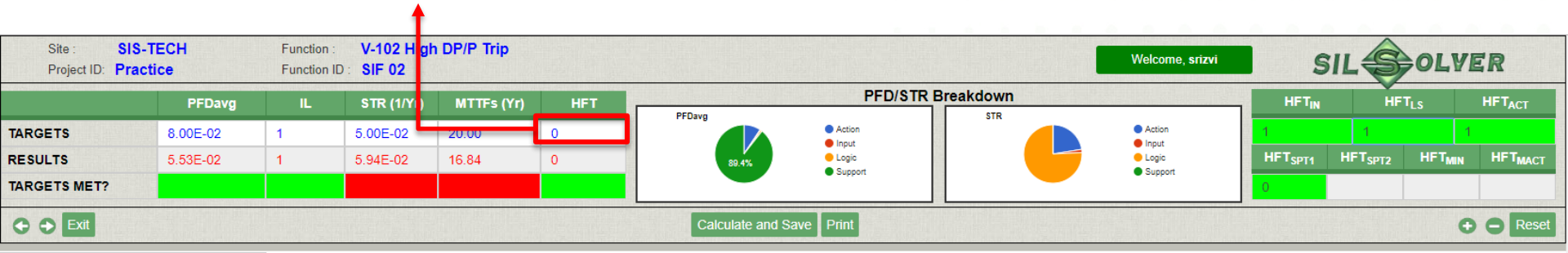
Close dialog box and select Logic Solver on left to begin configuration

HFT Target

HFT target is based on the SIL Target and SIS Mode of Operation. If no PFDavg target has been entered (which would result in no SIL target), HFT target will be set to null.

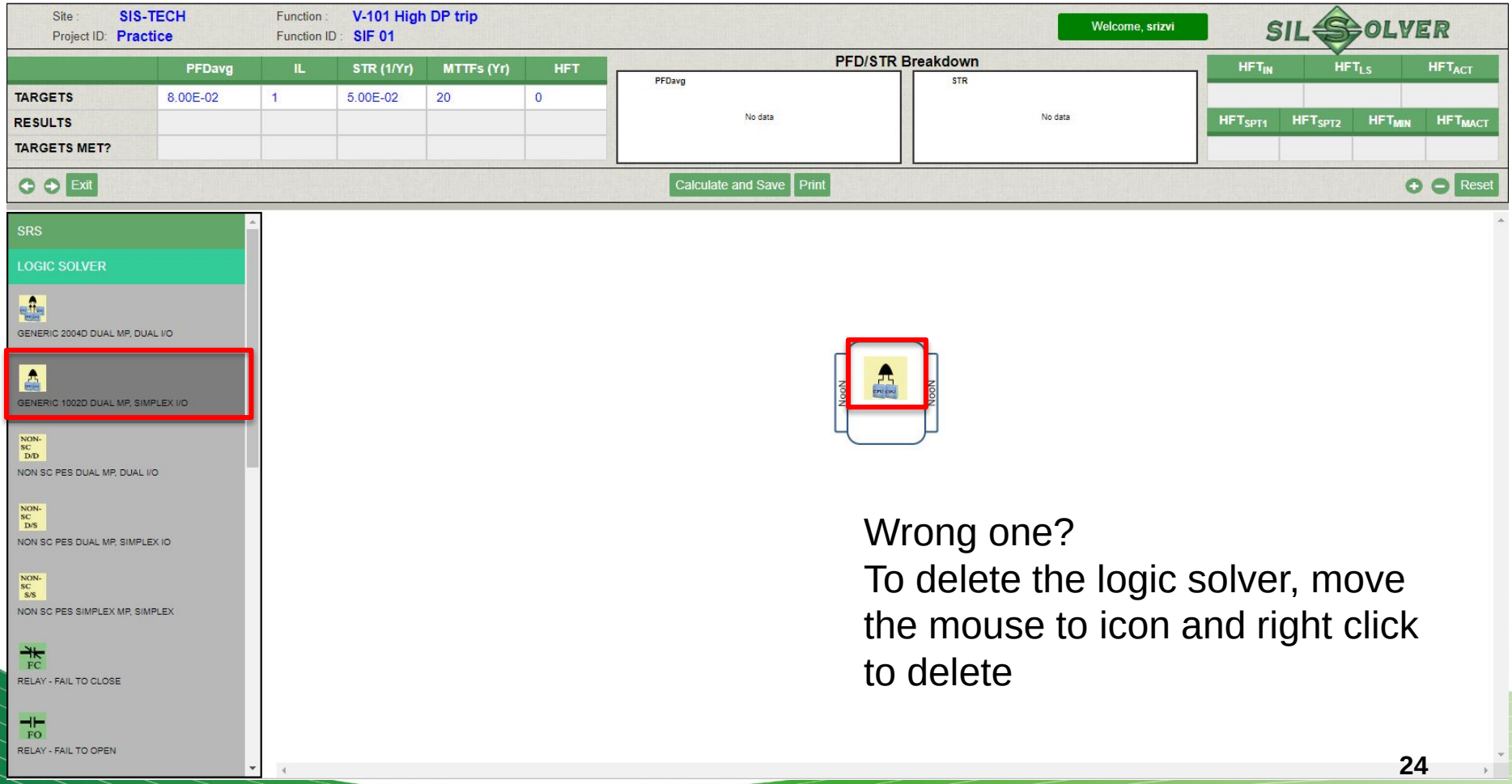
SILTarget	Mode of Operation	HFT target for each subsystem
1	Low Demand	0
1	High Demand	0
2	Low Demand	0
2	High Demand	1
3	Low Demand	1
3	High Demand	1

HFT Target



Picking Logic Solver (LS)

Left click desired logic solver to copy
Move the mouse to the box in the middle and click to paste.



Wrong one?
To delete the logic solver, move the mouse to icon and right click to delete

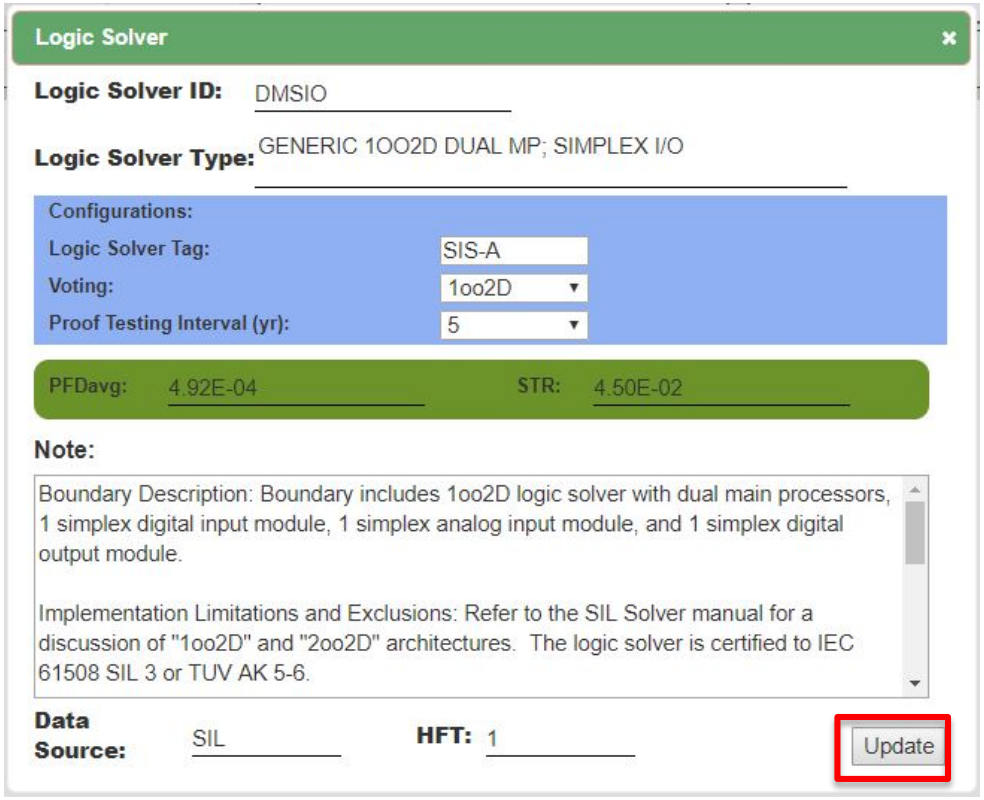
Adding LS details

Edit the logic solver parameter by left click the logic solver icon on in the box. Where Assign a tag name, select the voting, and enter the test interval (TI)

Note: the voting needs to be selected before test interval.

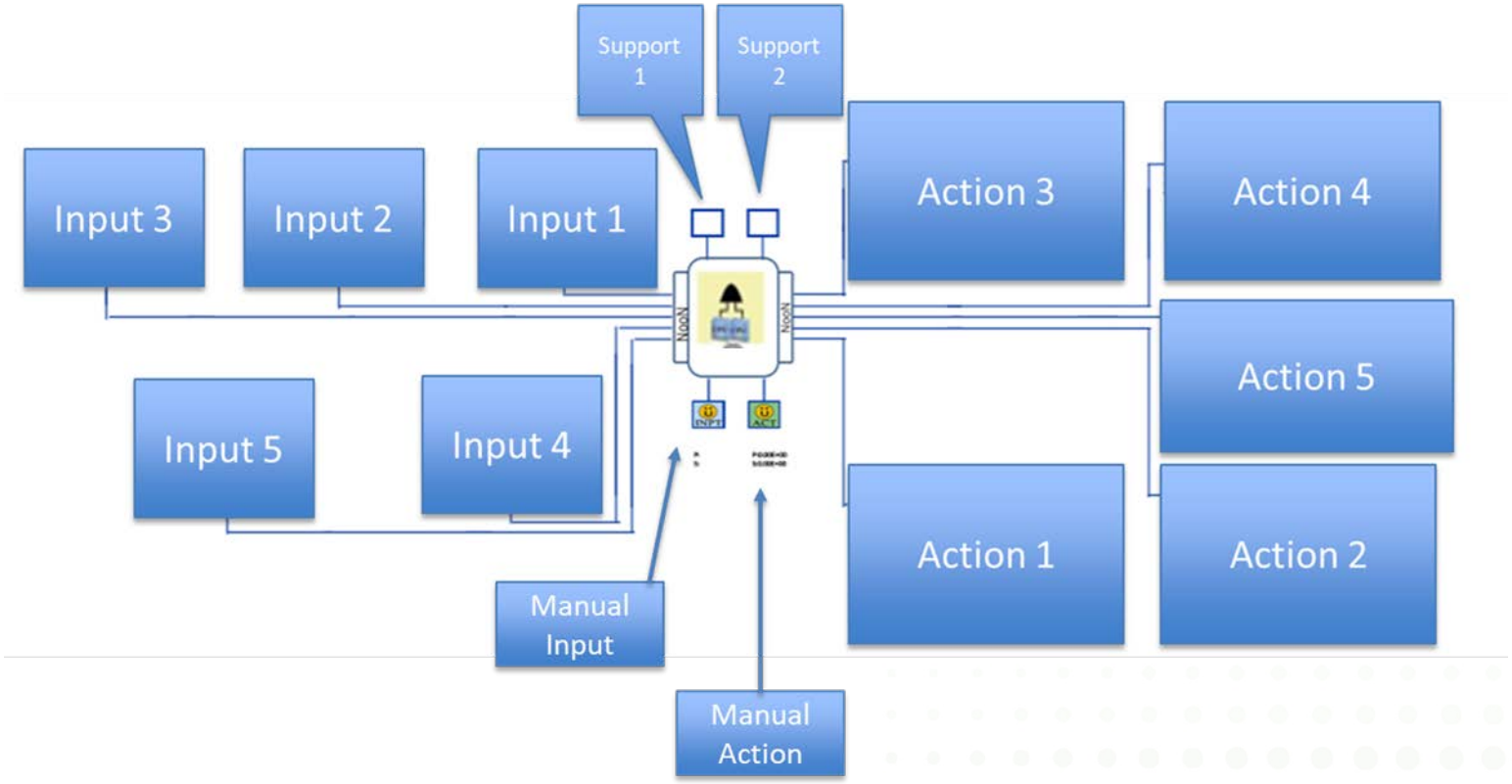
Caution: Logic Solver test interval may be prescribed in vendor safety manual or prior use justification documentation

Tool will automatically calculate LS contributions to PFDavg and STR



Click Update to return to GUI page

Other Subsystems are added to the GUI in the order selected



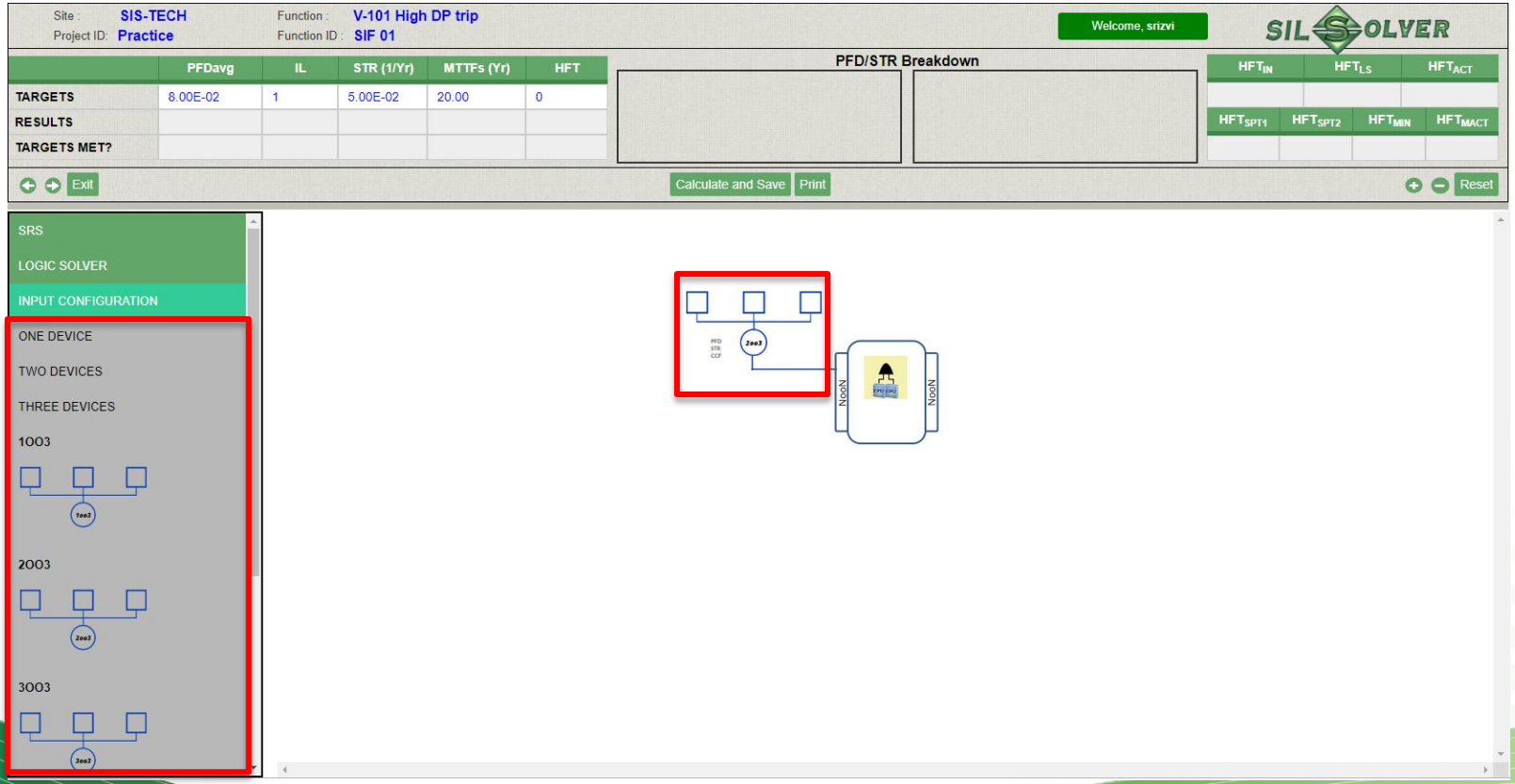
Adding Inputs (aka Sensors)

Adding an input is divided into two steps

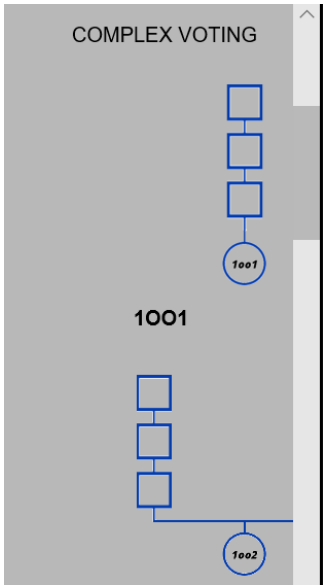
1. add the input configuration
2. add each device.

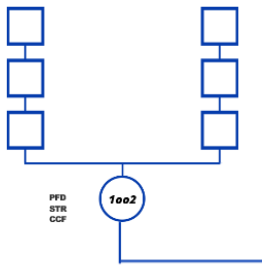
Input Configuration

Click “Input Configuration” to open selection list
Select the desired voting. Click the selected configuration to add to the GUI.
Wrong choice? Hover over that portion of the architecture until grey selection box appears and right-click to get option to delete.



Complex Voting Architectures





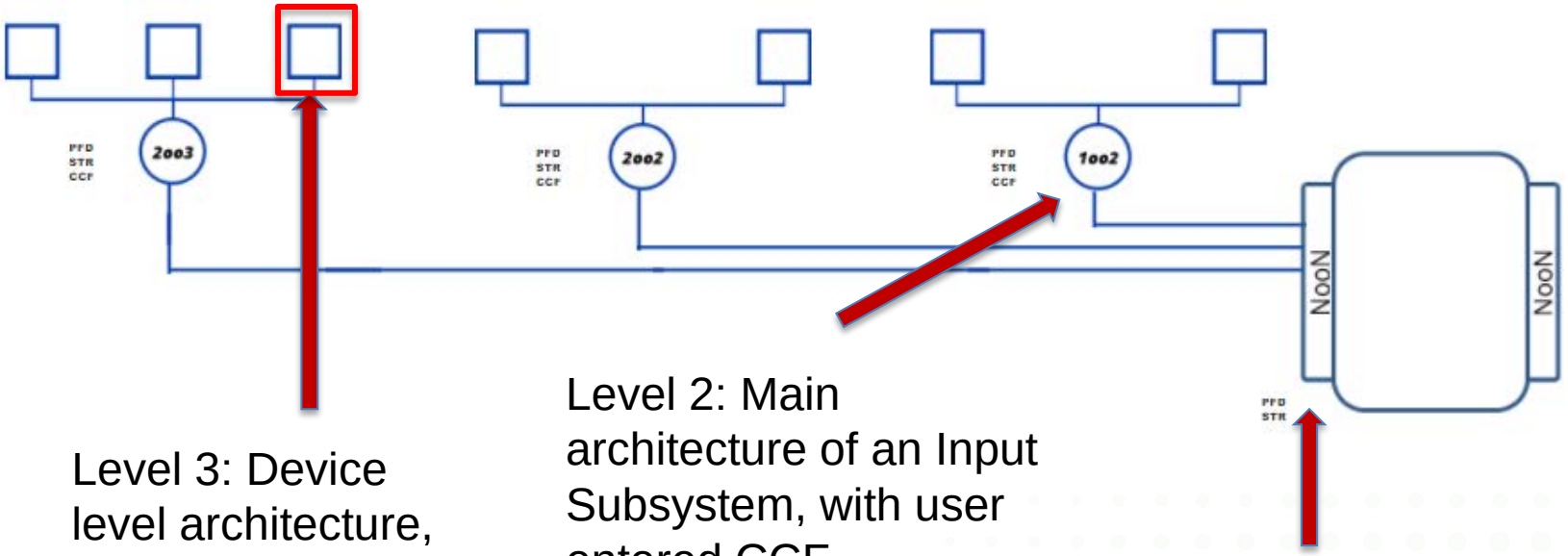
- If a single variable value is made up of multiple devices, use a **Complex Voting Architecture**
- All the devices for each separate value go in a single vertical channel

Common examples:

- Sensor Transmitter with a Signal Splitter, Trip Amp, or a Relay
- Pressure/Temperature compensated flow

Three levels of Input Architecture

Best Practice: Only use Level 3 if you must for the complexity of the function (some details will not show on reports)



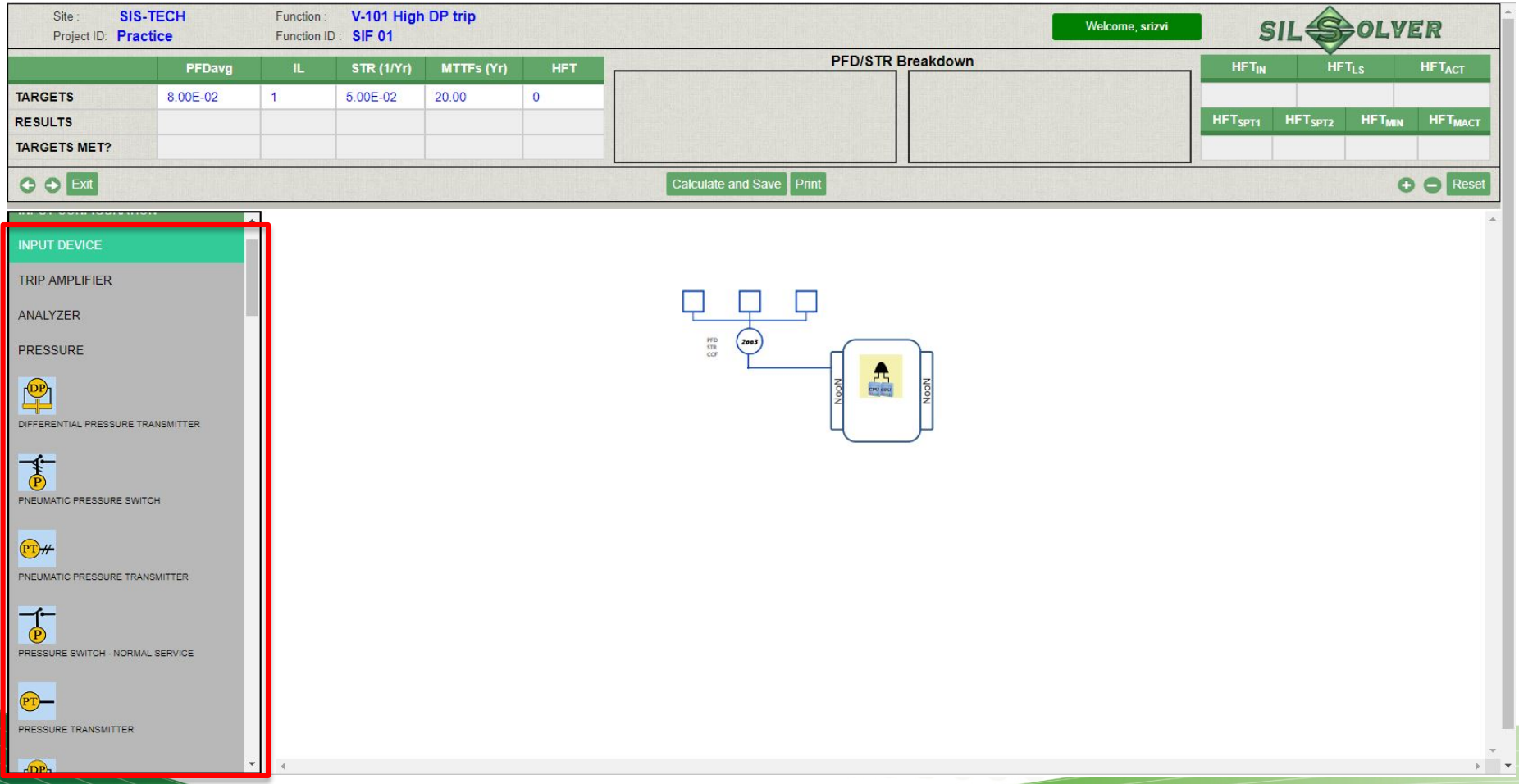
Level 3: Device level architecture, with fixed CCF from datasheet

Level 2: Main architecture of an Input Subsystem, with user entered CCF

Level 1: 1ooN or NooN **VOTING** between Input Subsystems, with no CCF

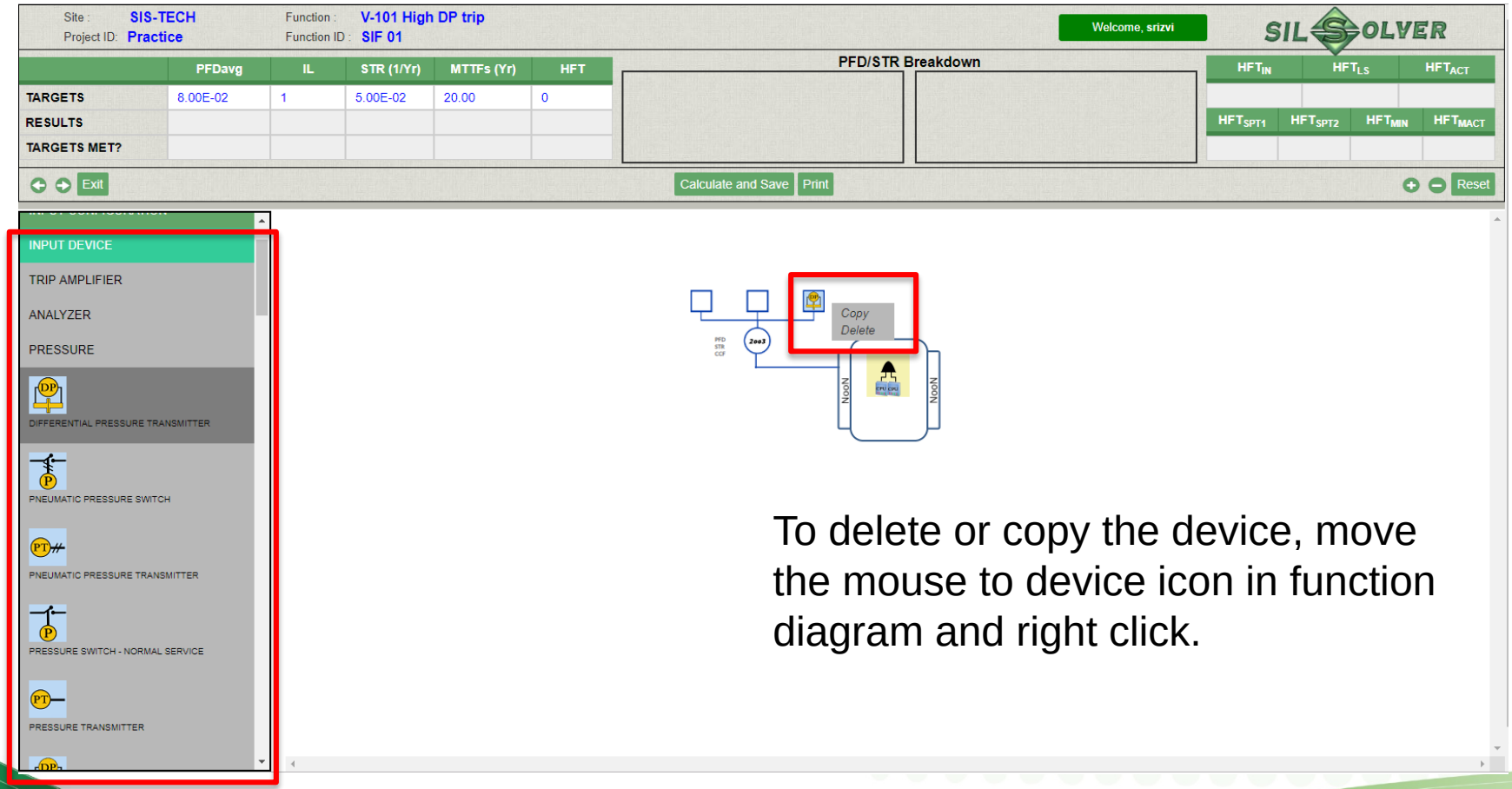
Picking Technology

Click “input device” to access to the list of device categories
Left-click the relevant category to access the list of devices technology



Selecting the Device

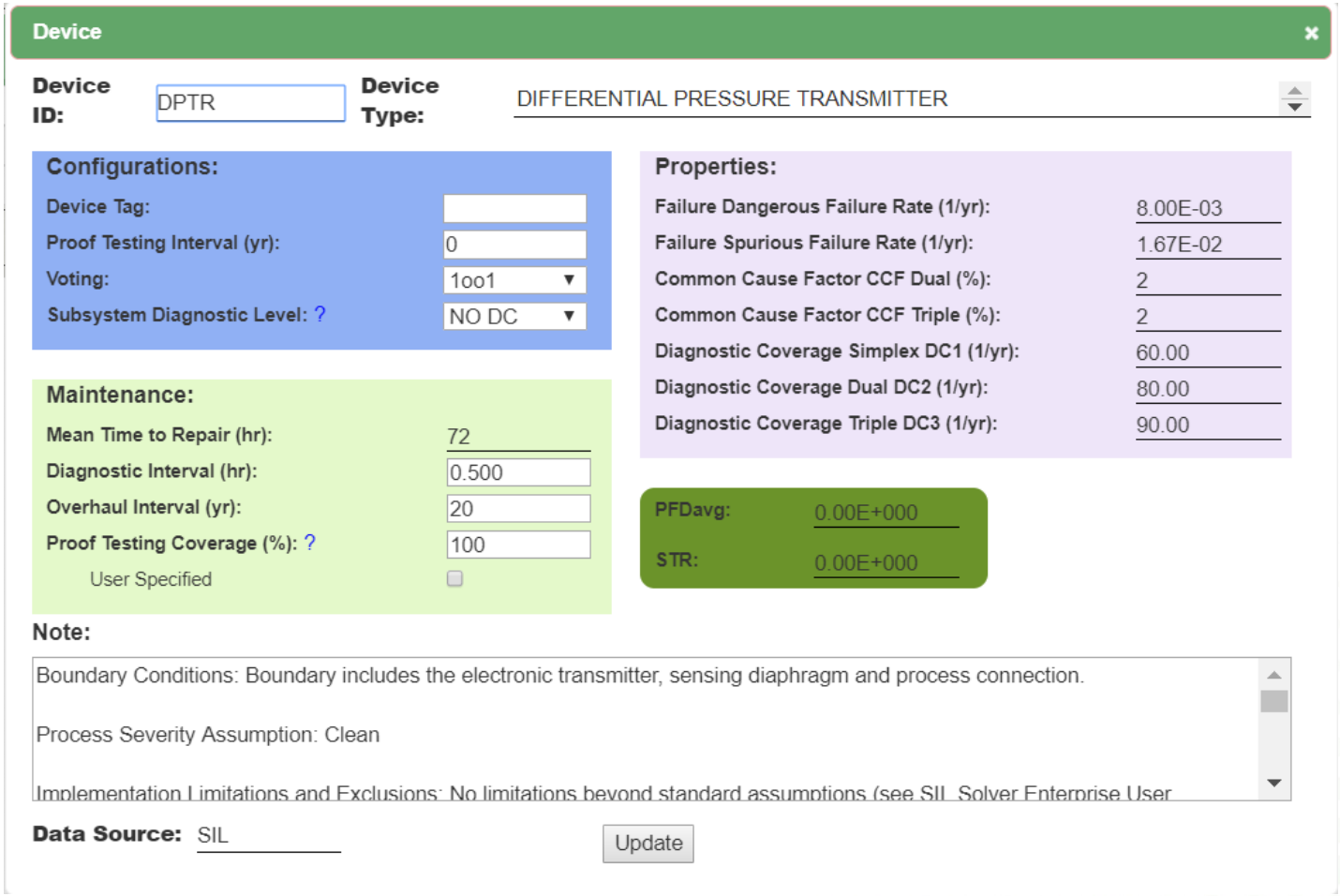
Scroll to the desired device
Left click device in list to copy (right-click to open datasheet – more later)
Left click in device box on diagram to add device to the input subsystem



To delete or copy the device, move the mouse to device icon in function diagram and right click.

Adding Device Details

White boxes are editable fields. Some are pre-populated



Filled In

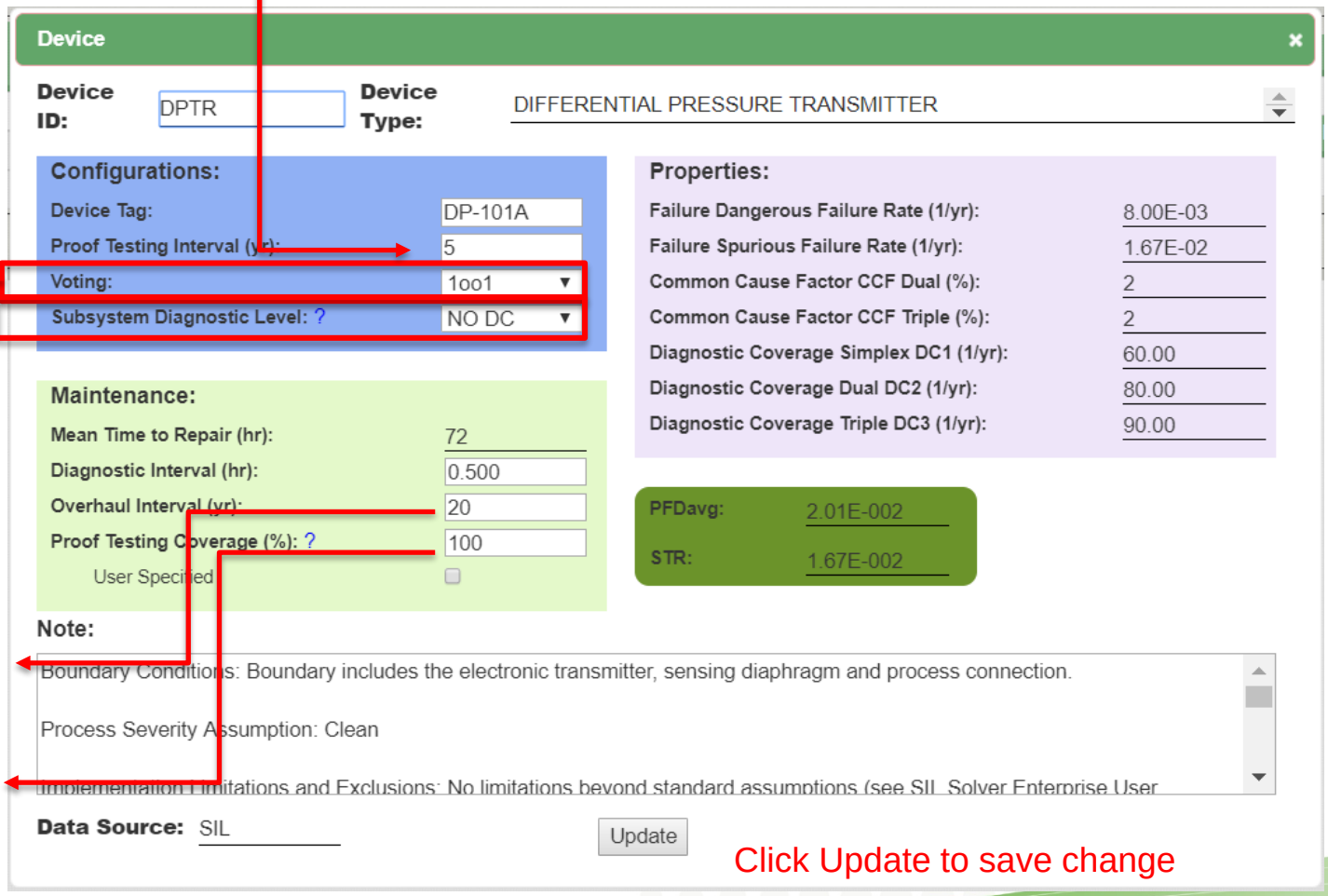
Test Interval is in years

Define Voting of one device. Use 1oo1 most of the time

Define Diagnostic NO DC in this case.

Define OI, default is 20Year

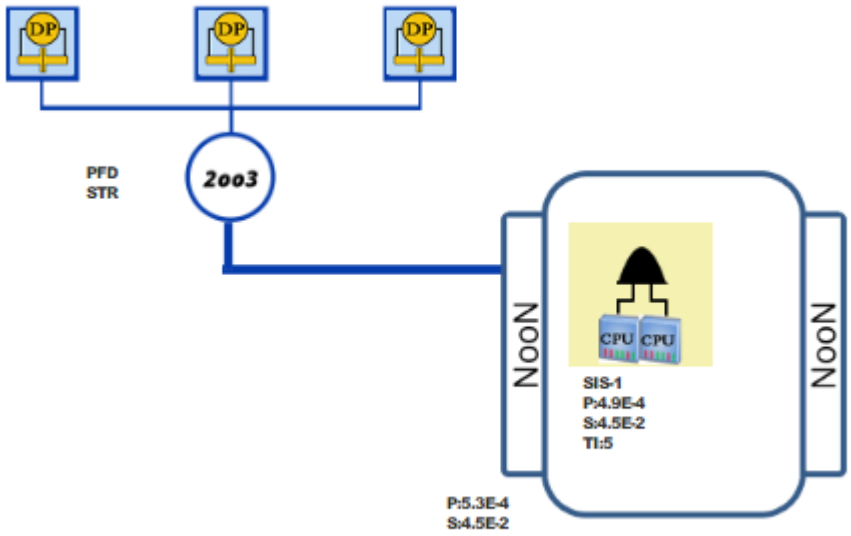
Define PTC, default is 100 %



Click Update to save change

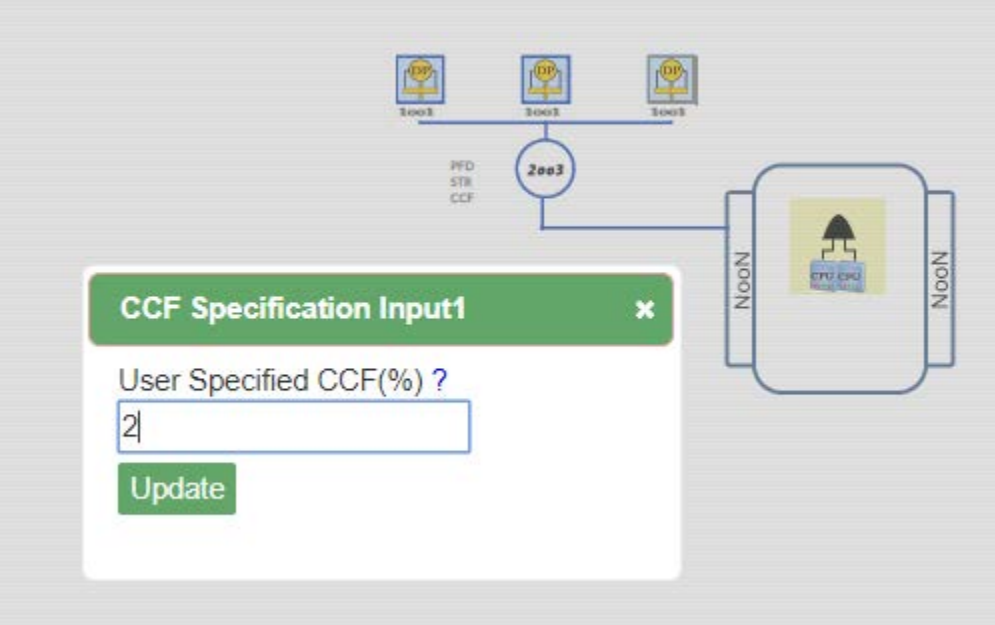
Completing the subsystem

1. Copy DP-101A Pressure transmitter
2. Paste DP pressure transmitter to each of box in the 2oo3 input configuration
3. Update the tags for DP-101B and DP-101C and any other parameters that were modified for DP-101A.



Adding Common Cause

- Left-click on the voting 2oo3 circle
- Put in CCF value as a percentage (for example, 2%)
  Note: Recommended values for duplex and triplex architectures are shown in the device datasheet under “Properties”
- Click Update to close the dialog box



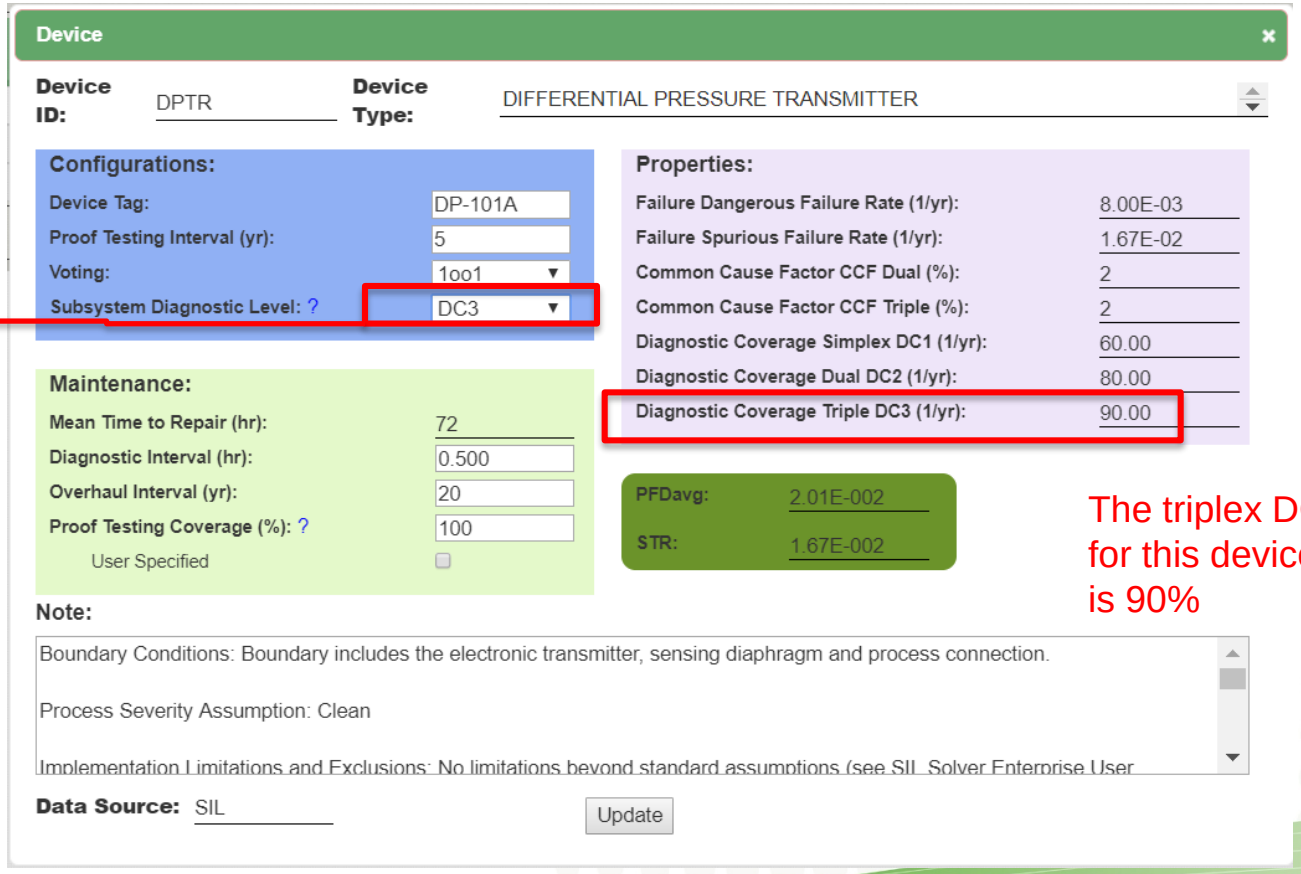
CCF is not used in non-redundant (i.e., 1oo1 or 2oo2) architectures

Note: When using diverse instrumentation in a redundant architecture, use the rightmost box(es) of the subsystem (input or action) for the channel with the highest total dangerous failure rate.

2oo3D vs. 2oo3

- What if automated diagnostics is going to be used to take safe action on diagnosed failure?
- Enter each device and change the Diagnostic level to DC3 (diagnostic level for intercomparison of 3 transmitters)
- Click Update to close dialog box

Define Diagnostic DC3 is used since 3 PTs are used for comparison. The DC used in 90%



The triplex DC for this device is 90%

FYI:
DC for other architectures

For all other input configurations with safe action on diagnosed failure, the general rule for the selection of Diagnostic level is as below:

1oo1D→ DC1 (Diagnostic Coverage Simplex)
1oo2D and 2oo2D→ DC2 (Diagnostic Coverage Dual)
1oo3D, 2oo3D and 3oo3D→ DC3(Diagnostic Coverage Triplicated)

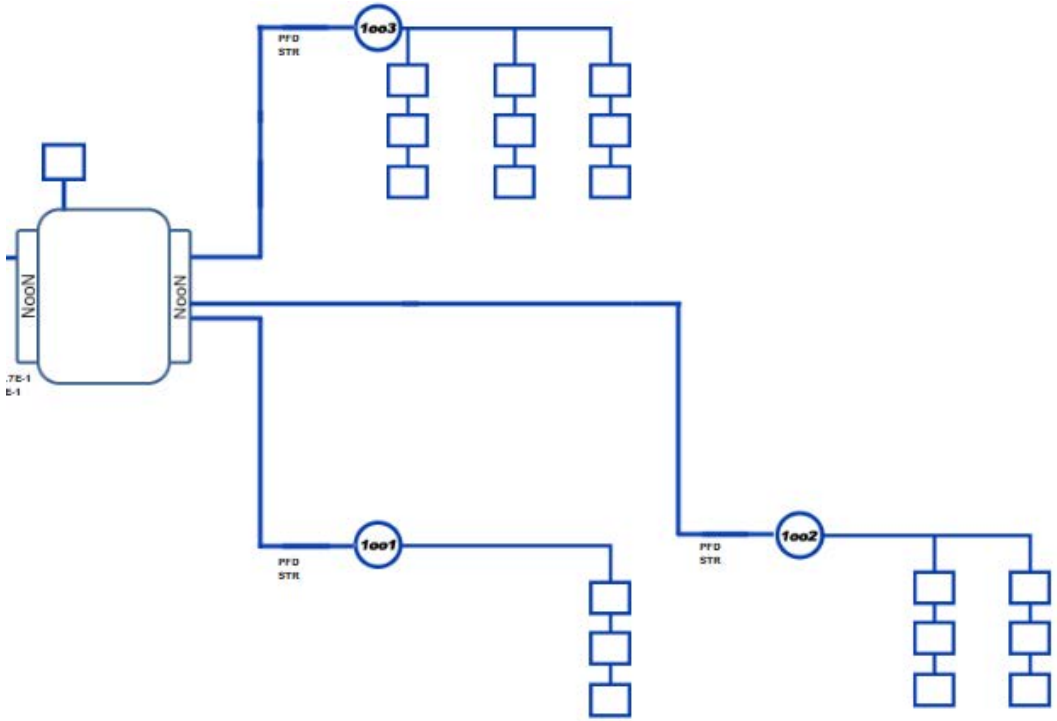
May need to select a lower DC when diverse devices are used in the same voting.

May select a higher DC when an external independent reading can be used for inter-comparison with the SIF sensor.

Adding the rest of the system

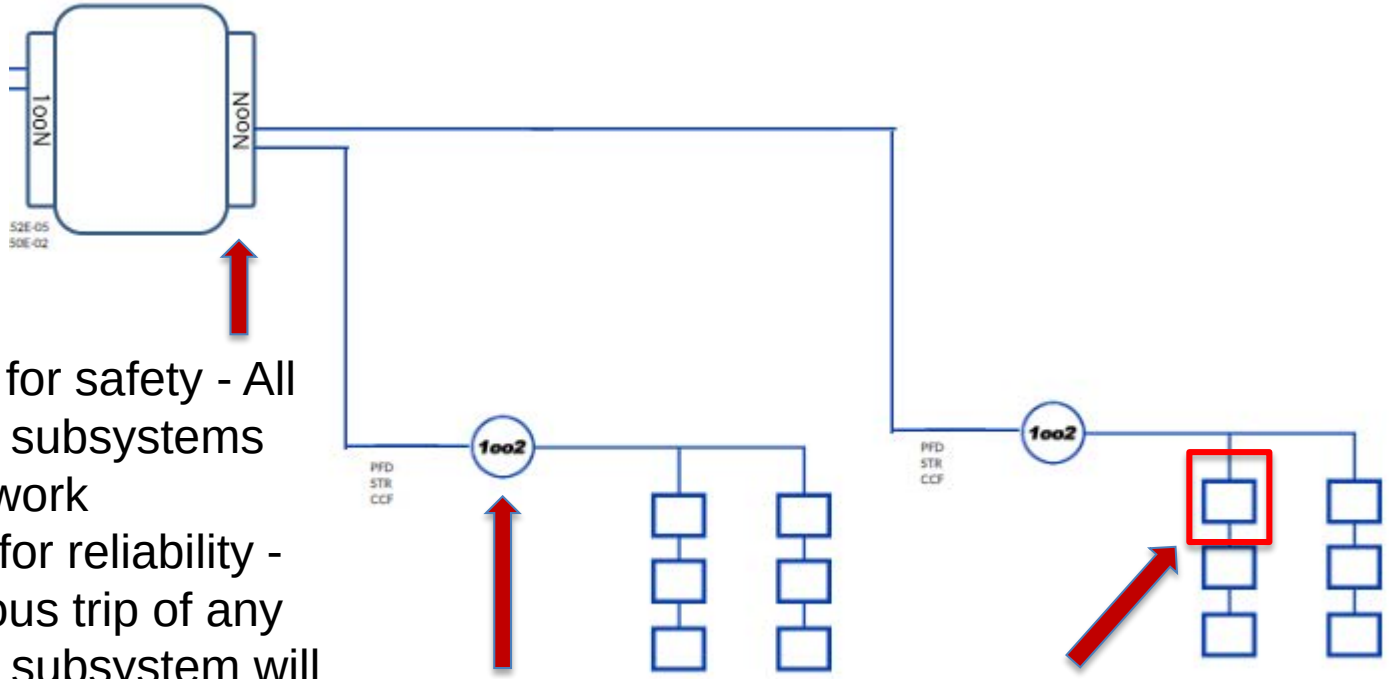
The support system and final actions are modelled in a similar way as the input.

1. Select the action configuration
2. Select the action device (Identical logic as SIL Solver® V 7.0)
3. Specify relevant parameters



Two configurable levels of Action Architecture

Best Practice: Only use Level 2 if you must for the complexity of the function (some details will not show on reports)



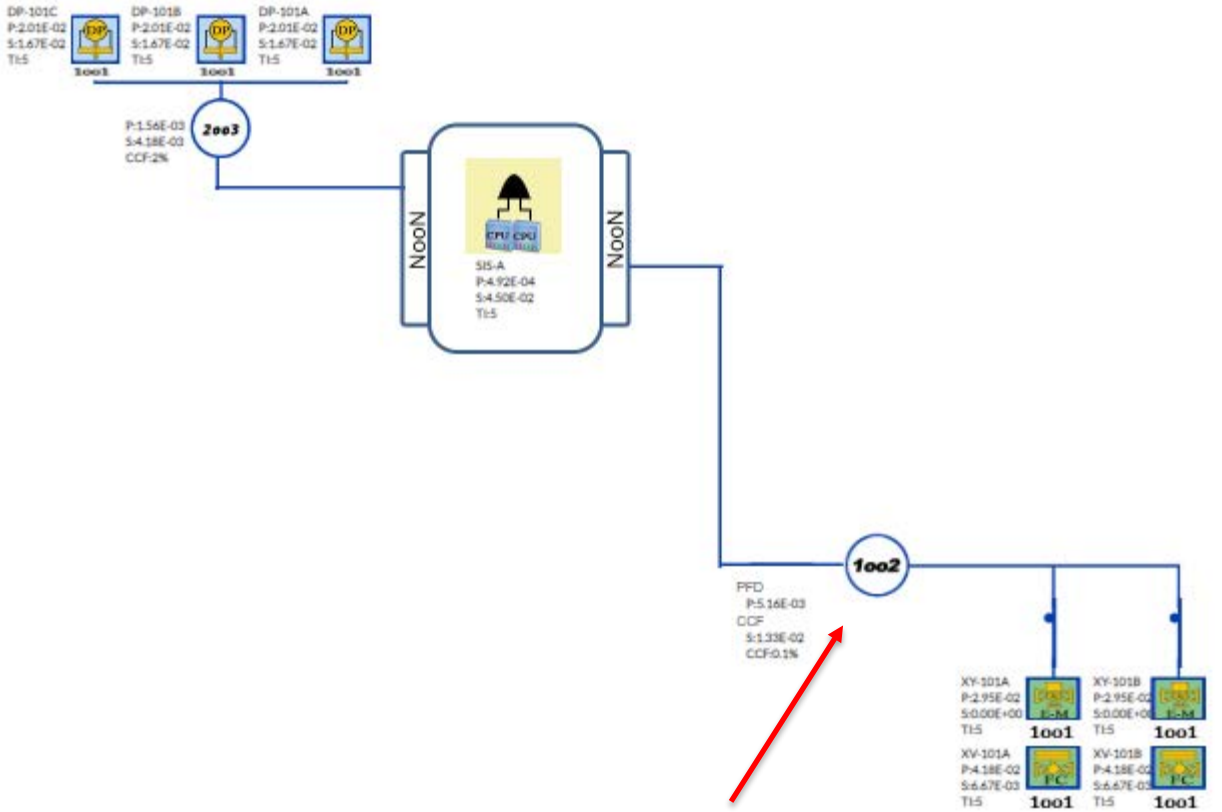
FIXED:

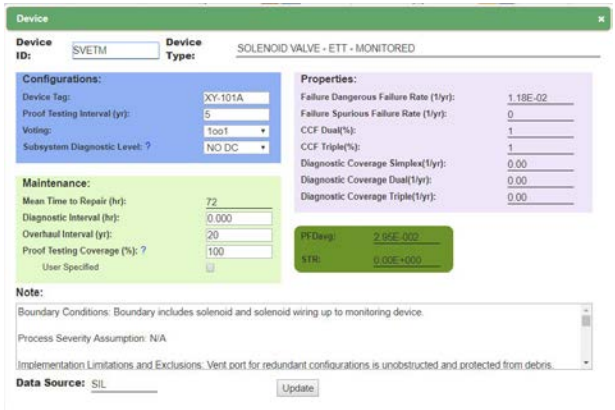
- NooN for safety - All action subsystems must work
- 1ooN for reliability - Spurious trip of any action subsystem will cause an operational problem

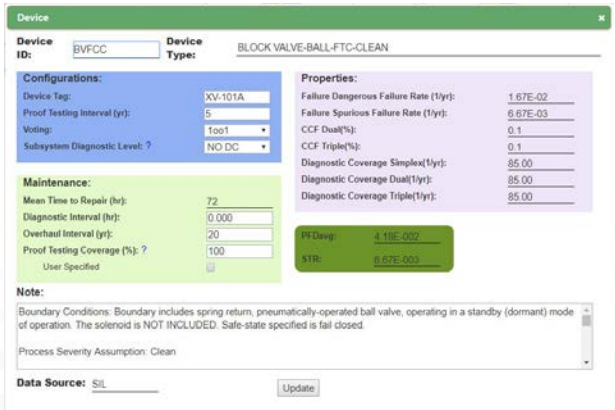
Level 1: Main architecture of an Action Subsystem, with user entered CCF

Level 2: Device level architecture, with fixed CCF from datasheet

Adding valves and solenoids

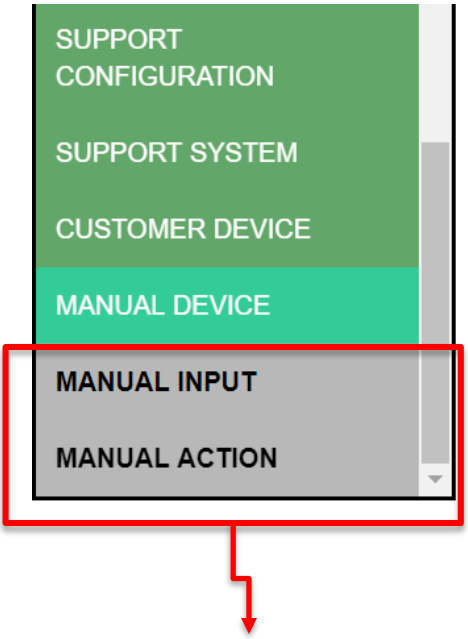






Don’t forget to enter CCF

What if the design has a complicated “black box” subsystem?



Click to add field to GUI

Most commonly used for complex designs where there is a complicated subsystem in the design that i evaluated using an advanced method such as FTA

SIL Solver® allows for q MANUAL ACTION subsystem and a MANUAL INPUT subsystem

THESE ARE NOT POPULATED LIKE NORMAL DEVICES

The PFDavg and STR contributions for these subsystems are entered directly into the tool

These performance of these subsystems are additive to the overall PFD and STR analysis

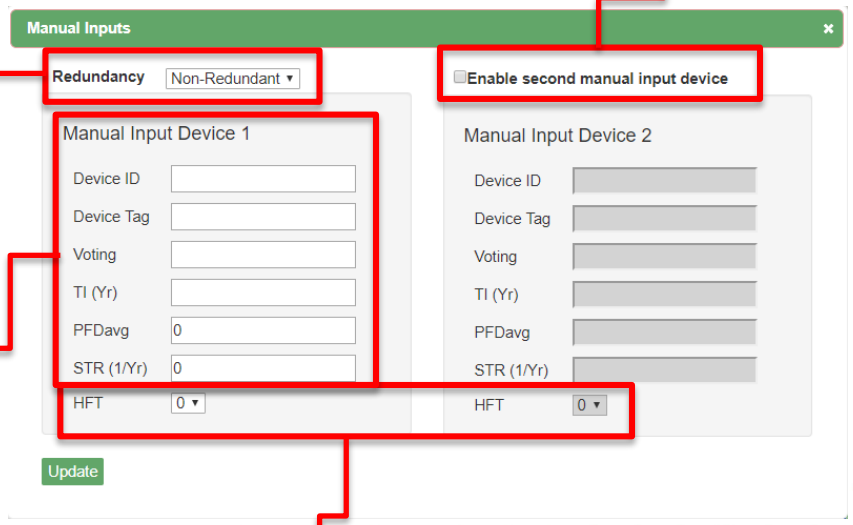
Manual Inputs

The user can enter two parts of a Manual Input analysis:

Check to allow entry of the second Manual Input

If two are used, the user must define whether they are redundant to each other (i.e., EITHER subsystem working will allow the overall Manual Input to work) or non-redundant (i.e., BOTH parts must work for the overall Manual Input to work

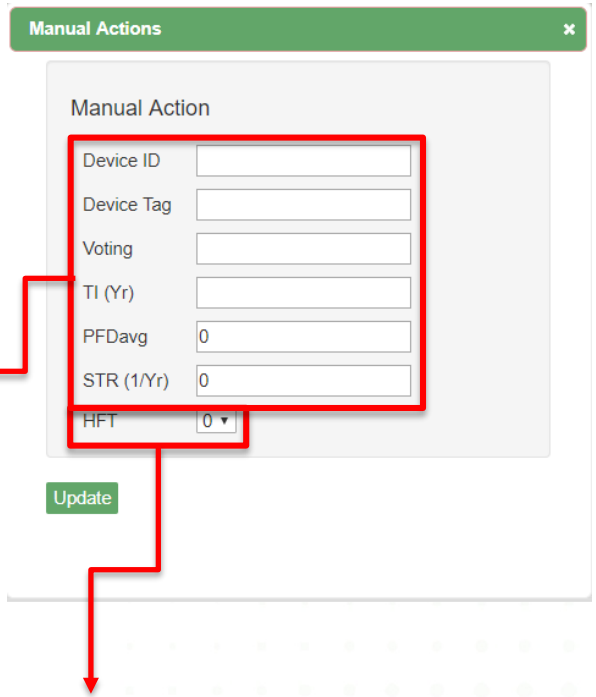
DeviceID, Tag, voting architecture and TI are entered for completeness of reporting. The PFDavg and STR are entered directly for each portion of the Manual Input



The user selects the Hardware Fault Tolerance value appropriate for each part of the Manual Input

Manual Action

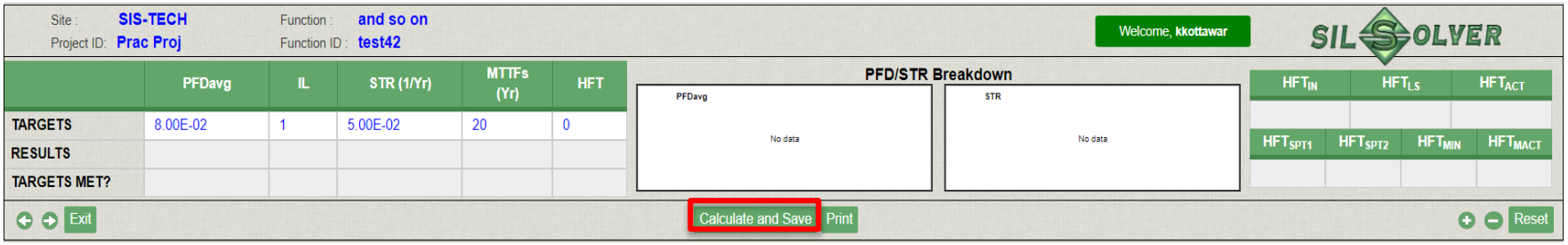
DeviceID, Tag, voting architecture and TI are entered for completeness of reporting. The PFDavg and STR are entered directly for each portion of the Manual Input



User enters Manual Action HFT Value

Ready to Calculate?

All devices entered, filled out, and CCF added?
Click the “Calculate and Save” button

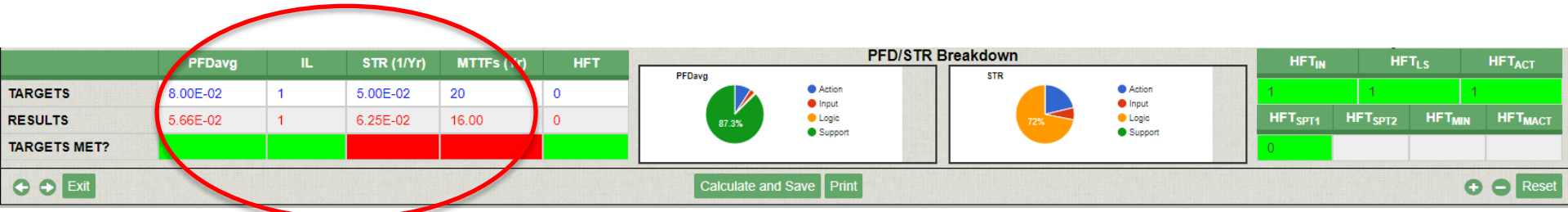


Note any **ERRORS** or Warnings that are generated during the calculation:

ERRORS: A problem exists in GUI configuration that will make the calculated results INCORRECT

Warning: A value is missing from the configuration that may or may not be a technical issue, depending on the overall design

Are PFDavg and STR good enough?



Numerical results and red-green pass-fail indicator on top left of GUI and most SIF reports

Graphical Charts provide information on which components are dominating PFDavg and STR

If necessary, modify design until performance targets are achieved.

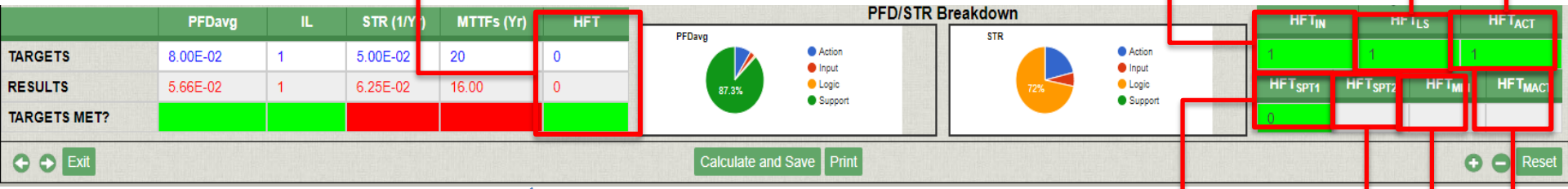
Don't forget Hardware Fault Tolerance (HFT)

HFT Target and Overall HFT Result

HFT for Input(s)

HFT for Logic Solver

HFT for Action(s)



HFT for Support System 1

HFT for Support System 2

HFT for Manual Input

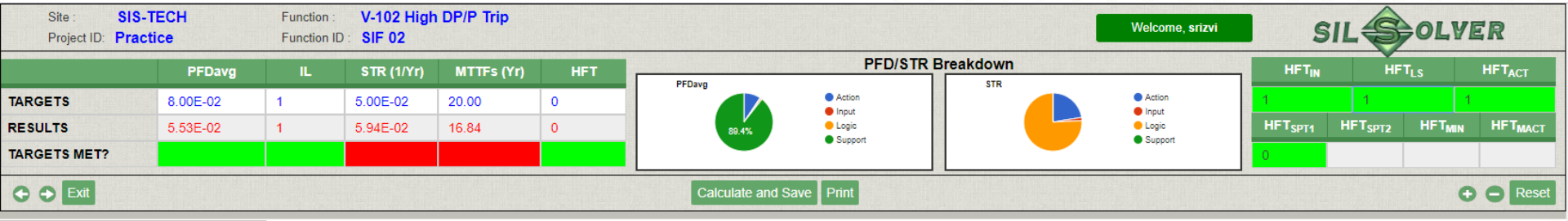
HFT for Manual Action

Overall HFT result is the minimum HFT out of the seven main subsystems (see far right side of GUI) for those subsystems that are configured for use in that architecture

HFT for Device

The HFT for each field device box (MooN) is determined by the selected architecture within that box as below. The resulting HFT value for each field device is not shown on the GUI, except for logic solver, support system, manual input, and manual action in their respective data sheets.

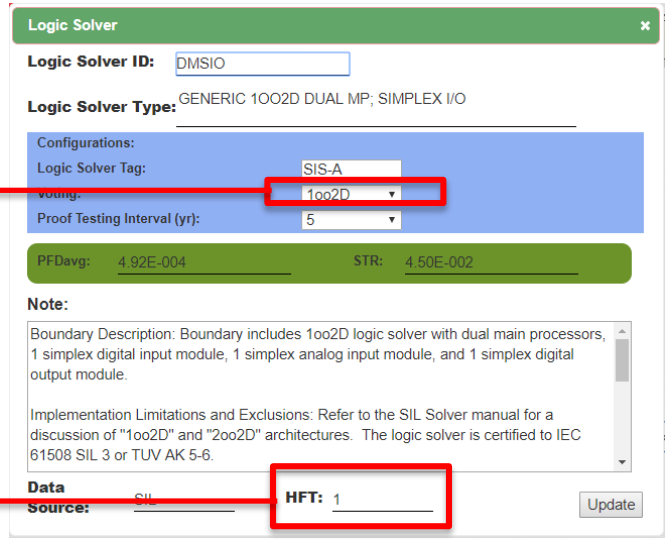
Architecture(s)	HFT = N - M
1oo1, 1oo1D	0
1oo2, 1oo2D	1
2oo2, 2oo2D	0
1oo3, 1oo3D	2
2oo3, 2oo3D	1
3oo3, 3oo3D	0
2oo4, 2oo4D	2
HFAT/HPATD (unused for LS, but used for some action devices)	1



HFT for Logic Solver

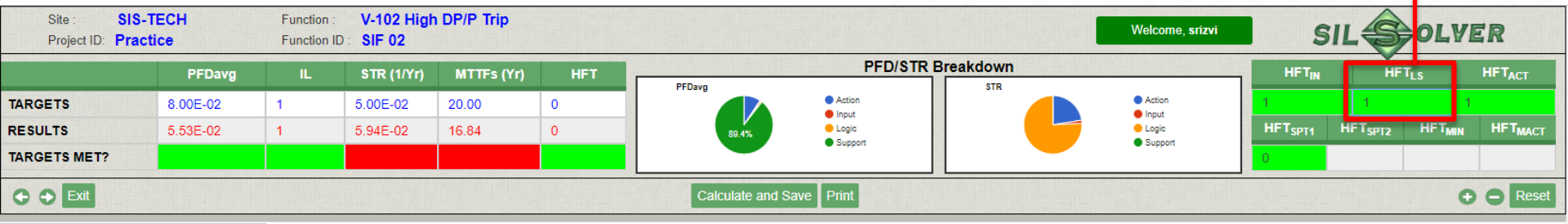
The HFT value for the logic solver (MooN) is determined by the selected architecture. The resulting HFT value for the logic solver is shown on the logic solver data sheet and on the GUI as below. Default value is 0 when importing a logic solver that is not in the current SIL Solver logic solver datasheet.

In this case, MooN is 1oo2D 2-1=1



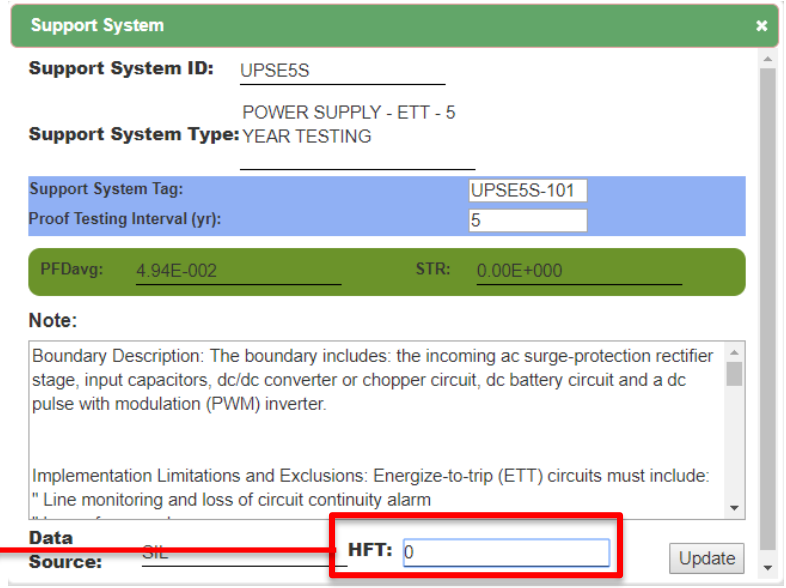
Logic Solver HFT Value

HFT for Logic Solver



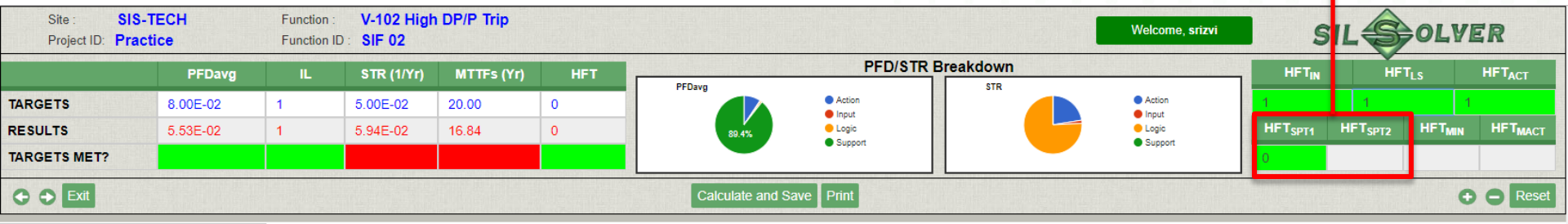
HFT for Support System

The HFT value for the support system is shown on the support system data sheet and on the GUI as below. Default value is 0 when importing support systems that are not in the current SIL Solver support system datasheet.



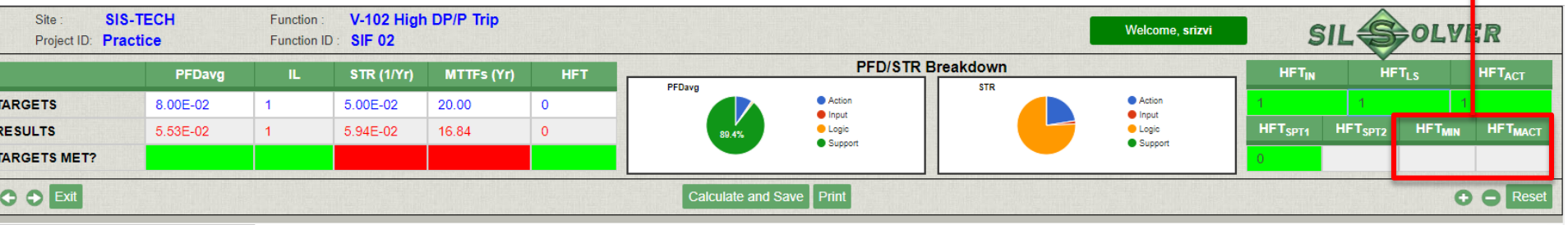
Support System HFT Value

HFT for Support System 1 and Support System 2



HFT Results for Manual Input and Manual Action

HFT Results for Manual Input and Manual Action

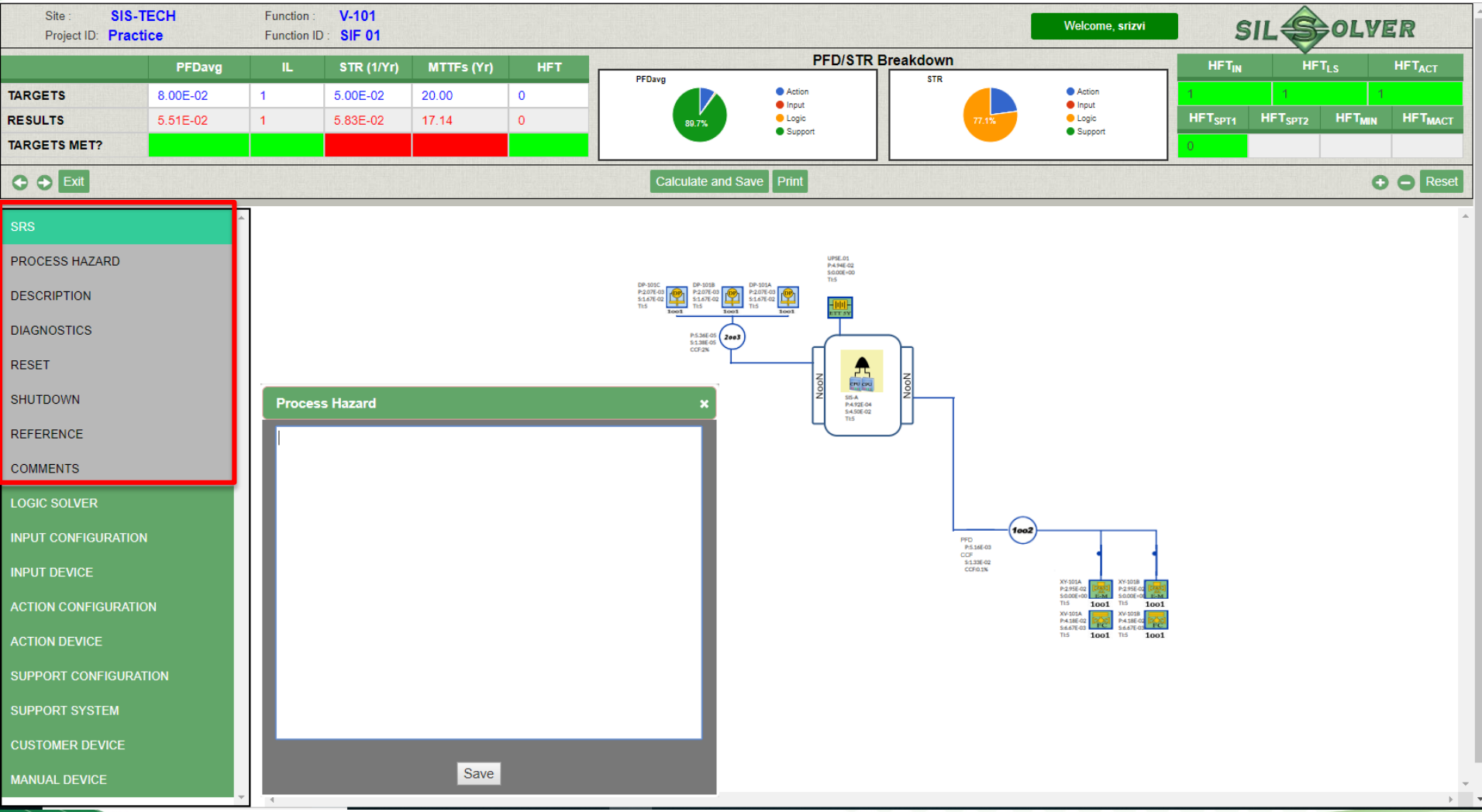


Is that all?

- The SIL Calculation is performed within a context of performance assumptions and other SIL evaluations (e.g., independence of SIF from other functions in the hazard case the SIF is designed for)

- The documentation of the SIL calculation should include sufficient SRS information to provide this context

SRS Info


Site : SIS-TECH
Project ID: Practice
Function : V-101
Function ID : SIF 01
Welcome, srizvi
SILSOLVER
PFDavg
IL
STR (1/Yr)
MTTFs (Yr)
HFT
TARGETS 8.00E-02 1 5.00E-02 20.00 0
RESULTS 5.51E-02 1 5.83E-02 17.14 0
TARGETS MET?
PFD/STR Breakdown
PFDavg
89.7%
STR
77.1%
Action
Input
Logic
Support
HFTIN
HFTLS
HFTACT
HFTSPT1
HFTSPT2
HFTMIN
HFTMACT
Exit
Calculate and Save
Print
Reset
SRS
PROCESS HAZARD
DESCRIPTION
DIAGNOSTICS
RESET
SHUTDOWN
REFERENCE
COMMENTS
LOGIC SOLVER
INPUT CONFIGURATION
INPUT DEVICE
ACTION CONFIGURATION
ACTION DEVICE
SUPPORT CONFIGURATION
SUPPORT SYSTEM
CUSTOMER DEVICE
MANUAL DEVICE
Process Hazard
Save
2oo3
NooN
1oo2
1oo1

Done with SIF 01

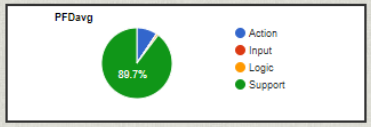
Site : SIS-TECH Function : V-101
Project ID: Practice Function ID : SIF 01

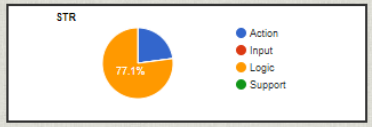
Welcome, srizvi

SIL SOLVER

	PFDavg	IL	STR (1/Yr)	MTTFs (Yr)	HFT
TARGETS	8.00E-02	1	5.00E-02	20.00	0
RESULTS	5.51E-02	1	5.83E-02	17.14	0
TARGETS MET?					

PFD/STR Breakdown





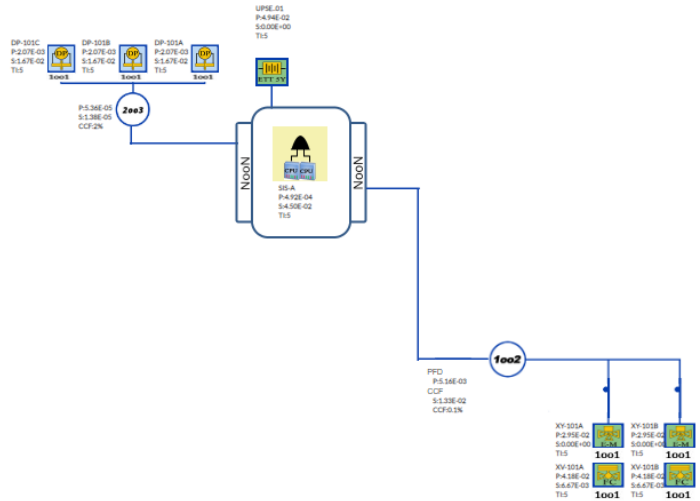
HFT_{IN}	HFT_{LS}	HFT_{ACT}
1	1	1

HFT_{SPT1}	HFT_{SPT2}	HFT_{MIN}	HFT_{MACT}
0			

Exit | Calculate and Save | Print | Reset

Exit to return to main Protective Function screen for this project

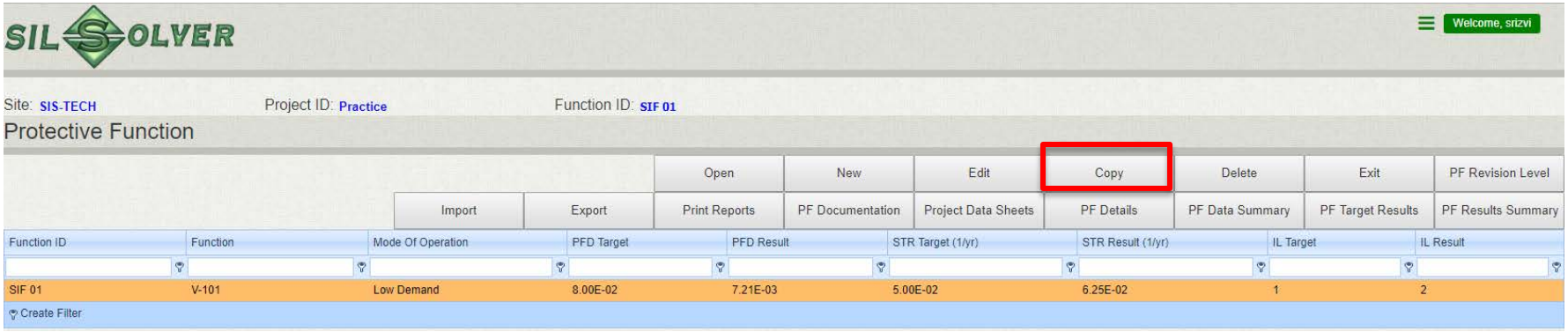
- SRS
- PROCESS HAZARD
- DESCRIPTION
- DIAGNOSTICS
- RESET
- SHUTDOWN
- REFERENCE
- COMMENTS
- LOGIC SOLVER
- INPUT CONFIGURATION
- INPUT DEVICE
- ACTION CONFIGURATION
- ACTION DEVICE
- SUPPORT CONFIGURATION
- SUPPORT SYSTEM
- CUSTOMER DEVICE
- MANUAL DEVICE



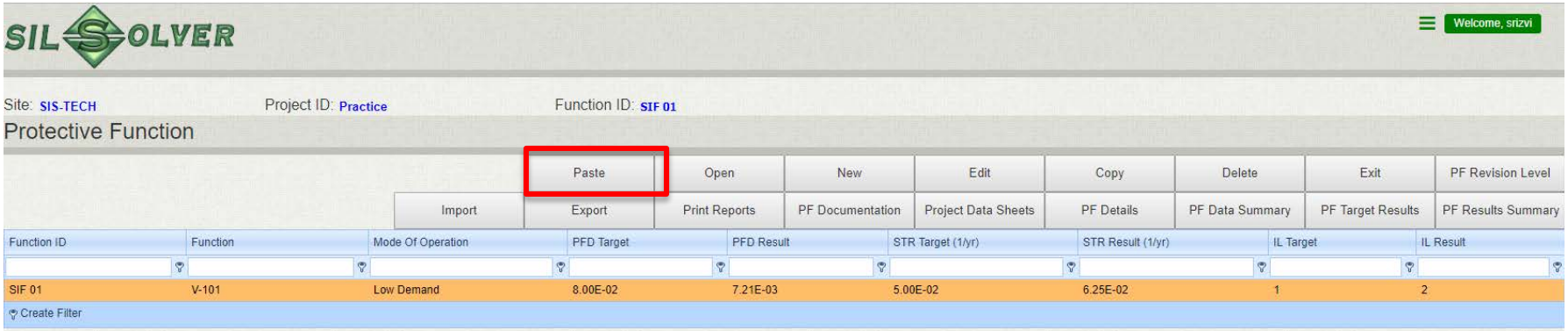
Second Function

- This project includes V-102 as well
- V-102 has an analogous protective function, SIF 02
- Key difference, SIF 02 uses a single pressure transmitter as the third device, instead of a DP
- Tags: DP-102A/B, PT-102, XV/XY-102A/B

Copy SIF 01



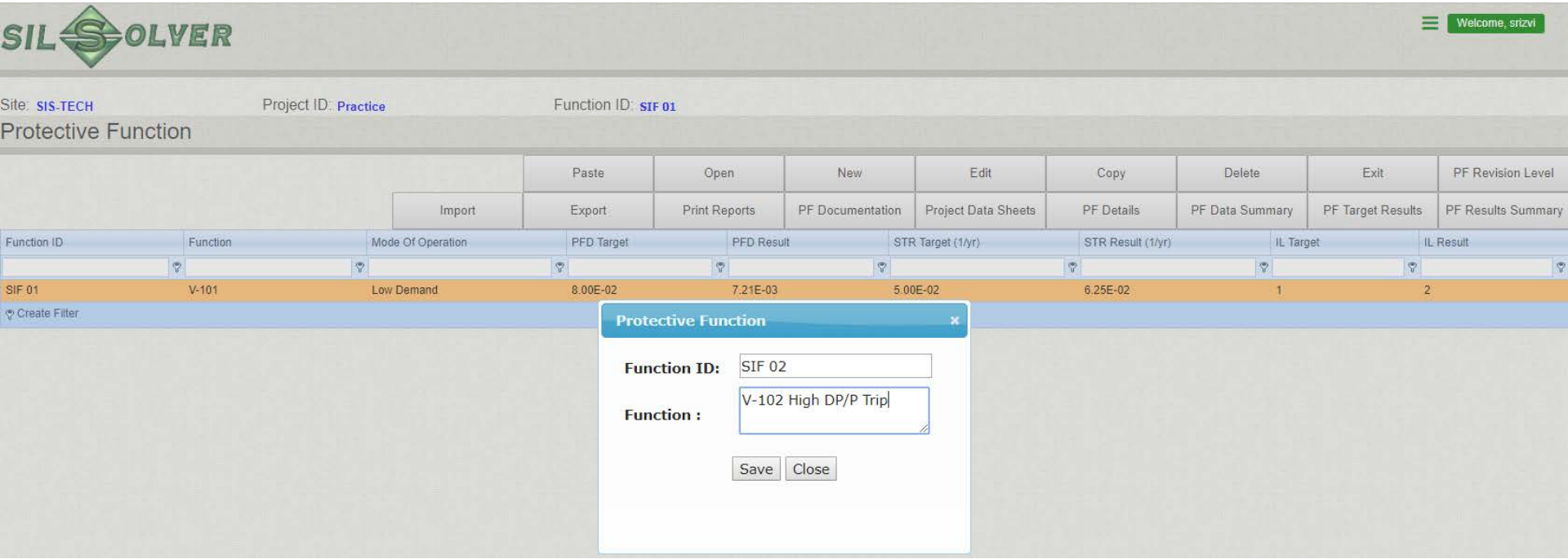
From the main Protective Function page, selecting the function to be copied and clicking the Copy button…



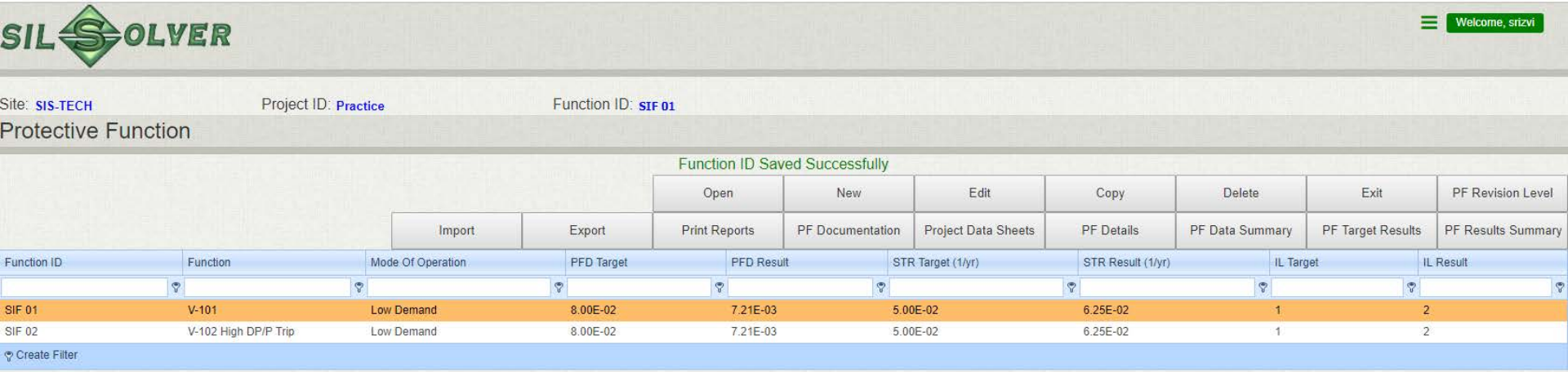
Causes the Paste button to activate…

Create SIF 02

Clicking the Paste button opens the dialog box to enter the new function ID and description



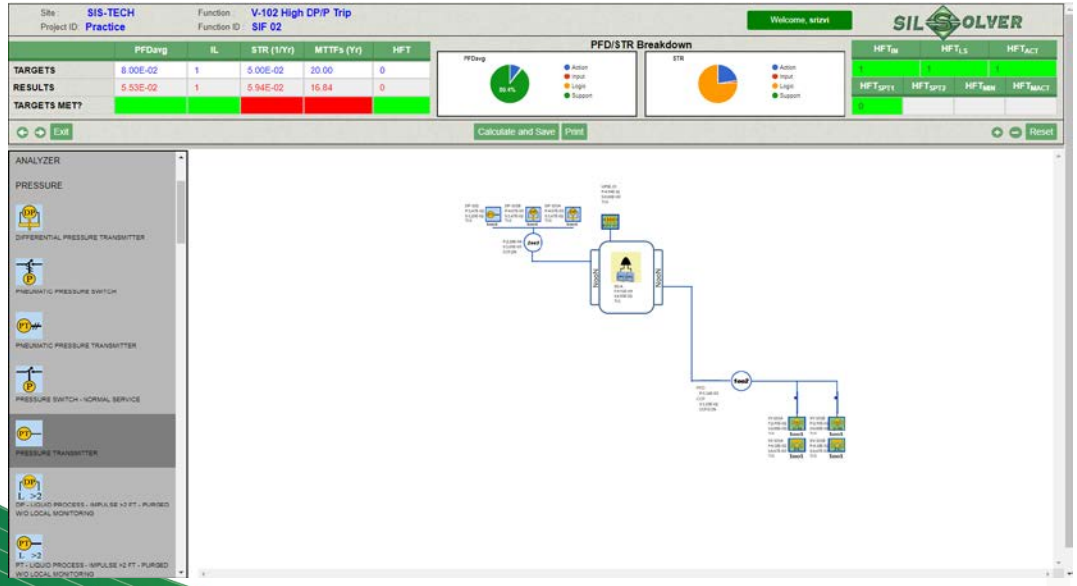
Success!

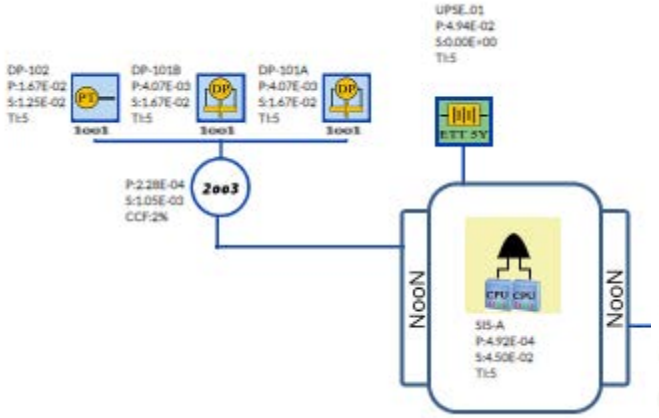


Select the new function and Open
Update tag ID fields for all devices

Modeling diverse sensors

1. Delete the third DP sensor
2. Copy General Pressure transmitter
3. Paste General pressure transmitter to the last box in the 2oo3 input configuration
4. Change Diagnostic level to DC2 for the two DP pressure transmitters and keep the General PT Diagnostic level as NO DC (no device to compare with).



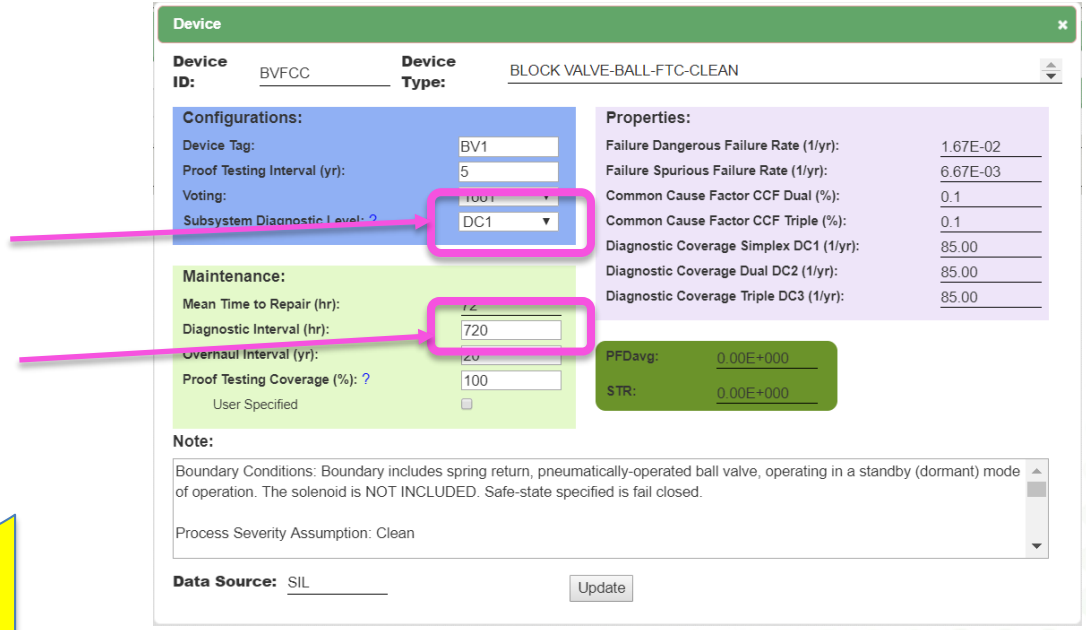


Partial Stroke Testing of Valves

- For valves, the DC selection can be used to model partial stroke testing

1. Set the diagnostic level to DC1

2. Set the diagnostic interval to partial stroke testing interval

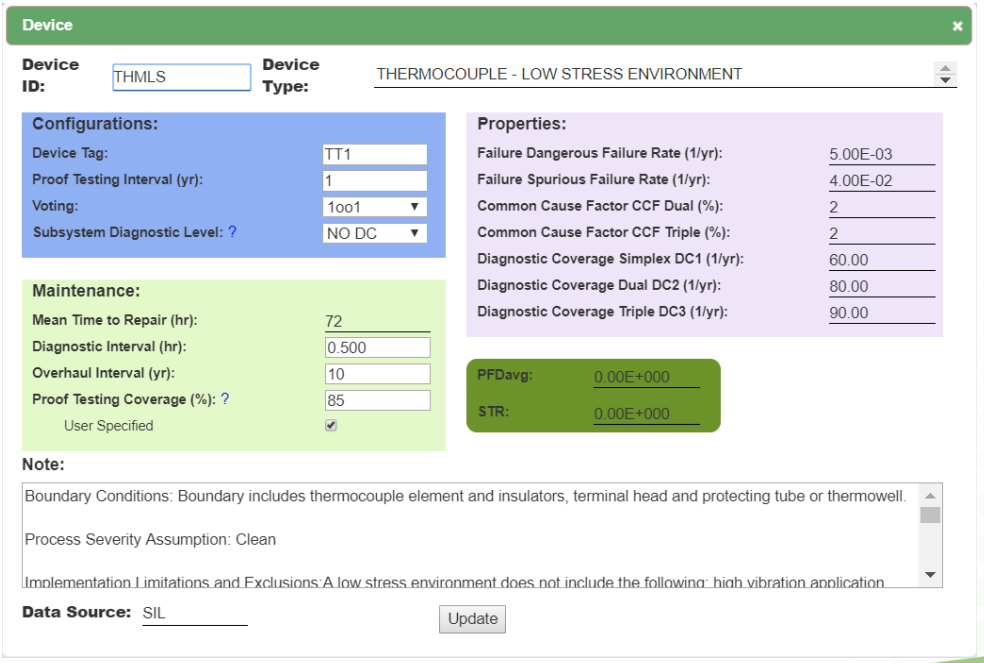


Both fields must be configured for correct use of equation

Partial Interim Testing of Sensors

- Sometimes an imperfect test is performed on a sensor at a shorter interval, with a 100% proof test (or complete replacement) performed at a longer interval
- Use the Proof Test coverage and Overhaul interval to model this

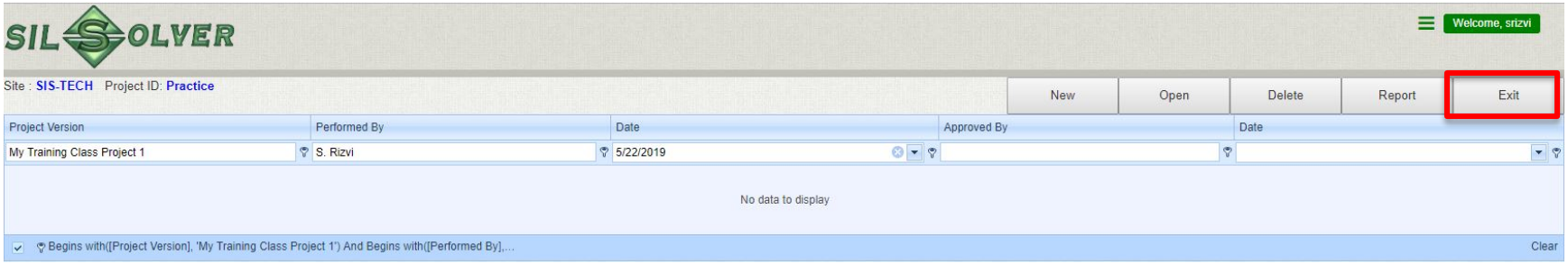
Example:
Sensor installation with an 85% test performed annually with 100% test or full replacement done every 10 years

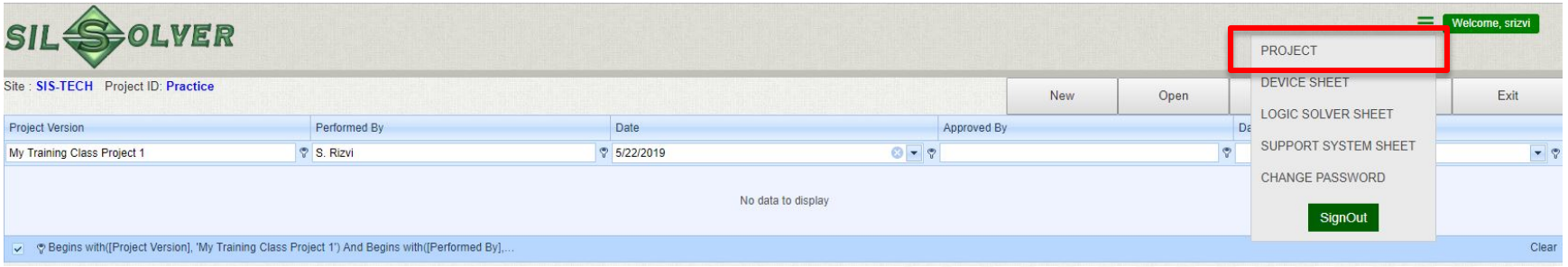


Both fields must be configured for correct use of equation

Getting back to Project Home

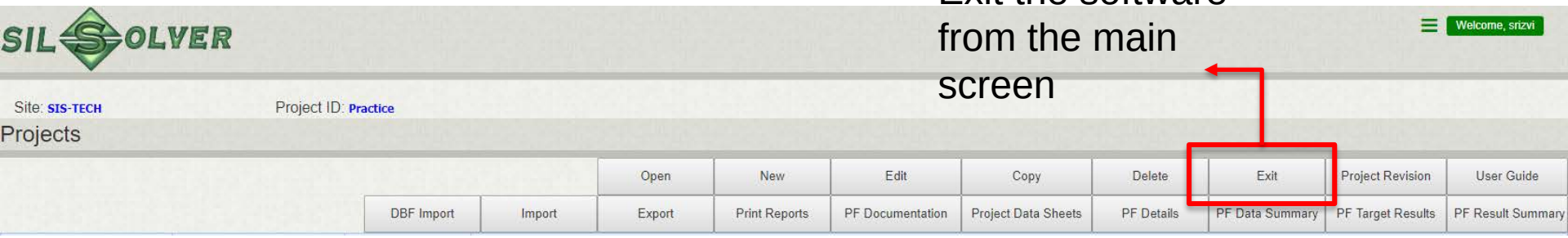
2 WAYS



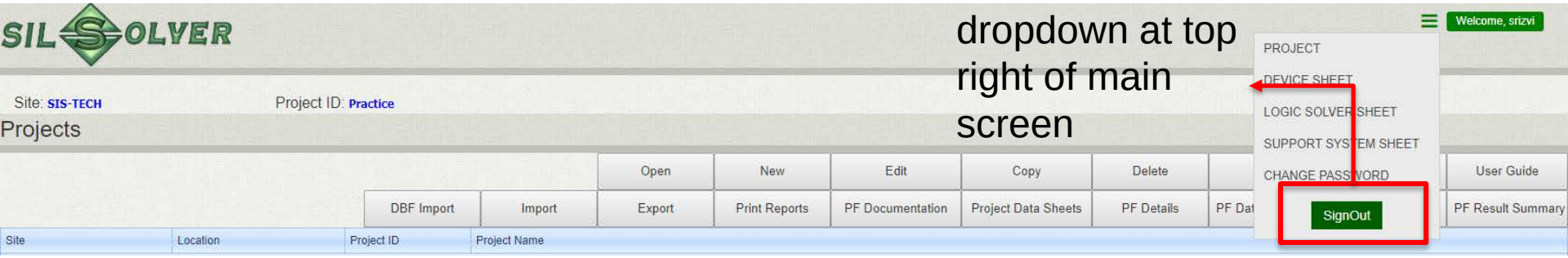


Exiting SIL Solver®?

Exit the software from the main screen



SignOut from the menu dropdown at top right of main screen

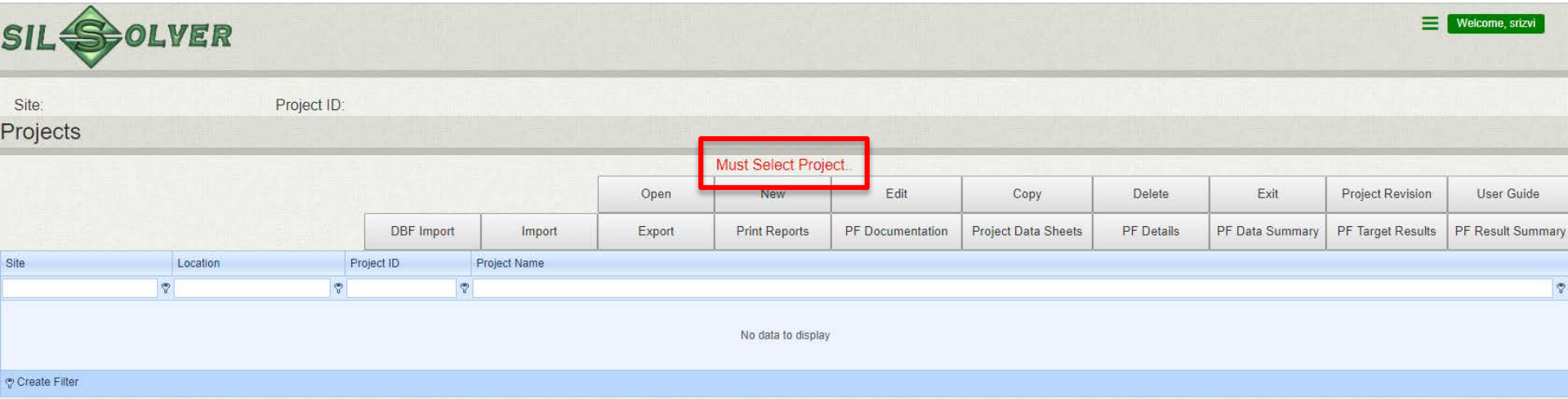


3. EDITING, COPYING OR DELETING AN EXISTING PROJECT

If click Edit on main screen when there are No projects…

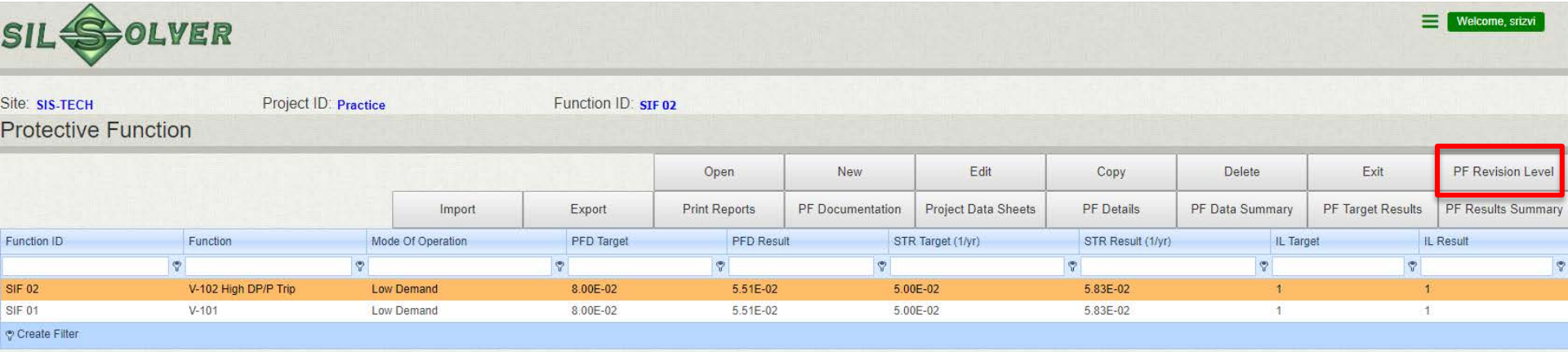
By default, the first project in the project list is selected.

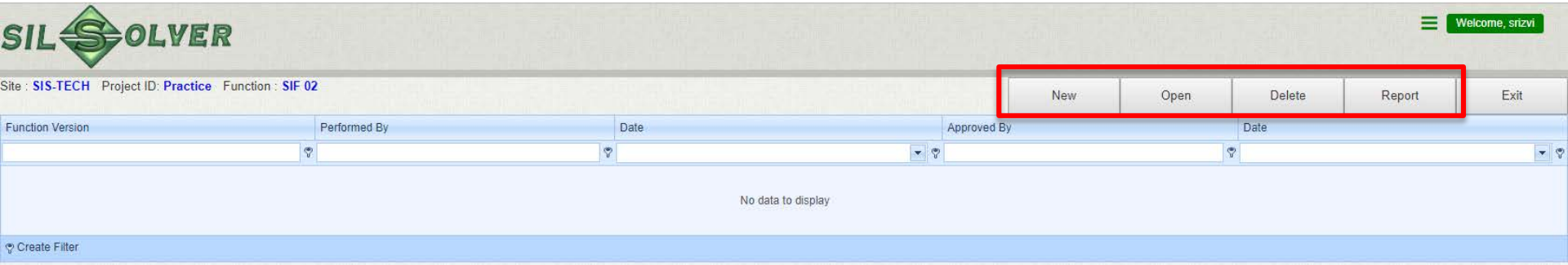
Error text will pop up if user attempts a feature (e.g., Edit) that requires a project to be selected and there are no projects in the list.



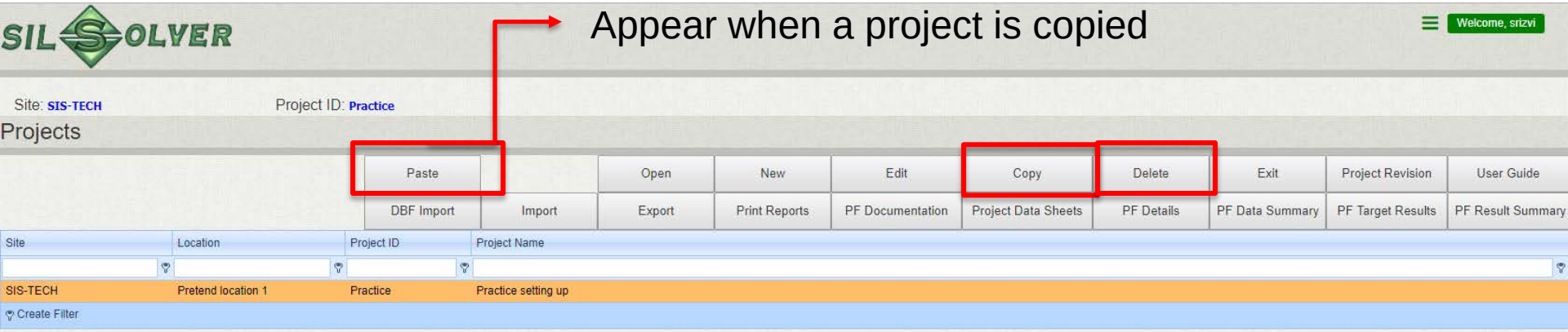
Function Revision Info

To create/edit function revision information, select the function and click “function Revision level” to get to the editing page, where you can create/edit and delete the function revision information





Copying or deleting a project works like copying or deleting a function

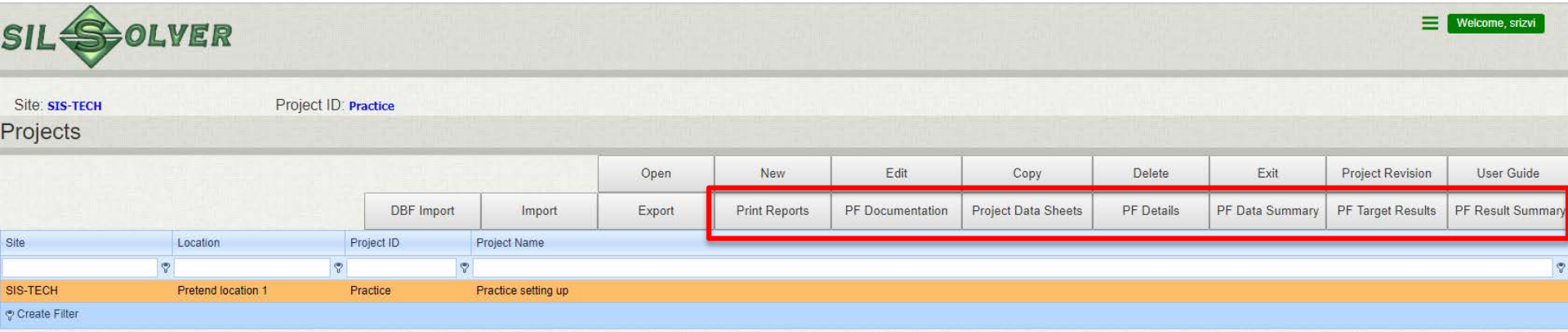


Select the project
Copy → Make a copy of the selected project and after that a paste button will appear, when “paste” is click a window will pop up for you to enter new project designation.
Delete → Delete the selected project

4. GENERATING REPORTS

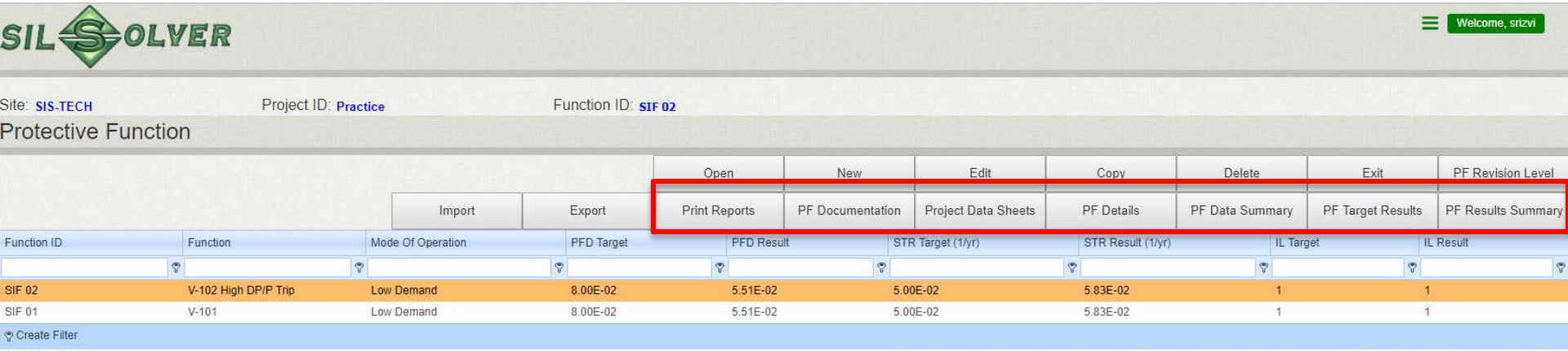
Project Report generation

Print the reports for the whole project by selecting project and click relevant report tab.
When the project reports are printed, the report will include project revision information



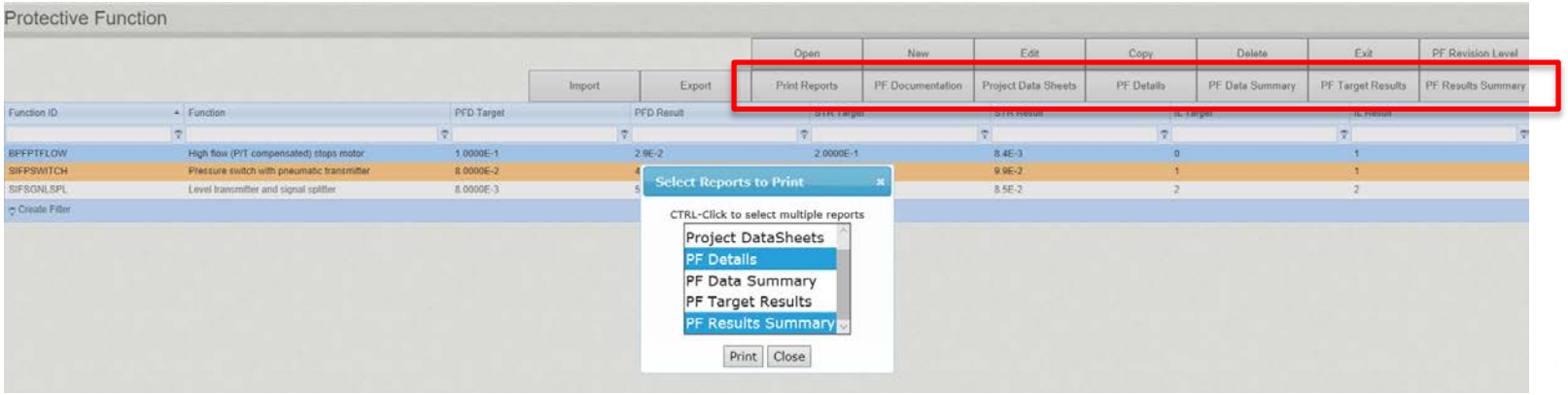
Function Report generation

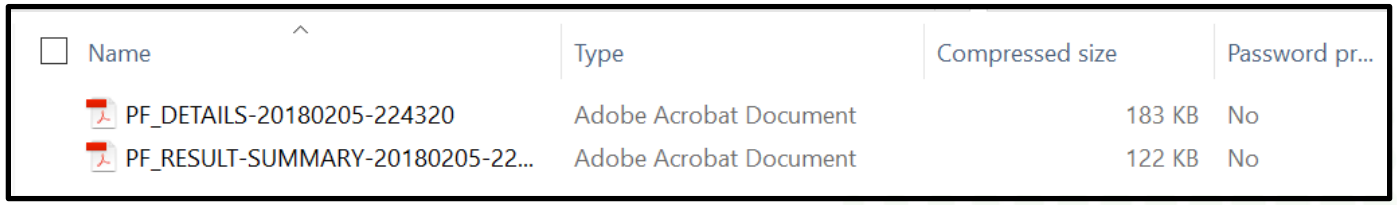
Print the reports for a function by going to the function list, select a function and click relevant report tab.
When the function level reports are printed, the report will include function revision information



Selecting Reports

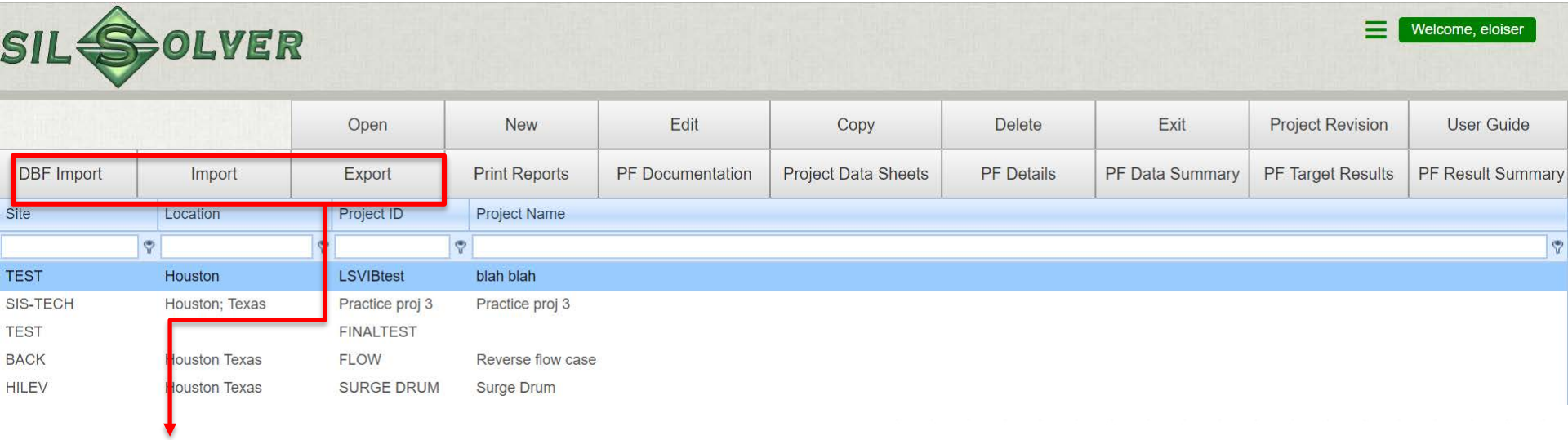
Use Print Report to select multiple reports at once or look at one at a time…





5. IMPORTING/EXPORTING

- Project export from SIL Solver® Enterprise
- SIL Solver® Enterprise project import
- Function Export/Import
- Importing SIL Solver® desktop application files into SIL Solver® Enterprise (DBF Import)

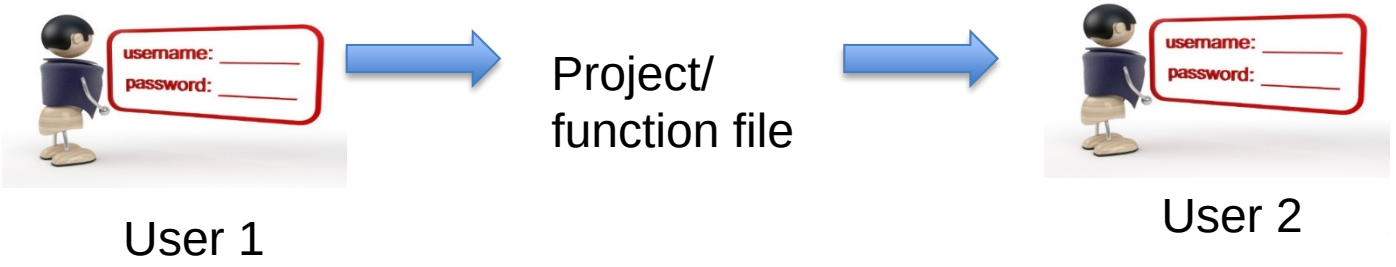


Used to transfer information

- between people
- between SIL SOLVER® Enterprise tool versions
- from SIL SOLVER® desktop program to SIL SOLVER® Enterprise

Import and export

- The way to share a project/function between SIL Solver® Enterprise users



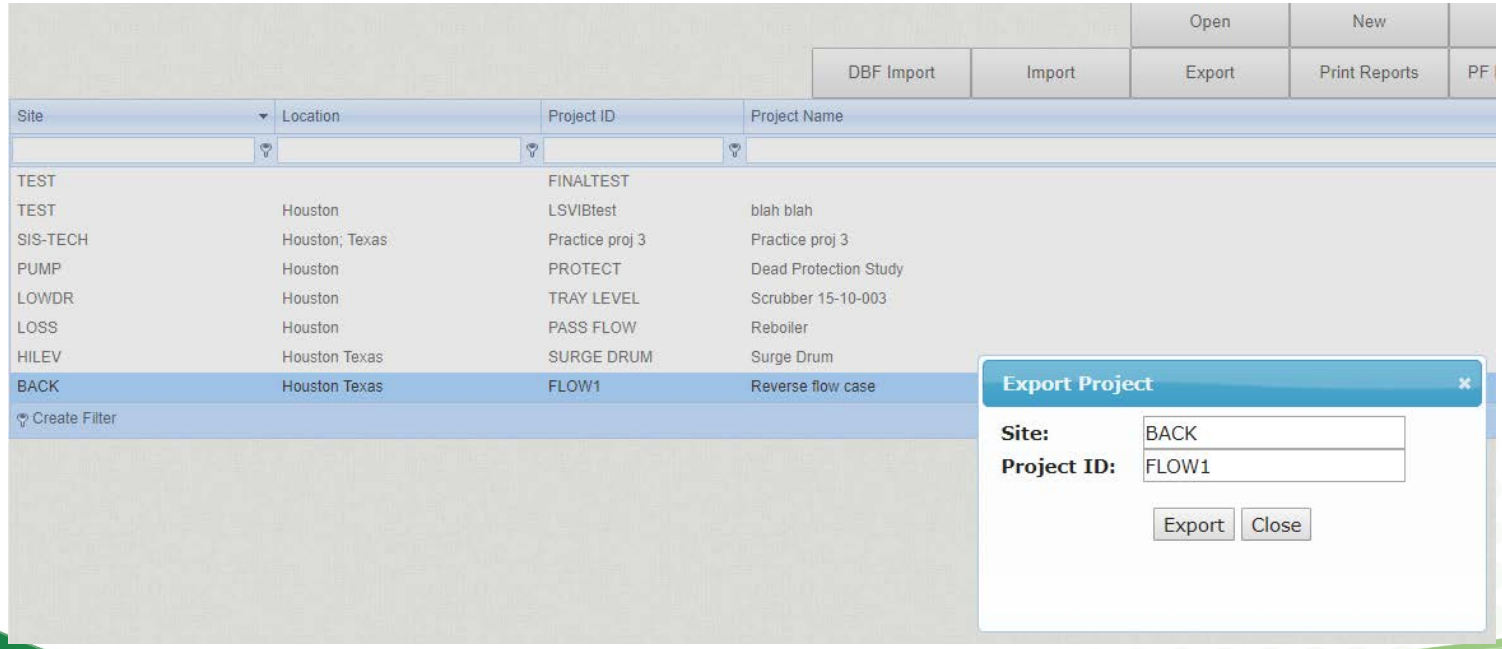
DBF Import

- The way to transfer a project from a SIL Solver® desktop program into SIL Solver® Enterprise

Project export

To export a project:

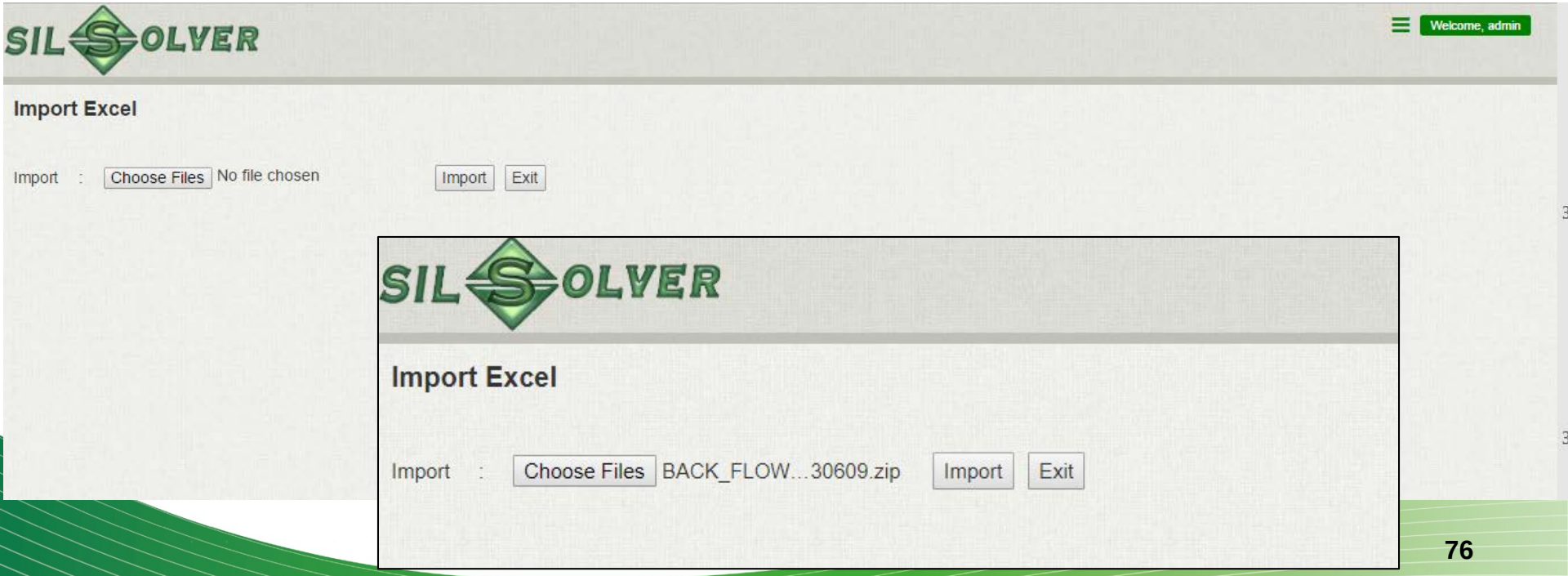
1. Go to the project page
2. Select the project
3. Click export – confirm the Site and ProjectID and click Export in dialog
4. A *.sifprj file of the project will be created in the download folder



Project import

To import a previously exported Enterprise project:

1. Go to the project page
2. Click import, the following page will open
3. Click “choose files”, then change the directory to the project (*.silprj)) file you want to import
4. Click Import and the tool will attempt to import the file



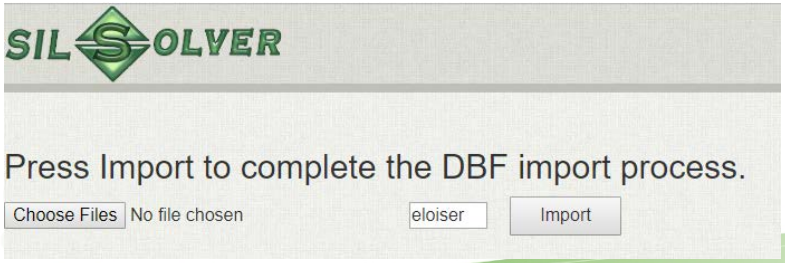
SIL Solver® Enterprise
Function export/import

To export/import an Enterprise function is the same as for a project, the only difference is that the operations are on the function level page and the exported file extension is *.silsif

DBF import to Enterprise

To import a **project** from SIL Solver® desktop versions into SIL SOLVER® Enterprise

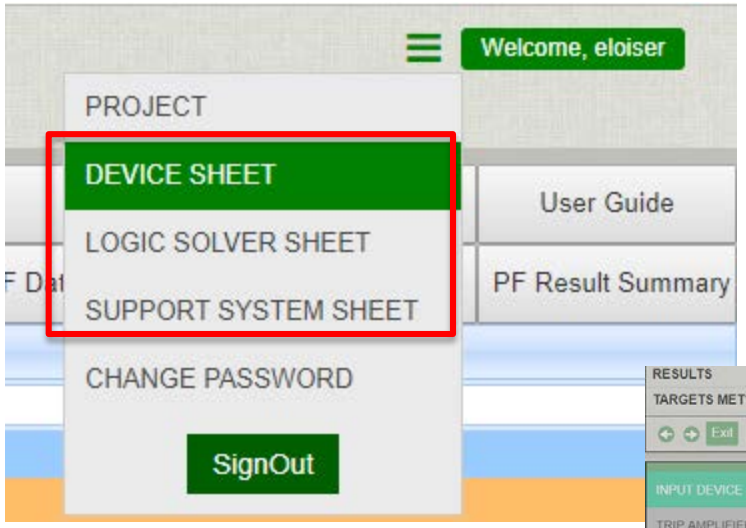
1. Go to the folder where you saved the desktop software project
   - For example the default directory: C:\SILSolver_Projects
2. Make sure the project folder name is correct, the files in the folder have not been modified, and no additional files have been added to the folder
3. Zip the project folder that you want to import to SIL Solver® Enterprise
4. Go to the SIL Solver® Enterprise project page
5. Click “DBF import” tab, the following page will open
6. Click Choose Files to browse to the Zipped project folder
7. Click “Upload_ZipFile”
8. When the upload is ready, click import
9. A message will pop up when the import is done, including any warnings



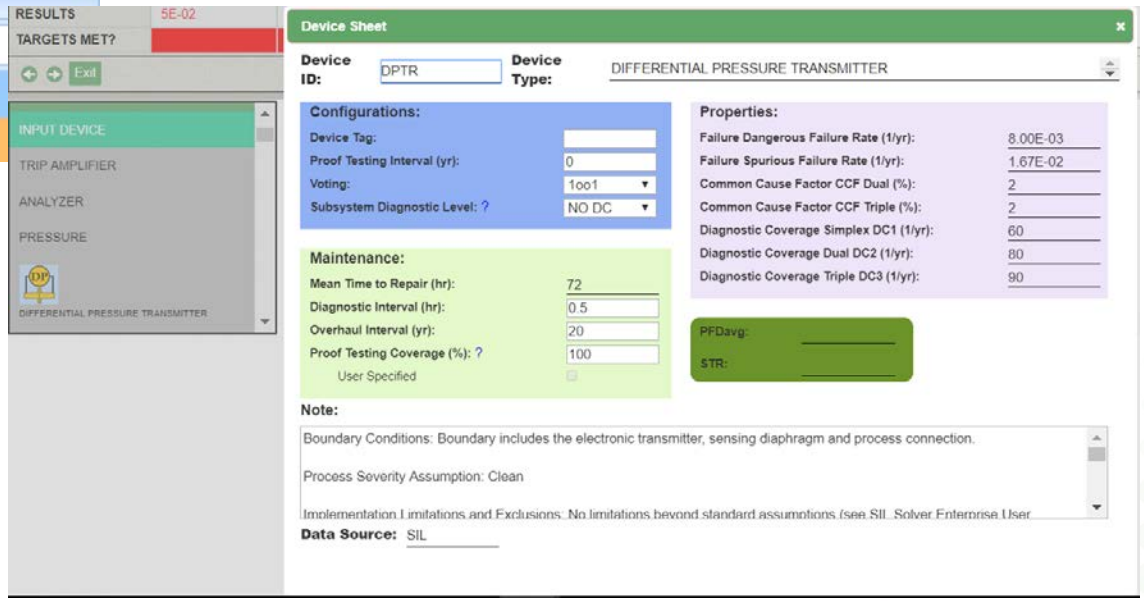
6. DATASHEETS

- Device
- Logic Solver
- Support System

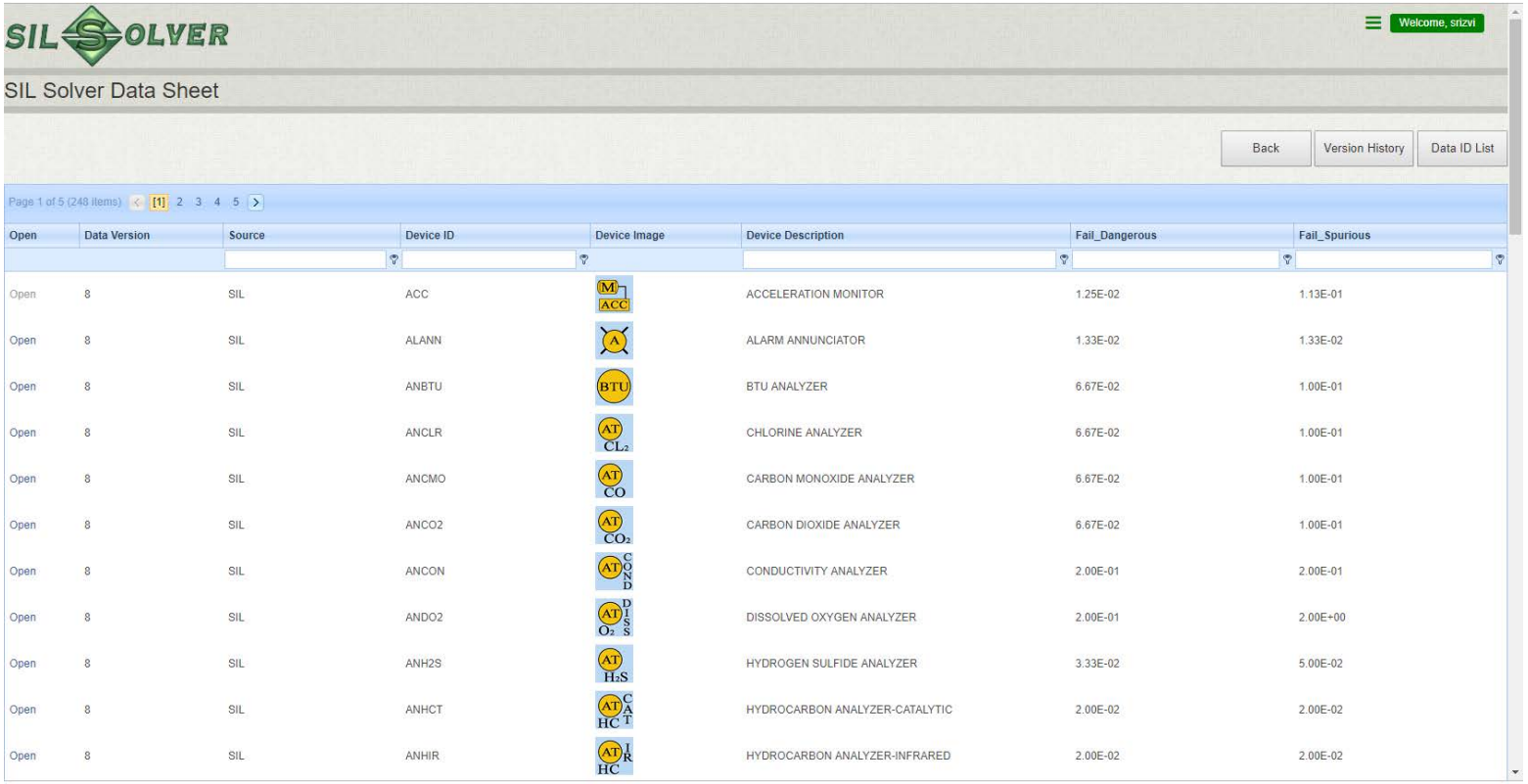
Accessing Datasheets



Access from main page dropdown menu or for individual devices right-click when in device list on GUI



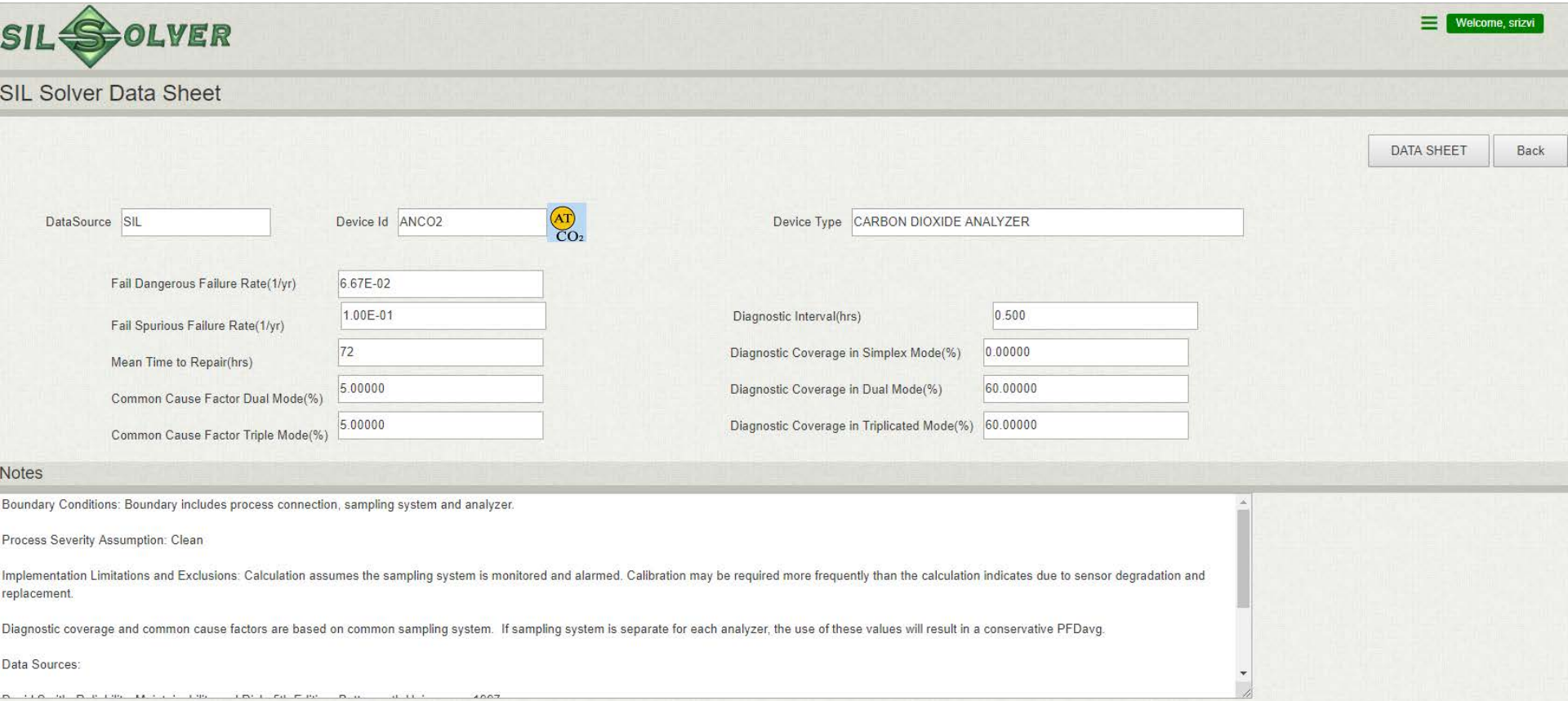
Device datasheet list



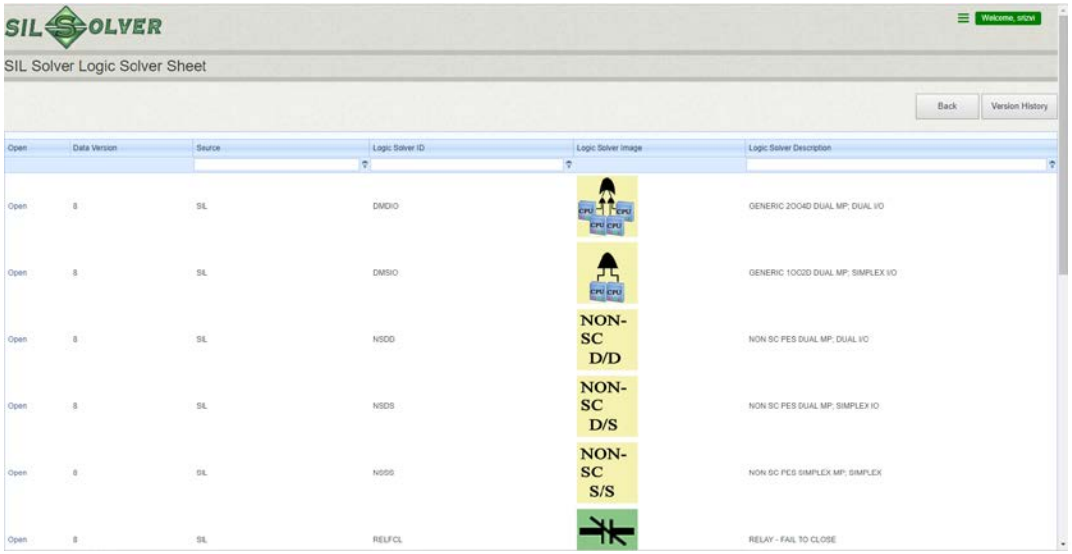
Open	Data Version	Source	Device ID	Device Image	Device Description	Fail_Dangerous	Fail_Spurious
Open	8	SIL	ACC		ACCELERATION MONITOR	1.25E-02	1.13E-01
Open	8	SIL	ALANN		ALARM ANNUNCIATOR	1.33E-02	1.33E-02
Open	8	SIL	ANBTU		BTU ANALYZER	6.67E-02	1.00E-01
Open	8	SIL	ANCLR		CHLORINE ANALYZER	6.67E-02	1.00E-01
Open	8	SIL	ANCMO		CARBON MONOXIDE ANALYZER	6.67E-02	1.00E-01
Open	8	SIL	ANCO2		CARBON DIOXIDE ANALYZER	6.67E-02	1.00E-01
Open	8	SIL	ANCON		CONDUCTIVITY ANALYZER	2.00E-01	2.00E-01
Open	8	SIL	ANDO2		DISSOLVED OXYGEN ANALYZER	2.00E-01	2.00E+00
Open	8	SIL	ANH2S		HYDROGEN SULFIDE ANALYZER	3.33E-02	5.00E-02
Open	8	SIL	ANHCT		HYDROCARBON ANALYZER-CATALYTIC	2.00E-02	2.00E-02
Open	8	SIL	ANHIR		HYDROCARBON ANALYZER-INFRARED	2.00E-02	2.00E-02

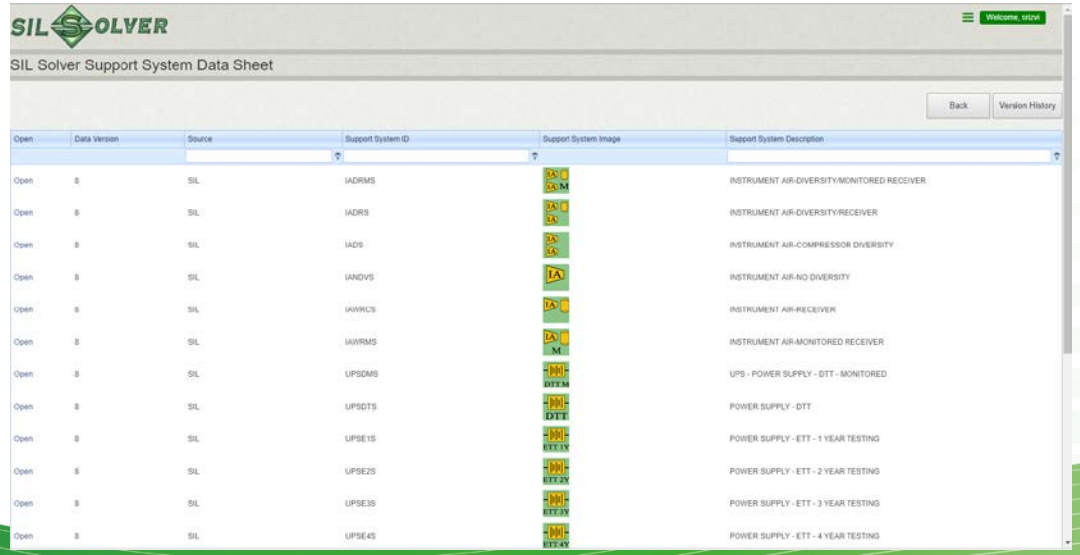
- Click open (far left) to look at the datasheet for that device

Device Datasheet

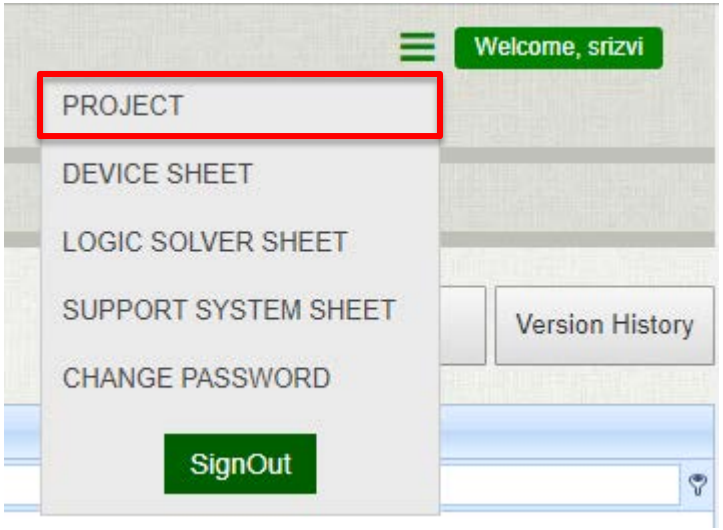


Same for LS and Support Systems





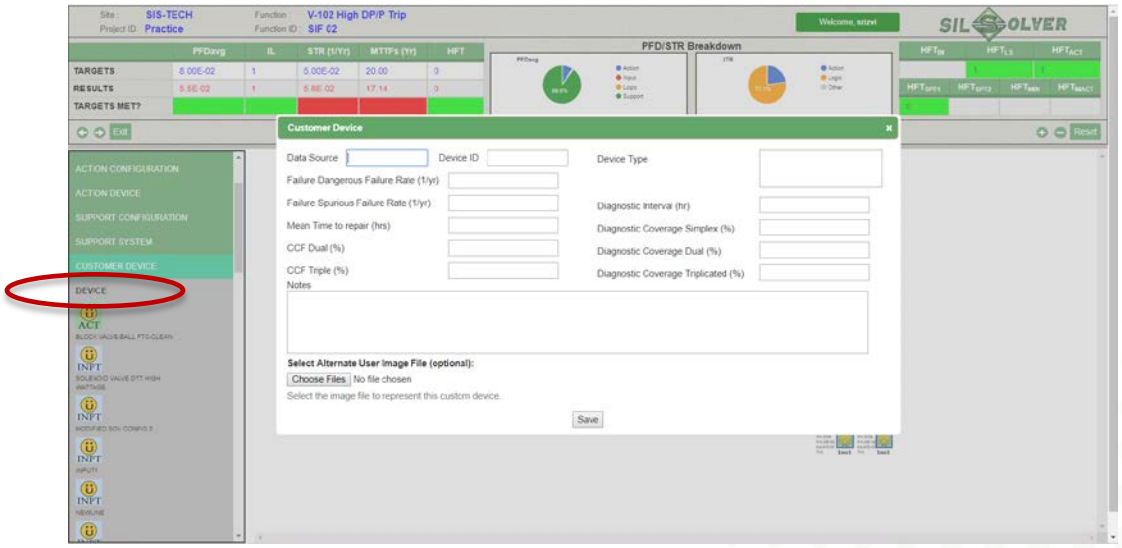
Returning to Project View



Click Project on the dropdown menu or use Back buttons on the datasheet pages

Adding a Custom Datasheet

- From GUI page, go to bottom of lists to the Customer Device section
- Left-click the **header** for the type of sheet this will be
- Enter the data for the new custom device and Save
  - Do not use special characters in the Data Source or Device ID fields
  - If desired, browse to a new image for this device to replace the default



Once created, custom datasheets are available to anyone on the server!

7. TROUBLESHOOTING

- Lost passwords
- Screen settings
- Import challenges
- Disconnects/timing out

Troubleshooting:
Lost Username or Password

- Individual username and password assignment is performed by the company that purchases the license through the ADMIN account for that license

Troubleshooting: Screen Settings

- Some SIL Solver® Enterprise application screen content may be obscured if
  - Window is not maximized
  - Zoom >100% is used on the window

Troubleshooting: Import Challenges

- When importing, confirm the final function successfully transferred into SIL Solver® Enterprise
- If warnings are generated during the import, there is an import log file that can be downloaded
- For DBF Import, use the Windows native “Send to” “Compressed (zipped) folder” feature, not any other zip application

Troubleshooting: Disconnects/Timing Out

- Do not delay too long before saving.
- SIL Solver® Enterprise will time out after a period of inactivity.
- A warning screen will pop up during the last minute.
  - Click “Yes” to extend the session