Standards SPC

Real time Statistical Process Control
LabSpeed Feature Add-in
Topos Technologies, Inc

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Standards SPC Overview

Standards SPC is a LabSpeed Feature add-in that provides automated statistical process control for control standards.

- Upper and lower control limits may be automatically calculated and saved for each instrument standard.
- Standards are monitored in real-time, data is evaluated against pre-set rules, and a Pass / Fail status is automatically displayed.
- Results may be analyzed using X/Bar and X/Bar-MR charts.
- Samples and elements may be excluded and tagged with user-entered notes.
- Historical evaluations may be retrieved for later analysis.

When the Standards SPC feature add-in is installed, a special top-level menu will appear in LabSpeed. All Standards SPC setup and operation functions are accessed through this menu:
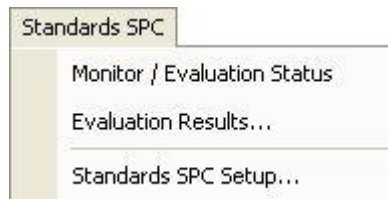
1. **Monitor / Evaluation Status** - display the current status of the most recently run standard
2. **Evaluation Results** - analyze saved evaluation results using charts
3. **Standards SPC Setup** - define standard control limits and monitoring conditions

Running and Monitoring Samples

Standard SPC works with instrument data that is imported into the Topos SQL Server database. Data is imported automatically by the service controller that monitors for newly exported instrument data. As the data is imported into the Topos SQL Server database, it is "tagged" with the instrument identifier. For more information, refer to the LabSpeed File Monitor Service User Guide, which is available under the Start Menu at "Start->All Programs->Topos Technologies->LabSpeed Services".

Standard SPC constantly checks the Topos SQL Server database for newly saved sample data. If a new sample matches the standard and identifier for one of the running Standard SPC Monitors, it will be loaded and evaluated. Depending on the rules being checked, multiple samples may be loaded in order to perform the evaluation. If an evaluation fails, the Monitor Status window and/or the Failure Warning dialog will pop up, alerting the operator. At that time the operator can determine what went wrong using Charts and add notes and/or exclude the sample.

Standard SPC Monitors can be setup to run automatically when LabSpeed starts up, or can be started manually from the *Standard SPC - Monitor / Evaluation Status* menu. In order for control standards to be evaluated in real-time, LabSpeed AND one or more Monitors must be running.

The Instrument Identifier

The instrument identifier is an important concept in Standards SPC setup and monitoring. The instrument identifier is a string value that identifies a specific instrument in the laboratory. It is important to be able to identify a standard that was run on a specific instrument if there are multiple instruments of the same type in a laboratory.

The instrument identifier is a user-entered value entered into the Service Controller settings dialog and is referred to as the "Service Identifier" there. By default it is blank and should be changed to a descriptive value, such as "Spark-1" or "Spark-Lab1". It's a good idea to include the instrument type (in this case Spark) in the name. Once specified, it should not be changed. This string value is used to filter samples and standards that are run on a specific instrument, for example, when calculating control limits.
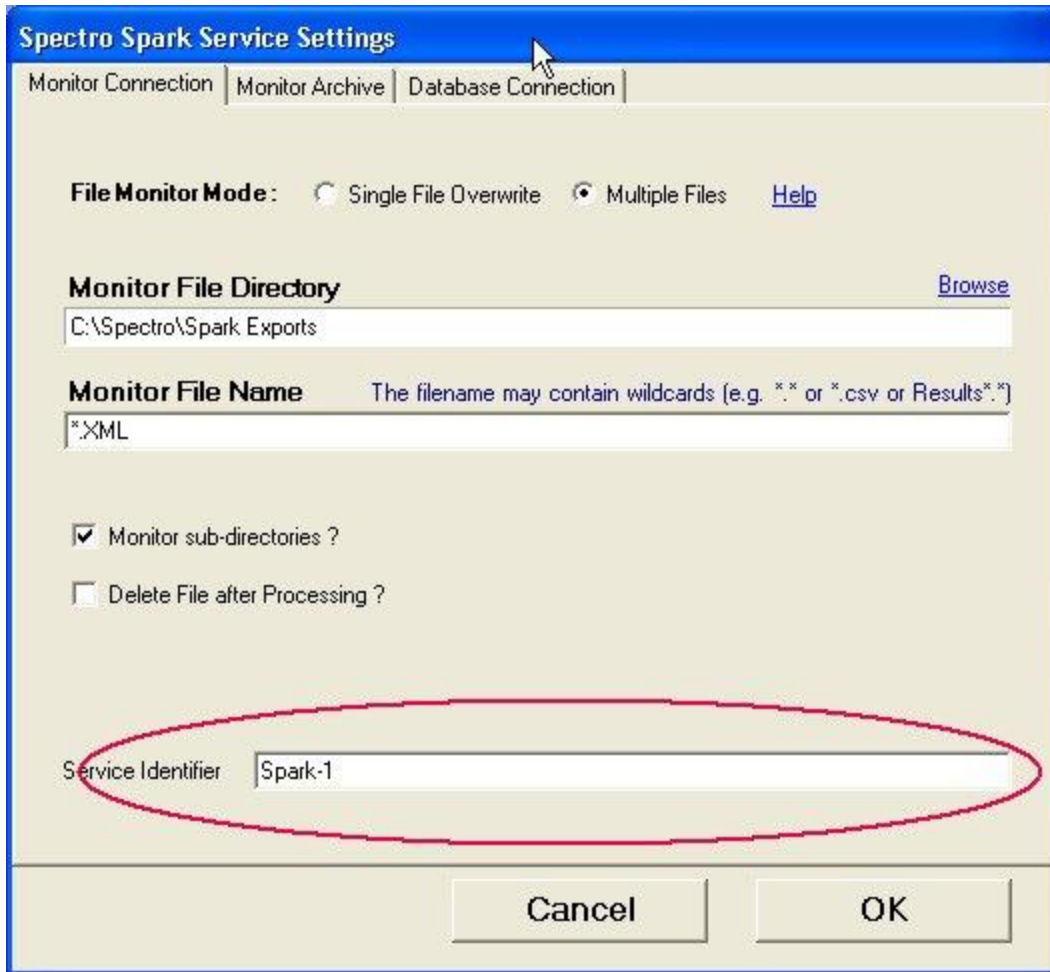
If you have only one instrument in the laboratory which is being monitored by Standards SPC, then the instrument identifier is not necessary. However, it is still recommended to specify an instrument identifier in the event additional instruments are added in the future.

Setting the Instrument identifier.

Double-click on the Service Controller tray icon (lower right in the taskbar) . This will bring up the Service Controller status window.

If the service is running, click "Stop". Click on "Settings..."

Enter a unique Service Identifier that will identify the instrument it is running on. Once entered, it should not be changed. Going forward, every sample imported into the database will be assigned this identifier to keep it separate from data generated by other instruments in the laboratory that are being monitored.

Click "OK" to exit. Remember to restart the service before closing the controller window.

All *future* samples imported into the database will be tagged with the new Identifier.

Standards SPC Setup

Standards SPC Setup Overview

This is where all standard control information and monitor parameters are defined and saved to the database. Click the Standards SPC Setup... menu item to bring up the Standards SPC Setup dialog:
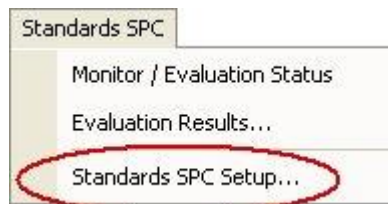
For security, all setup operations are password-protected. A default password "**Admin**" is supplied with the software, which can be changed by the administrator to control who has access to all setup operations.
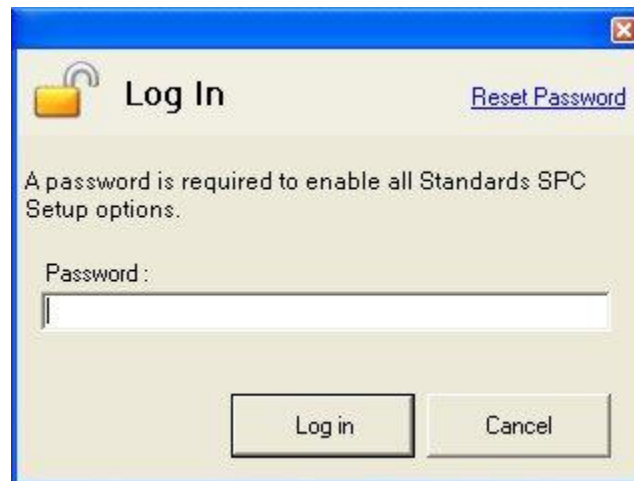
The Standards SPC Setup Dialog has three setup operations:

1. **Standards Setup** - this is where all standard control information and limits are defined and saved
2. **Monitor / Evaluation Setup** - this is where all monitor conditions and evaluation rules are setup
3. **Preferences Setup** - this is where all operational defaults are setup
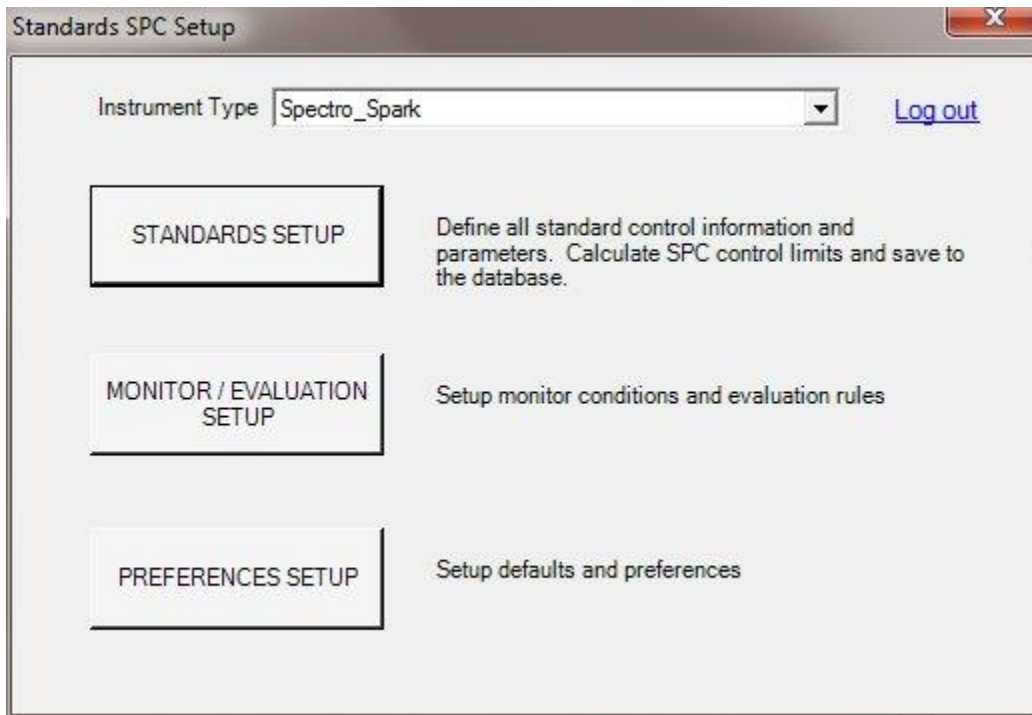
Instrument Type Selection: When there is more than one instrument installed for SPC monitoring, select the instrument to be used for Standards Setup and Monitor/Evaluation Setup.

Standards SPC Setup Security

For security, all setup operations are password-protected. The Log in dialog will pop up automatically when accessing Standards SPC Setup via the menu. A default password "**Admin**" is supplied with the software, which should be changed by the administrator to control who has access to all setup operations.
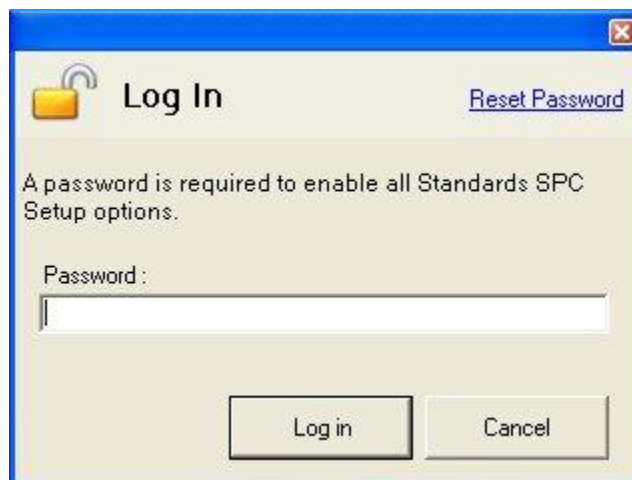
To change the current password, click the <u>Reset Password</u> button.

Enter the current and new passwords and click Save.

Warning: Write down the password and keep it in a safe place. If you forget the password, you will no longer be able to access the Setup operations. In the unlikely event this should happen, please contact Topos Technologies at labspeedsupport@topostech.com for obtaining reset instructions.

Standards Setup

This is where all the control limits for Instrument standards are defined. Control limits at standard deviation values of 1 to 6 sigma (+/-) may be automatically calculated from existing standard data, or control limits may be manually entered. Limits may "evolve" over time as more and more samples are run. Once a representative number of sample data has been run, the limits and all associated parameters may be "locked" to prevent changes.

Typical Scenario

- Select an existing SPC standard record, or create a new record for another instrument standard.
- Select a range of samples to use for generating limits.

- Use interactive Charts to calculate the limits for all elements, or enter manual values
- Use interactive Charts to exclude samples or specific elements within a standard
- Save all changes to the Standards SPC database

Standards Setup Tabs

Setup Standard Parameters
Charts
Table
Limits Editor

Setup Standard Parameters

Add Standard

Standards are added to the Standards SPC database by clicking on the Add Standard button. A list of existing standards from the current instrument database (that do not already have an SPC record) will be presented for selection. There may be multiple entries for the same standard, which differ only by the identifier, including the <All> identifier (the identifier identifies the unique instrument the sample was run on). Select

a standard and click "OK". A new record will be created for this standard. You will need to choose "Select Samples" to define the range of samples to use for calculating limits.

Load a Standard SPC Record from the Database

Standards that have already been added to the Standards SPC database may be opened by selecting from the drop-down list. When a standard is loaded, all parameters are loaded with it, including all limits and the exact sample list that was used to calculate the limits.

Select Samples

Click on "Select Samples" to browse the instrument database for standard data. There are three ways to select a specific range of samples that will be used to calculate Limits:

1. enter a start and end date
2. enter a start date and number of samples
3. enter a start date and Last N (previous) number of samples

Choose a method and click "Search".

Subset Elements

When selecting samples in the Browser, click on the **Elems / Order** tab. Choose a subset of elements and optionally setup a specific element display order. By default, all elements are enabled in the original method display order.

Click "Get All" to load the displayed sample list and element list.

Load Standard Samples Last Used

Click on the "Load Standard Samples Last Used" to re-load the list of samples and element list as last saved to the database.

Target Sigma

This is the default sigma value to use when calculating limits. It can be changed to any value from 1 to 6.

Delete Standard

Click on the Delete Standard button to remove the Standard SPC record from the database, including any calculated limits. It can be added back in again by selecting Add Standard.

Lock Standard

Click on the Lock Standard button to prevent any changes to the database. You may still "play" or experiment, but any changes to limits or other parameters will be temporary only. Click again to unlock the standard. While the standard is unlocked, all changes can be saved to the database, thus overriding existing saved limits.

The <All> Instrument Identifier

If a standard was added with the <All> identifier, it will be used to define limits for all instruments of the same type, regardless of what instrument the standard was run on.

Charts

Once a standard is loaded and a range of samples selected click on the "Charts" tab. A list of elements will be displayed on the left side. The first element will be selected and results plotted in a X-Bar (top) and X-Bar/MR chart (bottom). The X-Bar chart is plotted with the calculated mean for each element across all samples, along with the upper and lower control limits. The X-Bar/MR chart (Moving Range) represents the *absolute value* of the point differences of the X-Bar chart data (y2 - y1, y3 - y2, etc.). On the right side are the calculated +/-n Sigma values, the Mean and the UCL, LCL (upper and lower control limit). Optionally, there is a space for manually entering USL, LSL (upper and lower specification limits that are used to calculate the CpK, process control index).

Defining Control Limits

Click on "Calculate Limits" to calculate the limits for the current element only.
Click on "Calculate Limits for All Elements" to calculate the limits for all elements.
Enter values in the UCL and LCL fields to manually override calculated values for the current element.

Excluding Samples and points

A major reason for excluding samples is because the data is bad, or the wrong sample was run.

Right click on any point on the graph. A window will pop up allowing you to exclude the point (the element in a specific standard), or the whole standard.
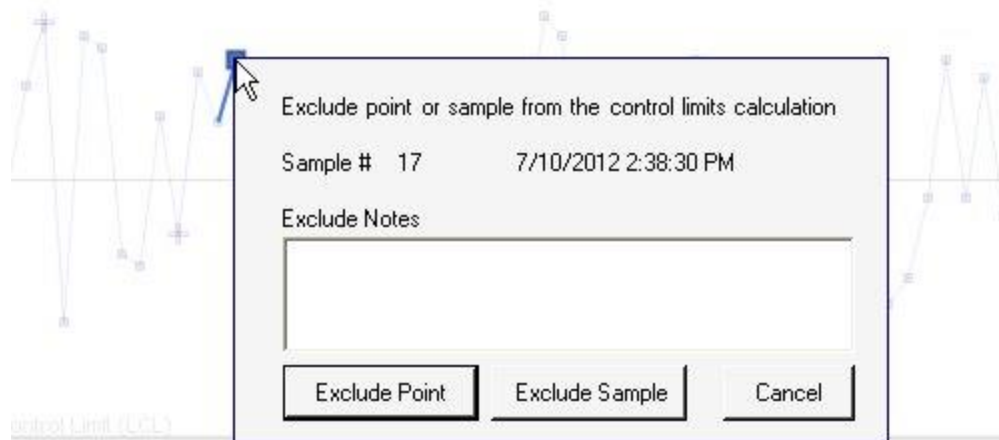
When excluding a point or sample, notes are required. These will be saved with the data and retrieved when viewing the excluded sample information at a later time. Excluded points are not included in the UCL and LCL calculations. The calculations are not re-performed automatically. After excluding a point or sample, you may wish to re-calculate the Limits.

An excluded point is displayed in a purple Cross marker (see chart above for examples of excluded points). Hovering the mouse over an excluded point will pop up a tool-tip with the exclude information included:

Changing Exclude Notes and Recovering Excluded Samples or Points

Right-Clicking on the excluded point allows you to view and/or change the existing Notes and also to recover the point or sample:

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Sample #14, 7/10/2012 2:35:21 PM has been excluded

Exclude Notes

This sample was excluded because the wrong standard was run

[Recover Sample?]   [OK]   [Cancel]
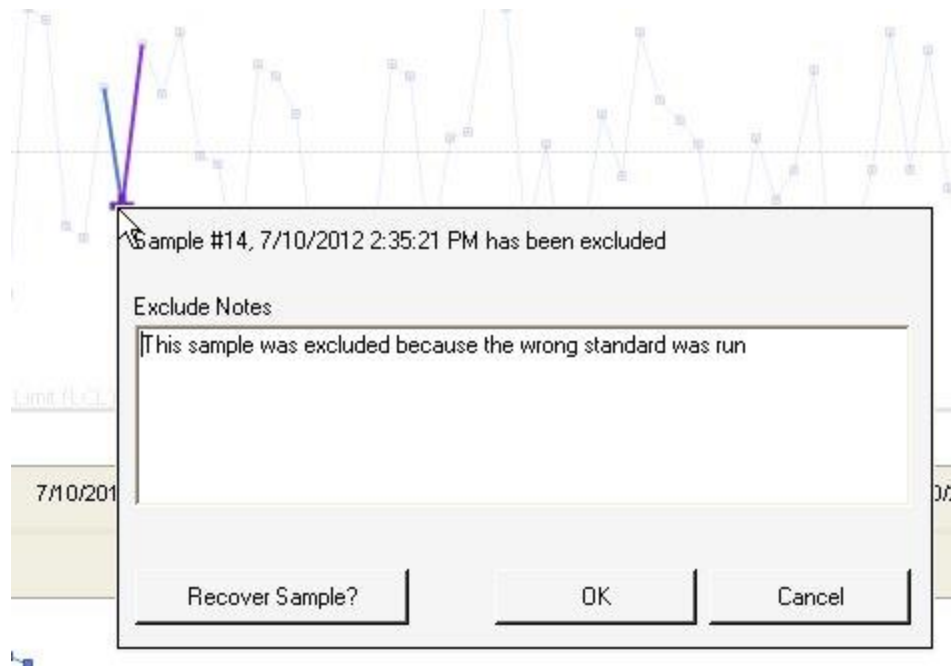
If just viewing the notes, click Cancel when done.

If updating the notes, change the Notes and click OK.

if recovering the sample, click on the "Recover Sample?" button. This will un-mark the standard (or point) as excluded. After recovering a point or sample, you may wish to re-calculate the Limits.

Show Excluded Points

The chart can be displayed with the excluded points or without the excluded points. When displayed with the excluded points, these points are displayed with a purple Cross marker. Typically, excluded points will have results that are very different than the majority of other points, either because the data is bad or the wrong standard was run. This can affect the overall scale of chart making it harder to read (the chart is always scaled to include all points and limits).

To show exclude point, *check* to box "Show Excluded Points".
To show the chart without excluded points, *un-check* the box "Show Excluded Points".

Show USL and LSL

The USL and LSL values are manually-entered specification limits. Check this item to display the USL (Upper Specification Limit) and LSL (Lower Specification Limit) lines on the chart. The chart will be automatically scaled to ensure the lines are visible.   Specification limits are optional and used to calculate the CpK (process control index).
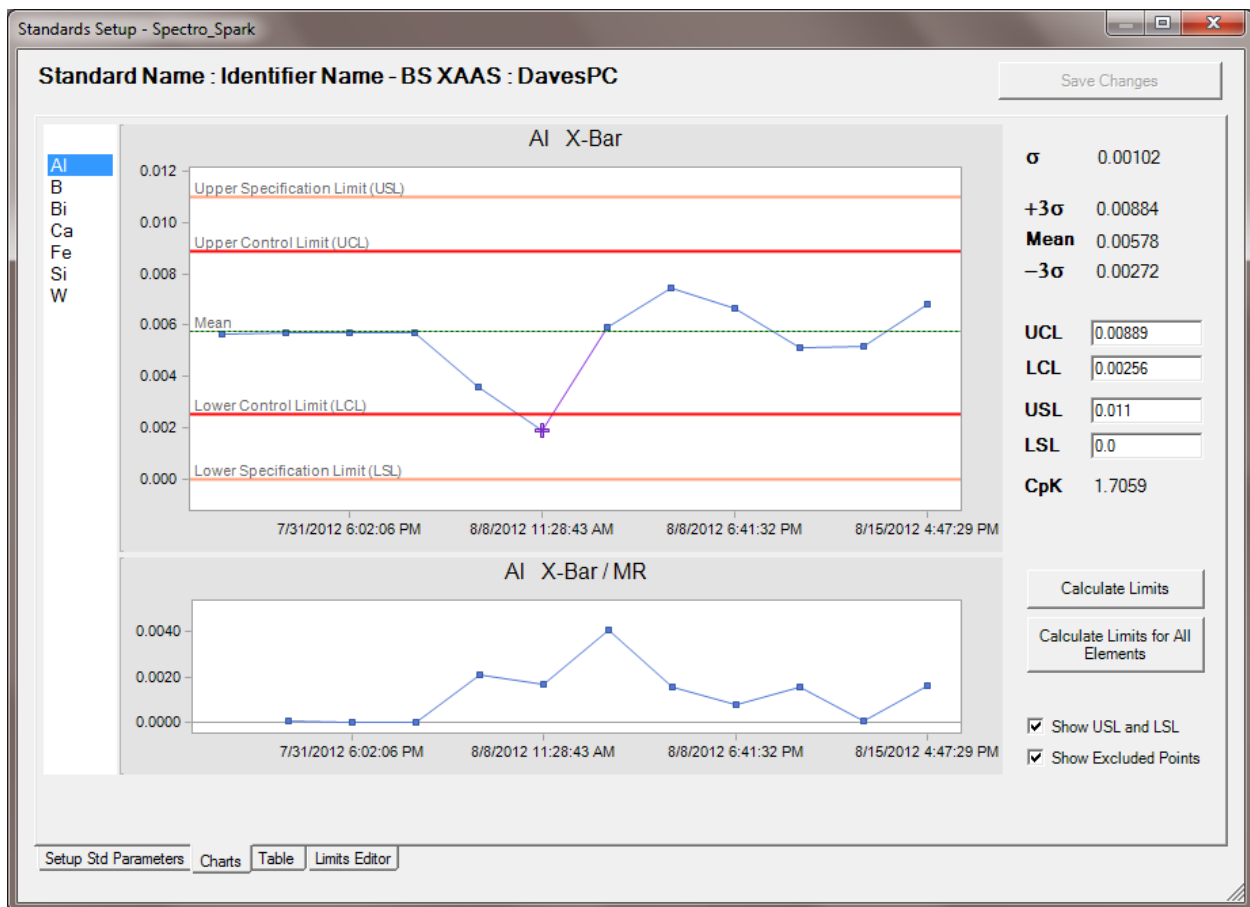
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Vertical Cursor Line

A standard (point) may be identified using a vertical line. This can help to identify the same standard for different elements. To assign a vertical line to a point, hover over the point and when it is selected, click the LEFT mouse button.   Repeat this to remove the line. There can be only one vertical cursor line. If another point is assigned a vertical line, a previous line is moved.
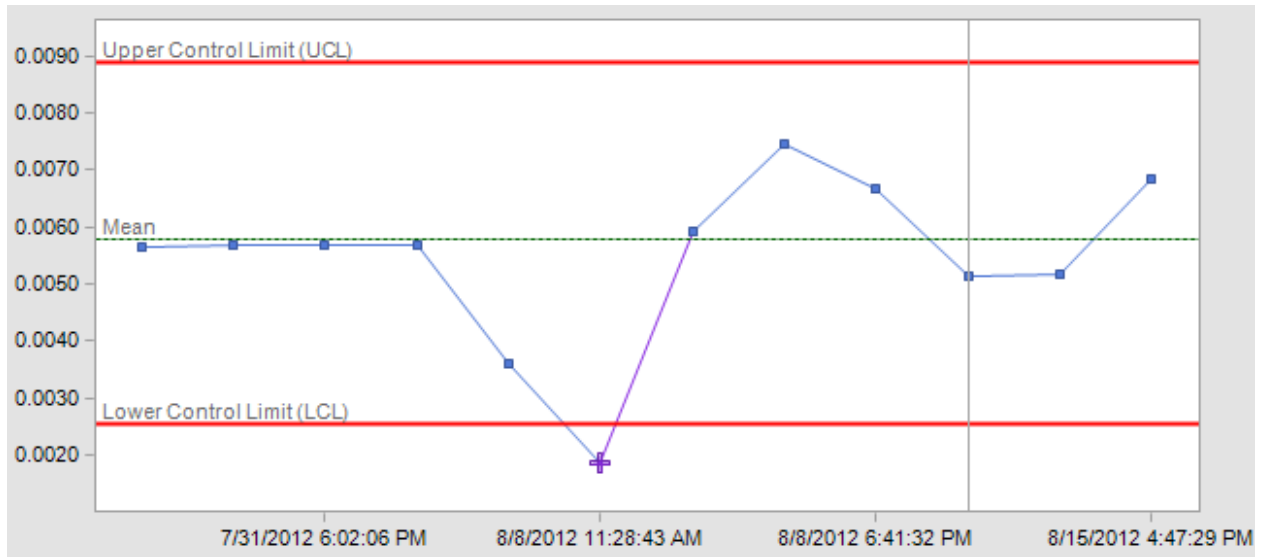
Table

The Table tab shows the data for all samples, elements in a grid of rows and columns. Excluded samples and points are displayed in a coral background color. If a sample is excluded, the sample is checked in the Excluded column (all elements excluded). If a point is excluded, the element is highlighted for a specific sample.

Standards Setup

Standard Name : Identifier Name - BS XAAS : DavesPC   Save Changes

Excluded	Identifier	AcquireDate	C	Si	Mn	P	S	Cr	Mo
☐	DavesPC	1/25/2012 6:33:09 PM	0.0462	0.0447	0.4242	0.0062	0.0087	0.0197	0.008
☑	DavesPC	1/25/2012 7:44:13 PM	0.0458	0.0435	0.4244	0.0063	0.0089	0.0197	0.008
☐	DavesPC	7/10/2012 2:23:48 PM	0.042	0.0442	0.3818	0.0072	0.0079	0.0154	0.0096
☑	DavesPC	7/10/2012 2:24:51 PM	0.0526	0.0433	0.3394	0.0075	0.0085	0.0235	0.009
☐	DavesPC	7/10/2012 2:25:54 PM	0.0439	0.0429	0.3733	0.0074	0.0093	0.0174	0.0099
☐	DavesPC	7/10/2012 2:26:57 PM	0.0522	0.0433	0.3436	0.0072	0.0076	0.0227	0.0084
☑	DavesPC	7/10/2012 2:28:00 PM	0.0568	0.0424	0.3394	0.0075	0.0095	0.0245	0.008
☐	DavesPC	7/10/2012 2:29:03 PM	0.0346	0.042	0.4963	0.0047	0.0086	0.0174	0.0081
☐	DavesPC	7/10/2012 2:30:06 PM	0.0559	0.0371	0.3436	0.0057	0.0086	0.0223	0.01
☐	DavesPC	7/10/2012 2:31:09 PM	0.0549	0.0505	0.3606	0.0049	0.0097	0.0203	0.0064
☐	DavesPC	7/10/2012 2:32:12 PM	0.0397	0.042	0.3479	0.0072	0.0097	0.0191	0.0076
☐	DavesPC	7/10/2012 2:33:15 PM	0.0388	0.0442	0.3691	0.0064	0.0108	0.0245	0.0088
☐	DavesPC	7/10/2012 2:34:18 PM	0.0499	0.0465	0.5218	0.0059	0.01	0.0233	0.0063
☑	DavesPC	7/10/2012 2:35:21 PM	0.0411	0.0465	0.3394	0.0057	0.0065	0.017	0.0072
☐	DavesPC	7/10/2012 2:36:24 PM	0.0531	0.0411	0.4709	0.0075	0.0086	0.0237	0.0076
☐	DavesPC	7/10/2012 2:37:27 PM	0.0494	0.0375	0.4836	0.0053	0.0099	0.0185	0.0085
☐	DavesPC	7/10/2012 2:38:30 PM	0.054	0.0496	0.5006	0.0049	0.0089	0.0239	0.0068
☐	DavesPC	7/10/2012 2:39:33 PM	0.0448	0.0402	0.3436	0.0072	0.0069	0.0211	0.0064
☐	DavesPC	7/10/2012 2:40:36 PM	0.0443	0.0411	0.4497	0.0073	0.0076	0.0191	0.0079
☐	DavesPC	7/10/2012 2:41:39 PM	0.036	0.0424	0.4454	0.0068	0.0093	0.0217	0.0067
☐	DavesPC	7/10/2012 2:42:42 PM	0.0517	0.0469	0.5218	0.0051	0.0086	0.0215	0.0076

Exclude Sample DavesPC : 7/10/2012 2:28:00 PM

☑ Exclude   Exclude Notes:

Apply   Type Exclude Notes Here...|

Setup Std Parameters | Charts | Table | Limits Editor

Clicking on any sample (excluded column), or any element in a sample allows you to toggle the Exclude state, view and update the Notes. The status of the selected cell is displayed in the panel below the table. Check the Exclude checkbox to exclude; un-check to recover a sample or point. Update the Notes. Click the "Apply" button to apply the changes.

Limits Editor

The Limits Editor is a tabular way to edit the Upper and Lower Control limits (Max and Min respectively) and Upper and Lower Specification Limits (MaxSpec and MinSpec respectively). In addition, comments may be added to each element. A modified date is maintained automatically and updated when the data is saved.

Standards Setup

Standard Name : Identifier Name - BS 2931 : Daves PC   Save Changes

Undo Changes

Element	Min	Max	MinSpec	MaxSpec	Mean	3Sigma	Cpk	Comment	ModifyDate
C	0.1219	0.2845	0.1	0.3	0.2032	0.0813	1.1907		8/15/2012 2:16:1
Si	0.1462	0.3124			0.2293	0.0831			8/15/2012 2:16:1
Mn	0.4566	1.0266			0.7416	0.285			8/15/2012 2:16:1
P	0.00756	0.0163			0.0119	0.00438			8/15/2012 2:16:1
S	0.0161	0.036	0.021	0.04	0.026	0.00996	0.502		8/15/2012 2:16:1
Cr	0.0886	0.217			0.1528	0.0642			8/15/2012 2:16:1
Mo	0.012	0.0263			0.0192	0.00717			8/15/2012 2:16:1
Ni	0.0639	0.1533			0.1086	0.0447			8/15/2012 2:16:1
▶ Al	0.00112	0.0028	0.001	0.003	0.00196	0.000843	1.1388		8/15/2012 2:16:1
Co	0.00559	0.014			0.00979	0.0042			8/15/2012 2:16:1
Cu	0.15	0.3354			0.2427	0.0927			8/15/2012 2:16:1
Nb	0.000322	0.000787			0.000555	0.000233			8/15/2012 2:16:1
Ti	0.000574	0.00149			0.00103	0.000459			8/15/2012 2:16:1
V	0.00113	0.00294			0.00204	0.000906			8/15/2012 2:16:1
W	0.000479	0.00135			0.000914	0.000435			8/15/2012 2:16:1
Pb	0.000123	0.000276			0.0002	7.68E-05			8/15/2012 2:16:1
Sn	0.00604	0.0141			0.0101	0.00402			8/15/2012 2:16:1
As	0.00435	0.00967			0.00701	0.00266			8/15/2012 2:16:1
Zr	0.000184	0.000468			0.000326	0.000142			8/15/2012 2:16:1
Bi	0.000579	0.00136			0.000969	0.00039			8/15/2012 2:16:1
Ca	0.000532	0.00123			0.000883	0.000351			8/15/2012 2:16:1
Ce	0.000294	0.00072			0.000507	0.000213			8/15/2012 2:16:1
Sb	0.0013	0.00313			0.00222	0.000912			8/15/2012 2:16:1
B	0.000181	0.000436			0.000309	0.000128			8/15/2012 2:16:1
Zn	0.000386	0.000891			0.000638	0.000252			8/15/2012 2:16:1
N	0.00723	0.0163			0.0118	0.00453			8/15/2012 2:16:1
Fe	58.4151	137.7915			98.1033	39.6882			8/15/2012 2:16:1
*									

Setup Std Parameters | Charts | Table | Limits Editor

All elements in a standard are always represented. In order to turn off checks for a specific element, clear the Max and Min values.

To turn off a specific Min or Max limit check, leave it blank (a blank Min value means there is no lower limit -- only Max limit is checked; a blank Max value means there is no upper limit -- only Min limit is checked).

Specification limits are optional. They are used only in the calculation of CpK capability index, which is viewed here in the limit table and on the Charts tab.

Monitor / Evaluation Setup

Standard SPC can be setup to simultaneously monitor multiple instruments of the same or different instrument types, for multiple failure rules, all in real-time. In order to monitor the standard results saved for an instrument as they are run, you must create a Monitor record, specify some evaluation rules and other properties, and give it a name. When the monitor "Starts", it automatically evaluates control standards and provides instant feedback to the user should a failure occur.

Monitor Setup Tabs

Define Monitor

In the Standards SPC Setup dialog, click on the Monitor / Evaluation Setup button. The following dialog is displayed:

New Monitor

Click on "New Monitor" to create a new Monitor record.

Select and Load Monitor from Database

Drop down the list and select an existing Monitor record.

Instrument Identifier

The default for new Monitors is "<All>". If you want this Monitor to monitor only a specific instrument, select the instrument identifier in the list.

Enabled

When the Monitor is Enabled, it will show up in the Monitor / Evaluation Status window, and can be started.

Auto-Start

When Auto-Start is checked, it will automatically start when LabSpeed is run. If Auto-Start is checked, Enabled must also be checked.

Number of Evaluate Results Samples

When a standard fails evaluation, this is the last number of samples that are automatically loaded into the evaluation chart for reference.

Popup Evaluation Status On...

When a standard is evaluated, it will automatically pop-up the Evaluation Status window based on which of these checked evaluation results occurs:
1. Fail - status window pops up automatically if an evaluation failure occurs
2. Error - status window pops up automatically if an outside error occurs (for example, network goes down)
3. Pass - status window pops up even if the evaluation succeeds

On Evaluation Fail - Show Warning Dialog

Check this item if you wish a Failure Warning Dialog to pop up when a standard fails evaluation. The Failure Warning dialog will specify the standard that failed and lists the specific elements that failed. The user will have the option to immediately evaluate the failure graphically. Note that if both the Evaluation Status window is checked for Failure, and this Failure Warning Dialog is also checked, both will appear automatically when a standard fails evaluation.

Select Evaluation Rules

A Monitor can evaluate standard data against multiple rules. In the "Select Evaluation Rules" panel, check the subset of rules you wish to apply. The maximum number of samples required to perform all selected rules is displayed (some rules will require more than one sample to evaluate, e.g. when determining random vs. trending

indicators). The rule "OneUnderLCLOrOverUCL" is the typical rule to select when checking data that exceeds either the Max or Min control limit value. This rule requires only one sample to evaluate. Note: there is another rule "OneUnderLSLOrOverUSL", which will check data that exceeds the manually entered Max or Min specification limit.

Evaluation Rules and Number of Samples
Nelson and Western Electric (WECO) rules, which check for randomness and trends in the data are available for selection. Most rules require 2 or more consecutive points of data in order to evaluate the rule. If a sample or element has been excluded by the user, it is ignored when combining consecutive points. Additional points are obtained from up to five additional consecutive samples (beyond what the rule normally requires) in order to evaluate the rule.

For more information, visit
http://en.wikipedia.org/wiki/Nelson_rules
http://en.wikipedia.org/wiki/Western_Electric_rules

LabSpeed Instance

The LabSpeed instance name is shown at the bottom of the dialog. "LabSpeed-1" is the default LabSpeed instance name, which is set when LabSpeed is first installed on a PC.   It can be changed in LabSpeed under the menu item "Tools | Settings". The LabSpeed instance name identifies a particular instance of LabSpeed where Monitors are running.

Why is this needed?
One Standards SPC database is used by more than one instrument PC and office PC. Each instance of LabSpeed will have it's own defined list of Monitors that can be edited and started up.

In the Monitor / Evaluation Setup - Monitor Schedule Tab, all monitors for all instances of LabSpeed are listed.

Note: The LabSpeed instance name is just a name for easy user identification. The actual instance is a unique GUID value obtained from the system when LabSpeed is first installed. To see the GUID, hover the mouse over the LabSpeed Instance name; it will pop up in a tool-tip.

Monitor Schedule

The Monitor Schedule allows you to view the status of all Monitors in the database for all LabSpeed Instances. You can quickly determine when Monitors are running and from where (LabSpeed instance), what instruments are being monitored and how they behave when a failure occurs.
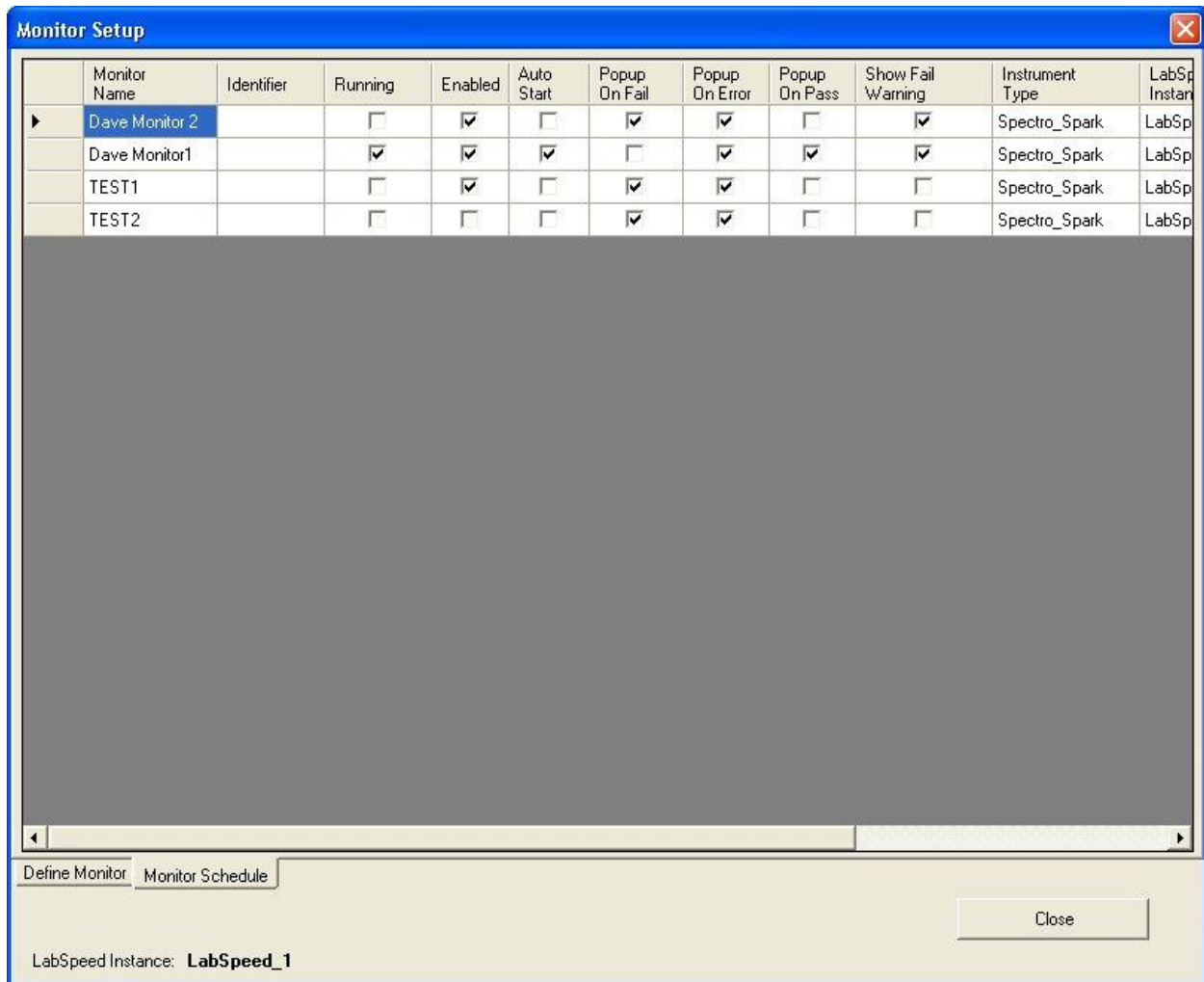
SPC Preferences Setup

On the Standards SPC Setup dialog, select the Preferences button. This is where you setup global behaviors and define certain global defaults for use when creating new SPC database records. You can also setup *Instrument Type definitions*, which defines database fields used to determine if a sample is a Control Standard.
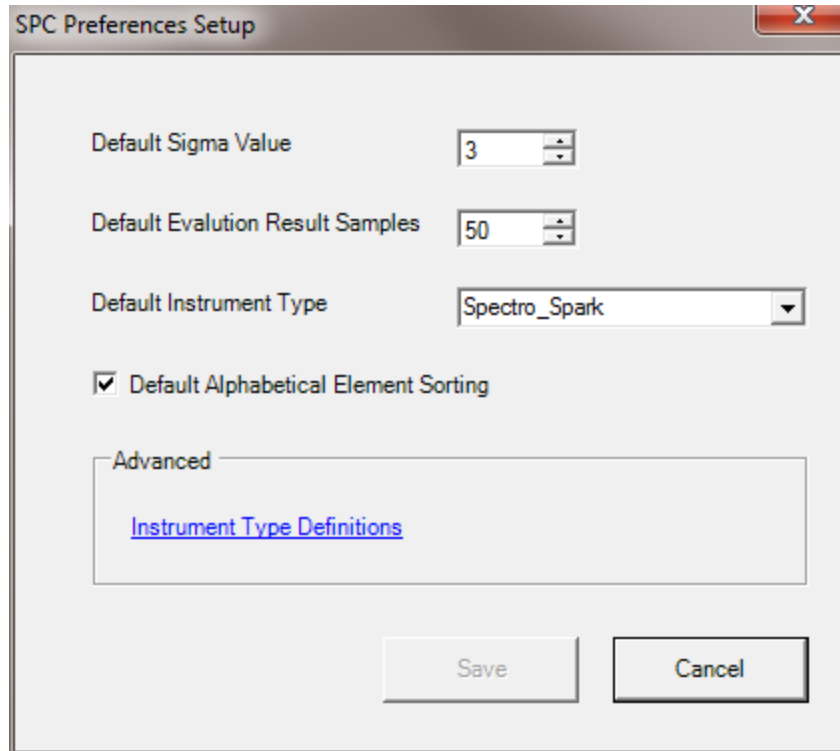
Default Sigma Value

When creating a new Standards SPC standard record, this will be the default value used for Target Sigma.

Default Evaluation Result Samples

When creating a new Monitor record, and when analyzing historical evaluation records, this is the default last number of samples to use.

Default Instrument Type

When creating a new Monitor record, this is the default instrument type to use. Note - The default instrument type is Spectro_Spark. Support for additional instrument types requires additional installations.

Default Alphabetical Element Sorting

When creating a new Standards SPC standard record, this is the default element ordering. You can override the default element ordering when selecting samples from the database for calculating limits.

Advanced - Instrument Type Definitions

Setting up Instrument Type Definitions is an advanced option. This is where you can define which fields in the database are to be used for sample identification and sample type, and setting up the logic for determining how to identify if a sample is a Control Standard.

Instrument Type Definitions

On the Preferences Setup dialog you can setup *Instrument Type definitions.*   Instrument Type Definitions is an advanced setup option that defines database fields and logic used to determine if a sample is a Control Standard.
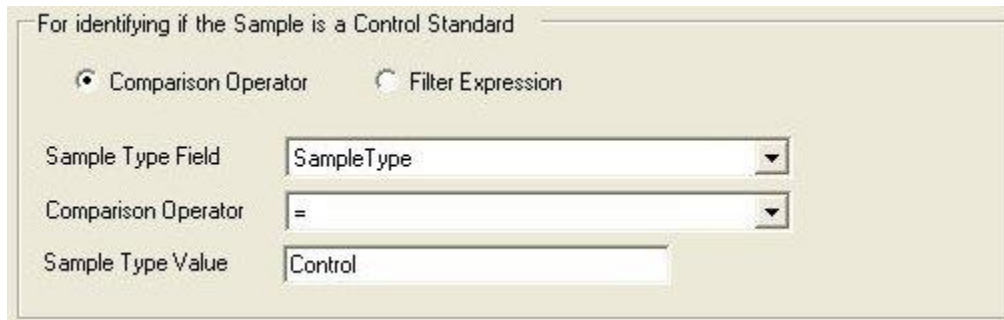
Instrument Type

There can be multiple instrument types supported by SPC, for example Spark, XRF, ICP or other, each with its own unique storage format and field names. If multiple SPC instrument types have been installed, they will appear for selection in the Instrument Type drop down list. Choose one for mapping specific fields.

Note: On installation, these mappings are defaulted and should not have to be changed. In rare circumstances, however, an administrator may want to narrow the scope of determining how a sample is determined to be a Control Standard and which ones are to be monitored for SPC.

Identifying if a Sample is a Control Standard

SPC works by collecting the data from specific Control Standards and calculating upper and lower control limits based on a statistical analysis of that data. SPC also monitors Control Standards as they are run in real-time and performs analysis based on specific rules.   So it is important that the program be able to distinguish Control Standards from other types of samples.

Comparison Operator "="

The most common way to determine if a sample is a Control Standard is simply to look at its stored Type. In the example above (for Spectro Spark Instrument type), the database field that contains the sample type information is a field called "SampleType". It is selectable from a list of other fields associated with a sample. The Sample Type value that is stored in that field is "Control", if the sample is a Control Standard. Finally, the Comparison operator is equals ("=").   This is the logic used to determine if a sample is a Control Standard on a Spectro_Spark instrument -- "The value in the field 'SampleType' is equal to 'Control' ".

Comparison Operator "Like"

The comparison operator "Like" adds the dimension of wildcards (e.g. '%'). In the example above, a company uses a naming convention when running Control Standards. All control standards are named beginning with the letters "BS", and no other sample type will have a name that begins with "BS". Therefore the logic used to determine if a sample is a Control Standard is "The Sample Name starts with 'BS' ", or "SampleName Like BS%". The % wildcard in "BS%" indicates a name that begins with "BS" and the rest of the name can be anything.
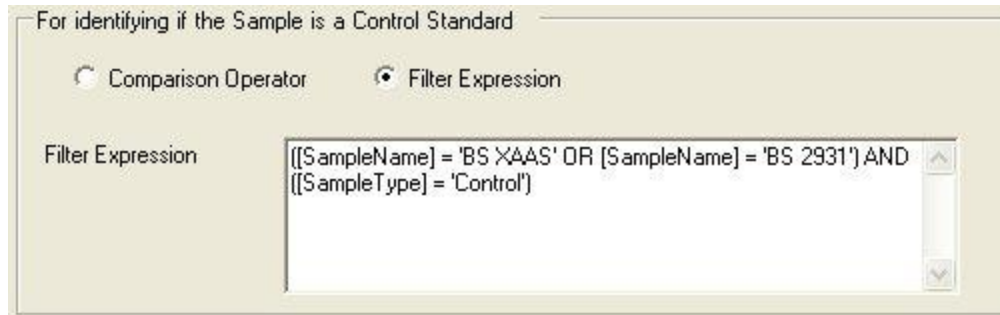
Multiple wildcards may be included in a value. A value of "%BS%" acts like a *Contains*, so the logic would be "The Sample Name contains "BS". Any sample name that contains the letters "BS" anywhere in the name would be considered a Control Standard.

Likewise, a value of "%BS" acts like an *Ends With,* so the logic would be "The Sample Name ends with 'BS' ". Any sample name that ends with the letters "BS" in the name would be considered a Control Standard.

The following wildcards can be used:

Wildcard	Description
%	A substitute for zero or more characters
_	A substitute for exactly one character
[charlist]	Any single character in charlist
[^charlist]	Any single character not in charlist

Filter Expression

For identifying if the Sample is a Control Standard

○ Comparison Operator   ⦿ Filter Expression

Filter Expression

```
([SampleName] = 'BS XAAS' OR [SampleName] = 'BS 2931') AND
([SampleType] = 'Control')
```

For maximum flexibility the user may choose to enter a filter expression. For example, if only a few Control Standards should be monitored, but not all of them. In the example above, there are only two Control standards that should be monitored - "BS XAAS" and "BS 2931". These must be of type "Control", but ignore all other samples of type "Control"

There are a few rules to follow if you set up a filter expression

- Field names must be encased in square brackets (e.g. **[**SampleName**]**)
- Use single quotes around string constants or other values (e.g. **'**BS XAAS**'**)
- Use = (equal) and <> (not equal) to indicate equality (e.g. [SampleName] **=** 'BS XAAS')
- Use >, >=, < or <= to indicate inequality (e.g. [AcquireDate] > #1/1/2010#)
- Use AND and OR operators to perform multiple expression logic (e.g. [SampleName] = 'BS XAAS' **OR** [SampleName] = 'BS 2931')
- Use parentheses to force the flow of logic (e.g. **(** [SampleName] = 'BS XAAS' OR [SampleName] = 'BS 2931' **)** AND **(** SampleType] = 'Control' **)**

Note: For a list of possible field names to use in an expression, drop down the list for selecting the Sample Type, Sample Name or Sample DateTime fields. The lists contain all possible sample fields.

Advanced

In the course of running SPC and analyzing the data for all elements, the names for a few fields must be mapped. The defaults are already specified and would not normally need to be changed. The fields that need to be mapped are 1. Sample Name, 2. Sample DateTime, 3. Element Name, 4. Element Result (concentration value). Each may be changed to a different field by selecting from the respective drop down list.

Monitor / Evaluation Status

Monitor / Evaluation Status Overview

Monitors are run in real-time. The status of all monitors running for a particular LabSpeed instance can be viewed by clicking the Monitor / Evaluation Status menu item:
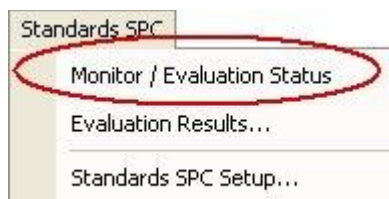
The monitor status window <u>will pop up automatically</u> depending on the settings defined in <u>Monitor setup</u>.

Example of a sample that passed all evaluation rules:

Start / Stop

In the example above, two Monitors are enabled, but only one is running (green color). To start the Monitor that is off (red color), click the "Stopped / Start" button. The red color will turn green, indicating it is running. To stop the Monitor that is running, click the "Running/Stop" button. The green color will turn red, indicating it is stopped.

The Monitor that is running, called "Spark1 Monitor" was setup to monitor only the specific Spectro_Spark instrument identified by the "Lab1" identifier. The current status shows the last standard evaluated -- "BS 2931" on 9/11/2013 at 11:52:55 PM, which PASSED all evaluation rules defined in that Monitor record.

Evaluation History

The Total # Evaluations is the number of standards evaluated since the Monitor was started.. Click "Show History" button to view the evaluations and results in list form.

Error Messages

If there are Messages, the button "0 - Messages" will indicate the actual number of messages. Messages are important to read and can indicate a problem with the

network or other unusual problem that could prevent an evaluation from succeeding. Usually messages accompany an Evaluation Status of "Error".

Evaluate Results

Click "Evaluate Results" to view the sample along with a preset number of other samples in an [Evaluation Chart](#). There you can analyze the elements that failed, exclude samples and elements, and add Notes.

**Example of a sample that failed one or more evaluation rules:**

Monitor Start/Stop	Monitor Name	Monitor Identifier	Instrument	Sample Standard	Sample Identifier	Sample Date/Time	Evaluation Status	Failure Count	Total # Evaluations	Evaluation History	Messages	Evaluate Results
Running / Stop	Spark1 Monitor	Lab1	Spectro_Spark	BS 2931	Lab1	9/11/2013 11:50:54 AM	FAIL	1/1	1	Show History	0 - Messages	Evaluate
Stopped / Start	Spark2 Monitor	<All>	Spectro_Spark						0	Show History	0 - Messages	Evaluate

Failure Count

Normally, SPC monitors standards as they are run. In the above example, the Failure Count indicates 1 sample failed out of a "batch" of 1. Sometimes, a batch of samples containing more that one standard is saved and imported into the database all at once. In this case, more than one standard can fail. For instruments that save data in batches, the Failure Count will indicate the status of the batch. For example, a Failure Count of 2/8 indicates 2 standards failed out of a batch of 8 samples. When multiple samples fail, clicking the Evaluate button will bring up an intermediate dialog to select which standard to evaluate.

Standard Evaluation Failure Warning

If the Monitor specifies the Show Warning Dialog on Evaluation Failure, the following dialog will pop up automatically when a current sample fails an evaluation rule:

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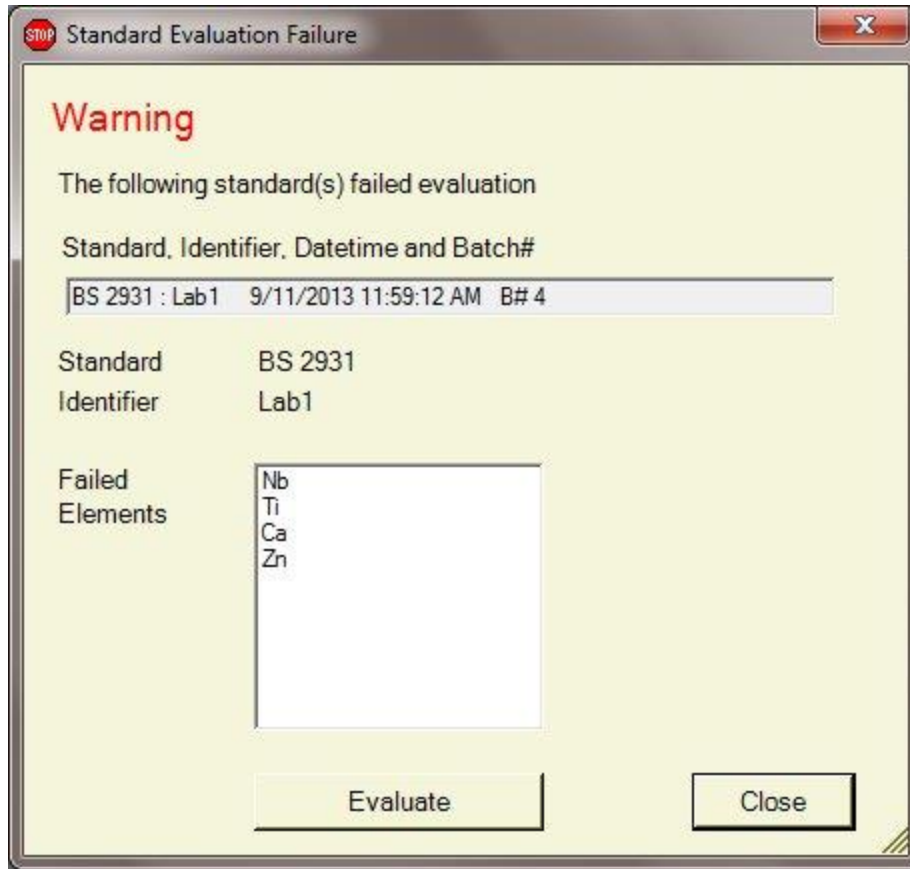
Standard identification information along with the subset of elements that failed are displayed.

Click "Evaluate" to go immediately to the Status Evaluation Charts, which will be pre-set to evaluate this standard. Click "Close" to exit.

Batch Standard Failures

When one or more standards fail in a batch of samples, the Failure Warning dialog contains a drop down list of the standards that failed. Select the standard you wish to evaluate before clicking the Evaluate button that brings up the data in a chart.
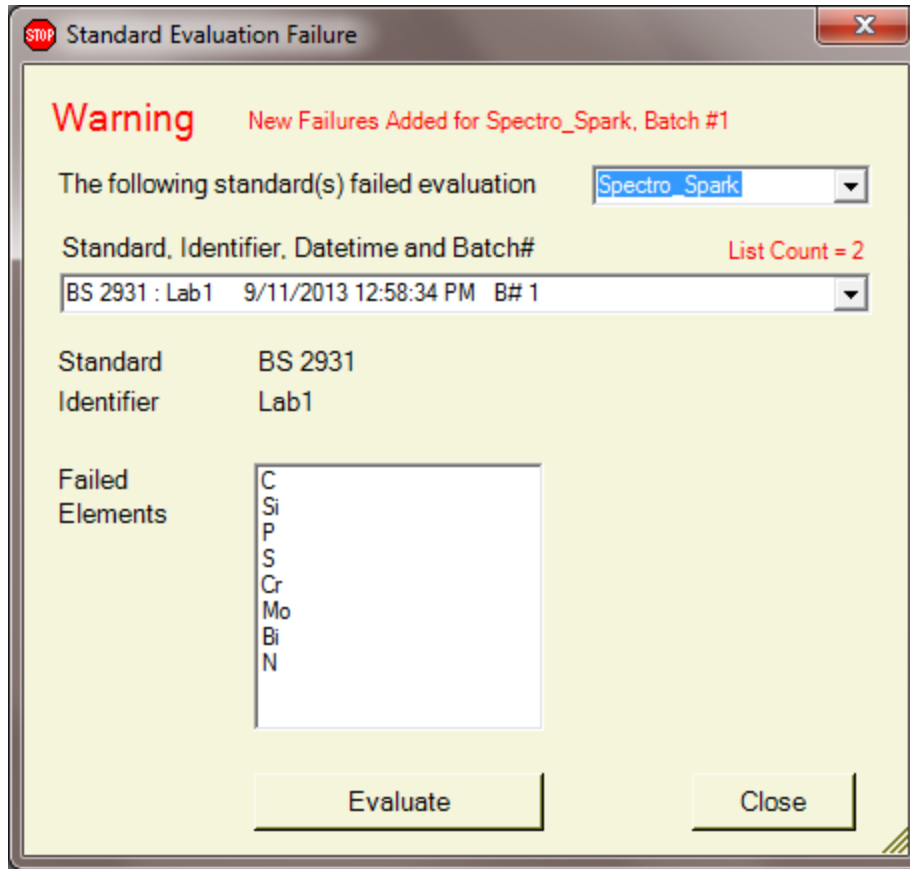
It is possible for new failures to arrive while the Failure Warning dialog or the Evaluation Chart is displayed for a previous batch of failures. In this case, the new failed standards are added to the standard selection list and an alert is displayed indicating new Failures have been added.

If standards from several different instrument types in the lab are monitored simultaneously, it is possible for them to fail concurrently while the Failure Warning dialog or the Evaluation Chart is displayed. In this unusual case, an instrument selection drop down list is displayed and you must first select the instrument in order to select a standard for evaluation.

The Failure Warning dialog remains active until closed by the user. Once closed, the multiple concurrent failures information is lost.   Clicking on the Evaluate button in the Monitor Status window will bring up only the most recent failure or batch failures.

Status Evaluation Charts

A standard that failed an evaluation may be analyzed from the Monitor / Evaluation Status window by clicking "Evaluate Results". The current sample, along with a pre-set number of other samples is plotted. You can analyze the elements that failed, exclude samples and elements, and add Notes.
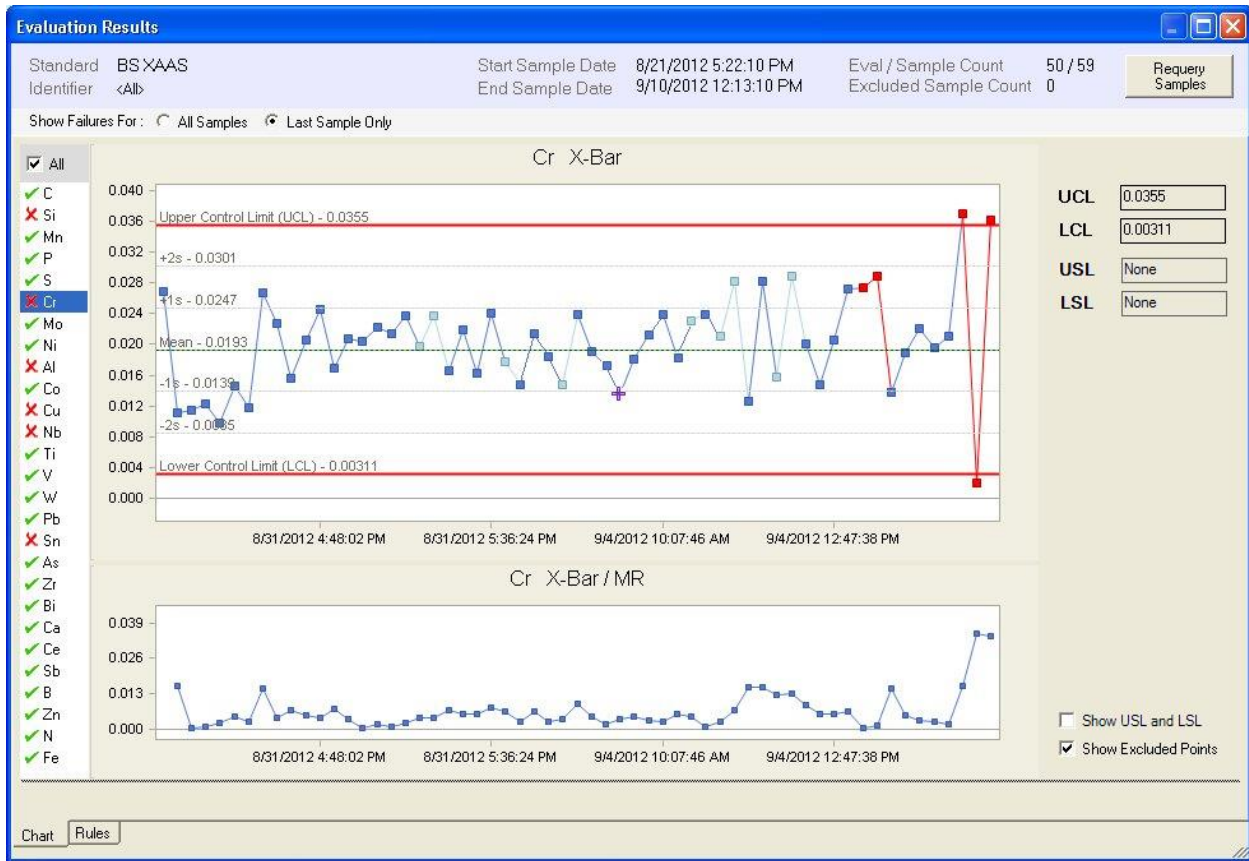
This is the same chart as described in Evaluation Results : Evaluation Charts with two differences. When called from Monitor Status, there is no initial Browser used to choose a list of evaluation samples. Instead, the chart automatically retrieves the last "n" samples as defined in the Monitor settings and begins the session with "Last Sample Only" checked.

- Failed points are displayed in **Red**.
- Points that have passed are displayed in **Blue**.
- Points that were not evaluated are displayed in **Light-Blue**.
- A purple Cross ✚ indicates an Excluded point. It may also be displayed in **Red** or **Light-Blue** depending on the status.

Eval / Sample Count

Evaluations use all non-excluded points available, even if the sample itself was not evaluated. The Evaluation count is the number of samples that have been evaluated (blue = passed; red = failed). The Sample count is the total number of samples loaded in order to perform the evaluation of all samples, including samples that were not evaluated (light-blue)

All Elements vs Failed Elements Only

- Check the "All" check box (above Elements List) to show All elements - Passed and Failed. The passed elements have a green check mark; the failed elements are marked with a red "x".
- Un-check the "All" check box to show only the Failed elements. Only elements marked with a red "x" will be displayed in the list.

All Samples vs Last Sample Only

Each element could have failed in any one of the samples that have been loaded and plotted.
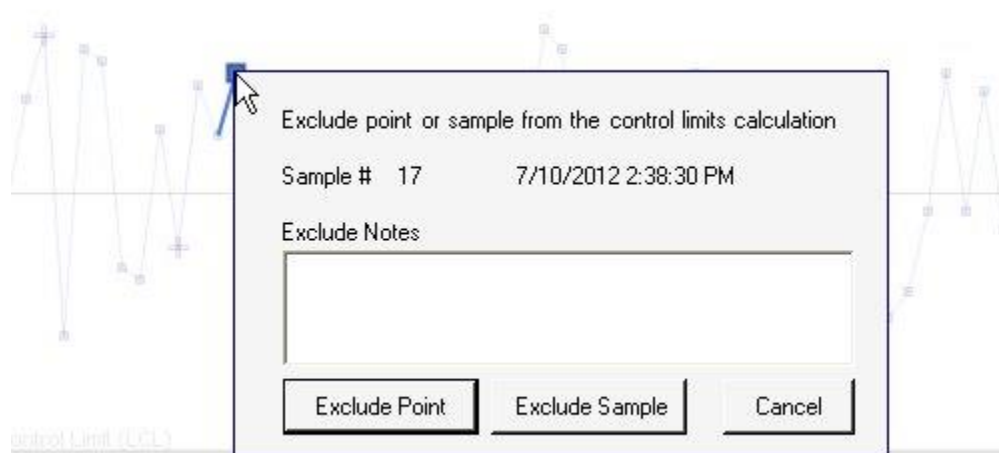
- Check "All Samples" to show the red "x" failure mark if that element failed in ANY sample that is plotted.
- Check "Last Sample Only" to show the red "x" failure mark if that element failed in the LAST sample only.

When evaluating the last sample that was run, it is typical to display failure markers only for that sample (last sample). This is the default when Evaluation Charts are called from the Monitor Status window.
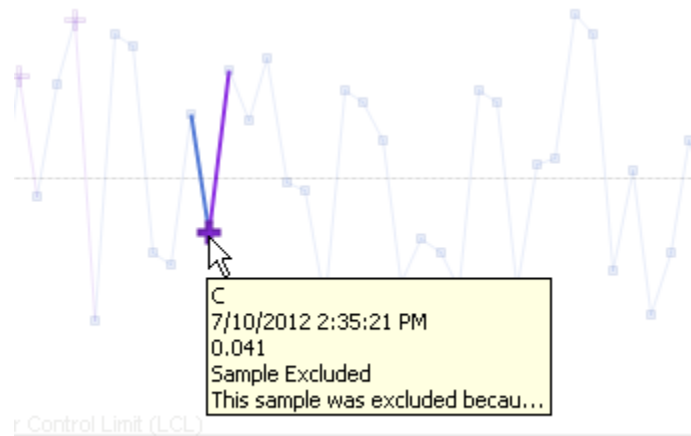
Excluding Samples and points

A major reason for excluding samples is because the data is bad, or the wrong sample was run.

Right click on any point on the graph. **If you want to exclude the sample just run**, right-click on the LAST point on the graph. A window will pop up allowing you to exclude the point (the element in a specific standard), or the whole standard.

When excluding a point or sample, notes are required. These will be saved with the data and retrieved when viewing the excluded sample information at a later time.
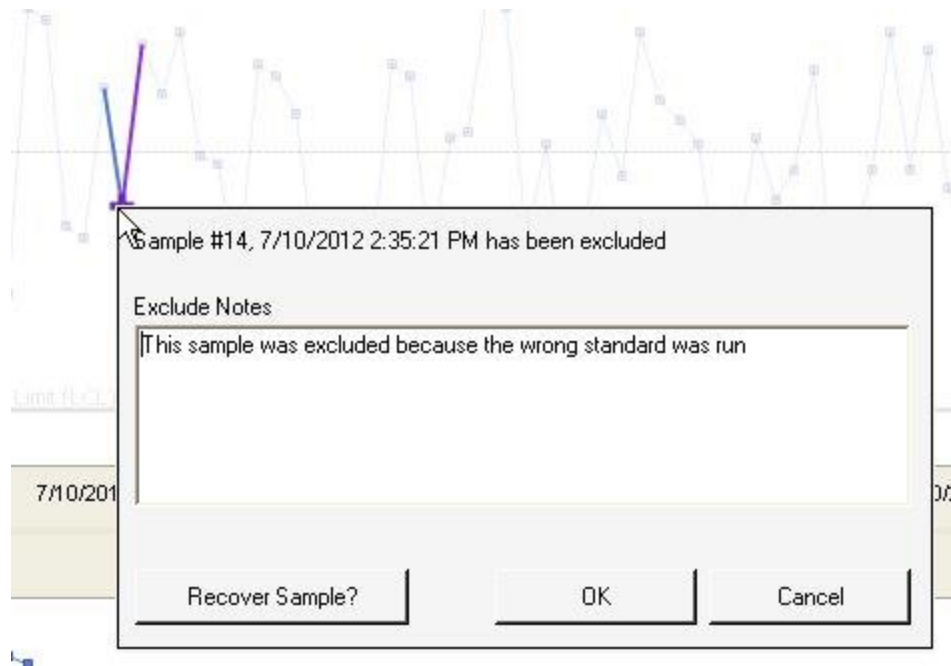
An excluded point is displayed in a purple Cross marker (see chart above for examples of excluded points). If the point is excluded and also failed, it will be displayed in a <u>red</u> Cross marker. Hovering the mouse over an excluded point will pop up a tool-tip with the exclude information included:

Note: Excluding a point does not re-evaluate the status of samples that have already been evaluated. Excluding a point only affects future samples. During the evaluation process for a new sample, excluded points are ignored (if the rule requires multiple samples to perform the evaluation).

Changing Exclude Notes and Recovering Excluded Samples or Points

Right-Clicking on the excluded point allows you to view and/or change the existing Notes and also to recover the point or sample:

Sample #14, 7/10/2012 2:35:21 PM has been excluded

Exclude Notes

This sample was excluded because the wrong standard was run

Limit (LCL,

7/10/201   )/2

| Recover Sample? | | OK | | Cancel |

If just viewing the notes, click Cancel when done.
If updating the notes, change the Notes and click OK.
if recovering the sample, click on the "Recover Sample?" button. This will un-mark the standard (or point) as excluded.

Show Excluded Points

The chart can be displayed with the excluded points or without the excluded points. When displayed with the excluded points, these points are displayed with a Cross marker. Typically, excluded points will have results that are very different than the majority of other points, either because the data is bad or the wrong standard was run. This can affect the overall scale of chart making it harder to read (the chart is always scaled to include all points and limits).

To show excluded point, *check* to box "Show Excluded Points".
To show the chart without excluded points, *un-check* the box "Show Excluded Points".

Rules Tab

Click on the Rules tab to display a list of the rules that failed and add notes. Notes may be added to the overall evaluation result and/or specifically to the rule that failed for each element. Notes are entered for the selected item in the light blue area under each list.

When "Last Sample Only" is checked, the rules list applies only to the last sample. When un-checked, the rules list will include all failures for all samples that were loaded.
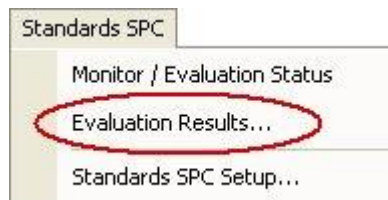
Requery Samples

Click the "Requery Samples" button to change the sample list.   A browser will appear allowing you to load a different number of previous samples.

Evaluation Results

Evaluation Results Overview

Every time a standard is evaluated, the result is stored to the Standards SPC database along with any user-entered notes and exclusions. These evaluated sessions may be re-loaded for analysis and additional modifications can be made.

Click on the "Evaluation Results..." menu item.   The first step is to load a range of evaluation samples. A browser will be presented with different options for searching for samples. Once samples are chosen, Evaluation Charts are displayed for interactive analysis. In addition, a Rules tab provides access to all failed rules and past notes, which can be updated if desired.

Selecting Evaluation Samples

Evaluation Charts

Evaluation Rules

Requery Samples

Click the "Requery Samples" button to change the sample list.   The sample evaluation results browser will appear allowing you to load a different number of previous sample evaluation results.

Selecting Evaluation Results

The Evaluations Browser provides several options for searching the database for past evaluation results.
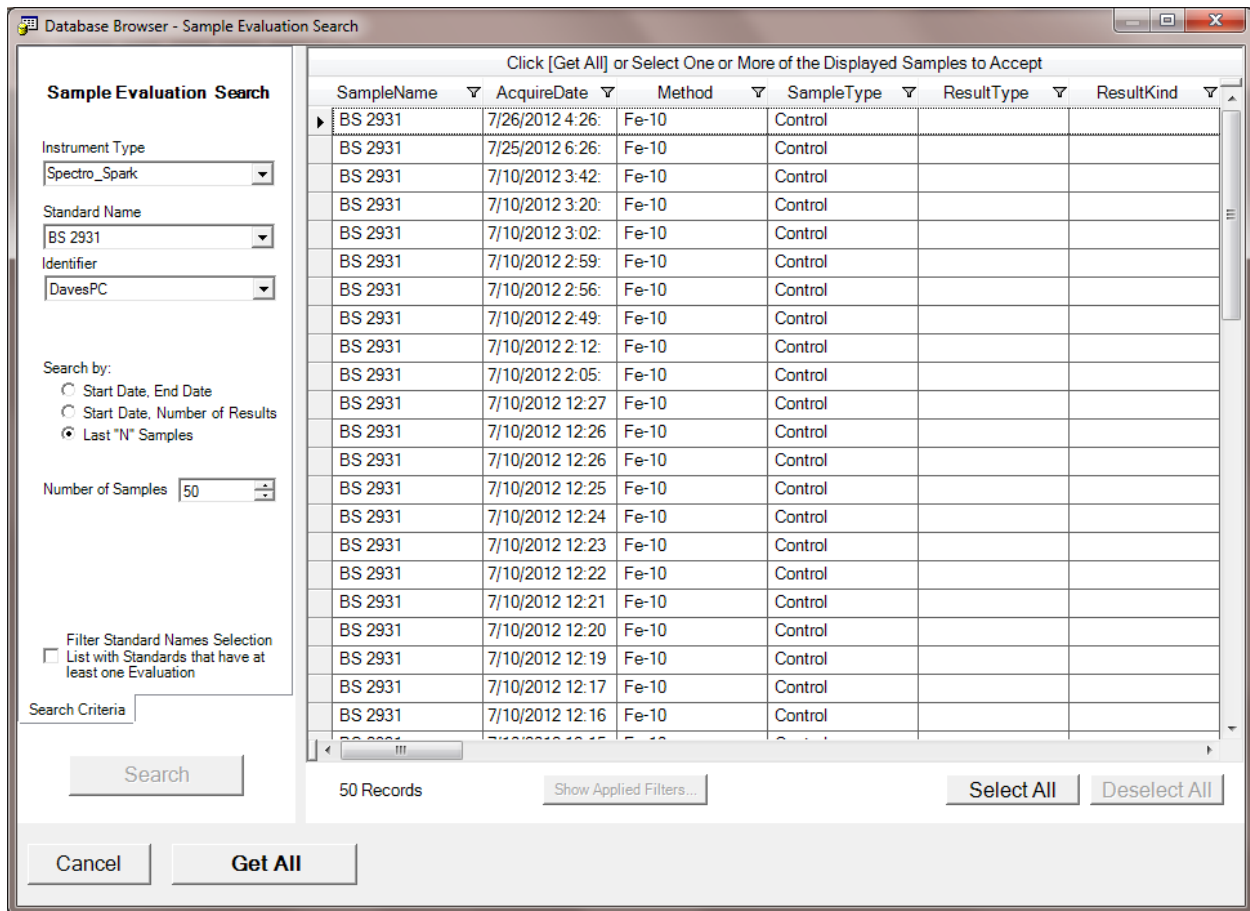
Instrument Type

Select an Instrument type. This list will be available if more than one instrument has been installed for SPC support.

Standard Name and Identifier

Select a standard name and identifier to evaluate a specific standard, specific instrument. Choose "All" for the identifier if you wish to use the general limits setup for the selected standard for all instruments of the same type.

Search by

Three options are provided for searching the database
1. **Start Date, End Date** - specify an exact start and end date
2. **Start Date, Number of Results** - specify a start date and then the number of results that follow. If there are fewer results than the number specified, then only the number that can be loaded will be loaded.

3. **Last "N" Samples** - choose the most recent "N" sample results that have been saved to the database

The default is "Last 'N' Samples" and the number of sample results is defaulted to the value that is set in [Preferences Setup](#). You can change the number of sample results to any value. If there are fewer than the number entered, only the number that can be loaded will be loaded.

Filter Standard Names Selection

Filter Standard Names Selection
☑ List with Standards that have at
least one Evaluation

All standards for which there is a Standards SPC database entry are available for evaluation, regardless if they have actually been evaluated against monitor rules during a run.   The standards selection list may be filtered to only include standards that have been evaluated at least once. In the chart that follows, points are dimmed if they have not been evaluated against a rule.

Click Search

The results that match the criteria entered will be loaded and displayed in a list. At any time you can change the search criteria and click the Search button to retrieve the new set of data.

Accept the results

When done, click "Get All", or manually select a subset of the results by highlighting rows and click "Get Selected"

Evaluation Charts

Once a list of sample evaluation results has been selected, the following Evaluation charts are displayed. You can analyze the elements that passed / failed, exclude / recover samples and elements, and review / add Notes.
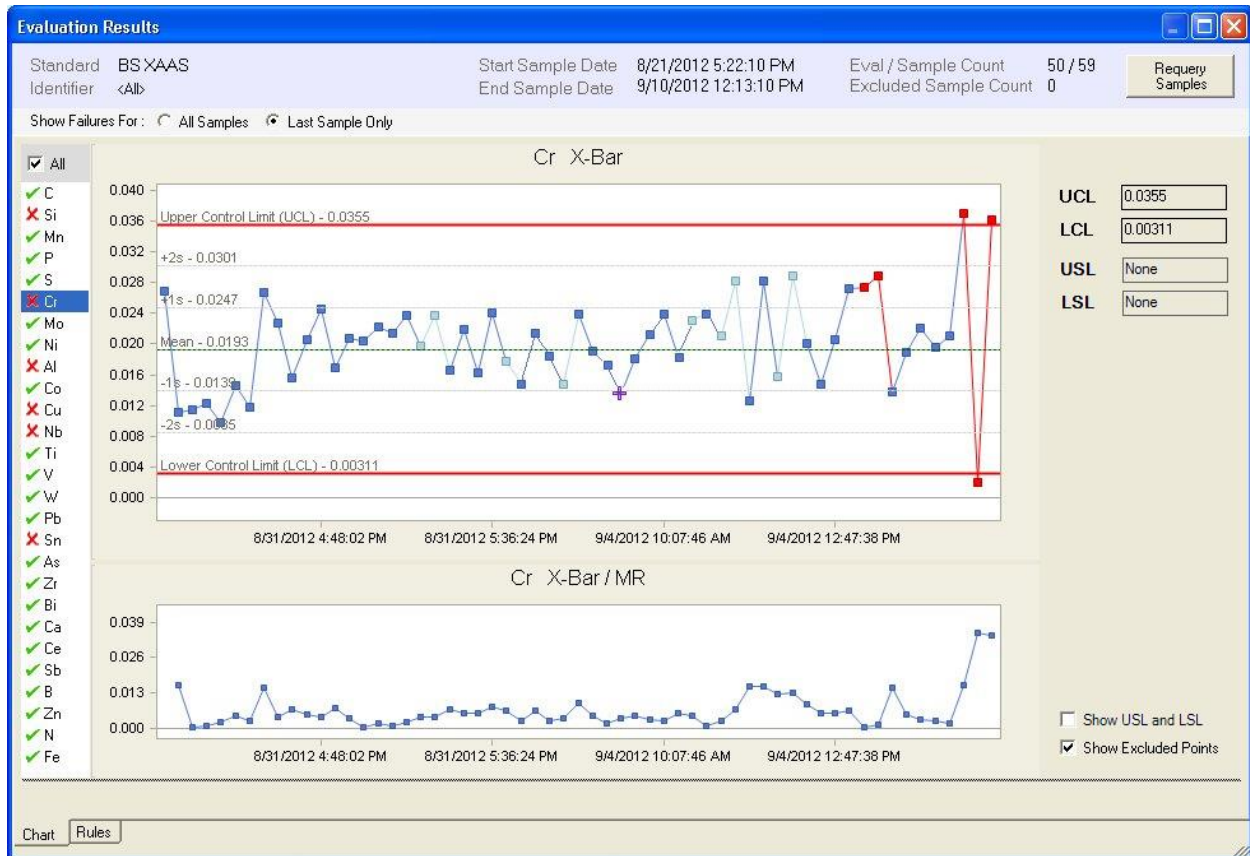
Depending on the browser conditions used to select samples, the session may begin with either "All Samples" or "Last Sample Only" checked.

- Failed points are displayed in **Red**.
- Points that have passed are displayed in **Blue**.
- Points that were not evaluated are displayed in **Light-Blue**.
- A purple Cross ✚ indicates an Excluded point. It may also be displayed in **Red** or **Light-Blue** depending on the status.

Eval / Sample Count

Evaluations use all non-excluded points available, even if the sample itself was not evaluated. The Evaluation count is the number of samples that have been evaluated (blue = passed; red = failed). The Sample count is the total number of samples loaded in order to perform the evaluation of all samples, including samples that were not evaluated (light-blue)

All Elements vs Failed Elements Only

- Check the "All" check box (above Elements List) to show All elements - Passed and Failed. The passed elements have a green check mark; the failed elements are marked with a red "x".

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- Un-check the "All" check box to show only the Failed elements. Only elements marked with a red "x" will be displayed in the list.

All Samples vs Last Sample Only

Each element could have failed in any one of the samples that have been loaded and plotted.

- Check "All Samples" to show the red "x" failure mark if that element failed in ANY sample that is plotted.
- Check "Last Sample Only" to show the red "x" failure mark if that element failed in the LAST sample only.
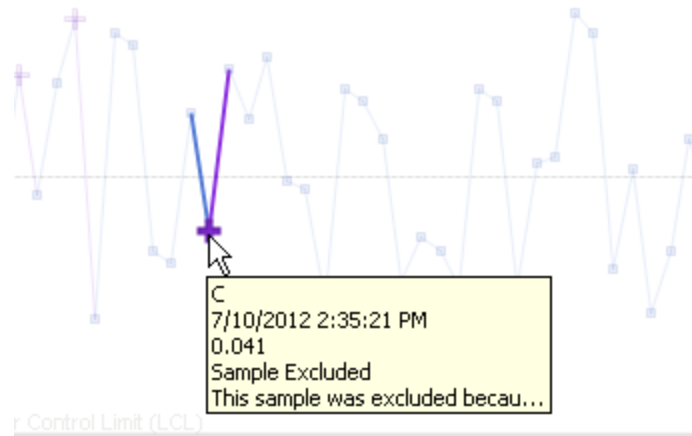
Excluding Samples and points

A major reason for excluding samples is because the data is bad, or the wrong sample was run.

Right click on any point on the graph to wish to exclude. A window will pop up allowing you to exclude the point (the element in a specific standard), or the whole standard.
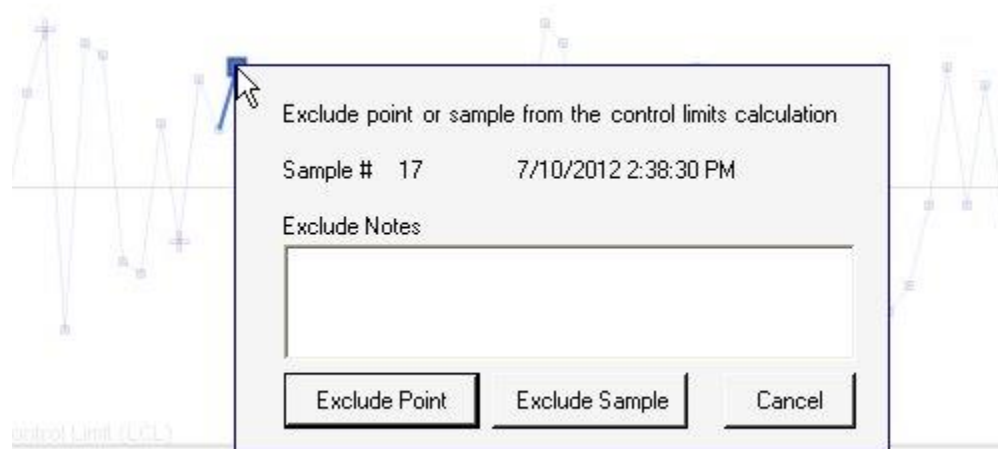
When excluding a point or sample, notes are required. These will be saved with the data and retrieved when viewing the excluded sample information at a later time.
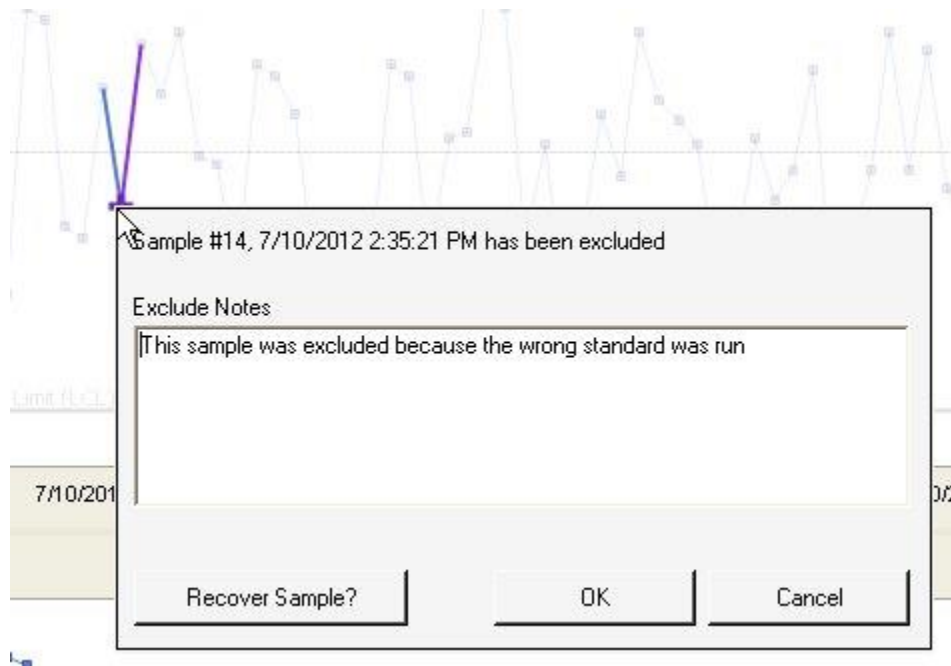
An excluded point is displayed in a purple Cross marker (see chart above for examples of excluded points). If the point is excluded and also failed, it will be displayed in a red Cross marker. If the point is excluded and not evaluated, it will be displayed in a light-blue Cross marker. Hovering the mouse over an excluded point will pop up a tool-tip with the exclude information included:

Note: Excluding a point does not re-evaluate the status of samples that have already been evaluated. Excluding a point only affects future samples. During the evaluation process for a new sample, excluded points are ignored (if the rule requires multiple samples to perform the evaluation).

Changing Exclude Notes and Recovering Excluded Samples or Points

Right-Clicking on the excluded point allows you to view and/or change the existing Notes and also to recover the point or sample:

If just viewing the notes, click Cancel when done.
If updating the notes, change the Notes and click OK.

if recovering the sample, click on the "Recover Sample?" button. This will un-mark the standard (or point) as excluded.

Show USL and LSL

Check this item to display the USL (Upper Specification Limit) and LSL (Lower Specification Limit) lines on the chart. The chart will be automatically scaled to ensure the lines are visible.   Note: Specification limits are optional and are manually entered for each element during Setup of the Standard.

Show Excluded Points

The chart can be displayed with the excluded points or without the excluded points. When displayed with the excluded points, these points are displayed with a Cross marker. Typically, excluded points will have results that are very different than the majority of other points, either because the data is bad or the wrong standard was run. This can affect the overall scale of chart making it harder to read (the chart is always scaled to include all points and limits).

To show excluded point, *check* to box "Show Excluded Points".
To show the chart without excluded points, *un-check* the box "Show Excluded Points".

Vertical Cursor Line

A standard (point) may be identified using a vertical line. This can help to identify the same standard for different elements during evaluation. To assign a vertical line to a point, hover over the point and when it is selected, click the LEFT mouse button.   Repeat this to remove the line. There can be only one vertical cursor line. If another point is assigned a vertical line, a previous line is moved.
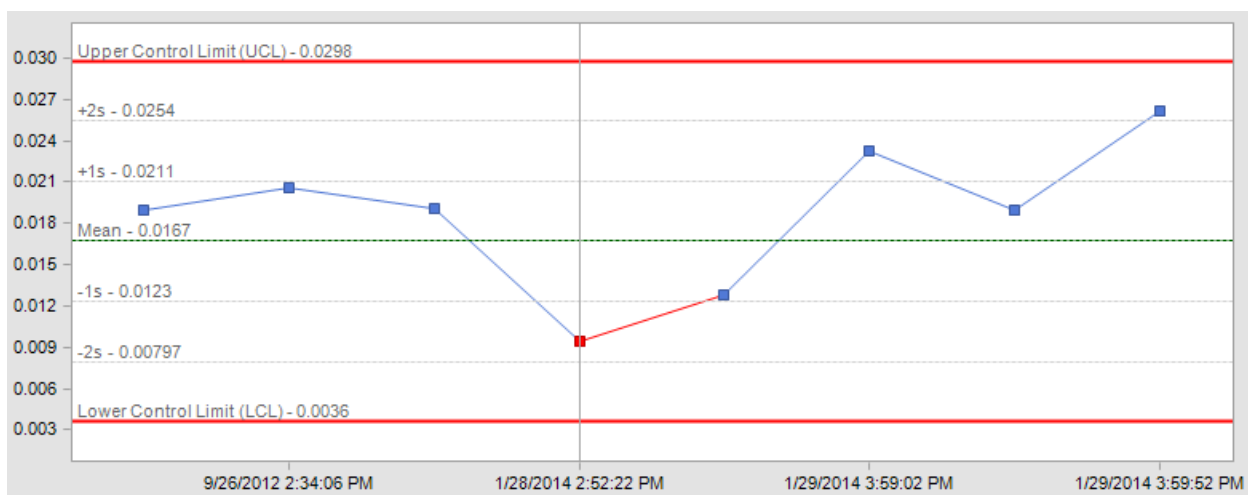
Evaluations Rules

Rules Tab

Click on the Rules tab below the Chart to display a list of the rules that failed and review, update or add notes. Notes may be added to the overall evaluation result and/or specifically to the rule that failed for each element. Notes are entered for the selected item in the light blue area under each list.

When "Last Sample Only" is checked, the rules list applies only to the last sample. When un-checked, the rules list will include all failures for all samples that were loaded.

Element Result Description

The following Result can be shown for an element depending on the evaluated rule:

OverallPass	All Elements Passed test
Pass	Element Passed test
Failed	Element Failed test
MinFail	Element Failed test - Below Minimum Control Limit
MaxFail	Element Failed test - Above Maximum Control Limit
MinSpecFail	Element Failed test - Below Minimum Specification Limit
MaxSpecFail	Element Failed test - Above

	Maximum Specification Limit
AboveMean	Element Failed test - n Points above the mean
BelowMean	Element Failed test - n Points below the mean
Increasing	Element Failed test - increasing trend
Decreasing	Element Failed test - decreasing trend
Inconclusive	Unable to Determine pass/fail -Too many excluded points for this element (usually > 5) -Not enough samples to evaluate the rule

Many rules require data from two or more consecutive samples to evaluate. If a sample or element has been excluded by the user, it is ignored when combining consecutive points. Additional points are obtained from up to <u>five</u> previous consecutive samples (beyond what the rule normally requires) in order to evaluate the rule. If the rule still cannot be evaluated, the Result is *Inconclusive*.

SPC Standards Editor

Standard Limits Editor Overview

Although Limits can be assigned to individual Standards in *SPC Standards Setup*, a full SPC Standards Limits editor is also available as a View in a LabSpeed Template called "SPC Standard Limits". It provides additional capability and is easier to view / edit / manipulate multiple standards at a time. To access this View, create a new Session and select the Client "Topos : Standard SPC". Then select the Template called "SPC Standard Limits".

You must log-in using the same password you use to access the Standards SPC Setup options.


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Standard Limits Editor Features

- Search database for existing standards using wildcards
- Add a new Standard
- Edit an existing Standard

- Duplicate an existing Standard

Retrieving Standards from the Database

There are several ways to search the database to retrieve standards:

- When both Standard Name and Identifier fields are empty (default), clicking on the Search button will load *All* standards from the database.
- Alternatively, you can enter a specific standard name and/or Identifier to load a single standard (click Search after entering the standard name).
- Or use a wildcard (*) in the name to load a list of standards related by name. In the example above, if "BS*" was entered for the standard name (followed by Search), only the BS XAAS and BS 2931 standards would be loaded.
- Finally, click on the ⊳ button above the standard name to select a subset of standards from a list. (then click Search).

Use the provided edit buttons to Edit, Remove, or Duplicate the selected standard in the list.

When changes are made to an element, click "Save Changes" to transfer the changes to the database. Click "Undo Changes" to undo all changes made since the last time changes were saved.

**Note: Although you can create a new standard limits record here it is recommended to not do so. You will need to type in the standard name and instrument identifier as well as all elements. Instead use the SPC Standards Setup to create a new standard limits record, since it uses existing instrument data to set up the matching standard name and identifier and all elements for you.

You can use the Duplicate function to create a new entry with the same elements and limits. Change the name of the Standard and /or just the Identifier. In SPC Standards Setup, when you create a new Standard record, these limits will be picked up automatically if the standard name and identifier match.

Reporting

Like any LabSpeed Session, Views may be added, such as Reports. Two reports have been installed called "Standard Limits Report I" and "Standard Limits Report II" (includes stats and CpK). You can easily modify these reports to include different columns of data or different header contents using the Report Designer. Whatever standards you have loaded into the Editor view will be included in the Report. Reports may also be exported in a variety of formats. You may also add your own Table View in order to export the limit data to Excel or as delimited text.

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