SAP Manufacturing Execution

How-To Guide

How To Set Up and Use the SAP ME SPC with MII Feature

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Document History

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1.0	Initial version	Chet Moutrie
1.1	Added alarm rule definitions, examples and mappings (Appendix D) and other minor corrections and additions	Chet Moutrie
1.2	Minor correction for process workflows (Section 3.2.1)	Chet Moutrie
1.3	Added Short Run information for ME 15.0.3	Chet Moutrie
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1 Introduction

1.1 Purpose

The SAP ME How-To-Guide for Statistical Process Control (SPC) - using MII, is intended to provide sufficient information to enable the feature to be easily configured and readily utilized to meet business needs, making use of available best practices.

1.2 Scope

This information covers all aspects of ME SPC using MII, including how to set it up. It also covers the SPC specific integration with the SAP ME Data Collection feature.

1.3 Glossary

Center Line	The average (**Mean**) of the set of chart points
Characteristic	A numerically measurable aspect of the production process, the production environment or a product feature
CL	**Center Line**
CS	Center Spec – centerline of the specifications (the Target or Nominal value)
LCL	**Lower control limit**
Lower control limit	Typically*, three **Sigma** below the **Center Line**
Lower spec	**Lower specification limit**
Lower specification limit	The minimum acceptable value for a **Characteristic**
LSL	**Lower specification limit**
ME	SAP Manufacturing Execution product
Mean	Average value for a set of values
Median	In a set of values, the median value has the same number of values that are larger than it as values that are smaller than it
MII	SAP Manufacturing Integration and Intelligence
Moving Average	For ME with MII SPC, the exponentially weighted moving average (EWMA) calculated with Lambda set to one divided by the number of data points on the chart

Moving Range	The **Range** calculated as the difference between the average of the current chart point and the average of the preceding chart point
MR chart	**Moving Range** chart
Mv. Average	**Moving Average**
Mv. Range	**Moving Range**
R chart	**Range** chart
Range	The largest value in a set of values minus the smallest value in the set
S chart	**Standard Deviation** chart
Sigma	One **Standard Deviation**
Sigma Coefficient	The number of **Sigma**, or standard deviations, that are used to calculate the upper and lower control limits and zone limits
SPC	Statistical Process Control
Standard Deviation	A value that expresses the variation or dispersion of a population from the average value for the population
UCL	**Upper control limit**
Upper control limit	Typically*, three sigma above the **Center Line**.
Upper specification limit	The maximum acceptable value
Upper spec	**Upper specification limit**
USL	**Upper specification limit**
Zone A	Typically*, between two **Sigma** and three **Sigma** from the **Center Line**
Zone B	Typically*, between one **Sigma** and two **Sigma** from the **Center Line**
Zone C	Typically*, between the **Centerline** and one **Sigma** from the **Center Line**
	* This can be modified via the **Sigma Coefficient**

2 SPC Feature Overview

This overview provides a high level description of SAP ME Statistical Process Control (SPC) – using MII. MII is a software product from SAP that includes an SPC engine and charting.

2.1 Description and Applicability

The SPC feature enables the monitoring of production processes and product quality, and the display of graphical information which indicates whether or not the production process is in statistical control. Variation in a manufacturing process is one of the primary causes of poor product quality. Variation can be due to common cause variation or special cause variation.

Common cause variation is the usual, historical, quantifiable variation in a process or system. It is the to-be-expected "noise" within the process or system. A manufacturing process with only common cause variation is considered to be in statistical control.

Special cause variation is the unusual, not previously observed, non-quantifiable variation in a process or system. It is the unexpected variation in the process or system. It indicates that the process is not in statistical control and either has produced, or is likely to produce, defective items.

By monitoring the variation in the manufacturing process by means of one or more SPC control charts, the occurrence of special cause variation can be detected and the production of defective items can be prevented or reduced in number.

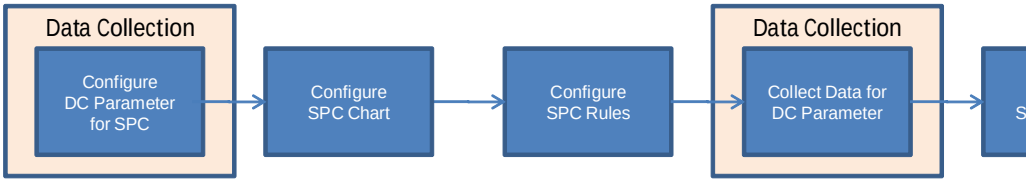
The SAP ME SPC feature is applicable to any production process where characteristic data from the process or product features can be measured and used to control or limit variability in the production process.

2.2 Business Purposes / Functions

The primary purpose of the SPC feature is to apply statistical calculations to collected characteristic data and to check the resultant data against established alarm rules to determine if the production process is out of statistical control. If the data meets the conditions established by an SPC alarm rule, the user can be alerted to the situation, so that action can be taken to prevent the production process from producing defective product.

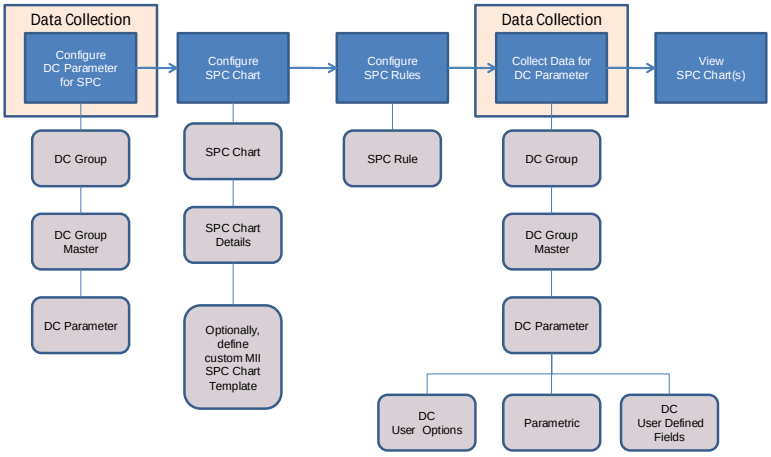
2.3 High-Level Process Flows

This figure illustrates the primary flow of user actions when setting up and utilizing the SPC feature.



2.4 High Level Data Model

The following figure shows the relationship between some of the SPC functions and ME database tables.



3 SPC Functions

3.1 View SPC Chart

3.1.1 Description and Applicability

SPC charts can be viewed on-demand and automatically as a result of data collection. Viewing of SPC charts enables the user to determine whether or not the associated manufacturing process is in statistical control.

The types of SPC charts supported and their descriptions are shown in the following table.

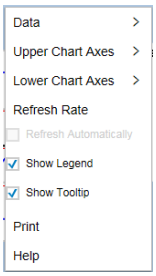
Chart Type	Description
Individuals	Displays each observation (value) of the characteristic being measured.
Individuals and Moving Range	Displays each observation (value) of the characteristic being measured and the range (difference) between successive measurements.
Median	Calculates and displays the median of each subgroup. This type of chart is used when it is desirable to give little weight to occasional "wild shot" values. The median chart should be used only when subgroup sizes are very small, since the efficiency of the median in estimating the true universe mean decreases with increasing subgroup size.
Moving Average	Calculates and displays the modified moving average of subgroups.
Moving Range	Calculates and displays the moving range, difference between subgroup averages.
Process Capability	Displays a normal distribution curve superimposed over a histogram of the individual observations, along with many statistics which include a measure of the capability of the process.
X-Bar and R	Displays the means and ranges of the subgroups. X-Bar chart calculates and displays subgroup means (averages). The R chart calculates and displays subgroup ranges.
X-Bar and S	Calculates and displays the means (averages) and standard deviations of the subgroups. The X-Bar chart calculates and displays subgroup averages. The S chart calculates and displays subgroup standard deviations.
Short Run Individuals	Displays each observation (deviation from nominal value) of the characteristic being measured for multiple materials on the same chart.
Short Run Individuals and Moving Range	Displays each observation (deviation from nominal value) of the characteristic being measured, and the moving range for the observations, for multiple materials on the same charts.
Short Run Moving Range	Displays the moving range for the mean of the observations, for multiple materials on the same chart.
Short Run X-Bar and R	Displays the means and ranges of the subgroups for multiple materials on the same charts. X-bar chart calculates and displays subgroup averages. R chart calculates and displays subgroup ranges.

Note: The above table describes the pre-configured chart types in SAP ME. As of SAP ME 15.1, it also allows usage of any additional chart types available in SAP MII but not pre-configured in ME. To do this you need to define a custom SPC Chart Template in MII and link this with the ME SPC Chart Configuration. The list of chart types supported in SAP MII are available here:
http://help.sap.com/saphelp_mii150sp00/helpdata/en/4c/d57cd3f29560c6e10000000a15822d/content.htm.

The user can interact with the SPC chart to view additional information by:

- Holding the cursor over the box, below a rule letter, at the top of the SPC Display window will display the SPC alarm rule definition(s)
- Moving the cursor near a data point on the chart will display a tooltip with the value for the data point (if the Show Tooltips option is selected)
- Opening the context menu by selecting the Settings icon in the upper right of the chart area

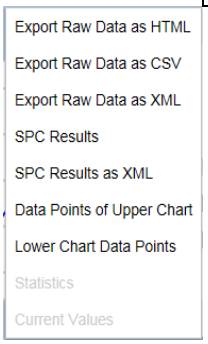
Opening the **context menu** provides the capabilities listed below.



Data	Options to view, export and save chart data, results and statistics
Upper Chart Axes	Options to display attributes and comments and to toggle point suppression
Lower Chart Axes	Options to display attributes and comments and to toggle point suppression
Refresh Rate	Option to set the refresh rate
Refresh Automatically	Not available with ME SPC
Show Legend	If selected, displays the chart legend
Show Tooltip	If selected, displays a tooltip for closest point when the cursor is in the chart area
Print	Options to print the chart
Help	Access to SAP MII SPC Help

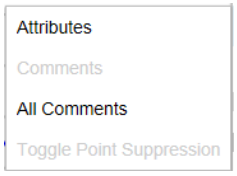
Data Options

Export Raw Data as HTML	View and save chart raw data in an HTML file
Export Raw Data as CSV	View and save chart raw data in a CSV file in Excel
Export Raw Data as XML	View and save chart raw data in an XML file
SPC Results	Displays summary statistics (see Appendix B), and upper and lower chart alarms and data points in HTML
SPC Results as XML	Displays summary statistics (see Appendix B), and upper and lower chart alarms and data points in XML
Data Points of Upper Chart	Displays summary statistics for the data (see Appendix B)
Lower Chart Data Points	Displays upper chart data points and control limits
Statistics	Not available with ME SPC
Current Values	Not available with ME SPC



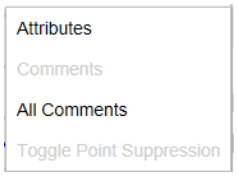
Upper Chart Axes Options

Attributes	Options to view, and adjust setting for, the upper chart attributes
Comments	Not available



All Comments	Options to view, and adjust setting for, the upper chart comments
Toggle Point Suppression	Not available

Lower Chart Axes Options



Attributes	Options to view, and adjust setting for, the upper chart attributes
Comments	Not available
All Comments	Options to view, and adjust setting for, the upper chart comments
Toggle Point Suppression	Not available

3.1.2 Purpose / Effects

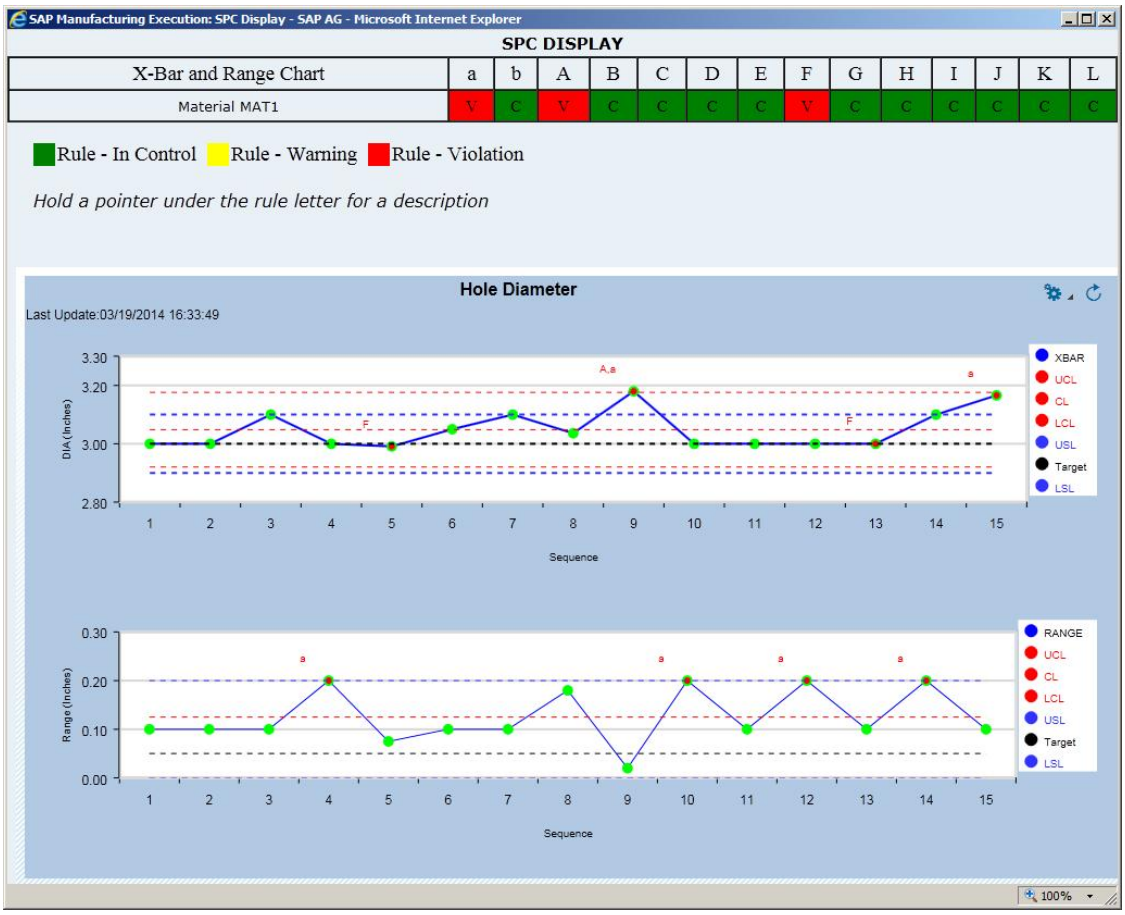
3.1.2.1 View SPC Charts On-Demand

The SPC Display activity (SPC500) enables the user to view the SPC chart(s) for any data collection parameter that is configured for SPC. This is accomplished by:

a) Selecting the SPC Display activity, typically located in the Real Time SPC activity group, under the Quality Management activity group in Activity Manager
b) Select the DC group and DC parameter whose chart is to be viewed
c) Specify the time range for the data that is to be included in the chart
d) Specify other filter parameters (such as material, operation and resource) as needed
e) Select the Search button to view the chart

SAP ME will retrieve the collected data that corresponds to the user specified filters and will pass the data to MII for processing and display. MII will use the data to generate and display the specified chart. The SPC chart will always be displayed in a separate window.

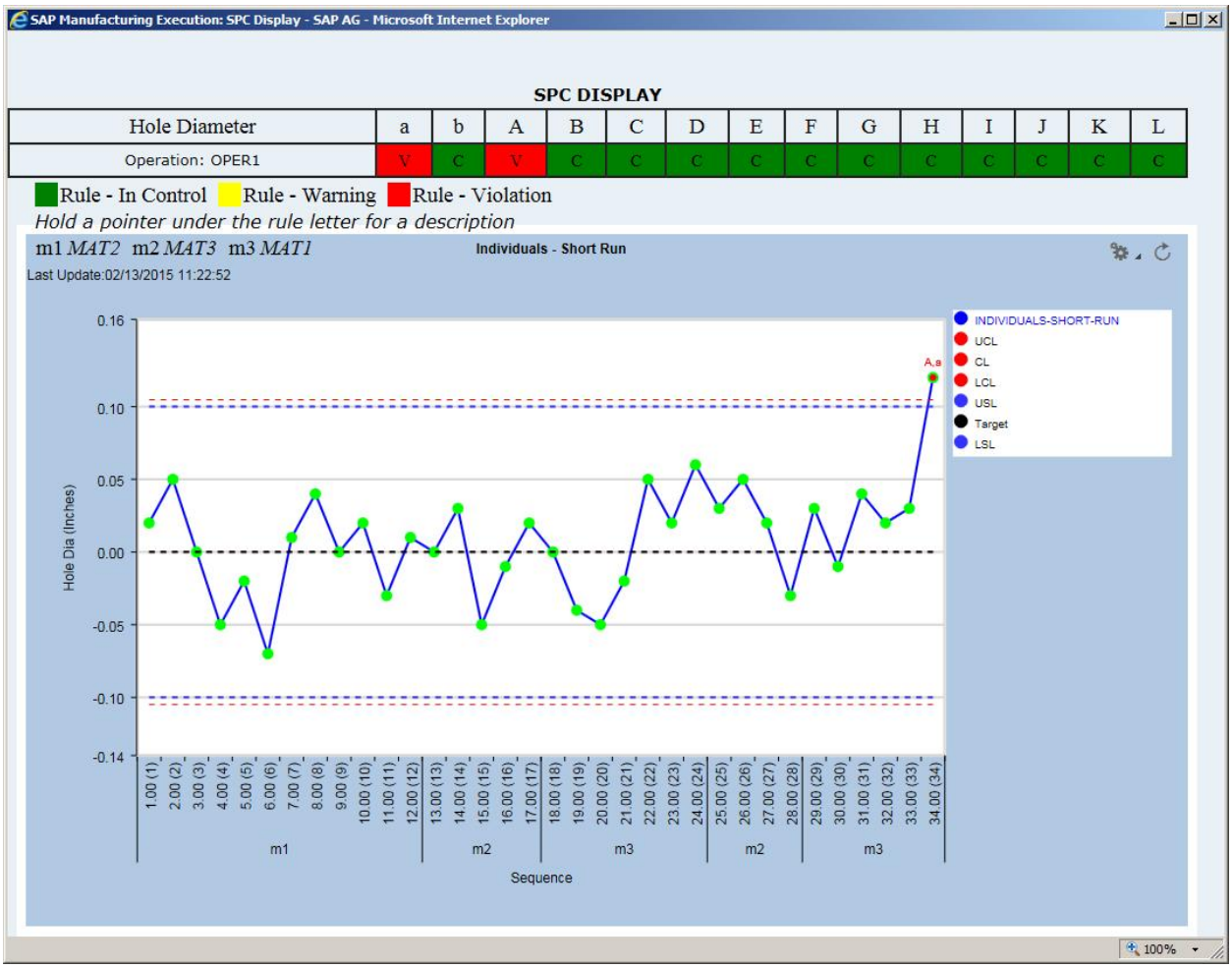
Example SPC chart



The MII SPC engine will also check the data against the SPC alarm rules that have been specified for the chart and will display the rule letter on the chart (above the last violating data point) for any SPC alarm rule whose conditions are violated. See SPC Alarm Rule Processing for more information.

Hold the cursor over the box below an alarm rule letter (displayed above the chart) to get a display of the definition of the alarm rule.

Example Short Run SPC chart



For short run charts, the material identifier for each data point (or group of data points) is displayed below the chart.

3.1.2.2 View SPC Charts During Data Collection

When a user collects data for a DC group, where one or more DC parameters has an associated SPC chart, an SPC pop-up window may be displayed to enable the user to view the SPC chart(s). Whether or not the pop-up window is displayed depends upon the Display Chart setting for the DC parameters:

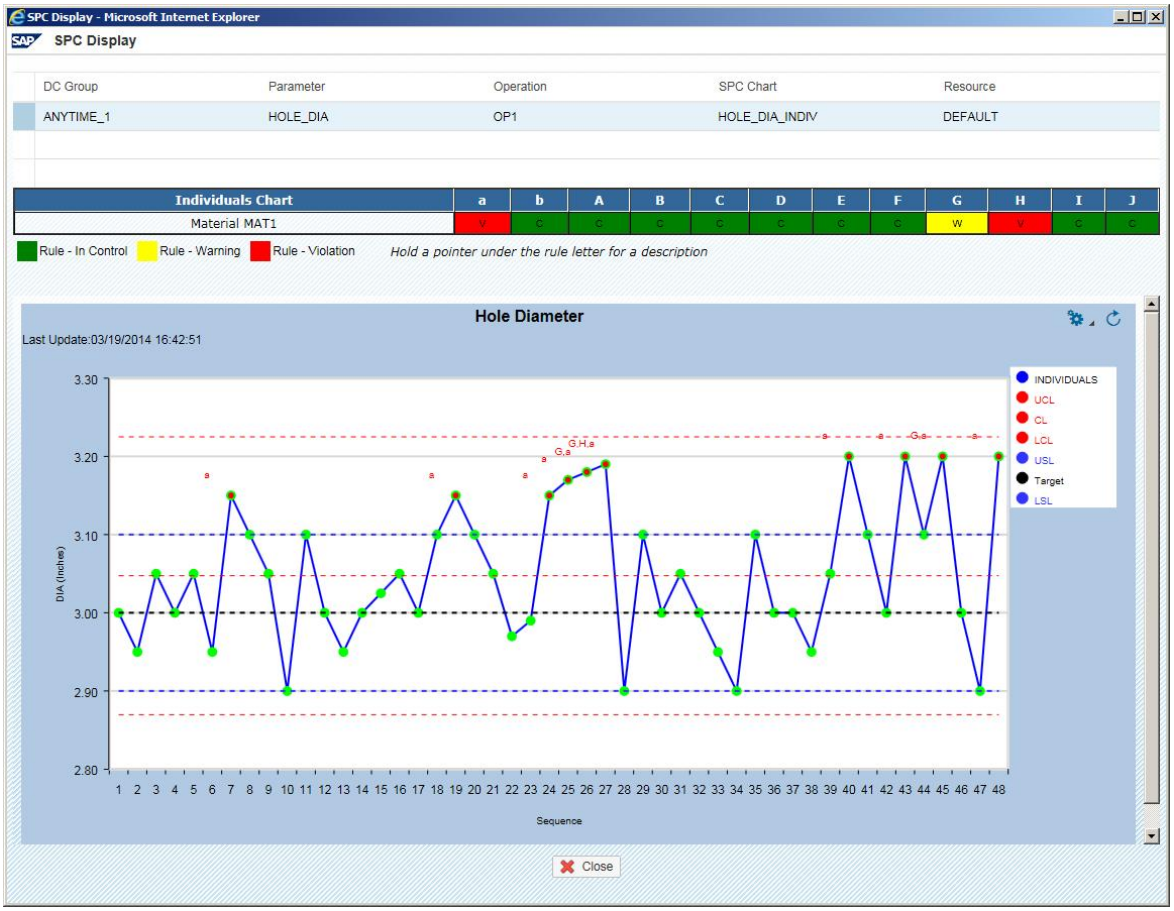
- If the setting for any of the parameters is Always, the pop-up window will be displayed
- Otherwise, if the setting for any of the parameters is Only Alarm, the pop-up window will be displayed if the associated chart has a new alarm rule violation
- If the setting for all of the parameters is Never, the pop-up window will not be displayed

If more than one parameter has an associated SPC chart, a list of the SPC charts, available for viewing for the DC group, will be displayed. After the user selects an SPC chart from the list, or if there is only one chart in the list, then the SPC chart will be displayed.

A chart will not be displayed until enough data has been collected to complete at least one subgroup.

The MII SPC engine will also check the data against the SPC alarm rules that have been specified for the chart and will display the rule letter above the points that have met the conditions for the SPC alarm rule. See SPC Alarm Rule Processing for more information.

The following screenshot shows an example of the pop-up window for an SPC chart.



3.2 SPC Alarm Rule Processing

3.2.1 Description and Applicability

The SPC alarm rules provide the capability to determine if the process has data out of specification or if the process is not in statistical control.

ME provides seven sets of SPC alarm rules:

Rule Set	Typically Used for
AT&T Rules	*X-Bar*, *Individuals*, and *Median* charts, and for *R (Range)* charts when the minimum subgroup is at least four
AT&T R Rules	*R (Range)* charts when the minimum subgroup is less than four
AT&T A Rules	*P*, *NP*, *C*, and *U* charts (these charts currently are not supported in ME)
Ford1 X Rules	*X-Bar* charts
Ford1 R Rules	*R (Range)* charts
Sigma Rules	*S (Standard Deviation)*, *Moving Average*, and *Moving Range* charts
Nelson Rules	*X-Bar* and *S (Standard Deviation)* charts

The specific rules for the AT&T Alarm Rules are shown in the table below.

Rule	Description
a	1 point above upper spec
b	1 point below lower spec
A	1 point above upper zone A
B	1 point below lower zone A
C	2 of 3 successive points in or above upper zone A
D	2 of 3 successive points in or below lower zone A
E	4 of 5 successive points in or above upper zone B
F	4 of 5 successive points in or below lower zone B
G	8 successive points above center line
H	8 successive points below center line
I	15 successive points in zone C
J	8 points on both sides of center line with 0 in zone C
K	14 successive points alternating up and down
L	6 successive points increasing or decreasing

For more information on alarm rules, see SPC Alarm Severity Maintenance and Appendix D.

Each alarm rule can be configured so that if the conditions for that rule are met during manual or automatic data collection, and the SPC chart is configured to propagate alarms, one of the following actions will be taken:

- Send SPC Violation message and place the operation and resource on hold
- Send an SPC Warning message and place the operation and resource on hold
- Do not take any action

For more details, see SPC Alarm Severity Maintenance.

Note: only one SPC alarm message will be sent for a data point even if multiple alarm rules are marked as violated for that data point.

The SPC Violation and SPC Warning messages have predefined workflows (e.g. OP_RES_HOLD_SPC_VIOL and OP_RES_HOLD_SPC_WARN) that automatically put the operation and resource on hold, see Message Type Maintenance and Process Workflow Maintenance in SAP ME Help.

3.3 SPC Chart Processing Details

The following sections describe the processing for each type of SPC chart. The constants d_2 A_2, $\tilde{A}_2$, A_3, B_3, B_4, D_3 and D_4 are bias correction and control chart factors (see Appendix B).

For each chart:

- If the Sigma Coefficient for the chart is not blank, the upper and lower control limits are adjusted by multiplying them by the Sigma Coefficient divided by 3.
- The zone limits for zones C and B are set at 1/3 and 2/3 of the distance between the Centerline and the control limit.

3.3.1 Individuals Chart

The Individuals chart plots each individual measurement (data collection value) in sequence, based upon the date and time at which it was recorded. The chart calculations are:

The average of the individual values is calculated as:

$\overline{x} = \frac{\sum_{i=1}^{m} x_i}{m}$ Where *m* is the number of values in the subgroup

The difference between data point x_i and its predecessor x_{i-1} (moving range) is calculated as:

$MR_i = |x_i - x_{i-1}|$

Next, the arithmetic mean (average) moving range of these values is calculated as:

$\overline{MR} = \frac{\sum_{i=2}^{m} MR_i}{m-1}$

The centerline, upper and lower control limits are calculated as:

$CL = \overline{x}$

$UCL = \overline{x} + 2.66\overline{MR}$

$LCL = \overline{x} - 2.66\overline{MR}$

3.3.2 Individuals Moving Range (MR) Chart

The Individuals Moving Range chart is used with the Individuals chart. For each individual measurement starting with the second one, the moving range is calculated and plotted. The chart calculations are:

$MR_i = |x_i - x_{i-1}|$ starting with $i = 2$ ($MR_1 = 0$).

The arithmetic mean (average) of these moving range values is calculated as:

$\overline{MR} = \frac{\sum_{i=2}^{m} MR_i}{m-1}$ where *m* is the number of measurement values on the chart

$CL = \overline{MR}$

$UCL = 3.268 * \overline{MR}$

$LCL = 0$

3.3.3 Median Chart

The Median chart plots the median value of each subgroup. The subgroups consist of the measurements (data collection values) taken in sequence, based upon the date and time at which they were recorded. The contents of each subgroup are ordered by value.

The median value in an ordered set has half of the values before it and half of the values following it. If there is an odd number of values in the set, the median value is the middle value in the set. If there is an even number of values in the set, the median value is equal to the average of the two middle values in the set.

$\bar{x}_M$ = the average of all of the median values for the chart

The range for each subgroup is calculated as:

R_i = | Max *x* – Min *x* | (absolute value of the maximum value minus the minimum value, for the subgroup)

The arithmetic mean (average) of these range values is calculated as:

$\overline{R} = \frac{\sum_{i=1}^{m} Ri}{m}$ where m is the number of plotted points

The centerline, upper and lower control limits are calculated as:

$CL = \bar{x}_M$

$UCL = \bar{x}_M + \tilde{A}_2 * \overline{R}$

$LCL = \bar{x}_M - \tilde{A}_2 * \overline{R}$

3.3.4 Moving Average Chart

The Moving Average chart is a modified moving average chart that plots values based on the averages of the subgroups. It uses the Exponentially Weighted Moving Average chart with lambda (λ) set to $\frac{1}{N}$, where *N* is the number of data points (subgroups) in the chart.

The subgroups consist of the measurements (data collection values) taken in sequence, based upon the date and time at which they were recorded.

The average of the values in each subgroup is calculated as:

$\overline{X} = \frac{\sum_{i=1}^{m} x_i}{m}$ where m is the subgroup size.

The average of the averages is calculated as:

$\overline{\overline{X}} = \frac{\sum_{i=1}^{m} \overline{x}\text{i}}{m}$ where m is the number of plotted points

The range for each subgroup is calculated as:

R_i = | Max x – Min x | (absolute value of the maximum value minus the minimum value, for the subgroup)

The arithmetic mean (average) of these range values is calculated as:

$\overline{R} = \frac{\sum_{i=1}^{m} R\text{i}}{m}$ where m is the number of plotted points

For the Moving Average chart, the MII Exponential Weighted Moving Average (EWMA) chart is used, with lambda, the weighting factor, set to $\frac{1}{N}$ (where N is the number of subgroups for the chart)

For the first point, EWMA uses the following calculation:

$$EWMA_1 = (1-\lambda)\cdot \overline{\overline{X}} + \lambda \overline{X}$$

For the remaining points, the following formula is used:

$$EWMA_{t+1} = (1-\lambda)\cdot EWMA_t + \lambda \overline{X}_{t+1}$$

For EWMA charts based on a range or moving range, the limits are calculated as follows:

$$UCL_{EWMA} = \overline{\overline{X}} + A_2 \overline{R}\sqrt{\frac{\lambda}{2-\lambda}}$$

$$LCL_{EWMA} = \overline{\overline{X}} - A_2 \overline{R}\sqrt{\frac{\lambda}{2-\lambda}}$$

Substituting $\frac{1}{N}$ for lambda, gives the following calculations.

For the Moving Average (MA) for the first point:

MA_1 = ((N – 1) * $\overline{\overline{x}}$ + $\overline{x}_1$) / N

For the Moving Average (MA) for the remaining points:

MA_{i+1} = ((N – 1) * MA_i + $\overline{x}_{i+1}$) / N

The centerline and limits are calculated as:

$CL = \overline{\overline{x}}$

$UCL = \overline{\overline{x}}$ + A_2 * $\overline{R}$ / (2*N – 1)

$LCL = \overline{\overline{x}}$ - A_2 * $\overline{R}$ / (2*N – 1)

3.3.5 Moving Range Chart

The Range chart plots the moving range for each subgroup. The moving range is the absolute difference between the average for the subgroup minus the average of the previous subgroup. For each subgroup, starting with the second one, the moving range is calculated and plotted. The chart calculations are:

The mean (average) of the values in each subgroup is calculated as:

$\overline{x} = \frac{\sum_{i=1}^{m} x_i}{m}$ where m is the subgroup size.

The moving range for each subgroup is calculated as:

$MR_i = |\ \overline{x}_i - \overline{x}_{i-1}\ |$ starting with $i = 2$ ($MR_1 = 0$).

The arithmetic mean (average moving range) of these values is calculated as:

$\overline{MR} = \frac{\sum_{i=2}^{m} MR_i}{m-1}$ where *m* is the number of subgroups

The centerline and limits are calculated as:

$CL = \overline{MR}$

$UCL = D_4 * \overline{MR}$

$LCL = 0$

3.3.6 X-Bar Chart (for X-Bar and Range)

The X-Bar chart plots the arithmetic mean (average) of each subgroup. The subgroups consist of the measurements (data collection values) taken in sequence, based upon the date and time at which they were recorded. The other chart calculations are:

The average of the values in each subgroup is calculated as:

$\overline{x} = \frac{\sum_{i=1}^{m} x_i}{m}$ where m is the subgroup size.

The average of the averages is calculated as:

$\overline{\overline{x}} = \frac{\sum_{i=1}^{m} \overline{x}\mathrm{i}}{m}$ where m is the number of plotted points

The range for each subgroup is calculated as:

$R_i = |\ \text{Max } x - \text{Min } x\ |$ (absolute value of the maximum value minus the minimum value, for the subgroup)

The arithmetic mean (average) of these range values is calculated as:

$\overline{R} = \frac{\sum_{i=1}^{m} R\mathrm{i}}{m}$ where m is the number of plotted points

The centerline, upper and lower control limits are calculated as:

$CL = \overline{\overline{x}}$

$UCL = \overline{\overline{x}} + A_2 * \overline{R}$

$LCL = \overline{\overline{x}} - A_2 * \overline{R}$

3.3.7 X-Bar Range Chart

The X-Bar Range chart plots the range within each subgroup.

The range for each subgroup is calculated as:

R_i = | Max x – Min x | (absolute value of the maximum value minus the minimum value for the subgroup)

The arithmetic mean (average) of these range values is calculated as:

$\overline{R} = \frac{\sum_{i=1}^{m} Ri}{m}$ where m is the number of plotted points in the X-Bar chart

The centerline, upper and lower control limits are calculated as:

$CL = \overline{R}$

$UCL = D_4 * \overline{R}$

$LCL = D_3 * \overline{R}$

3.3.8 X-Bar Chart (for X-Bar and Standard Deviation)

The X-Bar chart plots the arithmetic mean (average) of each subgroup. The subgroups consist of the measurements (data collection values) taken in sequence, based upon the date and time at which they were recorded. The other chart calculations are:

The average of the values in each subgroup is calculated as:

$\overline{x} = \frac{\sum_{i=1}^{m} x_i}{m}$ where m is the subgroup size.

The average of the averages is calculated as:

$\overline{\overline{x}} = \frac{\sum_{i=1}^{m} \overline{x}i}{m}$ where m is the number of plotted points

The standard deviation for each subgroup is calculated as:

$$StdDev_{subgroup} = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \overline{X})^2}$$

where n is the subgroup size and $\overline{X}$ is the subgroup average.

The arithmetic mean (average) of these standard deviation values is calculated as:

$\overline{S} = \frac{\sum_{i=1}^{m} Si}{m}$

where m is the number of plotted points (subgroups) and s_i is the standard deviation for the subgroup.

The centerline, upper and lower control limits are calculated as:

$CL = \overline{\overline{x}}$

$UCL = \overline{\overline{x}} + A_3 * \overline{S}$

$LCL = \overline{\overline{x}} - A_3 * \overline{S}$

3.3.9 X-Bar Standard Deviation Chart

The X-Bar Standard Deviation chart plots the standard deviation within each subgroup.

The standard deviation for a subgroup is defined as follows, where n is the subgroup size and $\overline{X}$ is the subgroup average.

$$StdDev_{subgroup} = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \overline{X})^2}$$

The arithmetic mean (average) of the subgroup standard deviations is defined as follows, where n is the number of subgroups and s_i is the standard deviation for the subgroup.

$$\overline{S} = \frac{1}{n}\sum_{i=1}^{n} s_i$$

The control limits for the standard deviation chart are calculated as follows:

$UCL = B_4 * \overline{S}$

$LCL = B_3 * \overline{S}$

3.3.10 Process Capability Chart

The Process Capability chart displays a histogram, representing the measurement data, with a superimposed normal distribution curve, and specification target and limit lines. The summary statistics for the process are available via the chart context menu (see Data Options for the context menu in View SPC Chart, and see Appendix B for the definitions of the summary statistics).

3.4 Short Run SPC Chart Processing

In order to adapt control charts to short production runs, the short run charts display measurement data for multiple materials on a single chart. Each subgroup contains data for a single material. The primary short run charts are based upon using the difference between the measurement value and the target value for the material, instead of just the measurement value. For this reason these charts are often described as Difference charts or DNOM (Difference from NOMinal) charts. The short run charts are described in the following sections.

3.4.1 Short Run Individuals Chart

The Short Run Individuals chart plots each individual measurement (data collection value) minus the target value. The chart calculations are:

The average of the individual values is calculated as:

$\overline{x} = \frac{\sum_{i=1}^{m} x_i}{m}$ where $x_i = x - x_t$ and x_t is the target value for the material

The difference between data point x_i and its predecessor x_{i-1} (moving range) is calculated as:
$MR_i = |x_i - x_{i-1}|$.

Next, the arithmetic mean (average moving range) of these values is calculated as:

$$\overline{MR} = \frac{\sum_{i=2}^{m} MR_i}{m-1}$$

The centerline, upper and lower control limits are calculated as:

$CL = \overline{x}$

$$UCL = \overline{x} + 2.66\overline{MR}$$

$$LCL = \overline{x} - 2.66\overline{MR}$$

3.4.2 Short Run Individuals Moving Range (MR) Chart

The Individuals Moving Range chart is used with the Individuals chart. For each individual measurement starting with the second one, the moving range is calculated and plotted. The chart calculations are:

$MR_i = |x_i - x_{i-1}|$ starting with I = 2 ($MR_1 = 0$) and using the x_i values from above.

The arithmetic mean (average moving range) of these values is calculated as:

$$\overline{MR} = \frac{\sum_{i=2}^{m} MR_i}{m-1}$$ where *m* is the number of measurement values

$CL = \overline{MR}$

$UCL = 3.268 * \overline{MR}$

$LCL = 0$

3.4.3 Short Run Moving Range Chart

The Short Run Range chart plots the range for each subgroup. For each subgroup, starting with the second one, the moving range is calculated and plotted. The chart calculations are:

The range for each subgroup is calculated as:

$R_i = |\text{Max } x - \text{Min } x|$ (maximum value minus minimum value, for subgroup *i*)

The moving range for each subgroup is calculated as:

$MR_i = |x_i - x_{i-1}|$ starting with I = 2 ($MR_1 = 0$).

The arithmetic mean (average moving range) of these values is calculated as:

$$\overline{MR} = \frac{\sum_{i=2}^{m} MR_i}{m-1}$$ where *m* is the number of measurement values

The centerline and limits are calculated as:

$CL = \overline{MR}$

$UCL = 3.268 * \overline{MR}$

$LCL = 0$

3.4.4 Short Run X-Bar Chart (for X-Bar and Range)

The Short Run X-Bar chart plots the arithmetic mean (average) of each subgroup. The subgroups consist of the measurements (data collection values) taken in sequence, based upon the date and time at which they were recorded.

The average of the values in each subgroup is calculated as:

$\overline{x} = \frac{\sum_{i=1}^{m} x_i}{m}$ - x_t where m is the subgroup size and x_t is the target value for the material.

The average of the averages is calculated as:

$\overline{\overline{x}} = \frac{\sum_{i=1}^{m} \overline{x}i}{m}$ where m is the number of plotted points

The range for each subgroup is calculated as:

R_i = | Max x – Min x | (maximum value minus minimum value, for the subgroup)

The arithmetic mean (average) of these range values is calculated as:

$\overline{R} = \frac{\sum_{i=1}^{m} Ri}{m}$ where m is the number of plotted points

The centerline, upper and lower control limits are calculated as:

$CL = \overline{\overline{x}}$

$UCL = \overline{\overline{x}} + A_2 * \overline{R}$

$LCL = \overline{\overline{x}} - A_2 * \overline{R}$

3.4.5 Short Run X-Bar Range Chart

The Short Run X-Bar Range chart plots the range within each subgroup.

The range for each subgroup is calculated as:

R_i = | Max x – Min x | (maximum value minus minimum value within the subgroup)

The arithmetic mean (average) of these range values is calculated as:

$\overline{R} = \frac{\sum_{i=1}^{m} Ri}{m}$ where m is the number of plotted points in the X-Bar chart

The centerline, upper and lower control limits are calculated as:

$CL = \overline{R}$

$UCL = D_4 * \overline{R}$

$LCL = D_3 * \overline{R}$

4 Integration

4.1 MII SPC Engine Integration

The SAP ME SPC feature uses the MII SPC engine by default. A customer can use a third party SPC engine by editing the ME SPC Service Extensions (see Service Extension Maintenance in SAP ME Help) and creating a custom SPC integration service.

4.2 SAP ME Data Collection Integration

The SPC feature is directly and indirectly integrated to the SAP ME Data Collection feature. It is directly integrated in that the SPC chart display pop-up window can be invoked when data is collected by a user. It is indirectly integrated via the parametric data that is stored in the SAP ME database via the Data Collection Entry (DC500) and Standalone Data Collection (DC550) plug-in activities.

4.3 SAP ME Test Plan Integration

The SPC feature is indirectly integrated to the SAP ME Test Plan (Parametric Data) feature via the test plan measurement data that is stored in the SAP ME database for the associated data collection group and parameter. This data can be viewed in an SPC chart through the SPC Display (SP500) activity.

5 SPC Feature Setup

5.1 External Configuration

The following configuration tasks are required in order to use the MII SPC engine and charting from ME.

5.1.1 Security Configuration

To allow users with the SAP_ME_USER role to view MII SPC charts from ME, the following steps should be performed.

5.1.1.1 Add XMII_USER Action to SAP_ME_USER Role

Use the following steps to add the *XMII_User* action to the role:

1. Go to the following URL: http://<server>:<port>/nwa and login to NetWeaver with an administrator user ID
2. Select the *Configuration* tab
3. Select *Identity Management*
4. In *Search Criteria* select *Role*, enter SAP_ME_USER and click *Go*
5. Select the role in the table
6. Select the *Assigned Actions* tab in the Details table
7. Select the *Modify* button
8. Enter *XMII_User* in the *Get* field in the *Available Actions* panel and select the *Go* button
9. Select the row containing *XMII_User* and select the *Add* button
10. Select the Save button

5.1.1.2 Assign SAP_ME_USER Role to XMLConnector

Use the following steps to assign the role to the XMLConnector Server in the SAP MII database table XMII_SERVERPRMMAP.

1. Access the MII database with an application that can modify the database via an SQL statement
2. Run the following statement against the MII database: *insert into XMII_SERVERPRMMAP (SERVERNAME, ROLENAME) values ('XMLConnector', 'SAP_ME_USER');*

Note the MII tables are located in the same database used by Netweaver. If Netweaver is configured to use SAP DB (aka Max DB), then perform the following steps to execute the insert statement.

1) Open a command prompt window on the Netweaver server.
2) Run the SAP DB SQL command line interface as follows:

   <Drive>:\sapdb\clients\M84\bin\sqlcli.exe -n<Netweaver server host name> -d<Netweaver node name> -u<SAP DB schema name>,<SAP DB password>

   An example is:

   C:\sapdb\clients\M84\bin\sqlcli.exe -nlocalhost -dN74 -uuser,password
3) Execute the insert statement

   insert into XMII_SERVERPRMMAP (SERVERNAME, ROLENAME) values ('XMLConnector', 'SAP_ME_USER')
4) Type "quit" to exit the SQL command line interface

5.1.2 Destinations Configuration

Create Netweaver destinations to support performing SPC analysis using the MII SPC Engine.

1. Login to NWA as an Administrator
2. Select the Configuration tab
3. Select the Destinations link
4. Click Create
5. Enter the Destination Name: MII_HTTP
6. Enter the Destination Type: HTTP Destination. Click Next.
7. Enter the URL: http://<host>:<port>/XMII/Illuminator. Click Next.
8. Select Authentication: Basic (User ID and Password)
9. Enter User Name: MESYS
10. Enter Password: (Password for MESYS User)
11. Click Finish

Repeat steps 4 through 11 with MIICatalog_HTTP as the destination name and http://<host>:<port>/XMII/Catalog as the URL.

5.1.3 Display Template Creation (Optional)

The MII Workbench can be used to create a customer specific Display Template for an SPC chart. Specifying the MII Workbench path and name of this display template in the MII Display Template field in SPC Chart Maintenance in ME, will cause ME to use this display template instead of the default template for the chart type. In addition to that, if appropriate configuration is done in SPC Chart Maintenance, following aspects defined in the chart template may be used for Real-time SPC Analysis and SPC Display:

1. Chart Type
2. SPC Alarms

3. Specification Limits
4. Control Limits

Assign the user's role to the customer specific display template as indicated in Add Role to Chart Template below.

See MII SPC Help for information regarding using the MII Workbench to create a display template. See Appendix A for information on which display template configuration parameters are overridden by the configuration data from ME.

5.1.3.1 Add Role to Custom Chart Display Template (optional)

This step is needed only for custom MII SPC chart display templates.

Log on to SAP MII with an Administrator user ID using the following URL: http://<SAP_MII_host>:<SAP_MII_port>/XMII.

Access the MII Workbench in the SAP MII Dashboard menu, by choosing *SAP ME ERP Integration > SAP MII Configuration > Navigation (Workbench -> Tools)*. For more information about using the MII Workbench, see the SAP MII Workbench online help.

Use the following steps to add the role to the custom display template:

1. Select the Catalog tab
2. Open the path to the custom display template and then double click the custom display template
3. In the *Template Categories* navigation pane, scroll down and double click on *Security*
4. Under Reader Roles, select the SAP_ME_USER role in the Available Roles list
5. Select the arrow button to add the role to the Reader Roles list
6. Select the Save icon at the top left of the window

If the Statit SPC engine is used, please refer to the SAP ME 6.1 How-To-Guide – SPC using Statit.

5.2 Maintenance Activities

5.2.1 System Rules

5.2.1.1 Statit Server Host Computer Name

The Statit Server Host Computer Name system rule should be set to blank or empty, if the MII SPC engine is to be used. For new installations, starting with ME 15.0, this system rule is set to empty by default.

5.2.2 Product Configuration

5.2.2.1 Data Collection Maintenance

In order to apply the SPC feature to data collected through the SAP ME Data Collection feature, the DC parameter must be set up for SPC in the Data Collection Maintenance (DC100) activity.

To have SAP ME pass the data collected for a DC parameter to the MII SPC engine for processing, the fields in the following table must be configured on the SPC tab in the Data Collection Maintenance activity.

Field	Description
Perform SPC Analysis	If selected, the MII SPC engine is used to generate the SPC chart and to perform alarm rule analysis based upon the alarm rule set assigned to the chart. SPC warning or violation messages will be sent, if an alarm rule is violated and the alarm rule is so configured. If not selected, the chart is not displayed during data collection, regardless of the setting for the Display Chart field below, and no SPC analysis is performed.
SPC Chart	The name of the SPC chart to generate. The chart must be defined in SPC Chart Maintenance.
Short Run	If selected, the user can enter the target value for each material for which data will be collected for the chart. In short run mode, data from multiple materials can be used in the same chart. Instead of using the actual measurement values, the deviation of each measurement value from the target (or nominal) value is used.
Display Chart	*Never*: SPC charts do not appear during data collection. *Always*: SPC charts always appear during data collection. *Only Alarm*: SPC charts appear only when an SPC alarm rule condition is met.

For data collection for a short run chart, the following information must be supplied for each material for which data will be collected for the short run chart.

Field	Description
Material	The material for which data will be collected for the short run chart.
Target	The target value for the data to be collected for the material.

5.2.3 System Configuration

5.2.3.1 Message Type Maintenance

In Message Type Maintenance, the following message types must **not** be deleted or disabled, if SPC alarm messages are to be propagated.

- SPC_ALARM_VIOLATION
- SPC_ALARM_WARNING

For more information on these messages, please see Message Type Maintenance in SAP ME Help.

5.2.4 Other Maintenance Activities

5.2.4.1 SPC Chart Maintenance

This maintenance activity is used to create an SPC chart that can be viewed during data collection, for the associated DC parameter, or viewed using the SPC Display activity.

The following tables describe the fields that can be set in SPC Chart Maintenance.

5.2.4.1.1 Main Tab Page

Field	Description
Chart Type	The type of control chart you are adding or modifying. All control chart types are for variable (characteristic) data. *Individuals*: Displays each collected value separately *Median*: Calculates and displays the median of each subgroup. This chart type is used when it is desirable to give little weight to occasional wild shot values. The median chart should be used only when subgroup sizes are small, since the efficiency of the median in estimating the true universe mean decreases with increasing subgroup size. *Moving Average*: Calculates and displays the moving average of each subgroup *Moving Range*: Calculates and displays the moving range of each subgroup *Process Capability*: Displays a standard normal distribution curve, and the specification limits and target value, superimposed over a histogram of data. It also provides access to calculated statistical values associated with the process capability **NOTE:** For a *Process Capability* chart, you must fill in the *Upper Spec Limit*, *Target*, and *Lower Spec Limit* fields. *X-Bar and R*: Displays the mean and range of each subgroup, using two charts. The *X-Bar* chart calculates and displays the mean of each subgroup. The *R* chart calculates and displays the range of each subgroup. *X-Bar and S*: Calculates and displays the mean and standard deviation of each subgroup, using two charts. *X-Bar* chart calculates and displays mean of each subgroup. *S* chart calculates and displays the standard deviation of each subgroup. Note that if you select the *X-Bar and R* or *X-Bar and S* chart type, the system enables all the fields on the *Secondary Chart* tab page. **The following short run chart types can be used by selecting the corresponding regular chart and selecting the Short Run checkbox (see below). The calculated value is the collected value minus the target value for the material.** *Short Run Individuals*: Displays each calculated value separately, for multiple materials on the same chart. *Short Run Individuals and MR*: Displays each calculated value and the moving range for each calculated value, using two charts. Displays each calculated value separately, for multiple materials, on a single chart. Displays the moving range for the calculated values, for multiple materials, on a single chart. *Short Run Moving Range*: Calculates and displays the moving range of each subgroup, for multiple materials, on a single chart. *Short Run X-Bar and R*: Displays the mean and range of each subgroup, using two charts. The *X-Bar* chart calculates and displays the mean of each subgroup, for multiple materials, on a

	single chart. The *R* chart calculates and displays the range of each subgroup, for multiple materials, on a single chart. *From Chart Template*: If this option is selected, it is mandatory to specify a path for chart template in the field "Chart Template". The chart type defined in the MII Chart Template will be used (with exception of short run charts). For short run scenario, the predefined ME chart types should be used.
Subgroup Size	The number of data points to be used per plot point for this control chart. For Individuals charts, this field is disabled. For *Median* charts, the entered number must be at least **2** and no more than **25**. For all other charts, the entered number must be at least **2** and no more than **30**.
Max Plot Points	The maximum number of plot points displayed on this control chart. A number between 2 and 100 is recommended.
Max Data Age (days)	The maximum age (in days) of the data points to be used in the analysis and the chart display
Display Template	The MII Workbench path and name of the MII Display Template to be used for this control chart (e.g. Project/SPC/Special DisplayTemplate). If left blank, ME will use the predefined display template for this control chart. See Appendix A for the contents of the MII Display Template for an SPC chart.
Propagate Alarms	If selected, allows the system to generate an alarm message if an associated SPC Alarm Rule is met (see SPC Alarm Severity Maintenance).
Create Messages for All Alarms.	This option comes into effect only if the 'Propagate Alarms' option is enabled. If this option is enabled, a message will be created per new alarm found during real-time SPC analysis. If this option is disabled, only one message will be created for any one of the new alarms found.
Short Run	If selected, the created chart will be a short run chart of the type selected in Chart Type (only available for *Individuals*, *Individuals and MR*, *Moving Range*, and *X-Bar and R*)

5.2.4.1.2 Chart Labels Tab Page

Field	Description
X Tick Label	Defines the type of labeling for each subgroup along the X Axis. *Sequential (1 to N)*: Displays a number starting at *1*, and incremented by *1* for each subgroup *Time*: Displays the time the data was entered *Date*: Displays the date the data was entered *Date/Time*: Displays the date and time the data was entered *SFC*: Displays the SFC number for which the data was collected
X Axis Label	The label displayed along the X-axis of the control chart
Y Axis Label	The label displayed beside the Y-axis of the control chart
Y Axis Min	The minimum value to be plotted on the control chart
Y Axis Max	The maximum value to be plotted on the control chart
Scale	Determines whether the chart's Y-axis scale is linear or logarithmic (based on powers of 10)

5.2.4.1.1 Primary Chart Details Tab Page

Field	Description
Control Limit Options	*None*: Control limits are not used. *Fixed*: Control limits are fixed as specified by the user. *Calculated*: Control limits are calculated from the process data and the sigma coefficient. *From Chart Template*: The control limit configuration defined in the custom MII Chart Template is used. Note that the upper and lower control limits specify the threshold values at which the process output is considered to be statistically "out of control".
Upper Control Limit	The maximum value above which the process is considered to be statistically "out of control". It is typically set at three standard deviations above the center line.
Center Line	The mean of the values plotted on the chart.

Lower Control Limit	The minimum value below which the process is considered to be statistically "out of control". It is typically set at three standard deviations below the center line.
Sigma Coefficient	The number of sigma, or standard deviations, used to calculate the upper and lower control limits
Spec Limit Options	*Fixed*: The spec limits are fixed as specified by the user. *From Chart Template*: The spec limit configuration defined in the custom MII Chart Template is used.
Upper Spec Limit	The maximum value above which the plotted value is considered to be "out of specification".
Target	The specified (nominal) value for the characteristic being plotted.
Lower Spec Limit	The minimum value below which the plotted value is considered to be "out of specification".
Alarm Rules	The identifier of the group of rules used to determine if a manufacturing process is in a state of statistical control. These rules are used during the SPC analysis. See SPC Alarm Severity Maintenance for more details. If the option '*Use Chart Template Rules*' is selected, then the alarm rules defined in the custom MII Chart Template is used. If any alarms are found as per this configuration, the alarms are treated with severity 'SPC Violation's. In this case, there is no additional configuration required in SPC Alarm Severity Maintenance.

5.2.4.1.1 Secondary Chart Details Tab Page

The fields on this tab page have the same description as fields on the Primary Chart Details tab page.

5.2.4.2 SPC Alarm Severity Maintenance

This maintenance activity is used to specify the type of message to be sent when the conditions for an SPC alarm rule are met. The type of message is set individually for each alarm rule in each alarm rule set.

Note: This activity is not relevant if the custom MII chart template is used to define the SPC Rules. In such case, all alarms found are by default treated as 'SPC Violation'.

The following table describes the action taken for each type of message.

Type of Message	Description
SPC Violation	The SPC_ALARM_VIOLATION message is sent and the operation and resource are placed on hold if the conditions for the rule are met.
SPC Warning	The SPC_ALARM_WARNING message is sent and the operation and resource are placed on hold if the conditions for the rule are met.
Ignore	No message is sent when the conditions for the rule are met.

By default, the SPC_ALARM_VIOLATION and SPC_ALARM_WARNING messages each have an associated process workflow, OP_RES_HOLD_SPC_VIOL and OP_RES_HOLD_SPC_WARN, respectively. For more details, see Message Type Maintenance and Process Flow Maintenance in SAP ME Help.

There are seven sets of SPC Alarm rules:

Rule Set	Typical Use
AT&T Rules	*X-Bar*, *Individuals*, and *Median* charts, and for *R* charts when the subgroup size is at least four
AT&T R Rules	*R* charts when the subgroup size is less than four

AT&T A Rules	*P*, *NP*, *C*, and *U* charts – Attribute charts for countable data (not supported in ME)
Ford1 X Rules	*X-Bar* charts
Ford1 R Rules	*R* charts
Sigma Rules	*S*, *Moving Average*, and *Moving Range* charts
Nelson Rules	*X-Bar* and *S* charts

For more details on the SPC alarm rules, see Appendix D

The specific rules for each Alarm Rule Set are shown in the tables below.

AT&T Rules

Rule	Description
a	1 point above upper spec
b	1 point below lower spec
A	1 point above upper zone A
B	1 point below lower zone A
C	2 of 3 successive points in or above upper zone A
D	2 of 3 successive points in or below lower zone A
E	4 of 5 successive points in or above upper zone B
F	4 of 5 successive points in or below lower zone B
G	8 successive points above center line
H	8 successive points below center line
I	15 successive points in zone C
J	8 successive points on both sides of center line with 0 in zone C
K	14 successive points alternating up and down
L	6 successive points increasing or decreasing

AT&T R Rules

Rule	Description
a	1 point above upper spec
b	1 point below lower spec
A	1 point above upper zone A
B	2 successive points in or above upper zone A
C	3 successive points in or above upper zone B
D	7 successive points in or above upper zone C
E	10 successive points in or below lower zone C
F	6 successive points in or below lower zone B
G	4 successive points in lower zone A

AT&T A Rules

Rule	Description
a	1 point above upper spec
b	1 point below lower spec
A	1 point above upper zone A
B	1 point below lower zone A
C	9 points in a row above center line
D	9 points in a row below center line
E	6 points in a row steadily increasing or decreasing
F	14 points in a row alternating up and down

Ford1 X Rules

Rule	Description
a	1 point above upper spec
b	1 point below lower spec
A	1 point above upper zone A
B	1 point below lower zone A
C	7 points in a row above center line
D	7 points in a row below center line
E	7 points steadily increasing or decreasing
F	14 points in a row alternating up and down
G	2 of 3 successive points in upper zone A or beyond
H	2 of 3 successive points in lower zone A or beyond

Ford1 R Rules

Rule	Description
a	1 point above upper spec
b	1 point below lower spec
A	1 point above upper zone A
B	1 point below lower zone A
C	14 points in a row alternating up and down

Sigma Rules

Rule	Description
a	1 point above upper spec
b	1 point below lower spec
A	1 point above upper zone A
B	1 point below lower zone A

Nelson Rules

Rule	Description
a	1 point above upper spec
b	1 point below lower spec
A	1 point above upper zone A
B	1 point below lower zone A
C	9 points in a row in upper zone C or beyond
D	9 points in a row in lower zone C or beyond
E	6 points in a row increasing or decreasing
F	14 points in a row alternating up and down
G	2 out of 3 points in a row in zone A or beyond and on the same side of the center line
H	4 out of 5 points in a row in zone B or beyond and on the same side of the center line
I	15 points in a row in zone C (above and below the center line)
J	8 points on both sides of the center line with none in zone C

6 Usage Scenario Examples

No usage scenario provided.

7 Links to Additional Information

SAP ME 15.0 Help Topics (Links not yet updated for ME 15.0 Help)

Statistical Process Control

Setting up Statistical Process Control

SPC Chart Maintenance

SPC Alarm Severity Maintenance

SPC Display

8 Other Reference Material

"Understanding Statistical Process Control" by David S. Chambers and Donald J. Wheeler, published by SPC Press, Inc.

"Evaluation of Measurement Processes" by David S. Chambers and Donald J. Wheeler, published by SPC Press, Inc.

"Short Run SPC" by Donald J. Wheeler, published by SPC Press, Inc.

"Introduction to Statistical Quality Control" by Douglas C. Montgomery, published by John Wiley & Sons, Inc.

9 Overview of Changes

9.1 ME 15.0.3

Short Run SPC was added for ME 15.0.3.

9.2 ME 15.0

The following changes were made to ME SPC for ME 15.0:

- ME SPC uses the MII SPC engine and chart display
- Individuals and Moving Range chart has been added
- Options to display and export information from each SPC chart
  - Data Points
  - Summary Statistics
  - Chart Image

- New field in Chart Maintenance to specify the MII Workbench path and name of an MII SPC Display Template
- Significantly more control over appearance, content and processing for SPC charts via the MII SPC Display Template / Workbench
- SPC charts are displayed using UI5

Appendix A - MII Display Template Data Mapping

The following table shows the SAP MII SPC Display Template parameter default values and which parameters are overridden by data from SAP ME or not used by ME SPC. Parameters shown in red were added to MII SPC for SAP ME.

MII SPC Config. Area	MII SPC Configuration Parameter	Value	ME SPC Config. Area	ME SPC Configuration Parameter
Chart Area	Chart Name	Set by ME	SPC Chart Maintenance - Header	SPC Chart
Chart Area	Description	Set by ME	SPC Chart Maintenance - Main	Description
Chart Area	Chart Type	Set by ME	SPC Chart Maintenance - Main	Chart Type
Chart Area	Main Border Color	#B1C9E2		
Chart Area	Main Background Color	#B1C9E2		
Chart Area	Marker Size	5		
Chart Area	Allow Item Selection			
Chart Area	Reverse Point Order	FALSE		
Chart Area	Show Suppressed Points	FALSE		
Chart Area	Show Limit Transitions	FALSE		
Chart Area	Enable Specification Limit Transitions	FALSE		
Chart Area	Show Comment Flags	FALSE		
Chart Area	Show Tooltip	TRUE		
Formatting	User Locale Format	FALSE		
Formatting	Date Format	MM/dd/yy HH:mm:ss		
Formatting	Number Format	0.00000		
Title	Show Application Toolbar	TRUE		
Title	Show Message Area	TRUE		
Title	Show Title	TRUE		
Title	Show Timebar	FALSE		
Title	Title	Set by ME	SPC Chart Maint. - Chart Labels	Chart Title (Line 3)
Title	Color	#000000		
Title	Font	Arial		
Title	Font Size	12		
Title	Font Style	Bold		
Title	Alignment	Center		
Data Mapping	Query Template			
Data Mapping	Value Columns	Set by ME		ACTUAL_VALUE
Data Mapping	Attribute Columns	Set by ME		XAXIS_ID
Data Mapping	ID Columns			
Data Mapping	Sample Size Column			
Data Mapping	Time Stamp Column	Set by ME		Test_Date_Time
Parameters	Subgroup Size	Set by ME	SPC Chart Maintenance - Main	Subgroup Size
Parameters	Sample Size	Set by ME	Run Time Calculation	Number of Plot Points
Parameters	Lambda	Set by ME	Run Time Calculation	1 / Number of Plot Points
Parameters	Use Avg of all subgroup for 1st point calculation	TRUE		
Parameters	Upper Chart Sigma Coefficient	Set by ME	SPC Chart Maint. - Primary Chart	Sigma Coefficient
Parameters	Lower Chart Sigma Coefficient	Set by ME	SPC Chart Maint. - Secondary Chart	Sigma Coefficient
Parameters	Lower Limit of Box	25		
Parameters	Upper Limit of Box	75		
Parameters	Whisker Lower Limit	0		
Parameters	Whisker Upper Limit	100		
Parameters	Histogram Cell Count	10		
Parameters	Tolerance Type	0		
Legend	Show Legend	TRUE		
Legend	Background Color	#FFFFFF		
Legend	Border Color	#000000		
Legend	Font	Arial		
Legend	Font Size	10		
Legend	Font Style	Plain		
X-Axis	Show X-Axis	TRUE		
X-Axis	Upper Chart X-Axis Label	Set by ME	SPC Chart Maint. - Chart Labels	Primary Chart X Axis Label
X-Axis	Lower Chart X-Axis Label	Set by ME	SPC Chart Maint. - Chart Labels	Secondary Chart X Axis Label
X-Axis	Font	Arial		
X-Axis	Font Size	10		
X-Axis	Font Style	Plain		
X-Axis	Number Format	0		
X-Axis	Label Color	#000000		
X-Axis	X-Axis Label Attribute	Set by ME		XAXIS_ID or blank
X-Axis	Tick Color	#000000		
Y-Axis	Show Y-Axis	TRUE		
Y-Axis	Font	Arial		
Y-Axis	Font Size	10		
Y-Axis	Font Style	Plain		
Y-Axis	Number Format	0.00		
Y-Axis	Label Color	#000000		
Y-Axis	Show Labels	TRUE		
Y-Axis	Show Tick Marks	TRUE		
Y-Axis	Tick Color	#000000		
Y-Axis	Show Y Axis Label	TRUE		
Y-Axis	Upper Chart Y Axis Label	Set by ME	SPC Chart Maint. - Chart Labels	Primary Chart X Axis Label
Y-Axis	Lower Chart Y Axis Label	Set by ME	SPC Chart Maint. - Chart Labels	Secondary_X Axis Label
Upper Chart Spec. Limits	Upper Spec. Limit Column			
Upper Chart Spec. Limits	Target Column			

MII SPC Config. Area	MII SPC Configuration Parameter	Value	ME SPC Config. Area	ME SPC Configuration Parameter
Upper Chart Spec. Limits	Lower Spec. Limit Column			
Upper Chart Spec. Limits	Specification Limit Source			
Upper Chart Spec. Limits	Param. 1 - 8 for Spec. Limit			
Upper Chart Spec. Limits	Upper Spec. Limit	Set by ME	SPC Chart Maint. - Primary Chart	Upper Spec. Limit
Upper Chart Spec. Limits	Target	Set by ME	SPC Chart Maint. - Primary Chart	Target
Upper Chart Spec. Limits	Lower Spec. Limit	Set by ME	SPC Chart Maint. - Primary Chart	Lower Spec. Limit
Upper Chart Spec. Limits	Upper Spec Limit of Upper Chart User	0		
Upper Chart Spec. Limits	Target of Upper Chart User	0		
Upper Chart Spec. Limits	Lower Spec Limit of Upper Chart User	0		
Upper Chart Spec. Limits	Show Upper Spec Limits	Set by ME	SPC Chart Maint. - Primary Chart	Display Spec. Limits
Upper Chart Spec. Limits	Show Upper User Spec Limits	FALSE		
Upper Chart Spec. Limits	Show Upper User Target	FALSE		
Upper Chart Spec. Limits	Spec. Limit Color of Upper Chart	#3333FF		
Upper Chart Spec. Limits	Color of Upper Chart Target	#000000		
Upper Chart Spec. Limits	Spec. Limit Color of Upper Chart User	#FF8C00		
Upper Chart Spec. Limits	Target Color of Upper Chart User	#FF0000		
Upper Chart Axes	Show Upper Tick Marks	TRUE		
Upper Chart Axes	Show Upper Labels	TRUE		
Upper Chart Axes	Use Scaling	Set by ME	SPC Chart Maint. - Chart Labels	Iif Y Max and Y Min set
Upper Chart Axes	Min. Range of Upper Chart	Set by ME	SPC Chart Maint. - Chart Labels	Y Axis Min
Upper Chart Axes	Max. Range of Upper Chart	Set by ME	SPC Chart Maint. - Chart Labels	Y Axis Max
Upper Chart Axes	Show Violation Border	FALSE		
Upper Chart Axes	Upper Violation Border Color	#FF0000		
Upper Chart Axes	Violation Border Line Thickness	2		
Upper Chart Axes	Limit Line Thickness	2		
Upper Chart WECO Texts	Show WECO Number Texts	TRUE		
Upper Chart WECO Texts	Alarm Text Color	#FF0000		
Upper Chart WECO Texts	Font Size	10		
Upper Chart WECO Texts	Font Style	Plain		
Upper Chart WECO Texts	Alarm Text Delimiter	,		
Upper Chart WECO Texts	Alarm 1 - 10 Text Abbreviation	Set by ME	SPC Chart Maint. Primary Chart	Based on Trend Rule Set
Upper Chart WECO Texts	Alarm 20, 21, 24, 25, 28, 30, 32, 33, 36, 37, 40, 42, 44, 45, 48	Set by ME	SPC Chart Maint. Primary Chart	Based on Trend Rule Set
Upper Chart Area	Upper Chart Background Color	#FFFFFF		
Upper Chart Area	Upper Chart Border Color	#B1C9E2		
Upper Chart Area	Color of Upper Chart Line	#000000		
Upper Chart Area	Color of Upper Centerline	#FF0000		
Upper Chart Area	Upper Bar Color	#C0C0C0		
Upper Chart Area	Color of Upper Chart Marker	#00FF00		
Upper Chart Area	Selected Marker Color of Upper Chart	#0000FF		
Upper Chart Area	Upper Alarms Color	#FF0000		
Upper Chart Area	Color of Upper Inner Limit	#33CC00		
Upper Chart Area	Warning Limit Color for Upper Chart	#33CC00		
Upper Chart Area	Color of Upper Control Limit	#FF0000		
Upper Chart Area	Show Upper Control Limits	Set by ME	SPC Chart Maint. - Primary Chart	Control Limit Options not. None
Upper Chart Area	Show Upper Warning Limits	FALSE		
Upper Chart Area	Show Upper Inner Limits	FALSE		
Upper Chart Area	Show Normal Dist Curve for Histogram	TRUE		
Upper Chart Area	Line Thickness	2		
Upper Chart Area	Line Style	Solid		
Upper Chart Control Limits	Upper Ctrl Limit Column of Upper Chart			
Upper Chart Control Limits	Center Line Column of Upper Chart			
Upper Chart Control Limits	Lower Ctrl Limit Column of Upper Chart			
Upper Chart Control Limits	Calculate Control Limits	Set by ME	SPC Chart Maint. - Primary Chart	Control Limit Options = Calculate
Upper Chart Control Limits	Source for Upper Control Limits			
Upper Chart Control Limits	Param. 1 - 8 for Upper Control Limit			
Upper Chart Control Limits	Upper Ctrl Limit for Upper Chart	Set by ME	SPC Chart Maint. - Primary Chart	Upper Control Limit
Upper Chart Control Limits	Upper CL	Set by ME	SPC Chart Maint. - Primary Chart	Center Line
Upper Chart Control Limits	Lower Control Limit of Upper Chart	Set by ME	SPC Chart Maint. - Primary Chart	Lower Control Limit
Lower Chart Spec. Limits	Upper Spec. Limit	Set by ME	SPC Chart Maint. - Secondary Chart	Upper Spec Limit
Lower Chart Spec. Limits	Target	Set by ME	SPC Chart Maint. - Secondary Chart	Target
Lower Chart Spec. Limits	Lower Spec. Limit	Set by ME	SPC Chart Maint. - Secondary Chart	Lower Spec Limit
Lower Chart Spec. Limits	Upper Spec Limit of Lower Chart User	0		
Lower Chart Spec. Limits	Target of Lower Chart User	0		
Lower Chart Spec. Limits	Lower Spec Limit of Lower Chart User	0		
Lower Chart Spec. Limits	Show Lower Specification Limits	Set by ME	SPC Chart Maint. - Secondary Chart	Show Specification Limits
Lower Chart Spec. Limits	Show Lower User Specification Limits	FALSE		
Lower Chart Spec. Limits	Show Lower User Target	FALSE		
Lower Chart Spec. Limits	Color of Lower Spec. Limit	#006300		
Lower Chart Spec. Limits	Lower Target Color	#000000		
Lower Chart Spec. Limits	Color of Lower User Specification Limit	#FF8C00		
Lower Chart Spec. Limits	Lower User Target Color	#DC143C		
Lower Chart Axes	Show Lower Tick Marks	TRUE		
Lower Chart Axes	Show Lower Labels	TRUE		
Lower Chart Axes	Use Scaling	Set by ME	SPC Chart Maint. - Secondary Chart	Depends if Y Axis and Y Min set
Lower Chart Axes	Lower Min. Range	Set by ME	SPC Chart Maint. - Secondary Chart	Y Axis Min
Lower Chart Axes	Lower Max. Range	Set by ME	SPC Chart Maint. - Secondary Chart	Y Axis Max
Lower Chart Axes	Show Violation Border	FALSE		
Lower Chart Axes	Lower Violation Border Color	#FF0000		
Lower Chart Axes	Violation Border Line Thickness	2		
Lower Chart Axes	Limit Line Thickness	1		
Lower Chart WECO Texts	Show WECO Number Texts	TRUE		
Lower Chart WECO Texts	Alarm Text Color	#FF0000		
Lower Chart WECO Texts	Font Size	10		
Lower Chart WECO Texts	Font Style	Plain		

MII SPC Config. Area	MII SPC Configuration Parameter	Value	ME SPC Config. Area	ME SPC Configuration Parameter
Lower Chart WECO Texts	Alarm Text Delimiter	,		
Lower Chart WECO Texts	Alarm 1 - 10 Text Abbreviation	Set by ME	SPC Chart Maint. Secondary Chart	Based on Trend Rule Set
Lower Chart WECO Texts	Alarm 22, 23, 26, 27, 29, 31, 34, 35, 38, 39, 41, 43, 46, 47, 49	Set by ME	SPC Chart Maint. Secondary Chart	Based on Trend Rule Set
Lower Chart Area	Background Color of Lower Chart	#FFFFFF		
Lower Chart Area	Border Color of Lower Chart	#B1C9E2		
Lower Chart Area	Lower Line Color	#0000FF		
Lower Chart Area	Color of Centerline on Lower Chart	#FF0000		
Lower Chart Area	Color of Bar on Lower Chart	#C0C0C0		
Lower Chart Area	Lower Marker Color	#00FF00		
Lower Chart Area	Lower Selected Marker Color	#0000FF		
Lower Chart Area	Lower Alarms Color	#FF0000		
Lower Chart Area	Color of Inner Limit on Lower Chart	#33CC00		
Lower Chart Area	Lower Warning Limit Color	#33CC00		
Lower Chart Area	Color of Control Limit on Lower Chart	#FF0000		
Lower Chart Area	Show Lower Control Limits	Set by ME	SPC Chart Maint. - Secondary Chart	Control Limit Options not None
Lower Chart Area	Show Lower Warning Limits	FALSE		
Lower Chart Area	Show Lower Inner Limits	FALSE		
Lower Chart Area	Line Thickness	2		
Lower Chart Area	Line Style	Solid		
Lower Chart Control Limits	Column for Upper Ctrl Limit of Lower Chart			
Lower Chart Control Limits	Column for Lower Centerline			
Lower Chart Control Limits	Column for Lower Ctrl Limit of Lower Chart			
Lower Chart Control Limits	Calculate Control Limits	Set by ME	SPC Chart Maint. - Secondary Chart	Control Limit Options = Calculate
Lower Chart Control Limits	Source for Lower Control Limits			
Lower Chart Control Limits	Param. 1 - 8 for Upper Control Limit			
Lower Chart Control Limits	Upper Ctrl Limit for Lower Chart	Set by ME	SPC Chart Maint. - Secondary Chart	Upper Control Limit
Lower Chart Control Limits	Lower Centerline	Set by ME	SPC Chart Maint. - Secondary Chart	Center Line
Lower Chart Control Limits	Lower Control Limit of Lower Chart	Set by ME	SPC Chart Maint. - Secondary Chart	Lower Control Limit
Alarms	Allow Upper Chart Control Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Lower Chart Control Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 1)	Alarm Limit for Control Limit	Set by ME		Set to 0
Alarms (Alarm 1)	Alarm Length for Control Limit	Set by ME		Set to 0
Alarms (Alarm 20)	Alarm Limit for Upper Chart Upper Control Limit	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 20)	Alarm Length for Upper Chart Upper Control Limit	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 21)	Alarm Limit for Upper Chart Lower Control Limit	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 21)	Alarm Length for Upper Chart Lower Control Limit	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 22)	Alarm Limit for Lower Chart Upper Control Limit	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 22)	Alarm Length for Lower Chart Upper Control Limit	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 23)	Alarm Limit for Lower Chart Lower Control Limit	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 23)	Alarm Length for Lower Chart Lower Control Limit	Set by ME	Determined by ME Rule Set	
Alarms	Allow Upper Chart Run Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Lower Chart Run Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 2)	Limit of Run Limit Alarm	Set by ME		Set to 0
Alarms (Alarm 2)	Length of Run Limit Alarm	Set by ME		Set to 0
Alarms (Alarm 24)	Limit of Upper Chart Above Centerline Run Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 24)	Length of Upper Chart Above Centerline Run Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 25)	Limit of Upper Chart Below Centerline Run Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 25)	Length of Upper Chart Below Centerline Run Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 26)	Limit of Lower Chart Above Centerline Run Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 26)	Length of Lower Chart Above Centerline Run Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 27)	Limit of Lower Chart Below Centerline Run Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 27)	Length of Lower Chart Below Centerline Run Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Upper Chart Trend Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Lower Chart Trend Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 3)	Alarm Limit of Trend Limit	Set by ME		Set to 0
Alarms (Alarm 3)	Alarm Length of Trend Limit	Set by ME		Set to 0
Alarms (Alarm 28)	Limit of Upper Chart Trend Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 28)	Length of Upper Chart Trend Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 29)	Limit of Lower Chart Trend Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 29)	Length of Lower Chart Trend Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Upper Chart Alternating Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Lower Chart Alternating Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 4)	Limit of Alternating Limit Alarm	Set by ME		Set to 0
Alarms (Alarm 4)	Length of Alternating Limit Alarm	Set by ME		Set to 0
Alarms (Alarm 30)	Limit of Upper Chart Alternating Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 30)	Length of Upper Chart Alternating Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 31)	Limit of Lower Chart Alternating Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 31)	Length of Lower Chart Alternating Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Upper Chart Zone A Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Lower Chart Zone A Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 5)	Limit of Zone A Limit Alarm	Set by ME		Set to 0
Alarms (Alarm 5)	Length of Zone A Limit Alarm	Set by ME		Set to 0
Alarms (Alarm 32)	Limit of Upper Chart Upper Zone A Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 32)	Length of Upper Chart Upper Zone A Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 33)	Limit of Upper Chart Lower Zone A Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 33)	Length of Upper Chart Lower Zone A Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 34)	Limit of Lower Chart Upper Zone A Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 34)	Length of Lower Chart Upper Zone A Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 35)	Limit of Lower Chart Lower Zone A Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 35)	Length of Lower Chart Lower Zone A Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Upper Chart Zone B Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Lower Chart Zone B Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 6)	Limit of Zone B Limit Alarm	Set by ME		Set to 0
Alarms (Alarm 6)	Length of Zone B Limit Alarm	Set by ME		Set to 0

MII SPC Config. Area	MII SPC Configuration Parameter	Value	ME SPC Config. Area	ME SPC Configuration Parameter
Alarms (Alarm 36)	Limit of Upper Chart Upper Zone B Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 36)	Length of Upper Chart Upper Zone B Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 37)	Limit of Upper Chart Lower Zone B Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 37)	Length of Upper Chart Lower Zone B Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 38)	Limit of Lower Chart Upper Zone B Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 38)	Length of Lower Chart Upper Zone B Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 39)	Limit of Lower Chart Lower Zone B Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 39)	Length of Lower Chart Lower Zone B Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Upper Chart Inside Zone C Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Lower Chart Inside Zone C Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 7)	Limit of Inside Zone C Limit Alarm	Set by ME		Set to 0
Alarms (Alarm 7)	Length of Inside Zone C Limit Alarm	Set by ME		Set to 0
Alarms (Alarm 40)	Limit of Upper Chart Inside Zone C Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 40)	Length of Upper Chart Inside Zone C Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 41)	Limit of Lower Chart Inside Zone C Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 41)	Length of Lower Chart Inside Zone C Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Upper Chart Outside Zone C Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Lower Chart Outside Zone C Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 8)	Limit of Outside Zone C Limit Alarm	Set by ME		Set to 0
Alarms (Alarm 8)	Length of Outside Zone C Limit Alarm	Set by ME		Set to 0
Alarms (Alarm 42)	Limit of Upper Chart Outside Zone C Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 42)	Length of Upper Chart Outside Zone C Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 43)	Limit of Lower Chart Outside Zone C Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 43)	Length of Lower Chart Outside Zone C Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Upper Chart Specification Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Lower Chart Specification Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 9)	Alarm Limit for Specification Limit	Set by ME		Set to 0
Alarms (Alarm 9)	Alarm Length for Specification Limit	Set by ME		Set to 0
Alarms (Alarm 44)	Alarm Limit for Upper Chart Upper Spec Limit	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 44)	Alarm Length for Upper Chart Upper Spec Limit	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 45)	Alarm Limit for Upper Chart Lower Spec Limit	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 45)	Alarm Length for Upper Chart Lower Spec Limit	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 46)	Alarm Limit for Lower Chart Upper Spec Limit	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 46)	Alarm Length for Lower Chart Upper Spec Limit	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 47)	Alarm Limit for Lower Chart Lower Spec Limit	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 47)	Alarm Length for Lower Chart Lower Spec Limit	Set by ME	Determined by ME Rule Set	
Alarms	Allow Upper Chart Alternating Centerline Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Lower Chart Alternating Centerline Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 10)	Limit of Alternating Centerline Limit Alarm	Set by ME		Set to 0
Alarms (Alarm 10)	Length of Alternating Centerline Limit Alarm	Set by ME		Set to 0
Alarms (Alarm 48)	Limit of Upper Chart Alternating Centerline Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 48)	Length of Upper Chart Alternating Centerline Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 49)	Limit of Lower Chart Alternating Centerline Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms (Alarm 49)	Length of Lower Chart Alternating Centerline Limit Alarm	Set by ME	Determined by ME Rule Set	
Alarms	Allow Upper Chart Sigma Difference Limit Alarm	Set by ME		Set to 0
Alarms	Allow Lower Chart Sigma Difference Limit Alarm	Set by ME		Set to 0
Alarms	Limit of Sigma Difference Limit Alarm	Set by ME		Set to 0
Alarms	Length of Sigma Difference Limit Alarm	Set by ME		Set to 0
Limit Texts - Upper Chart	Upper Control Limit Show Limit Text	FALSE		
Limit Texts - Upper Chart	Upper Control Limit Font Size	10		
Limit Texts - Upper Chart	Upper Control Limit Font Style	Plain		
Limit Texts - Upper Chart	Centerline Show Limit Text	FALSE		
Limit Texts - Upper Chart	Centerline Font Size	10		
Limit Texts - Upper Chart	Centerline Font Style	Plain		
Limit Texts - Upper Chart	Centerline Reverse Coloring	FALSE		
Limit Texts - Upper Chart	Lower Control Limit Font Size	10		
Limit Texts - Upper Chart	Lower Control Limit Font Style	Plain		
Limit Texts - Upper Chart	Upper Spec. Limit Show Limit Text	FALSE		
Limit Texts - Upper Chart	Upper Spec. Limit Font Size	10		
Limit Texts - Upper Chart	Upper Spec. Limit Font Style	Plain		
Limit Texts - Upper Chart	Target Show Limit Text	FALSE		
Limit Texts - Upper Chart	Target Font Size	10		
Limit Texts - Upper Chart	Target Font Style	Plain		
Limit Texts - Upper Chart	Lower Spec. Limit Show Limit Text	FALSE		
Limit Texts - Upper Chart	Lower Spec. Limit Font Size	10		
Limit Texts - Upper Chart	Lower Spec. Limit Font Style	Plain		
Limit Texts - Lower Chart	Upper Control Limit Show Limit Text	FALSE		
Limit Texts - Lower Chart	Upper Control Limit Font Size	10		
Limit Texts - Lower Chart	Upper Control Limit Font Style	Plain		
Limit Texts - Lower Chart	Centerline Show Limit Text	FALSE		
Limit Texts - Lower Chart	Centerline Font Size	10		
Limit Texts - Lower Chart	Centerline Font Style	Plain		
Limit Texts - Lower Chart	Lower Control Limit Show Limit Text	FALSE		
Limit Texts - Lower Chart	Lower Control Limit Font Size	10		
Limit Texts - Lower Chart	Lower Control Limit Font Style	Plain		
Limit Texts - Lower Chart	Upper Spec. Limit Show Limit Text	FALSE		
Limit Texts - Lower Chart	Upper Spec. Limit Font Size	10		
Limit Texts - Lower Chart	Upper Spec. Limit Font Style	Plain		
Limit Texts - Lower Chart	Target Show Limit Text	FALSE		
Limit Texts - Lower Chart	Target Font Size	10		
Limit Texts - Lower Chart	Target Font Style	Plain		
Limit Texts - Lower Chart	Lower Spec. Limit Show Limit Text	FALSE		
Limit Texts - Lower Chart	Lower Spec. Limit Font Size	10		
Limit Texts - Lower Chart	Lower Spec. Limit Font Style	Plain		
Context Menu Behaviors	Allow Popup Menu	TRUE		

MII SPC Config. Area	MII SPC Configuration Parameter	Value	ME SPC Config. Area	ME SPC Configuration Parameter
Context Menu Security	Allow Point Suppression	FALSE		
Context Menu Security	Allow Comment Editing	FALSE		
Context Menu Security	Point Suppression Roles			
Context Menu Security	Comment Editing Roles			
Refresh Page	Allow Automatic Refresh	FALSE		
Refresh Page	Automatically Refresh	FALSE		
Refresh Page	Refresh Rate	60		
Refresh Page	Initial Update	TRUE		
Security	Reader Roles	SAP_ME_USER SAP_MII_User		
Security	Writer Roles			

Appendix B – Summary Statistics Definitions

CP - Cp

Cp is a statistic that determines whether or not a process is capable of producing results which conform to specifications. It is usually referred to as "Capability."

The following formula is used to calculate *Cp*:

$$Cp = \frac{USL - LSL}{6s_{est}}$$

USL is the upper specification limit.

LSL is the lower specification limit.

s_{est} is the estimate of standard deviation (usually from a control chart).

For example:

Given a process with the following parameters,

USL = 105

LSL = 95

Estimate of standard deviation from an X-Bar and Range chart = 3

the *Cp* is calculated as:

$$Cp = \frac{105 - 95}{6 \times 3} = \frac{10}{18} = 0.556$$

In general, this statistic assumes that the process is normally distributed. It also assumes that the process is in a state of statistical control. When a process is not in a state of statistical control or not normally distributed, predictions about the process capability are not generally reliable.

There may be differences of opinion about the source of the estimate of standard deviation that is used in this calculation. The generally accepted practice is to use an estimate of standard deviation based on a control chart (see Standard Deviation below).

CPK - Cpk

Cpk is a statistic that indicates both the centering and ability of the process to produce results that conform to specifications. *Cpk* is usually referred to as the "Capability Index."

The following formula is used to calculate the *Cpk*:

$$Cpk = Min(Cpu, Cpl)$$

Cpu is the upper capability index.

Cpl is the lower capability index.

For example:

Given a process with the following parameters:

Cpu = 0.56

Cpl = 1.24

The *Cpk* is calculated as 0.56.

A process is generally considered capable when the *Cpk* is 1.33 or greater. For a one-sided tolerance, the *Cpk* is equivalent to either *Cpu* or *Cpl* depending on which tolerance limit is specified.

CPL - Cpl

Cpl is a statistic that indicates both the centering and ability of the process to produce results that conform to specifications. *Cpl* is usually referred to as the "Lower Capability Index."

The following formula is used to calculate the *Cpl*:

$$Cpl = \frac{\overline{\overline{X}} - LSL}{3s_{est}}$$

$\overline{\overline{X}}$ is the overall process average.

LSL is the lower specification or tolerance limit.

s_{est} is the estimate of standard deviation (see STANDARDDEVIATION below).

CPM - Cpm

Cpm is a measure similar to the *Cp* index that also takes into account variation between the process average and a target value. If the process average and the target are the same value, *Cpm* will be the same as *Cp*. If the average drifts from the target value, *Cpm* will be less than *Cp*.

The following formula is used to calculate *Cpm*:

$$C_{pm} = \frac{C_p}{\sqrt{1 + \frac{(\overline{\overline{x}} - T)^2}{\sigma_x^2}}}$$

where $\overline{\overline{x}}$ is the process average, *T* is the process target value and σ_x is the estimate of the standard deviation (see STANDARDDEVIATION below).

CPU - Cpu

Cpu is a statistic that indicates both the centering and ability of the process to produce results that conform to specifications. *Cpu* is usually referred to as the "Upper Capability Index."

The following formula is used to calculate the *Cpu*:

$$Cpu = \frac{USL - \overline{\overline{X}}}{3s_{est}}$$

$\overline{\overline{X}}$ is the overall process average.

USL is the upper specification or tolerance limit.

s_{est} is the estimate of standard deviation (see Standard Deviation below).

CR - Cr

The *Cr* is the capability ratio and is the inverse of *Cp*.

The following formula is used to calculate the *Cr*:

$$Cr = \frac{1}{Cp}$$

EFFECTIVE_LSL – LSL

The *LSL* is the lower specification limit value.

EFFECTIVE_TARGET - Target

The *Target* is the specification target value.

EFFECTIVE_USL - USL

The *USL* is the upper specification limit value.

ESTPCTNCOHIGH - EstPercentNCHigh

The *EstPercentNCHigh* statistic represents the total percentage of samples you would expect to see above the *USL* given a normal distribution with the same standard deviation that is estimated from the sample data.

ESTPCTNCOLOW - EstPercentNCLow

The *EstPercentNCLow* statistic represents the total percentage of samples you would expect to see below the *LSL* given a normal distribution with the same standard deviation that is estimated from the sample data.

ESTPCTNCOPPM - EstPercentNCPPM

The *EstPercentNCPPM* statistic represents the parts per million (ppm) percent non-conforming based on the assumption that the data is from a normal distribution. That is, this quantity represents the ppm you would expect, given a normal distribution with the same standard deviation that is estimated from the sample data.

ESTPCTNCOTOTAL - EstPercentNCTotal

The *EstPercentNCTotal* statistic represents the total percentage of samples you would expect to see outside of the specifications given a normal distribution with the same standard deviation that is estimated from the sample data.

ESTSTANDARDDEVIATION - EstStdDev

The *EstStdDev* is a measure of the spread or variation in a distribution and is calculated based on an average range, average moving range, or average standard deviation from a control chart. The formula that is used to calculate the *EstStdDev* depends on the type of control chart.

For control charts based on a range or moving range, the following formula is used:

$$EstStdDev = \frac{\bar{r}}{d_2}$$

For control charts based on standard deviation, the following formula is used:

$$EstStdDev = \frac{\bar{s}}{c_4}$$

where

$$\bar{r} = \frac{1}{n}\sum_{i=1}^{n} r_i$$

$$\bar{s} = \frac{1}{n}\sum_{i=1}^{n} s_i$$

and d_2 and c_4 are constants (see Appendix C) based on the subgroup size of the sample.

EST_CP - EstCp

The *EstCp* is similar to *Cp* except that *EstCp* always uses an estimate of standard deviation based on individuals, whereas *Cp* can use either an estimate based on a control chart or based on individuals.

The following formula is used to calculate the *EstCp*:

$$EstCp = \frac{USL - LSL}{6s_{est}}$$

USL is the upper specification limit.

LSL is the lower specification limit.

s_{est} is the estimate of standard deviation based on individual measurements.

The following formula (where *n* is the number of measurements used in the chart) is used to calculate the estimate of standard deviation for *EstCp*:

$$Std = \sqrt{\sum \frac{(x_i - \bar{x})^2}{n-1}}$$

EstCp is sometimes referred to as *Pp* and is equivalent to that statistic.

EST_CPK - EstCpk

EstCpk is a statistic that indicates both the centering and ability of the process to produce results that conform to specifications.

The following formula is used to calculate the estimated *Cpk*:

$$EstCpk = Min(EstCpu, EstCpl)$$

EstCpu is the estimated upper capability index.

EstCpl is the estimated lower capability index.

EstCpk and *Cpk* are equivalent when the estimate of standard deviation used to calculate *Cpu* and *Cpl* is based on individual measurements.

EST_CPL - EstCpl

EstCpl is a statistic that indicates both the centering and ability of the process to produce results that conform to specifications.

The following formula is used to calculate the *EstCpl*:

$$EstCpl = \frac{\overline{\overline{X}} - LSL}{3 s_{est}}$$

$\overline{\overline{X}}$ is the overall process average.

USL is the upper specification or tolerance limit.

s_{est} is the estimate of standard deviation based on individual measurements.

Cpl and *EstCpl* are equivalent when the estimate of standard deviation used is based on individuals. However, when the estimate of standard deviation used to calculate *Cpl* is based on a control chart, the values of these two statistics are slightly different. *EstCpl* always uses the estimate of standard deviation based on individuals whereas *Cpl* can use either an estimate based on individuals or an estimate from a control chart.

The following formula (where *n* is the number of measurements used in the chart) is used to calculate s_{est}:

$$Std = \sqrt{\sum \frac{(x_i - \bar{x})^2}{n-1}}$$

EST_CPM - EstCpm

??

EST_CPU - EstCpu

EstCpu is a statistic that indicates both the centering and ability of the process to conform to specifications.

The following formula is used to calculate the *EstCpu*:

$$EstCpu = \frac{USL - \overline{\overline{X}}}{3s_{est}}$$

$\overline{\overline{X}}$ is the overall process average.

USL is the upper specification or tolerance limit.

s_{est} is the estimate of standard deviation based on individual measurements.

Cpu and *EstCpu* are equivalent when the estimate of standard deviation used is based on individuals. However, when the estimate of standard deviation used to calculate *Cpu* is based on a control chart, the values of these two statistics are slightly different. *EstCpu* always uses the estimate of standard deviation based on individuals, whereas *Cpu* can use either an estimate based on individuals or an estimate from a control chart.

The following formula (where *n* is the number of measurements used in the chart) is used to calculate s_{est}:

$$Std = \sqrt{\sum \frac{(x_i - \bar{x})^2}{n-1}}$$

EST_CR - EstCr

The *EstCr* is the estimated capability ratio and is the inverse of *EstCp*.

The following formula is used to calculate the *EstCr*:

$$EstCr = \frac{1}{EstCp}$$

EST_ZLSL - EstZLSL

The following formula is used to calculate *EstZLSL*:

$$EstZLSL = \frac{LSL - Mean}{s_{est}}$$

LSL is the lower specification limit.

Mean is the overall average.

s_{est} is an estimate of standard deviation based on individual measurements rather than a control chart.

EST_ZUSL - EstZUSL

The following formula is used to calculate *EstZUSL*:

$$EstZUSL = \frac{USL - Mean}{s_{est}}$$

USL is the upper specification limit.

Mean is the overall average.

s_{est} is an estimate of standard deviation based on individual measurements rather than a control chart.

KURTOSIS - Kurtosis

The *kurtosis* of a distribution describes the relative peakedness or flatness of the distribution relative to a normal distribution. A positive *kurtosis* indicates a peaked distribution while negative *kurtosis* indicates a flat distribution.

The following formula is used to calculate the *kurtosis*:

$$Kurt = \left(\frac{n(n+1)}{(n-1)(n-2)(n-3)} \sum \frac{(x_j - \bar{x})^4}{s} \right) - \frac{3(n-1)^2}{(n-2)(n-3)}$$

where

$s = stddev$

$n = count$

For example:

With sample data of

94, 98, 90, 95, 91, 94, 96, 95, 100

the calculated estimate of *kurtosis* is **-0.0704**.

LOWERCHARTCL - CL

The *Lower Chart CL* is the centerline value for the lower chart.

LOWERCHARTLCL - Upper Chart LCL

The *Low Chart LCL* is the lower control limit (*LCL*) value for the lower chart.

LOWERCHARTUCL - Lower Chart UCL

The *Lower Chart UCL* is the upper control limit (*UCL*) value for the lower chart.

MAXIMUMVALUE - Max

The *max* is the largest value in a set of samples.

Mean

The *mean* of a distribution is the average of all samples. The following formula is used to calculate the *mean*:

$$Mean = \sum \frac{x_i}{n}$$

MINIMUMVALUE - Min

The *min* is the smallest value in a set of samples.

PCTNCOHIGH - PercentNCHigh

The *PercentNCHigh* statistic represents the percentage of samples that are above the upper specification limit (USL).

The following formula is used to calculate this statistic:

$$PercentNCHigh = \frac{CountAboveUSL}{TotalCount} \times 100$$

PCTNCOLOW - PercentNCLow

The *PercentNCLow* statistic represents the percentage of samples that are below the lower specification limit (LSL).

The following formula is used to calculate this statistic:

$$PercentNCLow = \frac{CountBelowLSL}{TotalCount} \times 100$$

PCTNCOPPM - PercentNCPPM

The *PercentNCPPM* statistic represents the parts per million percent non-conforming.

The following formula is used to calculate this statistic:

$$PercentNCPPM = PercentNCTotal * 10000$$

PCTNCOTOTAL - PercentNCTotal

The *PercentNCTotal* statistic represents the percentage of samples that are outside the specification limits.

The following formula is used to calculate this statistic:

$$PercentNCTotal = \frac{CountOutsideSpecifications}{TotalCount} \times 100$$

PP - Pp

Pp and *EstCp* are equivalent. *Pp* is often called a performance index. In recent years the use of a performance index versus a capability index has been somewhat discounted. In cases where the estimate of standard deviation used to calculate *Cp* is based on individuals and not a control chart, the *Pp* and *Cp* are equivalent.

PPK - Ppk

Ppk and *EstCpk* are equivalent.

PPM - Ppm

The *ppm* is the parts per million non-conforming.

The following formula is used to calculate *ppm*:

$$ppm = \frac{TotaNonConform}{TotalCount} * 10000$$

PR - Pr

The *Pr* is the estimated capability ratio and the inverse of *EstCp*.

$Pr = \frac{1}{EstCp}$ formula is used to calculate the *EstCr*:

Pr and *EstCr* are equivalent.

RANGE

The *range* is the difference between the *max* and *min*.

The formula that is used to calculate the *range* is:

$$Range = Max - Min$$

Example:

With sample data of

94, 98, 90, 95, 91, 94, 96, 95, 100

the *range* is **10**.

RANGEBAR - Range Bar

Range Bar is the mean (average) range for the chart and is calculated as:

$$\overline{R} = \frac{\sum_{i=1}^{m} Ri}{m}$$

where m is the number of plotted points in the chart and R_i is the range for subgroup *i*

SHAPIROWILK - Shapiro-Wilk Test

Please see the following references:

E.S. Pearson, R.B. D'Agostino, K.O. Bowman (1977), "Tests for departure from normality: Comparison of powers," Biometrika 64, pp. 231-246.

S.S. Shapiro, M.B. Wilk (1965) "An analysis of variance test of normality (complete sample)." Biometrika 52, pp. 591-610.

SHAPIROWILKSIGNIFICANCE - Shapiro-Wilk Significance

Please see the following references:

E.S. Pearson, R.B. D'Agostino, K.O. Bowman (1977), "Tests for departure from normality: Comparison of powers," Biometrika 64, pp. 231-246.

S.S. Shapiro, M.B. Wilk (1965) "An analysis of variance test of normality (complete sample)." Biometrika 52, pp. 591-610.

SKEWNESS - Skewness

The *skewness* describes the asymmetry of a distribution about its mean. A positive value for *skewness* indicates the distribution is skewed to the positive side. A negative *skewness* value indicates an asymmetric tail toward the negative side.

The following formula is used to calculate the skewness:

$$Skewness = \frac{n}{(n-1)(n-2)} \sum \left(\frac{x_i - \bar{x}}{s} \right)^3$$

where s is the sample standard deviation (see STANDARDDEVIATION below)

STANDARDDEVIATION - Standard Deviation

The *standard deviation* is a measure of the spread or variation in a distribution.

The following formula is used to calculate the *standard deviation*:

$$StdDev = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}$$

TOLERANCE - Tolerance

Tolerance is the difference between the upper and lower specification limits for the upper chart:

Tol = USL - LSL

TotalAboveUSL

The *TotalAboveUSL* is the count of the number of samples that are above the USL.

TotalBelowLSL

The *TotalBelowLSL* is the count of the number of samples that are below the LSL.

TOTALDEFECTS - TotalNonConformities

The *TotalNonConformities* is the count of the number of samples that are outside the specification limits.

Defects = TotalAboveUSL + TotalBelowLSL

TOTALSAMPLES – Total Samples

The *Total Samples* is the count of the number of subgroups for the chart.

TOTALSUBGROUPS - Total Subgroups

The *Total Subgroups* is the count of the number of subgroups for the chart (same as *Total Samples*).

UPPERCHARTCL - Upper Chart CL

The *Upper Chart CL* is the centerline value for the upper chart.

UPPERCHARTLCL - Upper Chart LCL

The *Upper Chart LCL* is the lower control limit (*LCL*) value for the upper chart.

UPPERCHARTUCL - Upper Chart UCL

The *Upper Chart UCL* is the upper control limit (*UCL*) value for the upper chart.

Variance

The *variance* of a distribution is the square of the standard deviation and an indication of the spread or dispersion of the distribution.

The following formula is used to calculate the *variance*:

$$Var = \frac{\sum (x_i - \bar{x})^2}{n-1}$$

ZLSL

The following formula is used to calculate *ZLSL*:

$$ZLSL = \frac{LSL - Mean}{s_{est}}$$

LSL is the lower specification limit.

Mean is the overall average.

s_{est} is an estimate of standard deviation from a control chart (see STANDARDDEVIATION above).

ZMIN

The following formula is used to calculate *ZMIN*:

$$ZMIN = Min(ZUSL, ZLSL)$$

ZUSL

The following formula is used to calculate *ZUSL*:

$$ZUSL = \frac{USL - Mean}{s_{est}}$$

USL is the upper specification limit.

Mean is the overall average.

s_{est} is an estimate of standard deviation from a control chart(see STANDARDDEVIATION above).

Appendix C - SPC Bias Correction and Control Chart Factors

n	c_4	d_2	d_3	A_2	A_3	$\tilde{A}_2$	B_3	B_4	D_3	D_4
2	0.7798	1.128	0.8525	1.880	2.659	1.880		3.267	0.000	3.268
3	0.8862	1.693	0.8884	1.023	1.954	1.187		2.568	0.000	2.574
4	0.9213	2.059	0.8798	0.729	1.628	0.796		2.266	0.000	2.282
5	0.9400	2.326	0.8641	0.577	1.427	0.691		2.089	0.000	2.114
6	0.9515	2.534	0.848	0.483	1.287	0.548	0.030	1.970	0.000	2.004
7	0.9594	2.704	0.8332	0.419	1.182	0.508	0.118	1.882	0.076	1.924
8	0.9650	2.847	0.8198	0.373	1.099	0.433	0.185	1.815	0.136	1.864
9	0.9693	2.970	0.8078	0.337	1.032	0.412	0.239	1.761	0.184	1.816
10	0.9727	3.078	0.7971	0.308	0.975	0.362	0.284	1.716	0.223	1.777
11		3.173	0.7873							
12		3.258	0.7785							
13		3.336	0.7704							
14		3.407	0.763							
15		3.472	0.7562							
16		3.532	0.7499							
17		3.588	0.7441							
18		3.640	0.7386							
19		3.689	0.7335							
20		3.735	0.7287							
21		3.778	0.7242							
22		3.819	0.7199							
23		3.858	0.7159							
24		3.895	0.7121							
25		3.931	0.7084							
26		3.965	0.7049							
27		3.997	0.7016							
28		4.028	0.6985							
29		4.057	0.6956							
30		4.086	0.6927							
31		4.114	0.6899							
32		4.141	0.6872							
33		4.166	0.6846							
34		4.190	0.6822							
35		4.213	0.6799							
36		4.236	0.6776							
37		4.258	0.6754							
38		4.280	0.6733							
39		4.301	0.6712							
40		4.322	0.6692							
41		4.342	0.6672							
42		4.361	0.6653							
43		4.380	0.6635							
44		4.398	0.6618							
45		4.415	0.6601							
46		4.432	0.6584							
47		4.449	0.6568							
48		4.466	0.6552							
49		4.482	0.6536							
50		4.498	0.6521							

For n > 10:

$A_2 = 3 / (d_2 * SQRT(n))$

$D_3 = 1 - (3 * d_3 / d_2)$

$D_4 = 1 + (3 * d_3 / d_2)$

Appendix D – Alarm Rule Definitions, Examples and Mappings

Alarms are rules that can be used to evaluate the acceptability of the SPC data or whether the data is in statistical control. Some alarm rules are categorized separately for upper and lower charts as well as upper and lower regions of upper and lower charts. For each alarm rule, you must provide the limit and length (numbers of data points) that are to be considered to determine if the alarm rule has been violated.

If the limit is 3 and length is 10, then the chart evaluates points 1-10, 2-11, 3-12 and so on against the alarm conditions in the rule. Of the 10 data points, only 3 data points violating the alarm conditions are needed for a violation of the rule. These data points can be anywhere within the string of points. If the rule is violated, the last data point, in the string, which violates the alarm conditions, is marked with the alarm color and the WECO text for the alarm rule.

The following alarms are supported by MII (all except the last two are used by SAP ME).

- Control Limit Alarm
- Run Limit Alarm
- Trend Limit Alarm
- Alternating Limit Alarm
- Zone A Limit Alarm
- Zone B Limit Alarm
- Inside Zone C Limit Alarm
- Outside Zone C Limit Alarm
- Specification Limit Alarm
- Alternating Center line Limit Alarm
- Sigma Difference Limit Alarm

1 Control Limit Alarm

Control limits are horizontal lines on SPC charts that are calculated and placed at a fixed distance (+/- 3 standard deviations by default) above and below the center line (mean). Alternatively, you can specify fixed control limits or calculate dynamic control limits using a query.

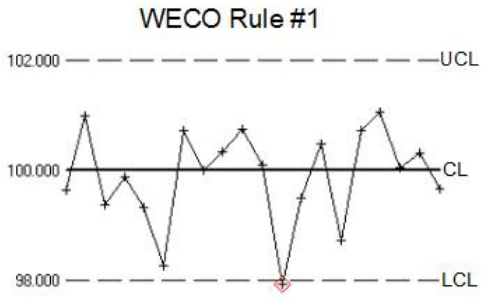
For alarm rule 1, the limit and length values are used for both the upper and lower chart and the upper and lower control limits. The data points plotted on the chart are compared to the specified control limits. For alarm rule 1, an alarm is triggered when there are <Limit> number of data points, in the <Length> data point string, which are beyond either of the control limits.

For example, if Limit is 2 and Length is 3, then if 2 points, in any string of 3 adjacent data points, are beyond either control limit on the chart, the alarm rule is violated. This includes the case where 1 point is above the upper control limit and one point is below the lower control limit.

For this alarm, you can use separate alarm rules to specify the limits and lengths for upper and lower charts and also for upper and lower regions of upper and lower charts. These are alarm rules 20, 21, 22 and 23.

For example, for alarm rule 20, if Limit is 1 and Length is 1, then only if 1 point, in any string of 1 adjacent points, is beyond the upper control limit on the upper chart, is the alarm rule violated.

A graphical representation of a *Control Limit Alarm* is shown below:



In the above example, a single point is marked below the lower control limit and is marked as a rule violation.

2 Run Limit Alarm

Run limit alarms address multiple points which are all above or all below the center line on the chart.

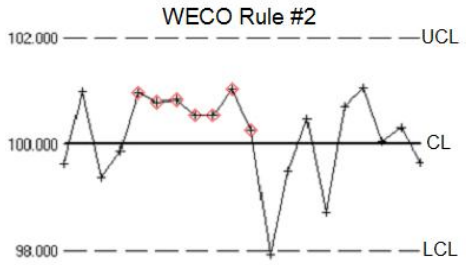
For alarm rule 2, the limit and length values are used for both the upper and lower chart and the upper and lower regions of the chart. The data points on the chart are checked against the center line of the chart. For alarm rule 2, an alarm is triggered when there are <Limit> number of data points, in the <Length> data point string, which are all above or all below the center line.

For example, if Limit is 7 and Length is 8, then if 7 points, in any string of 6 adjacent data points, are all above the center line or all below the center line, the alarm rule is violated.

For this alarm, you can use separate alarm rules to specify the limits and lengths for upper and lower charts and also for upper and lower regions of upper and lower charts. These are alarm rules 24, 25, 26 and 27.

For example, for alarm rule 24, if Limit is 7 and Length is 8, then only if 7 or more points, in any string of 6 adjacent points, are above the center line of the upper chart, is the alarm rule violated.

A graphical representation of the *Run Limit Alarm* is shown below:



In the above example, seven points are above the center line and are marked as a rule violation.

3 Trend Limit Alarm

Trend Limit alarm rules are triggered when multiple points, in a series of points, are all increasing or all decreasing.

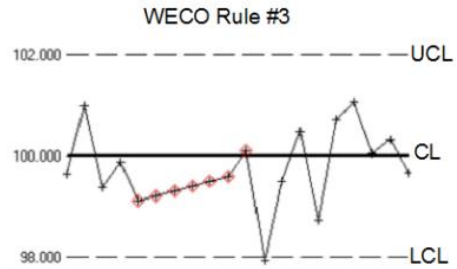
For alarm rule 3, the limit and length values are used for both the upper and lower chart. The data points plotted on the chart are checked for the specified number of increasing (or decreasing) points. For alarm rule 3, an alarm is triggered when there are <Limit> number of data points, in the <Length> data point string, which are either all increasing or all decreasing.

For example, if Limit is 7 and Length is 8, then if 7 points, in any string of 8 adjacent data points, are either all increasing or all decreasing, the alarm rule is considered violated.

For this alarm, you can use separate alarm rules to specify the limits and lengths for upper and lower charts. These are alarm rules 28 and 29.

For example, for alarm rule 28, if Limit is 7 and Length is 8, then only if 7 points, in any string of 8 adjacent points in the upper chart, are all increasing or all decreasing, is the alarm rule violated.

A graphical representation of the *Trend Limit Alarm* is shown below:



In the above example, seven points are all increasing and are marked as a rule violation.

4 Alternating Limit Alarm

Alternating Limit alarm rules are triggered when multiple points, in a series of points, are all alternating up and down anywhere on the chart.

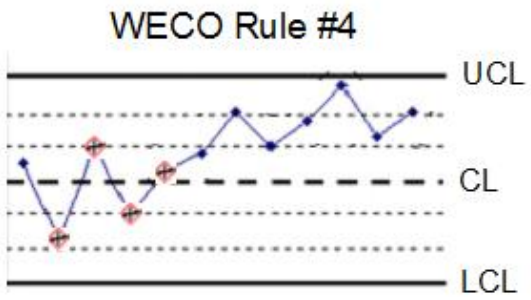
For alarm rule 4, the limit and length values are used for both the upper and lower chart. The data points on the chart are checked for the specified number of alternating points. For alarm rule 4, an alarm is triggered when there are <Limit> number of data points, in the <Length> data point string, which are all alternating up and down.

For example, if Limit is 4 and Length is 5, then if 4 points, in any string of 5 adjacent data points, are all alternating up and down, the alarm rule is considered violated.

For this alarm, you can use separate alarm rules to specify the limits and lengths for upper and lower charts. These are alarm rules 30 and 31.

For example, for alarm rule 31, if Limit is 4 and Length is 5, then only if 4 points, in any string of 5 adjacent points in the lower chart, are all alternating up and down, is the alarm rule violated.

A graphical representation of the *Alternating Limit Alarm* is shown below:



In the above example, four points are all alternating up and down and are marked as a rule violation. These four points are alternating about the center line, but that is not necessary for the rule violation. The points could be all in the upper region or all in the lower region or going at an angle across the center line. The only condition is that they have to be alternating up and down.

5 Zone A Limit Alarm

Alarm rule 5 is triggered when multiple points, in a series of points, are in zone A or beyond. Beyond means above upper zone A or below lower zone A.

The area between a control limit and the center line is divided into thirds which are called Zones.

Standard control limits are located 3 sigma away from the center line. So, for standard control limits, the distance from the center line to the control limit is divided in to 3 equal parts of one sigma each.

Zone A is closest to the control limit (typically between two and three standard deviations from the center line) and is often referred to as the 3-sigma zone. Zone B is the middle zone (typically between one and two standard deviations from the center line). Zone C is closest to the center line (typically between the center line and one standard deviation from the center line)

For alarm rule 5, the limit and length values are used for both the upper and lower chart. The data points on the chart are checked for the specified number of points in zone A or beyond. For alarm rule 5, an alarm is triggered when there are <Limit> number of data points, in the <Length> data point string, which are in either zone A or beyond either zone A.

For example, if Limit is 2 and Length is 3, then if 2 points, in any string of 3 adjacent data points, are in upper zone A or beyond and/or in lower zone A or beyond, the alarm rule is considered violated.

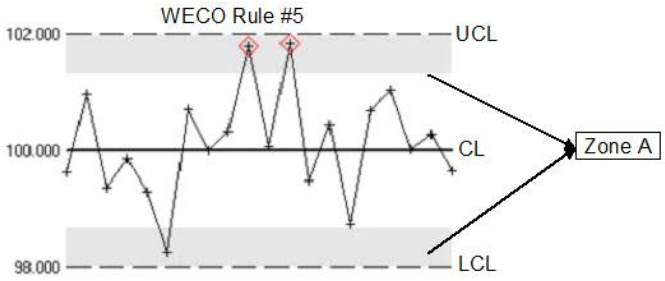
For this alarm, you can use separate alarm rules to specify the limits and lengths for upper and lower charts and upper and lower zones of the charts. These are alarm rules 32, 33, 34 and 35.

For example, for alarm rule 33, if Limit is 2 and Length is 3, then only if 2 points, in any string of 3 adjacent points in the upper chart, are in lower zone A or beyond, is the alarm rule violated.

General guidelines to detect instability in Zone A for different chart types are as follows:

Chart Type	**Maximum Points to apply Rule**
X-Bar	2 of 3 successive points in upper or lower Zone A or beyond
Individual Chart	
Median	
R-chart when the minimum subgroup size is 4	
R-chart when the minimum subgroup size is less than 4	2 successive points in upper Zone A or beyond
S	1 point in upper or lower Zone A or beyond
Moving Average	
Moving Range	
P	
NP	
C	
U	

A graphical representation of the *Zone A alarm* is shown below:



6 Zone B Limit Alarm

Alarm rule 6 is triggered when multiple points, in a series of points, are in zone B or beyond. Beyond means above upper zone B or below lower zone B.

The area between a control limit and the center line is divided into thirds which are called Zones. Standard control limits are located 3 sigma away from the center line. So, for standard control limits, the distance from the center line to the control limit is divided in to 3 equal parts of one sigma each.

Zone A is closest to the control limit (typically between two and three standard deviations from the center line). Zone B is the middle zone (typically between one and two standard deviations from the center line) and often referred to as the two sigma zone. Zone C is closest to the center line (typically between the center line and one standard deviation from the center line)

For alarm rule 6, the limit and length values are used for both the upper and lower chart. The data points on the chart are checked for the specified number of points in zone B or beyond. For alarm rule 6, an alarm is triggered when there are <Limit> number of data points, in the <Length> data point string, which are in either zone B or beyond either zone B.

For example, if Limit is 4 and Length is 5, then if 4 points, in any string of 5 adjacent data points, are in upper zone B or beyond and/or in lower zone B or beyond, the alarm rule is considered violated.

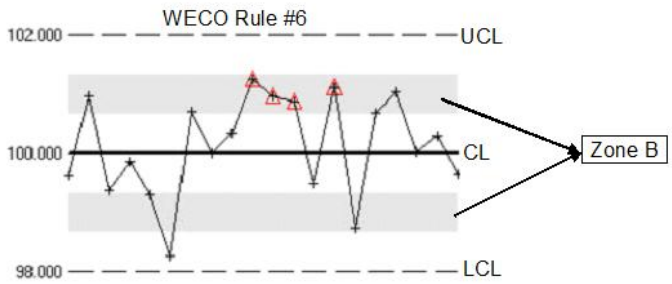
For this alarm, you can use separate alarm rules to specify the limits and lengths for upper and lower charts and upper and lower zones of the charts. These are alarm rules 36, 37, 38 and 39.

For example, for alarm rule 38, if Limit is 4 and Length is 5, then only if 4 points, in any string of 5 adjacent points in the lower chart, are in upper zone B or beyond, is the alarm rule violated.

General guidelines to detect instability in Zone B for different chart types are as follows:

Chart Types	Maximum Points to apply Rule
X-bar	4 of 5 successive points in or above upper or lower Zone B,
Individual Chart	
Median	
R-chart when the minimum subgroup size is 4	
R-chart when the minimum subgroup size is less than 4	3 successive points in or above upper Zone B

A graphical representation of Zone B Limit alarm is shown below:



7 Inside Zone C Limit Alarm

Alarm rule 7 is triggered when multiple points, in a series of points, are inside upper zone C and/or lower zone C.

The area between a control limit and the center line is divided into thirds which are called Zones. Standard control limits are located 3 sigma away from the center line. So, for standard control limits, the distance from the center line to the control limit is divided in to 3 equal parts of one sigma each.

Zone A is closest to the control limit (typically between two and three standard deviations from the center line). Zone B is the middle zone (typically between one and two standard deviations from the center line). Zone C is closest to the center line (typically between the center line and one standard deviation from the center line) and is often referred to as the one-sigma zone.

For alarm rule 7, the limit and length values are used for both the upper and lower chart. The data points on the chart are checked for the specified number of points inside zone C. For alarm rule 7, an alarm is triggered when there are <Limit> data points, in the <Length> data point string, which are in either upper zone C and/or lower zone C.

For example, if Limit is 15 and Length is 15, then if 15 points, in any string of 15 adjacent data points, are in upper zone C and/or in lower zone C, the alarm rule is considered violated.

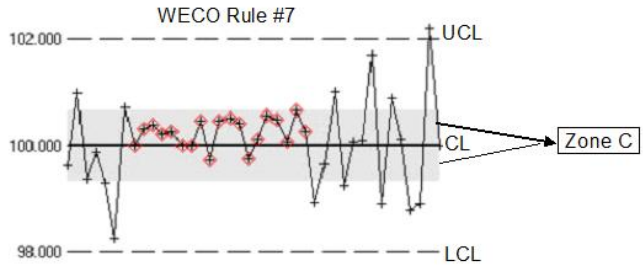
For this alarm, you can use separate alarm rules to specify the limits and lengths for upper and lower charts. These are alarm rules 40 and 41.

For example, for alarm rule 40, if Limit is 19 and Length is 19, then only if 19 points, in any string of 19 adjacent points in the upper chart, are in upper zone C and/or lower zone C, is the alarm rule violated.

General guidelines to detect instability within Zone C for different chart types are as follows:

Chart Type	**Maximum Points to apply Rule**
X-Bar	15 points in a row in Zone C above and/or below the Center Line
Individual Chart	
Median	
R-chart when the minimum subgroup size is 4	
R-chart when the minimum subgroup size is less than 4	10 successive points in Zone C above and/or below the Center Line

A graphical representation of the *Inside Zone C Alarm* is shown below:



8 Outside Zone C Limit Alarm

Alarm rule 8 is triggered when multiple points, in a series of points, are outside upper zone C and outside lower zone C.

The area between a control limit and the center line is divided into thirds which are called Zones. Standard control limits are located 3 sigma away from the center line. So, for standard control limits, the distance from the center line to the control limit is divided in to 3 equal parts of one sigma each.

Zone A is closest to the control limit (typically between two and three standard deviations from the center line). Zone B is the middle zone (typically between one and two standard deviations

from the center line). Zone C is closest to the center line (typically between the center line and one standard deviation from the center line) and is often referred to as the one-sigma zone.

For alarm rule 8, the limit and length values are used for both the upper and lower chart. The data points on the chart are checked for the specified number of points ouside zone C. For alarm rule 8, an alarm is triggered when there are <Limit> data points, in the <Length> data point string, which are outside upper zone C and outside lower zone C.

For example, if Limit is 15 and Length is 15, then if 15 points, in any string of 15 adjacent data points, are outside upper zone C and outside lower zone C, the alarm rule is considered violated.

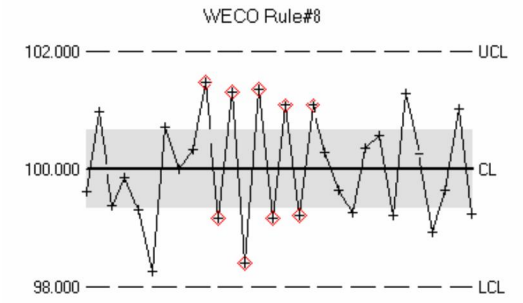
For this alarm, you can use separate alarm rules to specify the limits and lengths for upper and lower charts. These are alarm rules 42 and 43.

For example, for alarm rule 43, if Limit is 9 and Length is 9, then only if 9 points, in any string of 9 adjacent points in the lower chart, are outside upper zone C and outside lower zone C, is the alarm rule violated.

General guidelines to detect instability outside Zone C for different chart types are as follows:

Chart Type	**Maximum Points to apply Rule**
X-bar	15 consecutive points outside zone C
Individual	
Median	
R-Chart when the minimum subgroup size is 4	
R-Chart when the minimum subgroup size less than 4	10 consecutive points outside zone C

A graphical representation of the *Outside Zone C Alarm* is shown below:



9 Specification Limit Alarm

The Specification Limit alarm rule checks for points that are beyond a specification limit. Specification limits occur on either side of the center line.

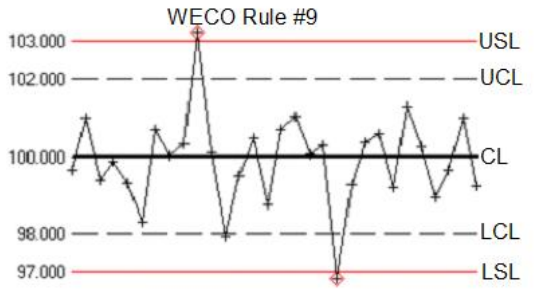
For alarm rule 9, the limit and length values are used for both the upper and lower chart and the upper and lower specification limits. The data points on the chart are compared to the specification limits. For alarm rule 9, an alarm is triggered when there are <Limit> number of data points, in the <Length> data point string, which are beyond either of the specification limits.

For example, if Limit is 2 and Length is 3, then if 2 points, in any string of 3 adjacent data points, are beyond either specification limit on the chart, the alarm rule is violated. This includes the case where 1 point is above the upper specification limit and one point is below the lower specification limit.

For this alarm, you can use separate alarm rules to specify the limits and lengths for upper and lower charts and also for upper and lower specification limits of upper and lower charts. These are alarm rules 44, 45, 46 and 47.

For example, for alarm rule 44, if Limit is 1 and Length is 1, then only if 1 point, in any string of 1 adjacent points, is beyond the upper specification limit on the upper chart, is the alarm rule violated.

A graphical representation of the *Specification Limit Alarm* is shown below:



In the above example, one violation is for a point above the upper specification limit while the other is for a point below the lower specification limit.

10 Alternating Center Line Limit Alarm

Alternating Center Line Limit alarm rules are triggered when multiple points, in a series of points, are all alternating up and down about the center line on the chart.

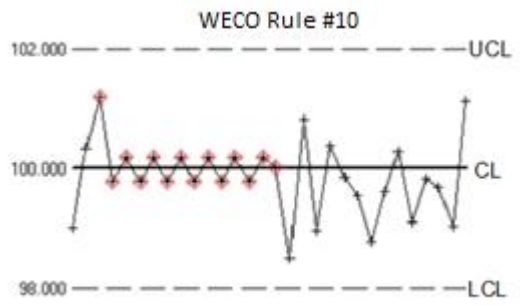
For alarm rule 10, the limit and length values are used for both the upper and lower chart. The data points on the chart are checked for the specified number of alternating points. For alarm rule 10, an alarm is triggered when there are <Limit> number of data points, in the <Length> data point string, which are all alternating up and down about the center line.

For example, if Limit is 4 and Length is 5, then if 4 points, in any string of 5 adjacent data points, are all alternating up and down about the center line, the alarm rule is considered violated.

For this alarm, you can use separate alarm rules to specify the limits and lengths for upper and lower charts. These are alarm rules 48 and 49.

For example, for alarm rule 49, if Limit is 4 and Length is 5, then only if 4 points, in any string of 5 adjacent points in the lower chart, are all alternating up and down about the center line, is the alarm rule violated.

A graphical representation of alternating center line limit alarms and the WECO rule is shown below:



11 Sigma Difference Limit Alarm

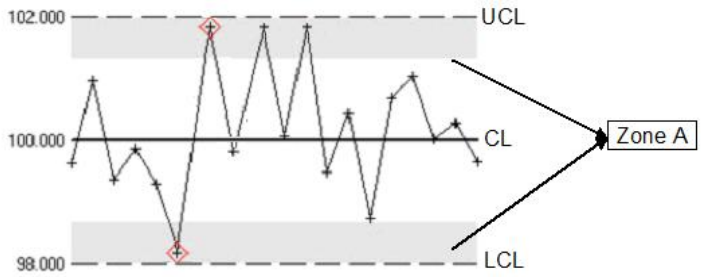
Alarm rule 11 is triggered when adjacent points, in a series of points, are vertically at least 4 sigma apart.

The area between a control limit and the center line is divided into thirds which are called Zones. Standard control limits are located 3 sigma away from the center line. So, for standard control limits, the distance from the center line to the control limit is divided in to 3 equal parts of one sigma each.

For alarm rule 11, the limit and length values are used for both the upper and lower chart. The data points on the chart are checked for the specified number of occurences of two adjacent points being at least 4 sigma apart. For alarm rule 11, an alarm is triggered when there are <Limit> number of adjacent points, in the <Length> data point string, which are vertically at least 4 sigma apart.

For example, if Limit is 4 and Length is 5, then if 4 sets of two points, in any string of 5 adjacent data points, are vertically at least 4 sigma apart, the alarm rule is considered violated.

A graphical representation of the *Sigma Difference Limit Alarm* is shown below:



Alarm Rule Mappings

The following tables map the MII alarm rule definitions to the SAP ME alarm rule sets for upper and lower charts.

Mapping for Upper and Lower Chart	AT&T	AT&T R	AT&T A	Ford1 X	Ford1 R	Sigma	Nelson
Rule Number 1 – **Control Limit Alarm**							
Rule Letter for Rule Number 20	**A**	**A**	**A**	**A**	**A**	**A**	**A**
Alarm Limit for Upper Chart Upper Control Limit	1	1	1	1	1	1	1
Alarm Length for Upper Chart Upper Control Limit	1	1	1	1	1	1	1
Rule Letter for Rule Number 21	**B**		**B**	**B**	**B**	**B**	**B**
Alarm Limit for Upper Chart Lower Control Limit	1		1	1	1	1	1
Alarm Length for Upper Chart Lower Control Limit	1		1	1	1	1	1
Rule Letter for Rule Number 22	**A**	**A**	**A**	**A**	**A**	**A**	**A**
Alarm Limit for Lower Chart Upper Control Limit	1	1	1	1	1	1	1
Alarm Length for Lower Chart Upper Control Limit	1	1	1	1	1	1	1
Rule Letter for Rule Number 23	**B**		**B**	**B**	**B**	**B**	**B**
Alarm Limit for Lower Chart Lower Control Limit	1		1	1	1	1	1
Alarm Length for Lower Chart Lower Control Limit	1		1	1	1	1	1
Rule Number 2 – **Run Limit Alarm**							
Rule Letter for Rule Number 24	**G**	**D**	**C**	**C**			**C**
Limit of Upper Chart Above Centerline Run Limit Alarm	8	7	9	7			9
Length of Upper Chart Above Centerline Run Limit Alarm	8	7	9	7			9
Rule Letter for Rule Number 25	**H**	**E**	**D**	**D**			**D**
Limit of Upper Chart Below Centerline Run Limit Alarm	8	10	9	7			9
Length of Upper Chart Below Centerline Run Limit Alarm	8	10	9	7			9
Rule Letter for Rule Number 26	**G**	**D**	**C**	**C**			**C**
Limit of Lower Chart Above Centerline Run Limit Alarm	8	7	9	7			9
Length of Lower Chart Above Centerline Run Limit Alarm	8	7	9	7			9
Rule Letter for Rule Number 27	**H**	**E**	**D**	**D**			**D**
Limit of Lower Chart Below Centerline Run Limit Alarm	8	10	9	7			9
Length of Lower Chart Below Centerline Run Limit Alarm	8	10	9	7			9

Mapping for Upper and Lower Chart	AT&T	AT&T R	AT&T A	Ford1 X	Ford1 R	Sigma	Nelson
Rule Number 3 – **Trend Limit Alarm**							
Rule Letter for Rule Number 28	L		E	E			E
Limit of Upper Chart Trend Limit Alarm	6		6	7			6
Length of Upper Chart Trend Limit Alarm	6		6	7			6
Rule Letter for Rule Number 29	L		E	E			E
Limit of Lower Chart Trend Limit Alarm	6		6	7			6
Length of Lower Chart Trend Limit Alarm	6		6	7			6
Rule Number 4 – **Alternating Limit Alarm**							
Rule Letter for Rule Number 30	K		F	F	C		F
Limit of Upper Chart Alternating Limit Alarm	14		14	14	14		14
Length of Upper Chart Alternating Limit Alarm	14		14	14	14		14
Rule Letter for Rule Number 31	K		F	F	C		F
Limit of Lower Chart Alternating Limit Alarm	14		14	14	14		14
Length of Lower Chart Alternating Limit Alarm	14		14	14	14		14
Rule Number 5 – **Zone A Limit Alarm**							G
Limit of Zone A Limit Alarm							2
Length of Zone A Limit Alarm							3
Rule Letter for Rule Number 32	C	B		G			
Limit of Upper Chart Upper Zone A Limit Alarm	2	2		2			
Length of Upper Chart Upper Zone A Limit Alarm	3	2		3			
Rule Letter for Rule Number 33	D	G	G	H			
Limit of Upper Chart Lower Zone A Limit Alarm	2	4	4	2			
Length of Upper Chart Lower Zone A Limit Alarm	3	4	4	3			
Rule Letter for Rule Number 34	**C**	B		G			
Limit of Lower Chart Upper Zone A Limit Alarm	2	2		2			
Length of Lower Chart Upper Zone A Limit Alarm	3	2		3			
Rule Letter for Rule Number 35	**D**	G	G	H			
Limit of Lower Chart Lower Zone A Limit Alarm	2	4	4	2			
Length of Lower Chart Lower Zone A Limit Alarm	3	4	4	3			
Rule Number 6 – **Zone B Limit Alarm**							H
Limit of Zone B Limit Alarm							4
Length of Zone B Limit Alarm							5
Rule Letter for Rule Number 36	E	C					
Limit of Upper Chart Upper Zone B Limit Alarm	4	3					
Length of Upper Chart Upper Zone B Limit Alarm	5	3					
Rule Letter for Rule Number 37	F	F					
Limit of Upper Chart Lower Zone B Limit Alarm	4	6					
Length of Upper Chart Lower Zone B Limit Alarm	5	6					
Rule Letter for Rule Number 38	E	C					
Limit of Lower Chart Upper Zone B Limit Alarm	4	3					

Mapping for Upper and Lower Chart	AT&T	AT&T R	AT&T A	Ford1 X	Ford1 R	Sigma	Nelson
Length of Lower Chart Upper Zone B Limit Alarm	5	3					
Rule Letter for Rule Number 39	F	F					
Limit of Lower Chart Lower Zone B Limit Alarm	4	6					
Length of Lower Chart Lower Zone B Limit Alarm	5	6					
Rule Number 7 – **Inside Zone C Limit Alarm**							
Rule Letter for Rule Number 40	**I**						**I**
Limit of Upper Chart Inside Zone C Limit Alarm	15						15
Length of Upper Chart Inside Zone C Limit Alarm	15						15
Rule Letter for Rule Number 41	**I**						**I**
Limit of Lower Chart Inside Zone C Limit Alarm	15						15
Length of Lower Chart Inside Zone C Limit Alarm	15						15
Rule Number 8 – **Outside Zone C Limit Alarm**							
Rule Letter for Rule Number 42	J						J
Limit of Upper Chart Outside Zone C Limit Alarm	8						8
Length of Upper Chart Outside Zone C Limit Alarm	8						8
Rule Letter for Rule Number 43							
Limit of Lower Chart Outside Zone C Limit Alarm							
Length of Lower Chart Outside Zone C Limit Alarm							
Rule Number 9 – **Specification Limit Alarm**							
Rule Letter for Rule Number 44	**a**	**a**	**a**	**a**	**a**	**a**	**a**
Alarm Limit for Upper Chart Upper Spec Limit	1	1	1	1	1	1	1
Alarm Length for Upper Chart Upper Spec Limit	1	1	1	1	1	1	1
Rule Letter for Rule Number 45	**b**	**b**	**b**	**b**	**b**	**b**	**b**
Alarm Limit for Upper Chart Lower Spec Limit	1	1	1	1	1	1	1
Alarm Length for Upper Chart Lower Spec Limit	1	1	1	1	1	1	1
Rule Letter for Rule Number 46	**a**	**a**	**a**	**a**	**a**	**a**	**a**
Alarm Limit for Lower Chart Upper Spec Limit	1	1	1	1	1	1	1
Alarm Length for Lower Chart Upper Spec Limit	1	1	1	1	1	1	1
Rule Letter for Rule Number 47	**b**	**b**	**b**	**b**	**b**	**b**	**b**
Alarm Limit for Lower Chart Lower Spec Limit	1	1	1	1	1	1	1
Alarm Length for Lower Chart Lower Spec Limit	1	1	1	1	1	1	1