

QC-CALC

SPC Analysis

**QC-CALC® SPC
Training
Manual & Workbook**
Version 3.4.72

Notices

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1. Welcome to QC-CALC Training

1.1 Introduction

QC-CALC[®] is a comprehensive data collection and statistical process control program designed to manage, analyze and report inspection data. Inspection data may be collected automatically from inspection devices or entered manually.

This portion of the training involves analyzing the data you have collected using QC-CALC Real-Time. However, we will discuss the process of manually creating a QC-CALC database, entering the numbers, and performing the analysis with a report as the end goal.

1.2 Course Prerequisites

To ensure your success with this training, we recommend that you do the following **before** you come to class:

- Install QC-CALC on your inspection equipment
- Print a few reports
- Review this manual – this assumes you purchased before attending

You should have a working knowledge of the following topics, which are **not** covered in this training:

- Knowledge of some SPC terms
- A working knowledge of Windows operating system

1.3 Course Objectives

The objective of this training is to familiarize the student with the operation of QC-CALC's analysis program known as QC-CALC SPC. After the basic overview of the program and its operation, you can skip sections that are not relevant to your operation and concentrate on sections you'll need.

Many customers require basic operating knowledge of the software while others require advanced detail to maximize QC-CALC's ability to reduce large amounts of data into useful information. You will learn data analysis, filtering, and printing reports. There are many overlaps and similarities of QC-CALC SPC and QC-CALC Real-Time so if you feel you have learned a particular topic and do not wish to repeat it, just skip that subject.

After completing this course, you will be able to:

- Change the look and feel of QC-CALC
- Manually create databases and enter data
- Modify Existing Databases
- Create inspection reports
- Use the on-line Help to find desired information

1.4 Before Running Setup

Before you install QC-CALC, make sure that your computer meets the minimum requirements listed below.



Note: You cannot simply copy files from the distribution disks to your hard disk and run QC-CALC. You must use the setup program, which decompresses and installs the files in the appropriate directories.

1.5 Hardware Requirements

To run QC-CALC, you must have certain hardware and software installed on your computer. The system requirements include:

- 1.5 Ghz processor minimum recommended
- A hard disk with 300 megabytes of free space
- A CD-ROM drive, USB port, or network connection
- An SVGA display
- 1 Gigabyte of memory minimum
- A mouse and keyboard
- Windows XP SP 3, Windows Vista, or Windows 7, 8, 8.1

* Terminal Services and equivalent virtual desktop software packages are not supported.

1.6 Running the Setup Program

You install QC-CALC on your computer using the SETUP.EXE program. The Setup program automatically installs QC-CALC, the Help system, sample data files and other product components from the distribution disks to your hard disk. You can optionally download QC-CALC SPC from our website.

To start Setup:

1. Insert the QC-CALC CD-ROM into your CD-ROM drive
2. If setup starts automatically go to step #5
3. From the Windows Start Menu choose **Run**
4. Type **d:\setup** (where d: is the assigned letter of your CD-ROM drive)
5. Follow the Setup instructions on the screen.



Note: QC-CALC has been adapted to collect information electronically from various inspection machines. If you have purchased this program with an inspection machine, please review any special instructions that may be contained in the gray paper section found in the front of this manual.

2. Layout Orientation

2.1 Start QC-CALC SPC

There are two icons on your Desktop that start QC-CALC Real-Time or QC-CALC SPC and they are labeled as such. Simply double click the green icon labeled QC-CALC SPC 3.3.

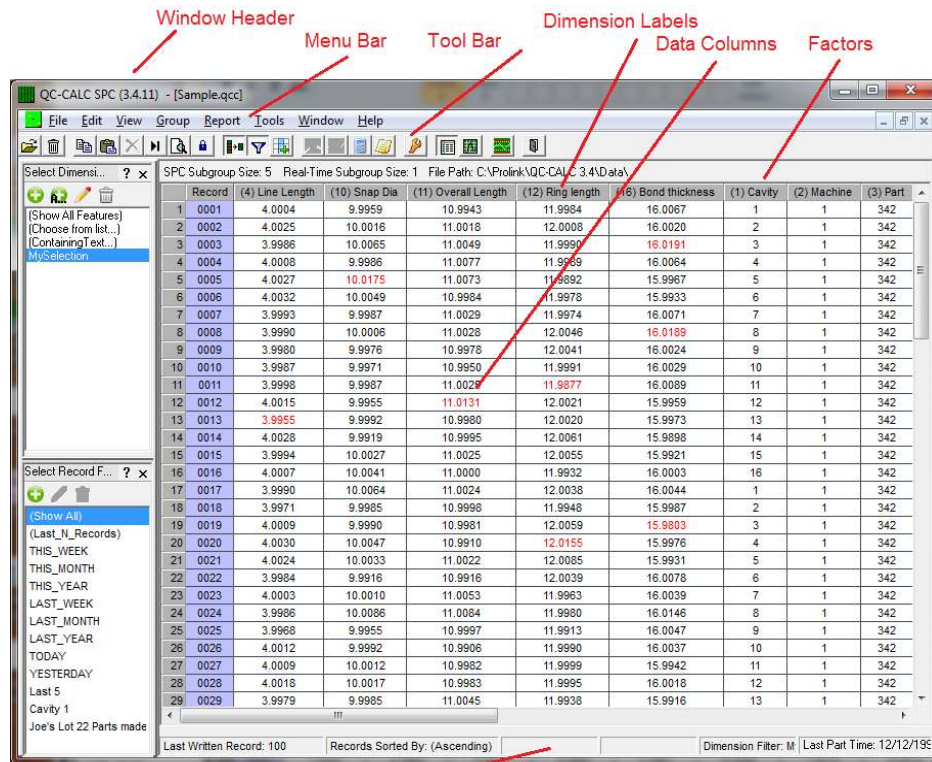


Optionally, the installation process created a menu folder for QC-CALC under your Windows **START** button. You can start QC-CALC SPC by choosing **Start – All Programs – Prolink – QC-CALC SPC 3.3**. When QC-CALC SPC starts you see the main screen and possibly an active file similar to the figure below.

2.2 Overview of Screen

The diagram below is the QC-CALC SPC screen. Various areas of this screen are discussed here and are referenced throughout this course.

- Window Header
- Menu Bar
- Tool Bar
- Record Numbers
- Dimension Labels
- Data Columns
- Horizontal Scroll Bar
- Vertical Scroll Bar
- Bottom Status Tray



Window Header Use this header to view the name of the active QC-CALC file. It always begins with QC-CALC SPC followed by the active file name.

Menu The QC-CALC SPC menu bar controls the overall operation of the software including all reporting, system settings, and display settings.

Tool Bar Buttons The QC-CALC SPC Tool Bar provides you with convenient shortcuts

to frequently used menu items. These shortcuts are easily identifiable by their icons, and by hovering the mouse over an icon, you will activate a tool tip that identifies the shortcut.

Record Numbers The extreme left column lists the actual record number of the part. This is un-editable.

Dimension Labels These labels were removed from your part program or typed by you. These labels can be changed by selecting the **Edit – Nominals & Tolerance** menu.

Data Column Each part is stored in a row or record. Each feature on the part is stored in a column. QC-CALC performs analysis on the column since the numbers are of the same magnitude.

Status Tray The next section of the tray is used to display information that does not require a response. Normally, you will see the last written record counting. Use this as a reference. Other colored messages may appear and are self-explanatory. They are usually exceptions or reports of abnormal situations.

Vertical Scroll Bar The scrolling area located at the right side of the data is used to scroll to older data in the grid.

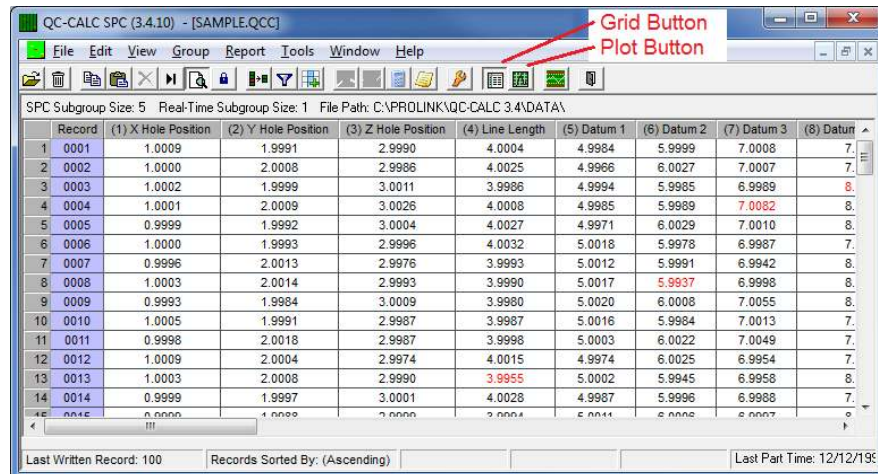
Horizontal Scroll Bar You use this scroll bar to move to more dimensions. QC-CALC can store up to 3000 dimensions on each part which translates to 3000 columns. This scroll bar gives you the movement needed to reach all dimensions.

2.3 Plots versus Spreadsheets

There are two different displays of the data available to all open files in QC-CALC SPC – **Spreadsheets** and **Real-Time Plots**. To change the view, simply click the **View** menu and select either **Plot View** or **Grid View**. The choice is yours but remember it may take a few seconds to display the data as networks tend to be slow.

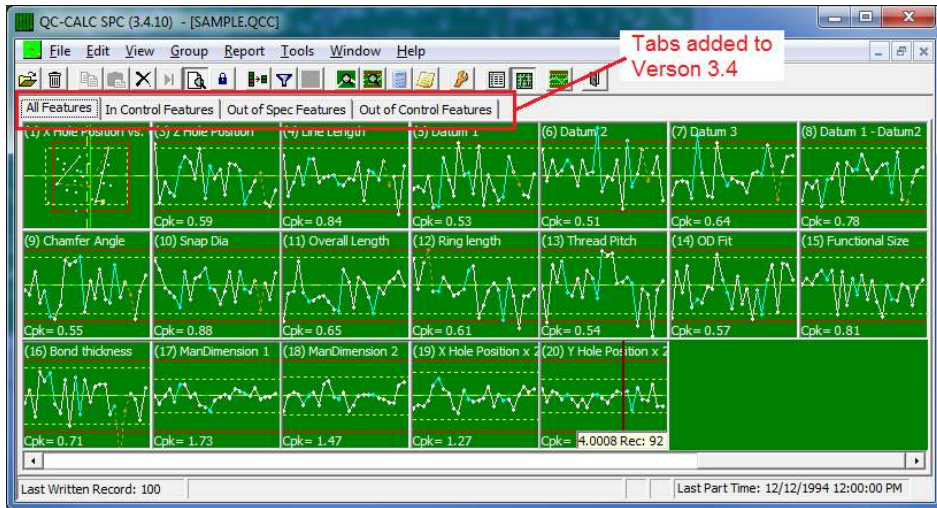
Grid View - Spreadsheet

With the **Grid View** interface you are able to work with all of the stored inspection data or with a selected subset by using filters on items like Lot Number, Operator, Inspection Date, Machine Number, etc. in a spreadsheet-style format.



Plot View

The **Plot View** interface contains a plot for each feature being measured. Each plot contains the plot background color, nominal and tolerance lines, text, and data points. The same filtering options are also available while in Plot View mode. QC-CALC SPC version 3.4 has added tabs showing the dimension filters for quick access.



If you have too many dimensions to view comfortable on the screen you can create multiple filters which appear in the left **Select Dimension Filter** panel. These filters provide a simple click to show just the plots you want to see. The tabs along the top of the plots include filters of:

1. All Features in your filter
2. All **In Control Features** in your filter
3. All **Out of control Features** in your filter
4. All **Out of Spec Features** in your filter

These 3 filters were part of the original filter list but were moved into the tabs along the top of the screen.

3. Data Layout

3.1 Introduction

A QC-CALC database is simply a way of dividing a large body of information into smaller, logical pieces. Each database contains information on the part being measured. The database is made up of individual records (rows) holding the measurement results of one part. Each column represents one feature over many parts. Many other data items are stored with the data as shown in the figure below.

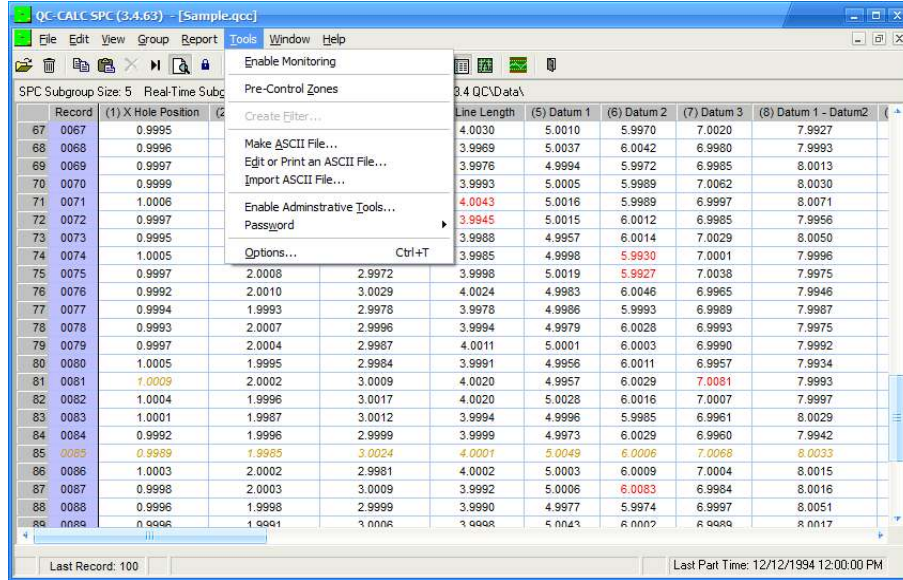
The screenshot shows the QC-CALC SPC software interface. The title bar reads "QC-CALC-SPC (3-4-63) - [Sample.qcc]". The menu bar includes "File", "Edit", "View", "Group", "Report", "Tools", "Window", and "Help". The main window displays a data table for "SPC Subgroup Size: 5" with the file path "C:\ProLink\QC-CALC 3.4\QCData1". The table has 11 columns: (1) X-Hole Position, (2) Y-Hole Position, (3) Z-Hole Position, (4) Line Length, (5) Datum 1, (6) Datum 2, (7) Datum 3, (8) Datum 1 - Datum2, (9) Chamfer Angle, (10) Snap Dia, and (11) Overall L. The data rows are numbered 67 to 100. The interface includes a toolbar with various icons for file operations and a status bar at the bottom right showing "Last Record: 100" and "Last Print Time: 12/12/1994 12:00:00 PM".

Record	(1) X-Hole Position	(2) Y-Hole Position	(3) Z-Hole Position	(4) Line Length	(5) Datum 1	(6) Datum 2	(7) Datum 3	(8) Datum 1 - Datum2	(9) Chamfer Angle	(10) Snap Dia	(11) Overall L
67	0.9995	2.0004	2.9974	4.0030	5.0010	5.9970	7.0020	7.9927	9.0124	10.0018	10.9989
68	0.9996	2.0020	3.0043	3.9969	5.0037	6.0042	6.9980	7.9993	8.9984	10.0027	11.0081
69	0.9997	1.9991	2.9986	3.9976	4.9984	5.9972	6.9985	8.0013	8.9997	9.9937	10.9944
70	0.9999	1.9987	2.9984	3.9993	5.0005	5.9989	7.0062	8.0030	8.9905	9.9902	10.9973
71	1.0006	1.9981	3.0004	4.0043	5.0016	5.9989	6.9997	8.0071	8.9981	10.0024	11.0011
72	0.9997	1.9993	3.0021	3.9945	5.0015	6.0012	6.9985	7.9956	9.0020	10.0040	10.9990
73	0.9995	1.9993	2.9991	3.9988	4.9957	6.0014	7.0029	8.0050	9.0037	10.0000	10.9934
74	1.0005	1.9988	3.0010	3.9985	4.9988	5.9930	7.0001	7.9996	9.0044	10.0008	11.0064
75	0.9997	2.0008	2.9972	3.9998	5.0019	5.9927	7.0038	7.9975	9.0037	10.0041	11.0010
76	0.9992	2.0010	3.0029	4.0024	4.9983	6.0046	6.9965	7.9946	8.9989	10.0073	10.9989
77	0.9994	1.9993	2.9978	3.9978	4.9986	5.9993	6.9989	7.9987	8.9977	10.0048	10.9975
78	0.9993	2.0007	2.9996	3.9994	4.9979	6.0028	6.9993	7.9975	9.0037	9.9996	10.9985
79	0.9997	2.0004	2.9987	4.0011	5.0001	6.0003	6.9990	7.9992	8.9956	9.9983	11.0079
80	1.0005	1.9995	2.9984	3.9991	4.9956	6.0011	6.9957	7.9934	8.9987	9.9969	10.9980
81	1.0009	2.0002	3.0009	4.0020	4.9957	6.0029	7.0081	7.9993	8.9921	9.9939	10.9951
82	1.0004	1.9996	3.0017	4.0020	5.0028	6.0016	7.0007	7.9997	8.9916	10.0041	10.9954
83	0.9998	1.9987	3.0012	3.9994	4.9996	5.9985	6.9961	8.0029	9.9951	9.9961	10.9964
84	0.9992	1.9996	2.9999	3.9999	4.9973	6.0029	6.9960	7.9942	9.0067	10.0022	10.9968
85	0.9999	1.9985	3.0024	4.0001	5.0049	6.0006	7.0068	8.0033	9.0056	10.0029	10.9962
86	1.0003	2.0002	2.9981	4.0002	5.0003	6.0009	7.0004	8.0015	9.0064	10.0052	10.9925
87	0.9998	2.0003	3.0009	3.9992	5.0006	6.0083	6.9984	8.0016	9.0077	9.9966	10.9921
88	0.9996	1.9998	2.9999	3.9990	4.9977	5.9974	6.9997	8.0051	8.9955	9.9990	11.0053
89	0.9996	1.9991	3.0006	3.9998	5.0043	6.0002	6.9989	8.0017	9.0014	9.9949	11.0013
90	0.9998	2.0000	2.9985	3.9996	4.9960	5.9995	6.9988	7.9996	8.9970	9.9984	10.9934
91	1.0005	2.0007	3.0011	4.0017	5.0003	6.0029	6.9968	8.0011	9.0043	10.0040	11.0027
92	0.9993	2.0004	3.0010	3.9973	4.9981	5.9945	7.0006	8.0029	8.9967	9.9955	11.0008
93	1.0000	2.0008	3.0005	4.0007	4.9966	6.0063	7.0009	8.0030	8.9956	10.0042	10.9966
94	0.9996	1.9991	2.9977	4.0005	4.9972	5.9983	7.0003	7.9996	9.0053	9.9992	10.9913
95	0.9995	2.0012	2.9988	3.9996	5.0029	6.0004	7.0063	8.0057	8.9972	9.9980	10.9995
96	0.9991	1.9996	2.9997	4.0018	5.0008	6.0046	7.0021	7.9949	9.0011	10.0014	10.9978
97	1.0000	1.9995	3.0003	3.9990	4.9990	5.9993	6.9954	7.9943	8.9978	9.9931	11.0012
98	0.9998	1.0005	2.9978	4.0001	4.9974	6.0006	7.0010	7.9989	8.9916	10.0007	11.0024
99	0.9999	1.0001	1.9986	2.9975	3.9957	4.9971	6.0036	8.0014	8.9987	9.9952	11.0046
100	1.0003	1.9986	2.9983	4.0013	5.0004	5.9960	7.0043	8.0023	9.0029	10.0039	11.0001

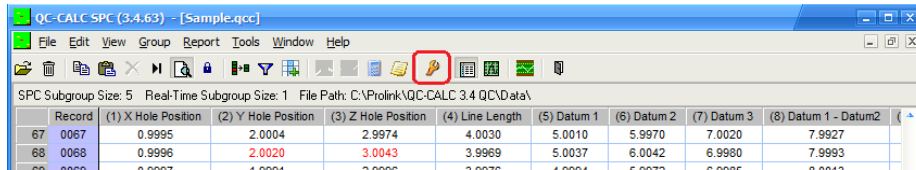
4. QC-CALC Settings Convention

4.1 Introduction

Like most Windows programs, QC-CALC's operation follows a convention that requires discussion. All settings are changed using the **Tools – Options** menu.

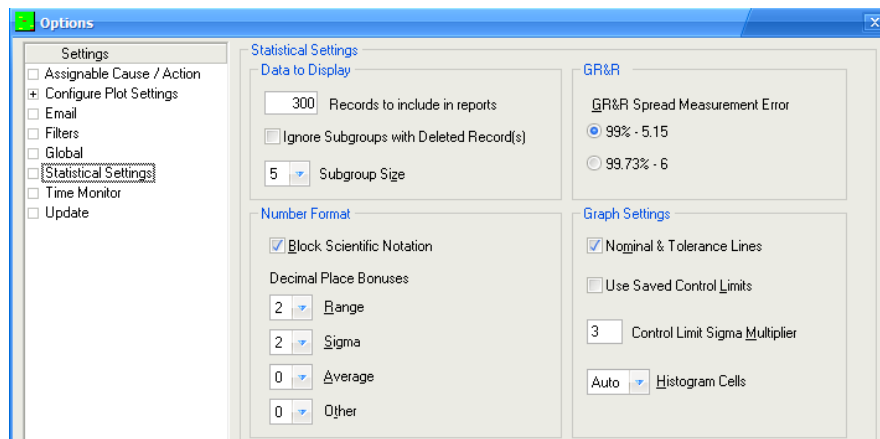


The **Tools – Options** shortcut button is the orange wrench found in the Tool Bar. We will refer to this menu option many times throughout this manual as we change QC-CALC's settings.



4.2 Tools – Options – Settings

When **Tools – Options** is selected, you see the **Settings** window. You can change QC-CALC's operation from this multi-purpose window. As you click on the menus located on the left side of this window the right side changes to show the available options. You select and change the option that best suits your needs. This is an important screen in QC-CALC and you will use it often during this training.

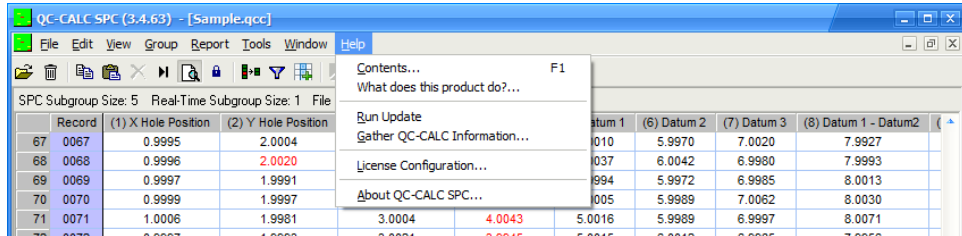


5. Help System

5.1 Getting Help

5.1.1 F1 Key is Context Sensitive

All Windows programs use the F1 key to initiate the Help system. QC-CALC is no different so whenever you need help, simply press the F1 key. The menu option shows the contents of the QC-CALC help file. Jump text is available to get to specific help topics.



5.1.2 Run Update

This menu option allows you to locate and run the update patch required to update your current version of QC-CALC Real-Time when a newer version is available. This feature requires the QC-CALC PC to be connected to your local area network and possibly the Internet.

5.1.3 Gather QC-CALC Information

If there is a problem with your software that cannot be solved by using the help system or your manual, you can call ProLink for technical support. We may ask you to choose this menu option which will automatically collect all of the information about your settings that we will need to assess the problem. You will need to either email or Fax the information to us after QC-CALC stores it in a file. A short wizard will guide you through the steps.

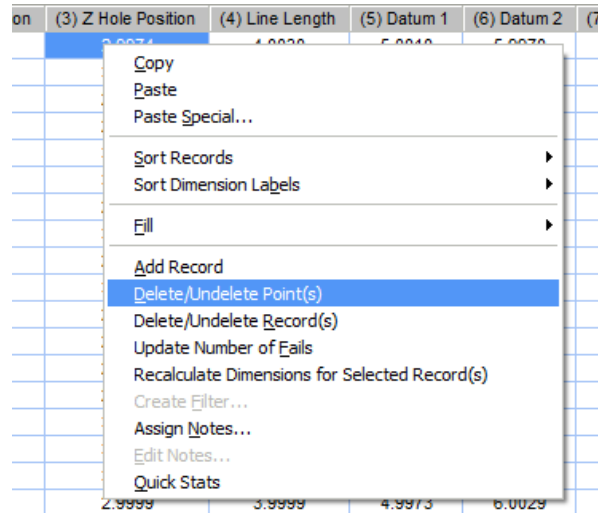
5.1.4 Help About

Use this menu to determine which version of QC-CALC you are running. There is other important information that our support team may request.

6. PopUp Menu

6.1 The Right Mouse

As with most Windows programs, the right mouse button usually has hidden options. If you Right Click the mouse when it is over the data screen, a special menu pops up with a variety of options. This type of interface allows you to select data with the mouse before activating the menu. For example, if you want to delete a data point but leave it in the database (ignore it) you would right click the value on the screen and select the **Delete/Undelete Point(s)** menu and your action is recorded.



In this example, we right clicked on Record 67, Dimension 3, and selected the **Delete/Undelete Point(s)** menu. The point changes color (gold) to indicate it is deleted – not part of any calculation. To see the definitions of each menu, please refer to the special Appendix in the back of this manual labeled [Right Mouse Menu Definition](#) on page 78. We will refer to many of these menu options as we explain QC-CALC's operation.

7. Report Concepts

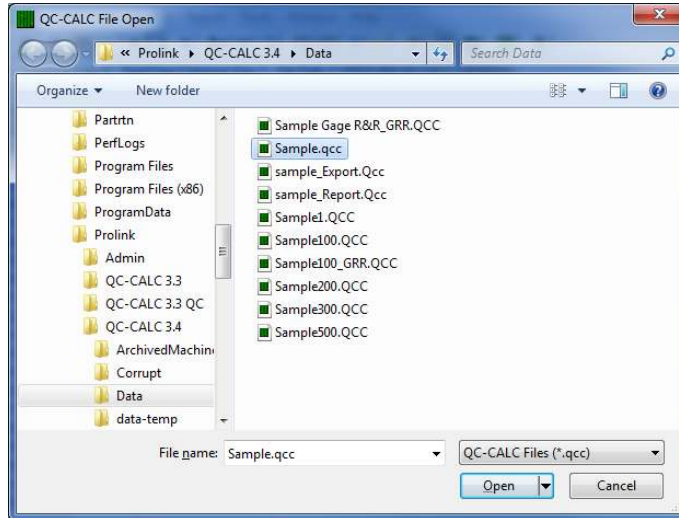
7.1 Introduction

In this section we show you how to analyze data using the default sample file shipped with QC-CALC. This tour helps you understand how the data is stored, analyzed, and reported. We will guide you through the following steps to create several QC-CALC reports.

1. Start QC-CALC.
2. Open the Sample.QCC file if not already active.
3. Maximize the data window to view the data.
4. Select the dimensions to use.
5. Select Xbar & R Charts.
6. Display the Charts.
7. Print the Xbar & R chart.

7.2 Open SAMPLE.QCC

Using the **File – Open** menu choice, locate and open Sample.QCC. All files found in the default folder that start with the word SAMPLE were shipped with QC-CALC and are used to present data and concepts to you. The default folder is **C:\Prolink\QC-CALC 3.4\Data**



Click the **Open** button and then the **Maximize** button on the data window to fill the screen.

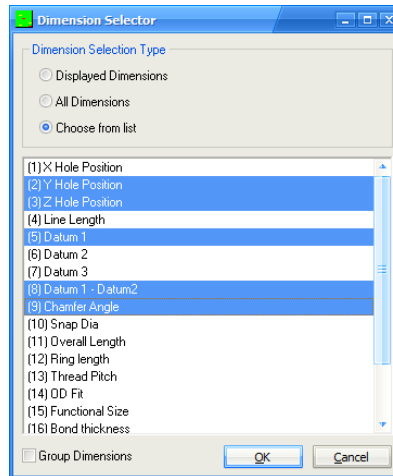
7.3 Grid View Screen

Your screen should look similar to the figure below. This sample file has reasonable labels at the top of each column. These labels are obtained from your CMM part program or entered by you if the file was created manually. Note the amount of data stored in the file is 100 records as depicted in the lower tray next to words **Last Written Record**. We will use this data in the analysis portion of this section.

Record	(1) X Hole Position	(2) Y Hole Position	(3) Z Hole Position	(4) Line Length	(5) Datum 1	(6) Datum 2	(7) Datum 3
67	0.9967	2.0004	2.9974	4.0030	5.0010	5.9970	7.0000
68	0.9968	2.0020	3.0043	3.9969	5.0037	6.0042	6.9999
69	0.9969	1.9991	2.9996	3.9976	4.9994	5.9972	6.9999
70	0.9999	1.9997	2.9994	3.9993	5.0005	5.9989	7.0000
71	1.0006	1.9981	3.0004	4.0043	5.0016	5.9989	6.9999
72	0.9997	1.9993	3.0021	3.9945	5.0015	6.0012	6.9999
73	0.9995	1.9993	2.9991	3.9988	4.9957	6.0014	7.0000
74	1.0005	1.9988	3.0010	3.9985	4.9998	5.9930	7.0000
75	0.9997	2.0008	2.9972	3.9998	5.0019	5.9927	7.0000
76	0.9992	2.0010	3.0029	4.0024	4.9983	6.0046	6.9999
77	0.9994	1.9993	2.9978	3.9978	4.9986	5.9993	6.9999
78	0.9993	2.0007	2.9996	3.9994	4.9979	6.0028	6.9999
79	0.9997	2.0004	2.9987	4.0011	5.0001	6.0003	6.9999
80	1.0005	1.9995	2.9984	3.9991	4.9956	6.0011	6.9999
81	1.0009	2.0002	3.0009	4.0020	4.9957	6.0029	7.0000

7.4 Select Dimensions to Plot

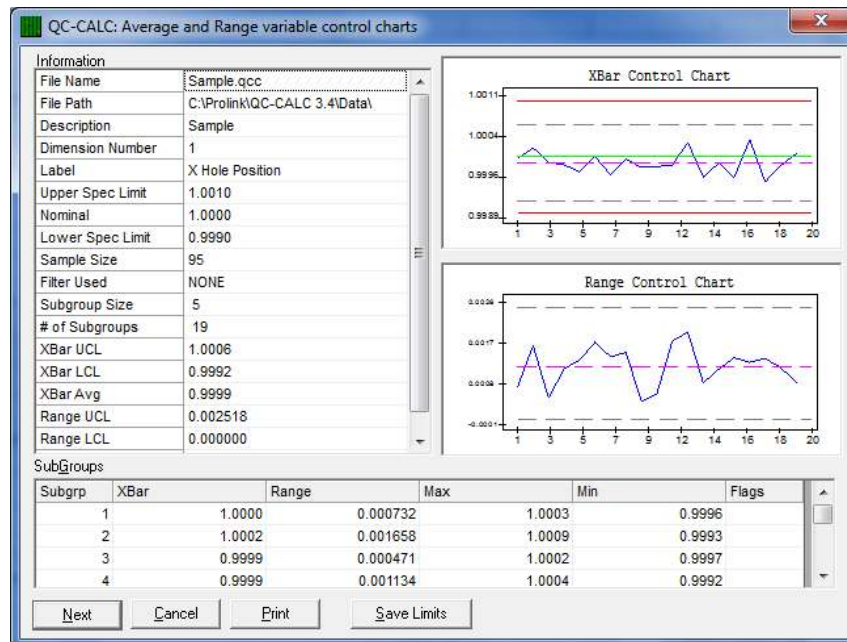
Now that you have data being displayed, choose the **Report – Xbar & Range** menu. The dimension selector is displayed allowing you to pick the features you wish to analyze – create an Xbar & Range Chart. All of the dimensions in this file are selected by default and shown in dark blue (solid gray on paper). You can de-select some of these dimensions by holding the Ctrl key down and clicking the mouse on them.



Click **OK** to start the analysis.

7.5 Xbar & R Charts

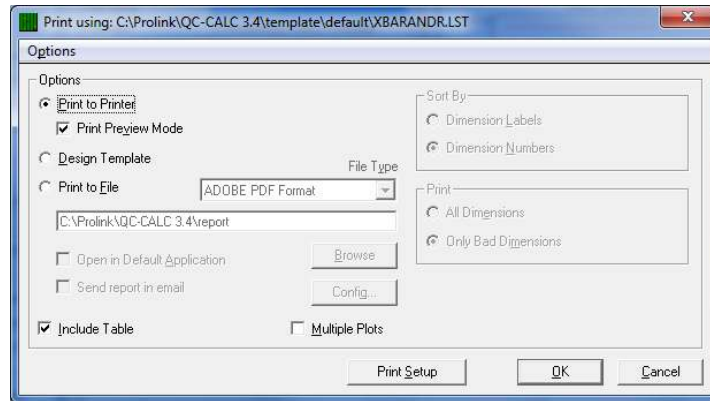
After clicking the **OK** button you begin to see charts. QC-CALC displays the Xbar and Range charts for each selected feature in this list. Here we see an example of a QC-CALC Xbar & Range Chart. We will discuss this chart in detail in another section of the manual but generally you see calculations on the left, charts on the right, and subgroup values in the lower table.



If you press the **Next** button, you will display the next dimension you selected in the Dimension Selector. Now press the **Print** button to commit this report to paper. The Print Dialog is displayed.

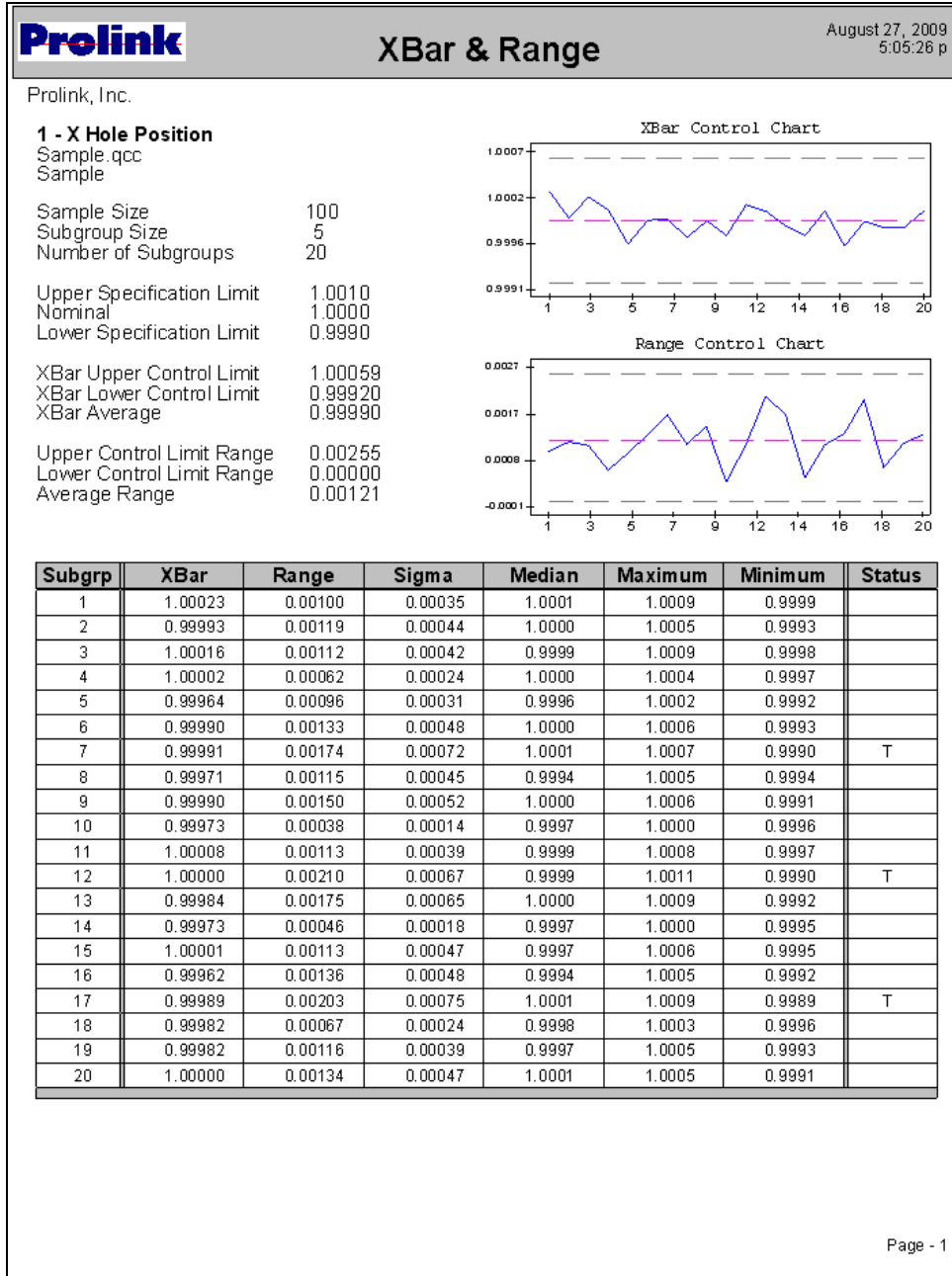
7.6 Print Dialog Box

For this example we selected **Print Preview Mode** so our report is sent to the screen instead of the paper. Press **OK** to see the above report sent to the QC-CALC report template.



7.7 Xbar & R Print Preview

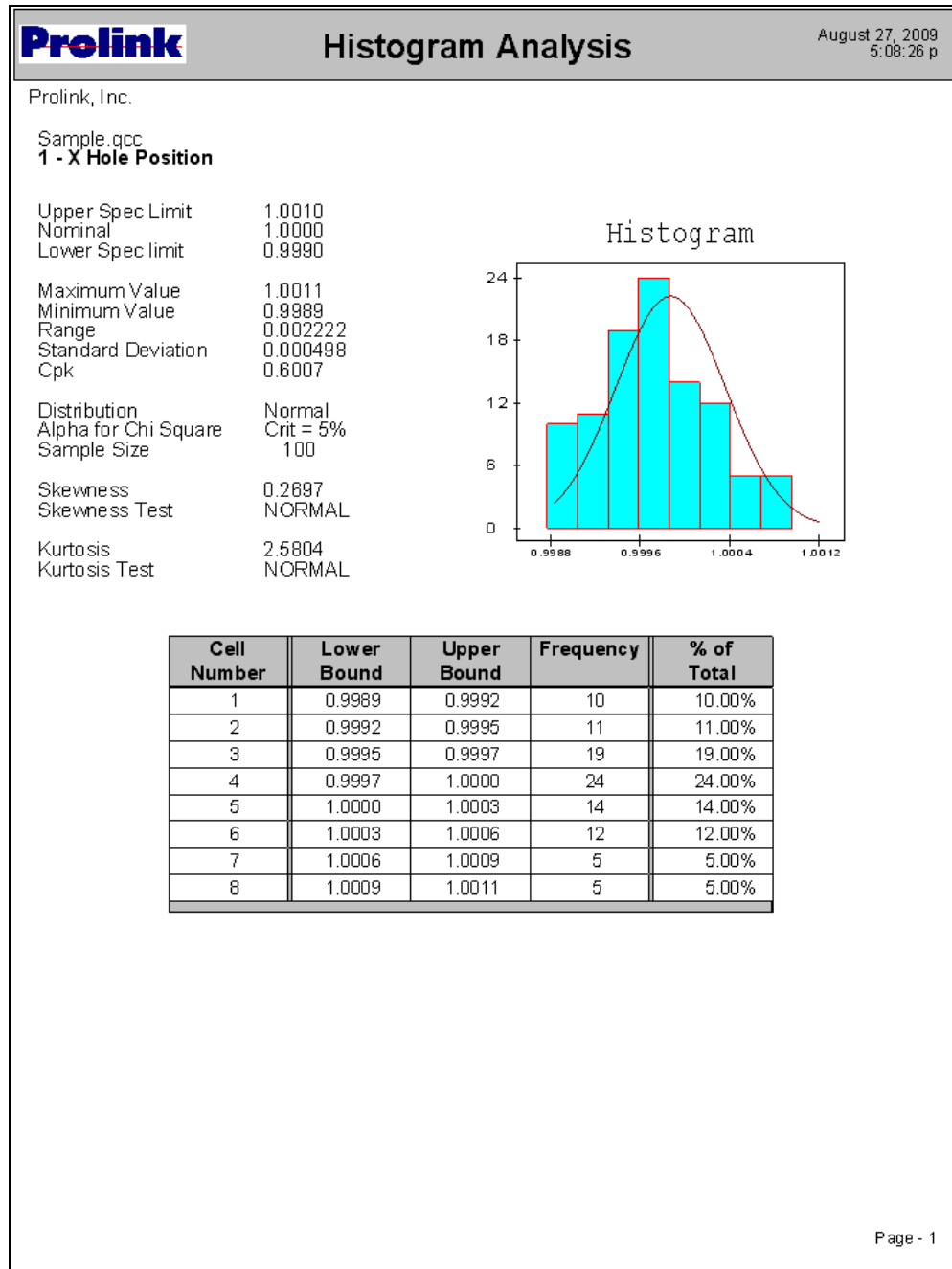
A full report on the selected feature is displayed on your screen or printed to paper depending on your choice.



7.8 Histogram Charts

As another example, create a Histogram Report with the same data by:

1. Choose menu **Report – Histogram Analysis**.
2. The **Dimension Selector** is displayed.
3. Click **OK** and your first dimension is displayed.
4. Click **Print** and then **OK** and you will see the same data presented in a Histogram instead of an Xbar & R.

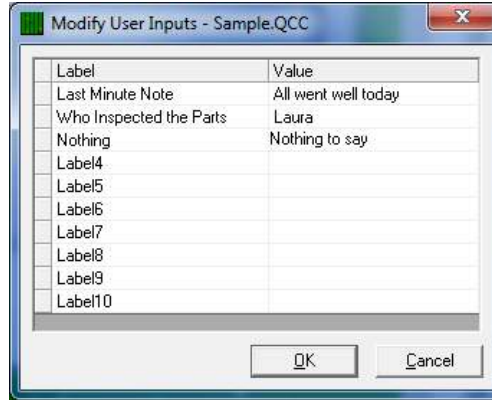


This sequence is always the same. You select the report type, the dimensions, and QC-CALC displays the rest.

7.9 Adding Notes to Reports

7.9.1 Modify User Inputs

The **User Inputs** are used to add information to the report that is not entered directly from the inspection machine. You decide which lines you want to show in the report. The report templates shipped with your software have the variables USERINPUT1 through USERINPUT10 added to the top of page 1. This means any last minute text you type in these boxes is shown in the reports.



The **User Inputs** are associated with the currently active part file being displayed so each file can have different **User Inputs** values. Any changes you make here will only affect the **User Inputs** for the specific part file seen in the title bar of the **Modify User Inputs** window.

Here we see the three **User Inputs** above being displayed automatically in the partial First Article report below. This last minute text addition is very useful to convey information that was previously unavailable before the report is printed.

First Article Report

Prolink, Inc.

MYPART 10.QCC	Cavity
MyPart 10	Employee

Date of Inspection August 27, 2009
 Time of Inspection 5:17:51 PM
 Record Number 100

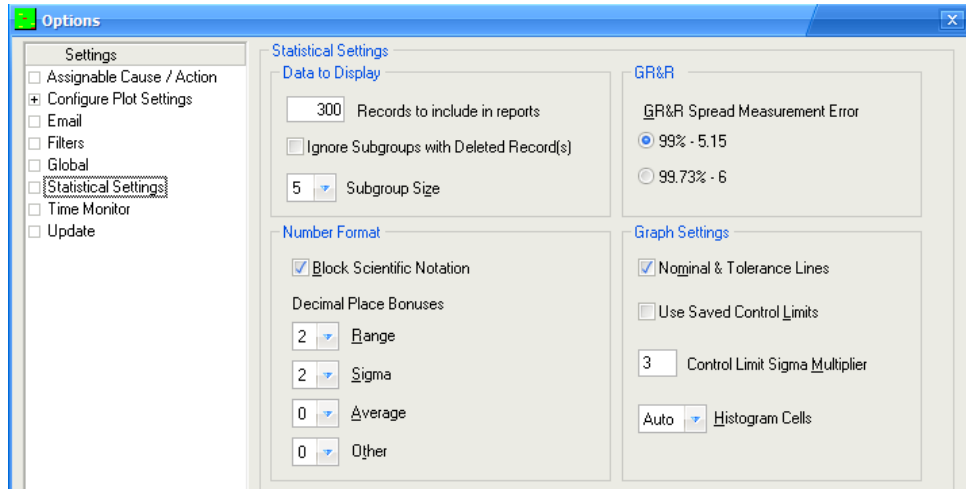
All went well today
 Laura
 Nothing to say

Dim	Dimension Label	Nominal	USL	LSL	A
1	Feature 1	1.5000	1.5100	1.4900	

This brief lesson should give you an appreciation of how easy it is to create SPC reports using QC-CALC. However, there are many features, options, and changes to learn. The next few sections convey some of the details so you can create more meaningful reports.

7.10 How much data is analyzed?

Since no filter is active, the amount of data is set by the value found in the **Tools – Options – Statistics Settings – Number of Parts to Plot**. This value has been set in the figure below and is equal to 50. This means QC-CALC will read the newest 50 records found in the database and use them in the analysis.



The fact that we set the subgroup size to 5 explains why there was exactly 10 points in the Xbar & R chart (50 points divided by subgroup of 5 = 10 points)

7.10.1 Filtering Data

To better control what data is plotted and analyzed, QC-CALC uses the concept of filters to categorize data in a more meaningful way. For example you may want only the parts made THIS-WEEK from machine 2. In the next section we describe how to create and use filters to obtain meaningful reports.

8. Filtering Data

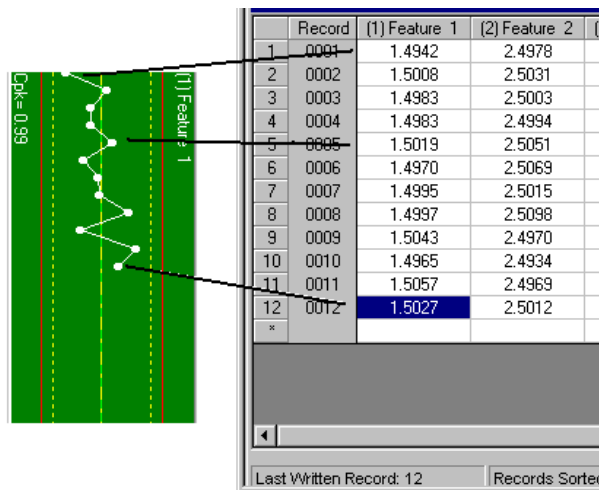
8.1 Introduction

QC-CALC can reduce the amount of data you see by removing records (parts) or removing plots (features) or both. Collectively this is known as filtering data. Reducing the number of plots is useful to show only the critical or important features thereby creating less confusion for you. By reducing the number of records (parts) you can separate parts made by the same machine, cavity number, operator, etc. This session discusses the manual and automatic methods of reducing data so you can quickly identify problems.

- Dimension Filter use to reduce the number of plots
- Record Filter use to reduce the number of records within the plots

8.2 The Data Layout

QC-CALC uses an easy to understand method of storing your inspection results. The database looks similar to a spreadsheet where each row is a part made up of many columns of features. Using the data we just created, picture in your mind the Real-Time plot data as a grid. The data would be displayed as 12 rows (parts) of 10 columns (dimensions). Each real-time plot is a column so QC-CALC calculates and displays everything within a column since this is the same feature across many parts. Here we rotated the Real-Time Plot clockwise and placed it next to the column of data to show you how the data is stored and plotted.



In this session we discuss how to filter data manually but remember QC-CALC can automatically filter data for you to help identify problems. For example, you might want QC-CALC to show all plots (features) having a Cpk of less than 1.33. Or you might want QC-CALC to show you which cavity or machine number is causing this low value. This is considered an advanced topic and is discussed in the [Record Filters - Details](#) on page [72](#).

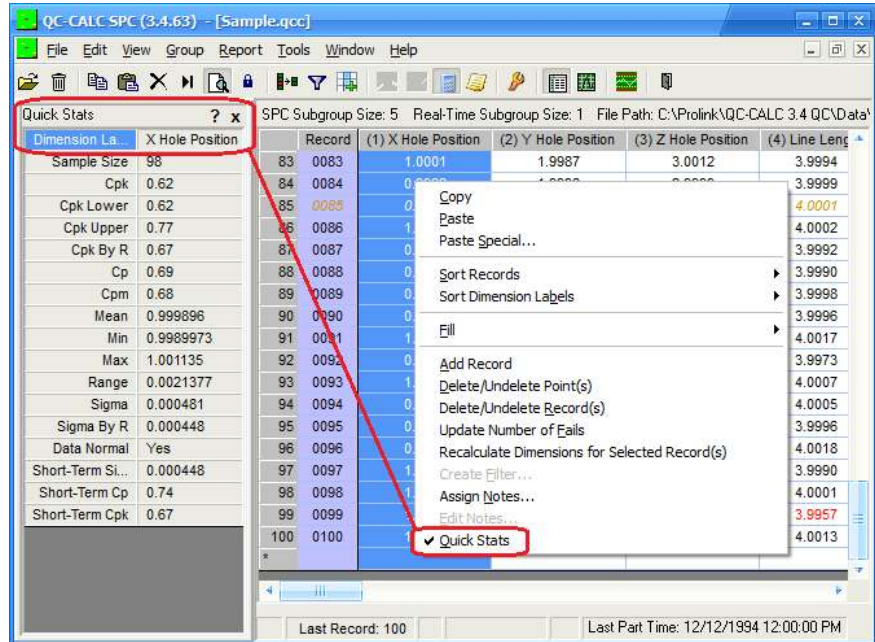
8.3 Viewing the Data Grid

You can see this data layout when using the Grid View of a file.

Exercises

Complete the following exercises to become familiar with the QC-CALC SPC screen.

1. Open a file in QC-CALC SPC and choose the **View – Grid View** method of displaying this file.
2. Notice the data layout shows each feature in a separate column.
3. Using the mouse, click the label for column 1 (X Hole Position) and the entire column will be highlighted.
4. Right click the mouse and select **Quick Stats**.
5. The Quick Stats panel is displayed on left side in the information section.



8.4 Conclusion

The purpose of this exercise is to familiarize you with the format of your stored data. By using the **Quick Stats** panel we show how QC-CALC uses all numbers in a column.

The data layout is important to understand. Many customers have hundreds of features per part and thousands of parts. The goal of filtering data is to reduce the number of rows (parts) and the number of columns (features) to a manageable number. Most people must identify problems as quickly as possible and filtering does this for you. The next two sections discuss the two filter methods.


8.5 Dimension Filters

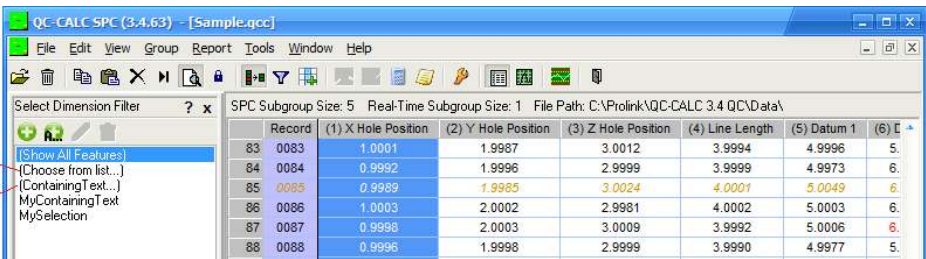
8.5.1 Introduction (Static List)

To reduce the number of plots displayed (dimensions) QC-CALC uses the concept of a dimension filter. This is a manual operation where you choose the dimensions you wish to display from a list. The list of dimensions was generated from your part program. You highlight the ones you want to see and click OK.

When you are inspecting parts on your CMM, QC-CALC Real-Time automatically saves your data assuming you want to see all dimensions. Therefore, all dimensions are selected by default. Clicking on a filter name in the list activates the highlighted filter and changes what plots you see to the right side because the filter is instantly applied.

8.5.2 Display the Filter

To view the dimension filter, choose menu **View – Dimension Filter** or click the  button. The **Dimension Filter** panel is displayed in the **Information Panel** area and the data area is pushed to the right. You can add, change, and delete your own filters. When you create a new filter, you give it a name and it is added to the bottom of the list. Your custom filters are editable by clicking on the pencil and are deleted using the trash can.



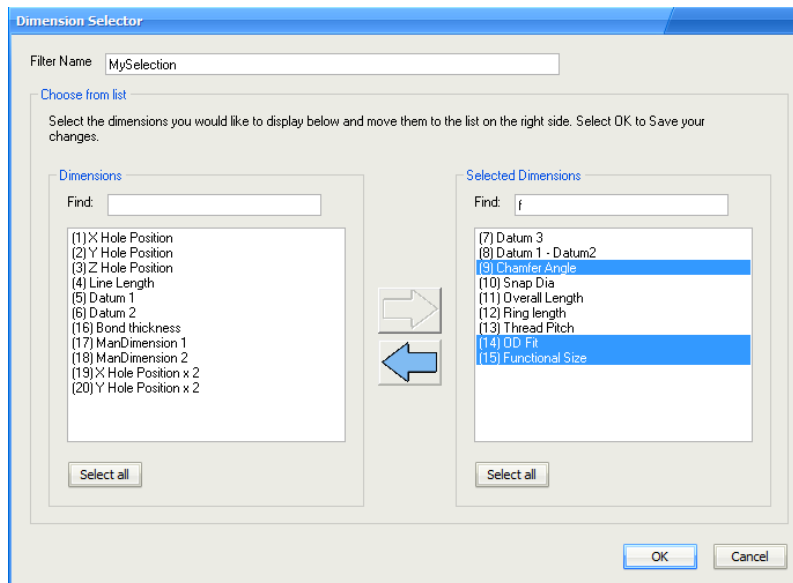
Click (Choose from list...) to begin a simple filter.

Click (Containing Text...) to begin a Text search filter.

Record	(1) X Hole Position	(2) Y Hole Position	(3) Z Hole Position	(4) Line Length	(5) Datum 1	(6) Datum 2
83 0083	1.0001	1.9987	3.0012	3.9994	4.9996	5.
84 0084	0.9992	1.9996	2.9999	3.9999	4.9973	6.
85 0085	0.9989	1.9985	3.0024	4.0001	5.0049	6.
86 0086	1.0003	2.0002	2.9981	4.0002	5.0003	6.
87 0087	0.9998	2.0003	3.0009	3.9992	5.0006	6.
88 0088	0.9996	1.9998	2.9999	3.9990	4.9977	5.

Choose from List

The **(Choose from List...)** filter is a static list of dimensions that you select with the mouse. The **Dimension Selector** is displayed showing all the feature names in the file and the features are easily chosen using a combination of the CTRL and SHIFT keys with the mouse. Click **OK** to display only the highlighted dimensions and automatically save the Dimension Filter using the name shown in the **Selection Name** area. **Note:** Data is still collected for the dimensions that are not displayed.



Dimension Selector

Filter Name: MySelection

Choose from list

Select the dimensions you would like to display below and move them to the list on the right side. Select OK to Save your changes.

Dimensions

Find:

- (1) X Hole Position
- (2) Y Hole Position
- (3) Z Hole Position
- (4) Line Length
- (5) Datum 1
- (6) Datum 2
- (15) Bond thickness
- (17) ManDimension 1
- (18) ManDimension 2
- (19) X Hole Position x 2
- (20) Y Hole Position x 2

Select all

Selected Dimensions

Find: f

- (7) Datum 3
- (8) Datum 1 - Datum2
- (9) Chamfer Angle
- (10) Snap Dia
- (11) Overall Length
- (12) Ring length
- (13) Thread Pitch
- (14) DD Fr
- (15) Functional Size

Select all

OK Cancel

The **Find** boxes at the top of each column aid the selection process when a large number of dimensions exist. Selecting dimensions becomes difficult when your part program has more than 100 dimensions. Consider how difficult it would be to pick and choose 3000 dimensions from the list.

The **Find** boxes provide a label search capability that helps speed up the selection process. All dimensions that you move to the right panel will be displayed. By default QC-CALC selects all features to display so you will see all dimensions in the right panel when this selector is first displayed.

For example, suppose you have 200 dimensions in a QC-CALC file and you want to quickly find and remove all dimensions containing the letter **F** in the label. Type the “f” in the right **Find** box and instantly all labels containing an F are highlighted as shown above. The large left arrow becomes enabled allowing you to remove the highlighted dimensions from the **Selected Dimensions** list and put them back into the column on the left.

You can type as many letters as needed to reduce the selection. You can move features back and forth to get just the right selection. Click **OK** when you have finished and the **Filter Name** shown at the top of the screen will be used to save your selections.


TIP: You can move dimensions back and forth by highlighting items in both sides and clicking the appropriate arrow. You can press and hold the CTRL key to highlight / un-highlight selected dimensions by clicking the mouse on the dimensions of interest. If your list is long you may not see all of the selected dimensions but understand they are selected even when out of sight.

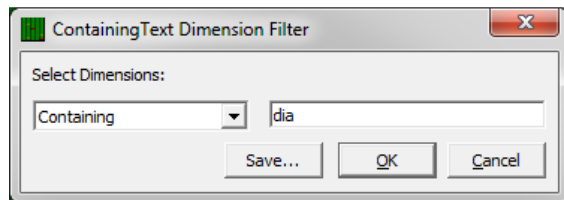
8.5.3 Introduction (Dynamic List)

(Containing Text)

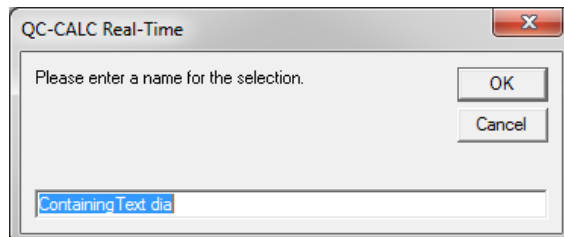
When you use **Choose from List** you are choosing a static list of dimension numbers that do not change across part files. The **Containing Text** filter is dynamic and is re-applied when you open another QC-CALC file. In other words, if you want QC-CALC to display all dimension labels that contain the letters TP no matter where they are positioned in the list, use the **Containing Text** filter.

For example, let’s assume your dimension labels for all **true** position dimensions always end with the letters “TP” or maybe you use “PC” for all **process** critical dimensions. If this is the case, you can quickly create a dimension filter for your file by using the **Containing Text** option.

Click on the words **(Containing Text)** or click the  button and you are asked to enter the search characters. **Dia** was entered into the text box to be used as a filter. If you press the **OK** button your filter is used.



Click **Save...** and enter a filter name to add this to the list of Dimension Filters available to use.




8.6 Record Filters

8.6.1 Introduction

The record filter is used to reduce the number of parts shown in the QC-CALC SPC window. By reducing the number of records you can group parts made within a week, by machine number, cavity number, operator, etc. This session discusses the manual and automatic methods of reducing data so you can quickly identify problems.

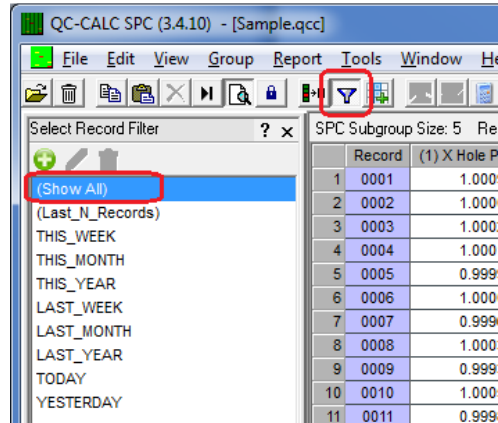
8.6.2 Display the Record Filters

The record filter panel is displayed by selecting the **View – Record Filters**


menu or clicking the  button. The top of the list may contain predefined filters denoted in parentheses and are not editable. The **Show All** is one such filter and selecting it removes any active filter.

8.6.3 Using Record Filters

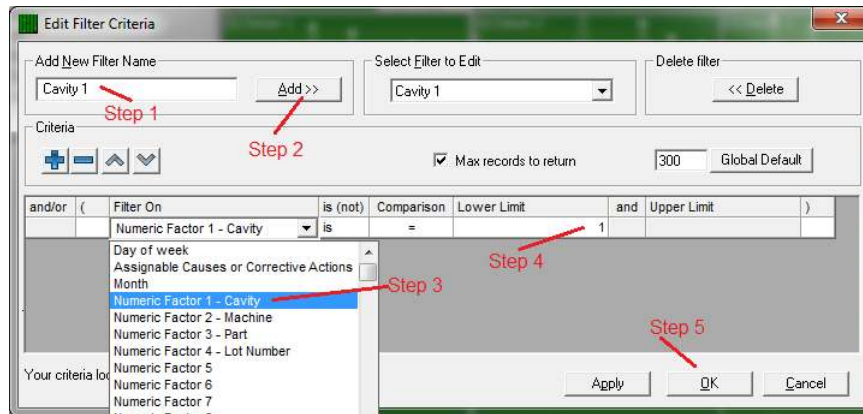
Several date oriented filters are provided to help you quickly reduce the viewed data to THIS_WEEK or LAST_WEEK. Using these built-in filters reduces the time spent creating filter of exact dates. In other words, the result of these filters changes each week since our calendar is constantly changing. Clicking on any filter name instantly activates that particular filter.



8.6.4 Creating a Record Filter

You can create your own record filter by clicking on the  button. The filter editor is displayed. You can display the same filter by choosing **Tools – Options – Filter Settings** – and click the **Edit a Filter** button. Click **OK** to save your filter. Here are the steps to create a filter to show all parts made in Cavity 1.

1. Enter **Cavity 1** in the **Add New Filter Name**
2. Click **Add >>** button
3. In the **Filter On** textbox select Cavity
4. In the **Lower Limit** type 1



Press the **OK** button to return to the QC-CALC SPC screen and your new **Cavity 1** filter is displayed at the bottom of the list.

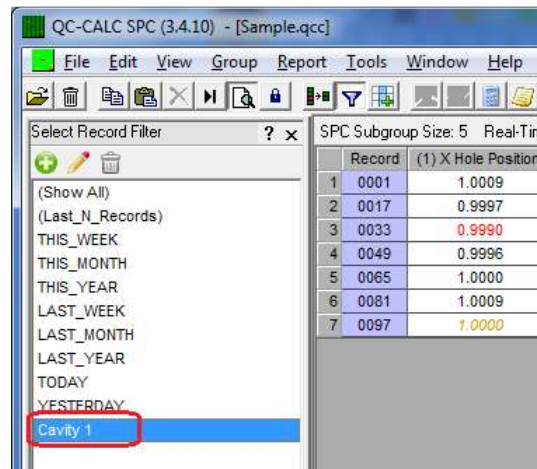
8.6.5 Edit the Record Filter

The pencil icon is now enabled and is used to edit filters. By clicking on the pencil the record filter editor is displayed again and you can change what you need in the same way you created the filter.

8.6.6 Delete Record Filters

Likewise, the trash can is also enabled and clicking it will delete the currently selected filter. Be careful since there is no confirmation on this action.

Note: When using filters, if no data matches your selected filter criteria all the plots will disappear and you'll see a message stating, **“No records passed the record filter criteria”**. In our example, clicking on **THIS_WEEK**, **THIS_MONTH**, or **THIS_YEAR** should not change the display since all displayed data passes these filters. However, if you select **LAST_WEEK**, **LAST_MONTH**, or **LAST_YEAR** no records are seen.



You should use very clear names on all filters since these names appear in the printed reports making it easy to identify the conditions when the report was created. You can use any characters in your filter name.

Exercises

Complete the following exercises to become familiar with record filtering.



Exercise 1:

Using the **Training CMM**, change the Lot number to 23 and add 5 data records to your QC-CALC file by clicking the **Inspect** button.

1. Find the **Training CMM** and change the Lot number to 23.
2. Now click the **Inspect** button 5 times.
3. Your plots are updated automatically with the new data.

Exercise 2:

Create a new record filter for all parts made with **Lot = 23**

1. Be sure the record filter is displayed by clicking the **Filter**  button
2. Select no filter by choosing (**Show All**) found at the top of the filter list.
3. Click the **Add** filter button  found at the top of the record filter list.
4. The record filter editor is displayed.
5. Enter a label of Lot **23** and click the **Add** button.
6. Click the mouse in the **Filter On** column and select Numeric Factor 1 – Lot.
7. Now enter a value of **23** in the Lower Limit.
8. Press **OK**.
9. Your new filter (Lot 23) is displayed in the filter list.
10. Click on this filter and watch the data be reduced to the last 5 records.



Exercise 3:

Using the Training CMM:

1. Add **Operator** as the second Factor with a value of **Joe**.
2. Change **Lot** to **22**.
3. Add 5 data records to your QC-CALC file by clicking **Inspect**.

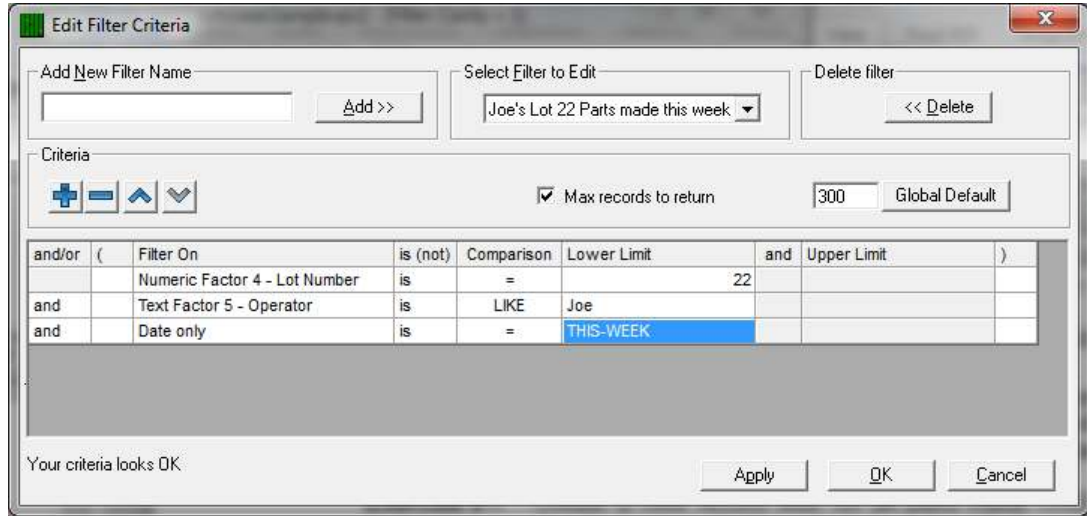
Exercise 4:

Create a new record filter for all parts made with Lot = 22 and Operator = Joe.

1. Be sure the record filter is displayed by clicking the **Filter**  button.
2. Select no filter by choosing (**Show All**).
3. **Click** the **Add** filter button  found at the top of the record filter list.
4. The record editor is displayed.
5. Enter a label of **Joe's Lot 22 Data** and click the **Add** button.
6. Click the mouse in the **Filter On** column and select Numeric Factor 1 – Lot.
7. Now enter a value of **22** in the Lower Limit.
8. Press **Append** which adds another line to the filter.
9. Click the mouse in the **Filter On** column and select Text Factor 1 – Operator.
10. Now enter a value of **Joe** in the Lower Limit.
11. Click **OK**.
12. Your new filter (Joe's Lot 22 Data) is displayed in the filter list.
13. Click on this filter and watch the data be reduced to the last 5 records.
14. Try clicking on other filters to see the live data change.

Exercise 5:

Create a new record filter for all parts made THIS-WEEK, with Lot = 22 and Operator = Joe. Call the filter **Joe’s Lot 22 Parts made This Week**. Here is a picture of your filter. Use the **Append** button to add more criteria.



For a more in-depth discussion of record filters, please see the “Record Filters – Details” section of the QC-CALC Real-Time Training manual.

9. Reports – Full Detail

9.1 Introduction to Historical Statistics

This portion of QC-CALC is dedicated to Historical analysis of the data you collected using automatic inspection equipment or manually entered data. Each type of statistical analysis is described and any differences in operation are discussed. Operational differences usually involve variations in keyboard commands or information you supply to run an analysis.

- Plot various Control Charts
- Plot various Attribute Charts
- Plot various Process Charts
- Print Charts
- [Print Dialog Box](#)
- [Create Your Own Templates](#)
- [Selecting Templates](#)
- [Deleting Templates](#)
- [Modifying User Inputs](#)
- [Print Setup](#)
- [Control Charts](#)
- [Attribute Control Charts](#)
- [Process Charts](#)
- [Miscellaneous Reports](#)
- [How to Select Dimensions to Plot](#)
- [Save Control Limits \(XBar Only\)](#)
- [Calculating All Control Limits at Once](#)
- [Calculating vs. Saving Limits](#)
- [Printing](#)

9.2 How to Select Dimensions to Plot

When you use any of the SPC charts, QC-CALC prompts you to select the characteristics or dimensions you wish to analyze. The dimension selector displays these dimensions in a list. Your last selections are always saved when you use the dimension.

9.2.1 Number of Dimensions Required for Analysis Functions

You must select the appropriate number of dimensions for the analysis or a warning message is displayed. Some analysis functions operate on one dimension at a time, while others require two to operate. You may select as many dimensions to analyze as available. The analysis function selected will process them one at a time from first to last displaying the results.

<i>Chart Type</i>	<i>Number of Dimensions to Select</i>
All Variable Control Charts	1 dimension per analyses
Cpk - Process Capability	1 dimension per analyses
Raw Data Plot & Outlier Detection	1 dimension per analyses
Correlation & Regression	2 dimensions per analyses
Histogram Analysis	1 dimension per analyses
C & nP Charts	1 dimension per analyses
P & U Charts	2 dimension per analyses
Pareto Analysis	2 or more dimensions per analyses
Non-Conformance Report	1 to all dimension per analyses
Statistical Summary	1 to all dimension per analyses

9.2.2 Viewing the Graph Screen

After you have selected the graph type from the Report menu and you have selected the dimensions to analyze, the first graph is displayed. The graph window has 2 to 4 areas shown in the XBar & Range chart below.

Each graph is displayed in the upper right hand corner of the window while the report of calculated values is broken into the descriptive statistics on the left and a subgroup list at the bottom of the screen. If either of the report sections

Report - Reference Section

becomes too large to display, a vertical scroll bar is provided to view the entire report.

The screenshot displays the 'QC-CALC: Average and Range variable control charts' window. It is divided into several sections:

- Information Table:** A table with 15 rows and 2 columns. The first column lists various statistical parameters, and the second column provides their values for the current sample.
- SubGroups Table:** A scrollable table with 5 rows and 7 columns, showing data for individual subgroups.
- Control Charts:** Two line graphs are displayed in the upper right. The top graph is an 'XBar Control Chart' showing data points fluctuating around a mean line. The bottom graph is a 'Range Control Chart' showing the range of data points for each subgroup.

Annotations in the image point to specific features:

- A red arrow points to the 'Information' table with the text: "Table includes calculated results. The information changes depending on the graph type."
- Another red arrow points to the 'SubGroups' table with the text: "Subgroup information in a scrollable table. This table exists only if relevant."
- Two red arrows point to the control charts with the text: "The graphs are located in the upper right portion of the window."

9.3 Save Control Limits (XBar Only)

You can save the currently calculated and displayed control limits to the QC-CALC database. This is particularly useful for comparing new analyzed data with limits set at an earlier time. You use this when all the assignable causes have been removed from your process and you want to save the values associated with what you consider "in control".

The 'Save Limits' dialog box is shown, containing two sections of settings:

- Data Limits:**
 - Upper Plot Limit: 1.001541 -> 1.0011
 - Upper Control Limit: 1.000956 -> 1.000576
 - Mean: 0.9998967 -> 0.9998887
 - Lower Control Limit: 0.9988374 -> .9992017
 - Lower Plot Limit: 0.9982967 -> .9989
- Range Limits:**
 - Upper Plot Limit: 0.003 -> 2.643714E-03
 - Upper Control Limit: 1.840257E-03 -> 2.517823E-03
 - Mean: 5.632865E-04 -> 1.191023E-03
 - Lower Control Limit: 0 -> 0
 - Lower Plot Limit: -0.0002 -> -1.258912E-04

Buttons for 'OK' and 'Cancel' are located at the bottom right of the dialog.

When you click the **Save Limits** button a window pops up containing 10 values with check boxes. You will see the new values that are going to overwrite the old values and you are requested to select each one of ten and confirm your choice. Each feature (dimension) saved in the database has these 10 limits associated

with them. You will only be saving the limits associated with the displayed chart at the time the **Save Limits** button is clicked.

To use these saved control limits instead of re-calculating new limits each time the analysis is run, select **Tools – Options – Statistical Settings – Configure – Historical Statistical Values** and select **Use Saved Control Limits**.

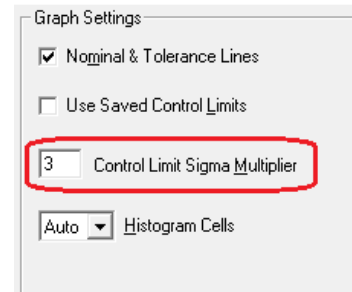
9.4 Calculating All Control Limits at Once

There are several locations where QC-CALC calculates the control limits as well as other limits. Each area is summarized in this section to help you identify the best method of achieving the limits you expect under the conditions you want. QC-CALC can make these calculations for you either manually or automatically and on one dimension or on all dimensions.

We have concentrated a great deal of effort in the Real-Time data collection portion of QC-CALC to provide a fully automatic system for you. As such, many options have been added to provide flexibility for every situation. If you are monitoring 20 or more part features you begin to appreciate the power of QC-CALC's ability to calculate and save hundreds and thousands of control limits in an instant. QC-CALC SPC can only save 1 dimension at a time so if you need to rapidly calculate and save many limits we recommend you use the method found in the Real-Time section of the software.

9.5 Sigma Multiplier for Control Limits

You enter a scaling multiplier for calculating new control limits based on this number multiplied by the standard deviation (sigma) of the data used in the plot you are viewing. When calculating control limits the sigma multiplier is normally set to 3. However, QC-CALC gives you the ability to enter different values for the multiplier. This multiplier is found in **Tools – Options – Statistical Settings – Control Limit Sigma Multiplier**.



9.6 Calculating vs. Saving Limits

QC-CALC divides the process of calculating and saving limits into two separate actions. QC-CALC calculates and displays new limits in the live plots but this action does not overwrite the previously saved limits unless you choose to save the new values. The saved limits are usually the values written to the database for each feature when the file is created. As time goes by and many parts are saved in the database you should calculate and save new Control Limits, Mean, Sigma Zones, etc.

9.7 Printing

Clicking the **Print** button invokes the **Print Dialog Box** allowing you to print a copy of the report or edit a report template. The plots are printed in color if a color printer is connected to your computer; otherwise gray scale is used.

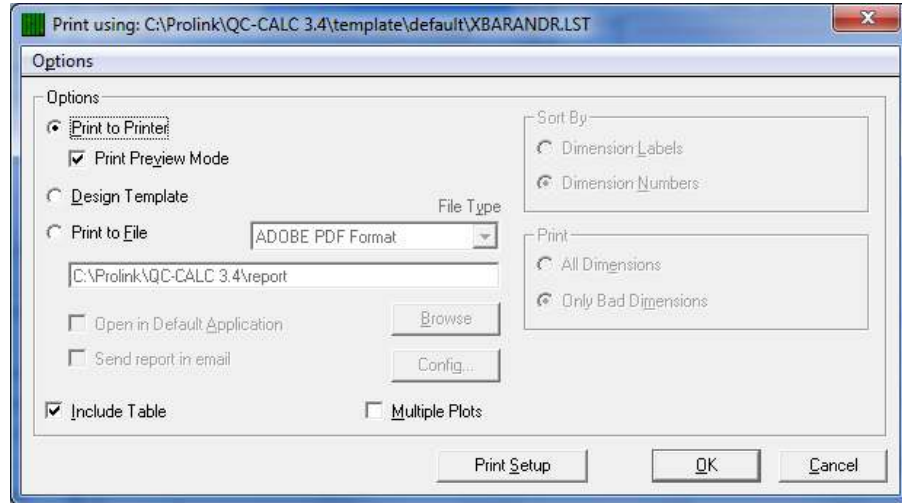


Note: For tables in reports that use subgroups for calculations the Date and Time values are taken from the last record (latest entered value) in each subgroup.

9.8 Print Dialog Box

When you choose to print a graph or report, QC-CALC displays the Print Dialog Box shown below. Here, you choose whether you want Custom Reports or to

initiate the Report Designer. These customizable reports allow you to modify the report templates using the Report Designer. See the **Report Designer** section of this manual for documentation on creating customized reports.



9.8.1 Print to Printer

With this option selected, reports are sent to the Windows default printer instead of to a file or designing a template.

Print Preview Mode

This feature lets you see what the report looks like on paper without actually printing it. **Print Preview** is available for all reports and shows all pages of the report.

9.8.2 Design Template

Use **Report Designer** to modify existing report templates or create new ones that are specific to your company's needs. See the special **Report Designer** section in your user manual for complete documentation.

9.8.3 Print to File

When this option is selected, the **Browse** button and the destination field are available. Click the **Browse** button to choose the name and path of the output file. To select different types of output formats, use the **File Type** pull-down list. You can print all of your reports in the following file formats:

Formats	Formats
RTF Rich Text	TIFF
HTML	Metafile
ADOBE PDF	JPEG-Picture
Multi-Mime HTML	Bitmap
XML Format	Excel
Text	Excel table
Text Table	

9.8.4 Single Plots

If you do not select the **Multiple Plot** checkbox, QC-CALC uses a single feature template and only information related to this one feature is printed. Many times this type of report is larger than needed and uses at least one sheet of paper for each graph.

9.8.5 Multiple Plots

If you select the **Multiple Plot** checkbox, QC-CALC uses the multi-feature template and many dimensions are printed on one piece of paper. Many companies require a graph and a few statistical calculations using a very small portion of the paper. These special templates act as labels on a sheet of paper. There is no limit to the number of graphs that can be printed on one sheet of paper, but each plot becomes smaller as the number of labels increases. A practical limit is 24 plots per page. The templates used for this type of report have a file extension name of .LBL.

Multiple Plots on one page reduce the amount of paper and time needed to display your part characteristics. A page of 10 XBar & R charts (2x5) is very readable and as many as 24 Process Capability charts fit nicely on 8 1/2 x 11 paper. Using the **Report Designer**, you design one "label" in size and content and then tell the designer how many you want on each page. More detail is found in the Report Designer portion of this manual.



Note: Correlation and Regression, Pareto Analysis, First Article, Raw Data, and Statistic Summary cannot use the **Multiple Plots** option.

9.8.6 Report Templates

The concept that QC-CALC uses to define templates is based on creating a directory of templates for one particular situation. For example, if you have customers or internal departments that need QC-CALC output presented in different ways, you can create a separate directory of templates for each customer or situation. We recommend you create all of the template directories within the C:\Prolink\QC-CALC 3.3\Template\Default\ directory to make it easy to find and select each individual customer's report template.

9.8.7 Template Names

Once the directory is set, the individual template is chosen based on the operation you are performing. For example, if you have an **XBar & R** chart displayed on the screen and you click the **Print** button, the **Print Dialog** box is displayed and QC-CALC uses the **XBar & R** template. Likewise, if you activate the designer, only the **XBar & R** template is modified. To change the template type select a different analysis from the **Report** menu and the associated template for that report type is used when you hit the **Print** button.

QC-CALC contains many different types of reports. These reports are either single dimension or multiple dimensions. Not all report types have the multiple plots option available as shown in the table below. Each template file name is **always** the name listed in the table below. It is the directory name that distinguishes one template from the next.

9.9 Create Your Own Templates

Please refer to the **QC-CALC Report Designer** supplied in the back of this manual to create your own reports and templates.

9.10 Selecting Templates

When the **Print Dialog** box is displayed, choose the **Options** menu then choose **Select Templates**. You use this option to change the active directory of templates. All subsequent template usage directs QC-CALC to work with the full set of templates found in this folder. To access the templates follow the steps below:

1. From the **Report** menu perform the analysis you desire (XBar & R, Cpk, Histogram etc.)
2. Click the **Print** button and the **Print** dialog box is shown.
3. From the **Options** menu click on **Select Templates** or CTRL+S
4. Select the directory containing the templates you want to use. i.e. C:\PROLINK\QC-CALC 3.4\TEMPLATE\IBM\
5. Select the files (templates) from that directory and click **OK**
6. The IBM directory stays active until you select a different set

9.11 Deleting Templates

You can delete templates from specific directories. You can delete more than one template at a time but the templates must all be in the same directory. Do not delete or edit the C:\Prolink\QC-CALC 3.4\Template\Default\ directory.

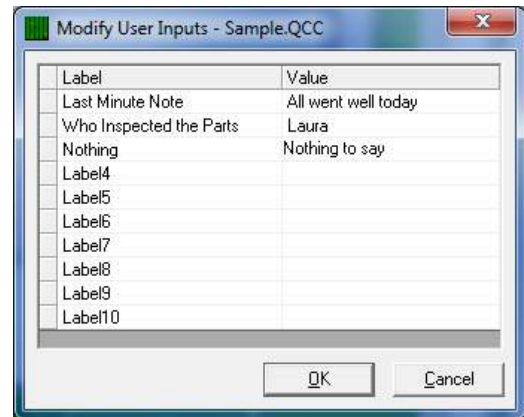
1. From the QC-CALC **Report** menu perform the analysis you desire (XBar & R, Cpk, Histogram etc.).
2. Click the **Print** button, the Print dialog box is displayed.
3. From the **Options** menu click **Delete Templates** or CTRL+D.
4. Select the directory containing the templates you want to delete. i.e. C:\PROLINK\QC-CALC 3.4\TEMPLATE\APPLE
5. Select the files (templates) from that directory and click **OK**.
6. A dialog box asking you to confirm is shown. If **OK** is clicked, the selected templates are deleted, otherwise you simply return to the print dialog box.

9.12 Modifying User Inputs

The **User Inputs** are used to send any input to your report that is not entered directly from the inspection machine or calculated by QC-CALC. The same User Inputs will be sent for each report. You decide which lines you want to show in the report from within the **Report Designer**.

9.13 Print Setup

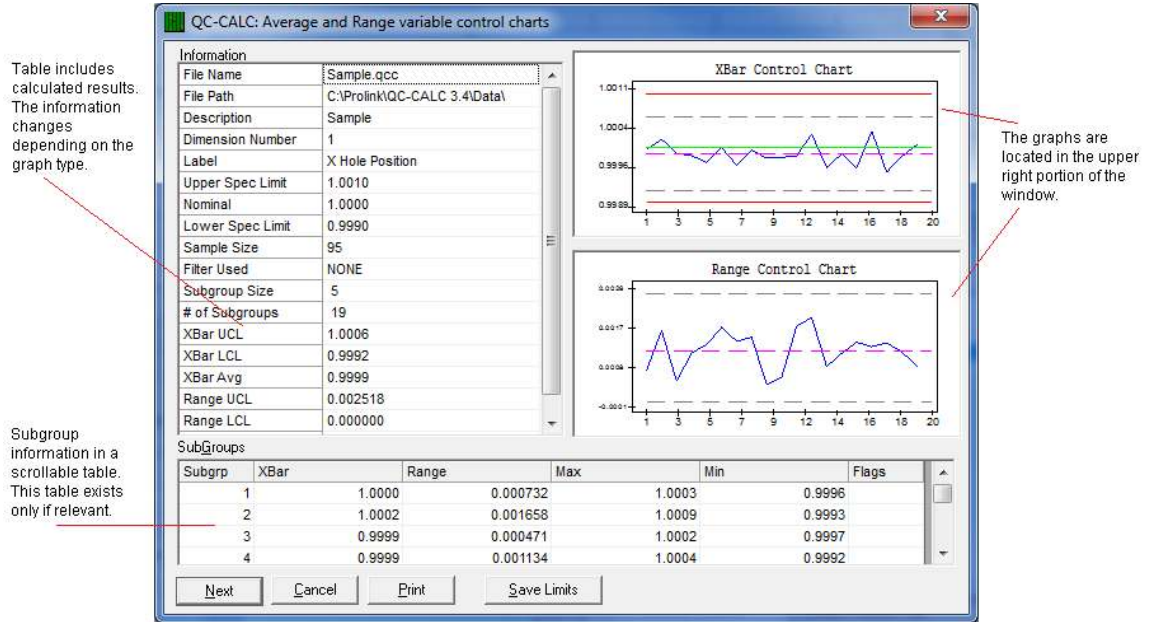
You click the **Print Setup** button to initiate the standard Windows Print setup. You may want to change the page from portrait to landscape or select a different printer.



9.14 Control Charts

9.14.1 Introduction

The methodology of control charts for process control provides the ability to distinguish between random process variation and variation assignable to a specific cause. Control chart techniques are based upon the distinct differences between:



- **Random cause variation** – variation that is inherent in the process
- **Assignable cause variation** - variation that results from disturbances outside the process.

Control charts are a valuable process control tool since they provide a signal that a process has assignable cause variation, which requires corrective action. A requirement for process control is the elimination of assignable cause variation. Control charts show whether a process is in statistical control or if assignable cause variation is present.

9.14.2 Automatic Calculation of Limits

There are several locations where QC-CALC calculates the control limits as well as other limits. Each area is summarized in this section to help you identify the best method of achieving the limits you expect under the conditions you want. QC-CALC can make these calculations for you either manually or automatically, and on one dimension or on all dimensions.

The control limits are initially set to be automatically calculated each time you chart your data. If the quality control process is in a state of control, you may wish to suspend automatic calculations and use the save limits allowing you to track the state of control over time. This allows you to historically track the system and know when the process may begin to trend out of control.

9.14.3 Variable Control Charts

Variable Control Charts provide a means to continuously monitor the behavior of a process. Process behavior can be characterized by its inherent variation and its

assignable cause variation. All processes exhibit some amount of inherent variation. This variation is relatively constant and is a result of the sum of the capability of the various components in a process. Typically, the inherent variation cannot be changed without altering the process. Assignable cause variation on the other hand can be attributed to a disturbance introduced into a process resulting in additional variation beyond the inherent variation. Variable control charts are an effective tool for identifying when assignable cause variation is present in a process. Variable control charts allow you to both monitor inherent variation and to identify when assignable cause variation is present.

Variable Control charts provide a plot showing the trend of a characteristic in relation to computed or user specified control limits. The charts are plotted in order of data collection with most recent results last (to the right), thus revealing behavior over time. The pattern of the plotted data and the relationship to control limits provides an indication of when a process is going out of control.

9.14.4 Use of Variable Control Charts

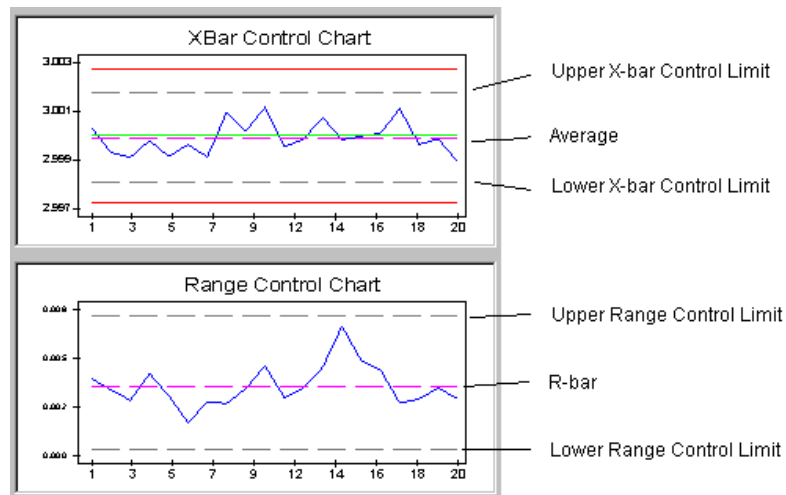
- To continuously monitor important characteristics of a process and to maintain the process in statistical control.
- To assist with isolating the sources of assignable cause variation and lack of control.
- To minimize the need for final inspection by keeping a process in control.

9.14.5 Available variable control charts

XBar & Range Control Chart	pg. 33
XBar & Sigma Control Chart	pg. 33
Median & Range Control Chart	pg. 34
Individual & Range Control Chart	pg. 34
Individual & Moving Range Control Chart (XmR)	pg. 34
Moving Average & Moving Range Control Chart	pg. 35
Bivariate Analysis	pg. 36

9.14.6 Viewing the Variable Control Charts

QC-CALC provides variable charts in pairs, such as the **XBar & Range** chart or the **Moving Average & Range** chart. The control chart pairs are displayed on the same graph with the range or sigma type chart located at the bottom position. Together the pair of control charts provides an accurate picture of a process.



Upper & Lower Control Limit

All control charts have the upper & lower control limits represented with gray dashed lines. These lines are automatically calculated or manually set by you.

Y Axis

The Y-axis displays the scale value of the axis. The value is generally centered on the nominal value of the feature being analyzed.

X Axis

The X-axis displays the subgroup number for the plotted subgroups. To set the subgroup size, select **Tools – Options – Statistical Settings**. The default subgroup size is 5.

Calculation Tables

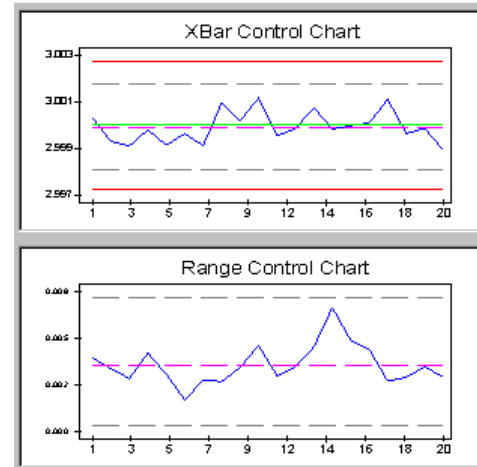
Each graph contains 1 or 2 tables reporting the calculation details. The Subgroup table has information that should be obvious except for the column labeled "Flags." These single character flags allow you to see if values within the subgroup exceed tolerance or control limits. They are represented as follows:

- U The subgroup is out of range in the upper graph.
- L The subgroup is out of range in the lower graph.
- T The subgroup value exceeded the tolerance limits.

9.14.7 XBar & Range Control Chart

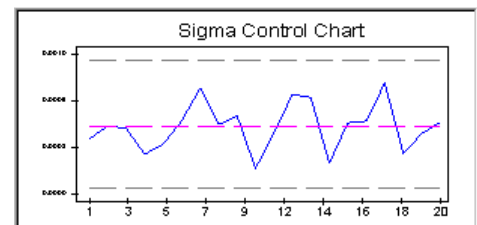
The **XBar & Range** chart provides a graph of the average of a process characteristic and the extent of the range. The **XBar** chart gives a picture of how well a process is centered and if it is stable. **XBar** is the average of the set of subgroup values. If subgroup points fall outside of the control limits or if identifiable trends in subgroup points exist, this indicates a change is occurring in the process that will most likely result in increased variability.

The **Range Chart** indicates the range of a subgroup's values. The **range** chart gives a picture of the change in variability. A stable process will have a fairly uniform range, while an unstable process will exhibit significant changes in the range. A range chart should show control before evaluating the **XBar** chart.



9.14.8 XBar & Sigma Control Chart

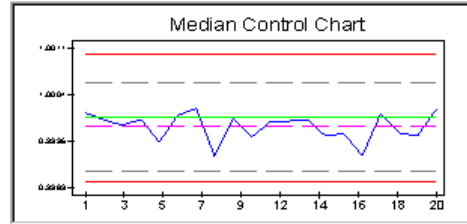
The **XBar & Sigma** chart, like the **XBar & Range** chart provides a graph of the average of a process characteristic. The difference is that the lower chart is a Sigma chart instead of a **Range** chart. This simply means the variation is based on the sigma of the subgrouped points instead of the range.



The **Sigma chart** indicates the standard deviation of a subgroup's values. The sigma chart also gives a picture of the change in variability. A stable process will have a fairly uniform standard deviation, while an unstable process will exhibit significant changes. A **Sigma chart** should be in control before evaluating the **XBar** chart.

9.14.9 Median & Range Control Chart

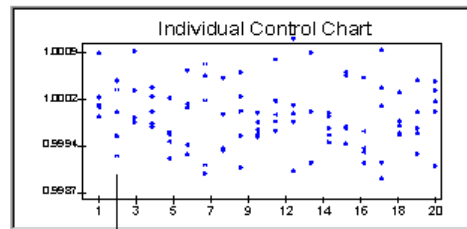
The **Median and Range** chart provides a graph of the median of a process characteristic and the extent of the range. The median chart provides a picture of how well a process is centered using the median or middle value. The median of a subgroup is the center value where, half of the observed values are above it and half below it. An important distinction between the median of a set of values and the average is that the median is influenced less by outliers than the average. This can be an advantage or a disadvantage depending on your objectives.



Similar to the **XBar** chart, if subgroup points fall outside of the control limits or if identifiable trends in subgroup points exist, this indicates a change is occurring in the process that will most likely result in increased variability.

9.14.10 Individual & Range Control Chart

The **Individual & Range** chart provides a graph of the actual readings of a process characteristic and the extent of the range. The Individual chart gives a picture of how well a process is centered and if it is stable. Individuals are plotted in subgroup fashion with all individuals data points displayed. **Individual & Range** charts are used for low volume processes or where few measurements are available.

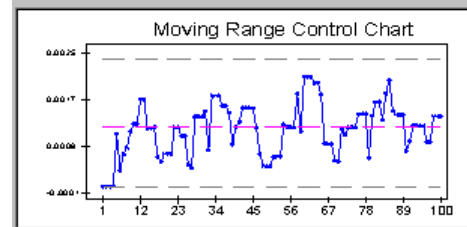
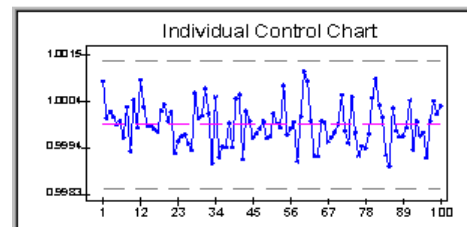


Subgroup size is 5. Note the vertical column of 5 points for each subgroup.

The **Range** chart indicates the range of the data within the subgroup. The range chart gives a picture of the change in variability. A stable process will have a fairly uniform range, while an unstable process will exhibit significant changes in the range.

9.14.11 Individual & Moving Range Control Chart (XmR)

Regular Control Chart data are data for which you may choose both the subgroup size and the subgroup frequency. That is, the subgroup size is independent of the subgroup frequency. For such data, the **XBar & R** charts are generally the best charts to use. The ability to choose the subgroup frequency allows you to obtain subgroups to match the time period that characterizes changes in the process. The ability to independently select the subgroup size allows you to collect several observations in a short time period and use the increased sensitivity of the **Average Chart**.



Periodically collected data for which the choice of subgroup size is NOT independent of the choice of subgroup frequency. Each value is uniquely identified with a specific period of time. In such a case, any change in subgroup size will also require a change in the time period covered by the subgroup.

Examples of this sort of data would be a series of monthly values, periodic measurements from a continuous process, or final test values from a series of batches.

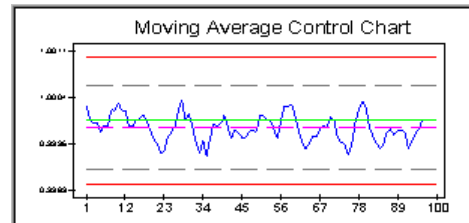
Periodically collected data are obvious candidates for the **XmR Chart**. Rather than having to wait for two or more time periods between successive subgroups, the **XmR Chart** allows you to plot a point every time you have a value. That is, periodically collected data will often have a logical subgroup size of 1.

However, there is a more fundamental reason for the use of an **XmR Chart** with periodically collected data - it is frequently the most sensitive chart for this type of data. With regular Control Chart data you may increase the subgroup size without changing the subgroups frequency. If you observe the principle of homogeneous subgroup's, any increase in subgroup size will be subject to the constraint that the additional values are logically homogeneous with the original values. Thus, increasing the subgroup size with regular Control Chart data should not substantially change the questions addressed by the charts. This ability to select the subgroup size is what enables you to use the sensitivity of Subgroup Averages rather than having to work exclusively with Individual Values. This means that, for regular Control Chart data, the Average Chart will generally be the preferred chart¹.

1. This discussion was taken from "Understand Statistical Process Control", by Dave S. Chambers, 2nd Edition, SPC Press.

9.14.12 Moving Average & Moving Range Control Chart

The **Moving Average & Moving Range** chart provides a graph of the moving average of a process characteristic and the extent of the moving range. The moving average is computed as the average of a sample of successive measured points. The number of points averaged equals the subgroup size. A new average is computed for each successive point by throwing away the oldest point and including the next in sequence. Think of a sliding cell whose width is equal to the subgroup size moving across the data in sequential order, point by point. At each point a new moving average is computed and plotted.



The **Moving Average** chart gives a picture of how well a process is centered and if it is stable. The moving average is computed for each subgroup of data using the subgroup size set in the **Tools – Options – Configure – Statistical Values** menu.

Moving averages tend to smooth variations in data. The larger the subgroup size the greater the effect of smoothing. Compare the plot shown above with the Median and XBar plots. Each plot was made with the same data set.

The **Moving Range** chart indicates the moving range of a subgroup's values. The Moving Range chart gives a picture of the change in variability. A stable process will have a fairly uniform range, while an unstable process will exhibit changes in the range. Moving ranges tend to smooth variations in data. The larger the subgroup size the greater the effect of smoothing.

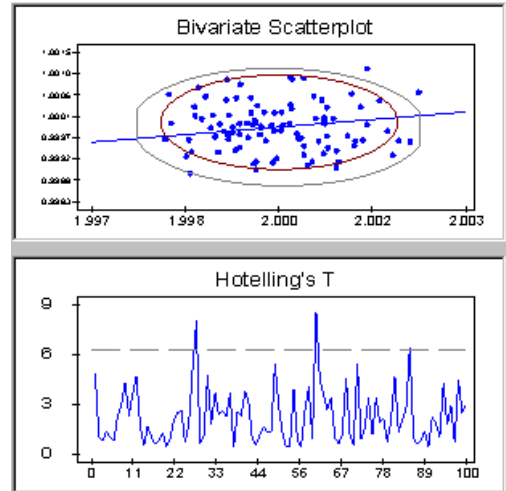
9.14.13 Bivariate Analysis

Bivariate control is the method of comparing and controlling two or more related variables in situations where quality depends on the combined effect of these variables. This method is most useful when two different variables work together to affect the acceptability of a process or part thereof; for example, the X and Y position of a hole, temperature and humidity of a drying oven or the concentrations of two chemicals in a reaction.

Note: The **Use saved control limits** option in **Tools – Options – Statistical Values** does not apply to the Bivariate control chart.

QC-CALC provides Bivariate analysis using variable control charts that operate on two variables simultaneously. In addition to control charts, the analysis provides the correlation of two variables and the critical value of Hotelling's T^2 .

Hotelling's T^2 is a method of combining the information from two (2) dimensions into a single number. This method provides the advantage of showing time-based trends in the data.



To select dimensions for analysis select **Report – Bivariate Analysis** from the menu. When the dimension selector window appears, select one to use as "X", and select one dimension to be used as "Y" and click **OK**.

Note: The process must be normally distributed for Bivariate Analysis to function properly. Use Histogram Analysis to determine if the process is normally distributed. Nominal and bilateral tolerances are required for both X and Y. There must be at least 3 records available for analysis (not deleted or filtered out).

9.15 Attribute Control Charts

9.15.1 Overview

Attribute Control Charts provide a means to monitor the behavior of a process when variable data is not obtainable. Attributes are discrete counts of a process parameter such as the number of non-conforming parts or the number of non-conforming characteristics.

Attribute Control Charts provide a plot showing the trend of a characteristic in relation to computed control limits. The charts are plotted in order of data collection with most recent results last, revealing behavior over time. The pattern of the plotted data and its relationship to control limits provides an indication when a process is going out of control.

9.15.2 Important to know for Attribute Control Charts

Only attribute characteristics can be used. Attribute characteristics are entered into QC-CALC using the data editor similar to manually entering variable data. Attribute data is stored in the dimension columns. Each entry corresponds to an attribute observation. One or two attribute columns are required depending on the type of attribute chart. The table below shows the number required:

Chart Type	Attr Required	Subgroup Size	Attr #1	Attr #2
P Chart	2	Varies	Subgroup or Sample Size	Number of Defects per Subgroup
nP Chart	1	Constant	Number of Defects per Subgroup	N/A
C Chart	1	Constant	Number of Non-conformities per part	N/A
U Chart	2	Varies	Subgroup or Sample Size	Number of Non-conformities per part

9.15.3 P Control Chart

The P chart (Percent defective) is an attribute chart showing the percent of non-conforming parts or items in a subgroup (sample) when the subgroup is not constant. The percent defective is the percent of defects for each subgroup. Points falling outside the control limits indicate out of control situations or a change in the process.

9.15.4 nP Control Chart

The nP chart (Number defective) is an attribute chart showing the number of non-conforming parts or items in a subgroup (sample) of constant size. The number defective is the total count of defects for each subgroup. Points falling outside the control limits indicate out of control situations or a change in the process.

9.15.5 C Control Chart

The C chart (Number of non-conformities) is an attribute chart showing the number of individual non-conformities (failures) of a specific type for a part or item. Each plotted point represents the number of non-conformities of a specific type, for a single part. This differs from the P and nP charts for which the sum of all types of defects is plotted for a subgroup.

As an example, if a part had five non-conformities because of five dents, the C chart would plot a value of five for the corresponding subgroup (dents). In this same case the nP chart or the P chart would consider this as one defective part regardless of the number of defects on the part.

9.15.6 U Control Chart

The U chart (Number of non-conformities per Unit) is an attribute chart like the C chart showing the number of individual non-conformities (failures) of a specific type for a part or item. However, a U chart is used when the subgroup size varies. Each plotted point represents the number of non-conformities of a specific type for a single part divided by the subgroup (number of parts) size.

9.16 Process Charts

9.16.1 Descriptive Report

These charts are different from each other and are described in this section. These types of charts are:

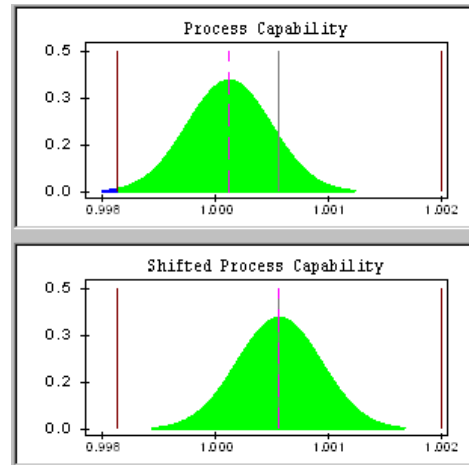
Cpk - Process Capability Analysis	pg. 38
Raw Data with Outlier Detection	pg. 40
Correlation & Regression	pg. 41
Histogram Analysis	pg. 43
Probability Plot	pg. 44
Pareto Analysis	pg. 45

9.16.2 Cpk - Process Capability Analysis

Process Capability charts provide an indication of the performance of a process. The **Process Capability** chart provides a graphical comparison of the distribution of a characteristic to its specification limits. The **Process Capability** chart depicts where a process is targeted in relation to the nominal and the spread of the process in relation to the specification tolerance limits.

QC-CALC displays two (2) distribution curves superimposed against the nominal and tolerance values corresponding to the characteristics being analyzed. The Upper distribution curve is the actual process distribution displayed in relation to the characteristic's nominal and specification limits and indicating where the process is targeted. The distance between the distribution's mean and the nominal line indicate the amount of process shift.

The lower distribution curve is the actual distribution re-positioned such that the mean of the distribution is located at the nominal specification limit. This provides an indication of what the process distribution would be if there was no shift. The width of the distribution curve provides an indication of the extent of the process in relation to the specification tolerances.



9.16.3 Use of the Process Capability Chart

The Process Capability Chart is used:

- To determine where a process is positioned in relation to the nominal specification for a characteristic.
- To determine the spread of a process in relation to the tolerance limit specifications for a characteristic.
- To estimate the percentage of the actual distribution which is outside of the tolerance limits. This provides an indication of the amount of defective parts that would be produced.
- To estimate the percentage of the shifted distribution outside of the tolerance limits. This provides an indication of the amount of defective parts that would be produced if the distribution were centered at the nominal.
- To monitor the capability of a process over time.
- To predict whether a process can meet specifications.
- To observe the effects of adjustments made to a process.

9.16.4 Viewing the Process Capability Chart

Introduction

As with all QC-CALC plots the calculated values are displayed in the left panel and the charts on the right. In this example, two bell curves can be seen above one another.

Upper Bell Curve

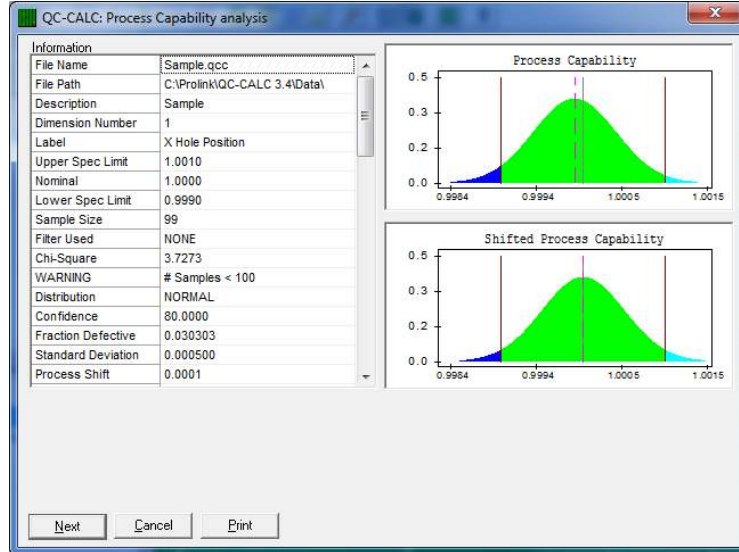
The upper portion of the plot consists of a normal (bell-shaped) curve computed from the sample data of the selected characteristic. This distribution pattern is a

Report - Reference Section

pictorial representation of the complete population being produced by the process for the selected characteristic.

Lower Bell Curve

The lower portion of the plot consists of the upper bell curve repositioned as such so that it is centered with respect to the characteristics nominal value.



Calculations

The list of calculations shown in the left panel is too long to display so a vertical scroll bar is added. To see the calculations for the shifted bell curve, scroll the list.

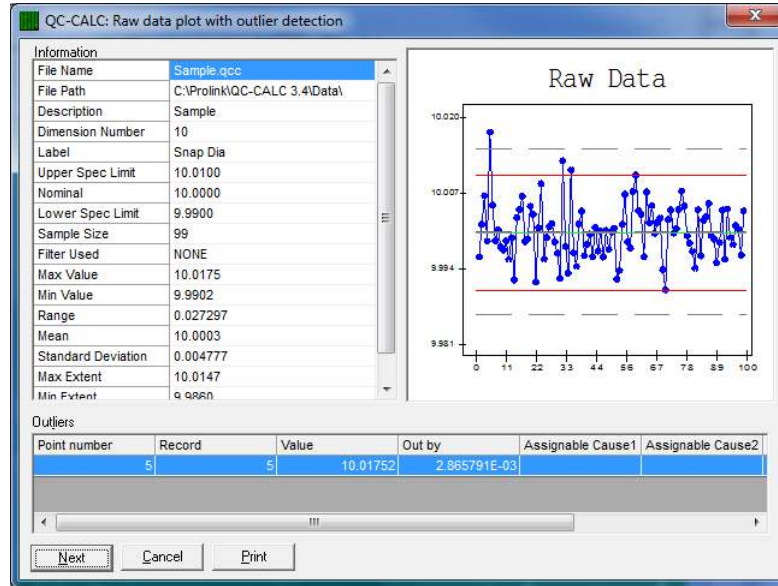
Nominal & Tolerance Limits

The values for the nominal and tolerance limits are displayed as solid vertical lines. By comparing the process distribution pattern to the tolerance, the process target and shift may be discerned. A shift problem is characterized by the distribution curve being skewed off center in relation to the tolerance band. A spread problem is discerned when the width of the distribution pattern is greater than the tolerance interval.

Processes must be in control and normally distributed for the process capability indices to be valid. Use the QC-CALC Control Charts to maintain control of a process within control limits. Nominal and tolerance values are required for characteristics analyzed. One-sided tolerance limits are acceptable.

9.16.5 Raw Data with Outlier Detection

Raw Data plots provide a chart of the actual data for a characteristic graphed in sequence of oldest data on the left to newest data on the right. In addition to displaying the raw data, the +/- 3 standard deviation limit lines are displayed for the sample data charted. Outlier points (points above and below the 3 standard deviation lines) may be deleted from the data file.



Viewing the Actual Data Plot

The top line of the plot identifies the type of chart while the X and Y-axis are labeled with the data groups and magnitude respectively. The plotting area is kept simple and clean while the pertinent calculations are displayed in a grid to the left of the screen.

+/- 3 Limits and Mean Line

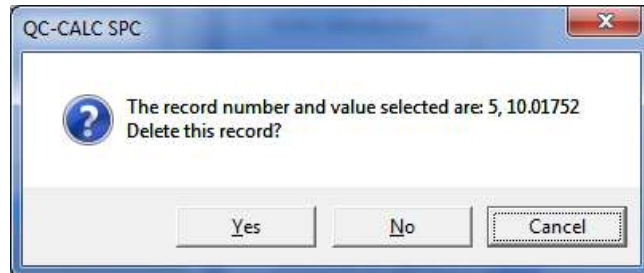
All actual data plots have +3S and -3S (sigma or standard deviation) limits displayed as horizontal gray dashed lines. A dashed magenta horizontal line representing the mean of the data sample is displayed. These lines are automatically calculated. The +/- 3S limits and the sample mean values are provided in an information window located in the grid on the left side of the screen.

Nominal & Tolerance Limits

The nominal and tolerance limit values are optionally displayed depending on the status of the **Nominal & Tolerance Line** check box in the **Tools – Options – Statistical Settings** menu. Tolerance values are displayed as solid red horizontal lines and nominal values are displayed as solid green horizontal lines. The tolerance values and the nominal value are provided in an information window located in the grid.

Examining the Graph

To examine a point move the cursor over the graph. The normal mouse pointer turns into a cross hair. Click the left mouse button when you are over the point of interest. A pop-up window asks if you want to delete the point. Remember, QC-CALC only marks the record containing the value as deleted and does not permanently delete the value.



This allows you to Undelete a record previously deleted. When you finish using the Raw Data graphs, all deleted points are printed in a gold font indicating they are deleted. Click the mouse on these records and press the Delete key to undelete them

Deleting All Outliers

To delete all reported outliers at once, position the mouse in the **Point Number** column and select the record number(s) to delete. You do this by clicking and holding the left mouse button down and dragging up or down the list. Once the record numbers are selected, press the **Delete** key and a dialog box asks you to confirm your choice.



Note: When deleting outliers QC-CALC deletes data on a record level. This means if an outlier value of a particular dimension characteristic is deleted, all other dimension characteristic values for that part are also deleted. In other words, the entire part is deleted. However, entering the data editor and “un-deleting” the appropriate data records can recover the data.

9.16.6 Correlation & Regression

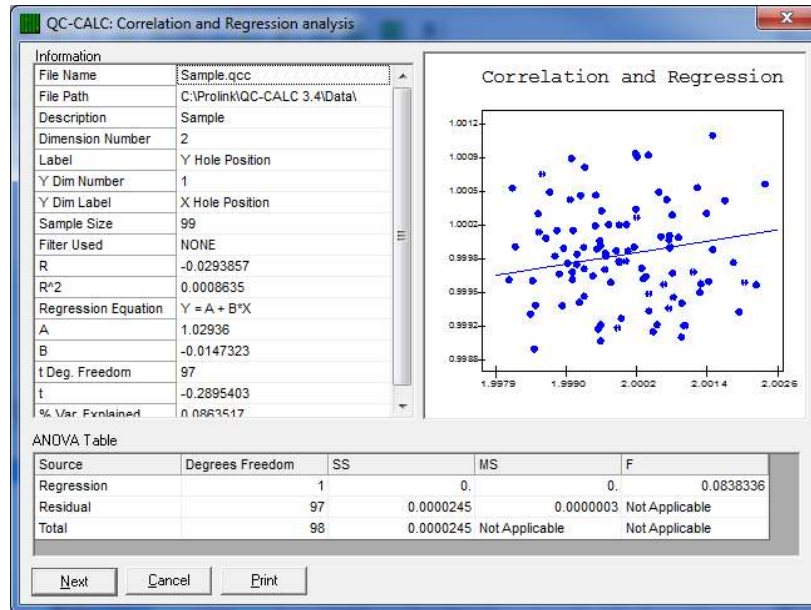
Introduction

Correlation and Regression Analysis is used to show the relationship of one characteristic to another. If a dependent relationship exists the regression plot will indicate strong correlation. If the two characteristics analyzed have little or no relationship, the regression plot will indicate little correlation. The amount of correlation is visually determined by observing how the data points behave. A tightly grouped pattern over the range of the plot generally indicates a stronger relationship than a loosely grouped pattern.

QC-CALC calculates the best linear fit line for the data sample. This is plotted against the data points providing a visual indication of the best linear relationship between the characteristics. QC-CALC calculates and reports various parameters that aid in understanding the relationships between characteristics analyzed.

Use of Regression Analysis

- To determine the relationship between two process variables. If a cause and effect is present the regression analysis will indicate strong correlation.
- To identify the key variable or variables which contribute to variation in other characteristics. Isolating the causes of variation provides knowledge of which characteristics should be continuously monitored for process control.



Y-Axis

The left Y-axis displays the range of the Y-axis variable.

X-Axis

The X-axis displays the range of the X-axis variable.

Important to Know

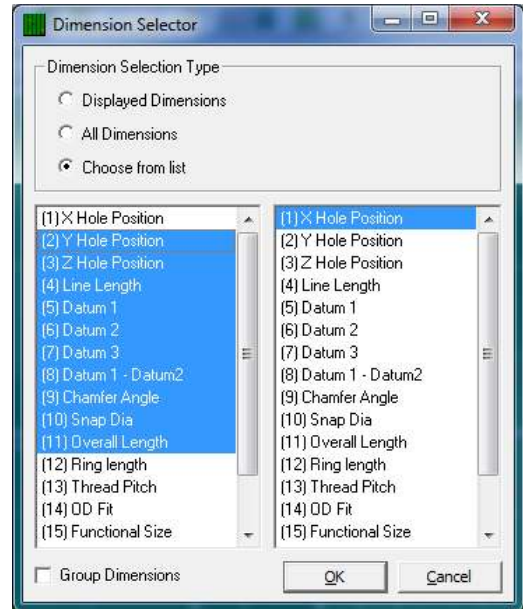
QC-CALC provides the best linear fit for regression analysis even if the relationship between characteristics is non-linear. A linear fit for characteristics with non-linear relationships will generally not correlate as well as a non-linear fit. Nominal and tolerance values are not required for characteristics analyzed.

Selecting the Dimensions

Since a regression plot shows the relationship of one dimension to another, two dimensions must be chosen. The dimension selector is displayed with two lists of dimensions.

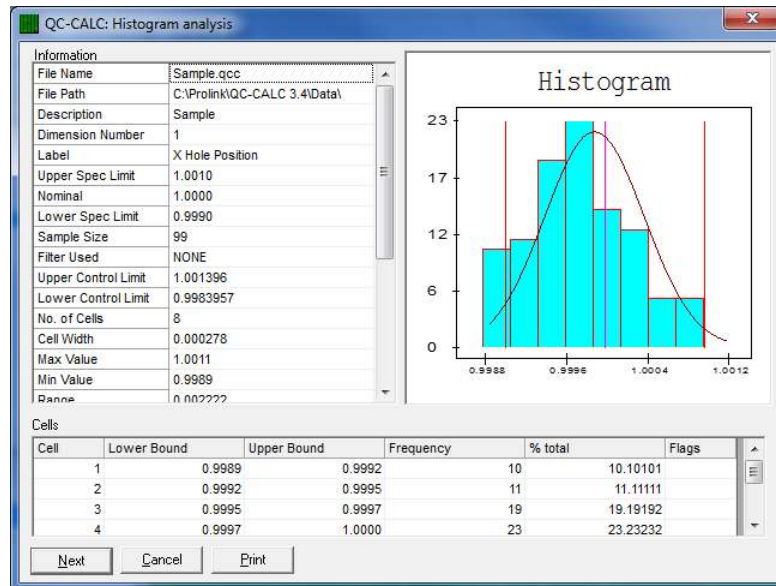
Choose the dimension to be plotted on the horizontal or X-axis from the list on the left side. The dimension is highlighted when you click on it. Choose the dimension to be plotted on the vertical or Y-axis from the list on the right side. Only one Y dimension can be selected but you may choose multiple X's. After you are finished viewing the regression plot of the first pair, click **OK** and the second selected X is regressed against the same Y.

Here we show the X-axis will be the X Hole Position while the Y axis is a Snap Dia.



9.16.7 Histogram Analysis

Histogram charts provide an indication of the frequency of occurrence of sample values over a range of measurements. A Histogram chart provides a bar style graph of frequency of occurrence plotted against the range of the actual data sample. The pattern of the bars provides an indication of the distribution of the sample data. If the bars are arranged with the tallest at the approximate center and the shorter bars at the left and right extremities of the range, the distribution is most likely to be normal.



QC-CALC tests the sample data to determine if it is normally distributed or non-normally distributed. A message indicating the data is normal or is non-normal is displayed in the Histogram report.

Use of the Histogram Chart

- Determine the amount of dispersion present in a characteristic's data.

- Obtain a "feel" for the shape of a characteristic's distribution, and if it is normally distributed.
- Generate descriptive statistics for sample data.

Viewing the Histogram Plot

The top line of the Histogram Plot identifies the type of chart while the bottom section displays the cells. The number of cells and their width is determined by the data being analyzed. You can override the automatic calculation by selecting **Tools – Options – Statistical Settings** and choosing a value for Histogram Cells instead of **Auto**.

Y-Axis

The left Y-axis displays the frequency of occurrence for each cell in integer units.

X-Axis

The X-axis displays the cell boundary values. Data points are compared to the boundary values to determine which cell each point belongs to. Data points belong to a cell if the data point value is greater than or equal to the cell's left boundary value and less than the cell's right boundary value.

Bell Curve

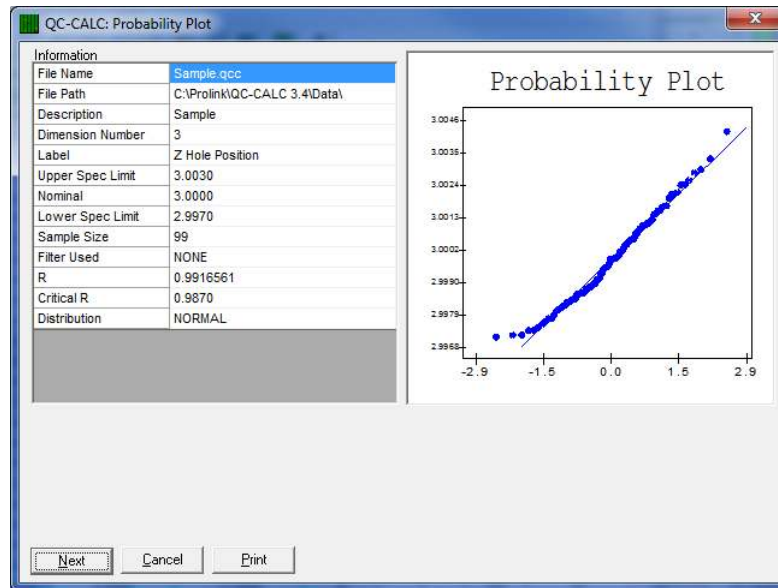
After the Histogram bar chart is displayed, QC-CALC overlays a bell curve on the bars indicating the approximate 3 sigma positions. The ± 3 -sigma position is where the curve touches the X-axis. In some cases, this point is off the graph and not visible.

9.16.8 Probability Plot

The Normal Probability Plot chart provides a test for normality that is more sensitive than the Chi Squared test when the sample is small. This test works with sample sizes as small as 3, and works well with sample sizes between 20 and 100. Samples larger than 100 are truncated to just the last 100 samples. This chart is equivalent to plotting the data on normal probability paper, drawing a straight (**Normal**) line on the graph with the same mean and standard deviation as the sample, drawing vertical lines through each data point, and calculating the correlation coefficient, R, between the data points and the corresponding points on the **Normal** line. The process is considered normal if the correlation coefficient is sufficiently close to 1 with the critical value determined by consulting the table printed in the manual. The significance level is .05, giving a 5% chance of rejecting data from a normal process.

Viewing the Probability Plot:

Data points are blue diamonds; the blue line represents a normal process.



Y-Axis

The Y-axis represents the value of each data point.

X-Axis

The X-axis represents the normalized value of each data point.

9.16.9 Pareto Analysis

The Pareto analysis charts provide an indication of the main sources of defective characteristics. A Pareto chart is a bar style graph of defective characteristics arranged in order of significance. The characteristic causing the greatest number of defects is displayed at the left-most position on the bar graph.

The traditional concept behind Pareto charts is to highlight the "significant few" causes of defects from the "trivial many". Generally speaking, most quality control problems can be attributed to a relatively few number of causes. Using a Pareto chart to sort defective characteristics in order of importance allows you to focus on the main cause of problems.

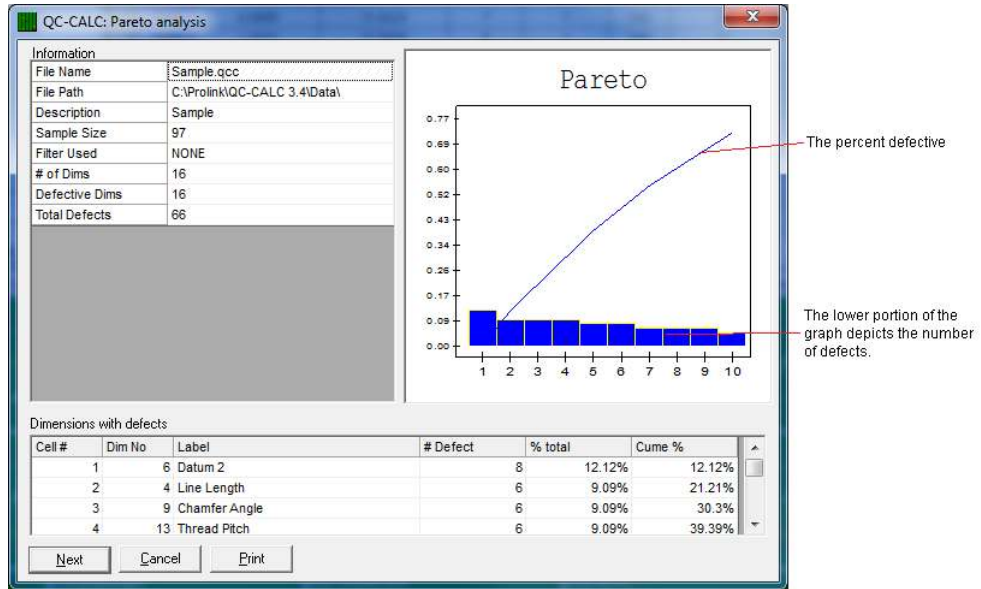
In QC-CALC, Pareto charts operate on characteristics (dimensions) with variable data. All, or a selected subset of characteristics in a data file can be included in the analysis. You select the dimensions to be included using the dimension selector window.

Use of the Pareto Chart

- Highlight the most serious causes of defects
- Track the results of corrective actions
- Monitor the quantity of defects over time

Viewing the Pareto Plot

The top line of the Pareto Plot identifies the type of chart while the bottom line defines the cells. The dark blue lower portion of the bar graph is the number of defects. The curve in the upper portion represents the percent of defects.



Y-Axis

The left Y-axis displays the number of defects for each characteristic plotted.

X-Axis

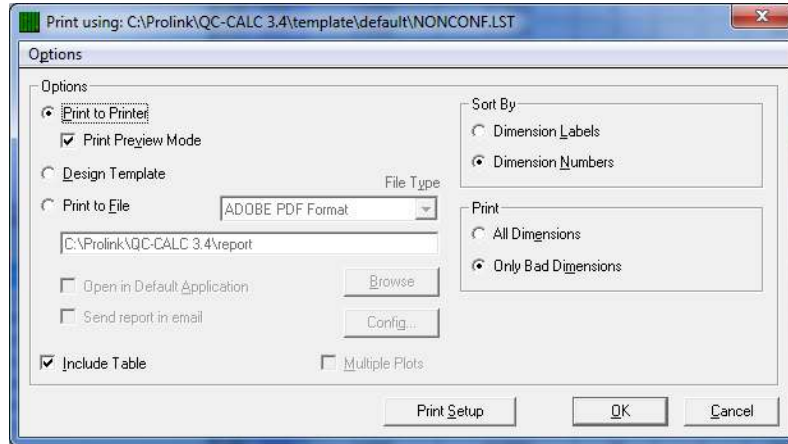
The X-axis displays the cell number. Each cell corresponds to a characteristic in the data file. The Pareto report provides the identifying labels and nominal value corresponding to each cell.

9.17 Miscellaneous Reports

There are several reports available that do not fit the standard control, process, or attribute chart. These are the non-conformance report and the statistical summary.

9.17.1 Non-Conformance Report

Use this option to generate a summary report on all or a subset of your data in each file. The summary is in report form as opposed to graphical form and aids production personnel in understanding particular characteristics about the data that statistics cannot provide. In fact, there are no statistical calculations involved in this report. The goal is to identify the features that are bad and by how much.



The standard print dialog box is changed to include a sorting method and a print option.

Sort By

You have two choices for sorting the data in your report. You can either sort the data in ascending alphabetical order by the dimensions label or ascending numeric order by the dimension number. This will not affect the data, just the order in which the data is printed.

Print

You have two choices for the contents of the data in your report. You can either show all of the dimensions selected in the file or just the dimensions selected that have bad parts. The report is printed after clicking **OK**.

Report With Filtered Data

QC-CALC allows you to filter certain information from the file based on a filter set by you in the **Tools – Options – Filter Settings** menu. All filter information used is printed on the default report. If you want to use a filter, you must setup and activate it before using this report option.

Sample Output of a Non-Conformance Report

Prolink	Non-Conformance Report	August 28, 2009 5:42:7 p
Prolink, Inc.		
Sample.qcc		All went well today
Total Dims in File	20	Bruce
Dimensions Selected	20	Nothing to say
Number of Bad Dims	16	
Records Selected	100	
Total Records in File	100	

Qty Rej	Dimension Label	Description				Acc/Rej
3	X Hole Position	Nominal +/- =	1.0000	0.0010	-0.0010	
	Dim 1	LSL/USL =	0.9990		1.0010	
		Actuals OUT =	0.9989	To	1.0011	() ()
		Actuals ALL =	0.9989	To	1.0011	
		Under Tol By =	-0.0001	& Over By =	0.0001	
3	Y Hole Position	Nominal +/- =	2.0000	0.0020	-0.0020	
	Dim 2	LSL/USL =	1.9980		2.0020	
		Actuals OUT =	2.0020	To	2.0024	() ()
		Actuals ALL =	1.9981	To	2.0024	
		Over Tol By =	0.0000	To	0.0004	
2	Z Hole Position	Nominal +/- =	3.0000	0.0030	-0.0030	
	Dim 3	LSL/USL =	2.9970		3.0030	
		Actuals OUT =	3.0033	To	3.0043	() ()
		Actuals ALL =	2.9972	To	3.0043	
		Over Tol By =	0.0003	To	0.0013	
5	Line Length	Nominal +/- =	4.0000	0.0040	-0.0040	
	Dim 4	LSL/USL =	3.9960		4.0040	
		Actuals OUT =	3.9945	To	4.0047	() ()
		Actuals ALL =	3.9945	To	4.0047	
		Under Tol By =	-0.0015	& Over By =	0.0007	
3	Datum 1	Nominal +/- =	5.0000	0.0050	-0.0050	
	Dim 5	LSL/USL =	4.9950		5.0050	
		Actuals OUT =	4.9942	To	5.0059	() ()
		Actuals ALL =	4.9942	To	5.0059	

No Filter Active

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Report - Reference Section

Report Content

Introduction

The table contents in the report are explained below. Although the template is editable by you, only the test surrounding the table is changeable. It is possible to move or delete columns from the table, but necessary information will appear out of order or be missing completely.

Qty Rej

This is the total number of records that contained measurements outside of the specification limits.

Dimension Label

This is the label for the reported feature you typed during the file creation process or that was transmitted from an automatic inspection gage.

Description

The description area has 5 possible items, which describe the numbers that appear in the following three columns.

Nominal +/-

This row contains three numbers, the nominal, plus tolerance, and minus tolerance. These numbers were taken from the active database for each feature.

LSL/USL

These two numbers are the Lower Specification Limit and the Upper Specification limit of the feature.

Actuals OUT

These two numbers display the range of all numbers over or under tolerance. If the out of tolerance values are all above the positive limit then the range is the difference between those values. If the out of tolerance values are all under the lower limit then the range is the difference between those values.

Actuals ALL

These two numbers display the total range of ALL numbers reported.

Over/Under Tol by

This depicts the amount the numbers were OVER or UNDER tolerance by.


Acc/Rej

() () Space for you to check either accept or reject.

9.17.2 Stat Summary

Introduction

At times, statistical calculations in table form can be more important than the graphical form. When graphs are not needed and a summary is what you want, use the **Stat Summary Report**. The contents of this report can be customized to present the information as you desire. The left edge of the report lists your features (dimensions) and the column headings list the calculation type.



Statistical Summary Report

August 28, 2009
5:50:58 p

Sample qcc

Num. Dimensions: 20
Subgroup Size: 2
of Subgroups: 50

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Dim	Dimension Label	Nom \ + Tol \ - Tol	Average	Range	Max	Min	Sigma	Cp	Cpk	Cp.R	Cpk.R
1	X Hole Position	1.0000 \ 0.0010 \ -0.0010	0.9999	0.0022	1.0011	0.9989	0.000498	0.67	0.60	0.60	0.67
2	Y Hole Position	2.0000 \ 0.0020 \ -0.0020	2.0000	0.0043	2.0024	1.9981	0.000994	0.67	0.67	0.67	0.84
3	Z Hole Position	3.0000 \ 0.0030 \ -0.0030	2.9999	0.0071	3.0043	2.9972	0.001550	0.65	0.62	0.61	0.58
4	Line Length	4.0000 \ 0.0040 \ -0.0040	4.0000	0.0101	4.0047	3.9945	0.001951	0.68	0.68	0.67	0.67
5	Datum 1	5.0000 \ 0.0050 \ -0.0050	5.0000	0.0116	5.0059	4.9942	0.002396	0.70	0.69	0.71	0.71
6	Datum 2	6.0000 \ 0.0060 \ -0.0060	5.9998	0.0176	6.0083	5.9908	0.003260	0.61	0.60	0.60	0.55
7	Datum 3	7.0000 \ 0.0070 \ -0.0070	7.0002	0.0171	7.0082	6.9911	0.003482	0.67	0.65	0.66	0.64
8	Datum 1 - Datum 2	8.0000 \ 0.0080 \ -0.0080	8.0003	0.0194	8.0122	7.9927	0.004058	0.66	0.63	0.63	0.64
9	Chamfer Angle	9.0000 \ 0.0090 \ -0.0090	9.0000	0.0279	9.0126	8.9947	0.005174	0.58	0.58	0.57	0.57
10	Snape Dia	10.0000 \ 0.0100 \ -0.0100	10.0031	0.1598	10.1500	9.9902	0.019882	0.17	0.12	0.35	0.74
11	Overall Length	11.0000 \ 0.0110 \ -0.0110	11.0000	0.0242	11.0131	10.9989	0.004940	0.74	0.74	0.74	0.77
12	Ring length	12.0000 \ 0.0120 \ -0.0120	11.9999	0.0352	12.0195	11.9943	0.006402	0.62	0.62	0.62	0.61
13	Thread Pitch	13.0000 \ 0.0130 \ -0.0130	12.9994	0.0320	13.0134	12.9814	0.006210	0.70	0.67	0.67	0.66
14	OD Fit	14.0000 \ 0.0140 \ -0.0140	13.9992	0.0289	14.0129	13.9840	0.006917	0.67	0.63	0.63	0.68
15	Functional Size	15.0000 \ 0.0150 \ -0.0150	15.0009	0.0351	15.0194	14.9843	0.007285	0.69	0.64	0.64	0.78
16	Bond thickness	16.0000 \ 0.0160 \ -0.0160	15.9998	0.0479	16.0191	15.9712	0.007803	0.68	0.68	0.70	0.69
17	ManDimension 1	1.5216 \ 1.2931 \ -1.2931	1.5216	1.0000	1.9800	0.9800	0.261923	1.65	1.65	2.00	2.00
18	ManDimension 2	2.5351 \ 0.9727 \ -0.9727	2.5351	0.8300	2.9600	2.1300	0.213624	1.52	1.52	1.69	1.69
19	X Hole Position x 2	1.9998 \ 0.0041 \ -0.0041	1.9998	0.0044	2.0023	1.9978	0.000985	1.38	1.38	1.37	1.37
20	Y Hole Position x 2	4.0000 \ 0.0097 \ -0.0097	4.0000	0.0086	4.0047	3.9962	0.001988	1.63	1.63	2.04	2.04

No filter active.

9.17.3 Other Reports

The QC-CALC Real-Time reports use a different report system and they are included in the QC-CALC SPC reports. They are used to generate Raw Data Reports, Stat Reports, Plot Reports and both one-part/multiple-part First Article Reports. To use the Real-Time reports in the QC-CALC SPC simply choose menu **Report – Other** and the familiar dimension selectors is displayed.

Make your choice of dimension to report and click the **OK** button. The QC-CALC Real-Time print dialog box is displayed. Follow the instructions in the Real-Time training manual.

10. Gage Repeatability and Reproducibility

10.1 Introduction

A Gage Repeatability and Reproducibility Study is a method of determining the suitability of a gage or gauging system for measuring a particular process. Every measurement taken has some error associated with it, and if this error is large compared to the allowable range of values (the tolerance band), the measuring device will frequently accept bad parts and reject good ones. It will also cause control limits to be incorrectly set because the variability of the measurement device is added to the variability of the process under study.

QC-CALC uses Numeric FACTORS 1, 2, & 3 to identify the **Part**, **Trial**, and **Operator Number** respectively. You are required to enter these values if this study is not using an automatic gage. If you are testing a CMM or automated data collection device, please see the GR&R Wizard in QC-CALC Real-Time. It will save you a lot of time.

10.2 Creating a Gage R&R Database

To create a Gage R & R database for manual gages follow the steps below.

1. Create a database with the **File - New** menu. For full details of file creation, please refer to [Creating New Files](#) on page 81.
2. Perform your study by inspecting the parts and enter the data in each cell and the FACTOR values as shown in the table below. Refer to [How to Conduct a GR&R Study](#) on page 57 for more details.

10.2.1 Database Format for a Gage R&R Study

Since QC-CALC performs gage studies on a variable amount of data, the following **.QCC** example file shows what your data might look like if you measured 2 features on 4 parts with 2 operators and 3 trials.

No.	Feature 1	Feature 2	(Factor 1)	(Factor 2)	(Factor 3)
			Part	Trial	Operator
0001	0.0116	217.0	1	1	1
0002	0.0121	220.0	2	1	1
0003	0.0116	217.0	3	1	1
0004	0.0114	214.0	4	1	1
0005	0.0115	216.0	1	2	1
0006	0.0115	216.0	2	2	1
0007	0.0116	216.0	3	2	1
0008	0.0112	212.0	4	2	1
0009	0.0116	216.0	1	3	1
0010	0.0118	218.0	2	3	1
0011	0.0116	216.0	3	3	1
0012	0.0112	212.0	4	3	1
0013	0.0114	216.0	1	1	2
0014	0.0115	216.0	2	1	2
0015	0.0116	216.0	3	1	2
0016	0.0116	216.0	4	1	2
0017	0.0119	219.0	1	2	2
0018	0.0116	216.0	2	2	2
0019	0.0115	215.0	3	2	2
0020	0.0112	212.0	4	2	2
0021	0.0120	220.0	1	3	2
0022	0.0120	220.0	2	3	2
0023	0.0116	216.0	3	3	2
0024	0.0112	212.0	4	3	2

10.3 Creating a Gage R & R Report

Now that you have entered the individual readings for each part measured along with the Part, Trial, & Operator numbers in QC-CALC's FACTORS 1, 2, & 3 to tag each measurement, you can perform the report as follows:

1. Select menus **Report – Gage R & R Report – Create Gage R&R Report** from the menu.
2. Select the dimension(s) to study. One report is generated for each dimension selected.
3. Fill in the **Gage R&R Report Header Info** used in the report.
4. Answer the "**Allow outlier delete?**" confirmation box.

Note: Removing outliers gives you a method removing a bad reading when it is accidentally added to the data set. However, if too many outliers are removed you may not have enough data to complete the gage study.

5. Your first dimension is presented in an on-screen report.
6. Click the **Print** button on the on-screen report to print a copy of the report. Refer to the [Print Dialog Box](#) on page 27 for more details.
7. If you want to save the report as a simple text file, clicking the **Save to File** button invokes a File dialog box, which prompts you for a file name. Specify a directory to save the file to and click **Save**.

10.3.1 Gage R&R Report Header Info

Your answers to these questions, along with the Feature Label for each dimension are used in the header of the report. These answers are saved for each .QCC file and can be edited by using the **Report - Gage R & R - Edit Gage R & R Notes**.

10.3.2 Setting FACTORS

The GR&R requires numeric FACTORs 1, 2, and 3 to contain the part number, trial number, and operator number respectively. In many inspection machines FACTOR values can be sent with the inspection data. If the FACTORs are not set during inspection they can be changed in the edit screen.

FACTOR 1 is used for the part number, FACTOR 2 is used for the trial number, and FACTOR 3 is the operator number. QC-CALC looks for the largest number in each column of FACTORs and considers the number of parts, trials, and operators respectively, so don't skip any numbers. If a database contains an operator 1 and an operator 3 but no operator 2 the study will not be conducted because all parts are missing operator 2's measurements. Similarly, if a part is missing any measurement, that part is not used.

Remember, record number refers to position in the database and part number refers to the number in FACTOR 1 which is also the number scribed on each part before starting the study. The minimum number of parts, trials, and operators is 2, 2, and 2. The maximum number of parts, trials, and operators is 20, 3, and 3 respectively. All combinations of these limits are valid.

10.3.3 Allow outlier delete confirmation box

Answering "Yes" means any parts that exceed the calculated range control limits are not used in the study, "No" means the parts are used in the study but a warning message is printed indicating what parts exceed control limits and "Cancel" aborts the report and returns to the **Main** menu. If outliers are deleted the control limits are recalculated. This process is repeated until no parts exceed control limits.

10.3.4 Edit Gage R & R Notes

This menu option is used to change the labels and values for the Gage R & R reports. The values shown on this screen are shown in the header area of the reports, so can send different values to the standard and custom reports. Both

the labels and the values are sent to the Standard report and the ASCII file, but only the values are sent to the Custom reports.

10.3.5 Example Reports

The following example report shows is a full report for one dimension.

February 21, 2006
 3:00:37 p

Gage R and R Report

Prolink Software Study Date May 6, 2005

Performed by Bruce Gage Type Zeiss Gage Size Big Gage Number 999	File Name = Grr-test_GRR.QCC Dimension Name = Circle diameter Dimension Number = 1 Tolerance = 0.0020
---	--

Overall Part Average = 1.0000083	Average Range = 0.0000244	K1 = 4.480
Range of Part Average = 0.0000172	Total Variation = 0.0001154	K2 = 2.694
Max Operator Average = 1.000014	Upper Ctrl Limit = 0.0000797	K3 = 2.076
Min Operator Average = 1.000001	Lower Ctrl Limit = 0.0000000	D3 = 0.000
Operator Avg Diff. = 0.000013		D4 = 3.267

Raw	Variation = 0.0001154	Tolerance = 0.0020
Part Variation = 0.0000358	30.9766%	PV = 1.7877%
Repeatability = 0.0001093	94.7081%	EV = 5.4656%
Reproducibility = 0.0000097	8.4160%	AV = 0.4857%
Gage R & R = 0.0001097	95.0813%	GRR = 5.4872%

Oper. #	Part #	Trial 1	Trial 2	Average	Range	Part Avg.
1	1	1.00002	1.00001	1.000013	0.0000150	
1	2	0.99999	1.00002	1.000004	0.0000323	
1	3	0.99997	1.00002	0.999999	0.0000486	
1	4	0.99996	1.00003	0.999997	0.0000710	
1	5	0.99999	0.99999	0.999991	0.0000048	
1	Avg	0.99999	1.00001	1.000001	0.0000343	
2	1	1.00002	1.00000	1.000012	0.0000221	
2	2	1.00002	1.00000	1.000009	0.0000233	
2	3	1.00003	1.00000	1.000011	0.0000280	
2	4	1.00003	1.00003	1.000028	0.0000069	
2	5	0.99998	1.00000	0.999990	0.0000128	
2	Avg	1.00002	1.00000	1.000010	0.0000186	
3	1	1.00003	1.00000	1.000013	0.0000355	1.000013
3	2	1.00004	1.00003	1.000035	0.0000089	1.000016
3	3	1.00001	1.00004	1.000026	0.0000260	1.000012
3	4	0.99997	1.00000	0.999982	0.0000309	1.000003
3	5	1.00002	1.00002	1.000015	0.0000000	0.999999
3	Avg	1.00001	1.00002	1.000014	0.0000203	1.000008

* Out of Control

Page - 1

10.3.6 Multiple Reports

You can optionally print a multiple dimensional report with 10 dimensions per page by checking the Multiple Plots on the print dialog box. This saves paper but in this format there is no room for supporting raw data, only the calculated results.

The details of one feature are seen here in a larger view

Circle diameter			
Sample Gage R&R_GRR.QC(		January 26, 2005	
Dim 1		Number of Parts	9
Type	Zeiss	USL	1.0010
Size	Very Large	Nominal	1.0000
Number	12B	LSL	0.9990
By	B Bruce	Part Average	1.0000
Operators	3	PV Part Variation	1.77%
Trials	3	EV Repeatability	5.06%
		AV Reproducibility	1.14%
		Gage R&R	5.19%

<table border="1"> <tr><td colspan="4">Circle diameter</td></tr> <tr><td colspan="2">Sample Gage R&R_GRR.QC(</td><td colspan="2">January 26, 2005</td></tr> <tr><td>Dim 1</td><td></td><td>Number of Parts</td><td>9</td></tr> <tr><td>Type</td><td>Zeiss</td><td>USL</td><td>1.0010</td></tr> <tr><td>Size</td><td>Very Large</td><td>Nominal</td><td>1.0000</td></tr> <tr><td>Number</td><td>12B</td><td>LSL</td><td>0.9990</td></tr> <tr><td>By</td><td>B Bruce</td><td>Part Average</td><td>1.0000</td></tr> <tr><td>Operators</td><td>3</td><td>PV Part Variation</td><td>1.77%</td></tr> <tr><td>Trials</td><td>3</td><td>EV Repeatability</td><td>5.06%</td></tr> <tr><td></td><td></td><td>AV Reproducibility</td><td>1.14%</td></tr> <tr><td></td><td></td><td>Gage R&R</td><td>5.19%</td></tr> </table>	Circle diameter				Sample Gage R&R_GRR.QC(January 26, 2005		Dim 1		Number of Parts	9	Type	Zeiss	USL	1.0010	Size	Very Large	Nominal	1.0000	Number	12B	LSL	0.9990	By	B Bruce	Part Average	1.0000	Operators	3	PV Part Variation	1.77%	Trials	3	EV Repeatability	5.06%			AV Reproducibility	1.14%			Gage R&R	5.19%	<table border="1"> <tr><td colspan="4">Circle X</td></tr> <tr><td colspan="2">Sample Gage R&R_GRR.QC(</td><td colspan="2">January 26, 2005</td></tr> <tr><td>Dim 2</td><td></td><td>Number of Parts</td><td>10</td></tr> <tr><td>Type</td><td>Zeiss</td><td>USL</td><td>2.0002</td></tr> <tr><td>Size</td><td>Very Large</td><td>Nominal</td><td>2.0000</td></tr> <tr><td>Number</td><td>12B</td><td>LSL</td><td>1.9998</td></tr> <tr><td>By</td><td>B Bruce</td><td>Part Average</td><td>2.0000</td></tr> <tr><td>Operators</td><td>3</td><td>PV Part Variation</td><td>11.66%</td></tr> <tr><td>Trials</td><td>3</td><td>EV Repeatability</td><td>33.26%</td></tr> <tr><td></td><td></td><td>AV Reproducibility</td><td>7.73%</td></tr> <tr><td></td><td></td><td>Gage R&R</td><td>34.00%</td></tr> </table>	Circle X				Sample Gage R&R_GRR.QC(January 26, 2005		Dim 2		Number of Parts	10	Type	Zeiss	USL	2.0002	Size	Very Large	Nominal	2.0000	Number	12B	LSL	1.9998	By	B Bruce	Part Average	2.0000	Operators	3	PV Part Variation	11.66%	Trials	3	EV Repeatability	33.26%			AV Reproducibility	7.73%			Gage R&R	34.00%
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10.4 Gage Repeatability and Reproducibility Background

At the beginning of this section we discussed how to use QC-CALC's version of GR&R. In this section we will provide you some background information and theory about the concepts of GR&R studies.

10.4.1 Why You Need GR&R

A Gage Repeatability and Reproducibility Study gives the following benefits:

- Help choose the proper type of gage for a quality control program
- Show when gages are beginning to wear
- Pinpoint sources of error in a quality control program
- Allow faster detection of an "out of statistical control" condition

10.4.2 When to Use GR&R

To realize the benefits of GR&R, a gage Repeatability and Reproducibility Study should be conducted when:

1. An SPC program is first being implemented. Several gages may be studied and the R&R will give a quantitative comparison of the "Quality" of the gages that, along with price, maintenance considerations, etc., will determine the best gage for the job.
2. Periodically to detect gage wear, establish or confirm maintenance schedules, detect damaged gages, confirm operator technique and to verify that the control limits on a process are as tight as they can be (thereby detecting assignable causes of variation as early as possible).
3. When the process being measured has gone out of control and the cause is not apparent, it is possible the process is in control and the gage or operator technique is introducing the error.
4. When a new fixture is being designed, a few hours spent conducting a gage study can save many hours of lost productivity.
5. Whenever you purchase a new gage you should require the supplier to furnish a GR&R report with the hardware. It may make sense to obtain a study during the quoting process. It may help you to select the right gage at the right price.

10.4.3 What GR&R Tells You

A Gage Repeatability and Reproducibility Study conveys 6 basic pieces of information. They are:

- Part variation
- Repeatability and reproducibility
- Repeatability
- Reproducibility
- Percent of total variation
- Percent of tolerance

Part Variation

Part Variation is a measure of how much the process is actually varying. If an infinite number of parts made by this process were measured using an Ideal Gage, 99.0% (5.15 sigma) of the parts would be within an interval Part Variation wide. This is only an estimate. This is important because unless the part variation is large compared to the gage variation (the R&R) the assumption that the sample (observed) standard deviation is approximately the same as the population standard deviation is not valid.

Note: The part variation is always less than or equal to the total variation. If the observed process is well within specification limits (and the Cpk is good) but the Part Variation is not large compared to the R&R, your process is better than it seems. Because of this condition, the resultant SPC information is not as useful or beneficial as it would be with more precise gages.

Repeatability and Reproducibility (R&R)

Repeatability and Reproducibility is a measure of the total variance caused by the gaging system as opposed to the manufacturing process. This number, expressed as a percentage of tolerance, is the most important "warning flag". If R&R is a large percentage of total variation but not a large percentage of tolerance, both the gage and the process are good and the process standard deviation is even smaller than it appears (meaning the process spread is smaller and Cpk larger than reported). This also means a more precise gage would allow tighter control limits for earlier detection of loss of control. The following table shows typical interpretation:

% Of Tolerance	Interpretation
0 - 10%	Gage is suitable
10 - 30%	May be acceptable based on importance of the measured part, cost of gage repair, etc. look at R and R separately
Over 30%	Gage system needs improvement

Reproducibility

Reproducibility is a measure of operator difference. The most common cause of a poor (large) Reproducibility is insufficient operator training. A gage that is sensitive to different techniques or is difficult to use would also cause a large Reproducibility.

Repeatability

Repeatability is a measure of how much the gage readings vary when the same operator measures the same part several times. A large value might indicate gage wear, improper measurement policy (but all operators are making the same "mistake", it is not a matter of individual operator skill), or a gage without sufficient resolution or with a defect. This number is best used by comparing it with reproducibility.

Percent of Total Variation

These numbers are listed first as raw numbers, then as percentages of total variation and finally as percentages of tolerance. The percent of total variation shows how the variation is distributed. Note that these numbers are not supposed to add up to 100% (see equations in appendix). These numbers are most useful in pinpointing a problem or showing where to concentrate improvement efforts.

Percent of Tolerance

These numbers are also displayed as percentages of total tolerance. It is these numbers that most companies use to determine the usefulness of the gage or if improvement is necessary. As with percentage of total variation, the numbers will not total 100%.

10.5 How to Conduct a GR&R Study

Conducting a study for each type of part the gage will measure ensures accurate results but takes more time than conducting one study. If you want to study the gage with only one type of part (trade off some accuracy for speed), use the part dimension with the smallest tolerance spread.

1. Obtain 10 parts to be measured by the gage. The parts selected should be randomly selected from the manufacturing process. Sorting the parts to get parts close to the tolerance or examples of largest and smallest parts will skew the study. Picking 11 or 12 parts and measuring the extras with the 10 required for the study will allow a quick replacement of parts that happen to exceed the control limits.

2. Write a part program and measure all part features (characteristics) you wish to study. Be sure to add the tolerances for each characteristic. If you are creating a ".QCC" file manually, select **File – New Data File** and answer the Number of Dimensions question with the total number of features being measured on the part and add the nominals and tolerances.
3. Decide how many operators (2 or 3) will participate in the study and how many times each operator will measure each part (2 or 3 times). More trials and operators give more accurate results but take more time.
4. Using a Blind Sampling Technique, have each operator measure each part the specified number of times. Make sure the measurement considerations cited in the note below are carefully followed.
5. Run your part program and automatically collect data. If manually entering data enter the measurement data into the grid. Make sure the parts are in the proper order. If the computer running QC-CALC and the gage under test are near one another, you may enter the data into QC-CALC as the test is conducted. This will save rewriting and possible transposition errors.
6. If desired, select the **Edit Gage R & R Notes** option from the **Report** menu and customize the report header.
7. Select the **Create Gage R&R Report** option from the **Report** menu.
8. If desired, replace or re-measure any part that QC-CALC lists as out of control and repeat steps 5 through 7 (replace **all** readings from all operators for the questionable part). Parts that have one or more readings that exceed the calculated control limits will trigger a warning message. We recommend that you not use parts that exceed the control limits, but all calculations are still valid. If you measured more than 10 parts, you may substitute one of the extra parts for the part that exceeds the control limit, but be sure to make the substitution for all trials by all operators for that part (the entire row in the database).
9. If you used the **Save To File** button then View and/or print the report you saved to file with the View an ASCII File and Print an ASCII File options in the utilities menus, or use a word processor of your choice to edit and print the report.

10.6 Blind Sampling Technique

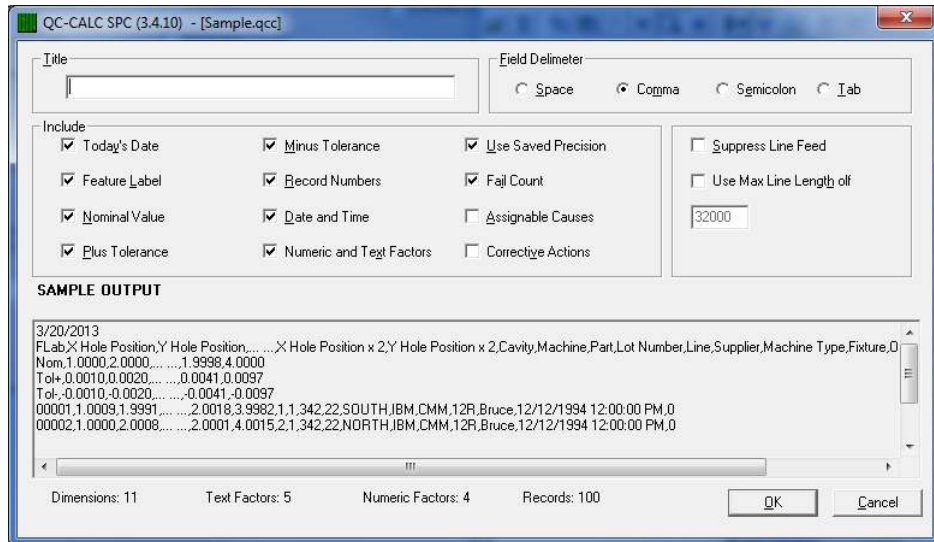
Obtain a blind sample by marking each part with a number 1 - 10 using a permanent marker, scribe, etc. Prepare 10 pieces of masking tape with the letters A - J. Pick the parts in a random order and cover each number with a piece of tape so the operator cannot read the number. Next have each operator measure each part and record the letter with the reading. Remove the tape from the parts one at a time and copy each operator's reading for that letter into the table for that part number. Put the tape back over the parts in a different order and repeat the measurements and recording procedure. This process keeps the operator's knowledge of previous readings from affecting his current reading.

All operators should measure each part in the same place each time. If the measurement in question is the diameter of a cylinder, mark the point on the circumference where the reading is to be taken. If the measurement is the thickness of a block, mark a point on the block for all operators to use. Make an exception to this rule if the gage is supposed to be finding the measurement point, i.e., a gage that finds the minimum thickness of a block.

11. Make an ASCII File

11.1 Introduction

The purpose of this option is to create an ASCII file from the QC-CALC database file. The ASCII file is used with other programs or printed using the **Tools - Edit or Print an ASCII File** command from the QC-CALC menu. When you choose this menu option the QC-CALC dimension selector is displayed and you choose which features to include in the output file.



When the dimensions are selected the form above is displayed. Using this screen, you specify the format of the ASCII file. The **Sample Output** display area at the bottom of the window shows a preview of the file you are creating. It is used only for previewing purposes not for editing. When you are satisfied with the file format click **OK** to continue or **Cancel** to abort.

A file dialog is displayed next to where you give the output file a name. The available file extensions are “.txt”, “.asc”, or “.csv”. If you wish to create a file to import into Microsoft Excel, use a file extension of .CSV for comma separated values. Be sure to use a comma for the field separator.

Title (Optional)

You can type any string here to be used to identify the output file contents. It is written to record 1 of the file.

Field Separator

Choose either a space (), comma (,), semicolon (;), or ^t (TAB). QC-CALC will use this separator as a marker to determine the beginning and the end of each data field.

If the space character is chosen as a separator, QC-CALC will change all spaces found in any of your titles & labels to underscores (_). This is required since it is assumed the program reading the file will confuse these extra space characters as field separators.

Include Today's Date

Checking this box causes the current date to be recorded at the top of the data file. The data associated with each data record is unaffected either way.

Include Feature Label

Checking this box will cause the feature labels specified at file creation to appear at the top of each column of numbers.

Include Nominal Value

When this box is checked the Nominal values for each selected feature appear under the labels or top of each column of numbers. This reminds you of target or expected value and may be useful with other programs.

Include Plus Tolerance

When this box is checked, the plus tolerance value for each selected feature appears under the nominal in your output file.

Include Minus Tolerance

When this box is checked, the minus tolerance values for each selected feature appears under the Plus Tol in your output file.

Include Record Numbers

Checking this box causes the record numbers to output on the left side of each record. You may want this reference number to determine where you are in the list at any time.

Include Date & Time

Checking this box causes the date & time for each record to be passed to the output file. It is found in the right most columns.

Include Numeric and Text Factors

Checking this box causes both Numeric and Text Factors to be included in output file.

Use Saved Precision

This option formats the output data according to the number of digits to the right of the decimal point as specified in the Nominal section. An unchecked box produces raw, unformatted numbers. Since round off occurs with formatted numbers, you might consider leaving this box empty. However, when formatted numbers are used, the column of numbers will line up uniformly.

Include Fail Count

When this box is checked, the count for the number of fails for each record appears at the end of each row of data values.

Include Assignable Causes

When this box is checked, a reference number is exported which is a code for the description of the assignable cause in the default assignable cause file in your system. This file should be a common file through out your company for the reference number and the assignable cause description to match in any computer.

Include Corrective Actions

When this box is checked, a reference number is exported which is a code for the description of the corrective action in the default corrective action file in your system. This file should be a common file through out your company for the reference number and the corrective action description to match in any computer.

Suppress Line Feed

Checking this box causes each record to terminate with a Carriage Return (CR) as opposed to Carriage Return/Line Feed (CRLF).

Use Max Line Length of

Type the maximum length of the records in your file. The maximum length allowed by QC-CALC is 32000 characters. If this file will be printed on a printer, reduce this number to ensure that the printer won't wrap.

11.2 ASCII Output Example

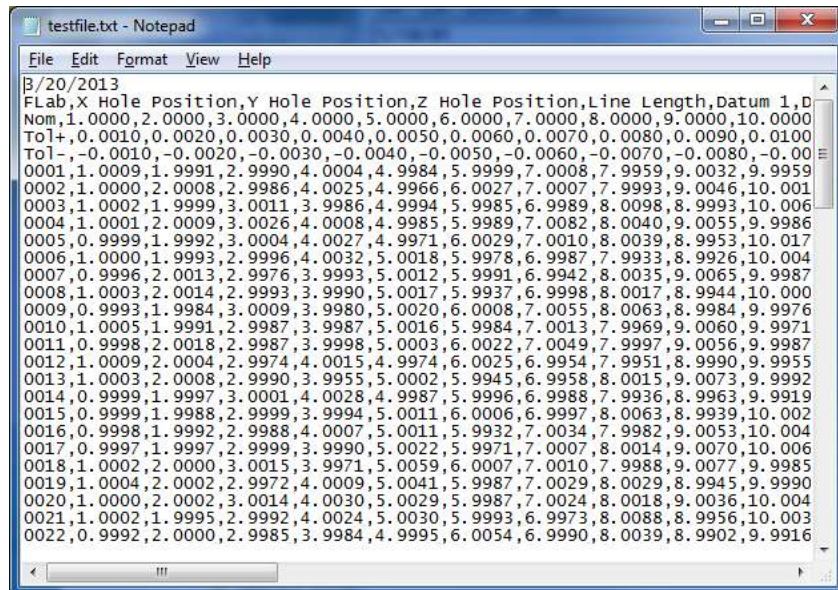
This file was created with the choices shown in the figure below. Note that line 2 contains an optional title; line 3 contains the Feature label; line 4, 5 & 6 have the Nominal, Plus and Minus tolerance; and the data starts on line 7. The record numbers on the left of the data indicate only eleven parts were stored in the database.

```
2/23/01
Sample ASCII file
FLab,X Offset X Cl,Y Offset Y Cl,Diameter D Cl,Date,Fails
Nom_,1.0000 ,2.0000 ,3.0000 ,
Tol+,0.0400 ,0.0400 ,0.0100 ,
Tol-, -0.0400 , -0.0400 , -0.0100 ,
00001,1.0127 ,1.9080 ,2.9196 ,11/24/92 5:00:00 PM,3
00002,0.9487 ,2.0022 ,3.0210 ,11/24/92 5:00:00 PM,3
00003,0.9758 ,2.0280 ,3.0107 ,11/24/92 5:00:00 PM,2
00004,1.0100 ,2.0047 ,3.0033 ,11/24/92 5:00:00 PM,2
00005,0.9998 ,2.0204 ,3.0003 ,11/24/92 5:00:00 PM,1
00006,1.0025 ,2.0168 ,3.0016 ,11/24/92 5:00:00 PM,2
00007,0.9957 ,2.0290 ,3.0002 ,11/24/92 5:00:00 PM,3
00008,0.9885 ,2.0325 ,2.9995 ,11/24/92 5:00:00 PM,2
00009,1.0038 ,2.0197 ,2.9994 ,11/24/92 5:00:00 PM,1
00010,1.0095 ,2.0182 ,3.0007 ,11/24/92 5:00:00 PM,2
```

12. Edit or Print an ASCII File

12.1 Introduction

You use this option to display ASCII files created by the **Tools – Make ASCII File** option. This allows you to view the contents of the file you created before printing it or sending it to another software package. Since QC-CALC uses the Windows Notepad program, you may set up your page layout, select the system printer or add minor formatting to the file. Print the file by selecting **File – Print** from Notepad. This option will display any file with a file extension name of .ASC, CSV, or TXT.



13. Import ASCII File

13.1 Introduction

The purpose of this option is to import data from an ASCII text file and append the data to an existing or new QC-CALC database. The source of the ASCII file can be any program capable of saving characters in a delimited row/column format. This section describes the format of the ASCII file and how to use each screen as it appears.

13.2 Before You Begin...

You must create a new QC-CALC database before importing data. This procedure called [Creating New Files](#) is found on page 83. The most important answer is the number of dimensions to add into the database. The number of dimensions is equal to the number of columns in your ASCII. If your ASCII file contains nominals and tolerances you will not have to enter them by hand as mentioned in the file creation process. It is assumed you have reviewed your ASCII file and know the number of columns. Future versions of QC-CALC will perform this function automatically.

13.3 The ASCII File Format

An ASCII text file that is to be read into QC-CALC must have a particular format. The inspection machine or any spreadsheet program, such as Microsoft Excel, may generate these plain text files.

13.3.1 Spreadsheet Sample

Below is an example of how a typical spreadsheet program will display the ASCII file data. QC-CALC stores this data in much the same way. For example, let's say this spreadsheet represents one kind of part called a 'Widget'. This 'Widget' has different features that need to be inspected and are identified by the Feature Labels in row 4. Notice how row 4 stores all of the Feature Labels for the 'Widget', identifying each dimension to be inspected.

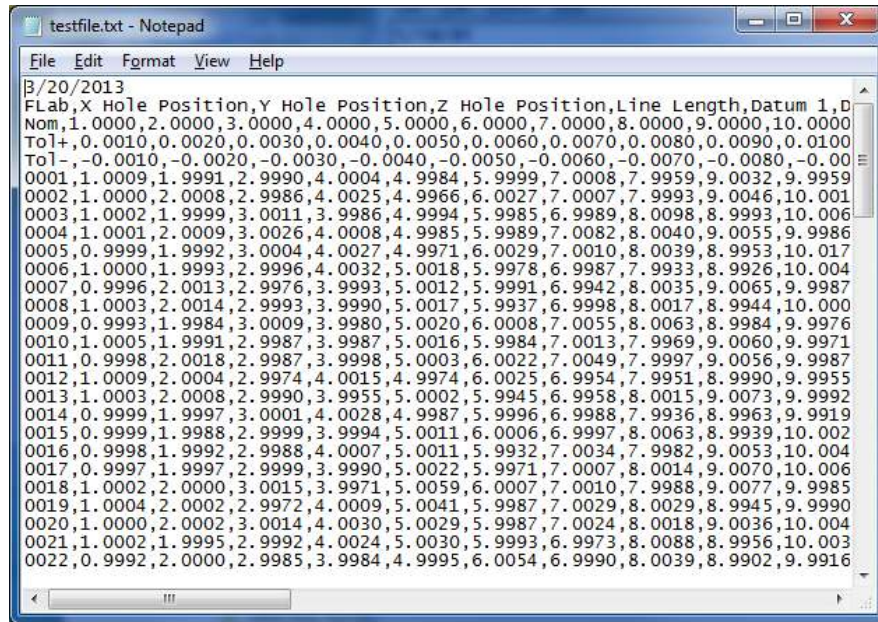
	A	B	C	D	E	F	G
1							
2	Standard Sample File						
3	QC-Calc 2.0						
4	FLab	X Hole Position	Y Hole Position	Z Hole Position	Line Length	Datum 1	Datum 2
5	Nom	1	2	3	4	5	6
6	Tol+	0.001	0.002	0.003	0.004	0.005	0.006
7	Tol-	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006
8	1	0.9989	1.9985	3.0024	4.0001	5.0049	6.0006
9	2	1.0003	2.0002	2.9981	4.0002	5.0003	6.0009
10	3	0.9998	2.0003	3.0009	3.9992	5.0006	6.0083
11	4	0.9996	1.9998	2.9999	3.999	4.9977	5.9974
12	5	0.9996	1.9991	3.0006	3.9998	5.0043	6.0002
13	6	0.9998	2	2.9985	3.9996	4.996	5.9995
14	7	1.0005	2.0007	3.0011	4.0017	5.0003	6.0029
15	8	0.9993	2.0004	3.001	3.9973	4.9981	5.9945

The Nominal value for each feature of the 'Widget' is stored in row 5, the Plus Tolerance in row 6, and the Minus Tolerance in row 7. The remaining rows, beginning at row 8, are inspection data. Each data row (also referred to as a record) contains the inspection results of a single 'Widget'. The ASCII data must be in column order (each feature is a column). QC-CALC does not read Excel spreadsheets directly,

13.3.2 ASCII Text File Sample

When the data is saved to an ASCII text file, the saving program usually removes the extra white space. Because of this, separators (also referred to as delimiters) must be inserted into each row where a column break occurs. In this way, when the ASCII text file is read back into a program such as QC-CALC, the program

can identify where a column starts and ends. This is an example of an ASCII text file, which is being viewed with Notepad, a simple text file editor.



13.3.3 Delimiters in the ASCII Text File

Any given row in the ASCII file needs to contain delimiters that signify to QC-CALC where one column ends and another begins. QC-CALC recognizes the following as delimiters: the comma (,), space (), TAB (^t), and semicolon (;).

If the space character is chosen as a delimiter, all spaces in your labels or titles must be an underscore (_) instead of a space, so that QC-CALC will not confuse these with column delimiters. For example, MY DIMENSION NAME becomes MY_DIMENSION_NAME. You will still need to use a space between each complete label to tell QC-CALC where the column breaks are located. We do not recommend using the space character.

13.3.4 Row Types in the ASCII Text File

The file may consist of different row types. The ASCII file may contain only data or may also contain information describing the data such as Feature Labels (descriptive names for the features), Nominals, and Tolerances. The ASCII file must be arranged in order where all Feature Labels, Plus Tolerances, Minus Tolerances, and Nominals (if any one or more of these exist) each take up their own single row. For example, if **Feature Labels** and **Nominals** are included in the file, then all of the Feature Labels will be in one row and all the Nominals will be in another row. The Data Records cannot come before any of the other row types and a single Data Record row contains all of the data for the inspection of one part.

13.3.5 Column Types

Each column in the QC-CALC database conforms to one of the following types:

1. **Data:** Representing the inspection results of each dimension there can be between 1 and 3000 columns depending on the number of features inspected on a particular part.
2. **Numeric FACTORS:** Are columns that can store additional numeric data that relates to the part being inspected. There can be between 0 and 15 columns of Numeric FACTORS.
3. **Text FACTORS:** Are similar to Numeric FACTORS. There can be between 0 and 15 columns of Text FACTORS containing alphanumeric data (alphabetic letters and numbers combined).
4. **Date:** Either the date or the date and time the part was inspected.
5. **Time:** The time the part was inspected.



Note: QC-CALC stores the date and time in one column of the database. If QC-CALC detects a separate **Time** column, it will automatically add the **Time** to the **Date** and show them both in a single column.

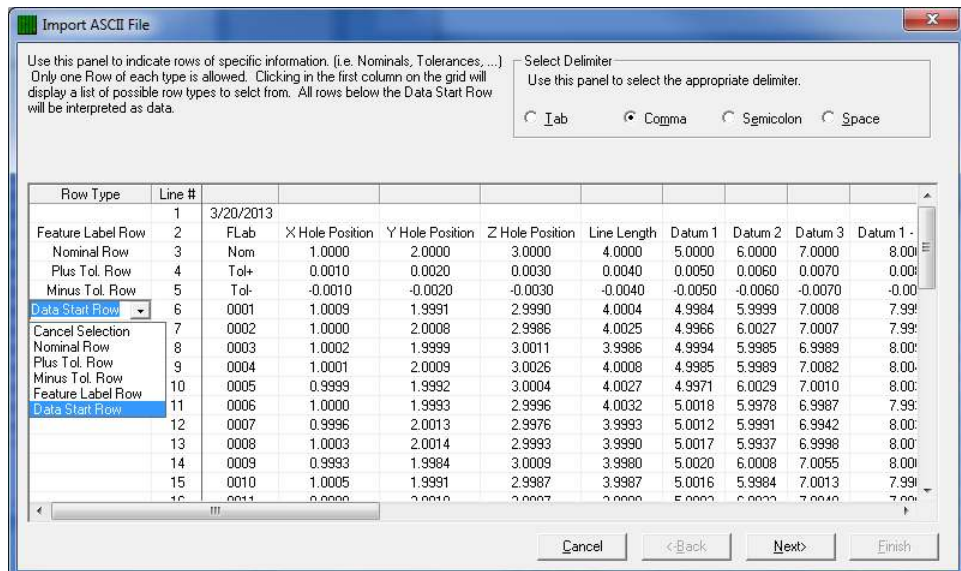
6. **Fails:** A column that represents the total number of out of tolerance dimensions found within that specific record. For example, if your part had 12 inspected features and 2 results were out of specification, Fails will contain a 2.

13.4 Importing an ASCII Delimited Text File

13.4.1 Selecting an ASCII File to Import

After you have created the database you wish to add data to, click on **Tools – Import ASCII File** from QC-CALC menu. You will see a window to select the ASCII file you would like to import. After you have selected the ASCII file, the next window that appears will walk you through the import process.

13.4.2 Screen One:



This window informs QC-CALC what kind of information is contained in each row and how it is separated. When this window appears, the first column (Row Type) is empty. At this point only the first 15 or so rows of data will be displayed.

Delimiter

First, select the **Delimiter** so data screen looks more organized. Once you tell QC-CALC how the columns are separated, it clearly displays the columns.

Selecting Row Types

Click in the first column (under the Row Type label) in a row containing information you would like to import. A list of possible row types will appear for you to select from. Only one of each row type may be used in the Row Type column. It is not necessary to import all of the different row types. If you make a mistake in your selection, simply click in that row again and choose **Cancel Selection** or select any other row type you want.

The **Data Start Row** must be the last selection in the Row Type column because QC-CALC assumes all rows following the **Data Start Row** contain data. With the exception of data rows, a row that does not have an assigned row type next to it will not be imported. Normally you will want to select the **Feature Label Row** and the **Data Start Row** as the Row Types to import. When you have finished selecting the Row Types, click the **Next >** button to go on to the next screen.

Nominal Row

If this row of Nominal values is imported it will overwrite the current Nominal values in the database. Do not select this row unless you want to replace the current Nominal values in the QC-CALC database.

Plus Tolerance Row

If Plus Tolerance values are imported they will overwrite the current Plus Tolerance values in the database. Do not select this row unless you want to replace the current Plus Tolerance values.

Minus Tolerance Row

If Minus Tolerance values are imported they will overwrite the current Minus Tolerance values in the database. Do not select this row unless you want to replace the current Minus Tolerance values.

Feature Label Row

This row should almost always be selected. QC-CALC will try to match these Feature Labels with the Feature Labels in the active database. Therefore, a new QC-CALC database will never have matching labels.

Data Start Row

This row and all rows following are assumed to be data. QC-CALC will not allow any other row types to follow the Data Start Row.

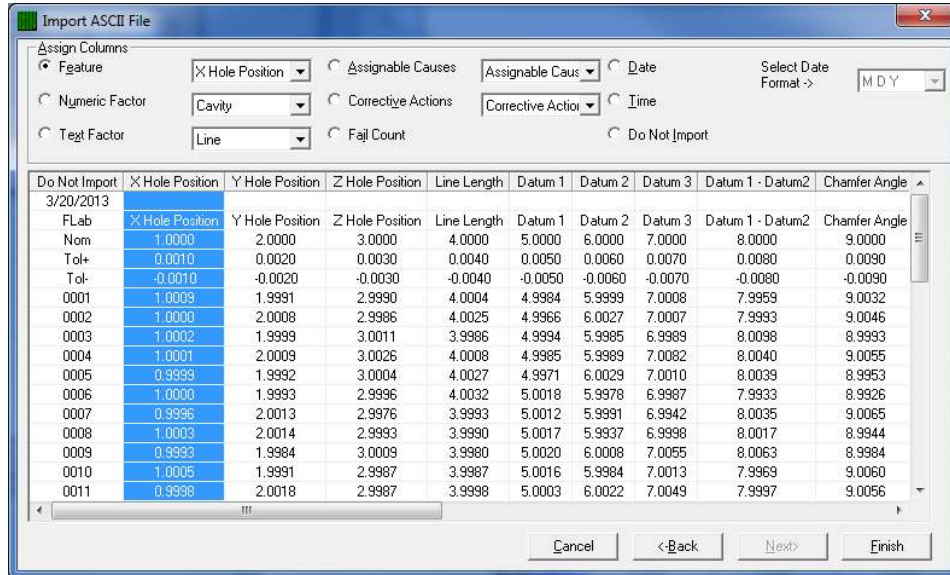


Note: All of the option buttons may not be available. QC-CALC disables those selections that are invalid delimiters for this ASCII file. Be aware that depending on the size of the file being imported, and the speed of the computer, it may take a few seconds to a few minutes before the third screen is shown.

13.4.3 Screen Two:

Specification of Column Types

This window is displayed after clicking the **Next >** button on the first screen. The purpose of this window is to identify the columns of the ASCII file. This is the final screen of the **Import ASCII File** process. When you arrive at this screen, one of the two following scenarios will apply:



The Database and ASCII File Structures are the Same

Usually, when you import data to a database, the ASCII file contains the same structure and format as the database (i.e. Feature Label names in the database match the Feature Label names in the ASCII file). If the database structure and the ASCII file structure are the same, and you have selected the Feature Labels row for import (Refer to [Screen One](#): on page 64), QC-CALC will match the Feature Labels in the database with the Feature Labels in the ASCII file.

When QC-CALC has been successful in matching these labels, it shows the names of the Feature Labels from the database in the header row (the top row) above the names of the Feature Labels from the ASCII file, giving you an indication that the database and the ASCII file contain the same information. When QC-CALC fails to match labels between the database and the ASCII file, the header row will contain the phrase "Do Not Import" above the Feature Labels in the Feature Label row.

The Database and ASCII File Structures are Different

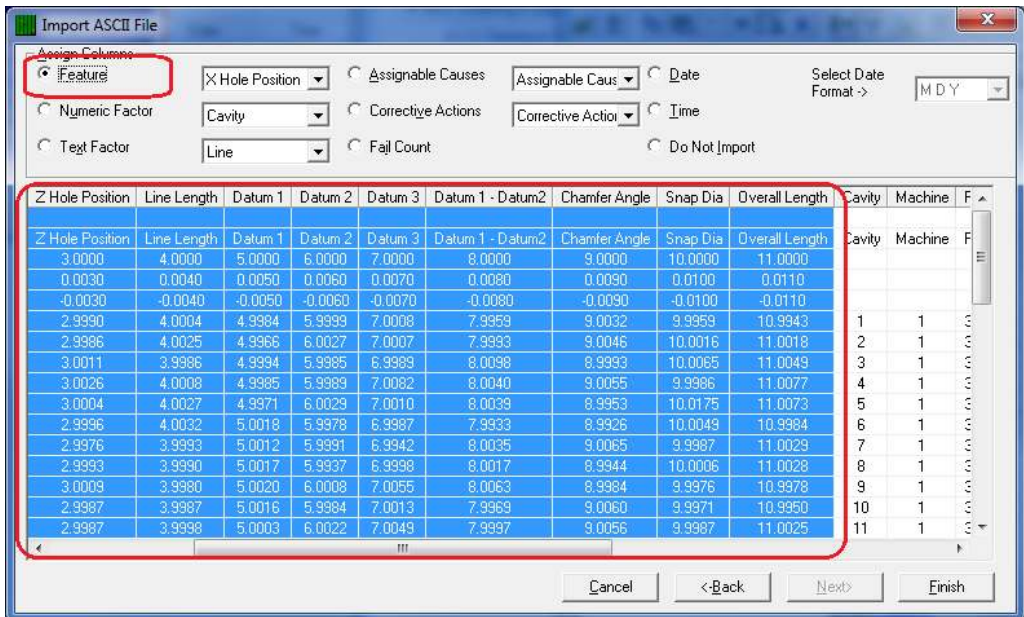
When the ASCII file and the active database have a different structure or when you have not imported the Feature Labels row, the header row will have the phrase "Do Not Import" above each column. This happens because QC-CALC is unable to match the Feature Labels in the database with the Feature Labels in the ASCII file. If this is the case, it will be necessary for you to associate each column with the correct Column Type and Feature Label from the **Assign Columns** area. To do this, perform the following three steps for each column you want to import:

1. Click in a column that you want to import and the column is highlighted.
2. Choose the type of data in the highlighted column from the **Assign Columns** area of the screen. For example, if you have a column containing data for a particular feature, click the **Feature** button.
3. For **Features**, **Numeric FACTORS**, and **Text FACTORS** choose the label for the matching area in the database. Click the dropdown list box

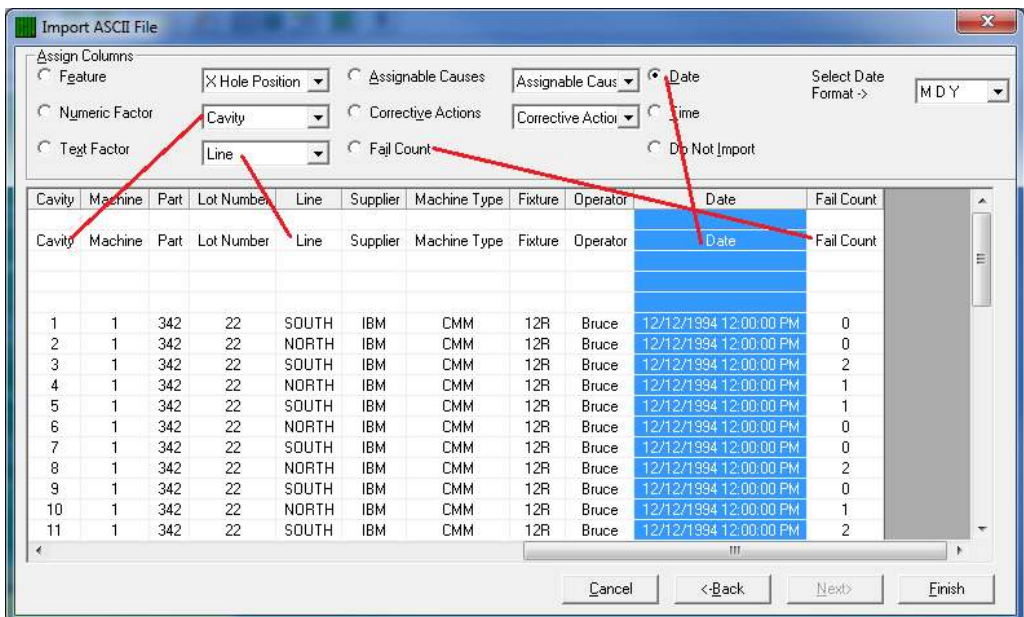
next to the button you have selected and choose the label from the list. For the **Date** column you will need to select the correct date format from the list. For example, **DMY** = Day, Month, Year; **YDM** = Year, Day, Month, etc.

Repeat these steps for each column you wish to import. The new column label appears in the header row (top row) as each new column is identified using the three steps above.

NOTE: To match all data columns in one operation, click into column 1 and select all data columns by dragging the mouse to the right until the far right side is reached. You may have to wiggle the mouse to force the scroll to move to the right-most column. Now that all columns are highlighted, click the **Feature** button and all labels are transferred into QC-CALC.



If the Date, Time, or Factor information is included as shown in the above figure, highlight each item and click the appropriate button to identify each column.



13.4.4 Click the Finish Button

After you have identified all the columns to import, click the **Finish** button to import the records from the ASCII file. This process may take some time depending on the processing speed of your computer, the size of the ASCII file, and the number of records you chose to import.

14. Assignable Cause & Corrective Action

14.1 Introduction

The QC-CALC database saves all the part data in one record and it includes other data such as the time & date, Factor values, and **Assignable Cause** and **Corrective Action** codes. These assignable causes are used to trace special events that occur to a part. The associated Corrective Actions explain what you did to fix the Cause. To create, select, or edit the Assignable Cause File, you select **Tools – Options – Assignable Cause / Action** menu.

Similar to the Assignable Cause, the **Corrective Action** allows you to say what you did to fix a problem. The QC-CALC database reserves space for tagging each part with 1 to 3 Corrective Actions. Use this option when a feature has been corrected with a known or identified Corrective Action. By assigning a Corrective Action to the part, you can track what was done to fix Assignable Causes.

You can add new Actions and modify old ones. The purpose of predefining Actions is to force consistent text when identifying corrections. For example you could say Replaced Tool or Tool Replaced. Once the Action is added you simply pick the Action from a list.

Note: Everything discussed in this section describes the Assignable Causes. Since the Corrective Actions operate the same we only discuss Assignable Causes. Please apply the same understanding to Corrective Actions.

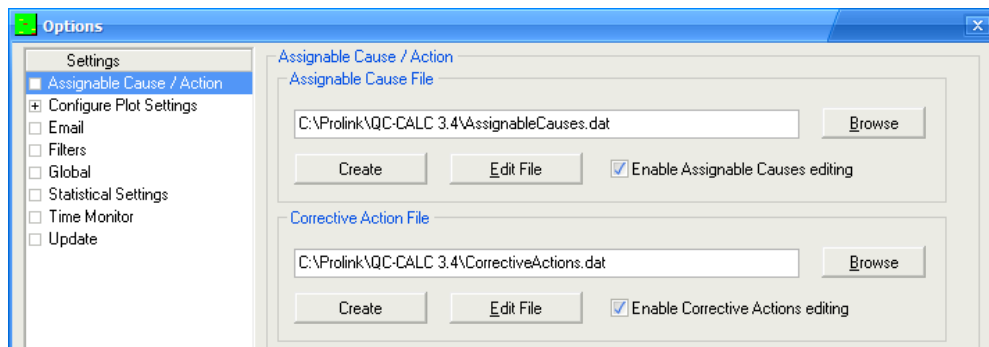
14.2 Set Assignable Cause File

14.2.1 Browse to File

QC-CALC uses two external text files to store your Assignable Cause and Corrective Action codes. These two files should be saved on a network server enabling all QC-CALC's to display a standard list of Causes. You choose the Assignable Cause file by clicking the **Browse** button.

14.2.2 Create New File

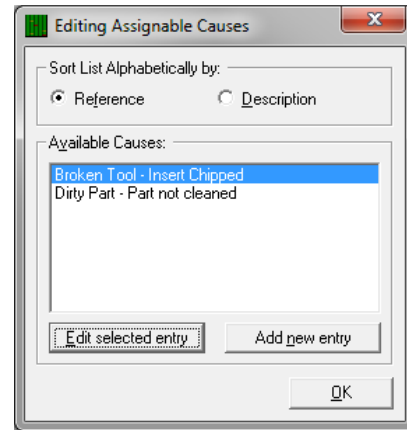
You can create a new file on your server by pressing the **Create** button to see a file dialog box appear. Here you select the folder location and enter your file name. Again, consider using a common name and location to ensure a consistent list of Causes for all inspectors pick from. **AssignableCauses.dat** is the default file, which is located in the QC-CALC install directory.



14.2.3 Edit Assignable Cause File

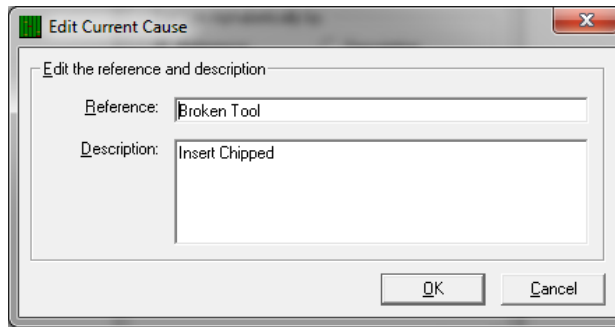
These files are empty when you install QC-CALC but you begin adding and building your list of standard codes by clicking the **Add New Entry** window.

To edit the Assignable Causes simply click the **Edit File** button and the existing codes are displayed allowing you to edit an old one or add a new Cause. The reference name or number is limited to 16 characters, and many times this is all that is needed to define the Cause. However, you can add up to 256 characters in the description. QC-CALC only displays the Reference text in QC-CALC Real-Time.



14.2.4 Add New Assignable Cause

When you click **Add New Entry** or **Edit selected entry** another window is displayed where you make your changes or add a completely new Cause.

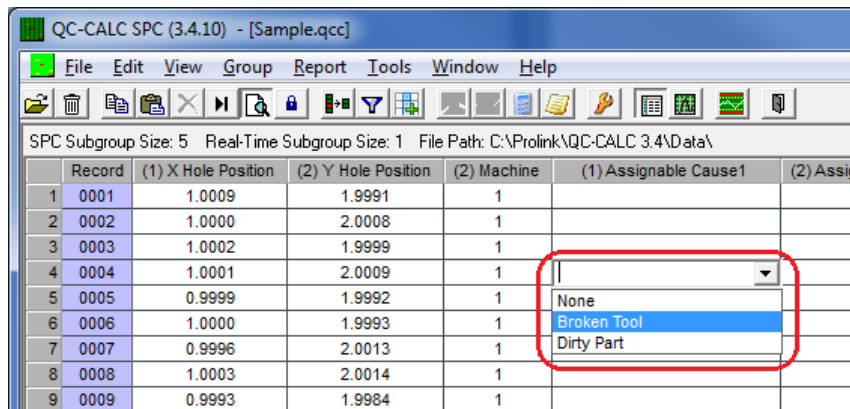


Click **OK** to save your changes.

14.3 Assign a Cause

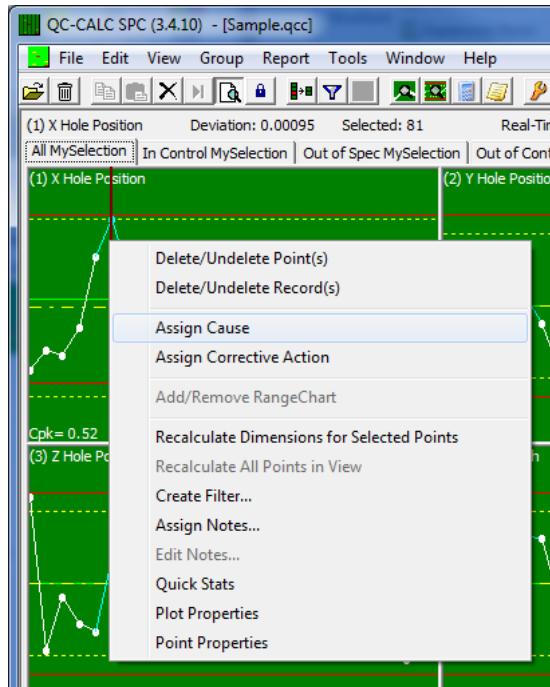
14.3.1 Grid View

The QC-CALC database reserves space for tagging each part with 1 to 3 Assignable Causes. While viewing the the file in Grid View, a list is available for each item in the Assignable Causes columns. To assign a Cause in this view just choose the appropriate item from the list.

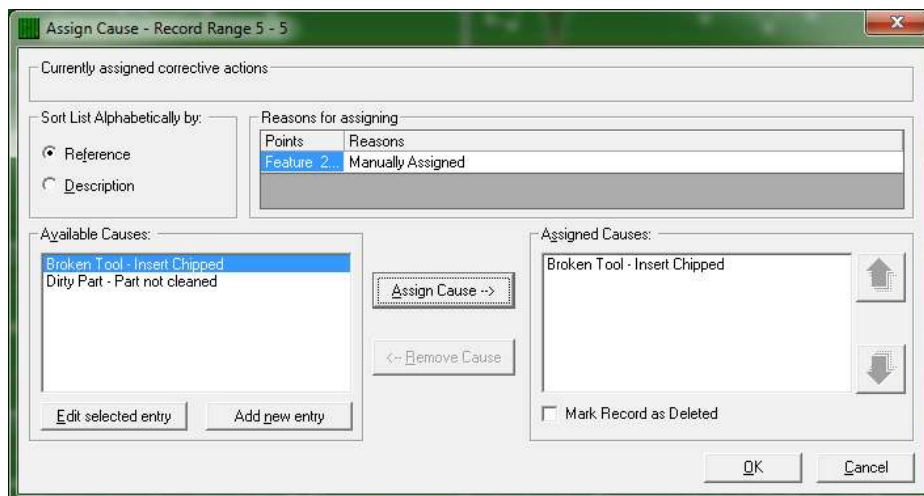


14.3.2 Plot View

When viewing the file in **Plot View** a Cause is assigned by right-clicking on the corresponding point and choosing the **Assign Cause** item from the menu that appears (shown to the right).



The screen below is displayed and you select one of the predefined Causes from the list. Now click the **Assign Cause** button to add the Cause to the part and click **OK**. Whenever the mouse floats over this point again, the tool tip pops up with the text describing the Cause.



Note: You can add new Causes to the list much like the discussion on the previous page. There is a button to **Edit** or **Add New** Causes.



Tip: Each Cause you add to the file has an internal number from 1 to xxx. Only the number is saved in your .QCC file. This means you cannot delete an entry since the numbers representing each Cause would be off by one. However, you can edit the Causes.

15. Record Filters - Details

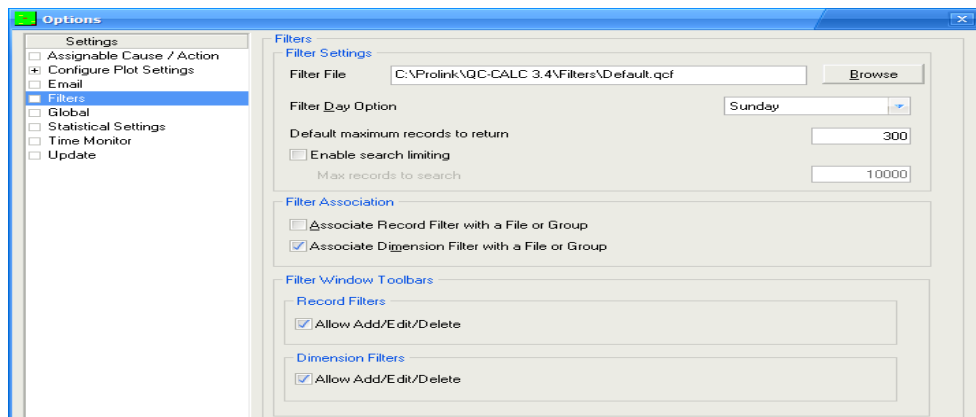
15.1 Introduction

This section contains the details of the **Record Filter** system used throughout QC-CALC. There are many options available and this expanded section was added to improve your understanding of this important subject. We create new filter files, add new filter criteria to existing files, and provide examples.

15.2 Creating a New Filter File

Select **Tools – Options – Filter Settings** to display the Filter file area. All filters are saved in files and QC-CALC's default filter file is DEFAULT.QCF which is the active filter when you start. You can create a new file by clicking the **Create Filter File** button. Enter a name in the file dialog box and you have a new – empty filter file. A filter file is where your filter criteria are stored for future retrieval.

One reason for creating multiple filter files would be to categorize filters for certain applications. For example, let's assume you have a 64-cavity mold and you want to create and save filters called Cavity 1, Cavity 2, through Cavity 64. You decide to save this set of filters on your local server in a file called Cavities. This organizes your filters and makes them available to all QC-CALC's within your facility. You can continue to make many filter files for every application.



15.2.1 Filter Day Option

QC-CALC has built-in filters such as TODAY, THIS-WEEK, LAST-WEEK, LAST-YEAR, etc to help you with date related filters. This type of filter returns the correct date without having to know the exact dates for the week, month, or year. These filters produce variable results allowing you to reuse a filter without having to edit it. Since the first weekday can be defined differently, you have the option of choosing which day of the week begins the week.

15.2.2 Default maximum records to return

This option controls the total number of records returned from any filter. This value cannot be larger than the maximum number of records allowed in the database (2,000,000). This is just a default value. Each record filter has separate settings to control the amount of data returned for that specific filter.

15.2.3 Enable search limiting

Once this option is enabled you can limit how many records will be searched for results that match the filter criteria by entering the **Max records to search** in the box. If this setting is not used then all records in the .qcc file will be searched regardless of how long this search may take.

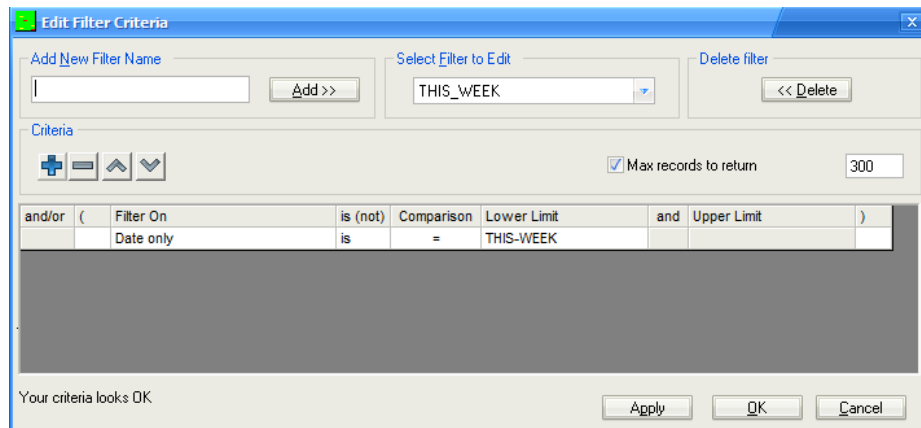
15.2.4 Global Filters

As you create and use filters you may find you want your filters to be available for all parts you inspect. This global concept is useful because you only have to create one filter and it is useful for all parts. However, the number of filters shown in the filter selector may become overwhelming and you may want to reduce this list. You can associate each filter with an individual part or associate it with all QC-CALC files. Click the **Associate Record Filter with a File or Group** to reduce the filter's range of use to the currently active QCC file. Uncheck this checkbox to make the filter available for all QCC files. This concept can be applied to dimension filters which are located under the record filter.

15.3 Create a New Filter

15.3.1 Introduction

When you click the **Edit a Filter** button the filter editor is displayed. To create a new filter, enter a name below the **Add New Filter Name** caption shown in the top left hand corner. Choose a name for the filter and click **Add>>**.



To edit an existing filter, select the filter's name from the **Select Filter to Edit** list, then edit the filter contents in the **Criteria** frame. Once you have modified your filter, click **OK** and your changes are saved.

15.3.2 Deleting a Filter

Just to the right of the **Select Filter to Edit** list is the **Delete Filter** button. Clicking this button removes the currently selected filter from the list. A dialog box is displayed asking you to verify your choice.

15.3.3 Max Records to Return

The **Max records to return** option allows you to stop running the filter after a certain number of results have been found. As your QCC files grow, filters will slow down since they have to search through more and more records. This feature allows you to set a governor on the number of results so the filter stops running after x number of records have been returned. The default value for this is set in **Tools – Options – Filters**. In this screen, you can choose to not govern the query at all, set your own value, or leave it as the default value.

15.3.4 Entering Criteria

In the middle of the filter editor is the **Criteria** frame where your filter is created and edited. The choices you make for the items in this frame affect the data you see and any reports you run. The **Filter On** list contains all the possible types of information QC-CALC uses as a filter.

From the **Select Filter to Edit** list pick the filter name you wish to begin editing. Clicking the **Append** button adds new criteria to the end of the filter. Clicking the **Remove** button removes the currently selected criteria record. You can use the /

and V buttons to move criteria up and down respectively to change the selection process of the filter.

15.3.5 Filter Criteria

The design of the filter criteria is setup to create a “man readable” sentence as the filter. As you select the fields in this row think about what the sentence is saying and the filter technique should be clear. For example, it should be obvious what you are trying to obtain when the filter reads **Lot is between 22 and 23** or maybe **Date only is = THIS WEEK**. A combined example might be:

Lot is between 22 and 23
and **Date only is = THIS WEEK**

15.3.6 Criteria Field Explained

- And/or** When you enter more than one criteria (line) you can specify how the given criteria is combined with those before it. **AND** means both criteria have to be satisfied for a record to be included. **OR** means if either of the criteria are satisfied the record will be included. Use parenthesis for grouping criteria when using complex filters to ensure criteria is combined in a manner you’d expect. When you have two or more record criteria in the filter you can switch between **And** and **Or** by clicking on the word and a Drop-down list provides your choice.
- (&)** Parentheses are used to specify the beginning or end of a criteria group. Grouped criteria are first evaluated together before it’s combined with other criteria. The examples at the end of this appendix should clarify the use of parentheses.
- Filter On** This is the list of items QC-CALC provides to build your filters. You select the **Filter On** item and add the range of acceptable values. A full definition of each item follows this section.
- is (not)** This option allows you to specify whether you want to include records that match this criteria or exclude them. e.g. **Lot is = 22** versus **Lot is not = 22**.
- Comparison** This portion of the criteria specifies how the data in the searched record will be compared to your criteria. “=”, “>”, “>=”, “<”, and “<=” have the standard meaning, “BETWEEN” lets you specify an inclusive range in which the data must fall to satisfy this criteria. “LIKE” lets you use wildcards to do pattern matching against your data: “*” matches zero or more characters, “?” matches a single character, and “#” matches a single digit. e.g.

Record number is LIKE 5	returns record 5 only
Record number is LIKE *5	returns all records ending with 5
Record number is LIKE *5*	returns all records containing a 5
Operator is LIKE Laura	returns all cases of LAURA
Lot is LIKE 2#	returns any Lot in the range of 20 – 29
Lot is LIKE ?5?	returns Lots with a 5 in the tens column
- Lower Limit** This is where you specify the lowest acceptable value of the searched record. It can be the only portion of the filter if you are searching for a single item such as **Lot is = 22**. This field can also contain special keywords selected from its own Drop-down list.
- And** This is an un-editable field and its only purpose is to make the criteria easier to read. The word “and” is displayed if you select **BETWEEN** as the comparison type.
- Upper Limit** This field specifies the upper limit for the range if you select

BETWEEN as the comparison type. It is un-editable otherwise.

15.3.1 Filter On Explained

The **Filter On** column is a list containing several possible values. Each of these keywords is detailed here. Keep in mind the **Filter On** items also have special keywords you can use instead of filtering on just a number or text. These values are summarized in the table below with details following:

Filter On	Enter	or Special Key Words
Record Number	number	LAST N RECORDS
Date Only	number	TODAY, LAST_WEEK, etc.
Time Only	number	
Date & Time	number	
Number of Fails	number	
Day of the Week		MONDAY, TUESDAY, etc.
Assignable Cause or		TRUE or FALSE only
Corrective Action		TRUE or FALSE only
Numeric Factors	number	LATEST_VALUE or ASK_VALUE
Text Factors	number/text	LATEST_VALUE or ASK_VALUE
Features	number	

Filter On Details

Record Number	Using this keyword lets you filter based on the QC-CALC record numbers. You can specify the range of records by entering a Lower and Upper Limit. You can also select the LAST-N-RECS in the Lower Limit column where this word has been added by QC-CALC. Use this keyword as a variable whenever you wish the newest X records to always be returned from the end of the database. You will be prompted for the value of N.
Date Only	Using this keyword allows you to ignore the time portion associated with a date. It also lets you specify special keywords such as TODAY, YESTERDAY, THIS-WEEK, THIS-MONTH, THIS-YEAR, LAST-WEEK, LAST-MONTH, and LAST-YEAR. These special keywords let you create a filter that is timeless so when you create your reports for last week's work you can always use the same filter without having to know the actual dates of that week.
Time Only	Using this keyword lets you specify the time of day the part was received. There are no keywords associated with time.
Date and Time	This keyword lets you specify both the date and the time the part was received.
Number of Fails	Each part stored in the QC-CALC database has a fail count saved with it. This keyword allows you to filter on the number of failed features within a part. For example, you can build a filter that only reports the parts containing bad features. The filter would read: Number of Fails is > 0
Day of Week	This keyword allows you to specify the day of the week the part was received. The possible values are SUNDAY – SATURDAY. These values are supplied in the Drop-down list and cannot be entered by you.
Assignable Cause or Corrective Action	This keyword allows you to specify whether the part has an Assignable Cause or a Corrective Action associated with it. The only possible values are TRUE or FALSE. You can filter all parts that have Causes or Actions assigned to them.

Numeric Factor Each part saved in the database has Factors saved with it. This keyword lets you specify the value a Numeric Factor equals to satisfy the criteria. There are two special keywords to discuss for the Numeric Factor and they are:

LATEST-VALUE – Only parts having the same Numeric Factor as the most recently received part satisfy this criteria. This filter keyword is very important since it allows for dynamic filtering. For example, let's say you are inspecting plastic parts made in a 16 cavity mold and you want to filter on the part just inspected. Normally you would create 16 different filters labeled Cavity 1 through Cavity 16. To filter on each cavity you would click on each filter and instantly see the parts made in Cavity 1. This can be tedious because it is a manual task that humans must perform.

The LATEST-VALUE keyword allows QC-CALC to filter on the part just received from the inspection equipment. What this means is you can request QC-CALC to automatically filter on the current cavity without touching the filters. This is a very useful tool when full automation is in use. When a problem occurs you know immediately which cavity caused the issue.

ASK-VALUE – This keyword is preloaded into the **Lower Limit** field to assist you with quick lookups. When you click a filter containing this keyword, QC-CALC asks you to supply the filter value. For example, let's say you have a 64-cavity mold and you do not want to create 64 separate filters. You can create a filter containing a value of ASK-VALUE. The filter might read:

Cavity is = ASK-VALUE

To activate the filter, click on the name and a dialog box asks for the Cavity number and your data is filtered using that value.

Text Factor The Text Factors are the same as the Numeric Factors but they allow you to enter text as a value. Please read the definition on Numeric Factors to gain an understanding of Text Factor Filter use.

Feature You can specify the value of any feature in the database by selecting the feature number. You then specify the allowable range for the feature. You might use this to find all parts within the last 100 inspected parts with a feature exceeding a particular value.

15.3.2 Filter Examples:

The following set of examples is supplied to increase your understanding of the QC-CALC filter use.

Example #1

Show only the last 20 records:

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Record Number	is	=	LAST:20-RECS			

Example #2

Show only records received yesterday:

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Date only	is	=	YESTERDAY			

Example #3

Assuming Text Factor 5 holds the operator's name, show parts measured by all operators whose names are between "B" and "G" alphabetically:

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Text Factor 5 - Operator	is	BETWEEN	B	and	G	

Example #4

Show only records with odd record numbers (ending in 1, 3, 5, 7, or 9):

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Record Number	is	LIKE	*1			
or		Record Number	is	LIKE	*3			
or		Record Number	is	LIKE	*5			
or		Record Number	is	LIKE	*7			
or		Record Number	is	LIKE	*9			

Example #5

Assuming you have multiple machines collecting data to the same file and storing the machine ID in Numeric Factor 2, show only parts collected from the machine that sent the last part.

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Numeric Factor 2 - Machine	is	=	LATEST-VALUE			

Example #6

Show parts from this week that had at least one feature out of spec.

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Date only	is	=	THIS-WEEK			
and		Number of fails	is	>=		1		

Example #7

Assuming Text Factor 5 contains the operator's name and Numeric Factor 2 contains Machine, show parts measured last month, on the 2nd shift (between 3pm and 10pm), on machines 1 or 3, measured by Bob or John.

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Date only	is	=	LAST-MONTH			
and		Time only	is	BETWEEN	03:00:00 PM	and	10:00:00 PM	
and	(	Numeric Factor 2 - Machine	is	=		1		
or		Numeric Factor 2 - Machine	is	=		3)
and	(	Text Factor 5 - Operator	is	=	BOB			
or		Text Factor 5 - Operator	is	=	JOHN)

Example #8

Assuming Text Factor 5 holds the operator's name, show parts measured by operators other than Bob, which had at least 1 feature out of spec and did not have an Assignable Cause or Corrective Action assigned to them:

and/or	(	Filter On:	is (not)	Comparison:	Lower Limit:	and	Upper Limit:)
		Assignable Causes or Corrective Ac	is	=	FALSE			
and		Number of fails	is	>=		1		
and		Text Factor 5 - Operator	is not	=	BOB			

16. Right Mouse Menu Definition (Grid View)

16.1 Introduction

As with most Windows programs, the right mouse button usually has hidden options. If you Right Click the mouse when it is over the data screen, a special menu pops up with a variety of options. This type of interface allows you to select data with the mouse before activating the menu. For example, if you want to delete a data point but leave it in the database (ignore it) you could right click the value on screen and select the **Delete/Undelete Point(s)** menu and your action is recorded. Each menu item is discussed in this section.

16.1.1 Copy / Paste

As with all Windows programs QC-CALC allows you to Cut, Copy, and Paste data from and to other Windows programs. You make your selection using the usual click and drag and then press Ctrl C to copy and Ctrl V to paste.

16.1.2 Paste Special

Use this menu to transfer copied data from the clipboard to the active database file when the separator is something other than a TAB character. When you copy the numbers into the clipboard, note the character that separates the values. This might be a comma, semicolon, <space> character, etc.

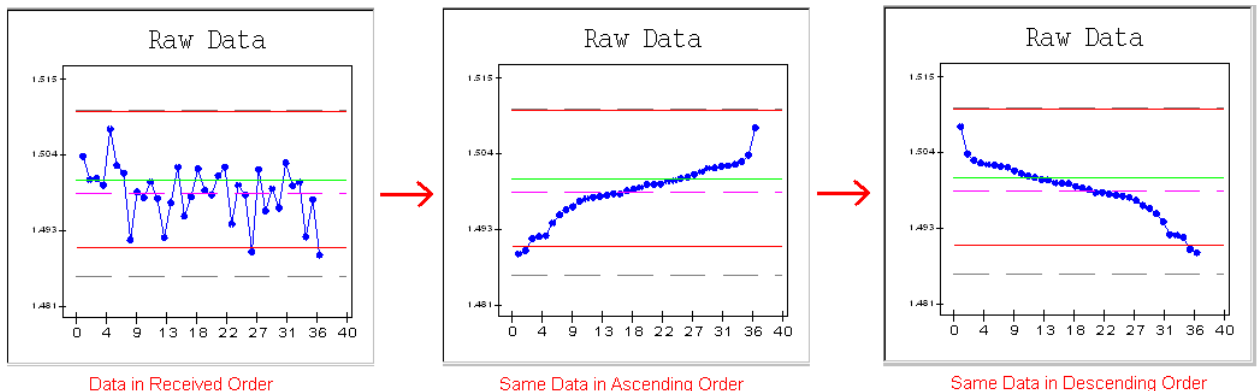
Highlight the QC-CALC rows and columns where you wish to paste and click the right mouse button. After selecting Paste Special, choose or enter the character separator and click OK. If you do not highlight enough rows and columns, some of your data will not be copied so select more rows and columns than you need. The clipboard data is transferred into the QC-CALC database.

16.1.3 Sort Records

Use this menu option to sort the records by the column your cursor is located in. Your sorting choices are ascending (First to Last), descending (Last to First), or Order Received (original order). This sort order is remembered when you leave QC-CALC and return. Statistically, this may not be the correct method to use but it is available for special cases. The sort order is only in effect when the data is viewed in table form (Grid View). If you change to Plot View chronological order is enforced.

Sort Example

The next figure shows the same data in a **Raw Data w/ Outlier Detect** report.



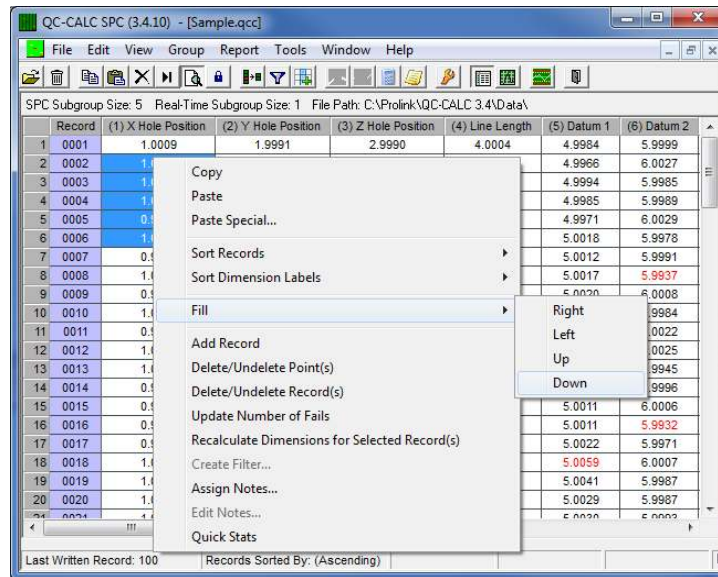
16.1.4 Sort Dimension Labels

Similar to sorting records, this menu option sorts the dimensions (columns) in the file. Sorting options are ascending (alphabetical first to last), descending (alphabetical last to first) or order received (the original order of the dimensions). This is a convenient way to move similarly named dimensions close to one another for comparison. The sort order is only in effect when the data is viewed in table form. If you change to **Plot View** the order originally received is restored.

16.1.5 Fill

The **Fill** option helps you quickly fill a block of numbers with the same value. Fill will not fill records excluded by a filter and will not add new records. You must enter records manually in one column before you can fill in other columns.

To use the **Fill** option, enter the value you want to fill in a cell and then highlight that cell plus the cells to be filled with this value.



Now click the right mouse button and pick menus **Fill – Down** or **Right** etc, and the value is written into the database. In the example above, we entered 3.5 in record 2, selected cells 2 through 8, and then chose **Fill – Down**. This caused 3.5 to fill all selected cells.

16.1.6 Add Record

Use this menu to add a record to the active database file. This provides a means to start inserting blank or empty data records. QC-CALC Real-Time adds data and records automatically so normally you should not require this menu. If you are adding records manually, press the ENTER key as you enter numbers in a column. The records are added automatically for you when the ENTER key is used.

16.1.7 Delete/Undelete Point(s)

Use this menu option to mark points as deleted. Once a data point is deleted it is shown both in the grid and in a graph as a different color (gold). Deleted Points are not removed completely from the database but they are not used in any calculations. Then if you decide to keep the data point you may select Edit – Delete/Undelete Point(s) again to restore the data point.

16.1.8 Delete/Undelete Record(s)

Use this menu option to mark a record or records for deletion. This is similar to the Delete Point except the entire part (record) is removed from all calculations. The data is not permanently deleted, it is only marked for deletion and changes

color to indicate its removal. You may undelete any record or records by pressing the Delete key where the cursor is current positioned. This returns all deleted records back to normal. To fully delete the data points mark them for deletion and then select **File – Compact Database**.

16.1.9 Update Number of Fails

The last item (extreme right column) in every QC-CALC database contains a count of the failed features within each record (part). If you edit any data values this count may become inaccurate. This option compares each feature to its Upper and Lower Specification Limits and updates this count for you. Therefore, it updates the total number of dimensions that have measurements outside of the tolerance limits within each record.

16.1.10 Recalculate Dimensions for Selected Record(s)

If calculated dimensions are being used in the active database and new records are added, this option uses the equation and writes the solution into all new calculated records.

16.1.11 Create Filter

This is a quick method of creating a record filter visually. You select the records of interest, right click the mouse and choose this option. QC-CALC asks for a name and presents the filter editor. If the filter is what you want, click OK and your filter is created.



TIP: You must select the entire record by clicking in the Record column!

16.1.12 Assign Notes

For details see the [Data Notes](#)  section on page [126](#).

16.1.13 Edit Notes

After assigning a note to a point, you can right-click on the same point and use the **Edit Notes** menu to edit the note previously entered.

16.1.14 Quick Stats

This option presents a quick list of on-screen calculations based on the highlighted data you see in the grid of numbers. Select a group of points in the active database file and then choose this menu option. A pop-up screen will show the calculated information. Normally, you only select (highlight) one column at a time since crossing columns may yield numbers of different magnitude.

Dimension Label	Y Hole Position
Sample Size	15
Cpk	0.61
Cpk Lower	0.65
Cpk Upper	0.61
Cpk By R	N/A
Cp	0.63
Cpm	0.63
Mean	2.000067
Min	1.998436
Max	2.001825
Range	0.0033891
Sigma	0.0010538
Sigma By R	N/A
Data Normal	Yes
Short-Term Sigma	0.0011031
Short-Term Cp	0.6
Short-Term Cpk	0.58

17. Security Passwords

17.1 Introduction

Password protection is provided to limit the functionality of QC-CALC to unauthorized employees. If you want to limit access to specific areas of QC-CALC simply lock the menu choice for each item. When a menu is locked, it appears “grayed out” in the menu list. To limit the functionality of QC-CALC SPC select the **Tools – Password**. The **Tools** menu and the **Password** menu within the **Tools** menu cannot be locked. This is to ensure access to the password protection at all times.

17.2 Establishing your Initial Password

When QC-CALC is first installed, **Change Password** is the only menu option available. The first time this menu option is selected a dialog box appears asking for a password. Enter the first 4 or 5 digits of the PSN (Prolink Serial Number) for the copy of QC-CALC you are running. This number can be found by selecting the **Help – About** menu. Once you successfully enter the serial number you must establish your own password by following the normal change password procedure. Once a password is established the serial number no longer applies to any of the requests for a password. This procedure prevents inadvertent setting of the initial password by unauthorized personnel.

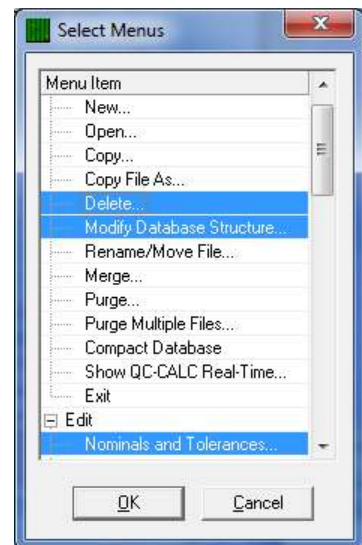
17.3 Lock/Unlock Menus

The **Tools – Password – Lock Menus** option toggles between “Lock Menus” and “Unlock Menus.” When this option is selected a dialog box appears asking for the password. Enter your password in the space provided and click **OK**. A message appears indicating the appropriate action happened. When you choose to **Lock Menus**, all menus you chose to lock out in the **Configure Menus to Lock** area still appear but are grayed out so they cannot be accessed. When you choose **Unlock Menus**, the entire QC-CALC program is available to all users no matter which menus were locked. It should be noted that if you activate the **Lock Menus** option and do not select individual menus to lock out, the entire program is still completely open.

17.4 Configure Menus to Lock

This menu option is used to establish which menus you want disabled when the **Lock Menus** option is chosen. In this example, the **Modify Database**, **Delete File**, and **Edit – Nominals and Tolerances** are locked.

This option is not available while the menus are locked. When you select **Configure Menus to Lock** a dialog box appears prompting you for a password. Enter the password and click the **OK** button. Next, a dialog box appears with a list of menus available to lock. Use the mouse to select the items you wish to be disabled by clicking on the items in the list. Multiple items are selected by holding down the control or shift keys while clicking. Once all the menus are selected click the **OK** button to commit your selection. Clicking the **Cancel** button will retain the previous selection.



One thing to remember when locking menus involves the **Exit** menu in both QC-CALC SPC and QC-CALC SPC. The **File – Exit** menu may be disabled to prevent an inadvertent exit, but the Windows Control Menu (The “x” in the upper right hand corner of the form) is still available. Users will be required to enter the password in order to exit if they click the “X” while the **Exit** menu is locked.

17.5 Change Password

When this menu item is selected a dialog box appears prompting you for the existing password. Enter your password in the space provided and click the **OK** button. A second dialog box appears to confirm your new password. Enter your new password in both places and click the **OK** button. A message appears indicating you successfully changed your password. Clicking the **Cancel** button at any point in the procedure brings you back to the main QC-CALC screen and the old password remains in effect.

17.6 Logout

To avoid being asked for the password multiple times as you move from the various password options, you have the ability to choose the **Keep me logged in** option. When this option is checked you will no longer be asked to enter your password each time you use one of the items in the Password area. Your Password will be remembered until you choose the **Tools – Options – Password – Logout** menu. It is critical to remember to use the **Logout** menu when you have finished, otherwise anyone will be able to control the Password Protection area.

18. Creating New Files

18.1 Introduction

The **File – New** menu is used to create a new QC-CALC database when you want to manually enter data, otherwise new files are automatically created by QC-CALC Real-Time. You name the file and tell QC-CALC the number of features in each record and the maximum number of records in the file. Since most people use QC-CALC to analyze manufactured parts inspected on CMMs or Video CMMs, the Part Program Name is used to identify the QC-CALC file. Records identify the Parts in a file and Dimensions to identify the number of features on each part. Keep these definitions in mind when answering the questions.



Note: If you purchased QC-CALC to be used with inspection equipment, please refer to the machine-specific section printed on gray paper found in the beginning of this manual. Follow the instructions there for creating new files.

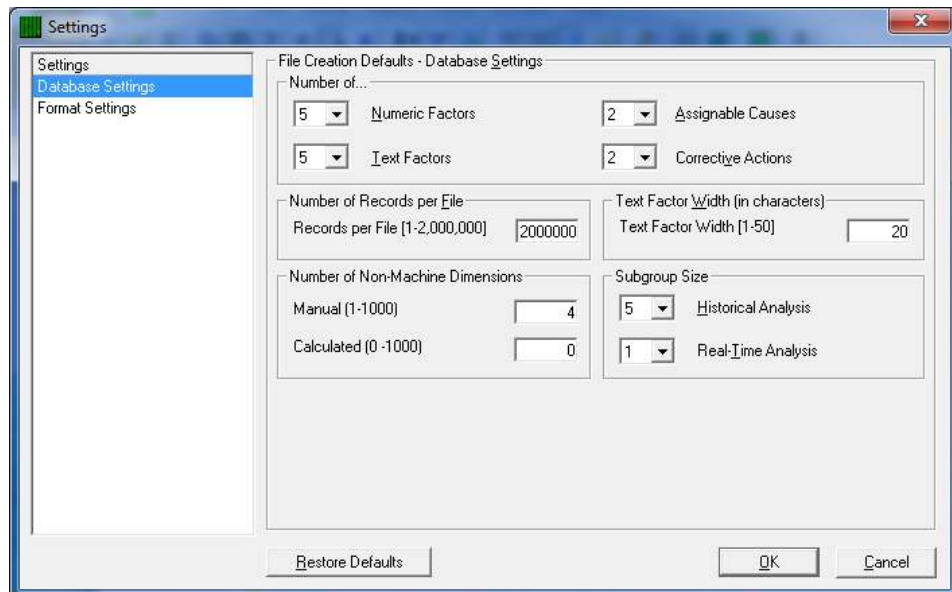
18.2 Overview

To manually create a QC-CALC database you perform the same steps QC-CALC Real-Time performs but much slower. These steps include:

1. Select the **File – New** menu and enter the name of the file.
2. Answer the **Database Settings** describing what you want in the file.
3. **Enter Nominals & Tolerances**, Labels, Precision etc. for each feature.
4. Enter the **Raw Data**.

18.3 File – New

After you select the **File – New** menu, a file dialog box is displayed and you select the drive, path and enter the file name for the new QC-CALC file. Click the **OK** button and an empty database is created.



18.3.1 Database Settings Tab

Number of...

Numeric or Text Factors

With each inspected part, QC-CALC saves the time, date, and any Factor values you add. You can use these Factors to tag each part with additional information that is not a measured value. For example, you can use Numeric Factor 1 to store the Machine Number, or Text Factor 1 to store the Operator Name. You use this non-measurement data to filter your records so you are reporting a subset of data that interests you. You may assign up to 15 of each type of factor to every part that you save in the database. The default is 5 each.

Assignable Causes or Corrective Actions

Choose the number of Assignable Cause columns to include in the database. This is the number of unique Causes you can add to any part. Usually you only need 1 but the limit is 3.

Number of Records per File

Since each record of a QC-CALC file is the data collected for one part, the number of records is the maximum number of parts to be stored. Enter the maximum number of records you want in this file. You can increase the maximum number of parts later by using the **File – Modify Database Structure** menu.

Text Factor Width

This is the maximum number of characters allowed for Text Factors. The default is 20 characters per value.

Number of Non-Machine Dimensions

Manual

As mentioned above, each database file is generally one part type and each part has a fixed number of measured features. Enter the number of measured features on this part. For example, if you are measuring and recording four features on your parts, enter a 4 here. When the file is completed you are presented with a grid containing four columns where your data is entered.

Calculated

A calculated dimension is one that you do not enter the data for but instead it calculates its own values based on an equation. For example, you could add dimension 1 & 2 together to obtain dimension 5. More details are available in the section called [Calculated Dimensions](#) on page [98](#).

Subgroup Size

Historical Analysis

This controls the number of data points that make up a subgroup on the control charts. The minimum subgroup size is 2 and the maximum is 25.

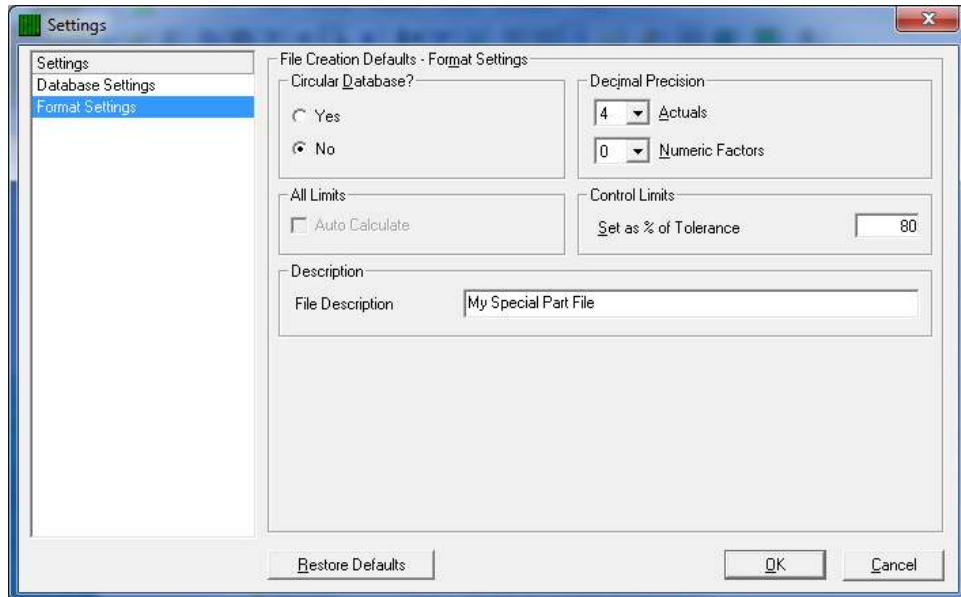
Real-Time Analysis

This controls the number of data points that make up a subgroup (or points) on the graphs in QC-CALC Real-Time. The minimum value allowed to produce a graph of raw data is 1 and the maximum is 20. However, since this is a manually created database, this value is not very important.

18.3.2 Format Settings Tab

Circular Database

This field tells QC-CALC what to do when the data file becomes full. It only applies to Real-Time inspections. If the file is circular, QC-CALC automatically wraps around from the largest record back to the first record and begins writing over the old data. For more details on Circular, please consult the QC-CALC Real-Time training manual.



Decimal Precision

Actuals

Enter the number of places needed to the right of the decimal point. If you enter a four, your format will be **nnn.nnnn**. If you enter a three, your format will be **nnnn.nnn**. You can change each feature's precision after the file is created in the **Edit – Nominals & Tolerances** section.

Numeric Factors

The Decimal Precision set here is used as the default precision for all Numeric Factors. Zero or no decimal place is normal since most use the factors for items such as Lot, Cavity, Machine numbers.

All Limits – Auto Calculate

This option is not available for files created by QC-CALC SPC.

Control Limits

Default settings for Control Limits only apply to Real-Time inspections. The Real-Time XBar charts are displayed in green rectangles with the center based on the feature's nominal value. Setting the Control Limits as a percent of tolerance gives you an approximate location to place the yellow dashed control lines based on the nominal and tolerance values. A suggested value to enter is 80%. This moves your control lines to something less than your specification limits. Once you have entered data and your process is in control you should calculate and save real control limits over these "best guess" numbers.

File Description

Use this field to assign a descriptive name to the file. You can use up to 32 characters. This description is displayed in the reports.

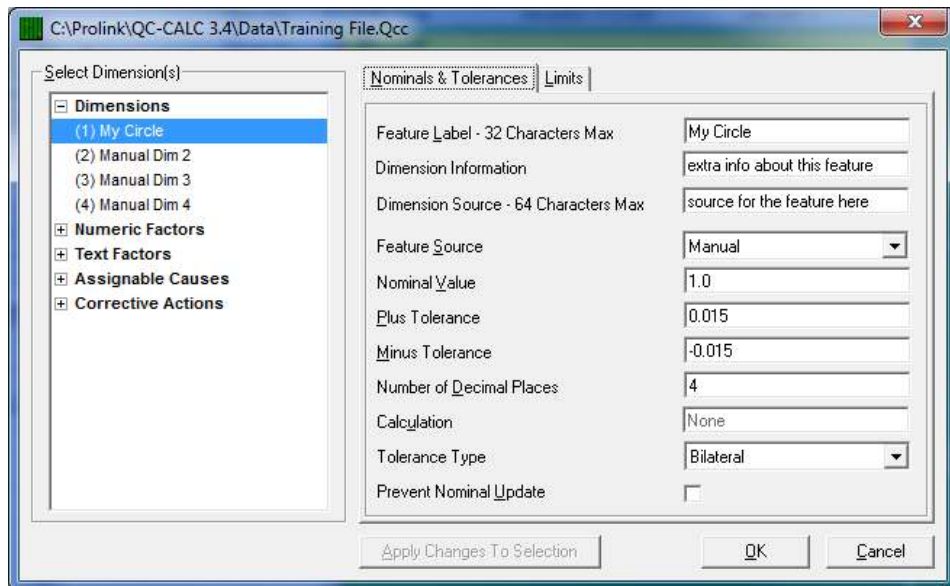
18.3.3 Complete the file Create

Now that you've entered all of the values into the create window, click the **OK** button to create your file. Next we will add the nominal information.

18.4 Enter Nominals & Tolerances

18.4.1 Introduction

The next step after creating your new file is entering all of the Nominals and Tolerances for the dimensions within the file. The **Edit – Nominals and Tolerances** menu is used for this. You can see each feature in the list on the left that we created. A database file can contain up to 3000 separate dimensions or features. The number of dimensions contained in the file was selected by you during file creation process. Additional parameters stored with each dimension can be accessed and edited using this option. The statistical analysis portion of QC-CALC uses these additional parameters.



To edit each feature click on the label in the left window and all of its settings are displayed on the right side. We will describe these settings next. If you have common values on some features, highlight as many features as you want, edit the common values and press the **Apply Changes To Selected** button. For example, if all of your tolerances are 0.005 highlight everything and enter the number once and press the **Apply Changes to Selection** button.

18.4.2 Feature Label

Use this label to describe the dimension so you'll recognize each feature in your SPC reports. Up to 32 alphanumeric characters can be used. The default label is ManualDim1 but we edited this example to **MyCircle**.

18.4.3 Dimension Information

This is an area that is available to store additional information about this feature. You might want to describe how this feature is measured for example. This area holds up to 255 characters.

18.4.4 Dimension Source

This area is used to store the information about the machine that created this feature. You can store up to 64 characters describing the Dimension Source.

18.4.5 Feature Source

The term “source” describes where the data is coming from. There are 3 sources of data in QC-CALC and they are:

Machine	Data is received from an inspection machine automatically.
Manual	Data is entered manually (by you) which is the purpose of this section of the manual.
Calculated	Data is calculated based on mathematical equations. See Calculated Dimensions on page 98.

You should choose **Manual** since this exercise explains how to create files manually instead of using automatic equipment.

18.4.6 Nominal Value

This is the target value of the dimension. In our example, we entered a decimal value of 1.0000.

18.4.7 Plus Tolerance

This value, when added to the Nominal creates the **Upper Specification Limit (USL)** used throughout the program. All values that exceed the USL are considered “out of spec”. In our example, we entered 0.05 for both the plus and minus tol.

18.4.8 Minus Tolerance

This value, when added to the Nominal creates the **Lower Specification Limit (LSL)** used throughout the program. All values smaller than the LSL are considered “out of spec”. Normally, this number has a minus sign in front of it.



Note: If both tolerance values are on one side of the nominal, both may be positive or both may be negative. See the example below.

NOMINAL	LOWER TOL	UPPER TOL
1.00	+ .001	+ .005
1.00	- .005	- .001

If you forget to enter the tolerance values on a feature, QC-CALC will enter +/- 0.000050. In all cases, the Minus Tolerance is always added to nominal to create the Lower Specification Limit. If a zero is entered here, the feature is considered single sided.

18.4.9 Number of Decimal Places

Enter the number of decimal places (to the right of the decimal) to display for this dimension. QC-CALC uses this parameter when outputting and displaying data and analysis results for this dimension. Each dimension has its own value for the number of decimal places used to format displayed results. QC-CALC holds 7 significant digits of accuracy so if you have 4 digits on the right side of the decimal point, you’ll have 3 digits on the left side.

18.4.10 Calculation

This option is only available for Dimensions with a **Feature Source** of **Calculated**. When you click in this area the Calculation Editor window appears to assist you with creating the equation used to calculate the value of each point. See [Calculated Dimensions](#) on page 98.

18.4.11 Tolerance Type

There are 4 types of tolerance used throughout QC-CALC. They are:

Bilateral

A bilateral tolerance type meaning the Nominal is located between the Upper and Lower Specification Limits.

Single Sided Upper

A Single Sided Upper Tolerance Type means the Nominal and the Lower Specification Limit are the same (usually both zero).

Single Sided Lower

A single sided lower tolerance type meaning the Nominal and the Upper Specification Limit are the same (usually both zero).

Not Toleranced

Meaning the feature was received without tolerances specified. You will see a similar looking plot but without tolerance lines. You can plot this type of feature in Control Charts, Raw Data Charts, Correlation Plots, and Probability Plots. Any plot requiring tolerances such as Process Capability cannot be created with non-toleranced features and will be ignored.

This type of tolerance type cannot trigger failure status such as trend detection and out-of-control reports. You will see blanks in reports where tolerances or upper spec limits are normally printed.

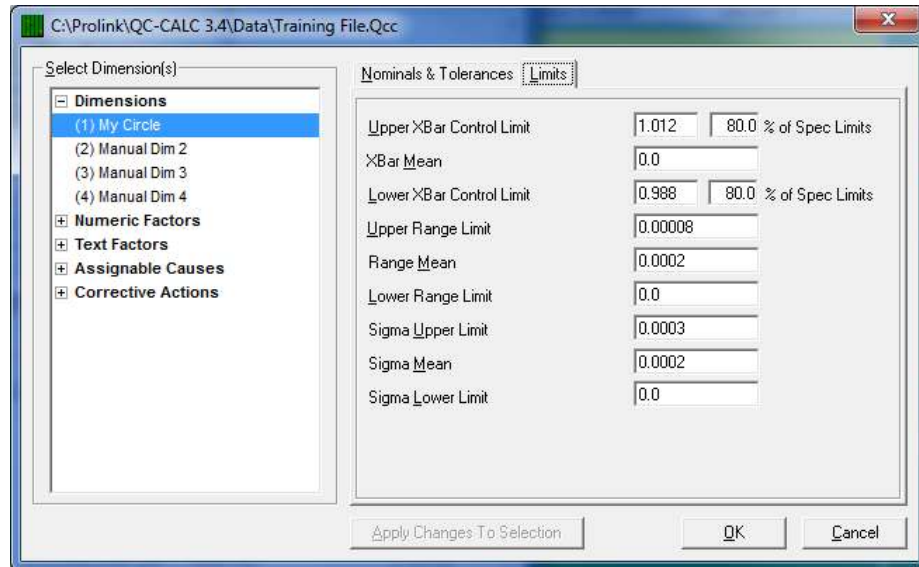
18.4.12 Prevent Nominal Update

This checkbox is used to prevent QC-CALC from updating the labels, nominals and tolerances of a dimension during Real-Time Inspection mode. QC-CALC has a special feature to Update Nominals to synchronize the QC-CALC database with your CMM part program. This subject is not discussed here but you can read about this automatic feature in the QC-CALC Real-Time section. The idea of this option is to stop the automatic update for the chosen feature you are editing. The nominal and tolerances will not be updated even if **Update Nominals** (in QC-CALC Real-Time) is set to **Always**. See the **Tools – Options – Data Collection – Actions** window in QC-CALC Real-Time.

18.5 Limits

18.5.1 Introduction

The **Limits Tab** contains additional information about each feature in your data base. You see the following window when you click on this Tab.



18.5.2 Upper XBar Control Limit

This is a user-defined upper control limit for each XBar chart. If you know the value you want you can enter it here for each dimension. However, we recommend you let QC-CALC calculate and save the value for you so you don't have to type.

During analysis of Xbar Control charts QC-CALC can calculate the control limits based on the data you are analyzing or you can use these saved limits. The **Use Saved Control Limits** check box is found in **Tools – Options – Statistical Settings** area.

18.5.3 Percent of Spec Limits

You may type a percent value in this field and QC-CALC will calculate the control limit for you. The calculation = NOMINAL + (xx% of TOLERANCE). To enter the value as a percent, type the percent value such as 80. The calculation occurs as you type.

i.e. If the nominal is 1.000 and the tolerance is +/- 0.05 and you choose 85%, The Upper XBar Limit is computed as:

$$\text{Upper XBar Limit} = 1.000 + (.85 \times 0.05) = 1.0425$$

This value is also used in the Real-Time data collection portion of QC-CALC. If you are using this program with automated inspection equipment, the yellow dashed line is placed on the plot using this technique to obtain a reasonable limit. However, once you have sufficient data to calculate the limits, we highly recommend you do so.

18.5.4 XBar Mean

This is the average of the subgroups in the XBar charts. You can assign a previously obtained value. This value may be used in place of QC-CALC calculated XBar mean when control charts are generated for this dimension. Should you have QC-CALC calculate and save the Mean value, it is stored in this location for each feature in the database.

18.5.5 Lower XBar Control Limit

This is a user-defined lower control limit constant for XBar charts. You can assign a unique, lower XBar control limit for each dimension. This limit may be used in place of QC-CALC calculated lower control limits when control charts are generated for this dimension. You can use the user-defined limits, the QC-CALC calculated limits or a one-time, manually inputted limit when the control chart is run for this dimension.

18.5.6 Percent of Tolerance

You may type a percent value in this field and QC-CALC will calculate the value for you. The calculation = NOMINAL – (xx% of TOLERANCE). To enter the value as a percent, type the percent value followed by a percent sign (%) i.e. 80%.

i.e. If the nominal is 1.000 and the tolerance is +/- 0.05 and you choose 85%, the Lower XBar Limit is computed as:

$$\text{Lower XBar Limit} = 1.000 - (.85 \times 0.05) = 0.9575$$

18.5.7 Upper Range Limit

This is a user-defined upper-control limit value for the range charts. You can assign a unique, upper Range control limit for each dimension. This limit may be used in place of QC-CALC calculated upper control limits when control charts are generated for this dimension. You can use the user-defined limits (by checking the **Use Saved Control Limits** check box) or the QC-CALC calculated limits.

18.5.8 Range Mean

This is the average of the ranges in the Range charts. You can assign a previously obtained value. This value may be used in place of QC-CALC calculated range mean when control charts are generated for this dimension.

18.5.9 Lower Range Limit

This is a user-defined lower-control limit constant for range charts. You can assign a unique, Lower Range control limit for each dimension. This limit may be used in place of QC-CALC calculated lower control limits when control charts are generated for this dimension. You can use the user-defined limits or the QC-CALC calculated limits for this dimension.

18.5.10 Sigma Upper Limit

This is a user-defined upper-control limit value for sigma charts. You can assign a unique upper Sigma control limit for each dimension. This limit may be used in place of QC-CALC calculated upper control limits when control charts are generated for this dimension. You can use the user-defined limits, the QC-CALC calculated limits or a one-time, manually inputted limit when the control chart is run for this dimension.

18.5.11 Sigma Mean

This is the average of the subgroups in the sigma charts. You can assign a previously obtained value. This value may be used in place of QC-CALC calculated sigma mean when control charts are generated for this dimension.

18.5.12 Sigma Lower Limit

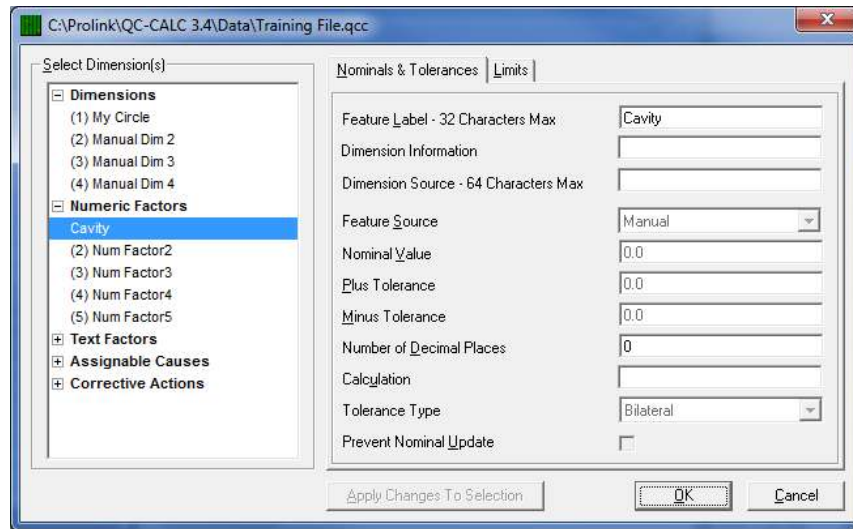
This is a user-defined lower-control limit value for sigma charts. You can assign a unique, Lower Sigma control limit for each dimension. This limit may be used in place of QC-CALC calculated lower control limits when control charts are generated for this dimension. You can use the user-defined limits or the QC-CALC calculated limits for this dimension. Click **OK** when you have finished entering the nominals and tolerances.

18.6 Factors

18.6.1 Numeric Factors

Numeric Factors are used to record information specific to each part stored in the database. For example, you can define Numeric Factor 1 as **Cavity**, **Heat Code**, **Operator Number**, **Machine #**, etc. Each part record contains up to 15 Numeric Factors to help you filter the data for more specific analysis. Usually, an automatic inspection machine provides this information, however you must enter it manually when creating files manually. To use this “trace information” known as Factors in a filter, please see [Report Concepts](#) on page 9.

The labels for each Factor are edited in the Nominal screen. To open the list of Numeric Factors, click on the **+ Numeric Factors** and choose Num Factor 1 and then edit its name in right-hand panel.



18.6.2 Text Factors

Text Factors are used to record information specific to each part stored in the database. Text Factor (alpha-numeric) allow you to enter any keyboard characters in as opposed to the Numeric Factors which only allow numbers. You can use these columns to record information specific to each part stored in the database, the same as you did for Numeric Factors. The difference is that you can use either letters or numbers, giving you the opportunity to enter in an actual operator’s name. Each record contains up to 15 Text FACTORS to help you filter the data. All other aspects of the Text Factors are the same as the Numeric Factors.

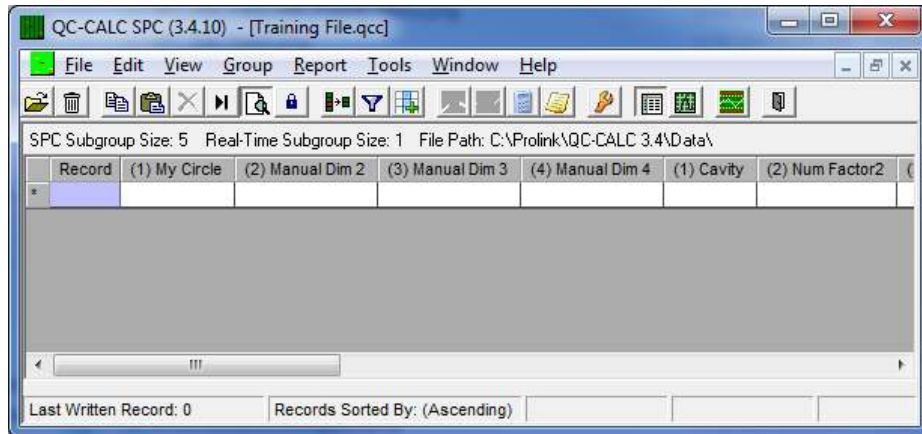
18.6.3 Entering Factor Information

In the next section we will add the raw data and any Numeric or Text Factor information in a grid. Please note how each record (part) has these extra columns of non-measurement data on the extreme right side.

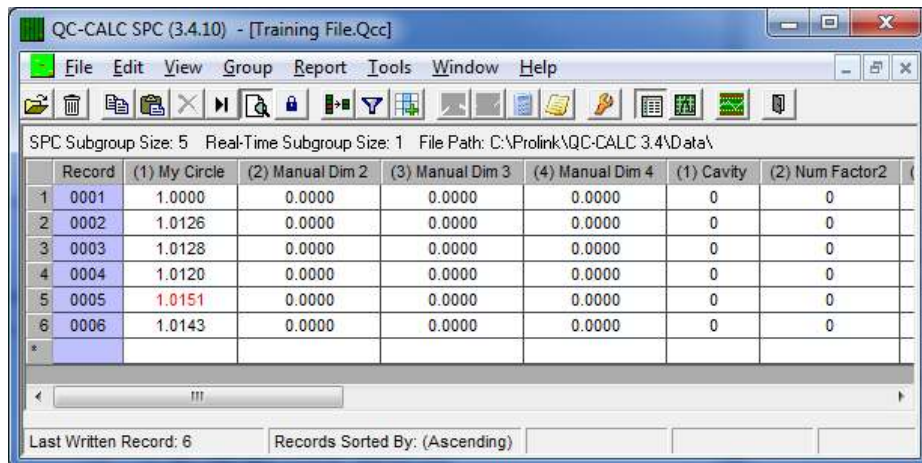
18.6.4 Enter the Raw Data

You have now created a new QC-CALC database file, you have entered the nominal and tolerance information and you are now ready to enter the data for each feature. You do this by placing the cursor into the first row and column and typing your values for the first feature. When you press the ENTER key, a new row is added automatically for you.

Here we see the empty file where data entry begins. Place the cursor in the first cell of the grid and begin typing the values of the first feature. In our example, the column is labeled with MyCircle.



After entering 6 values in the first column we see the database begins to grow. This is the chosen method of data entry when you create a database manually. If your data is stored in Excel, you can cut and paste the data directly into this screen. Also note we entered the Cavity details (Factor value) for each part. This data is used in a filter later on.



At this point your database file is created and some of the data has been entered. Continue in this fashion until all data is entered.

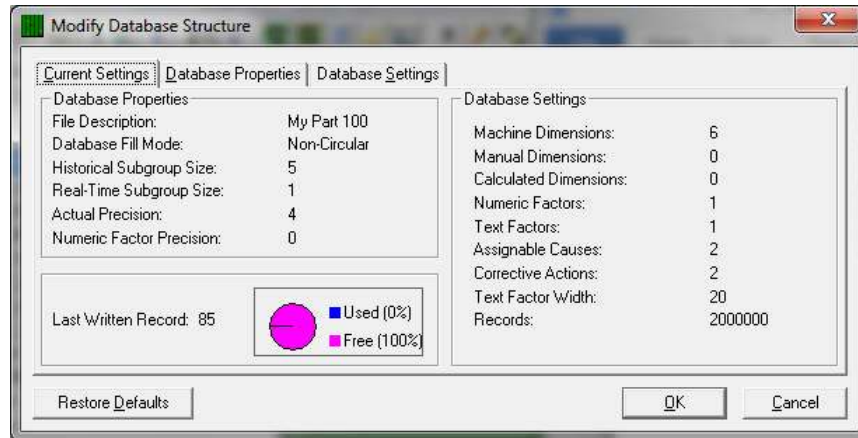
19. Modify Database Structure

19.1 Introduction

QC-CALC automatically builds its database when it reads a never before seen “results file” from your CMM. Since QC-CALC has a policy of not asking questions, it must obtain reasonable answers from somewhere. QC-CALC uses a **File Creation Default** area for these answers that was setup during installation. The file creation default area contains the answers to any questions that would normally have been asked of you. You can change these answers but they may have been incorrect for some situations. Therefore, we provide a tool to change the structure and content of any database previously created. This section of the training gives you an understanding what QC-CALC saves and how to change the settings.

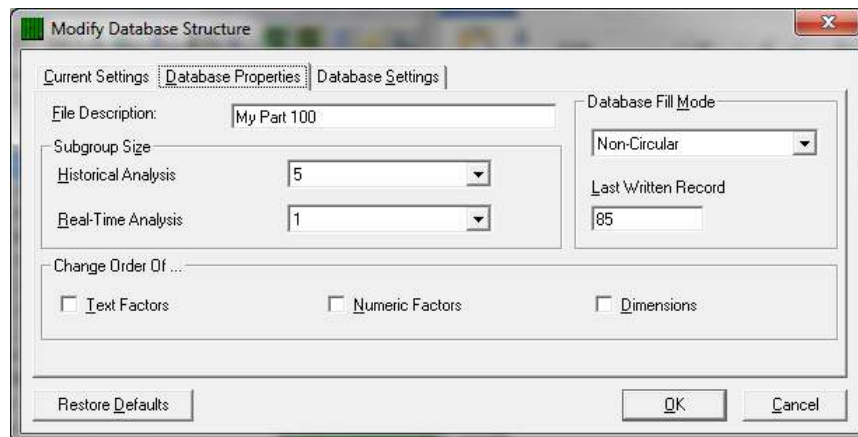
19.2 Current Settings

Select menu **File – Modify Database Structure** and the following window is displayed. This tab summarizes all the information about the currently open database file on one screen. You can change these values from the **Database Properties** and **Database Settings** tabs.



19.3 Database Properties

The tab contains the basic organization of the database file. You can modify these values to adjust how QC-CALC displays your data.



19.3.1 File Description

This is a description of the currently open file that may be used to give additional information about the file. If a specific value was not entered the .qcc file name will be save into this area.

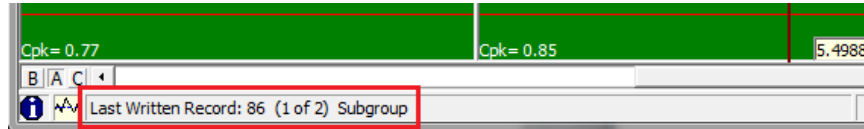
19.3.2 Subgroup Size

Historical Analysis

This controls the number of data points that make up a subgroup on the control charts in the statistical menu. The minimum subgroup size is 2 and the maximum is 25.

Real-Time Analysis

This controls the number of data points that make up a subgroup (or points) on the graphs in QC-CALC Real-Time. A subgroup size of 1 is the minimum size where each inspected part is displayed immediately as raw data. If you set the subgroup size to 2, no visible point is displayed until two parts are received. QC-CALC displays the current point within the subgroup in the lower status bar.



19.3.3 Database Fill Mode

This option only applies to Real-Time and tells QC-CALC what to do when the data file becomes full. The maximum parts store in each database is 2,000,000. If the file is circular, QC-CALC automatically wraps around from 2,000,000 back to the first record and begins writing over the old data. If you do not want the old data to be erased, archive the data file to another disk or select non-circular.

19.3.4 Last Written Record

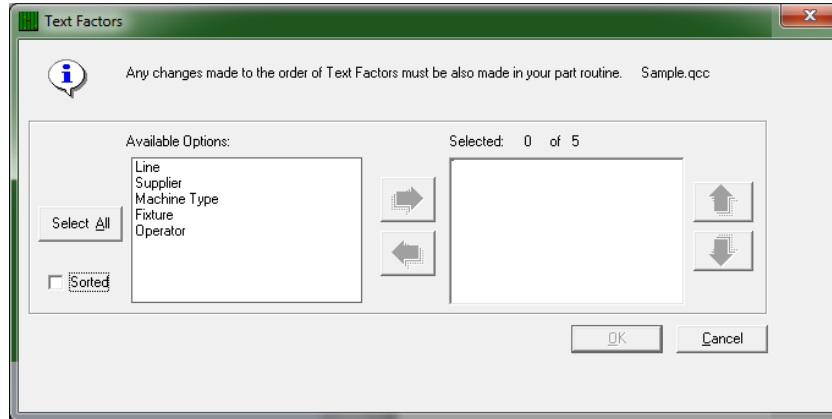
This is the number of the last record that was inspected. The number tells you where new data will be added when data collection or data entry resumes. Changing this number to a lower number will effectively erase the records located beyond that number. For example, if 42 were the last written record, changing this to 40 would cause records 41 and 42 to be overwritten when data is again received from the inspection equipment. If you move it back to 42 before any data is saved, your records are returned.

19.3.5 Change Order Of ...

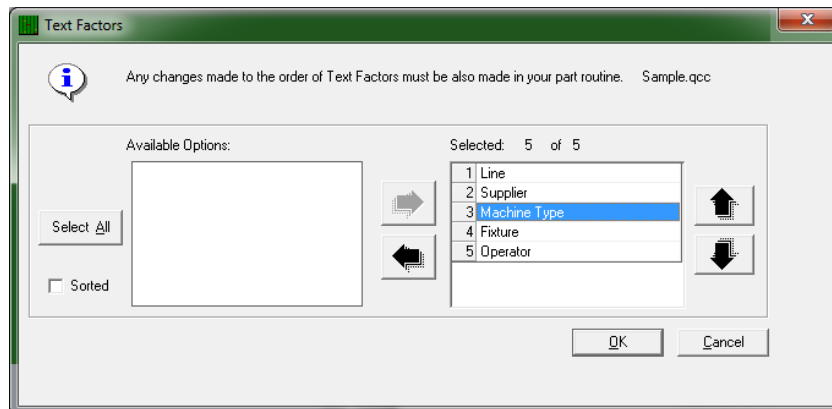
This frame contains three check boxes that allow you to change the column order in which your data is placed in the database. For example, you can swap the position of Dimension 1 with Dimension 2 or Text Factor 2 with Text Factor 3, etc. It is rare that you would need this type of maintenance but it is included should you change your part program and need to change the QC-CALC database to match.

Text Factors

These columns are used to record information specific to a part such as operator name, work order numbers, machine names, etc. In this example we swap Text Factor 3 (labeled Plant) with Text Factor 4 (labeled Division).



We start with the screen above and move all five Text Factors to the right panel using the right arrow and then using the vertical upper and down arrow keys, adjust their final position to look like the screen below. Pressing the **OK** button causes QC-CALC to move all text Factors to the newly selected order.



Numeric Factors

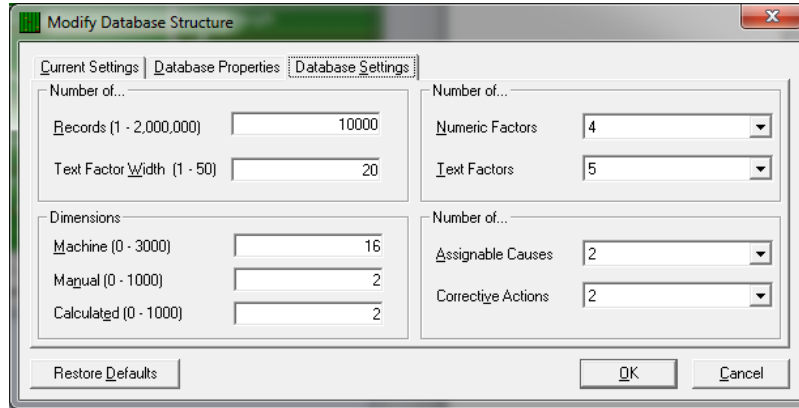
Numeric Factor operate the same but only numbers can be entered in these columns, which are mainly used to record information specific to each part stored in the database as well as to help you filter the data to create a more specific analysis.

Dimensions

The measured values operate the same but only numbers are allowed. These columns contain measurement results for each dimension in the database. A total of 3000 dimensions per part and up to 2,000,000 parts can be stored in one database. You can move or remove any of these columns of numbers to match your latest part program configuration.

19.4 Database Settings

The database settings tab contains items that change the size of the database. You can add or remove records, dimensions, Factors, assignable causes, etc. If you choose a value less than the value shown (existing), you are warned that information will be lost. When you finish and click **OK**, you see a screen of the selected items to keep and items to discard. You can change the order of each item as well. Each item is briefly discussed.



19.4.1 Number of...

Records (1 – 2,000,000)

This is the number of records (parts) stored in this database. If the number you enter is small than the current amount of records QC-CALC takes the number of records you specify from the newest data and discards the oldest.

Text Factor Width (1 – 50)

This is the width of each label stored in the Text Factor columns of your data file. You may choose any width up to a maximum of 50 characters.

19.4.2 Number of...

Numeric Factors

This refers to the number of columns of Numeric Factors you would like in your database. This number can be larger or smaller than the current value. You will be warned if you enter a value smaller than the present value.

Text Factors

This refers to the number of columns of Text Factors you wish to have converted. You can add, subtract, or move the order of these values.

19.4.3 Dimensions

This is the number of dimensions to convert. QC-CALC has three types of dimensions:

Machine

Dimensions created automatically by receiving data from an inspection machine.

Manual

Extra dimensions not received from an inspection machine and are entered by hand using the Grid View in QC-CALC SPC or the **View – Manual Dimensions** area in QC-CALC Real-Time.

Calculated

You can add Dimensions that are made up of calculations. These are useful for creating features that are not available from the gage. For example, if a plot contains a measure value for one side of a panel and a second value for the

other side, you can calculate thickness by subtracting the two dimensions. [Calculated Dimensions](#) are detailed on page 98.

19.4.4 Number of...

Assignable Causes

The purpose of an Assignable Cause file is to store your company's entire standard Causes that occur during the manufacturing process used to trace special events that occurred to a part. This selection lets you decide how many **Assignable Causes** you want to include. The range is 0 to 3 causes per part.

Corrective Actions

The associated **Corrective Actions** explains what you did to fix the Cause, however, the number of **Assignable Causes** do not have to match the amount of **Corrective Actions** and vice versa. Therefore you may select as many **Corrective Actions** as you have or desire but limited to 3.

20. Calculated Dimensions

20.1 Introduction

You can add Dimensions that are made up of calculations. These are useful for creating features that are not available from the gage. For example, if a plot contains a measured value for one side of a panel and a second value for the other side, you can calculate thickness by subtracting the two dimensions. Or you may wish to add a bias to the nominal of a number that is zeroed out on a gage block.

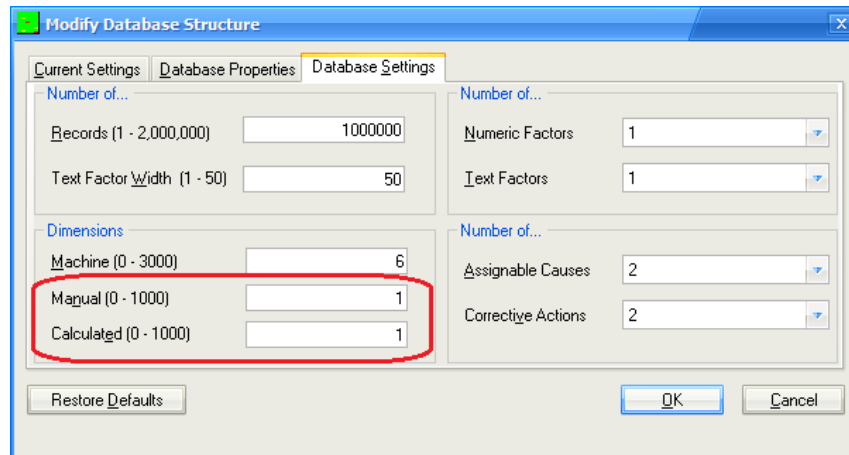
QC-CALC can also include dimensions where you manually enter the values into the QC-CALC Real-Time or QC-CALC SPC screens. This means QC-CALC has a total of 3 different measurement types it can plot in Real-Time.

Machine Dimension	Received from your CMM part program
Calculated Dimension	Extra dimension calculated by QC-CALC
Manual Dimension	Extra dimension typed by you

This unique capability means you can add separate features to your existing QC-CALC file that cannot be measured on your CMM. This section focuses on how to extend QC-CALC's capability.

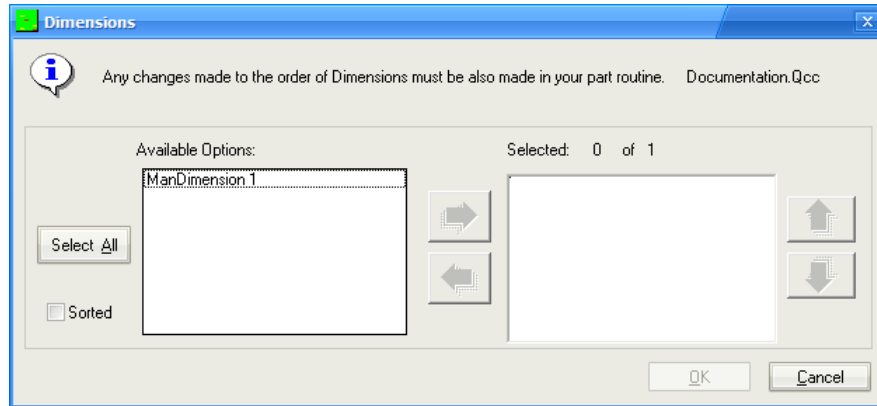
20.2 Adding the Extra Features

When we discussed [Modify Database Structure](#) on page 93 we briefly touched on the subject of Calculated Dimensions. We will now add a Calculated Dimension by using the Modify Database Structure options. Select **File – Modify Database Structure** and then select the **Database Settings** tab. Here we changed the Manual and Calculated Dimensions from 0 to 1 meaning we are adding 2 new dimensions to the database.

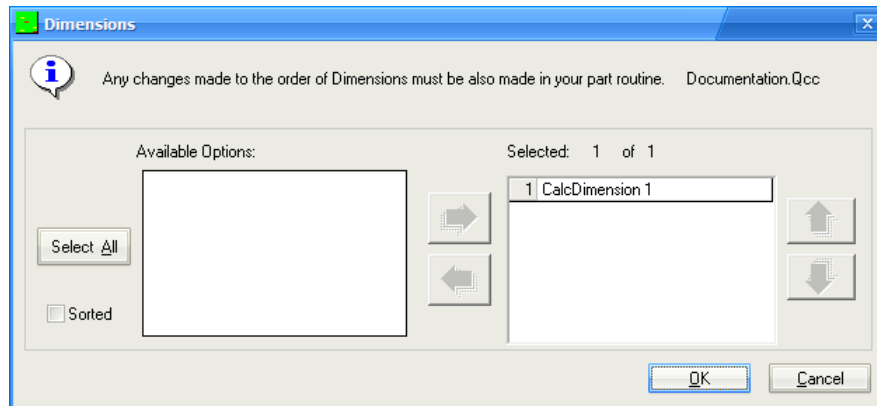


Note the Machine Dimensions value is set to 6. This is automatically set when QC-CALC reads your CMM data results and creates the database automatically. Click **OK**.

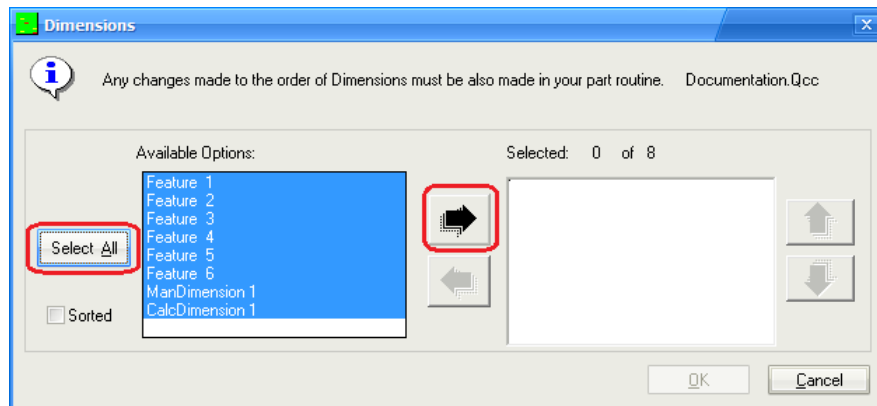
Select “ManDimension 1” (this happens to be the default **Feature Label** for a **Manual Dimension**) and click the **Right Arrow** to move it to the right side, then click **OK**.



The added **Calculated Dimension** is displayed on the left side of the next screen. Now select that dimension and click the **Right Arrow** button to move it to the right side. Click **OK**



Lastly, you are prompted to move all of your machine, manual, and calculated dimensions. This last step allows you to rearrange the order each feature is displayed in the .qcc file. In this example, click **Select All** followed by the **Right Arrow**, then click **OK**. This moves everything from the left side to the right side.



20.3 View the Extra Dimensions

Scrolling to the right of the edit screen shows the two extra columns we added. Note the data line is filled with 12 parts before adding these extra two dimensions. QC-CALC back fills the new dimensions with 0's.

Record	(4) Feature 4	(5) Feature 5	(6) Feature 6	(7) ManDimension 1	(8) CalcDimension 1
1 0001	4.5002	5.5041	6.5047	0.0000	0.0000
2 0002	4.4989	5.5062	6.5007	0.0000	0.0000
3 0003	4.5023	5.4958	6.4965	0.0000	0.0000
4 0004	4.4977	5.4930	6.4962	0.0000	0.0000
5 0005	4.4967	5.4999	6.5042	0.0000	0.0000
6 0006	4.4992	5.5058	6.4985	0.0000	0.0000
7 0007	4.4993	5.4967	6.4920	0.0000	0.0000
8 0008	4.5011	5.4995	6.5016	0.0000	0.0000
9 0009	4.5026	5.5008	6.5001	0.0000	0.0000
10 0010	4.5015	5.5012	6.4997	0.0000	0.0000
11 0011	4.5041	5.5007	6.5003	0.0000	0.0000
12 0012	4.5049	5.4965	6.4990	0.0000	0.0000

20.4 Display the Equation

Next, select the **Edit – Nominal and Tolerance** menu. Change the label to identifiable text, change the nominal and tolerances, and click the word **none** found in the **Calculation** field to expose the equation editor. This field is editable only because it is a calculated dimension.

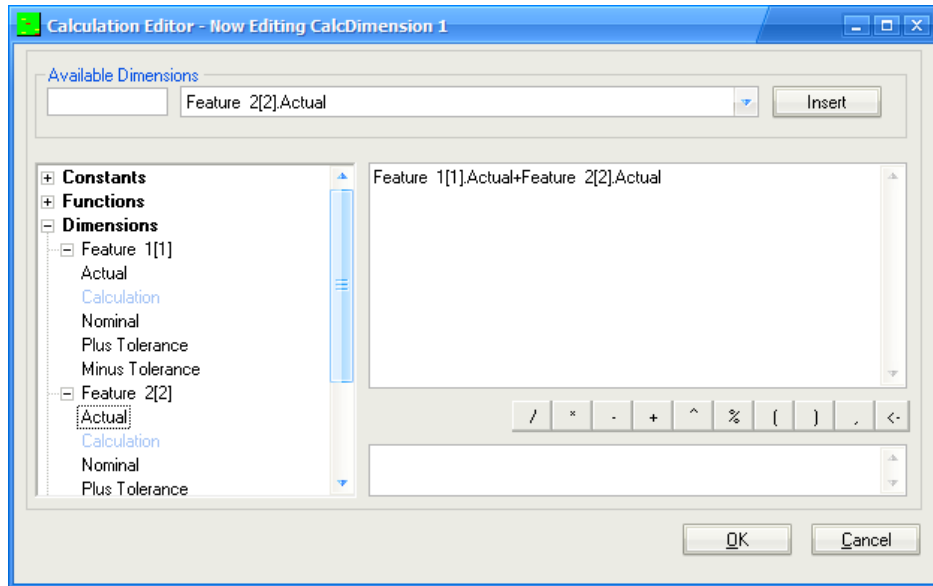
Select Dimension(s)
 Dimensions:
 (1) Feature 1
 (2) Feature 2
 (3) Feature 3
 (4) Feature 4
 (5) Feature 5
 (6) Feature 6
 (7) ManDimension 1
 (8) CalcDimension 1
 + Numeric Factors
 + Text Factors
 + Assignable Causes
 + Corrective Actions

Nominals & Tolerances Limits
 Feature Label - 32 Characters Max: My Calculation
 Dimension Information:
 Dimension Source - 64 Characters Max:
 Feature Source: Calculated
 Nominal Value: 0.0
 Plus Tolerance: 0.00005
 Minus Tolerance: -0.00005
 Number of Decimal Places: 4
 Calculation: None
 Tolerance Type: Bilateral
 Prevent Nominal Update:

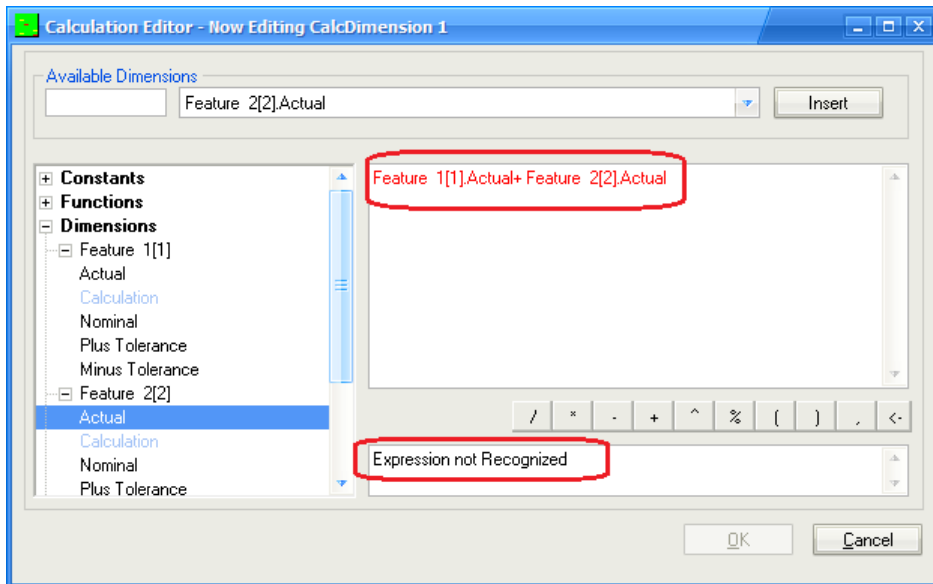
Apply Changes To Selection OK Cancel

20.5 Edit the Equation

By clicking the white area of the Calculation property, an equation editor is displayed. Here we selected **Feature 1 Actual**, added a plus sign, and selected **Feature 2 Actual** from the list as our simple calculation. Click **OK** and the column containing the calculated dimension is updated. However, the nominals and tolerances have not been set correctly so all values are shown as our of specification. Follow the directions in the [Enter Nominals & Tolerances](#) section on page [86](#) for more details.



Tip: You **cannot** enter <spaces> in your equation. If you do, the equation is displayed in **red** letters and you are not able to save it.



20.6 Update Calculations

As you enter values into the database, the Calculated dimensions are not updated automatically. As shown in the screen below, records 15 and 16 of Feature 1 and Feature 2 have new values entered yet the Calculated dimension still shows 0.000. To update the calculations, select the **Edit – Update Calculated Dimensions** menu to force a complete update of all records.

QC-CALC SPC (3.4.10) - [Sample.qcc]

File Edit View Group Report Tools Window Help

SPC Subgroup Size: 5 Real-Time Subgroup Size: 1 File Path: C:\Prolink\QC-CALC 3.4\Data\

Record	(1) X Hole Position	(2) Y Hole Position	(17) ManDimension 1	(18) My Calculation	(1) C
8 0008	1.0003	2.0014	0.0000	3.0017	
9 0009	0.9993	1.9984	0.0000	2.9977	
10 0010	1.0005	1.9991	0.0000	2.9996	1
11 0011	0.9998	2.0018	0.0000	3.0016	1
12 0012	1.0009	2.0004	0.0000	3.0013	1
13 0013	1.0003	2.0008	0.0000	3.0011	1
14 0014	0.9999	1.9997	0.0000	2.9996	1
15 0015	0.9999	1.9988	0.0000	0.0000	1
16 0016	0.9998	1.9992	0.0000	0.0000	1
17 0017	0.9997	1.9997	0.0000	2.9994	
18 0018	1.0002	2.0000	0.0000	3.0003	
19 0019	1.0004	2.0002	0.0000	3.0006	

Last Written Record: 100 Records Sorted By: (Ascending) Dim

Remember, QC-CALC stores the calculated results in the database not the equation so you can treat the Calculated dimension the same as any other dimension.

21. Database Functions

21.1 Compact Database

This option allows you to remove any records marked for deletion from the file. If the file is circular and has been previously filled, the file is reordered placing the oldest record at record 1 and the newest record at the maximum number of records, if there are no records marked for deletion. While compacting, any record marked with a different color (deleted) is removed from the file and the records will be renumbered to cover the holes left by the removed records. This operation can only be done if you own the file.

21.2 Purge

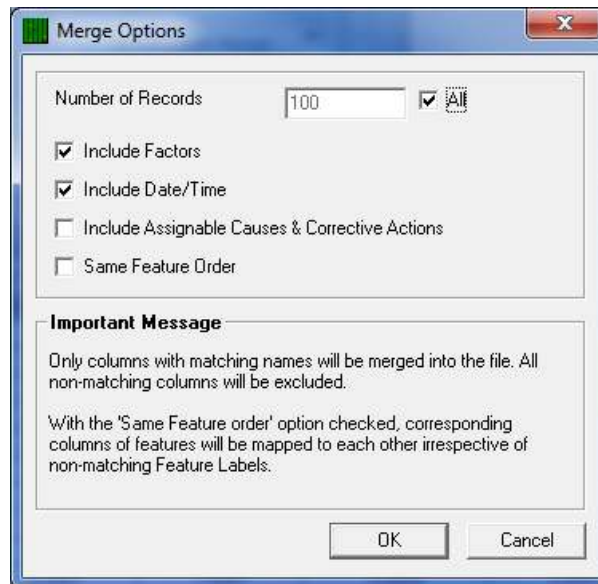
This option allows you to replace all of the actual data in a file with zeros. The last written record value and the time and date values are set to zero, but the nominals, tolerances, and labels keep the values they previously had. Be careful with this option since you will lose all of your data. You will be asked to type a random number before the Purge will occur.

21.3 Merge

21.3.1 Introduction

The merge function is found by clicking on the **File – Merge** menu. The merge tool allows you to import a selected number of records into the active database from another QC-CALC database. After you choose the source of the data to merge into the active database, there are several options available to control how the merge occurs.

The first step in a Merge is to open the QC-CALC file you wish to add this extra data to. Now select **File – Merge** and select the file containing the source of the data to add to this active file. After you click **OK** on the file dialog box, the following screen is displayed.



21.3.2 Number of Records

The records chosen to merge in are always the most recent records from the source database. You have two options here. You can either choose to specify the number of records to merge, or else check the **All** checkbox. This will give you the maximum number of records available to merge. If you do not specify the

number of records, QC-CALC will automatically calculate the maximum number of records available in the source file or the number of records there is space for in the destination file.

21.3.3 Include Factors

Checking this box will import the Factor values for each record from the file that is being merged with the active file.

21.3.4 Include Date/Time

Checking this box will import the Date and Time values for each record from the file that is being merged with the active file.

21.3.5 Include Assignable Causes & Corrective Actions

Checking this box will import the Assignable Causes and Corrective Actions for each record from the file that is being merged with the active file.

21.3.6 Same Feature Order

When checked, QC-CALC will assume that the dimensions from the source file are in the same order as the dimensions in the active file. It will therefore match the first dimension from the source file with the first dimension in the active file, the second with the second in the active file, and so on.

When unchecked, QC-CALC will assume that the order of the dimensions has been changed. For example: This will be true if the second dimension is missing, thus changing the position of all other dimensions after it. QC-CALC will therefore try to match up the dimension labels between the two files. They must match exactly or they will not be imported.

22. Groups

22.1 Introduction

QC-CALC SPC allows you to open multiple .QCC data files at the same time. This is useful when you have similar parts and want to use them as a group so your reports can span across multiple QC-CALC files. Another advantage of having groups is that you can apply a filter specific only to that group of .QCC files. All Group functionality is located under **Group** menu.

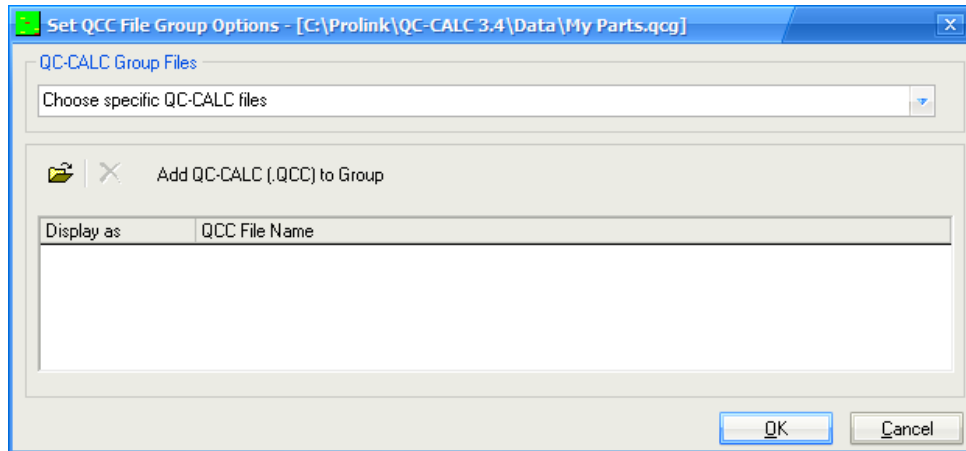
Normally, you open a QC-CALC file by using the **File – Open** menu. When you create and name a Group of files you must use the **Group – Open** menu when you wish to see this Group in the future. This automatically closes any currently active file or Group before displaying the Group to you.

The purpose of Groups is to tie together dissimilar data files created at different times and places. For example, suppose you use a probe CMM to obtain half of your inspection data and a vision system to gather the other half. Now you wish to create one report for all data instead of separate reports. You could add these two files to the Group and create one large report.

There is one other advantage to the Group functionality. A special Monitor capability is available for live, remote monitoring of inspection data. You can display live data as a single file running on an inspection machine in another location of your company. More details are available in this section.

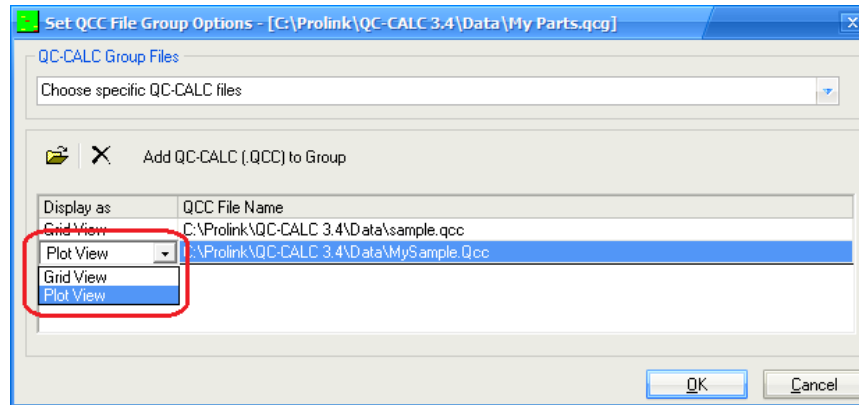
22.2 Create a New Group

To open multiple files you need to create a group file first. Select menus **Group – New** to begin the process. A dialog box is displayed where you give the Group a name. After clicking **OK**, the following window is displayed. The file name you use is given a file extension of .QCG and an empty Group window is displayed.



22.2.1 Choose specific QC-CALC files

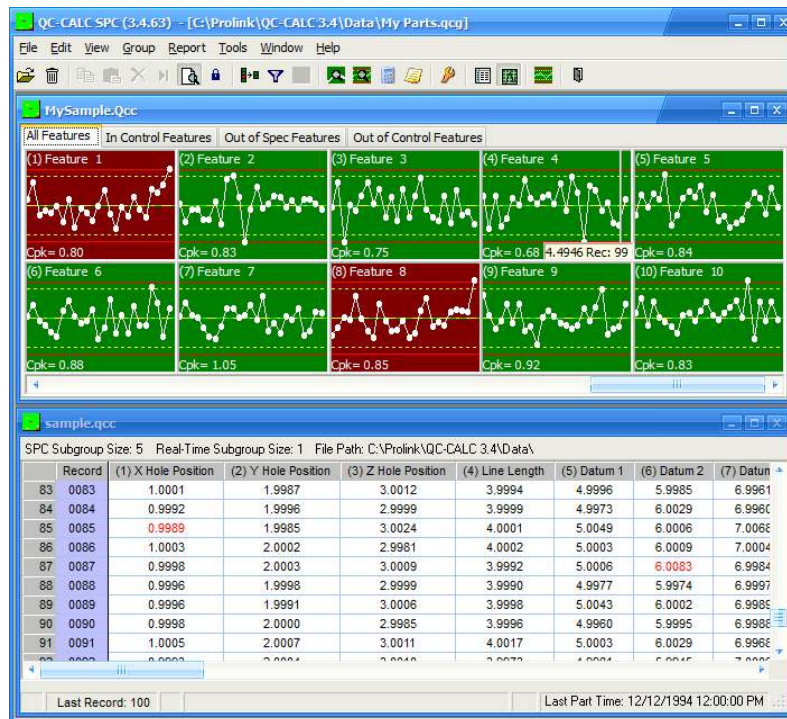
To add QCC files simply press the **File** button and multi-select the files you want to add to the Group. You can browse any file location to create the group. The folder path is shown with the name.



22.2.2 Display As

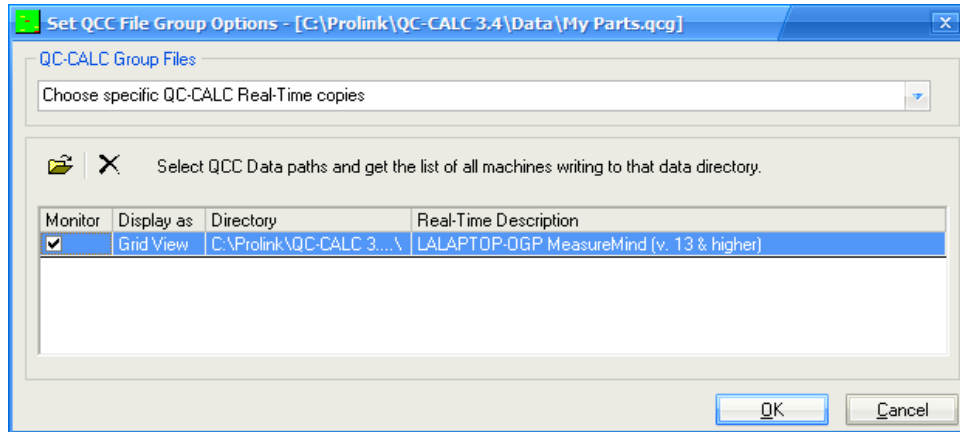
There are two methods to display the files, a spreadsheet of numbers (**Grid View**) or Real-Time plots (**Plot View**). You make this choice by clicking the mouse in the **Display as** window and a dropdown list box allows you to make your choice. Click **OK** to save and display your changes. At any time you can return and edit your choice by adding or removing QC-CALC files. Here we show a group of 2 files, one as Grid View and one as Plot View.

Each file opened within the Group is displayed as a “child” window within the “parent” QC-CALC main window. Each file in the Group can be a spreadsheet or a window of Real-Time plots. When many QC-CALC files are displayed at the same time they may overlap and become difficult to see. Use the **Window – Tile Horizontally** or **Vertically** to neatly arrange the separate child windows.



22.2.3 Choose specific QC-CALC Real-Time copies

When you choose to use the **QC-CALC Real-Time copies** option instead of the **QC-CALC Files** option, the Group will actually watch a specific copy of QC-CALC Real-Time that is collecting data. Instead of adding one specific file to a Group you are adding a directory (folder) where QC-CALC Real-Time copies are saving their data. You will be shown a list of all QC-CALC Real-Time copies that are saving data into that folder and you enable the ones you wish to monitor. The Group will display the currently active file for that copy of QC-CALC Real-Time. This means you can monitor a machine on the network, not just a file. As the CMM changes part programs and QC-CALC Real-Time reacts to these changes, you will see the active file change in QC-CALC SPC as well.



If you see more than one QC-CALC in the list this means several QC-CALC's throughout your company are adding data to this folder. For example, you might have 3 Zeiss Calypso machines saving to the same folder. To see the output of each machine, click the checkbox on the left side of each machine.

22.2.4 Most recent file within the specified folder

The **Most recent file within the specified folder** option is useful if there are multiple machines saving data into the same directory, but you just want to view the information for the very last part that ran.

22.3 Edit

This menu option allows you to add and remove files from the group as well as select their display format (Grid View or Plot View).

22.4 Delete Group

This option allows you to delete a group file from the QC-CALC directory.

22.5 Close Group

This option closes the current QC-CALC group file leaving all files closed.

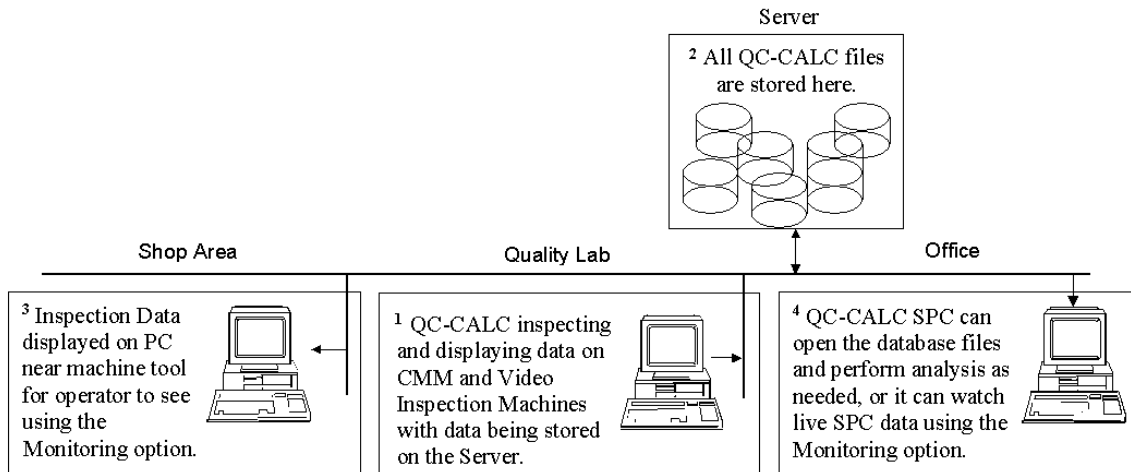
23. Monitoring

23.1 Introduction

“Monitor” is a built-in feature of QC-CALC SPC designed to monitor and display changes in QC-CALC database files. This feature is available if you are using QC-CALC RT to read and display your inspection results and want to display the real-time plots on another computer. As data is added to the files you’re monitoring, the screen (plots or spreadsheet) is updated with the new data. These are live, local screens that mimic the distant QC-CALC program usually found in the Quality lab. You can monitor a single file or a group of files. Another option allows you to monitor a directory and automatically switch to the current file that is being written to by the QC-CALC Real-Time on the inspection machine. See the [Create a New Group](#) section on page [105](#) for more details.

23.2 The Concept Explained

The basic idea, as described on the diagram below, is to use a shared file server somewhere on your internal network. You will undoubtedly require your IT department to establish the shared area on a server. For discussion purposes, let’s assume you have a shared drive called S:\SPC\Data\ where all QC-CALC SPC data is saved.



Remember, each QC-CALC Real-Time running in your CMMs, Video systems, or QC-Gage stations writes the data to the S:\SPC\Data\ drive. And, each copy of QC-CALC SPC running at your desk or maybe the shop area is used to read, display, and analyze the data. Many copies of QC-CALC SPC can read the same file at the same time thereby enabling you to display the live data throughout the facility while you create histograms on your office PC. The first step is to measure a part so we will begin in the Quality Lab.

1. In the Quality Lab QC-CALC runs in the inspection machines and reads the inspection results files. The data is then saved on the server in QC-CALC format and displayed locally.
2. The Server stores the inspection results from many QC-CALC programs running on various CMMs and QC-Gage stations at various locations.
3. Monitor displays the part geometry in the shop area to the machine operator as live plots for instant feedback.
4. The Office copies of QC-CALC are used for historical analysis. The office worker can open the QC-CALC database files and perform analysis or watch live SPC data using Monitor

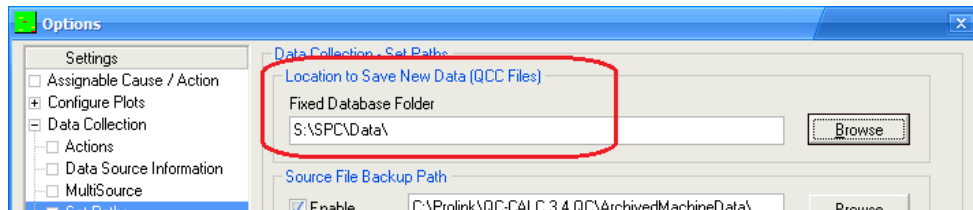
23.3 Installation & Setup

1. Copy the contents of the supplied CD into a folder on your shared server drive called **S:\SPC\QC-CALC**. This will be the location of the installation software during all setups. We will also save all future updates of QC-CALC which we will explain later.
2. Visit each PC that will be running QC-CALC and run the SETUP.EXE found on **S:\SPC\QC-CALC** and install QC-CALC in the PC.

23.3.1 On the CMM PC

If the PC you just installed QC-CALC into is a CMM, Video system, or a QC-Gage data collection with QC-CALC, do the following

1. Run QC-CALC Real-Time by double clicking the desktop icon
2. Select **Tools – Options** from the menu.
3. Select **Data Collection – Set Paths** in the **Settings** screen
4. Choose the **Fixed Database Folder** option and browse to the **S:\SPC\Data** folder
5. Now click **OK**

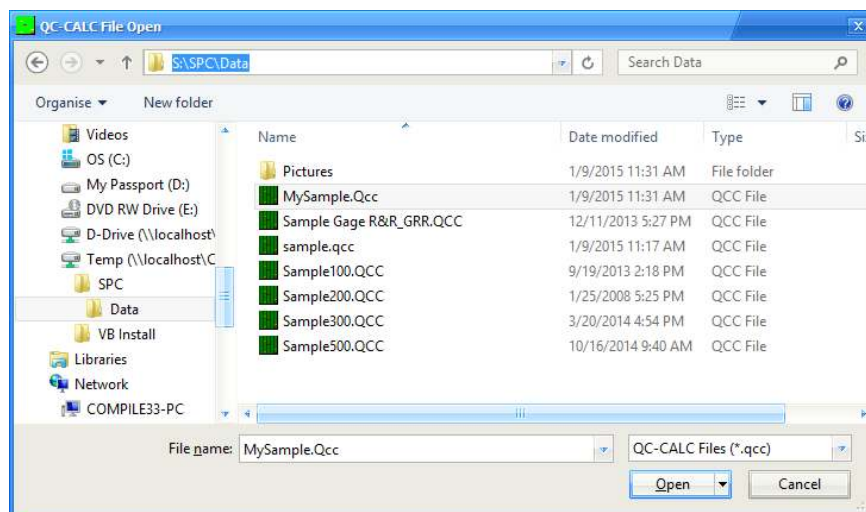


This setting will force QC-CALC to always save inspection data to the **S:\SPC\Data** drive making it available for all other QC-CALC's to read. You should copy all existing .QCC files (if you have any) from your local data area to make it available to others.

23.3.2 On the Office or Shop PC

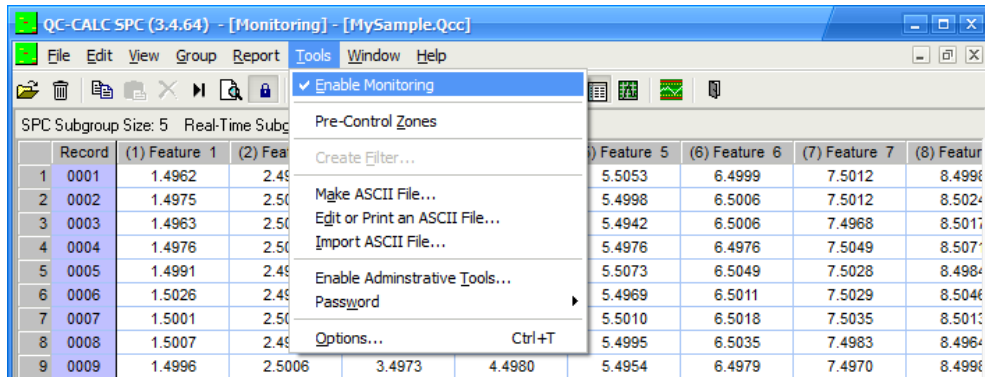
If the PC you just installed QC-CALC into is in the office or the shop floor for Monitor display, do the following:

1. Run QC-CALC SPC by double clicking the desktop icon
2. Select **File – Open** from the menu and select your S: drive.



3. Now open any .QCC file you find there. There should be some files if your CMM has been collecting data. If not, you can copy the sample files shipped with QC-CALC found in the QC-CALC data folder on your C: drive.

4. Lastly, you must turn on the monitoring capability by selecting the **Tools – Enable Monitoring** menu as seen in the next diagram.



5. From this point forward, any file opened on this computer will automatically update the live screen when new data is added to the .QCC file from another QC-CALC.

23.4 Exiting Monitor

To exit or turn off Monitor simply select the **Tools – Enable Monitoring** menu which removes the check mark next to the menu. This action toggles between checked and unchecked.

23.5 Network Issues

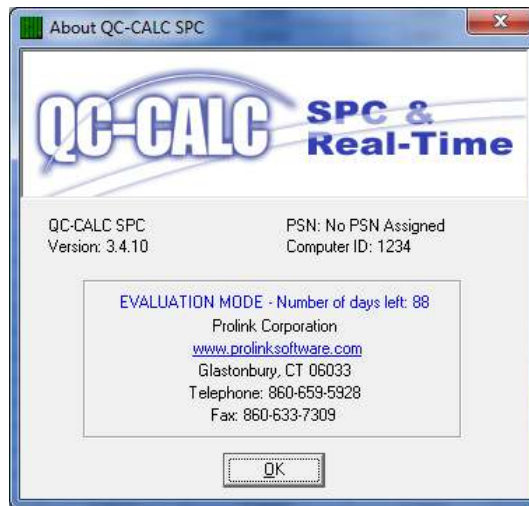
Occasionally, networks or servers interrupt the data flow by crashing. Should this happen, Monitor will lose connection with the files you are monitoring. You can refresh the screen by pressing the F5 key or menu **View – Refresh All Files**. F5 is the hot key to reconnect to the server should the plots stop updating. If the network loss causes the program to crash, simply restart QC-CALC.

24. License Configuration

24.1 Introduction

All copies of QC-CALC are installed as evaluation copies whether you purchased it or not. When you run QC-CALC for the first time you see a “splash” screen indicating the software has 30-Run Days Remaining. You may select the **Help – About** menu to see this screen.

An evaluation period of 30-run days means you can run the software for 30 non-consecutive days. This means if you use it today and don't use it for a week, when you return, you still have 29 days remaining. You can visit our website to extend your evaluation period without calling our office.



All users of QC-CALC must activate it by one of several methods. This section of the manual discusses the various activation options.

24.2 The Purchase Cycle

Our website provides an excellent method of purchasing, updating, and distributing our software. You may still order QC-CALC through our sales agents or your local equipment distributors and we encourage you to do so. However, you should visit our website to become familiar with the options the site offers. If you purchase QC-CALC via the internet the basic purchase cycle is:

1. Download an evaluation copy of QC-CALC from our website.
2. Install and tryout the software for 30 days.
3. Purchase the software via charge card, purchase order, or Paypal.
4. Activate software by visiting our website and obtain the Activation Code.

If you purchased the software from a sales agent or equipment manufacturer the process is a little different.

1. Purchase the software via sales agent.
2. Install software from the CD and use for up to 30 days.
3. Activate software by visiting our website and obtain the Activation Code.

In either case, your free updates and notifications are present on our website so you should visit it to see “what's new”.

24.3 License Activation Details

All software is activated through our website, www.ProlinkSoftware.com but more traditional methods still are available. When you purchase, install, and are ready

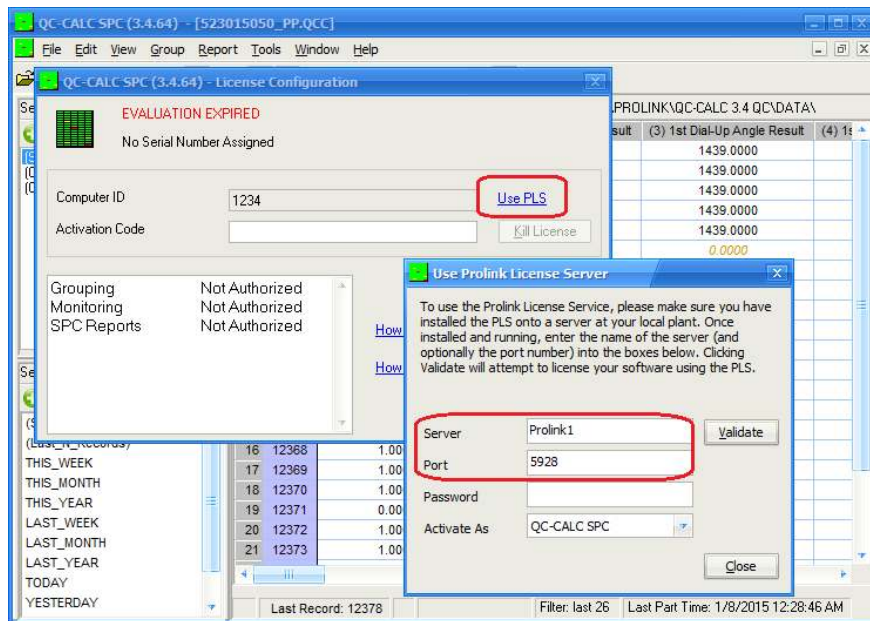
to activate our software you must visit our **website** and log in to **My Account** to obtain and Activation Code.

24.3.1 License Activation via Prolink License Server

In the QC-CALC Real-Time example below, we chose the **Help – License Configuration** menus and clicked the **Use PLS** link. The **Use Prolink License Server** window appeared requesting the following:

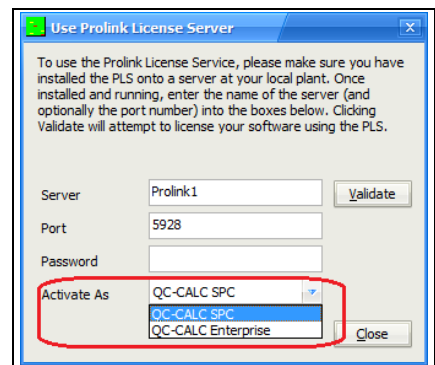
- The **Server** name – the name of computer PLS is installed within your company.
- The **Port** – 5928 by default but can be changed throughout your company.
- An optional **Password** – if a password was setup in PLS, you will have to enter it here. The password is intended to stop unintended licensing.

Clicking the **Validate** button causes QC-CALC to request a license from PLS and PLS to request a license from the Prolink website via the Internet. The license is automatically set into to the software and you are done. Remember, the **Port** number is the port used within your facility not the Internet.



For a few of the Prolink programs there are a couple options for how to license the software. For those programs the **Activate As** option will be available and you should choose the correct program from the list. This is important because you don't want to use a QC-CALC Enterprise license when you really only need a QC-CALC SPC license. Another computer may need the QC-CALC Enterprise and wouldn't be able to use it since it had already been taken.

For more information on this option or to download the Prolink License Server go to the **My Account > My Licensing** area on www.prolinksoftware.com.



24.3.2 License Activation on Web

After you purchase your software and are ready to activate it, go to our website, click on **My Account** and login. This is your "**My Account**" screen. You see:

The area in the center of the screen is labeled **My Software**. In this box click the **Activate** link next to the product you wish to activate. You are presented with the following window asking you for a **Friendly Name** and your **Computer ID**.

Product Name: QC-CALC SPC

PSN: 14622

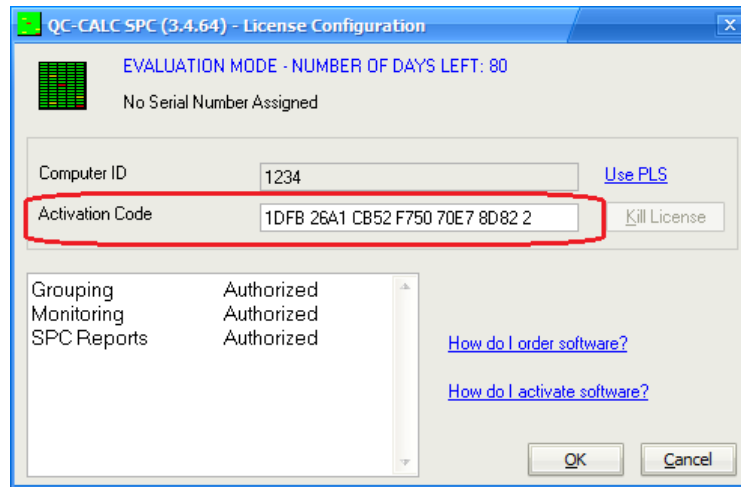
Computer ID: 1234

Machine Description: John's Blue CMM

Activation Code: 2763 2D92 4232 FA16 D0D2 97D3 6

Remember to use the correct **ComputerID** for the machine you are activating this software for which is found in **Help – License Configuration** of QC-CALC. Click the **Get Authorization Code** button and the code is displayed. It is this number you enter into the **License Configuration** screen. The Friendly Name is intended to be a name that helps you identify the machine you are activating. Remember, if you have 3 CMMs and they are very similar it might be hard to remember which machine you're viewing when you come to the website so use something descriptive to that machine. You might use a machine serial number or other identifiable name.

Back in QC-CALC enter the **Activation Code** that was provided into the **Help – License Configuration** screen and click the **OK** button. Your software is now activated.



24.4 License Activation (manually)

Each copy of QC-CALC is installed on an individual PC Personal Computer and must be activated using the license screen. Select the **Help – License Configuration...** menu to access the license screen. The basic concept of activating your purchased software is:

1. Select the **Help – License Configuration...** menu and a **Computer ID** number is generated by QC-CALC. You cannot change this number.
2. Supply the **Computer ID** to Prolink
3. Prolink generates and provides you with the **Activation Code**.
4. Enter the **Activation Code** into the box provided and click the **OK** button.
5. You will be shown a confirmation screen to tell you the license was accepted.

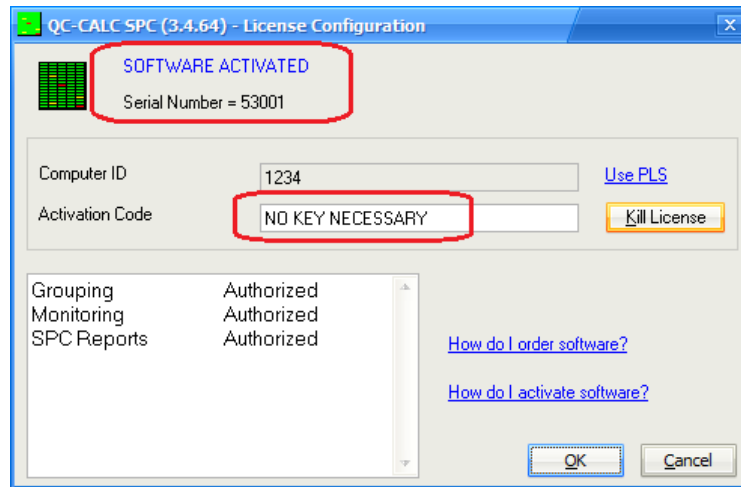


6. Looking at the **Help – License Configuration** screen again will show you that the software is now licensed.

24.5 License Screen Details

24.5.1 Introduction

Most of this window is self-explanatory but various aspects are detailed here.



24.5.2 Top of Window

The top of the license screen displays the status of your license. If you are running an evaluation copy it tells you how many days are left until the evaluation period expires. If it is a full purchased copy that has been activated it reads, "SOFTWARE ACTIVATED".

Your serial number is printed on the second line. From time to time you will supply the serial number to Prolink during phone support or identifying your software on the website. This serial number is available by choosing **Help – About QC-CALC SPC**.

24.5.3 Computer ID

The number that appears in this area is generated by QC-CALC and is considered your PC's identification number. This helps you identify which copy of QC-CALC you are working with and it is the origin of the **Activation Code**. If you have purchased multiple copies of QC-CALC, it makes it easier to identify which copy you are discussing with our support staff or the website.

24.5.4 Activation Code

If the **Activation Code** is blank it means you have not activated the software and you are still running an evaluation copy. Your **Activation Code** is issued by our website or by Prolink personnel. The **Activation Code** contains 6 groups of 4 and 1 single character at the end which totals to a 25 character code. This code consists of numbers 0 - 9 and letters A – F. (i.e. 0103 EEF4 ADDD 603B AB2A 9CE9 4). After entering an **Activation Code** and clicking the **OK** button, the **Activation Code** disappears and is replaced by "NO KEY NECESSARY" in order to avoid any confusion. The current software status is displayed at the top of the window.

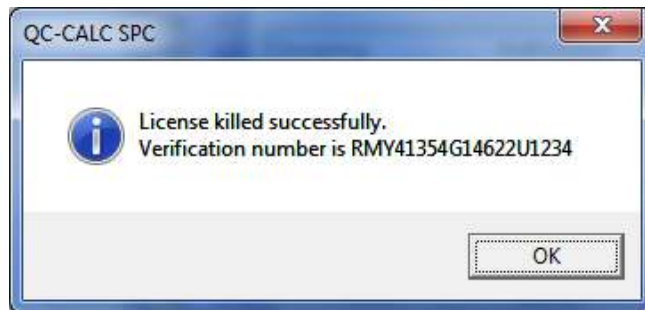
24.5.5 Options Area

The **Options** area displays the options activated by the **Activation Code** you entered. Most of the options are included with the standard software but some options may be turned off in the future to reduce the software cost. They include:

Grouping	Authorized
Monitoring	Authorized
SPC Reports	Authorized

24.5.6 Kill License

This option is used to remove the QC-CALC license on a particular machine. We use this option to transfer a license from one computer to another. You are asked if you are sure before the license is removed. When successful a dialog box is displayed verifying your action.



You will read this number to a Prolink support staff member to allow you to move the license to a different machine. But in most case this is not required.

25. File Menu

25.1 New

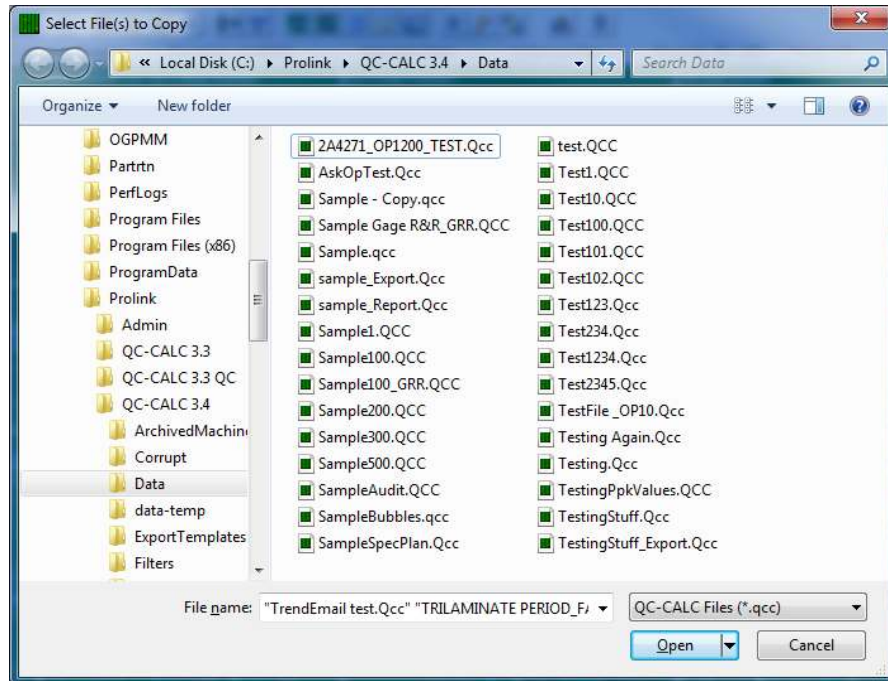
For details on this see the [File – New](#) section on page [83](#).

25.2 Open

Use this option to open and work with an existing QC-CALC file. Select the file you want to work with from the file dialog box. When a file is opened, it becomes active for all subsequent QC-CALC operations. The active file name is displayed at the top of the **Main** menu screen. Only one file can be open or active at a time unless you create a **Group** of .qcc files. See the [Groups](#) section on page [105](#) for more details.

25.3 Copy

You use this option to copy one or more QC-CALC files to other directories or disks. A list of QC-CALC files is displayed in the file dialog box. As with most Windows programs, point and click the file(s) you wish to select then click **OK**. If you want to select more than 1 file, use the Multiple File Selection.



Select all of the files you wish to copy to another folder. Click **OK** when your selection is complete.

Next, another file dialog box is displayed but no file names are presented. QC-CALC is requesting that you select the destination folder location. Click **OK** after making your selection.

25.4 Copy File As

You use this option to make a copy of the active file. The active file becomes inactive and the new copy with the new name becomes the active file.

25.5 Delete

This menu item provides a convenient method of removing unwanted QC-CALC files. A dialog box is displayed, you pick all .QCC files you want deleted, and click the **Open** button. You are asked “Are you sure you want to delete this file?” If you select **Yes**, the files are removed.

25.6 Modify Database Structure

This menu allows you to change the settings of the structure of the currently open data file. See the [Modify Database Structure](#) section on page [93](#) for details.

25.7 Rename/Move File

This menu is used to rename your .qcc files and/or move them to another folder. There are many support files that are used in conjunction with your .qcc file and using this menu will rename and move those files along with your .qcc file.

25.8 Merge

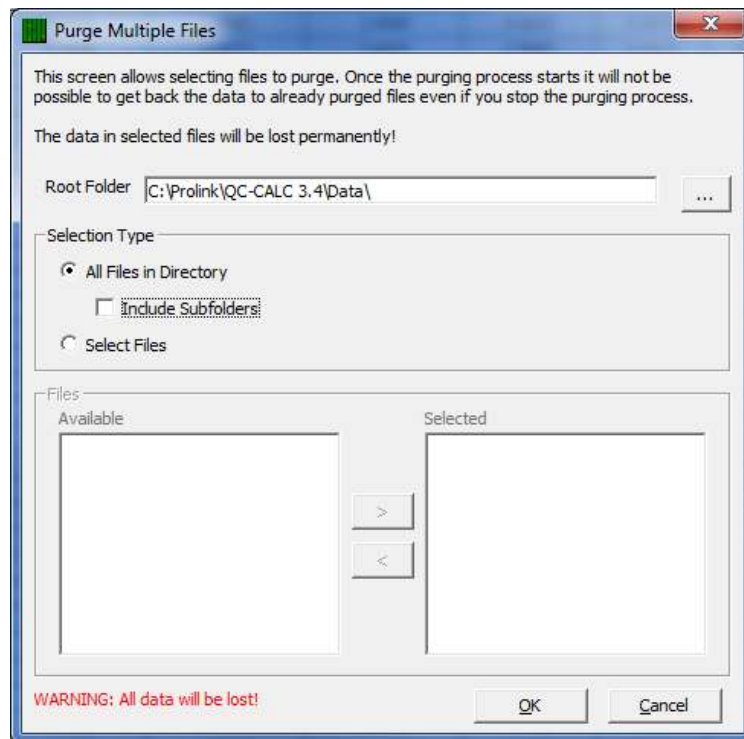
For details see the [Database Functions](#) section on page [103](#).

25.9 Purge

For details see the [Database Functions](#) section on page [103](#).

25.10 Purge Multiple Files

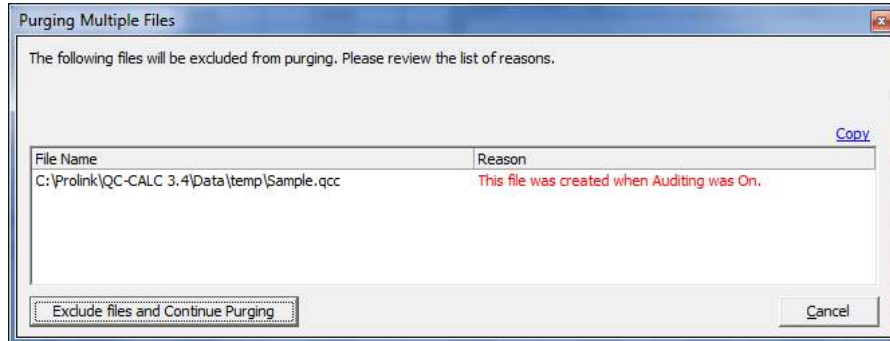
This screen is used to select multiple files to be purged. All files chosen will be processed one by one and cancelling at any point will not recover data in files that have already been purged.



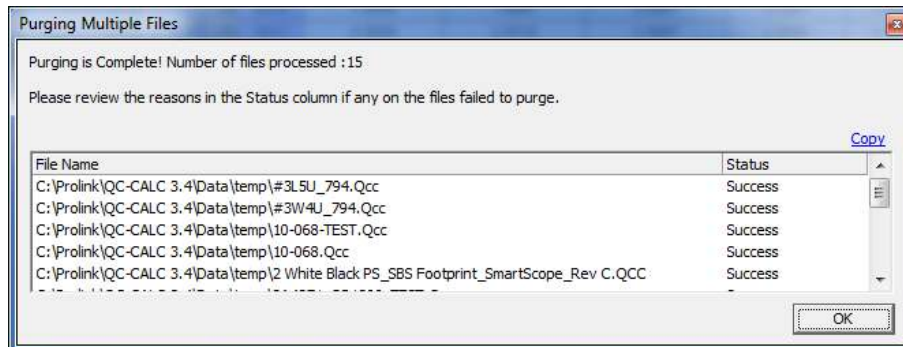
The **Root Folder** will be used as a starting point for selecting files. If the **All Files in Directory** option is chosen then all files found in the **Root Folder**, and any subfolder if that option is checked, will be purged.

If the **Select Files** option is chosen then the **Files** area at the bottom will be populated. All .qcc files found in the **Root Folder** will be listed in the **Available** column and any you want to purge should be moved to the **Selected** column on the right.

Once the folder location and files are chosen QC-CALC will check to see if there are any files that cannot be purged. If files are found that cannot be purged the next window appears showing the results of that check and giving you the choice of continuing the process or cancelling. The **Copy** link can be used to copy the list of excluded files to the Clipboard. **NOTE:** Any files used with Auditing enabled cannot be purged.



Once the purging has finished a screen showing the names of the files that were purged will be shown. The **Status** column will show “Success” or “Failed” and the **Copy** link can be used to copy the list of file names to the Clipboard to be pasted anywhere you choose.



25.11 Compact Database

For details see the [Database Functions](#) section on page [103](#).

25.12 Show QC-CALC Real-Time

This option is used to open QC-CALC SPC.

25.13 Exit

This option exits the program.

26. Edit Menu

26.1 Nominals and Tolerances

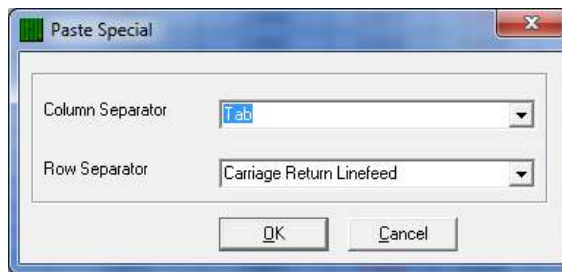
For details see the [Enter Nominals & Tolerances](#) section on page [86](#).

26.2 Copy / Paste

(Grid View only) - Copy selected data to the clipboard, or Paste data from the clipboard into selected grid cells.

26.3 Paste Special

(Grid View only) - Use this tool to transfer copied information from an ASCII format into the active database file. This allows for multiple lines of delimited data to be parsed and pasted into a block of the grid. After selecting **Edit – Paste Special**, choose or enter what was used to separate the information by column and row. Then choose the location to paste the data.



26.4 Fill

(Grid View only) - The Fill option helps you quickly fill a block of cells with the same value. When this choice is selected, the value in the first cell is used to fill all highlighted cells in the direction specified by the submenu you chose. Fill will not fill records excluded by a filter.

26.4.1 Fill for Gage R&R

When this menu option is selected a dialog box pops up asking you to fill in the number of parts, operators, and trials. Once your selections have been made QC-CALC will automatically fill the Part, Trial, and Operator Numeric Factor columns with ordered values. The order used will be Parts 1 – 10 for Trial 1 and Operator 1, followed by Parts 1 – 10 for Trial 2 and Operator 1 again. Once all trials have been finished for Operator 1, Operator 2 will be filled in and will continue in that order until all Part, Trial, and Operator values have been filled in.

26.5 Delete/Undelete Point(s)

Use this menu option to mark points as deleted. Once a data point is deleted it is shown both in the grid and in a graph as a different color, but is not removed completely from the database. This way if you decide to keep the data point you may select **Edit – Delete/Undelete Point(s)** again to undelete the data point.

26.6 Delete/Undelete Record(s)

Use this menu option to mark records for deletion. The data isn't deleted automatically however. Instead, once selected a different color appears over the entry. This way if you decide to keep the data you may select **Edit – Undelete Records in Current View**. This will remove the new color. To fully delete the data points mark them for deletion and then select **Tools – Compact Database**.

26.7 Undelete Records in Current View

QC-CALC uses a different color to mark records for deletion. This menu choice removes all gold (deleted) points from the **Grid View** screen. This will not affect your data, but any calculations will be done using all the data.

26.8 Add Record

(Grid View only) - This menu is used to add additional records to the end of the currently open database. This is mainly used to hand enter data into new records. When you choose this item you will be asked how many records you wish to add to the file.



26.9 Update Fails Column

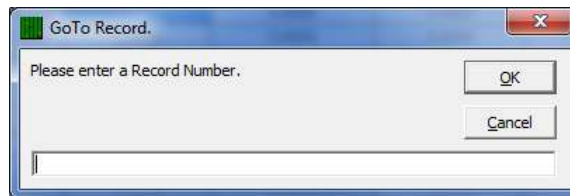
If new data has been recorded you may use this tool to update the fails column. This will update the total number of dimensions that have measurements outside of the tolerance limits, for each record.

26.10 Update All Calculated Dimensions

This menu choice will reapply the calculation for all calculated dimensions to all records in the file. This process may take a while depending on the size of the file.

26.11 GoTo Record

(Grid View only) - This menu choice asks you to enter a record number, then it will show that record at the top of the data grid.



26.12 Go to Last Written Record

(Grid View only) - The lower left corner of the **Grid View** window contains a area labeled **Last Written Record**, which is used as a link to move the cursor to the newest data entered into the database.

26.13 Sort Records

(Grid View only) - Use this menu option to sort the record by Ascending (First → Last) order, Descending (Last → First) order, or Order Received.

If you click in a dimension column, then choose to Sort the Records in Ascending order, the order of the records in the file will change so that the data shown in that column is in numerical order with the smallest values at the top and the largest at the bottom of the column. The Record Number column will reflect the current order of the records.

26.13.1 Order Received

If the order of the records has been modified and you would like to return them to the order in which they were received initially from the inspection machine, then use this menu option.

26.14 Sort Dimension Labels

(Grid View only) - Similar to sorting records, this menu option allows you to sort the dimensions present in the active database file. Sorting options are Ascending (First → Last) order, Descending (Last → First) order, or Order Received.

26.14.1 Order Received

If the order of the dimensions has been modified and you would like to return them to the order in which they were received initially from the inspection machine, then use this menu option.

26.15 Point Properties

(Plot View only) - When you are viewing the **Point Properties** window you may wish to change a value you see. In order to do this you need to turn on the editing mode for the Point Properties area by using this menu.

26.16 Plot Properties

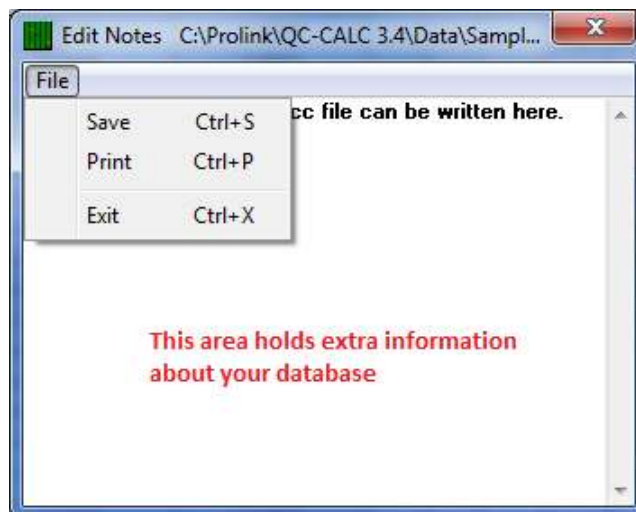
(Plot View only) - When you are viewing the **Plot Properties** window you may wish to change a value you see. In order to do this you need to turn on the editing mode for the Plot Properties area by using this menu.

26.17 Lock Editing

This menu item is available to prevent you from typing or overwriting data in the **Point Properties** window (QC-CALC Real-Time) or the Grid View grid (QC-CALC SPC). In addition, once this item is checked, a supervisor can lock down this menu item by using the **Tools – Password – Lock Menus** menu or the **Menu System Manager** option within the Admin Tool and ensure that no data values can be changed once the data has been collected.

26.18 Notes

From time to time it may be to your advantage to make notes concerning the data, parts, or procedures involved. QC-CALC makes this possible by providing a one-page area to write notes and details that you will want to remember or pass along to another person using the same file.



27. View Menu

The purpose of the **View** menu is to customize which items are displayed on the screen.

27.1 View as Grid View/ Plot View

Selecting **View – Plot View / Grid View** toggles the active window between a grid interface and a plot interface. With the **Grid View** interface you are able to work with all of the stored inspection data or with a selected subset by using filters on items like Lot Number, Operator, Inspection Date, Machine Number, etc. in a spreadsheet-style format. The **Plot View** interface contains a plot for each feature being measured. Each plot contains the plot background color, nominal and tolerance lines, text, and data points. The same filtering options are also available while in Plot View mode.

27.2 View Graph Types

27.2.1 Add Range Charts

This option shows a graph displaying the Range values for each subgroup just below the Average chart in Plot View. This is only available with a Subgroup Size greater than 1.

27.2.2 Remove Range Charts

This option removes the Range charts turned on in the menu above.

27.3 View Items

27.3.1 Toolbar

This menu turns on and off the display of the Toolbar.

27.3.2 Status Bars

At the bottom of the QC-CALC SPC window is a Status Bar that shows pertinent information about the currently displayed data.

Last Written Record: 100	Records Sorted By: (Ascending)	Filter: Cavity 1	Dimension Filter: M	Last Part Time: 12/12/1994 12:00:00
--------------------------	--------------------------------	------------------	---------------------	-------------------------------------

Last Written Record

The first section of the tray is used to display information that does not require a response. Normally, you will see the latest QC-CALC record number received here. Use this as a reference or click on the label to be brought to that record.

Status Area


The remaining sections of the information tray display the Sort order being used for Records or Dimension, any Filters that are applied, and other information that is self-explanatory.

27.4 Panels

The Real-Time screen has special docked information panels you can display on the left-side of the plot screen. These windows contain several categories of information. For example, you might want to know information about each point within a plot such as its value, the date and time, etc. This window is known as the **Point Properties**. Or, you might want to know details about each plot such as nominals, tolerances, control limits, etc. This window is known as the **Plot Properties**. Others might want to see statistical calculations of the displayed data known as the **Quick Stats** window.

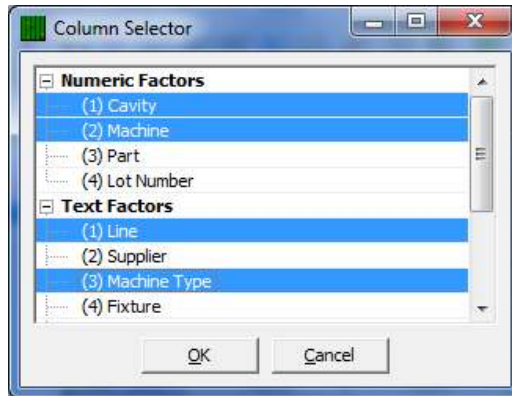
The **View** menu contains all of these panels and more. The collection of 10 separate panels is referred to as the **Information Panel**.

27.4.1 Dimension Filter

See the [Dimension Filters](#)  section on page 19 for details.

27.4.1 Columns to View

This menu displays the **Column Selector** so you can choose the extra columns of information you wish to see in the **Grid View** screen. These extra columns appear to the right of the dimension columns.



27.4.2 Record Filters

See the [Record Filters](#)  section on page 21 for details.

27.4.3 Point Properties

(Plot View only) - Each point in each plot has specific properties you might want to investigate. For example, you may want to see the actual value of the point or a calculation result.

There are 3 methods of displaying the **Point Properties**:

- Use menu **Window – Point Properties** (unlocked view of data)
- Use Toolbar icon for **Point Properties** (unlocked view of data)
- Use **Right Click** menu – **Point Properties** (locked view for editing of data)

Unlocked means the **Point Properties** window updates as you float the mouse over different points in each plot. This is useful for rapid investigation of each point. When you right click a specific point in a specific plot and choose **Point Properties**, QC-CALC deliberately stops the updating (**Lock**) so you can focus on changing the details of that specific point.

You may edit some of the values within the **Point Properties** window. Press the **F6** key to lock and unlock editing.

Watch Individual Values Change

When the **Point Properties** Window is displayed, watch the values change as you move the mouse around the screen. Note that **Point Properties** change within each plot while the Plot Properties change as you move from plot to plot.

Record	3
Dimension Label	Feature 1
Date	2/5/2013
Time	10:27:10 AM
Value	1.5007
Deviation	0.00069
Lot	22
Operator	Bruce
Assignable Cause1	None
Assignable Cause2	None
Corrective Action1	None
Corrective Action2	None
Fails	0

27.4.4 Plot Properties

(Plot View only) - The **Plot Properties** window can be displayed with or without the **Point Properties** window. Each plot has properties that you may wish to see by floating the mouse over each point.

As you move the mouse over each point, the plot properties does not change. This is due to the fact that all points within each plot have common properties such as Label, USL, Nominal, etc. So to see the **Plot Properties** change you must move the mouse over a different plot.

You may edit some of the values within the **Plot Properties** window. Press the **F7** key to lock and unlock editing. The USL and LSL are calculations and are not editable. The Calculation is only editable when the plot is a calculated plot.

Plot Properties (Editing Locked) ? x	
Label	Feature 4
Dimension Informat...	
Dimension Source	
USL	4.5100
Plus Tol	0.0100
UCL	4.5080
Nominal	4.5000
LCL	4.4920
Minus Tol	-0.0100
LSL	4.4900
Precision	4
Calculation	None
Tolerance Type	Bilateral

27.4.5 Quick Stats

The **Quick Stats** window can be displayed with or without the **Point Properties** and the **Plot Properties** window. Each plot has calculation that you may wish to investigate by floating the mouse over each point within a plot. These are simple stat calculations used for quick, no-print reports. Remember, any points or records shown as deleted are not involved in the display calculations.

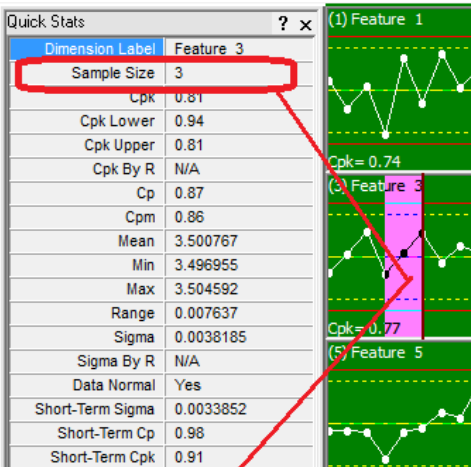
As you move the mouse over each point, the stat calculations no not change. This is due to the fact that all points within each plot are involved in the calculation. So to see the **Stats Calculations** change you must move the mouse over a different plot.

There is nothing editable in this window since every item is the result of a calculation. However, if you change a Point or Plot Property the calculations in this window are updated to reflect your change.

Selecting Points with the Mouse

You can select a reduced number of points on each plot by holding the left mouse button down and then dragging across the points of interest. QC-CALC highlights these points in a complimentary color. Looking closely at the plot, we see 6 points are highlighted. It may be easier to view the second line in the **Plot Properties** since it tells us how many are highlighted. Remember, all calculations are now being made on the highlighted values only.

Quick Stats ? x	
Dimension Label	Feature 5
Sample Size	15
Cpk	0.87
Cpk Lower	1.16
Cpk Upper	0.87
Cpk By R	N/A
Cp	1.01
Cpm	0.93
Mean	5.501447
Min	5.496788
Max	5.506691
Range	0.009903
Sigma	0.0032865
Sigma By R	N/A
Data Normal	Yes
Short-Term Sigma	0.003317
Short-Term Cp	1.0
Short-Term Cpk	0.86



Quick Stats ? x	
Dimension Label	Feature 3
Sample Size	3
Cpk	0.81
Cpk Lower	0.94
Cpk Upper	0.81
Cpk By R	N/A
Cp	0.87
Cpm	0.86
Mean	3.500767
Min	3.496955
Max	3.504592
Range	0.007637
Sigma	0.0038185
Sigma By R	N/A
Data Normal	Yes
Short-Term Sigma	0.0033852
Short-Term Cp	0.98
Short-Term Cpk	0.91

There are 3 points highlighted giving you Quick Stats on just the 3 points.

27.4.6 Data Notes

There are times you need to add notes to an individual point or even an entire plot. The **Data Notes** panel is used to display the text associated with a note you or another person has assigned.

You can display the Notes panel by selecting the **View – Data Notes** menu or click the yellow button in the toolbar shown on the right. Floating the mouse over a blue colored point displays the text in the panel. Using panels to display the text saves space on the graph and reduces the plot clutter.

You assign a note by right clicking on the point of interest and choosing the **Assign Note** menu. Enter your text in the window that appears (shown below) and choose to assign that note to the point or the entire part.

27.5 Refresh All Files

QC-CALC SPC works with static data. This means when new data is received while QC-CALC SPC already has the file open, the new data will not be displayed. If you wish to include the results of this new data, this menu option will re-read all data including any new information that has been received.

28. Group

QC-CALC SPC allows you to open multiple .QCC data files. This is useful when you have similar parts and want to see them as a group or to print a report on the same page with data from multiple files. Another advantage of having groups is that you can apply a filter specific only to that group of .QCC files. All the things associated with grouping the files are located under the **Group** menu.

28.1 New

For specific instructions for creating a new Group, see the [Groups](#) section on page [105](#).

28.2 Open

This menu is used to open your QC-CALC group files.

28.3 Edit

This menu option allows you to add and remove files from the open group as well as select the display format (**Edit Data** or **Plot Data**) for each file.

28.4 Delete

This option allows you to delete a group file from the QC-CALC directory.

28.5 Close

This utility closes the current QC-CALC group file.

29. Report

This portion of QC-CALC is dedicated to Historical analysis of the data you collected using automatic inspection equipment or manually entered data. Each type of statistical analysis is described and any differences in operation are discussed. Operational differences usually involve variations in keyboard commands or information you supply to run an analysis.

29.1 Control Charts

For more information see the [Control Charts](#) section starting on page [31](#).

XBar & Range Control Chart	pg. 33
XBar & Sigma Control Chart	pg. 33
Median & Range Control Chart	pg. 34
Individual & Range Control Chart	pg. 34
Individual & Moving Range Control Chart (XmR)	pg. 34
Moving Average & Moving Range Control Chart	pg. 35
Bivariate Analysis	pg. 36

29.2 Attribute Charts

For more information see the [Attribute Control Charts](#) section starting on page [36](#).

P Control Chart	pg. 37
nP Control Chart	pg. 37
C Control Chart	pg. 37
U Control Chart	pg. 37

29.3 Process Charts

For more information see the [Process Charts](#) section starting on page [37](#).

Cpk - Process Capability Analysis	pg. 38
Raw Data with Outlier Detection	pg. 40
Correlation & Regression	pg. 41
Histogram Analysis	pg. 43
Probability Plot	pg. 44
Pareto Analysis	pg. 45

29.4 Print Charts

For more information see the [Miscellaneous Reports](#) section starting on page [47](#).

Gage Repeatability and Reproducibility	pg. 52
Non-Conformance Report	pg. 47
Stat Summary	pg. 50

29.5 Other Reports

The QC-CALC Real-Time reports use a different report system and they are included in the QC-CALC SPC reports. They are used to generate Raw Data Reports, Stat Reports, Plot Reports and both one-part/multiple-part First Article Reports. To use the Real-Time reports in the QC-CALC SPC simply choose menus **Report – Other** and the familiar dimension selectors is displayed.

Make your choice of dimension to report and click the **OK** button. The QC-CALC Real-Time print dialog box is displayed. Follow the instructions in the Real-Time training manual.

29.5.1 Printing Reports Across Multiple Files

Using the new Group feature of QC-CALC SPC you may now print reports that that compare a single dimension from across several files. With a Group file active, choose any report from the **Report** menu, then select the dimension(s) for each open file that you would like a report on. QC-CALC will automatically generate the report with the dimension(s) you chose.

29.6 Use My Logo

Would you like to see your company logo in the reports you generate? All default templates are setup to use a bitmap from the same directory the template is in. This bitmap file must be called "Logo.bmp" and be in the specified directory, so this menu provides an easy way to choose your own logo to use in the report. This menu will make a copy of the bitmap logo you choose, rename it to "logo.bmp" and save that new file into the template directory.

30. Tools Menu

You use this option to perform tasks not directly related to statistics and are considered add-on tools expanding SPC's capabilities.

30.1 Enable Monitoring

For details see the [Monitoring](#) section on page [108](#).

30.2 Create Filter

This menu item creates a record filter of the highlighted records. If you have not already done so, you will be asked to highlight a group of records to include in this filter. You will then be prompted to enter a name for this new filter. Enter a name and click the **Save** button. The filter editor will appear allowing you to add and edit this and other filters.

30.3 Make ASCII

For details see the [Make an ASCII File](#) section on page [59](#).

30.4 Edit or Print an ASCII File

For details see the [Edit or Print an ASCII File](#) section on page [61](#).

30.5 Import ASCII File

For details see the [Import ASCII File](#) section on page [62](#).

30.6 Enable Administrative Tools

For more information see the [Enable Administrative Tools](#) section on page [148](#).

30.7 Password

For details see the [Security Passwords](#) section on page [81](#).

30.8 Options

For details see the [Tools – Options](#) section on page [130](#).

31. Tools – Options

When **Tools – Options** is selected, you see the **Options** window. You can change QC-CALC's operation from this multi-purpose window. When you click on the menus located on the left side of this window, the right side changes showing the available options. You select and change the option that best suits your needs. This is an important screen in QC-CALC Real-Time.

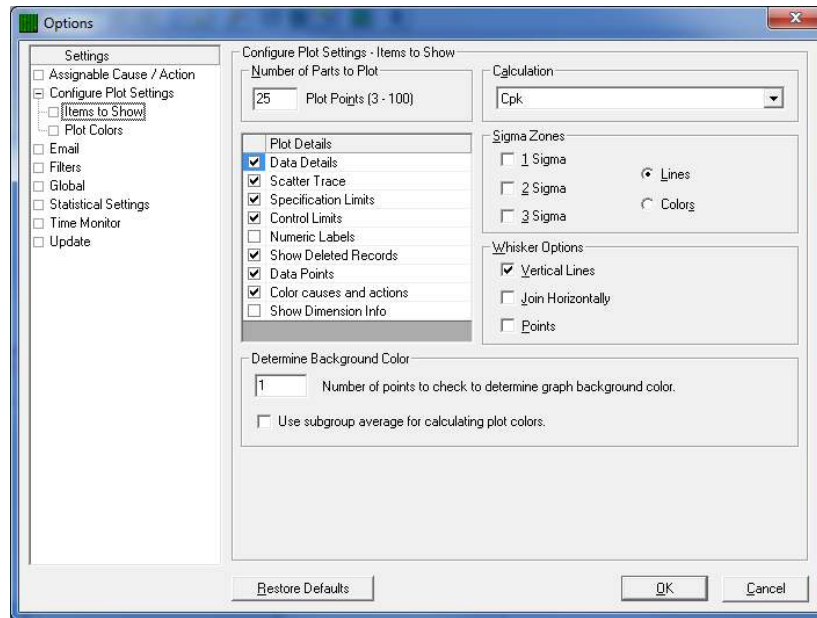
31.1 Assignable Cause / Action

For more information see the [Assignable Cause & Corrective Action](#) section on page [69](#).

31.2 Configure Plots

31.2.1 Items to Show

The Real-Time plot screen has many options you can adjust. For example, you may want to change the color of the plots, the displayed calculation, the number of points within a plot, etc. All of the available plot configurations are found in the **Tools – Options – Configure Plot Settings** menu. The **Items to Show** menu changes what is displayed on the plots and the **Plot Colors** menu relates to the available colors of each item.



Number of Parts to Plot

This is the maximum number of actual data point values displayed within each plot. QC-CALC attempts to read this number of values from the file. Data is read from newest to oldest and plots are viewed with oldest data on the left side of the plot with newest on the right. If a database filter is active you may see less points if some of the points do not match the filter criteria.

When the subgroup size is set to a number greater than 1 the **Number of Parts to Plot** is multiplied by the subgroup. This means if the subgroup size is 5 and the **Number of Parts to Plot** is set to 100 a total of 500 parts is included in each plot.

Calculation

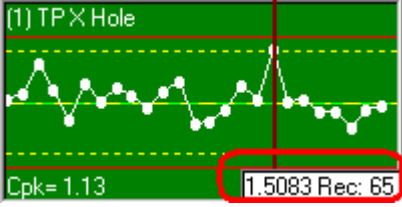
The lower left corner of each plot contains a calculated result. This number gives you immediate feedback of each feature's current situation. The calculation is not displayed on Scatter plots. You can display one of the following calculations:

Calculation	Description
None	No calculations are displayed on the plots.
Average	Shows the average value of all displayed data points.
Avg & Range	Shows both the average and the range values of all displayed data points.
Cpk	<p>QC-CALC calculates Cpk on all displayed numbers using the lesser of:</p> <p>Cpk_u based on upper tolerance = $(USL - Mean) / 3\sigma$ Cpk_l based on lower tolerance = $(Mean - LSL) / 3\sigma$</p> <p>where: USL is Upper Spec Limit LSL is Lower Spec Limit σ is standard deviation</p> <p>If the feature has a single-sided tolerance, the Cpk for that particular side is displayed.</p>
Cp	If you choose Cp to be displayed in the live plots, QC-CALC

	<p>calculates Cp on all displayed numbers using the following equation:</p> $Cp = (USL - LSL) / 6\sigma$ <p style="text-align: right;">where: USL is Upper Spec Limit LSL is Lower Spec Limit σ is standard deviation</p>
Cr	<p>Computed by dividing 1 by the Cp value.</p> $Cr = 1 / Cp$ <p>This value is printed in the same place as the Cp value.</p>
Cpk by R	Cpk except $\sigma_{by R}$ is used instead of σ .
Cpm	$= \frac{(USL - LSL)}{6\sqrt{(\sigma^2 + (\bar{X} - Nom)^2)}}$
Range	Shows the range of all displayed data points.
Sigma	Shows the sigma value for all displayed data points.
Last Point Value	The last data point in the plot is displayed. This is useful for quickly seeing all values of the most recent part without having to float the mouse over each point.
P/T Ratio	This is the same calculation of Cr but convenient for displaying the repeatability value when measuring one part over and over again in a Gage R type of test. For more details see the section on Gage R & R.
Cmk	This is the same calculation of Cpk but it is used when your data is measuring the capability of a machine instead of the process.
Zupper and Zlower	Indicates the number of sigmas a point is from the upper or lower spec limit. Please see a full explanation of ZUpper and ZLower in the Real-Time Training Manual.

Plot Details

Each plot can contain tolerance lines, control lines, etc. You can control what is shown on the plots by checking the appropriate item. Each item is now discussed.

<p>Data Details</p>	<p>Because each plot has many data points it is impractical to display the value of each point on the screen. Data Details is used to display both the point's value and its record number. Float the mouse pointer close to the point of interest and the value is displayed.</p>  <p>This figure shows the mouse pointer over record 65 with a value of 1.5083 for the point. Note how the red (vertical) line is used to show you the closest point to the mouse.</p>
<p>Scatter Trace</p>	<p>The scatter plot is used to plot data in an X vs. Y type chart. Because scatter plots are X vs. Y all time reference is lost. Checking Scatter Trace causes the last 6 points to be connected with a line to show the most recent part history. More than 6 points clutter the plot so you cannot change the number of points connected, it is always the last 6.</p>
<p>Specification Limits</p>	<p>The tolerance lines (solid red lines) are displayed on all plots. You might want these lines turned off if the Real-Time subgroup size is greater than 1.</p>
<p>Control Limits</p>	<p>The control lines (yellow dashed lines) are displayed on all plots. The value of these lines is set at 80% of tolerance during file creation.</p>
<p>Numeric Labels</p>	<p>These are values of the Upper and Lower Specifications limits for each plot and were obtained from your part program. These numbers are normally turned off since they crowd the plots. Zooming in on a plot yields their value also.</p>
<p>Show Deleted Records</p>	<p>This option allows you to view any records that you may have deleted. The delete point is connected with gold dashed lines in the active plots display.</p>
<p>Data Points</p>	<p>This option displays a dot where each point occurs on the data line making it easier to see the data point. These dots disappear if the plots become too crowded.</p>
<p>Mark Records with Causes</p>	<p>This option displays points that have an Assignable Cause or Corrective Action assigned to it. A different color is used for clarity.</p>

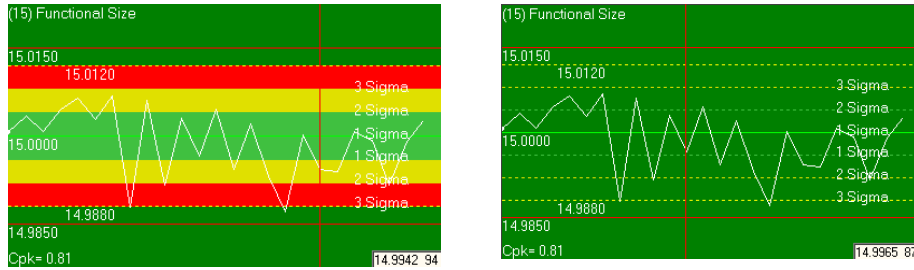
Sigma Zones

QC-CALC can display sigma lines on the plots. The calculation of the sigma value is based on the points currently displayed in the plots only. There are two ways of showing the sigma values: Lines or Colors.

Sigma Zone Values

When QC-CALC creates a new file it calculates and sets the **Control Limits** to 80% of the given tolerance. QC-CALC also calculates the sigma zone to be 1/3

of this value. Each line is drawn on the plot as 1 x Sigma, 2 x Sigma, and 3 x Sigma creating the plots below. Once you have enough valid data to calculate the correct sigma zones use, QC-CALC's **Calculate Limits** menu to set the sigma zones as needed.



You choose the specific sigma zones to show on the plot by selecting the appropriate check boxes in the **Sigma Zone** area.

31.2.2 Plot Colors

Each plot containing the data changes color depending on the value of the current raw data point received from the inspection machine. The current point is added to the right side of the plot, and all other points are shifted left.

If the current point (latest) is...

- ...is within specification, the background is **green**
- ...exceeds the control limits, the background color is **yellow**
- ...exceeds the specification limits, the background color is **red**
- ...breaks a specified Trend, the background color is **purple**

Use **Tools – Options – Configure Plot Settings – Plot Colors** from QC-CALC Real-Time to change the background color of the plots.



Note: To make the background color based on the last 5 parts, select **Tools – Options – Configure Plot Setting – Items to Show** to change **The Number of Points to Check to Determine the Background Color**. Enter a 5 and any point out of spec in the last 5 will cause the background to be red.

Configure Plot Settings - Plot Colors

The color of each element of the plots is selectable. There are four conditions used to change colors.

Raw Data or Xbar colors

	Out of Spec	Out of Control	In-control
Plot Background	Red	Yellow	Green
Specification Lines	Bright Red	Bright Red	Bright Red
Control Lines	Bright Yellow	Dark Blue	Bright Yellow
Nominal Line	Bright Green	Bright Green	Bright Green
Data Line	White	White	White
Feature Label	White	Black	White
1 Sigma Line or Area	Green	Green	Green
2 Sigma Line or Area	Yellow	Blue	Yellow
3 Sigma Line or Area	Red	Red	Red
Not Toleranced	Green	Green	Green

Range Chart Colors

	Out of Spec	Out of Control	In-control
Plot Background	N/a	Red	White

Control Lines	N/a	Compliment	Compliment
---------------	-----	------------	------------

In addition to these you can also choose the colors to represent the three separate Sigma lines or areas. These default colors were chosen for their contrast but can be changed using the Color Editor.

Not Toleranced dimensions always appear green and will not change the background color no matter what value is received.

Dimension that **have Trends** when Trend Analysis is being used will always show with a purple background color. The remaining colors follow the In-control settings.

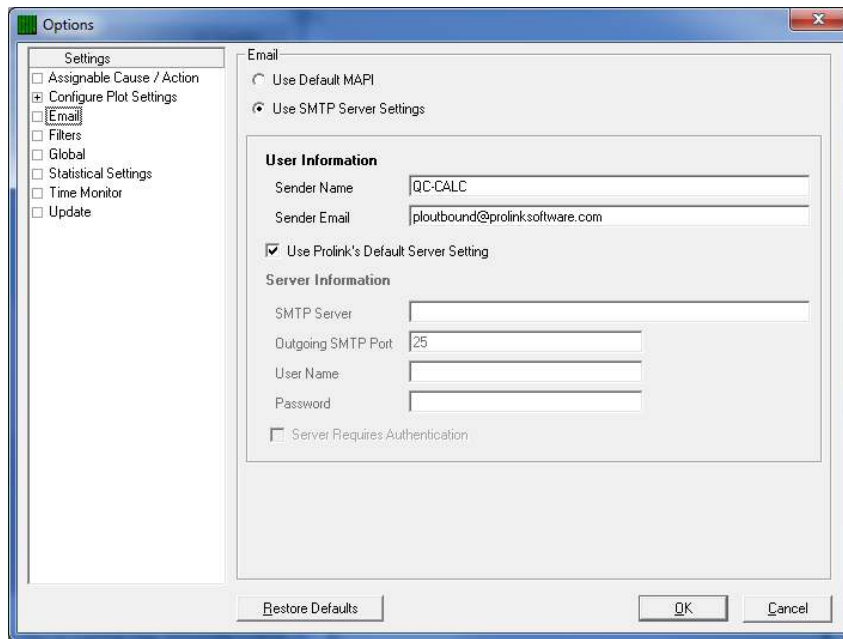
31.3 Email

31.3.1 Introduction

When using QC-CALC to email a report to yourself or others, QC-CALC has three different methods of sending your note.

- Use Your Email Account (Outlook, Lotus Notes, etc)
- Use an SMTP Server – Prolink
- Use an SMTP Server – Your company’s SMTP server

QC-CALC can act as an independent email program and therefore does not require an interface with your company’s internal system such as Outlook or Lotus Notes. However, all 3 methods are available.



31.3.2 Using Prolink Mail Server

The default setting uses a special account setup on the Prolink website which means no other settings are required. However, you should change this setting to match your company’s mail system. Select **Tools – Options – Email** and the following setup screen is shown.

Sender Name

Change **Sender Name** to a name that represents the equipment on which QC-CALC is running. This tells you which machine sent you the email.

Sender E-Mail

This default address must be **ploutbound@prolinksoftware.com** if you use our server. If you use your server, change the default address to your email address since it appears in the FROM address of the sent email. This is the address where all Replies are sent.

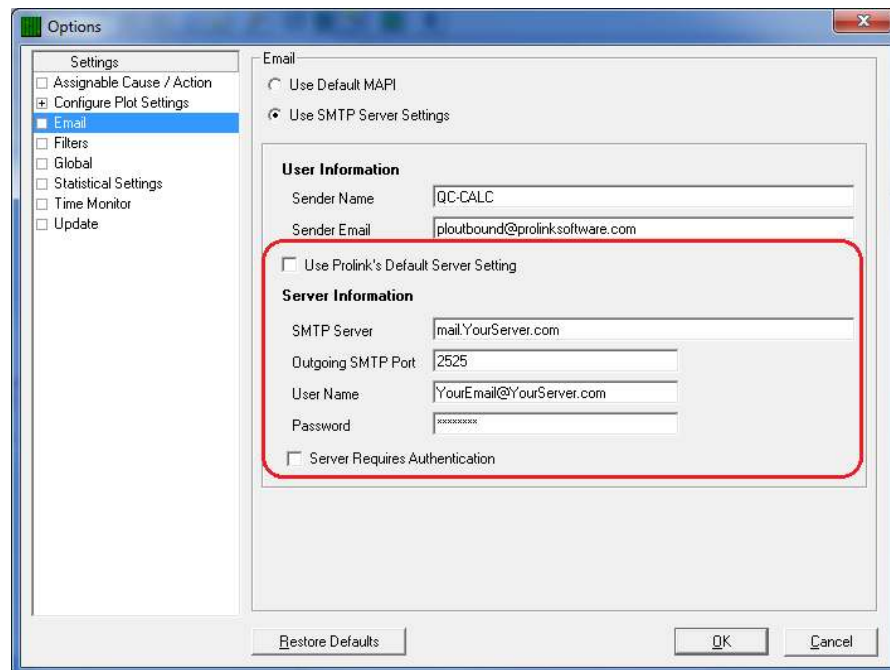
31.3.3 Using Outlook or Other Email Account

Choose the **Use Default MAPI** option to have QC-CALC use the default email found in the PC. All other options are disabled. You will find a copy of the email in the SENT folder of this email account. This method is not recommended since the latest versions of Outlook tend to block it.



Using Your Mail Server

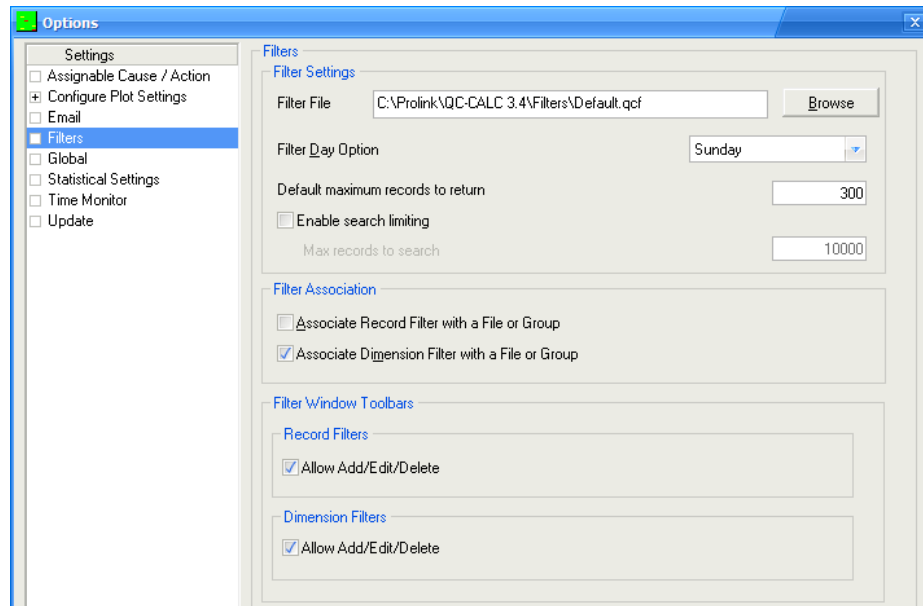
Start by asking your IT Department for the correct **SMTP Server** settings. Choose the **Use SMTP Server Settings** option and un-check **Use Prolink's Default Server Settings**. Then enter the settings as shown below. The answers will vary depending on your company.



31.4 Filters

Select **Tools – Options – Filter Settings** to display the Filter file area. All filters are saved in files and QC-CALC's default filter file is DEFAULT.QCF which is the active filter when you start. You can create a new file by clicking the **Create Filter File** button. Enter a name in the file dialog box and you have a new – empty filter file. A filter file is where your filter criteria are stored for future retrieval.

One reason for creating multiple filter files would be to categorize filters for certain applications. For example, let's assume you have a 64-cavity mold and you want to create and save filters called Cavity 1, Cavity 2, through Cavity 64. You decide to save this set of filters on your local server in a file called Cavities. This organizes your filters and makes them available to all QC-CALC's within your facility. You can continue to make many filter files for every application.



31.4.1 Filter Day Option

QC-CALC has built-in filters such as TODAY, THIS-WEEK, LAST-WEEK, LAST-YEAR, etc. to help you with date related filters. This type of filter returns the correct date without having to know the exact dates for the week, month, or year. These filters produce variable results allowing you to reuse a filter without having to edit it. Since the first weekday can be defined differently, you have the option of choosing which day of the week begins the week.

31.4.2 Default maximum records to return

This option controls the total number of records returned from any filter. This value cannot be larger than the maximum number of records allowed in the database (2,000,000). This is just a default value. Each record filter has separate settings to control the amount of data returned for that specific filter.

31.4.3 Enable search limiting

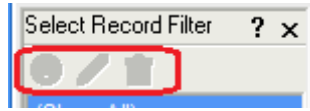
Once this option is enabled you can limit how many records will be searched for results that match the filter criteria by entering the **Max records to search** in the box. If this setting is not used then all records in the .qcc file will be searched regardless of how long this search may take.

31.4.4 Global Filters

As you create and use filters you may find you want your filters to be available for all parts you inspect. This global concept is useful because you only have to create one filter and it is useful for all parts. However, the number of filters shown in the filter selector may become overwhelming and you may want to reduce this list. You can associate each filter with an individual part or associate it with all QC-CALC files. Click the **Associate Record Filter with a File or Group** to reduce the filter's range of use to the currently active QCC file. Uncheck this checkbox to make the filter available for all QCC files. This concept can be applied to dimension filters which are located under the record filter.

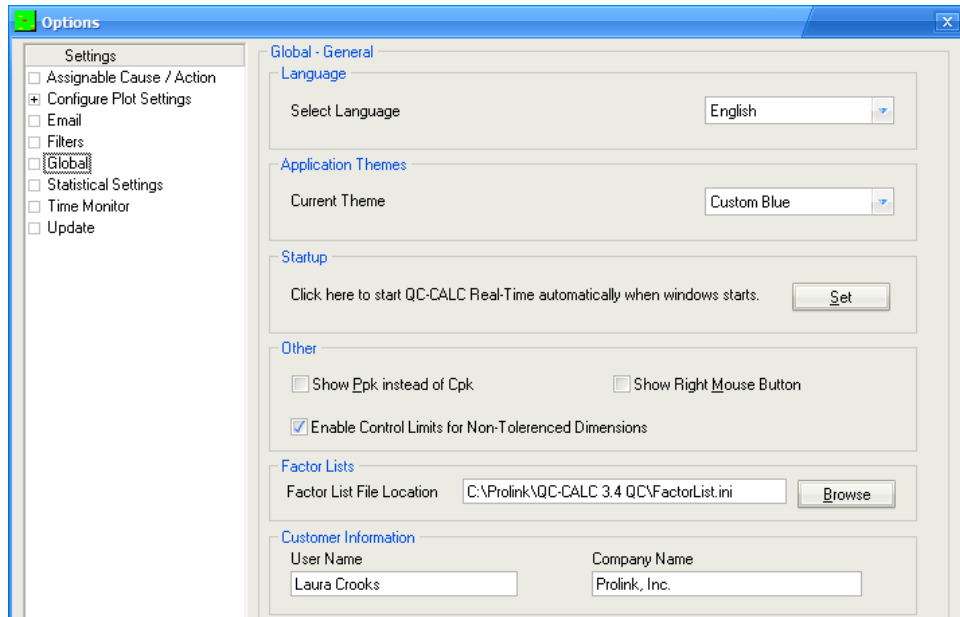
31.4.5 Filter Window Toolbars

The options shown in this area control the buttons available in the **Record** or **Dimension Filter** panels. If the **Allow Add/Edit/Delete** option is unchecked the corresponding buttons in the panel will be disabled as shown below.



31.5 Global

The settings in this area are used in both QC-CALC Real-Time and QC-CALC SPC. Any changes made to the settings here in QC-CALC Real-Time will also apply to the QC-CALC SPC software running on the same computer.



Language

This allows you to change the language file that controls all of the captions and messages in QC-CALC. The languages that are currently supported are: Chinese, English, French, German, Italian, Polish, Russian, Spanish, and Swedish. Choose the language from the list and click **OK**. You must re-start QC-CALC for the new language to be shown.

Application Themes

You can change the look and feel of the screens within SPC Office Buddy with this option. Choosing "None" will remove any theme and the current Windows style will be used.

Startup


The **Set** button will place a shortcut to QC-CALC Real-Time in the startup folder so that QC-CALC Real-Time will be run every time the computer is started.

Other

Show Ppk instead of Cpk

For anyone following the AIAG standards, this option changes the **Cpk** (or **Cp**) labels through-out the program and reports to **Ppk** (or **Pp**).

Show Right Mouse Button

This option is designed for users utilizing a touch-screen monitor or who otherwise only have a single mouse button. Checking this option adds the  button to the toolbar on your screen. Click on the icon and then click on the plot point you would like to access; and the right-mouse click pop-up window appears. For more information on right-mouse click options, please refer to the [Right Mouse Menu Definition \(Grid View\)](#) section on page 78.

Enable Control Limits for Non-Toleranced Dimensions

There are times you have dimensions that do not have tolerances associated, but you still want to watch to see how that feature is doing or run a report if a point goes out of Control. Enabling this feature gives you the ability to use any of the Out of Control options within the program.

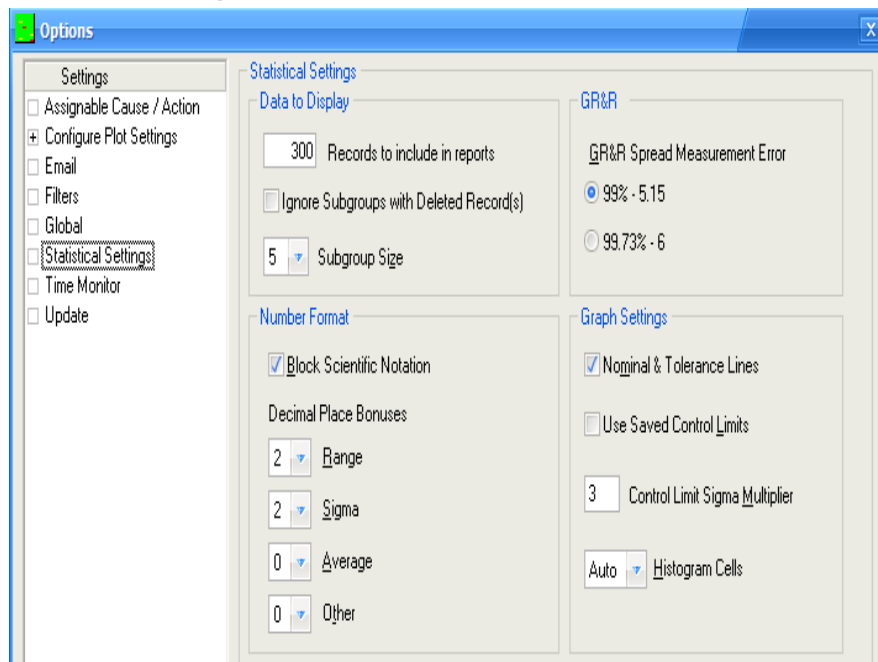
Factor Lists

This setting is used to set the location of the file used to store the lists of values used when entering factors into QC-CALC. This file can be located on a server and the same file can be used for QC-Gage, QC-CALC Real-Time, and QC-CALC SPC.

Customer Information

The information in this area is typically entered during the install process, but you can make changes to the User and Company Names from this area instead of having to reinstall when things change. The Company Name is used in most reports, so it is necessary to fix this when your company name changes.

31.6 Statistical Settings



31.6.1 Data to Display

Records to include in reports

This is the maximum number of actual data values (parts) that will be used for an analysis. QC-CALC will attempt to read this number of values from the file for analysis. Data is read from newest to oldest and plots are viewed with old data on the left side with newest on the right. If a database filter is active, only data belonging to records matching the filter criteria are used. QC-CALC always

attempts to supply **Records to include in reports** values unless specific record number ranges are specified in a filter criterion.

For control charts, if the **Records to include in reports** is set to 300 and the subgroup size is 3, 100 XBar points will be plotted.

Ignore Subgroups with Deleted Record(s)

With this option enabled any subgroup that contains a deleted point will not be used in any graphs or calculations.

Subgroup Size

The subgroup size is the number of data points that will be included in each point on the chart or in your Analyses. For example, when your Subgroup Size is set to 2 one dot on the graph is actually the average of 2 data points. You have the choice to keep your existing values, or you can select a different value to be used with your Real-Time Analyses.

31.6.2 Gage R&R

You can choose to use a spread value of 5.15 sigma (99%), or 6 sigma (99.73%) in the Gage R&R reports.

31.6.3 Number Format

Block Scientific Notation

When QC-CALC calculates and prints statistical results in the on-screen or printed report, the numbers may “snap” into scientific notation if their magnitude is very large or very small. Many people are unfamiliar with numbers displayed in scientific notation such as 1.23456E-9. This check box allows you to block this action.

Decimal Place Bonuses

The four text boxes for Decimal Places tell QC-CALC how many places to add to the existing decimal positions. The decimal places are relative to the right side of the decimal point and range from 0 to 7 extra places. The number entered is added to the number of decimal places defined for each dimension found in the **Edit - [Enter Nominals & Tolerances](#)** area on page [86](#). You can add additional decimal places (bonus) to any calculation. For example, you may have 3 decimal places accuracy on a feature with a nominal of 1.200 and a tolerance of ± 0.001 . A range calculation of 2 numbers of similar magnitudes will yield a very small result. In this case you may want two additional decimal places so that you can “see” the small range.

e.g. $1.20345 - 1.2032 = 0.00025$, which needs at least 2 more decimal places.

In general, **Range Decimal Place Bonus** is related to calculations with subtraction, **Sigma Decimal Place Bonus** is used with calculations of higher-level mathematics and **Average Decimal Place Bonus** is used on calculation of division. **Other Decimal Places** is not a bonus but a straight value used to display all other calculations in the QC-CALC reports.

31.6.4 Graph Settings

Nominal & Tolerance Lines

This option controls the display of the Nominal, Average, and Specification Limit lines on the reports.

Use Saved Control Limits

Normally, QC-CALC calculates the Control Limits best suited for each analysis. Enabling this option overrides this calculation and uses Control Limits that were previously saved in the file.

Control Limit Sigma Multiplier

The sigma multiplier is a number that is used to scale the control limits by multiplying it by the standard deviation (sigma) of the visible data set. Enter a 4.8 if you want QC-CALC to change the control limits to 4.8 sigma. The next time you use Calculated Limits, QC-CALC calculates the standard deviation of the visible data, multiplies this result by **Sigma Multiplier for Control**, and uses this value to draw the yellow dashed control limits and for any control limits in the Control Chart reports.

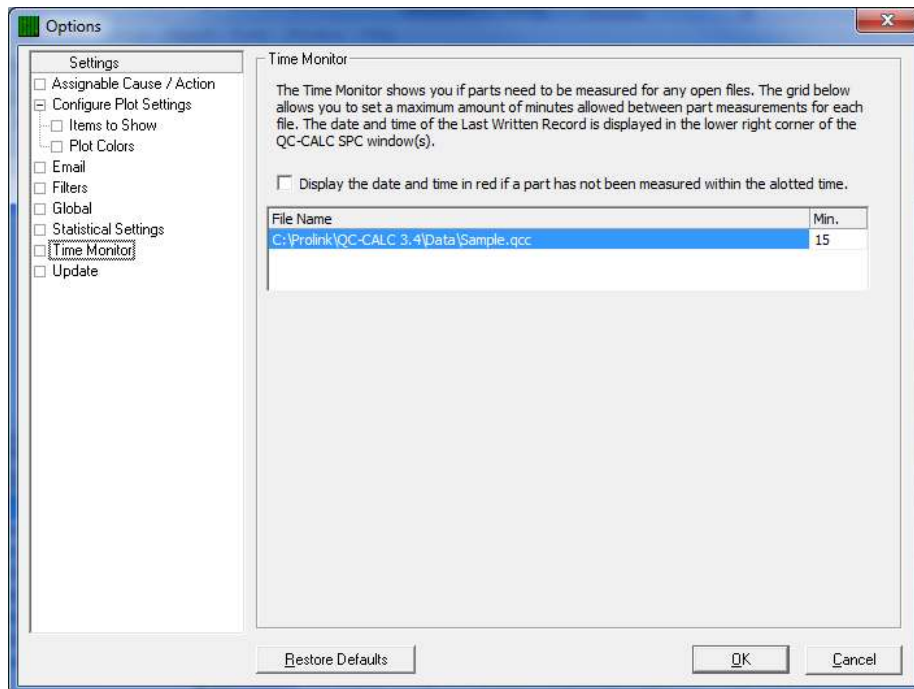
Histogram Cells

This function allows you to select Auto or any number of histogram cells between 7 and 15. When using automatic cell calculation the amount of points in the study (Sample Size) determines the number of cells to use. The table below is what QC-CALC uses:

Sample Size	Cells Used
Less than 90	7
Greater 90 but less than 181	8
Greater 181 but less than 362	9
Greater 362 but less than 724	10
Greater 724 but less than 1448	11
Greater 1448 but less than 2896	12
Greater Or equal to 2895	13

31.7 Time Monitor

The Time Monitor shows you if parts need to be measured for any open files. The grid area allows you to set the maximum minutes allowed between part measurements for each file. The date and time of the last inspection will be shown in the lower right corner of the QC-CALC SPC window for each file.

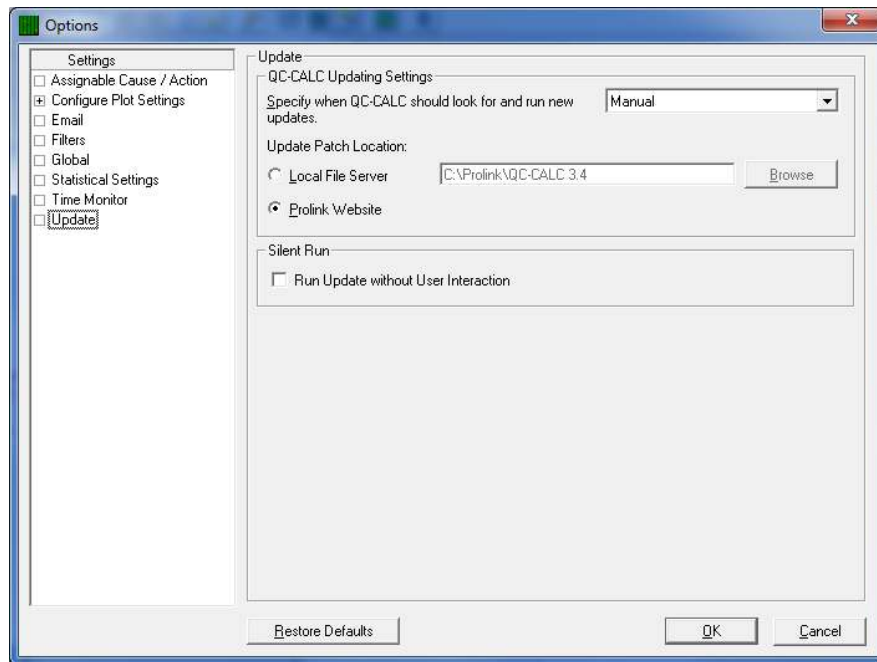


31.7.1 Display the date and time...

When the **Display the date and time in red if a part has not been measured within the allotted time** option is checked the date and time of the last inspection will turn red when a new measurement is overdue.

31.8 Update

QC-CALC has the ability to automatically check for updates to the latest version. There are two ways of getting an update: from the **Prolink Website** (www.ProlinkSoftware.com) or from a **Local File Server**.



31.8.1 Specify when QC-CALC should look for...

You have the option of having QC-CALC automatically check to see if updates are available. If you do not want QC-CALC to check for updates automatically, then set the frequency to **Manual**. With the setting at **Manual**, the **Help – Run Update** menu will be the only way to perform the update operation. The choices to check for updates are:

- Manual
- Every Time QC-CALC Starts
- Once Every Day
- Once Every Week
- Once Every Month.

31.8.2 Update Patch Location

QC-CALC can be configured to look in 1 of 2 locations for the update patch. By default QC-CALC will look at the Prolink website to see if a new patch is available, but you can also choose a location on your local network if that is preferable.

If you want to update individual copies using a central location (meaning you control when the updates are downloaded and installed), then you need to visit the Prolink website to download the update to a location where it will be accessible to everyone. After the update has been downloaded, configure all QC-CALCs to check for available updates from that location by setting the **Update Patch Location** to the path where the update has been stored.

31.8.3 Run Update without User Interaction

Using the **Silent Run** option along with the automatic updating will keep QC-CALC up to date without the operators having to do anything at all. If a needed update was detected when the program started, the update will be downloaded and installed, then the program will start automatically when the updating process is finished.

32. Administrative Tools Menu

Historically, QC-CALC Real-Time has been used within an individual inspection machine as a single copy of software. Each person controlled and adjusted QC-CALC's operation individually. As networks became more prevalent, the inspection devices were connected to the network making data movement easier. This created the need to control the individual copies of QC-CALC running throughout the shop from a central location.

As of QC-CALC version 3.2, an **Administrative Tool** was added to help the Quality Department set up and control every copy of QC-CALC within the entire company. This tool can be activated and used from any of the QC-CALC copies on the network.

In addition, the medical supply companies must satisfy FDA title 21 Code of Federal Regulations (CFR21 Part 11) Electronic Records; Electronic Signatures, as it applies in a medical manufacturing environment. A special section has been added to this document which describes how QC-CALC can be configured to help you meet the requirements of Part 11.

If you are not seeing this menu, you will need to reinstall and follow the directions for setting up the Administrative Tool in the [Setup and Installation Instructions](#) section on page [152](#).

32.1 Set Current User Group

Once the User Groups are created and the options are set for each group, you activate the group by choosing **Administrative Tools – Set Current User Group** menu. This should be a one-time change and QC-CALC will remain in this configuration until further notice.

32.2 Manage User Groups

This menu is used to configure the User Groups. For details see the [Manage Options](#) section on page [156](#).

32.3 Change Password

This menu is used to change the Admin Password. You will be asked to enter the current password before you are allowed to enter a new password.

32.4 Logout

When you enter your password to modify anything in the **Administrative Tools**, there is a checkbox saying **Keep me logged in**. Once you check this you can modify multiple settings without re-typing your password each time. The Logout feature is used to cancel the edit feature. Closing QC-CALC and re-starting it cancels the login as well.

32.5 Disconnect from Admin Path

In the Administrative Tools menu, there is the **Disconnect from Admin Path** option which will allow you to leave the Administrative settings you're currently connected to.

32.6 Edit Application Defaults

The **Edit Application Defaults** selection gives the administrator the ability to modify the default values for QC-CALC Real-Time. Normally, these values do not need to be modified but they can be under certain conditions. The most commonly changed default values are surrounded with red. For more details see the [Edit Application Defaults](#) section on page [158](#).

33. Window

These organizing tools can only be used when viewing a QC-CALC Group file. This means that there are multiple windows open within the main QC-CALC SPC window. In order to view them more easily, we offer you the following menu options:

33.1 Tile Horizontally

This choice is for files that are best viewed in a short, wide window. All active database files will be arranged in this manner, giving equal amounts of the screen to each of them. The files are ordered (top to bottom) based on the order in which they have most recently been used.

33.2 Tile Vertically

This choice is for files that are best viewed in a tall, thin window. All active database files will be arranged in this manner, giving equal amounts of the screen to each of them. The files are ordered (left to right) based on the order in which they have most recently been used.

33.3 Cascade

All active database files are arranged overlapping (top left to bottom right) each other with each title bar clearly visible, based on the order in which they've recently been used.

33.4 Arrange Icons

Arrange all minimized database files (icons) along the bottom of the QC-CALC window in the order in which they've recently been used. If no windows are minimized then this will do nothing.

34. Help

34.1 Contents

This menu option shows the Contents of the QC-CALC help file. Jump text is available to get to specific help topics.

34.2 What does this product do?

This menu launches the PowerPoint presentation that explains the differences between QC-CALC Enterprise, QC-CALC Real-Time, and QC-CALC SPC. This is the same presentation that runs after you install the program.

34.3 Run Update

This menu option will locate and run the update patch required to update QC-CALC Real-Time and/or QC-CALC SPC, if a newer version is available. See [Update](#) on page [142](#) for a description of the settings.

34.4 Gather QC-CALC Information

If there is a problem with your software that cannot be solved by using the help system or your manual, you can call ProLink for technical support. We may ask you to choose this menu option which will automatically collect all of the information about your settings that we will need to assess the problem. You will need to either email or Fax the information to us after QC-CALC stores it in a file. A short wizard will guide you through the steps.

34.5 License Configuration

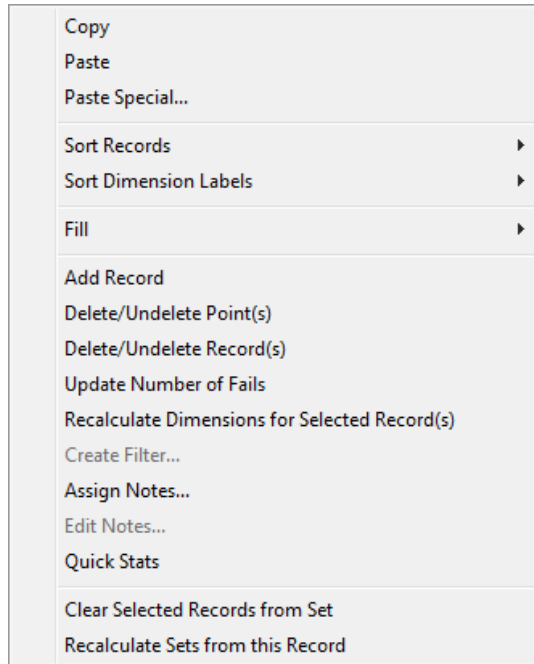
See [License Screen Details](#) on page [115](#) for details.

34.6 About QC-CALC SPC

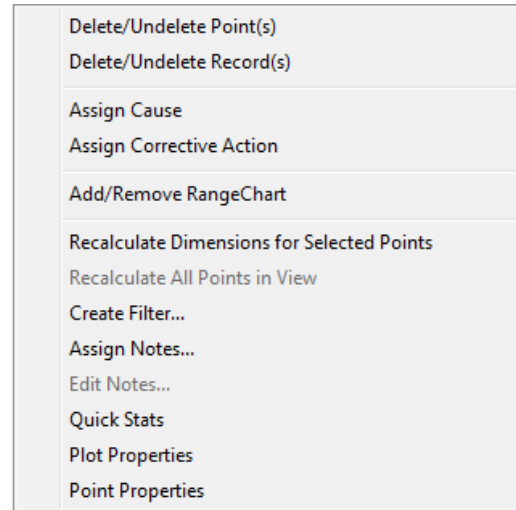
Use this menu to determine which version of QC-CALC you are running. There is other important information that our support team may request.

35. PopUp Menu (Right Click)

When you right click on a file in QC-CALC SPC one of two menus will appear based on if you are viewing that file using **Grid View** or **Plot View**.



Grid View PopUp Menu



Plot View PopUp Menu

35.1 Grid View PopUp Menu

This menu is described completely in the [Right Mouse Menu Definition \(Grid View\)](#) section on page 78.

35.2 Plot View PopUp Menu

Delete/Undelete Point(s)

Use this menu option to mark points as deleted. Once a data point is deleted it is shown both in the grid and in a graph as a different color (gold). Deleted Points are not removed completely from the database but they are not used in any calculations. Then if you decide to keep the data point you may select Edit – Delete/Undelete Point(s) again to restore the data point.

Delete/Undelete Record(s)

Use this menu option to mark a record or records for deletion. This is similar to the Delete Point except the entire part (record) is removed from all calculations. The data is not permanently deleted, it is only marked for deletion and changes color to indicate its removal. You may undelete any record or records by pressing the Delete key where the cursor is current positioned. This returns all deleted records back to normal. To fully delete the data points mark them for deletion and then select **File – Compact Database**.

Assign Cause

This will show the Assignable Cause window which enables you to assign a cause to the record you clicked on.

Assign Corrective Action

This will show the Corrective Action window which enables you to assign a corrective action to the record you clicked on.

Add/Remove Range Chart

This menu will create a Range Chart on the plot where you clicked, or it will remove the Range Chart if one already existed on that dimension.

Recalculate Dimensions for Selected Points

Right clicking on a single point and choosing this menu item will update the corresponding point in any calculated dimensions.

Recalculate All Points in View

This menu is only available when you right click on a Calculated Dimension and it will re-apply the calculation for that specific calculated dimension to the visible data points. Only the records visible on the screen will be updated, so if you would like to update all records you should use the **Edit – Update All Calculated Dimensions** menu instead.

Create Filter

This menu item creates a record filter of the highlighted records. If you have not already done so, you will be asked to highlight a group of records to include in this filter. You will then be prompted to enter a name for this new filter. Enter a name and click the **Save** button. The filter editor will appear allowing you to add and edit this and other filters.

Quick Stats

Please see [Quick Stats](#)  on page [125](#) for more details.

Plot Properties

Please see [Point Properties](#)  on page [124](#) for more details.

Point Properties

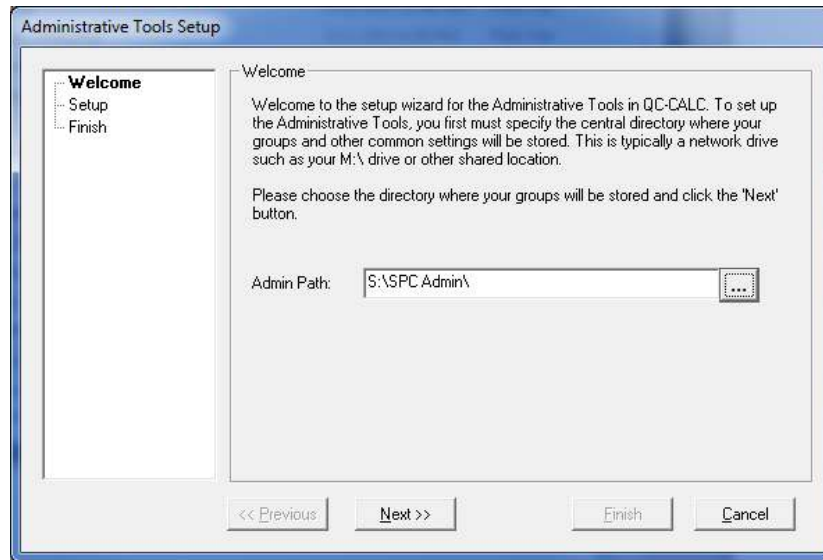
Please see [Plot Properties](#)  on page [125](#) for more details.

36. Enable Administrative Tools

Using this menu allows already installed copies of QC-CALC to use the Admin Tools area without having to reinstall. Once you choose this option a wizard will walk you through connecting to an Admin group. The steps below are for creating an entirely new Admin group, but the directions for joining an existing Admin group will follow this section.

36.1 Starting a New Admin Group

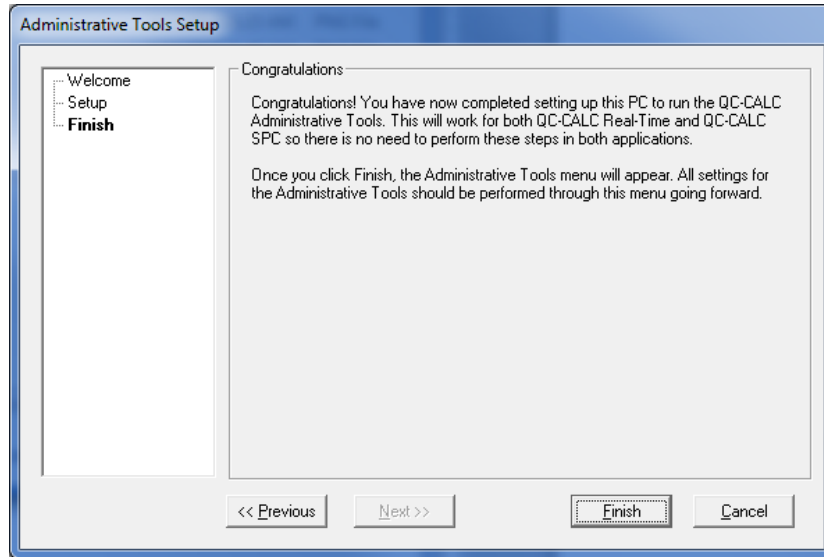
The first screen that is shown when you are creating a new Admin group asks you to choose the storage location of the Admin files. When you are starting a new Admin group choose the location where you plan to store the settings and as you start the setup process the files will appear there. This location should be on a server that all copies of QC-CALC will have access to.



On the second screen you are prompted to enter the password for your Admin group. This is a password you do not want others to learn, since it would enable them to change all of the settings you lock later.

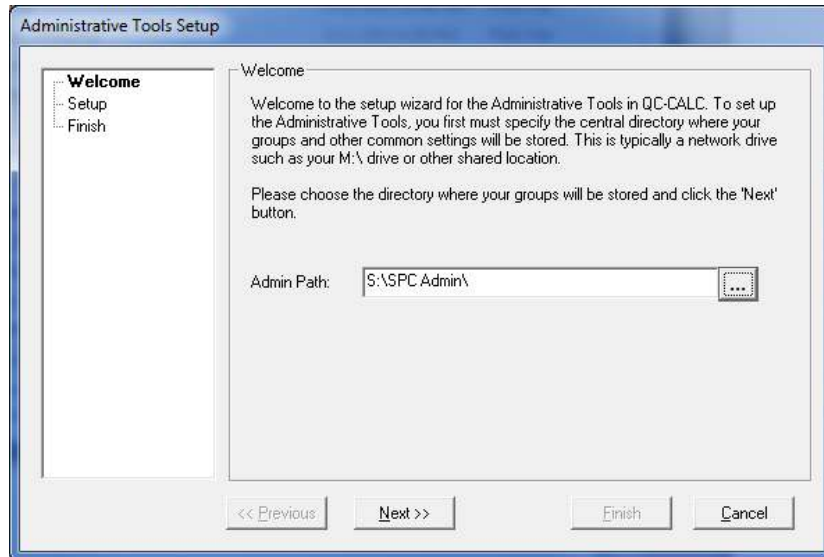


The final screen of this Wizard tells you the creation of the Admin group location was successful.



36.2 Joining an Existing Admin Group

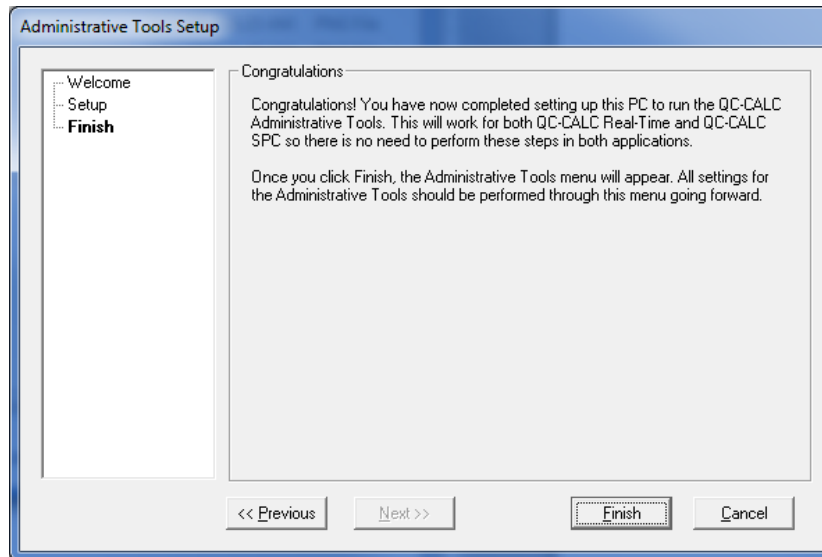
The first screen that is shown when you are creating a new Admin group asks you to choose the storage location of the Admin files. This location should be on a server that all copies of QC-CALC will have access to and should already have existing settings in that location.



Since the Admin group already exists the list of **User Groups** setup for that Admin group will be shown on the next screen. Choose the **User Group** this copy of QC-CALC should join and enter the **Admin Password**.



The final screen of this Wizard tells you that you successfully joined the Admin group.



For more information see the [Administrative Tool & Part 11](#) section on page [151](#). **Note:** This menu will not be visible once the **Administrative Tools** functionality is in use.

37. Administrative Tool & Part 11

37.1 Introduction

Historically, QC-CALC Real-Time has been used within an individual inspection machine as a single copy of software. Each person controlled and adjusted QC-CALC's operation individually. As networks became more prevalent, the inspection devices were connected to the network making data movement easier. This created the need to control the individual copies of QC-CALC running throughout the shop from a central location.

As of QC-CALC version 3.2, an **Administrative Tool** was added to help the Quality Department set up and control every copy of QC-CALC within the entire company. This tool can be activated and used from any of the QC-CALC copies on the network.

In addition, the medical supply companies must satisfy FDA title 21 Code of Federal Regulations (CFR21 Part 11) Electronic Records; Electronic Signatures, as it applies in a medical manufacturing environment. A special section has been added to this document which describes how QC-CALC can be configured to help you meet the requirements of Part 11.

- [Setup and Installation Instructions](#) pg. [152](#)
- [Silent Install](#) pg. [153](#)
- [Setup Batch File](#) pg. [153](#)
- [Running QC-CALC Real-Time](#) pg. [154](#)
- [Manage User Groups](#) pg. [154](#)
- [Establishing First Time Password](#) pg. [155](#)
- [Create User Groups](#) pg. [155](#)
- [Manage Options](#) pg. [156](#)
- [Edit Application Defaults](#) pg. [158](#)
- [Set Current User Group](#) pg. [159](#)
- [Logout](#) pg. [159](#)
- [Disconnecting from Admin Path](#) pg. [160](#)
- [Troubleshooting](#) pg. [160](#)
- [CFR21 Part 11 Considerations](#) pg. [160](#)
 - [Trackable Changes](#) pg. [160](#)
 - [The Setup](#) pg. [161](#)
 - [Adding Users to the Group](#) pg. [162](#)
 - [LDAP](#) pg. [162](#)
 - [Account Management](#) pg. [163](#)
 - [Enable Auditing](#) pg. [164](#)
 - [Set Current User Group](#) pg. [164](#)
 - [Editing the Data](#) pg. [164](#)
 - [Documenting the Change in Real-Time](#) pg. [165](#)
 - [Documenting the Change in SPC](#) pg. [167](#)
 - [CFR Part 11 Audit Report](#) pg. [167](#)
 - [Sample Audit Report](#) pg. [169](#)
 - [LDAP \(Lightweight Directory Access Protocol\)](#) pg. [170](#)

37.2 Setup and Installation Instructions

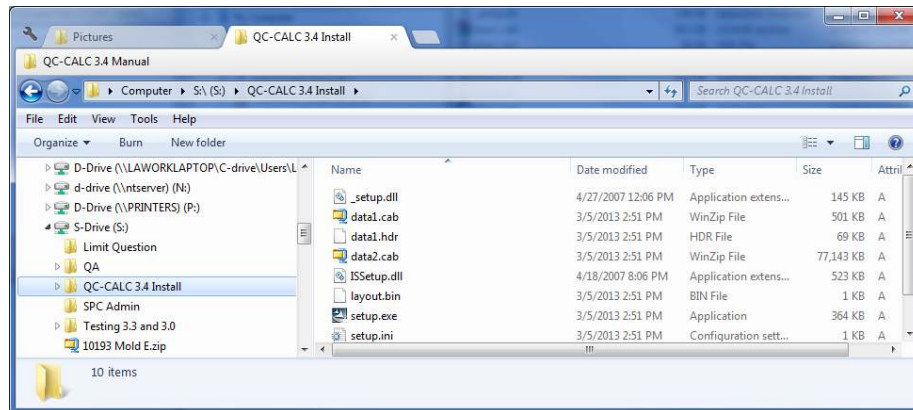
37.2.1 Introduction

There are several installation options for QC-CALC. You can install the standard QC-CALC Enterprise or a QC-CALC Administrative copy. Installing the Administrator copy involves copying all setup files to a server and running the **setup.exe** from this location. This saves you from carrying a CD or USB Flash Drive. Furthermore, you can write a batch file to perform a silent install as well.

You can use a System Management Server such as **Microsoft's SMS** or **Altiris' Service-Oriented Management** solution. Both of these programs can be used to install multiple copies of QC-CALC throughout your company at the same time. By using our batch file commands, you can run these installations in silent mode or allow the user to see the installation on their local screen.

37.2.2 Install

Create a folder on a shared drive such as **S:\QC-CALC 3.4 Install**. This folder must be available to all computers that will use QC-CALC.

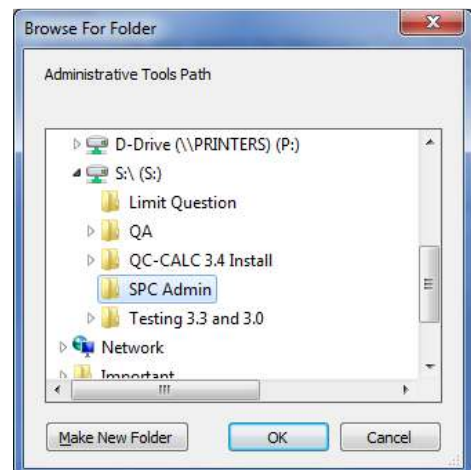


Note: If you use a mapped drive, the same drive letter must be used on all PCs.

1. Download the QC-CALC Administrator file from our website.
2. Unzip the contents of this file into the **QC-CALC 3.4 Install** folder just created on the shared drive.
3. From any computer use Windows Explorer to open the **QC-CALC 3.4 install** folder on the shared drive. (S: drive in our example)
4. Double-click the **Setup.exe** file.
5. During installation the Install Wizard shows 6 screens but take special note of the **Install Folder**. Installation screens are as follows:

- The Welcome Screen
- The License Screen
- The Customer Screen
- **The Install Folder** →
- The Destination Location
- The Program Folder

The **Install Folder** is an added screen to tell QC-CALC where to obtain the common settings for all QC-CALCs configured for common control. In this example we created **S:\SPC Admin**



6. Browse to the **SPC Admin** folder on the shared drive, click **OK**, and finish the rest of the install process.
7. Steps 3-6 are repeated for every PC on which you want QC-CALC installed

37.3 Silent Install

The installation of QC-CALC (Administrative Copy) can be automated to a point where no questions are asked. Optionally, you can run the install in a silent mode where no screens are displayed. This type of installation requires a batch file that contains instructions to tell QC-CALC what to do and how to do it.

Normally, this type of automated installation is used in companies where the IT department “rolls out” the installation from a central server. This type of install reduces time and increase control in physically large companies.

You can use a System Management Server such as **Microsoft’s** SMS or **Altiris’** Service-Oriented Management solution. Both programs can be used to install multiple copies of QC-CALC throughout your company at the same time. By using our batch file commands, you can run these installations in silent mode or allow the user to see the installation on their local screen.

The silent install commands can be used with QC-CALC 3.4, QC-Gage 3.4, EDL 3.3, QC-Audit 3.0, and QC-Sort 3.0.



Note: In all cases, an installation screen will appear briefly during the installation process. Following this, a progress bar will be displayed. This is meant as a visual cue that the install is taking place.

37.4 Setup Batch File

37.4.1 The Batch File Location

The batch file needed to automate QC-CALC’s installation should be located on a shared server that is accessible to all shop floor PCs. In our continuing example, let’s assume you chose to store this batch file in the **S:\QC-CALC 3.4 Install** folder. Instead of running SETUP.EXE, you will run QC34.bat.

37.4.2 The Batch File Contents

The batch file consists of one line starting with the server path and **Setup.exe** followed by optional arguments. The following shows the contents of an example file called QC34.BAT. Keep in mind this is one long command even though it appears on 3 lines. All arguments are separated by (;) semi-colons.

If you omit any of the arguments below, the corresponding installation screen will appear asking the user to provide this information.

```
q:\QC-CALC\setup.exe /silent;destinationpath=c:\prolink\;
adminpath=S:\SPC Admin\;usergroup=CMM
User;username=Ben;companyname= My Co
```

Batch File Command Item	Comments
Q:\QC-CALC\SETUP.EXE	Command to install a Windows program. Must be first
/silent;	If this switch is present, the installation process is not visible on the target PC. If this switch is omitted, the InstallShield screen is displayed and someone will have to click the installation

destinationpath=c:\prolink\;	This is the installation path where QC-CALC will be installed in the CMM or gaging station. You can change it to whatever path you desire.
adminpath=S:\SPC Admin\;	This is the folder used to control all QC-CALC's in your facility. All common settings are stored here. You should standardize on the location by using a batch file like this one.
usergroup=CMM User;	This command sets the active user group when the installation is complete. This command will work if you set up one copy of QC-CALC on your desktop PC and created this user groups first.
username=Ben;	Sets the user name into QC-CALC. This name appears on some reports.
companyname=My Co	Sets the company name into QC-CALC. This name appears on some reports.

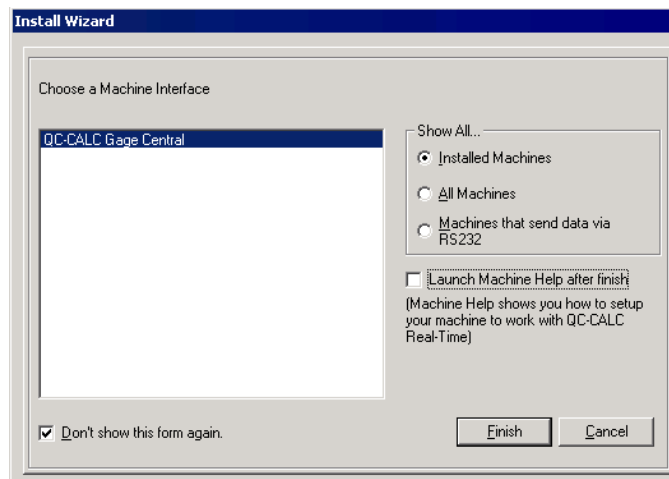


Note: `adminpath` and `usergroup` only apply to QC-CALC installations.

37.5 Running QC-CALC Real-Time

Now that you have QC-CALC installed in your office PC, you'll want to change some settings. First, you must run QC-CALC and answer a few questions:

1. Double click the **QC-CALC 3.4 Real-Time** icon on your Desktop.
2. When running for the first time you will be asked what type of inspection machine you are working with. Choose **QC-CALC Gage Central** from the list since you probably are not seated at an inspection machine.
3. Uncheck the **Launch Machine Help After Finish** option.
4. Click **Finish**.



5. The SAMPLE.QCC file is displayed in QC-CALC Real-Time.

37.6 Manage User Groups

For simplicity reasons, QC-CALC does not save administrative settings at the user level. Instead, groups are created with default settings and locked from being changed. Copies of QC-CALC are then assigned to these groups. It is not necessary to log in as a particular user in order to obtain your group settings

since groups are assigned at the PC level. It is assumed that all users using a particular PC are in the same group. This form of security was chosen because QC-CALC runs without human intervention. It is critical not to interrupt data collection due to login errors.

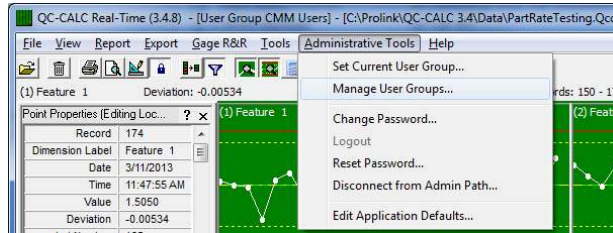


Note: Individual user id/password combinations are assigned to individual persons for Part 11 related activities such as auditing and the digital signing of reports. However, the user name and password are only requested when a change is being made to the data. Please see the [CFR21 Part 11 Considerations](#) section on page 160 for details.

37.7 Establishing First Time Password

You must establish a password as Administrator the first time you run the Administrative Tool in QC-CALC. You are requested to enter this password twice as discussed in the next section.

1. Select the **Administrative Tools – Manage User Groups** menu and the password screen is seen only the first time you select this option.

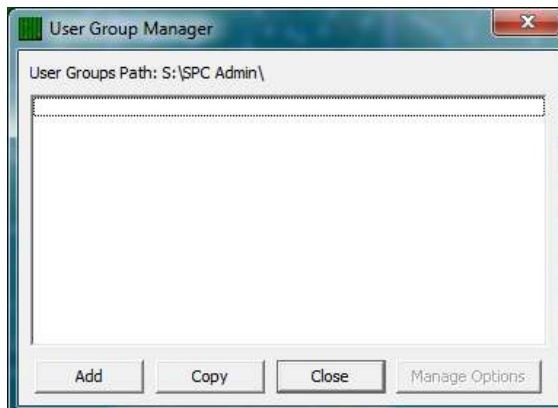


2. You are asked to set your password as the Administrator for the Administrative Tool. This Password is the key to logging in as the administrator from any copy of QC-CALC using this network install.



37.8 Create User Groups

After your password is established, the **Manage User Groups** screen is displayed. There are no User Groups shown since this is the first time you have run the software.



- To create a new user group, click the **Add** button and enter a name for the first group. For our example we entered **CMM User**.



- Choose the settings you wish the **CMM User** computers to follow by clicking the **Manage Options** button. You can set the available features your users have access to and the features you want locked.

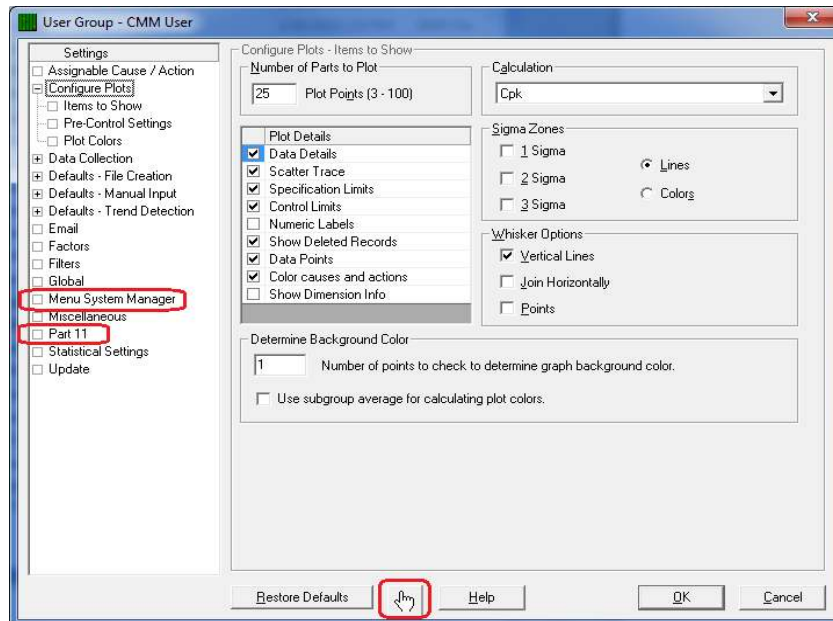
37.8.1 Manage Options

The **Manage Options** button is used to set the configurations applied to all computers within a group and therefore establish the look and feel of each QC-CALC in the group. The settings you choose can optionally be locked to ensure the operation of each QC-CALC is controlled. You can:

- Select Common Settings
- Lock the Settings

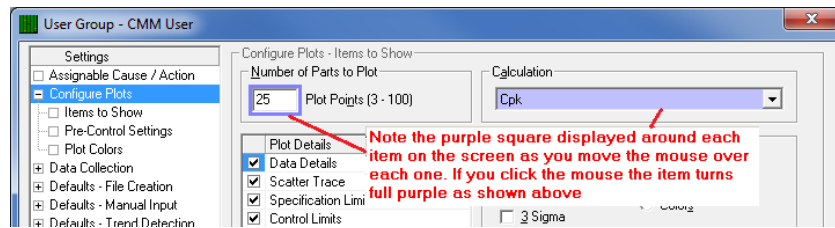
Select Common Settings

The **Settings** screen that appears is the same as the **Tools – Options** screen used in QC-CALC Real-Time. There is an additional **Finger** button at the bottom of the window and two items in the list on the left labeled **Menu System Manager** and **Part 11**. To lock a setting, change any option to the desired value, click the Finger button, and click the option. The option becomes purple which indicates it cannot be changed by the user.



Lock the Settings

When the **Finger** button is depressed and you float the mouse over any option, the item is temporarily outlined with a purple square. Clicking on the item while the purple square is shown causes the item to turn fully purple indicating it's locked.



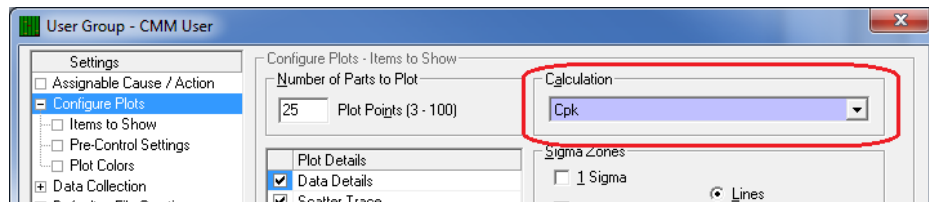
On some screens there are items that are grayed out. Any grayed item changes from part-to-part so they cannot be assigned globally in the Admin Tool.



Note: Any file settings needing global access such as Assignable Causes, Corrective Actions, Filters, and the Update location should be set so that all computers use the same files. This ensures the entire company uses the same settings. You set these items in this configure window.

The Finger Button

Change all settings to values that make sense for your company and use the **Finger** button to lock all values you want restricted from the Group.



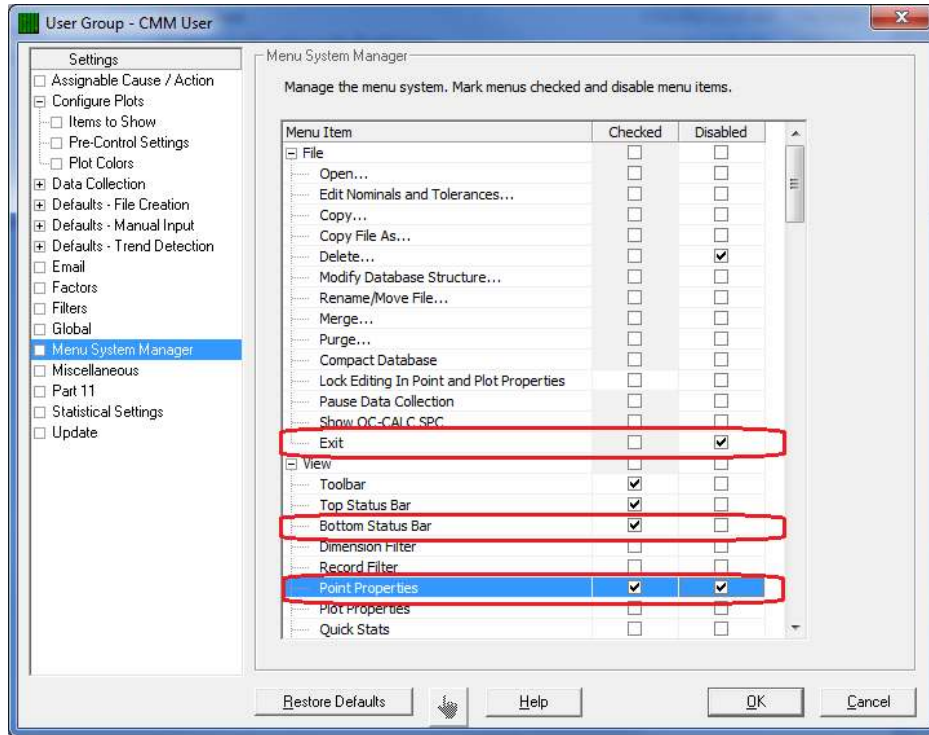
In this example the **Calculation** was set to **Cpk** and then locked so all computers in the group display the Cpk value in the lower left corner of each plot. The computers in the Group cannot change this setting since you locked it.



TIP: By default, the **Finger** button stays depressed allowing you to multi-select many items. Once depressed, the button stays down until you click it again or you click on an item that is not lockable.

Menu System Manager

All menus can be disabled and/or checked from the **Menu System Manager** in the **Manage Options** screen. There is no need to use the Finger button on this particular screen. Simply check the box in the **Disabled** column for the menus you want to disable for the particular group you're currently editing.



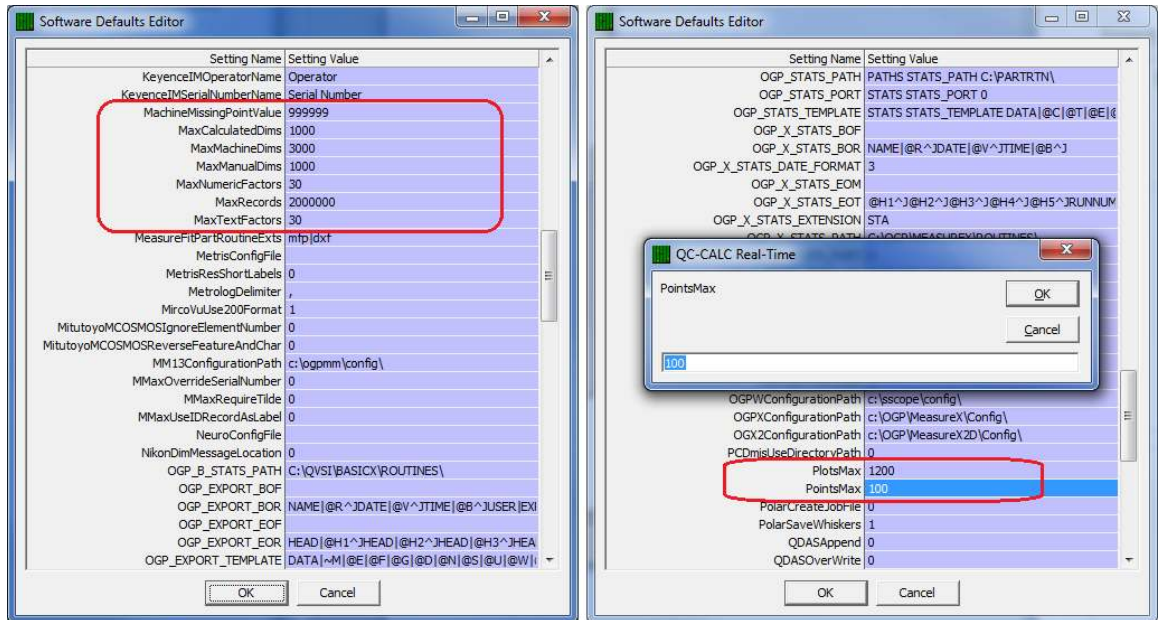
In addition, “checkable” menus throughout QC-CALC can be set and locked. The menus without a gray background in the Checked column are the “checkable” menus. These menu items include viewing the Dimension Filter, Point Properties, Plot Properties, etc.

In the picture above the **File – Exit** menu was disabled (a user hitting the X button will be prompted to enter a password to exit the program), the **View – Bottom Status Bar** was checked (so that status bar will be displayed), and the **View - Point Properties** panel was checked to be displayed and disabled so no one can shut it off.

37.9 Edit Application Defaults

The **Edit Application Defaults** selection gives the administrator the ability to modify the default values for QC-CALC Real-Time. Normally, these values do not need to be modified but they can be under certain conditions. The most commonly changed default values are surrounded with red.

Choose the **Administrative Tools – Edit Application Defaults** menu to display this window.



To modify the values in the boxes simply double click on the item on the right side in the grid you wish to change. This displays a dialog box with the current value in it as shown above on the right.

Be sure that you follow the current format in the box, for example if it is a number you can only change it to another number. If it is a folder path you can only change it to a new path and so on. If the format changes and you click **OK**, you will get an error message saying **An Invalid Input value was entered** and you will have to change it.



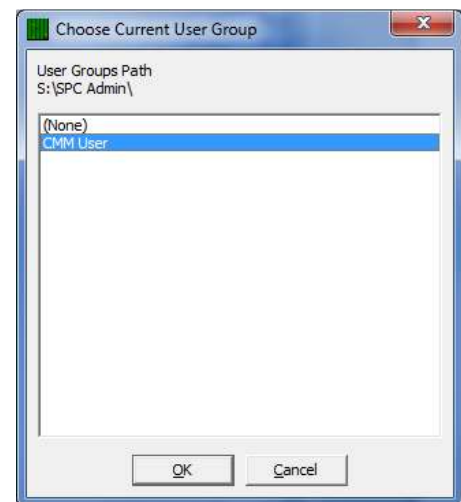
Note: Changing the default values that are numbers are much simpler than changing the paths (C:\QVSI\BasicX\Config) or any of the values that have pipes (|) in them. You have to be very careful because you can change those values and QC-CALC may not know your value is invalid.

37.10 Set Current User Group

Once the User Groups are created and the options are set for each group, you activate the group by choosing **Administrative Tools – Set Current User Group** menu. This should be a one-time change and QC-CALC will remain in this configuration until further notice.

37.11 Logout

When you enter your password to modify anything in the **Administrative Tools**, there is a checkbox saying **Keep me logged in**. Once you check this you can modify multiple settings without re-typing your password each time. The Logout feature is used to cancel the edit feature. Closing QC-CALC and re-starting it cancels the login as well.



37.12 Disconnecting from Admin Path

In the Administrative Tools menu, there is the **Disconnect from Admin Path** option which will allow you to leave the Administrative settings you're currently connected to.

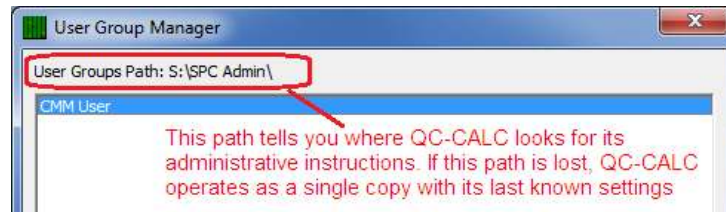
37.13 Troubleshooting

Administrative Tools Menu Not Visible

If you do not see the Administrative Tools menu when you start QC-CALC, it either means QC-CALC was not installed as an Admin copy (there are special installation instructions for this) or QC-CALC no longer has access to the central admin settings folder. If QC-CALC was installed correctly then check the following:

- Check to make sure the user currently logged on has access to the central administrative folder.
- If you are using mapped drive letters, make sure the drive letter originally specified is still pointing to the same shared directory on the network.

The User Group Path is shown at the top of the User Group Manager window.



37.14 CFR21 Part 11 Considerations

37.14.1 Introduction

This section describes QC-CALC's operation as it pertains to the FDA title 21 Code of Federal Regulations (21CFR Part 11) requirements. It discusses how QC-CALC is configured to meet the high level requirements of Part 11.

In order to run QC-CALC in Part 11 Mode, you must run the Administrator Version of QC-CALC due to the control nature of the Part 11 requirements. Part 11 settings are stored at the group level, so you will find the settings screen for Part 11 in the **Manage Options** window of each group.

37.14.2 Trackable Changes

QC-CALC's Part 11 Auditing feature tracks all changes made to the collected data. Each time a change is made, the user making the change is required to enter his user name, password, and a reason for the change. The following changes to the data trigger an audit dialog:

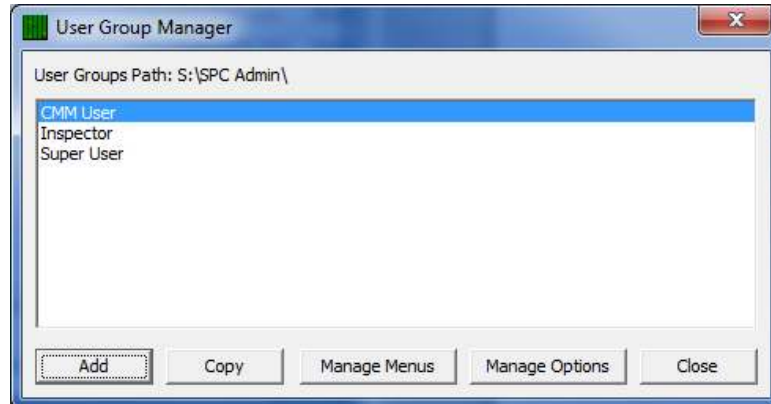
1. Changes to the actual value measured
2. Changes to the measure date or time of the measurement
3. Changes to the number of fails count
4. Changes to the name of any factor (non-measurement trace field)
5. Changes to the value of any factor (non-measurement trace field)
6. Deletions/un-deletions of individual points
7. Deletions/un-deletions of records (parts)
8. Re-measurements of a part
9. Additions, removals, or display order changes of assignable causes
10. Additions, removals, or display order changes of corrective actions

37.14.3 The Setup

The setup of Part 11 Auditing requires you to:

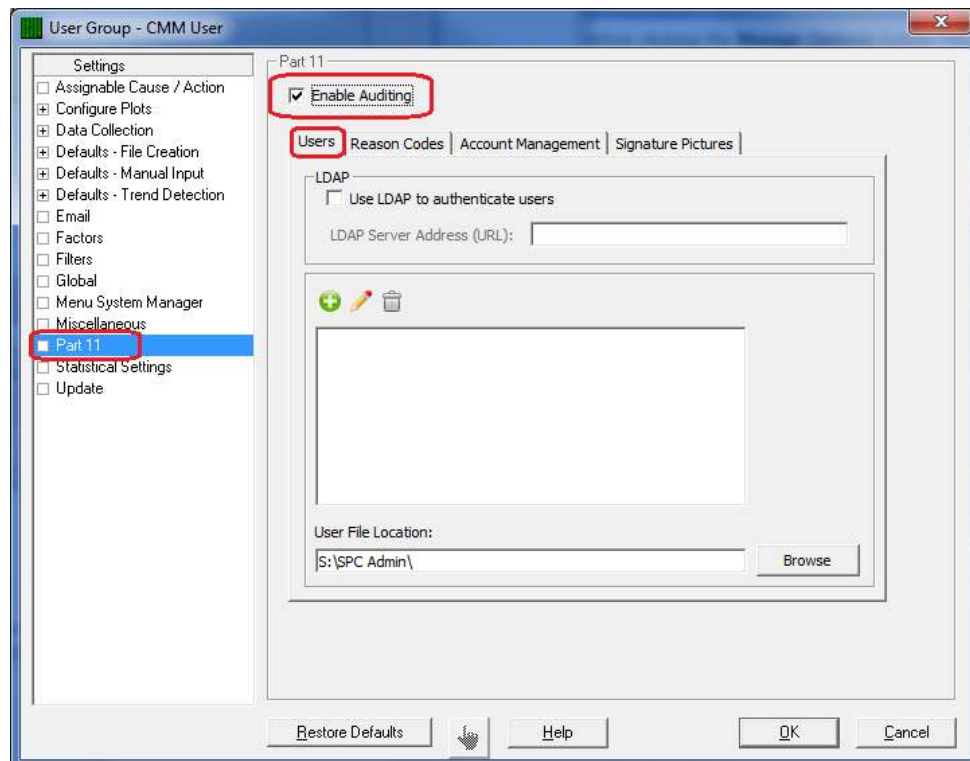
- Create User Groups Administrative Tool
- Set the Options for each Group Administrative Tool
- Add Users to the Groups Part 11 Setting
- Enter Reason Codes Part 11 Setting
- Enable Auditing Part 11 Setting

Begin the Part 11 setup by selecting the **Administrative Tools – Manage User Groups** menus. Add as many user groups as necessary. Here we added Inspector and Super User to our original CMM User.



Select the user group before clicking the **Manage Options** button. This sets the group you edit. Set and lock the options for each group as discussed in the previous section.

Select the **Part11** menu on the left side to see the following screen.



37.14.4 Adding Users to the Group

You use the **User** tab and the **Add** button to add individual people to your groups. Each person requires a name and password. You may also add a graphic signature file to the user record. This is optional and can be placed on digitally signed PDF reports.



Note: Graphic signature files are digitally stored within QC-CALC for security reasons. As such, there is a 100K byte size limit to each uploaded image. You can manage your uploaded signature pictures on the **Signature Pictures** tab.

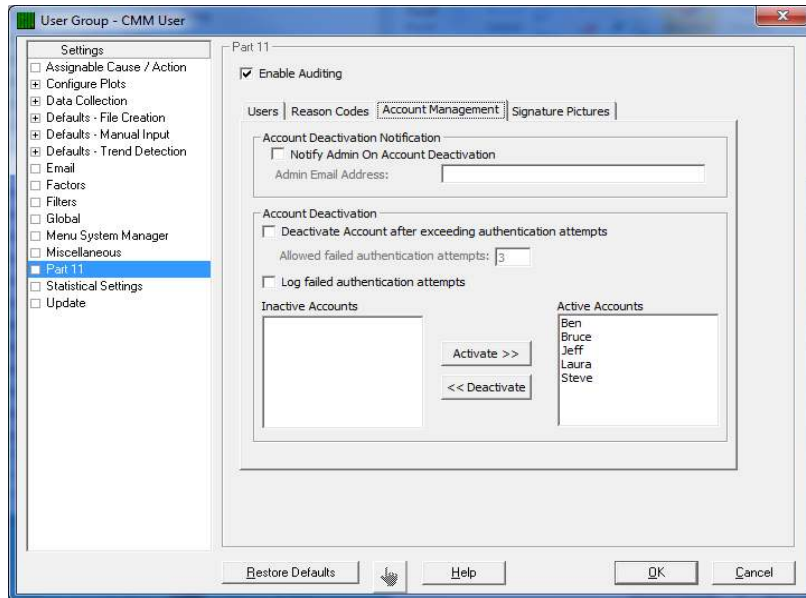
Add as many users as desired and remember that users are not group specific and are shared across all groups.

37.14.5 LDAP

You cannot add Users if you choose LDAP as discussed in the [LDAP \(Lightweight Directory Access Protocol\)](#) section on page [170](#).

37.14.6 Account Management

The **Account Management** tab houses several options for account configuration, specifically options for account deactivation, failed login attempts, along with managing active and inactive accounts.



Account Deactivation Notification

If this box is checked, an email will be sent to the address specified whenever an account is deactivated

Account Deactivation

Deactivate Account after exceeding authentication attempts

If this box is checked, an account will be activated after a certain number of failed attempts to access it. You can set the number of attempts in the box immediately below

Log failed authentication attempts

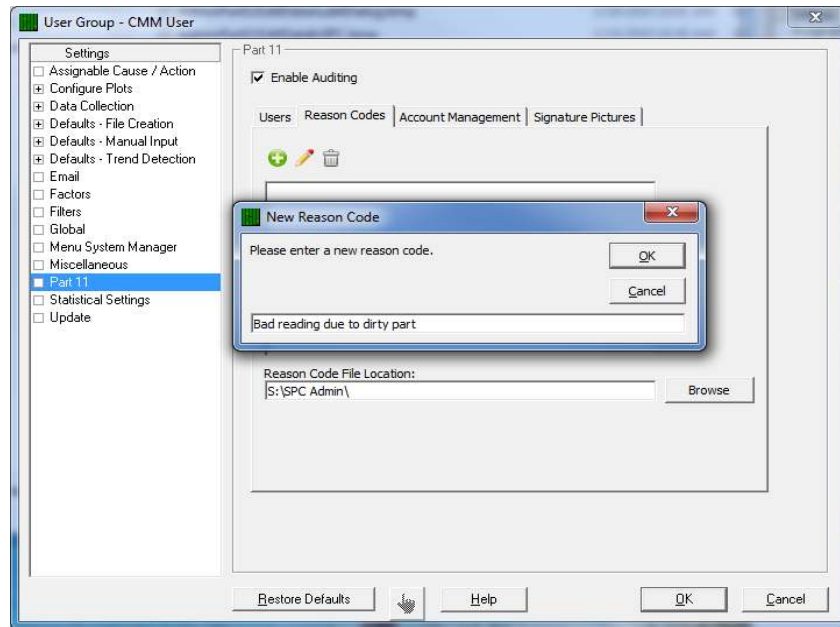
If this box is checked, all failed authentication attempts will be logged and saved to the administrative folder path

Active and Inactive Accounts

Here you can deactivate accounts or reactivate accounts that had been deactivated.

Adding Reason Codes to the Group

Reason Codes are added to a list so your users can pick from a list to assign a reason why a value was changed. You must add all reason codes since your Users will be picking the reason from this list and are not allowed to type free-hand notes.



It is recommended that you choose brief codes and keep the list short since users tend not to scroll through long lists. Reason codes are shared across all groups and are not group specific. The max length of a reason code is 64 characters.

37.14.7 Enable Auditing

The last thing you must do is enable the auditing system. This is done by checking the checkbox labeled **Enable Auditing**. You now have all of the requirements established to use the system.



Note: The **Enable Auditing** setting is not shared across all groups. Therefore, you should set this value manually for each group that requires auditing.

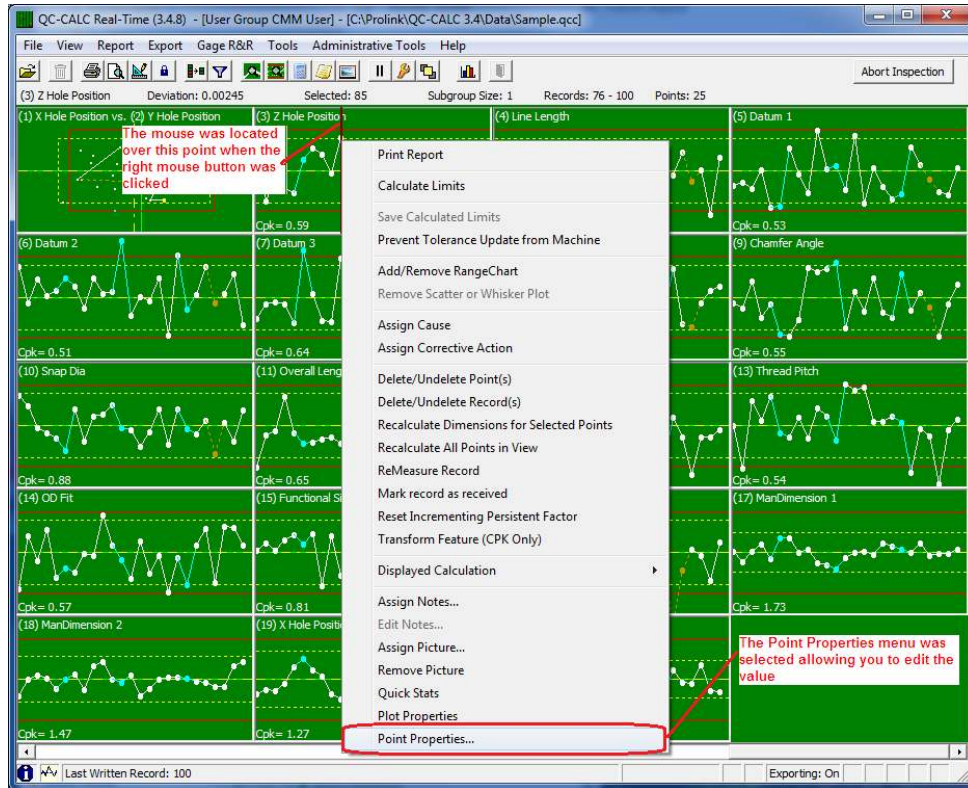
37.14.8 Set Current User Group

Once the User Groups are created and the options are set for each group, you activate the group by choosing the **Administrative Tools – Set Current User Group** menu. This should be a one-time change and QC-CALC will remain in this configuration until further notice.

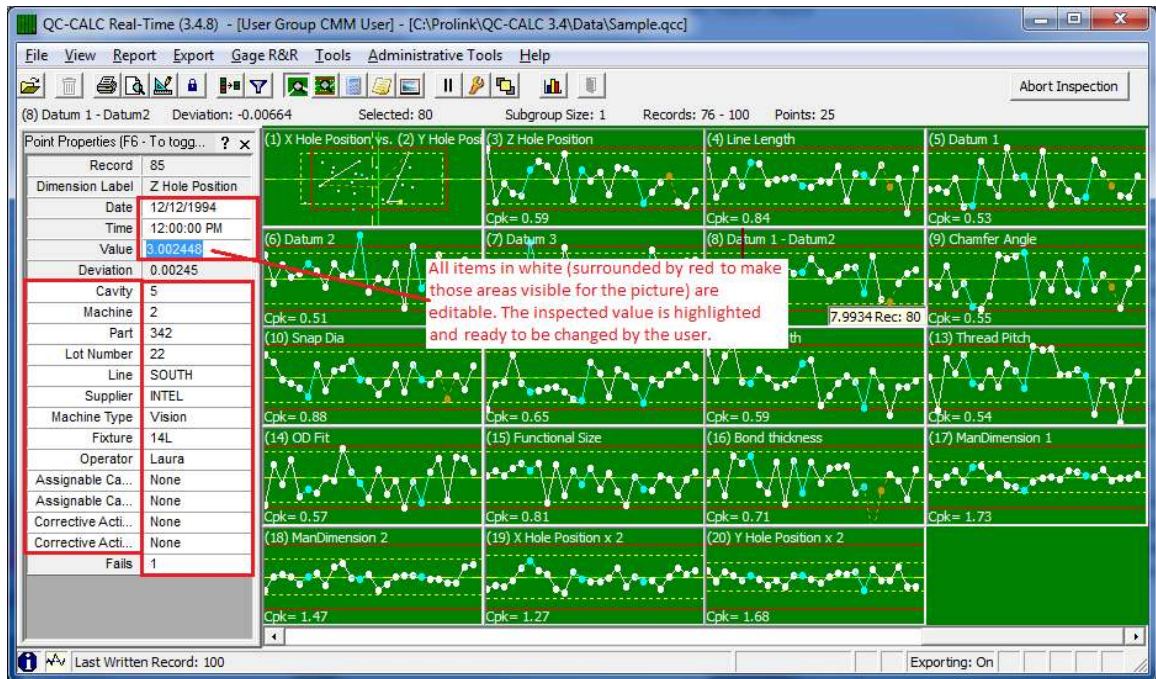
37.14.9 Editing the Data

Editing tools were added to QC-CALC to help you fix bad readings. Please recognize Prolink makes a distinction between bad readings vs. bad parts. When a gage saves a reading that must be changed due to gaging errors, the Part 11 tools described here help control the “who, what, and why” of the change that was made.

Right clicking on a point in QC-CALC Real-Time yields the familiar pop-up menu shown below.



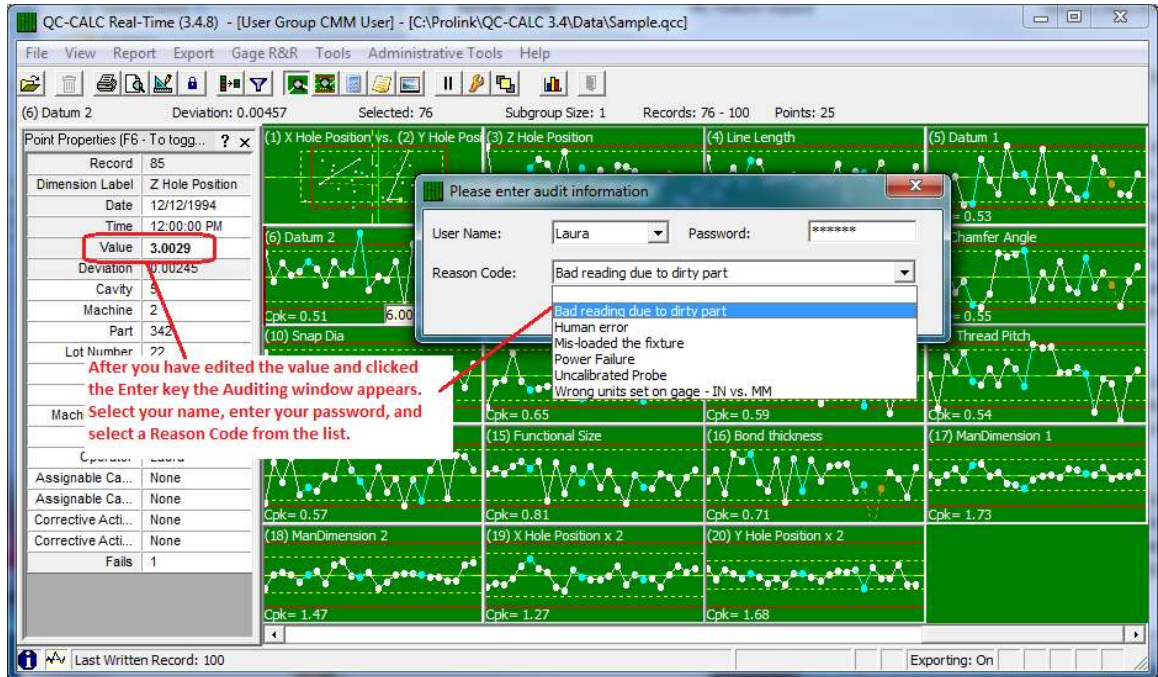
Selecting **Point Properties** allows you to edit the value as shown.



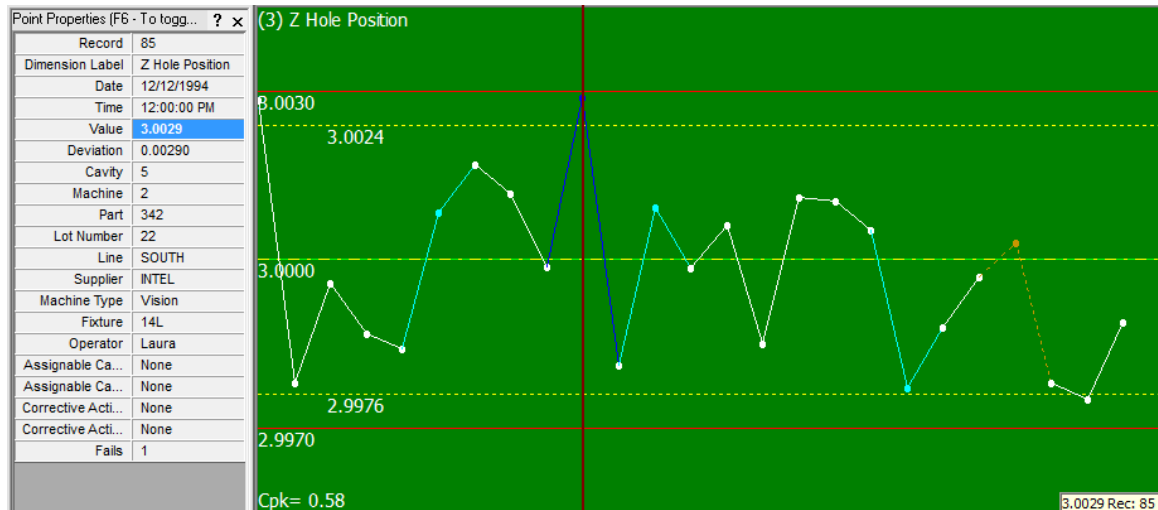
37.14.10 Documenting the Change in Real-Time

When you finish the edit and press ENTER or attempt close the **Point Properties** dialog box, the Part 11 Audit dialog box appears requesting information. You must complete this dialog or your changes are discarded!

Select your name from the **User Name** list, enter your **Password**, and select a **Reason Code** from the list. Now click **OK** and your changes are saved. If you do not complete this sequence or press Cancel, your changes are discarded.

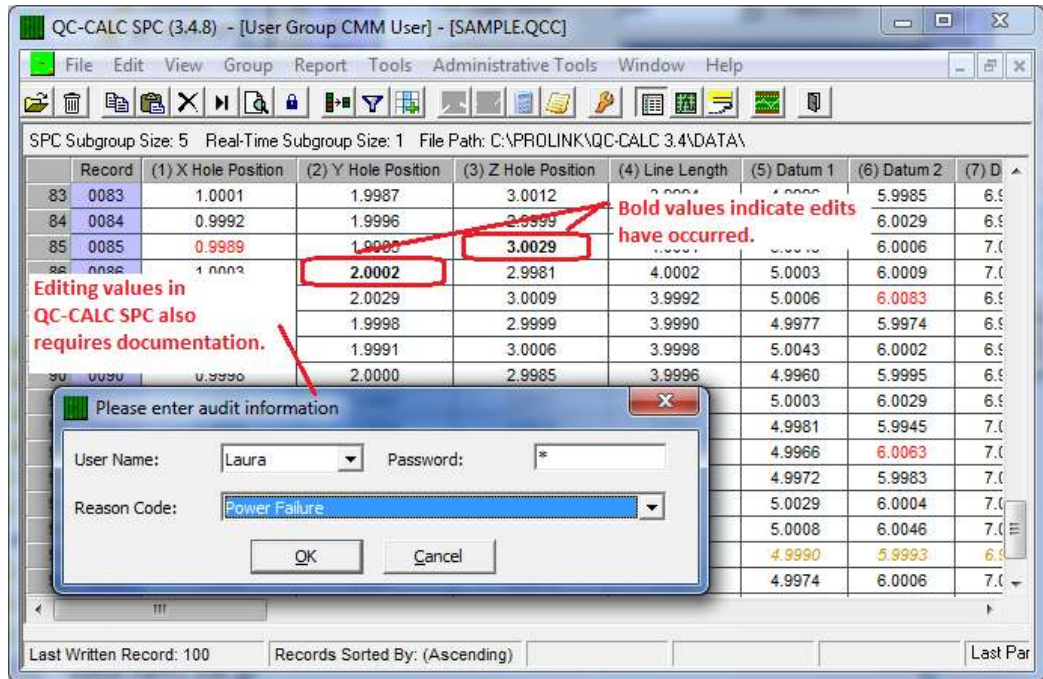


Once the Audit dialog box is removed from the screen, the edited point turns navy blue. The connecting lines also are blue. The value is displayed in the **Point Properties** dialog box as bold text. This is your visual clue the value has been edited. Press the F6 key if editing is still active.



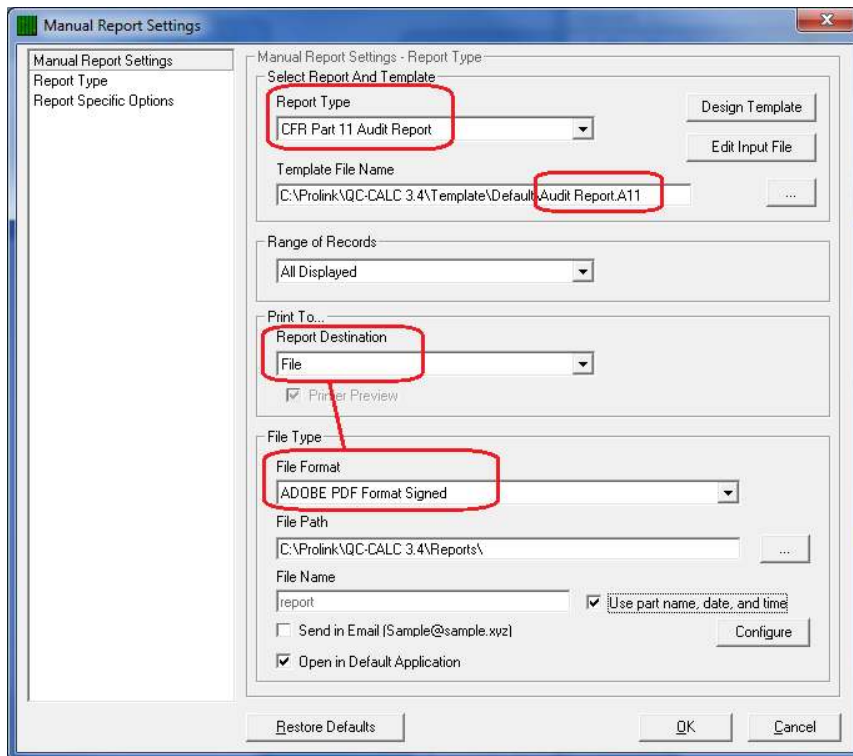
37.14.11 Documenting the Change in SPC

Should you decide to edit data in the QC-CALC SPC screen, you are prompted the same as in QC-CALC Real-Time. All edited values are displayed in bold text as in the Point Properties of QC-CALC Real-Time.



37.14.12 CFR Part 11 Audit Report

You can generate a report containing all changes made to a part file by printing a special report included in the Real-Time report list called the "CFR Part 11 Audit Report." This report is generated the same as all other Real-Time reports but it contains the pertinent audit trail information as required by Part 11.

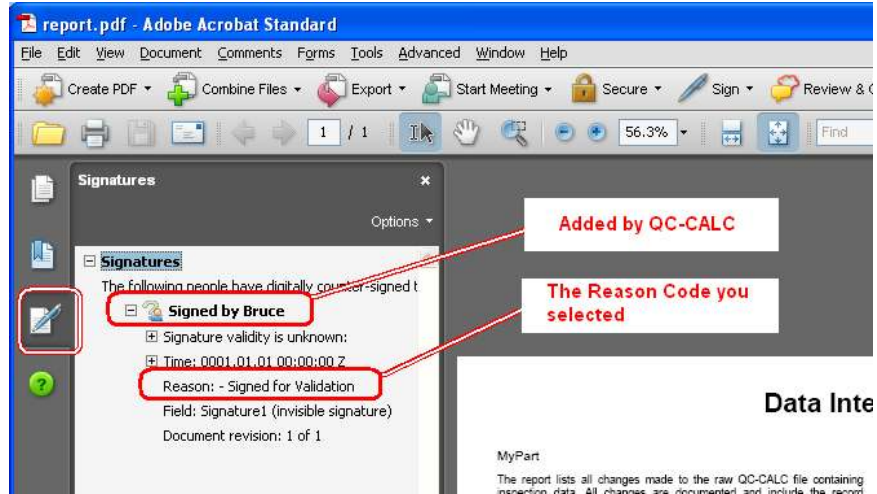


Signed Reports PDF Only

You must print signed reports to **File** and select a **File Type** of **Adobe PDF Format Signed** in order to see your signature. If the file has been tampered with, it will say so. Change the File Name and location to the appropriate name and click **OK**. The PDF file has properties that you can review.

PDF File Signature Properties


The tamper proof signature is found in the signature section of the final PDF file. Clicking the Signature button reveals the status of the file. QC-CALC adds the password protected user name to the document and includes the Reason Code they chose. If the file is modified in any way, the signature property indicates it is a tampered file.



37.14.13 Sample Audit Report

This sample audit report shows the detail necessary to trace any changes to any QC-CALC database. It includes the original value before the edit and the new value. All editable items in the database are added to this report. You can print this report for an individual point by **right clicking** on the point and selecting the **Print Report** menu. A history of that one point (part) is printed.

Printed on May 12, 2008



Electronically Signed by: Bruce South

Data Integrity Report

Page 1

MyPart

The report lists all changes made to the raw QC-CALC file containing inspection data. All changes are documented and include the record number, user, and reason the change occurred.

Rec	Date of Change	Item Changed	Label	Old Value	New Value	User	Reason
8	5/12/2008 3:41:30 PM	Dimension 8	Feature 8	8.4992	8.5000	Tom	Uncalibrated Probe
12	5/9/2008 5:39:14 PM	Dimension 4	Hole 1 TP	4.5000	4.5020	Bruce	Bad reading due to dirty part
12	5/12/2008 3:42:27 PM	Dimension 8	Feature 8	8.5048	8.5010	Bruce	Typo during data entry

You create a signature file and add it to your user name and password to ensure the document has a name associated with it.

You can add a picture or Avitar to your signature to ensure it was you that signed this PDF file.

This name will only be present if the user enters his or her password.

37.14.14 LDAP (Lightweight Directory Access Protocol)

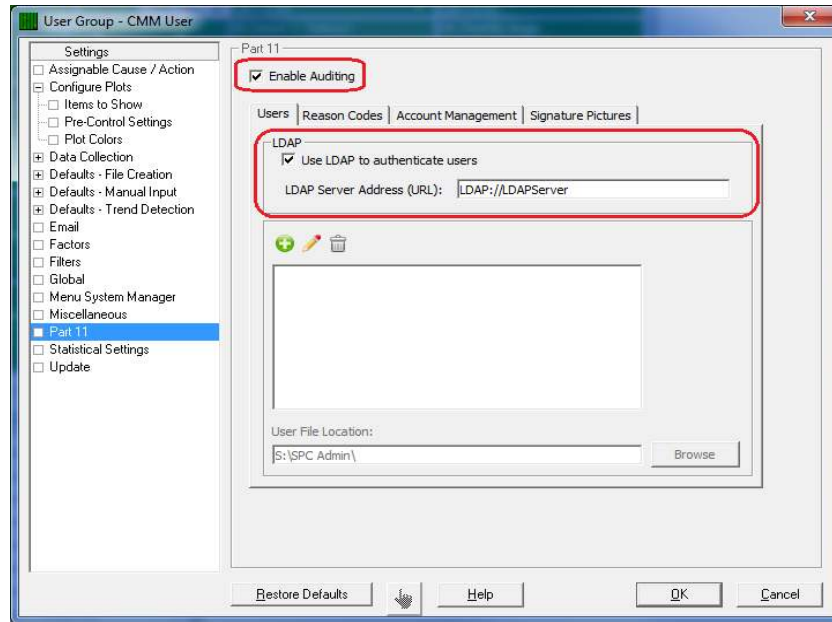
Introduction

The Lightweight Directory Access Protocol (LDAP) is a directory service protocol that provides a mechanism used to connect to, search, and modify Internet directories. LDAP servers exist at three levels: big public servers, large organizational servers at universities and corporations, and smaller LDAP servers for workgroups.

LDAP was designed at the University of Michigan to adapt a complex enterprise directory system (called X.500) to the modern Internet. X.500 is too complex to support on desktops and over the Internet, so LDAP was created to provide this service "for the rest of us."

QC-CALC has a built-in **User – Password** system but some organizations require these account names be stored and managed at the company level, not the PC level. The chosen standard is an LDAP server. For such organizations, QC-CALC provides a simple interface.

When the “**Use LDAP to authenticate users**” checkbox is unchecked, QC-CALC uses its built-in system for auditing Part 11 Users.



When you check the “**Use LDAP to authenticate users**” checkbox the **Add**, **Edit**, **Remove** buttons are grayed out indicating all user information is stored elsewhere within the company server. You will need to contact your IT department to setup the required “connection string”. When you record data changes you are asked for your **User Name** and **Password**. You must enter your company logon name and password instead of any identification you may have entered into the QC-CALC system.

38. Equation Section

53. Equations

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53.1 Control Charts

Terms used:

USL	=	Upper Specification Limit (+Tolerance + Nominal)
LSL	=	Lower Specification Limit (-Tolerance + Nominal)
UCL _{xxxx}	=	Upper Control Limit where xxxx is the type of chart
LCL _{xxxx}	=	Lower Control Limit where xxxx is the type of chart
CLine _{xxxx}	=	Center Line where xxxx is the type of chart
\tilde{X}_i	=	The Median of the i^{th} subgroup
X_i	=	The i^{th} reading in the database
$X_{i,k}$	=	The k^{th} reading in the i^{th} subgroup
$X^{i,k}$	=	The k^{th} reading in the i^{th} subgroup after the subgroup has been sorted.
$X_{i \max}$	=	The largest reading in the i^{th} subgroup
$X_{i \min}$	=	The smallest reading in the i^{th} subgroup
n	=	The number of parts (readings) in each subgroup
n^i	=	The number of parts in subgroup i (same as n except in some attribute charts)
m	=	number of subgroups
Defective _{i}	=	The number of defective parts in subgroup i
c_i	=	The number of defects observed on part i
exp(X)	=	An alternate notation for e^X , exp(X) is easier to read in large equations
σ	=	Standard deviation
k	=	The "Sigma Multiplier" - a constant the user can change in the Statistical Values section of the Tool – Options menu. This should almost always be left at 3.

53.1.1 Variable Control Charts

For Range control charts

$$R_i = X_{i \max} - X_{i \min}$$

$$\bar{R} = \left(\frac{1}{m}\right) \sum_{i=1}^m R_i$$

$$\sigma_{\bar{X}} = \frac{\bar{R}}{d_2 \sqrt{n}}$$

$$UCL_{\text{Range}} = D_4 \bar{R}$$

$$LCL_{\text{Range}} = D_3 \bar{R}$$

$$CLine_{\text{Range}} = \bar{R}$$

For σ control charts

$$\sigma_i = \sqrt{\left(\frac{1}{n}\right) \sum_{j=1}^n (X_{i,j} - \bar{X}_i)^2}$$

$$\bar{\sigma} = \left(\frac{1}{m}\right) \sum_{i=1}^m \sigma_i$$

$$\sigma_{\bar{X}} = \frac{\bar{\sigma}}{C_2 \sqrt{n}}$$

$$UCL_{\sigma} = B_4 \bar{\sigma}$$

$$LCL_{\sigma} = B_3 \bar{\sigma}$$

$$CLine_{\sigma} = \bar{\sigma}$$

For \bar{X} control charts

$$\bar{X}_i = \left(\frac{1}{n}\right) \sum_{j=1}^n X_{i,j}$$

$$\bar{\bar{X}} = \left(\frac{1}{m}\right) \sum_{i=1}^m \bar{X}_i$$

$$UCL_{\bar{X}} = \bar{\bar{X}} + k\sigma_{\bar{X}}$$

$$LCL_{\bar{X}} = \bar{\bar{X}} - k\sigma_{\bar{X}}$$

$$CLine_{\bar{X}} = \bar{\bar{X}}$$

For \tilde{X} (median) control charts

$$\tilde{X}_i = \begin{cases} X'_{i, \frac{n+1}{2}} & \text{n odd} \\ \frac{1}{2} \left(X'_{i, \frac{n}{2}} + X'_{i, \frac{n}{2}+1} \right) & \text{n even} \end{cases}$$

$$\tilde{\bar{X}} = \left(\frac{1}{m}\right) \sum_{i=1}^m \tilde{X}_i$$

$$UCL_{\tilde{X}} = \tilde{\bar{X}} + k\sigma_{\tilde{X}}$$

$$LCL_{\tilde{X}} = \tilde{\bar{X}} - k\sigma_{\tilde{X}}$$

$$CLine_{\tilde{X}} = \tilde{\bar{X}}$$

Note that for the moving range control chart $X_{i+1, j} = X_{i, j+1}$ because adjacent subgroups overlap by n-1 measurements.

Constants used:

n	d ²	D ³	D ⁴	C ²	B ³	B ⁴	E ²
2	1.128	0.00	3.27	0.5642	0.00	3.27	2.660
3	1.693	0.00	2.57	0.7236	0.00	2.57	1.772
4	2.059	0.00	2.28	0.7979	0.00	2.27	1.457
5	2.326	0.00	2.11	0.8407	0.00	2.09	1.290
6	2.534	0.00	2.00	0.8686	0.03	1.97	1.184
7	2.704	0.08	1.92	0.8882	0.12	1.88	1.109
8	2.847	0.14	1.86	0.9027	0.19	1.81	1.054
9	2.970	0.18	1.82	0.9139	0.24	1.76	1.010
10	3.078	0.22	1.78	0.9227	0.28	1.72	0.975
11	3.173	0.26	1.74	0.9300	0.32	1.68	0.946
12	3.258	0.28	1.72	0.9359	0.35	1.65	0.921
13	3.336	0.31	1.69	0.9410	0.38	1.62	0.899
14	3.407	0.33	1.67	0.9453	0.41	1.59	0.881
15	3.472	0.35	1.65	0.9490	0.43	1.57	0.864
16	3.532	0.36	1.64	0.9523	0.45	1.57	
17	3.588	0.38	1.62	0.9551	0.47	1.53	
18	3.600	0.39	1.61	0.9576	0.48	1.52	
19	3.689	0.40	1.60	0.9599	0.50	1.50	
20	3.735	0.41	1.59	0.9619	0.51	1.49	

53.2 Descriptive Statistics

These terms and equations are common to all of the following graphs. Additional terms and equations specific to a graph are given under the heading for that graph.

Terms used:

X_i	=	The i^{th} reading in the database
$X_{i \max}$	=	The largest reading in the i^{th} subgroup
$X_{i \min}$	=	The smallest reading in the i^{th} subgroup
n	=	The number of parts (readings) in the sample
$\exp(X)$	=	An alternate notation for e^X , $\exp(X)$ is easier to read in large equations
$F(X)$	=	The Cumulative Distribution Function for the selected dimension (assumed normal)
$F^{-1}(p)$	=	The inverse of the Cumulative Distribution Function, for $0 < p < 1$ this function returns the z such that $p = F(z)$
USL	=	Upper Specification Limit (+Tolerance + Nominal)
LSL	=	Lower Specification Limit (-Tolerance + Nominal)
σ	=	The standard deviation of the population estimated from sample standard deviation
$\sigma_{\text{by R}}$	=	The standard deviation of the population estimated from subgroup ranges
$\sigma_{\text{by S}}$	=	The standard deviation of the population estimated from subgroup standard deviations
m_k	=	The k^{th} moment of the sample
α	=	The significance level (expressed as a probability) of a test of hypothesis. For example, a significance level of .05 in a test of normality means there is a 5% chance of claiming a sample came from a non-normal process when it came from a normal process.

for $0 < p \leq 0.5$

$$B = \sqrt{\ln\left(\frac{1}{p}\right)}$$

$$F^{-1}(p) = -A$$

for $0 < p \leq 0.5$

$$B = \sqrt{\ln\left(\frac{1}{1-p}\right)}$$

$$F^{-1}(p) = A$$

$$\text{where } A = B - \frac{2.515517 + 0.802853B + 0.010328B^2}{1 + 1.432788B + 0.189269B^2 + 0.001308B^2}$$

$$\bar{X} = \left(\frac{1}{n}\right) \sum_{i=1}^n X_i$$

$$m_k = \left(\frac{1}{n}\right) \sum_{i=1}^n (X_i - \bar{X})^k$$

$$\sigma = \sqrt{\frac{n \sum_{i=1}^n X_i^2 - \left(\sum_{i=1}^n X_i\right)^2}{n(n-1)}} \quad \text{or} \quad \sigma = \sqrt{\left(\frac{1}{n-1}\right) \sum_{i=1}^n (X_i - \bar{X})^2}$$

53.3 Process Capability

$$F(X) = \int_{-\infty}^X \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{1}{2}\left(\frac{y-\mu}{\sigma}\right)^2\right) dy \quad \text{normalized by } z = \frac{y-\mu}{\sigma}$$

This cannot be evaluated directly so we make the substitutions below. The continued fraction expansion of R(z) may take one of 2 forms, depending on the value of z. In either case N recursions (20 in QC-CALC) are used to calculate W(1).

$$\begin{array}{lll} z \leq 2.5 & & z > 2.5 \\ z = \frac{X - \bar{X}}{\sigma} & R(z) = z + \sum_{i=1}^N \frac{i(-1)^i z^2}{2i+1} & R(z) = \frac{1}{z} + \sum_{i=1}^N \frac{i}{z} \\ \mathcal{O}(z) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{z^2}{2}\right) & W(N) = 2N - 1 + z^2(-1)^N N & W(N) = z + \frac{N}{z} \\ \Phi(z) = \int_{-\infty}^z \mathcal{O}(x) dx & W(J) = 2J - 1 + \frac{z^2(-1)^J J}{W(J+1)} & W(J) = z + \frac{J}{W(J+1)} \\ \therefore & & \\ F(X) = \Phi(z) & & \\ R(z) = \frac{1 - \Phi(z)}{\mathcal{O}(z)} & & \\ \therefore \Phi(z) = 1 - R(z)\mathcal{O}(z) & & \end{array}$$

in either case

$$R(z) = \frac{z}{W(1)} \qquad F(X) = 1 - R(z)\mathcal{O}(z)$$

$$\begin{array}{ll} \% \text{ Over Upper Tolerance} & = [1 - F(\text{USL})] * 100 \\ \% \text{ Under Lower Tolerance} & = F(\text{LSL}) * 100 \\ \text{Maximum Process Extent} & = \bar{X} + 3\sigma \\ \text{Minimum Process Extent} & = \bar{X} - 3\sigma \\ C_p & = (\text{USL} - \text{LSL}) / 6\sigma \\ \text{Process Capability} & = 100 * 6\sigma / (\text{USL} - \text{LSL}) \\ C_{pk} \text{ based on upper tolerance} & = (\text{USL} - \bar{X}) / 3\sigma \\ C_{pk} \text{ based on lower tolerance} & = (\bar{X} - \text{LSL}) / 3\sigma \\ C_{pk} & = \text{Lesser of } C_{pk} \text{ upper or } C_{pk} \text{ lower} \\ C_{pk R} & = C_{pk} \text{ except } \sigma_{by R} \text{ is used instead of } \sigma \\ C_{pk S} & = C_{pk} \text{ except } \sigma_{by S} \text{ is used instead of } \sigma \\ C_{pm} & = \frac{(\text{USL} - \text{LSL})}{6\sqrt{(\sigma^2 + (\bar{X} - \text{Nom})^2)}} \\ \bar{R} & \text{ as defined in Variable Control Charts.} \\ X_{i,k} & \text{ The } k^{\text{th}} \text{ reading in the } i^{\text{th}} \text{ subgroup} \end{array}$$

- n The number of parts (readings) in each subgroup
m number of subgroups

$$\sigma_i = \sqrt{\left(\frac{1}{n-1}\right) \sum_{j=1}^n (X_{i,j} - \bar{X}_i)^2}$$
$$\bar{\sigma} = \sqrt{\left(\frac{1}{m}\right) \sum_{i=1}^m \sigma_i^2}$$

$$\sigma_{\bar{X}} = \sqrt{\frac{\sum_{i=1}^m (\bar{X}_i - \bar{\bar{X}})^2}{m-1}}$$
$$\sigma_{by S} = \sqrt{\sigma_{\bar{X}}^2 + \bar{\sigma}^2 \frac{n-1}{n}}$$
$$\sigma_{by R} = \frac{\bar{R}}{d_2}$$

53.4 Histogram Analysis

The Number of cells is either specified in **Tools – Options – Statistical Settings** or automatically calculated from the sample size. If calculated, the following table is used.

Sample Size	Cells
< 90	7
< 181	8
< 362	9
< 724	10
< 1448	11
< 2896	12
>= 2896	13

The size of each cell (bar width) in the pictorial histogram is determined by the range of data. The range is the difference between the largest and smallest values in the data set. The cell width is calculated by dividing the range by the number of cells required.

$$\text{Range} = X_{MAX} - X_{MIN} \quad \text{Cell Width} = \frac{\text{Range}}{\text{Number Of Intervals}}$$

The cell frequency or number of data points falling within a particular interval is determined by comparing the value of each data point with the lower and upper cell limits. For the i^{th} cell:

$$\text{Lower Cell Limit}_i = X_{MIN} + (\text{Cell Width})(i - 1)$$

$$\text{Upper Cell Limit}_i = X_{MIN} + (\text{Cell Width})(i)$$

The test of normality used is a chi-square with 7 degrees of freedom. This procedure divides a normal distribution into 10 cells each containing 10% of a normal distribution. The cell boundaries are listed below:

Cell #	Lower Bound	Upper Bound
1	Minimum	$\bar{X} - 1.2817\sigma$
2	$\bar{X} - 1.2817\sigma$	$\bar{X} - 0.8418\sigma$
3	$\bar{X} - 0.8418\sigma$	$\bar{X} - 0.5244\sigma$
4	$\bar{X} - 0.5244\sigma$	$\bar{X} - 0.2533\sigma$
5	$\bar{X} - 0.2533\sigma$	\bar{X}
6	\bar{X}	$\bar{X} + 0.2533\sigma$
7	$\bar{X} + 0.2533\sigma$	$\bar{X} + 0.5244\sigma$
8	$\bar{X} + 0.5244\sigma$	$\bar{X} + 0.8418\sigma$
9	$\bar{X} + 0.8418\sigma$	$\bar{X} + 1.2817\sigma$
10	$\bar{X} + 1.2817\sigma$	Maximum

Each cell has 10% of a normal distribution. Therefore, the expected frequency in each cell is:

$$E = n/10$$

The actual or observed frequency (O) of each cell is determined by comparing each data point to the cell boundaries above. Chi-square is then calculated by the formula

$$\chi^2 = \frac{1}{E} \sum_{i=1}^{10} (O_i - E)^2$$

Note that large data sets are required for this test to work properly. 100 to 300 samples should be considered the minimum with 500 to 1000 recommended. If the χ^2 of the data is < 6.35 the data is assumed normal with a risk, α , obtained from the table below with linear interpolation. If the χ^2 of the data is > 6.35 the data is assumed non-normal with a risk $1-\alpha$.

Critical values of χ^2 with 7 degrees of freedom and the risk error if normality is assumed.

Risk	.005	.010	.025	.050	.100	.250	.500	.750	.900	.950	.975	.990	.995
Critical	.989	1.24	1.69	2.17	2.83	4.25	6.35	9.04	12.0	14.1	16.0	18.5	20.3

Skewness

$$Skewness = \frac{m_3}{\sqrt{m_2^3}}$$

$$A = (Skewness) \sqrt{\left(\frac{(n+1)(n+3)}{6(n-2)} \right)}$$

$$B = \frac{3(n^2 + 27n - 70)(n+1)(n+3)}{(n-2)(n+5)(n+7)(n+9)}$$

$$C = \frac{1}{\sqrt{\ln\left(\sqrt{-1 + \sqrt{2(B-1)}}\right)}}$$

$$D = \sqrt{\frac{2}{\sqrt{2(B-1)} - 2}}$$

$$Z_{Skew} = C \ln\left(\frac{A}{D} + \sqrt{\left(\frac{A}{D}\right)^2 + 1}\right)$$

$$Z_{Critical} = F^{-1}\left(\frac{\alpha}{2}\right)$$

$$K^2 = Z_{Skew}^2 + Z_{Kurt}^2$$

Kurtosis

$$Kurtosis = \frac{m_4}{m_2^2}$$

$$A = \frac{Kurtosis - \frac{3(n-1)}{n+1}}{\sqrt{\frac{24n(n-2)(n-3)}{(n+1)^2(n+3)(n+5)}}}$$

$$B = \frac{6(n^2 - 5n + 2)}{(n+7)(n+9)} \sqrt{\frac{6(n+3)(n+5)}{n(n-2)(n-3)}}$$

$$C = 6 + \frac{8}{B} \left(\frac{2}{B} + \sqrt{\left(1 + \frac{4}{B^2}\right)} \right)$$

$$Z_{Kurt} = \frac{1 - \frac{2}{9C} - \sqrt{\frac{1 - \frac{2}{C}}{1 + A\sqrt{\frac{2}{C-4}}}}}{\sqrt{\frac{2}{9C}}}$$

$$Z_{Critical} = F^{-1}\left(\frac{\alpha}{2}\right)$$

For both Skewness and Kurtosis α is 0.05 and the process is considered non-normal if:

$$|Z_{Skew}| > Z_{Critical} \quad \text{or} \quad |Z_{Kurt}| > Z_{Critical}$$

53.5 Probability Plot

The Probability Plot is constructed by sorting the most recent 100 records thereby limiting the sample size. Each element of the sorted sample, X_i , is plotted against and correlated with:

$$F^{-1}\left(\frac{i - 0.375}{n + 0.25}\right)$$

using the equations listed in Correlation and Regression. The hypothesis of normality is rejected if the correlation coefficient, R , is lower than a critical value determined from the table below. All values in the table are for $\alpha = 0.05$ (5%).

n	R	n	R	n	R	n	R	n	R	n	R
		11	.923	21	.952	31	.965	41	.973	55	.979
		12	.928	22	.954	32	.966	42	.973	60	.980
3	.879	13	.932	23	.956	33	.967	43	.974	65	.981
4	.868	14	.935	24	.957	34	.968	44	.974	70	.983
5	.880	15	.939	25	.959	35	.969	45	.974	75	.984
6	.888	16	.941	26	.960	36	.969	46	.975	80	.985
7	.898	17	.944	27	.961	37	.970	47	.976	85	.985
8	.906	18	.946	28	.962	38	.971	48	.976	90	.986
9	.912	19	.949	29	.963	39	.971	49	.976	95	.987
10	.918	20	.951	30	.964	40	.972	50	.977	100	.987

53.5.1 Outlier detect

Point X_i is considered an outlier if:

$$X_i > \bar{X} + 3\hat{\sigma} \quad \text{or} \quad X_i < \bar{X} - 3\hat{\sigma}$$

53.6 Regression and Correlation

- Y_i = The i^{th} reading of the Y dimension in the database
- X_i = The i^{th} reading of the X dimension in the database
- n = The number of parts (readings) in the sample
- USL = Upper Specification Limit (+Tolerance + Nominal)
- LSL = Lower Specification Limit (-Tolerance + Nominal)
- t = A test of the significance of the slope of the regression line
- F = Another test of significance of the slope of the regression line. Use the distribution you have tables for or pick either, the results will be identical.
- r = The correlation coefficient. r^2 represents the proportion of the variance of Y that can be attributed to its linear regression on X.
- σ^{b1} = The standard deviation of the regression coefficient
- $\exp(X)$ = An alternate notation for e^X , $\exp(X)$ is easier to read in large equations
- dF = The degrees of freedom
- SSE = The sum of squares of deviations
- MSE = The mean square deviation from regression

$$\bar{X} = \left(\frac{1}{n}\right) \sum_{i=1}^n X_i$$

$$\bar{Y} = \left(\frac{1}{n}\right) \sum_{i=1}^n Y_i$$

The equations in this section make use of the following notation.

$$\begin{aligned}\sum x^2 &= \sum_{i=1}^n (X_i - \bar{X})^2 &&= \sum_{i=1}^n X_i^2 - \left(\frac{1}{n}\right) \left(\sum_{i=1}^n X_i\right)^2 \\ \sum y^2 &= \sum_{i=1}^n (Y_i - \bar{Y})^2 &&= \sum_{i=1}^n Y_i^2 - \left(\frac{1}{n}\right) \left(\sum_{i=1}^n Y_i\right)^2 \\ \sum xy &= \sum_{i=1}^n (X_i - \bar{X})(Y_i - \bar{Y}) &&= \sum_{i=1}^n (Y_i X_i) - \frac{1}{n} \sum_{i=1}^n Y_i \sum_{i=1}^n X_i \\ b_1 &= \frac{\sum xy}{\sum x^2} && b_0 = \bar{Y} - b_1 \bar{X}\end{aligned}$$

The regression line has the following equation: ordinate = (abscissa) $b_1 + b_0$

$$\begin{aligned}SSE &= \sum y^2 - \frac{(\sum xy)^2}{\sum x^2} && MSE = \frac{SSE}{N-2} \\ t &= \frac{b_1}{\sigma_{b_1}} && \sigma_{b_1} = \sqrt{\frac{MSE}{\sum x^2}} \\ r &= \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}} && SST = \sum y^2 \\ \sigma_{\hat{y}_m} &= \sqrt{MSE \left(\frac{1}{n} + \frac{x^2}{\sum x^2} \right)} \quad (\text{for mean}) && SSR = \frac{(\sum xy)^2}{\sum x^2} \\ &&& SSE = SST - SSR \\ &&& \text{or} \\ \sigma_{\hat{y}_i} &= \sqrt{MSE \left(1 + \frac{1}{n} + \frac{x^2}{\sum x^2} \right)} \quad (\text{for individual})\end{aligned}$$

Writing the sample regression equation of Y on X as:

$$\hat{Y} = \bar{Y} + b_1(X - \bar{X})$$

We can obtain 95% confidence intervals for the population mean and for prediction of an individual Y using the equation:

$$\hat{Y} + t_{.05} \sigma_{\hat{y}} \quad \text{where } t_{.05} \text{ is the 5\% level of the } t \text{ distribution with } n-2 \text{ degrees of freedom.}$$

ANOVA (Analysis of Variance) Table for linear regression

Source	dF	SS	MS	F
Regression	1	SSR	MSR	MSR/MSE
Residual	n-2	SSE	MSE	
Total	n-1	SST		

Note that either t or F can be used to determine whether or not the correlation between the variables is significantly different from 0.

53.7 Bivariate Analysis

$$(1) \quad \hat{\sigma}_x^2 = \frac{N \sum x^2 - (\sum x)^2}{N(N-1)}$$

$$(2) \quad \hat{\sigma}_y^2 = \frac{N \sum y^2 - (\sum y)^2}{N(N-1)}$$

$$(3) \quad \hat{\sigma}_{xy} = \frac{N \sum xy - \sum x \sum y}{N(N-1)}$$

$$(4) \quad \hat{\rho} = \frac{\hat{\sigma}_{xy}}{\hat{\sigma}_x \hat{\sigma}_y}$$

$$(5) \quad T_{critical}^2 = \frac{2(N-1)}{N-2} F(\alpha, n_1, n_2)$$

where $\alpha=0.05$, $n_1=2$ and $n_2=N-2$.

The equation for Hotelling's T^2 is:

$$(6) \quad T^2 = \frac{\hat{\sigma}_x^2 \hat{\sigma}_y^2}{\hat{\sigma}_x^2 \hat{\sigma}_y^2 - \hat{\sigma}_{xy}^2} \left(\frac{(x-\bar{x})^2}{\hat{\sigma}_x^2} + \frac{(y-\bar{y})^2}{\hat{\sigma}_y^2} - \frac{2\hat{\sigma}_{xy}(x-\bar{x})(y-\bar{y})}{\hat{\sigma}_x^2 \hat{\sigma}_y^2} \right)$$

(7) To plot the control ellipse use $T^2 = T_{critical}^2$ and find all values of X and Y that satisfy the equation for Hotelling's T^2 .

The equation for the probability density of the bivariate random normal is

$$(8) \quad f(x,y) = \frac{e^{-\left(\frac{(x-\mu_x)^2}{\hat{\sigma}_x^2} + \frac{(y-\mu_y)^2}{\hat{\sigma}_y^2} - \frac{2\hat{\sigma}_{xy}(x-\mu_x)(y-\mu_y)}{\hat{\sigma}_x^2 \hat{\sigma}_y^2} \right)}}{2\pi \hat{\sigma}_x \hat{\sigma}_y \sqrt{1-\hat{\rho}^2}}$$

Equations 1, 2, 3, 4, 5, 6, and 7 are from Jackson, J. Edward, "Quality Control Methods for Two Related Variables", Industrial Quality Control, January, 1956.

Equation 8 and the F table are from Devore, Jay L., Probability and Statistics for Engineering and the Sciences, Brooks/Cole, Monterey CA, 1987

Also according to Jackson the α error (the probability of the control chart indicating an out of control process when the process is in control) is 0.05 (5%).

53.8 Attribute Control Charts

Percent Defective (P Chart)

$$P_i = \frac{\text{Defective}_i}{n_i}$$

$$\bar{P} = \frac{\sum_{i=1}^m \text{Defective}_i}{\sum_{i=1}^m n_i}$$

$$\sigma_{P_i} = \sqrt{\frac{(1 - \bar{P})\bar{P}}{n_i}}$$

$$UCL_{P_i} = \bar{P} + k\sigma_{P_i}$$

$$LCL_{P_i} = \bar{P} - k\sigma_{P_i}$$

$$CLine_p = \bar{P}$$

Number Defective (nP Chart)

$$P_i = \frac{\text{Defective}_i}{n}$$

$$\bar{P} = \frac{1}{m} \sum_{i=1}^m P_i$$

$$\sigma_{nP} = \sqrt{n(1 - \bar{P})\bar{P}}$$

$$UCL_{nP} = n\bar{P} + k\sigma_{nP}$$

$$LCL_{nP} = n\bar{P} - k\sigma_{nP}$$

$$CLine_{nP} = n\bar{P}$$

Number of Defects (C chart)

$$\bar{c} = \frac{1}{m} \sum_{i=1}^m c_i$$

$$\sigma_c = \sqrt{\bar{c}}$$

$$UCL_c = \bar{c} + k\sigma_c$$

$$LCL_c = \bar{c} - k\sigma_c$$

$$CLine_c = \bar{c}$$

Unit Defects (U chart)

$$u_i = \frac{c_i}{n_i}$$

$$\bar{u} = \frac{\sum_{i=1}^m c_i}{\sum_{i=1}^m n_i}$$

$$\sigma_{u_i} = \sqrt{\frac{\bar{u}}{n_i}}$$

$$UCL_{u_i} = \bar{u} + k\sigma_{u_i}$$

$$LCL_{u_i} = \bar{u} - k\sigma_{u_i}$$

$$CLine_{u_i} = \bar{u}$$

53.9 Gage Repeatability And Reproducibility

Variables used in equations

$\bar{\bar{R}}$	=	The average of the operator average ranges
\bar{R}_n	=	the average of the ranges measured by operator n
\bar{X}_n	=	The average of all reading for operator n
\bar{X}_{Diff}	=	The largest \bar{X}_n - the smallest \bar{X}_n
R_p	=	The range of part averages (largest part average - smallest part average)
\bar{XP}_p	=	The average of all readings taken by all operators for part p
$M_{part,operator,trial}$	=	The observed Measurement of a given part, taken by a specific operator on the specified trial.
$R_{part,operator}$	=	The range (largest - smallest) of observed measurements for a given part by a given operator.
LCL	=	Lower control limit.
UCL	=	Upper control limit
Repeatability	=	Equipment Variation (EV)
Reproducibility	=	Appraiser Variation (AV)
R&R	=	The combined effect of EV and AV (Repeatability & Reproducibility)
$d_2^*(m,g)$	=	A constant used to estimate the standard deviation from the range
nr	=	number of parts times the number of trials

$$K_1 = (6/d_2^*) * (\text{Number of Trials}, \text{Number of Parts} * \text{Number of Operators})$$

$$K_2 = (6/d_2^*) * (\text{Number of Operators}, 1)$$

$$K_3 = (6/d_2^*) * (\text{Number of Parts}, 1)$$

$$R_{part,operator} = MAX\left(M_{Part,Operator,1}, M_{Part,Operator,2}, \dots, M_{Part,Operator,NumberOfTrials}\right) - MIN\left(M_{Part,Operator,1}, M_{Part,Operator,2}, \dots, M_{Part,Operator,NumberOfTrials}\right)$$

$$\bar{R}_{Operator} = \frac{\sum_{Part=1}^{\text{Number Of Parts}} R_{Part,Operator}}{\text{Number Of parts}}$$

$$\bar{\bar{R}} = \frac{\sum_{Operator=1}^{\text{Number Of Operators}} \bar{R}_{Operator}}{\text{Number Of Operators}}$$

$$\bar{XP}_{Part} = \frac{\sum_{Operator=1}^{\text{Number Of Operators}} \sum_{Trial=1}^{\text{Number Of Trials}} M_{Part,Operator,Trial}}{\left(\text{Number Of Operators}\right) * \left(\text{Number Of Trials}\right)}$$

$$\bar{X}_{Diff} = MAX\left(\bar{X}_1, \bar{X}_2, \dots, \bar{X}_{\text{Number Of Operators}}\right) - MIN\left(\bar{X}_1, \bar{X}_2, \dots, \bar{X}_{\text{Number Of Operators}}\right)$$

$$R_p = MAX\left(\bar{XP}_1, \bar{XP}_2, \dots, \bar{XP}_{\text{Number Of Parts}}\right) - MIN\left(\bar{XP}_1, \bar{XP}_2, \dots, \bar{XP}_{\text{Number Of Parts}}\right)$$

$$UCL = \bar{\bar{R}} * D_4$$

$$LCL = \bar{\bar{R}} * D_3$$

$$Total\ Variation = \sqrt{(Part\ Variation)^2 + R\&\ R^2}$$

$$repeatability = \bar{\bar{R}} * K_1$$

$$reproducibility = \sqrt{(\bar{X}_{Diff} * K_2)^2 - (repeatability^2 / nr)}$$

$$R\&\ R = \sqrt{repeatability^2 + reproducibility^2}$$

$$Part\ Variation = R_p * K_3$$

% Of Process Variation

$$\%repeatability = 100 * \frac{repeatability}{Total\ Variation}$$

$$\%reproducibility = 100 * \frac{reproducibility}{Total\ Variation}$$

$$\%R\&\ R = 100 * \frac{R\&\ R}{Total\ Variation}$$

$$\%Part\ Variation = 100 * \frac{Part\ Variation}{Total\ Variation}$$

% Of Tolerance

$$\%repeatability = 100 * \frac{repeatability}{Tolerance}$$

$$\%reproducibility = 100 * \frac{reproducibility}{Tolerance}$$

$$\%R\&\ R = 100 * \frac{R\&\ R}{Tolerance}$$

$$\%Part\ Variation = 100 * \frac{Part\ Variation}{Tolerance}$$

d2* values for selected m and g

	g=1	g>15
m=2	1.41	1.128
3	1.91	1.693
4	2.24	2.059
5	2.48	2.326
6	2.67	2.534
7	2.83	2.704
8	2.96	2.847
9	3.08	2.970
10	3.18	3.078
11	3.27	3.173
12	3.35	3.258
13	3.42	3.336
14	3.49	3.407
15	3.55	3.472