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Emperor™ Lite

Force and Torque Data Acquisition Software

Mecmesin
FORCE & TORQUE TEST SOLUTIONS
www.mecmesin.com

431-364-04

August 2013

Emperor Lite™

This document relates to *Mecmesin Emperor™ Lite* software V1.18-407. The .chm HELP file is derived from Operating manual document number 431-364-04.

Mecmesin Force and Torque testing systems comprising Mecmesin force and torque instruments, with Emperor™ Lite software, have been designed as versatile and precision solutions for quality, design and production roles. This manual describes the operation of the software for data acquisition, handling, and analysis. Please refer to the appropriate manual for operation of the instruments themselves.

Scope

This reference manual covers the operation of Emperor Lite with the following products:

Type	Instrument	Optional motorised test stand
Force	CFG+	MultiTest-d series, M500E
	BFG	MultiTest-d series, M500E
	AFG	MultiTest-d series, M500E
	AFTI	MultiTest-d series
	Myometer	
Torque	AFTI	Vortex-d
	Orbis	
	Tornado	

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Part no. 431-364-04

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1. Introduction

1.1 What is Emperor Lite?

Emperor™ Lite is Mecmesin's data acquisition software for use with Mecmesin force and torque measuring instruments. A handheld instrument can detect and store maximum and minimum data points, and manually-selected data points. By connecting it to a PC running Emperor Lite, it becomes a data-streaming device, with calculation and analysis features for a wide range of test characteristics. Emperor Lite can:

- plot results live in a graph
- display a results grid for multiple samples
- overlay sample graph traces for comparison
- replay a test sequence to examine characteristics and events closely
- indicate pass and fail against multiple user-defined criteria
- record and deliver data for other destinations.

1.2 Using this manual

The purpose of this manual is to get you up and running quickly by taking you through:

- installing the software and adding users
- configuring the system for the way you want to work
- understanding the testing environment
- configuring the test environment preferences and defaults
- configuring report and data export templates
- adding calculations.

The following stylistic conventions are used in the text:

Onscreen Button or keyboard character to press.

Program Set-up > *Calculations* for directions via a sequence of menu options.

[Report Templates] for the tab name for a particular page of settings.

'Torque Units' for the name of a data entry field/box.

2. Installation and Connections

2.1 Your system

A typical force or torque testing scenario comprises:

- Emperor™ Lite data acquisition and analysis software on a PC
- a USB licence key
- a digital force or torque gauge or instrument
- optionally, a manual or motorised test stand to move the instrument or sample in a controlled and consistent way.

This manual covers the Emperor Lite software. Please refer to the relevant manuals for the instruments and stands themselves.

The minimum specification for the PC or laptop to be used is 2 GB RAM and 320 GB hard drive, running Microsoft Windows™ XP Pro with SP3, or above. Emperor Lite is compatible with all later versions of Windows. A CD drive is required for installation. At least one USB port and one RS232 port, or two USB ports (using a USB/RS232 converter), are required for attachment to the system.

Note: Emperor Lite software is not available for Linux or Apple Macintosh operating systems.

2.2 The USB licence key

A USB licence key is supplied with every purchased copy of the Emperor™ Lite software. It allows the software to communicate with an instrument and acquire data. To make the connection, the USB key must be present before logging on. It cannot be reinserted once the software is running. Insert the key before installing the software.

If the USB licence key is not present, the software can still be used on previously-saved results files:
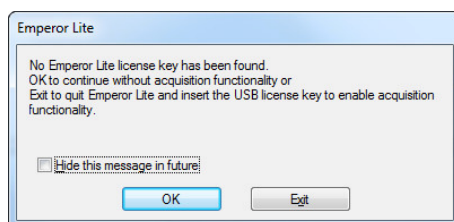
2.3 Installing the Emperor software from CD

2.3.1 Program and data folders

Emperor requires access to certain folders listed below. Before installing the program, please make sure that read and write access is granted for these folders. You may need to right click the Setup file and select 'Run as administrator'. In particular, if the computer is part of a centrally-controlled Windows Domain system, it may be necessary to consult with your IT department to allow correct access to these locations.

Windows XP : User Data location

C:\Documents and Settings\All Users\Application Data\Mecmesin\Emperor\Emperor Lite

Windows Vista or Windows 7 : User Data location

C:\ProgramData\Mecmesin\Emperor\Emperor Lite

All Windows versions : Program files location

C:\Program Files (x86)\Emperor\Emperor Lite

2.3.2 Installation

Place the Emperor Lite CD in the CD drive and close it. The program should start automatically, and ask if you wish to proceed with installation of the software.

If the installation program does not start automatically:

- On your computer desktop, click on the shortcut to 'My Computer'

- Click on the CD drive that contains the Emperor software CD

- Navigate to the \Emperor Lite folder on the CD

- Double click the 'Setup.exe' file

The InstallShield Wizard will now take you through the process with a series of prompts:

- When prompted to continue, click Next >

- Accept the terms of the license agreement.

- Select the language you need to have installed, or all languages.

Emperor will now be installed on the PC. When complete, remove the CD from the drive and store it in a safe place.

2.4 Logging on and user accounts

Emperor initially loads a 'splash screen' showing the software version, that a license key is present, and with boxes for entry of a valid Operator name and Password. Emperor has two levels of user, Master and Operator. The current operator can be identified in test results and data files.

Masters have full access to all parts of the Emperor program, including creating new users, and may create as many new masters and operators as required.

Operators have access that can be restricted to certain parts of the system, to prevent accidental changes to settings.

Until you set up your own user accounts, you will need to use the installed default operator names and passwords. These are case sensitive:

Status	Operator name	Password
Operator	operator	operator
Master	supervisor	supervisor

Once logged on, you are in the working space of Emperor Lite. Familiarise yourself with the various elements (see Section 5, *The Emperor Lite Working Space*).

3. Connecting a Gauge or Instrument

Before running the Emperor control software, your PC should be connected to your system (gauge, instrument, motorised test stand), using the supplied cables (note: the supplied serial/USB cable contains an embedded chip in the serial plug). How you connect depends on whether you require a data cable to control a test stand, for stop or reverse. Any gauge or instrument may be connected directly to your Emperor Lite PC. Here is a schematic illustration of how a force gauge may be connected.
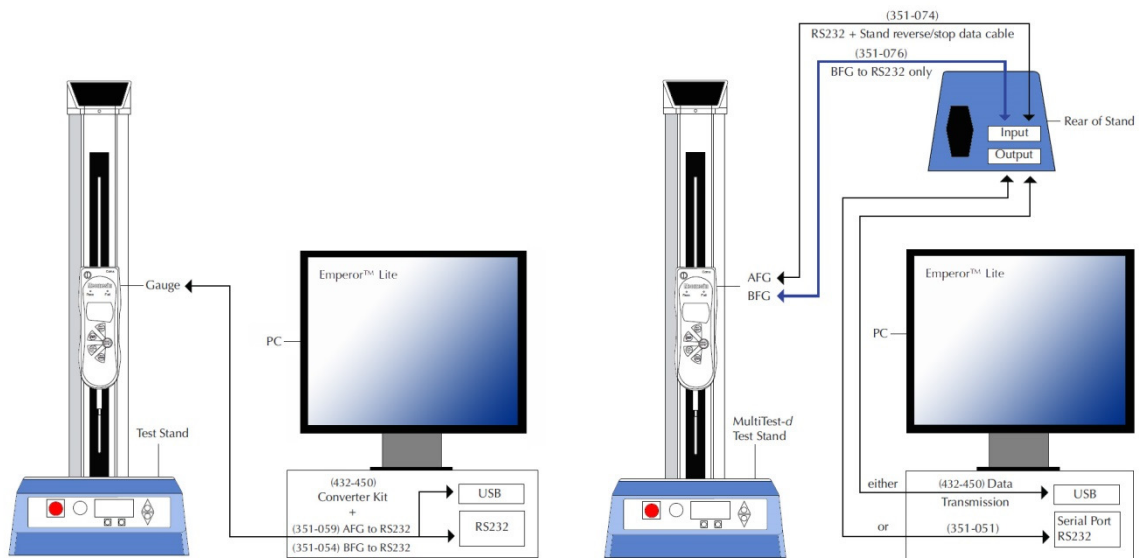
Connecting direct to PC   **Connecting for stand reverse/stop control**

351-059 : AFG / Orbis / Tornado to RS232 (PC)

351-054 : BFG to RS232 (PC)

432-450 : RS232 to USB

351-077 : CFG+ to PC

351-074 : AFG to test stand

351-076 : BFG to test stand

3.1 System setup

To communicate, Emperor Lite needs to know how it is connected, and how much data you wish to collect. How will the data acquisition begin, and how will it be stopped?

System setup ensures you match your instrument output with software input. Go to *Setup > System >* [System Settings].

Primary data input	This will list the available ports on your PC to which a device may be connected. The Test Communication button will confirm your choice if you are unsure.
Mecmesin instruments	Select the device you have connected.
Baud rate	The rate at which data will be sent to the PC by the gauge or instrument. See the instructions for the instrument you are using, and setting it up to match.
Measurement units	Depending on the instrument attached, choose from available units for force or torque **load**.
	Displacement (or angle) units are offered when a test stand is selected, since controlled movement takes place.

Click Test Communication and apply a small load to the connected instrument or gauge, to verify that data from the instrument is arriving correctly at Emperor Lite. You should see this confirmation:
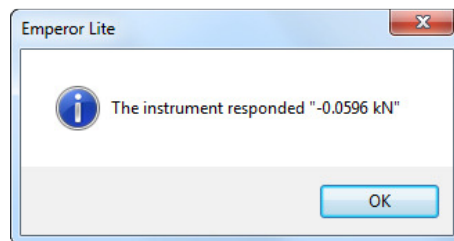
If not, you will see a timeout message, indicating a failed connection. The most likely cause, if everything has been connected correctly above, is the choice of communications port. Check that the port is correct, and that the baud rate set on the instrument matches your selection here.
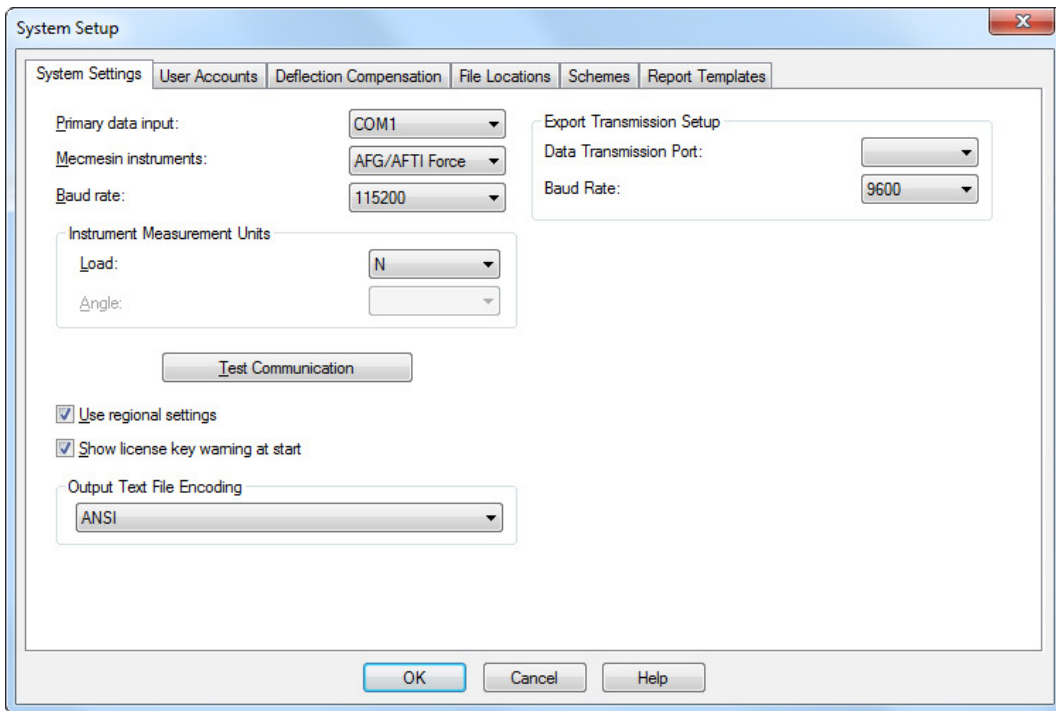
If exporting data to another system, select a port, and the appropriate baud rate.

Use regional settings   Normally you will use the Windows regional (time, keyboard, language) settings.

Show license key warning   If the USB license key is withdrawn after use, the alert at startup can be useful.

Output text file encoding   When you save or export results, you may need to change this. (If it is not right, you will see spurious characters in the data.)

4. System Settings

Make Emperor Lite ready to use by configuring the system settings under *Setup > System*.

4.1 User accounts: setting-up and adding users

User accounts provide either unrestricted access to all parts of the Emperor Lite program (Master) or selective access (Operator). Accounts may only be set up under a Master-level user logon. Add a new user by typing in a name (alphanumeric, no spaces) and password, allocating level and permissions, then click Add . Details may be changed by selecting a name on the left, making the changes, then clicking Change followed by OK .
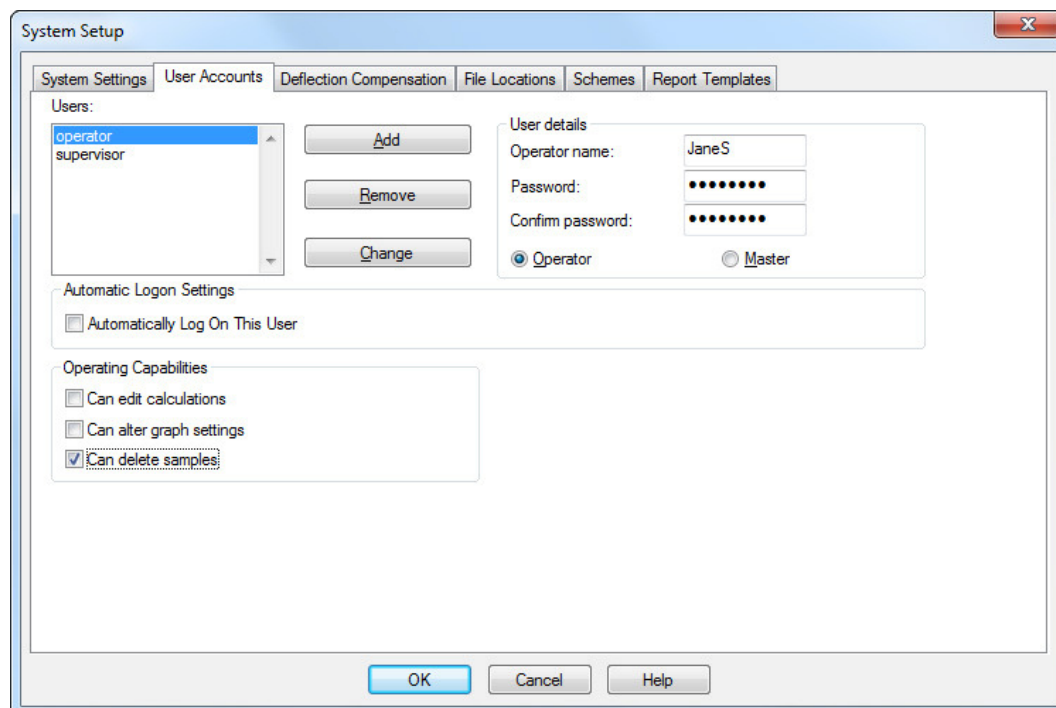

Here JaneS is being added as an Operator-level user, with permission only to delete samples. If she was the most-frequent or daily user, she could be automatically logged on. (Someone else would then have to first log off and then log back in under their own username.)

4.2 Deflection compensation

Emperor Lite can maintain a list of 'stiffness factors' for the systems that use it. Under larger forces and longer travel (e.g. a MultiTest 1-*d* with an AFG 1000N) there will be a limited amount of flexing within the system (i.e the combination of a motorised stand column, the loadcell and fixtures). If this compromises the accuracy sought, it can be compensated for. To do so, the flexing will need to be tested.

This can be done by setting an entire system up, and using a very slow tension or compression test on a completely rigid sample, or against the anvil plate of a test stand. Use the slope command (see 8.3, *Calculations*) on the full extent of the test, and from this result, set a compensating value.
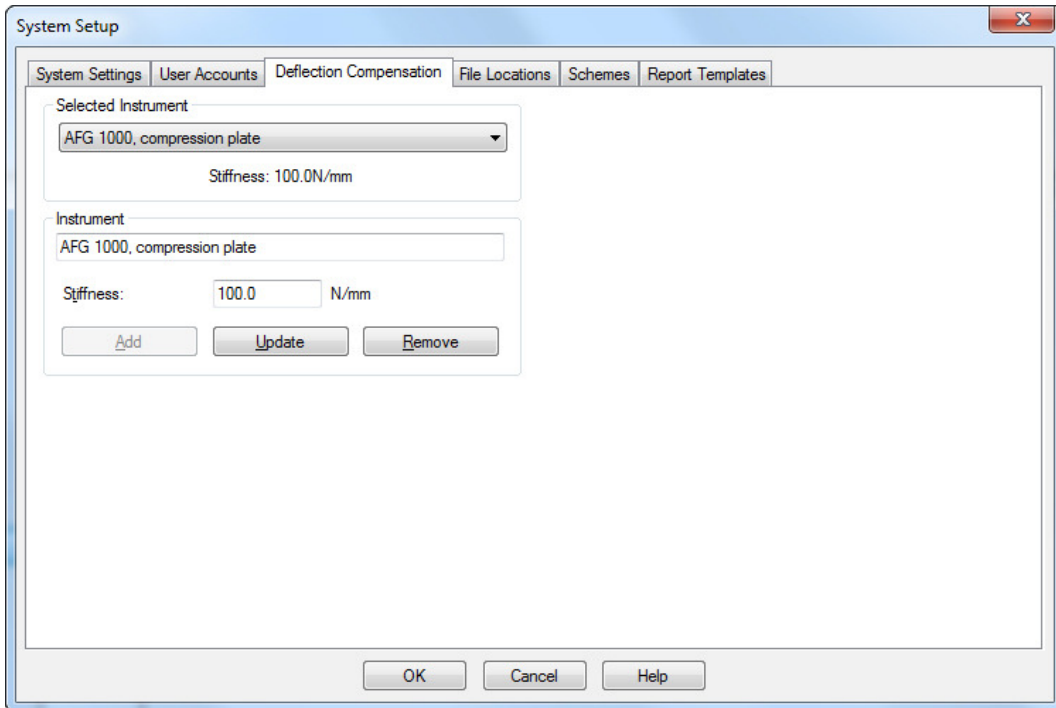

Here an AFG 1000N has been used with compression fixtures on a motorised stand, and the deflection compensation added to Emperor Lite. Subsequent tests can use this, but remember that the compensation applies to *this* system, and may be different on another. Whilst this deflection is selected, it will be applied. To use another, or none, reselect here before you run a test.

If you do use deflection compensation, you may find it useful to add an Information line to the results file (see 8.3, *Calculations*).

4.3 File locations

You can leave the default file locations for these files (which may differ slightly depending on your version of Windows), or allocate a different or networked location.
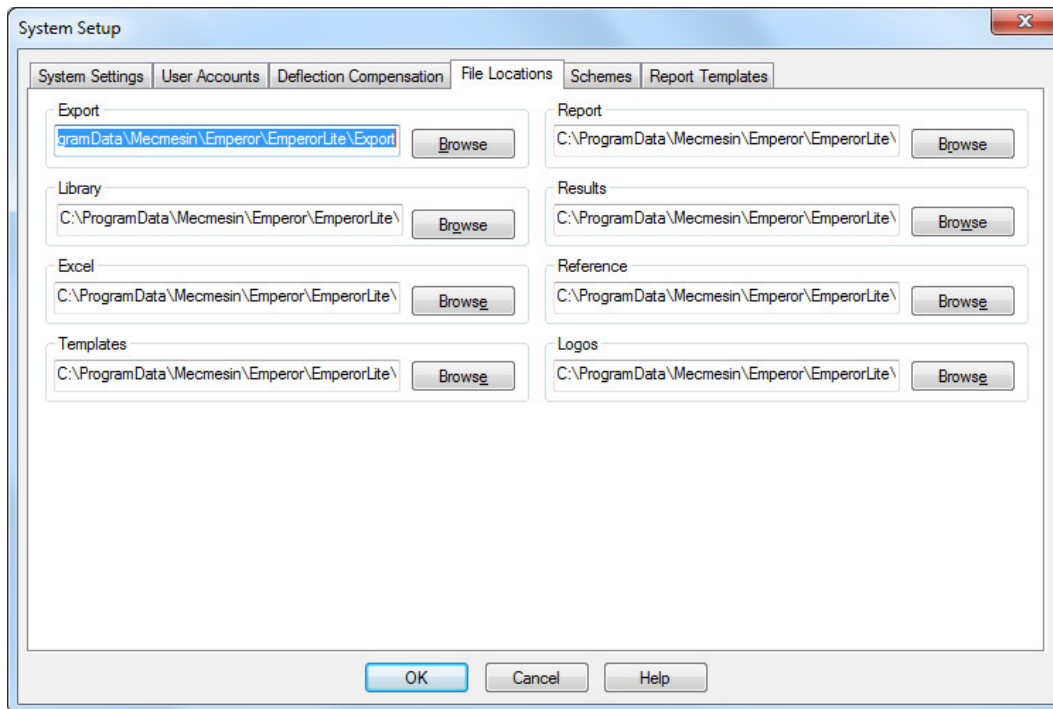
Change any file location, click OK and log off and on again for the change to take effect.

4.4 Schemes

Data schemes are templates defining how results data are arranged for export. Data may be exported as raw data (all data points recorded) or as results (calculation results only). There are default templates available, but you can create and name schemes of your own.
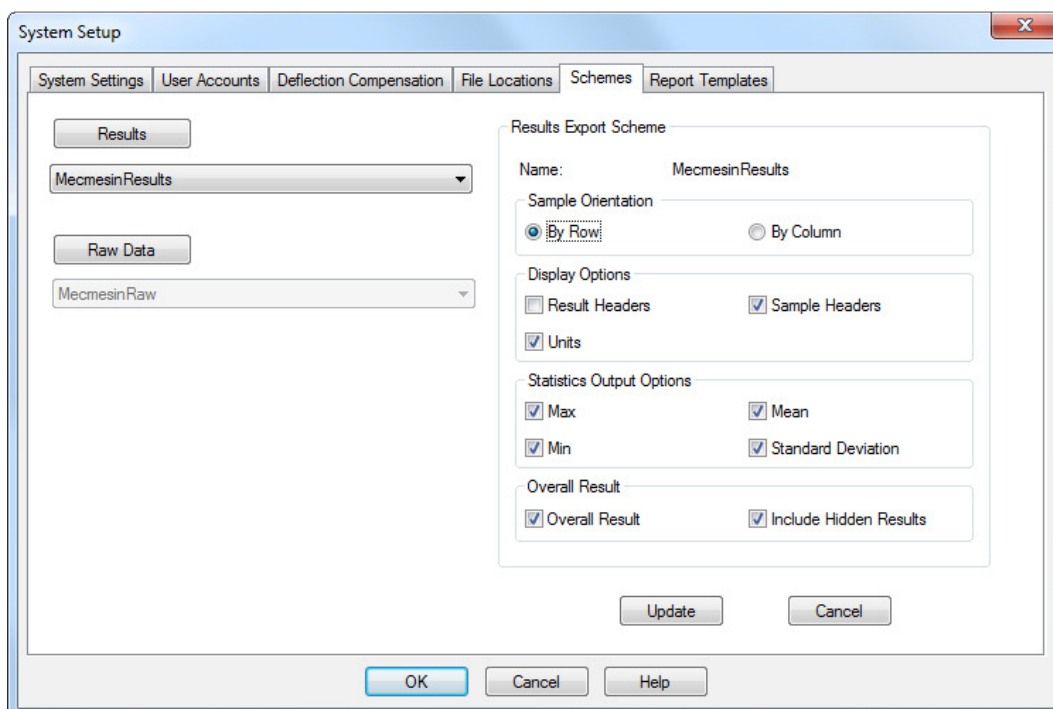
> To begin with you don't need to do anything; read through and come back here when you start to export real data. Use the defaults at first and then decide how you need to create your own schemes.

Choose to create a scheme for either Results or Raw Data , and select New Scheme from the drop-down list, then enter a name and confirm with OK .

Now profile what you require for the Scheme and click Update to save.

Results:

Sample Orientation	Arrange samples in rows or columns
Display Options	Include headers for results, samples and display units
Statistics Output Options	Include the statistical information you require
Overall Result	Show 'Pass' and 'Fail' against combined criteria for all verified calculations. Hidden results are those results used in calculations that have been chosen not to be displayed (see Appendix B, *A Note on Overall result and Hidden Results*).
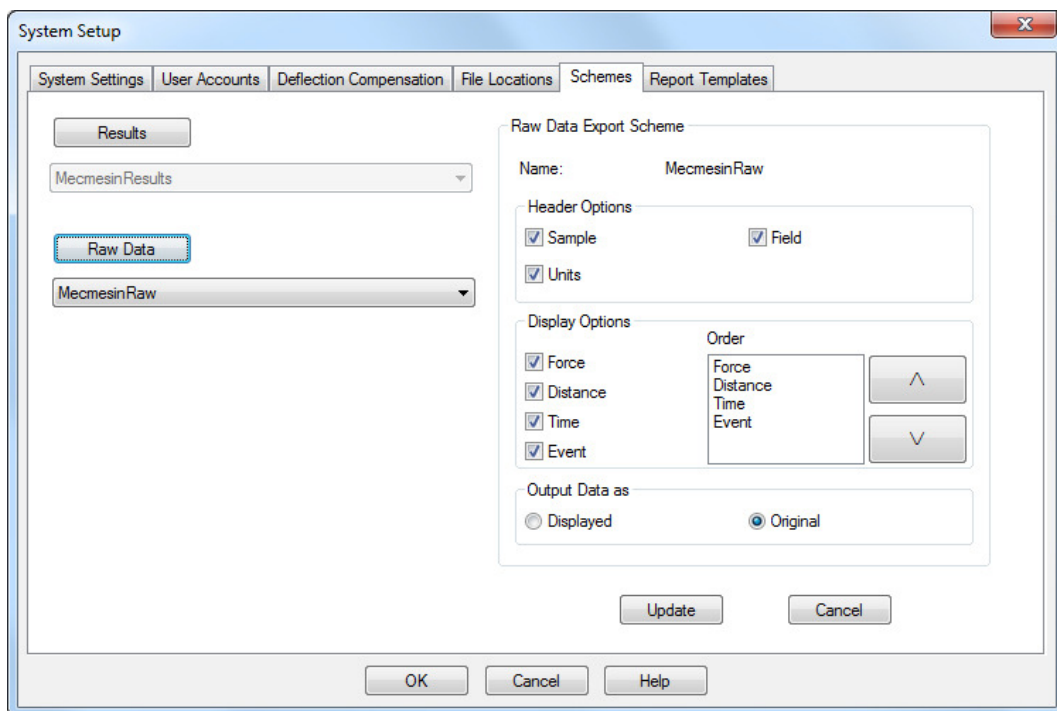
Raw Data:

Header Options	Include those header elements you require.
Display Options	Choose which elements to include (e.g. time or distance may not both be important.

Output Data as   'Original' data is without display options, whereas 'Displayed' might include Preferences such as accumulative displacement under graph settings.

To change the sequence in which data are presented, select a row and use the up and down arrows to reposition it.
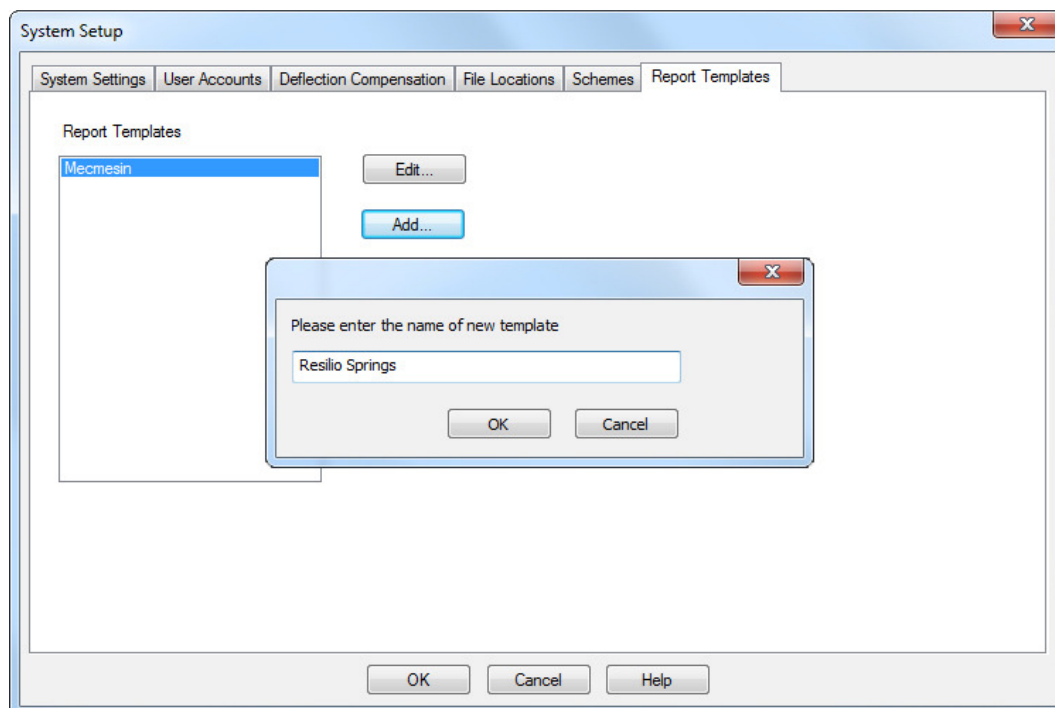
4.5 Report templates

Report templates enable you to customise the layout of printed reports of results. You can define two logos, headers and footers, the layout of the data itself, and whether to include a graph.

> To begin with you don't need to do anything; read through and come back here when you start to report real data. Use the default template at first and then decide how you need to create your own templates for different tests.

4.5.1 Add a new report template

You can edit a report template or add your own. You might prefer to leave the Mecmesin default template as a permanent reference.


Add and name your template (or select a name and Edit) to bring up the Report Template Wizard.

Logos

The first option is to add logos top left and top right. You might choose to use your own along with that of a client or product. Double click either logo box for a Windows browser to list your images, which must be stored in the file location for Logos, as set in the *Set-up > System >* [File Locations] tab. Any images you use must be in bitmap format. You may need to resize images to avoid very large files.

No bitmap?

You can open any image you have in Windows Paint (in Windows, Accessories—or right click the file name in Windows Explorer and choose *Open With > Paint*), and Save As a 24-bit bitmap into the Logos file location.
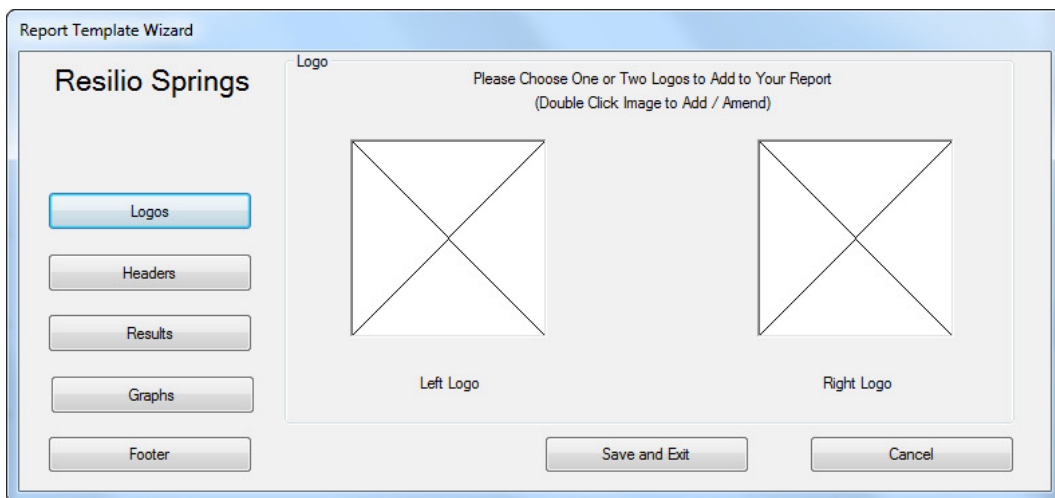
Note: Images cannot be linked from anywhere other than the defined File Location for Logos (see 4.3, *File locations*).

Remember to Save and Exit before you leave the Wizard.

Headers and Footers

Headers and Footers both work in the same way. Available elements are listed in the box at the top, and the two boxes below represent left and right print areas. The content for each of these items is added before a test is run and the results saved, under *Test > Notes*.

Select each item you want to include and use the ▽ down arrow above the respective box to add it.

To move an item out of the used list, back into the available list, select the item and use the △ up arrow.

To change the order of header or footer contents, left or right, select the item and use the △ and ▽ arrows to the right of the box.
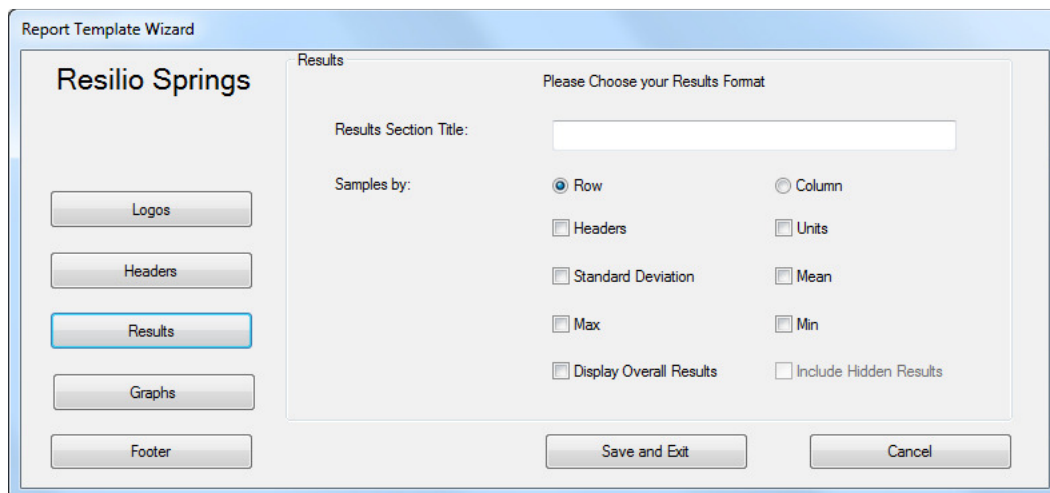
Note: Custom Notes fields are not implemented in Emperor Lite

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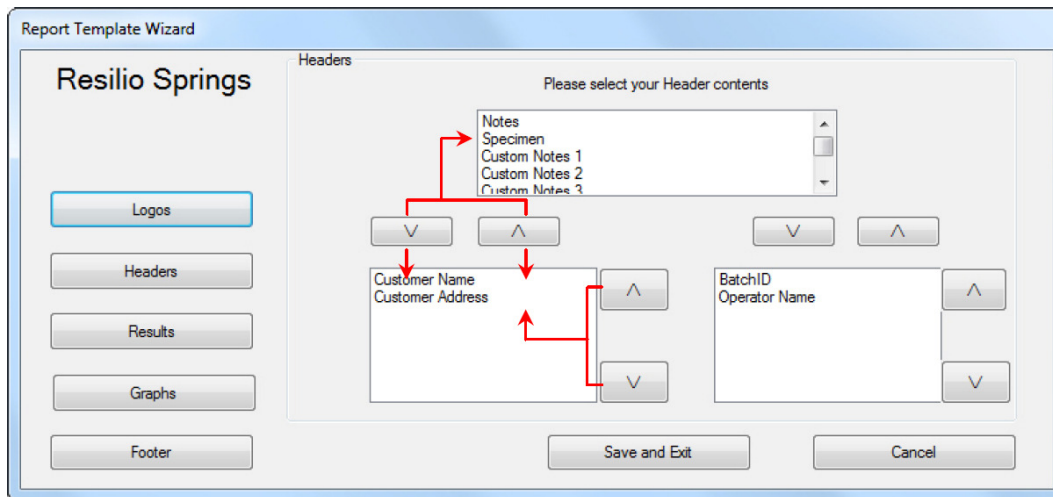
Remember to Save and Exit before you leave the Wizard.

Results

The title of your template now shows top left. You may now decide what you want to appear as a heading for the results section, what to include, and how to lay it out:

Remember to Save and Exit before you leave the Wizard.

Graphs

This option simply allows you to choose whether to include a graph or not, and to give it a report section heading.
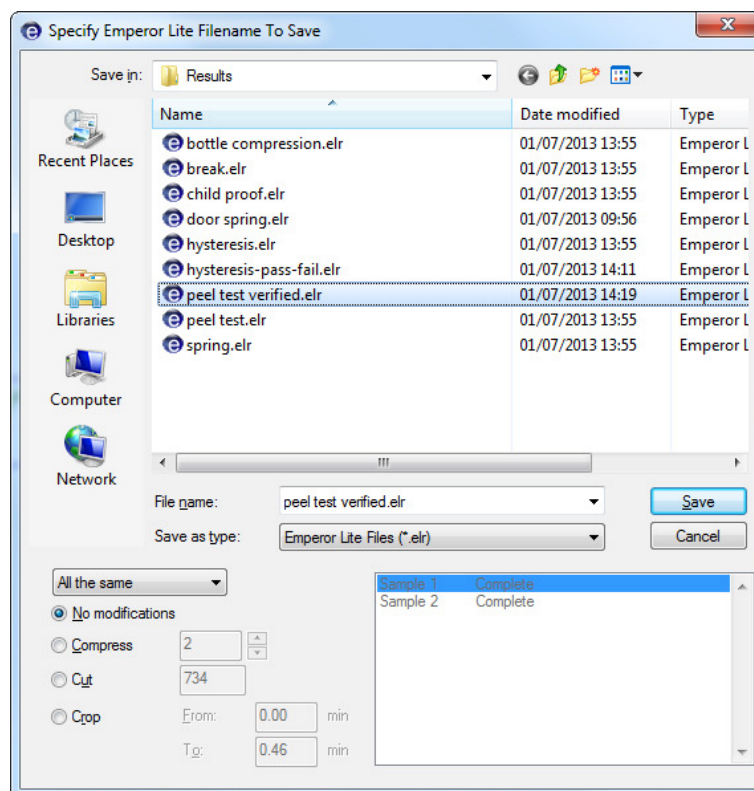

Printing

Report templates only define content, not final appearance. More often than not, a landscape paper orientation is required. This is set in *File* > *Print Set-up*.

# 5. The Emperor Lite Working Space

5.1 Menus

5.1.1 File menu

New
Opens a new, empty, test file. Any other file currently open will be closed with appropriate warnings to save.

Open
Opens the last used folder for Results files (.elr). Library Files (.ell) are not 'opened', but 'loaded'.

Save
Saves the current results file, if changed.

Save As
Saves the current results to a new file name. Here you are invited also to manage file size by selecting 'Individual' samples or 'All the same', to Compress, Cut or Crop the data (See Appendix A.2, *Managing File Size*).

Load Library File
Loads a test file (with calculations for results), ready to run.

Save Library File
Saves an edited test file, with a prompt about overwriting the original Yes or creating a new file No .

|	
Print Setup	Select your printer, and print options, including paper orientation.
Print Report	Prints these results using the embedded report template.
Print Report Preview	Examine your results report before printing.
Print Graph	Just prints the currently displayed graph. Check your paper orientation in Print Setup: landscape may be more useful.
Export Raw Data	Exports **raw data results** with options (below), when enabled for these results and a filename specified, in *Setup > Report and Data Export* > [Raw Data Export]
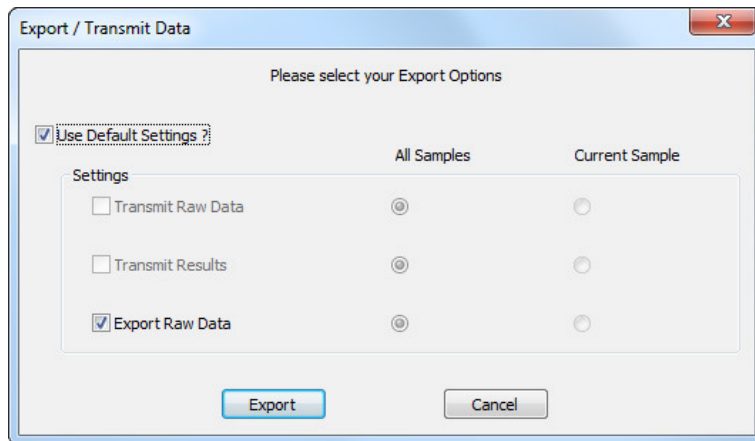
Transmit options are greyed out because *Setup > Report and Data Export* > [Transmission] options have not been enabled for these results.

Note: To export **results** only (see 7.2, *Results Data Export*):

1. *Setup > Reporting and Data Export* > [Results Data Export]
2. add the file name you want (or leave blank for a default name)
3. add the required samples to the results
4. click OK

Send to Excel	Exports raw data or results to Excel, with options (below), when enabled, in *Setup > Report and Data Export* > [Excel]
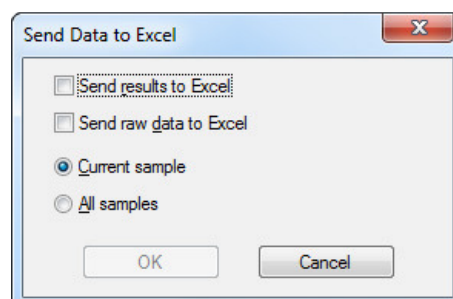
This example shows both results and raw data have been enabled. Remember that Excel has limits on its number of rows and columns that raw data can easily exceed. You may choose to cut or crop data in the Setup choices (see 7.3, *Raw Data Export*).

Recent Results Files Links to the six most recent results files to have been used.

Recent Library Files Links to the six most recent test files to have been loaded.

Logout Returns you to the Emperor splash (logon) screen.

Exit Logs off and closes the Emperor software.

5.1.2 Test menu

Notes Notes may be added to, and saved with, a results file and used in a report template.

The date shown is that of the last edit of the Notes.

Note: Custom Notes are not implemented in Emperor Lite.

Calculations Add calculations to the data to produce results to evaluate and/or display. See Section 8, *Test Calculations.*

Results Displays results one sample at a time, with print options
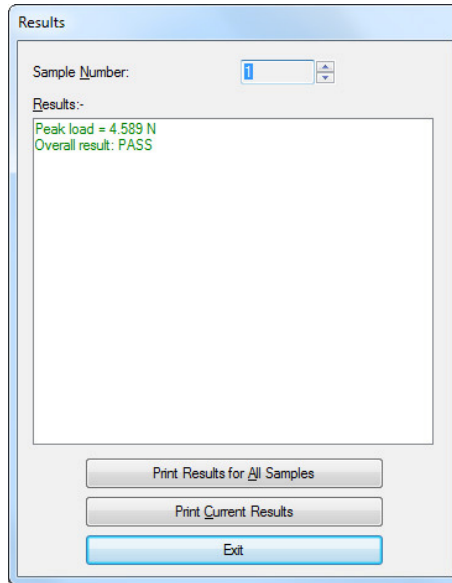
5.1.3 Display menu

Graph   Adds the Graph Toolbar (see page 21) for analysis and removes onscreen controls.

Settings   Displays the *Setup* > *Preferences* > [Graph Settings tab]. (See Section 6.4, Graph Settings.)

Overlays   For visual comparison overlaying graph traces can be very useful. Overlay multiple traces from samples tested, or compare a trace with a reference file for tolerance (see Appendix Appendix C: *Tolerance Bands*). Available to Master users only.

Data   Displays the data from a single sample, up to the first 32,000 points. These may be selected and copied and pasted into Excel.
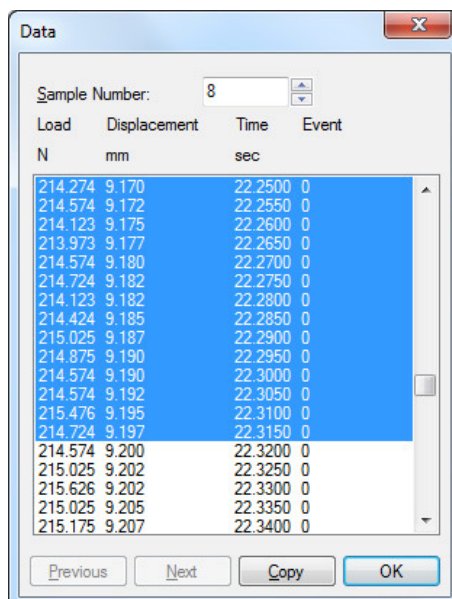
Replay	Presents the graph axes and an x-axis slider. This can be dragged across to 'replay' the graph trace whilst displaying Load, Displacement, Time and Events (see page 23).
Copy Graph	In *Display > Graph* mode, this will copy the graph as an image to paste into a document elsewhere.
Interrogate	For Cursor Drop, Time Line, Review Results, see Graph Toolbar on page 21.
Summary View	Displays or hides the panel above the graph, where results are displayed.
Status Bar	You may choose not to display the Status bar, which carries information on test mode, load, data rate, sample no., and cursor x/y co-ordinates.

5.1.4 Setup menu

Preferences

See Section 6, *Preferences*

System

See Section 4, *System Settings*

Language

Choose from the list of installed languages. Requires a restart of Emperor.

Report and Data Export

See Section 7, *Report and Data Export*

5.1.5 Tools menu

Recalculate Results

In most cases, when calculations are changed, you will be prompted and you will choose to recalculate results straight away, but recalculation can be done later or at any time by using this option.

5.1.6 Help

Help Topics raises the Emperor Lite help file (based on this manual).

Email provides the appropriate address to seek technical advice from Mecmesin.
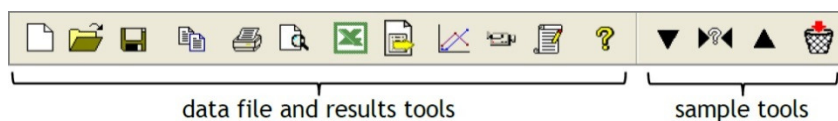
About provides version and contact information:
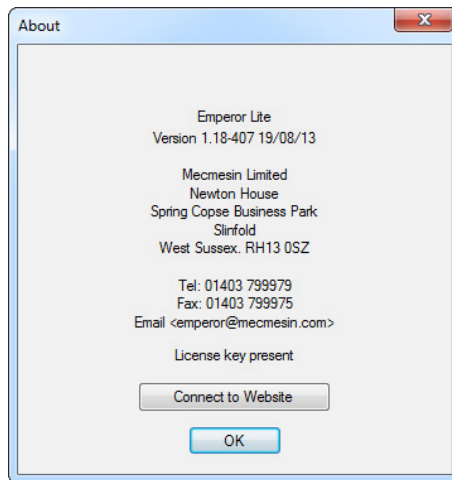
5.2 Test run area
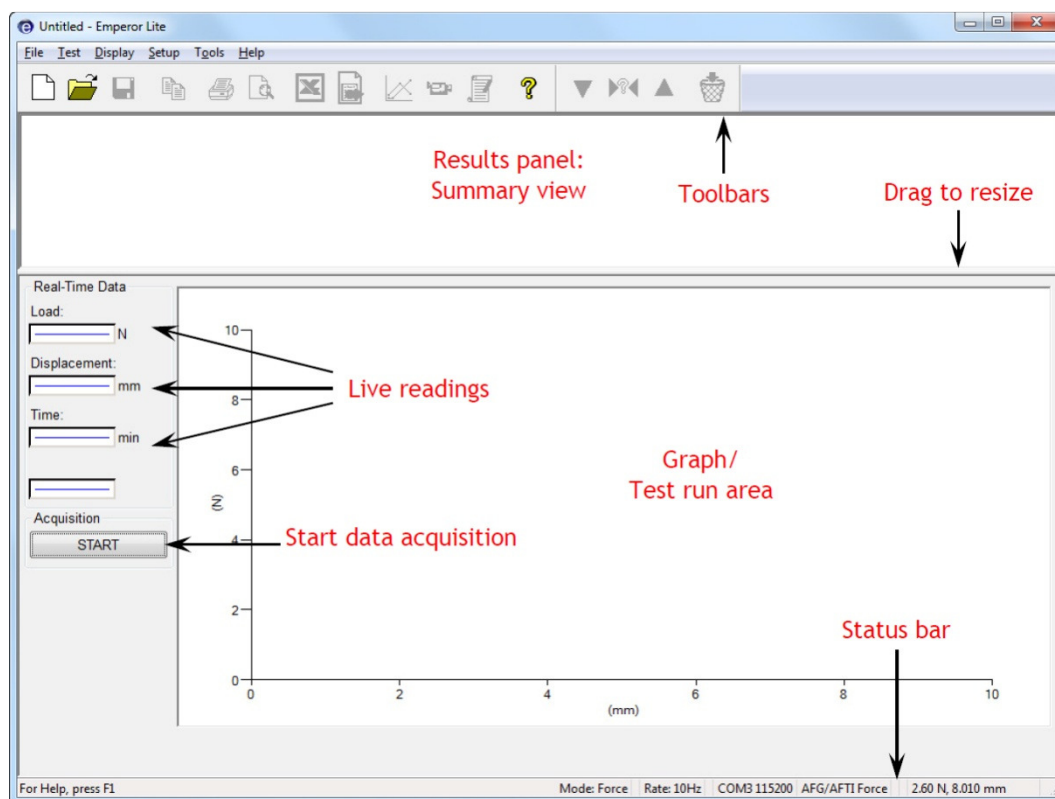
5.3 The Emperor toolbars

Toolbar buttons and segments are available or greyed out according to relevance. Here, for clarity, all are shown as available. Many are duplicated on the drop-down menus (e.g.

File > *Open* is the first button) but also here for ease of use. Hover over a button to see its name.

The complete toolbar is in segments, with buttons for:

- managing the editing of calculations and notes, handling results and files, and help

- working through sample results and editing samples out

Data files and results tools (Standard toolbar)

Left to right:

- **New** (also *File* > *New*, or Ctrl+n) gives a 'blank canvas' for creating a new results file.

- **Open** (also *File* > *Open*, or Ctrl+o) opens results files.

- **Save** (also *File* > *Save*, or Ctrl+s) saves results files.

Note: to load and save **Library (calculation) files**, use the File menu.

- **Copy Graph** is activated with the **Graph Analysis Mode** button (see below).

- The **printer** icon (*File* > *Print Report*) will send your results to print according to the default report preferences and default report template, or as amended under *Set-up* > *Report and Data Export*.

- Use the adjacent **Report Preview** button to see how your printout will look.

Printing note

On the screen graph display, the *current selected sample* trace is always picked out in red for clarity. When printing, red is not used. The first sample trace is restored to black. You may need to adjust your printer preferences as well for colour, orientation and margins.

- The standard **Excel** button and the adjacent **Export Data** button (for raw data only) become available when respective export destinations are defined in *Set-up* > *Report and Data Export*.

 Graph Analysis Mode adds the **Graph toolbar**:

 Graph Settings (also *Display* > *Settings*) allow the graph to be viewed in different ways

 Zoom allows you to drag a marquee with the mouse to select an area to examine in close-up. Click the button again to return to normal view.

⊕ **Cursor Drop** (also *Display > Interrogate > Cursor Drop*) allows you to click on a data point, then click on a second position to drop in a text box with the co-ordinates. Right click the box to add a caption, move or delete the box.

> **Note:** Cursor drop features can only used to annotate an immediate printout. They are not saved.

⊕ The **Timeline** button (also *Display > Interrogate > Timeline*) adds an x-axis slider or sliders below the graph. (See illustration below.) This draws a vertical line for an accurate observation of the x-axis for an event along the current selected sample (always shown as a red line).

🔬 **Review Results** (also *Display > Interrogate > Review Results*) allows you to click on any calculation cell for a given sample in the results panel, and see the position of this calculated value as a point, line or area on the graph. This allows the refinement of calculation values, such as limits, in line with the actual behaviour of test samples. In the case of limits, these may be repositioned with the slider controls beneath the graph to *change the calculation values in the results file*, which can then be saved.

Note that in Graph Analysis Mode, the cursor position in the graph is shown dynamically as coordinates in the Load, Displacement/Angle or Time boxes, and that a graph image can be copied to the Windows clipboard (right-click, Copy Graph).

The following illustrates Cursor Drop, with Sample 2 selected, and a sample compared with a reference for tolerance. Note also the pass and fail criteria results in green and red.
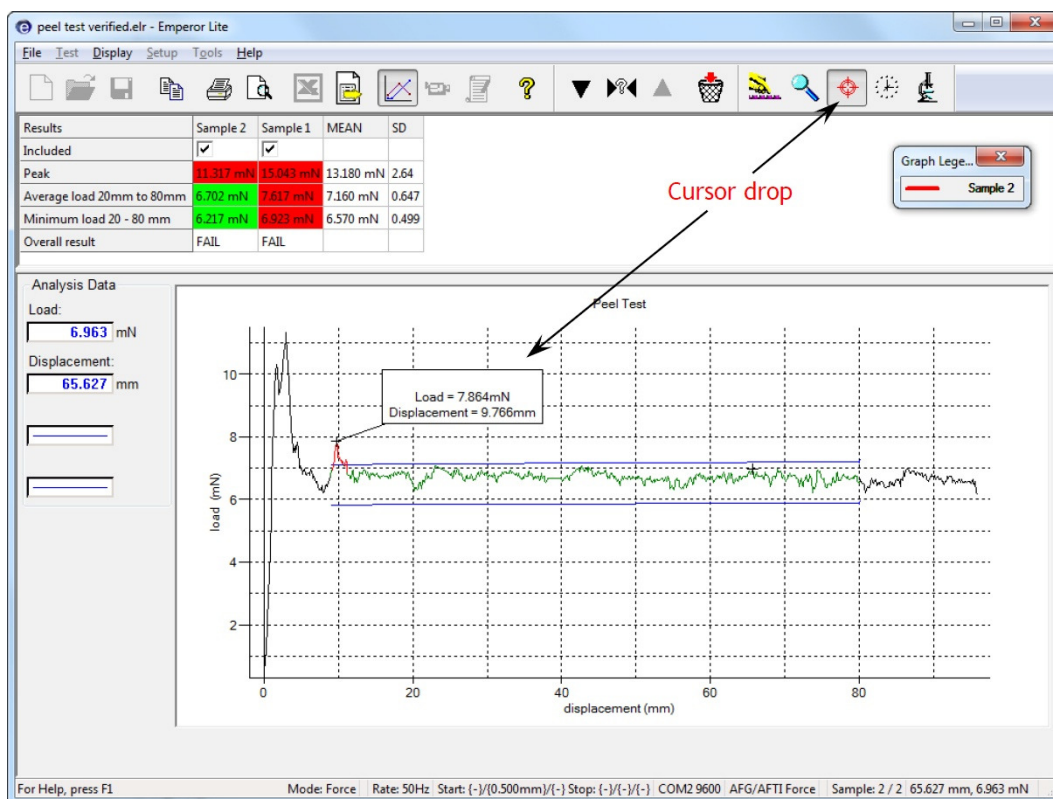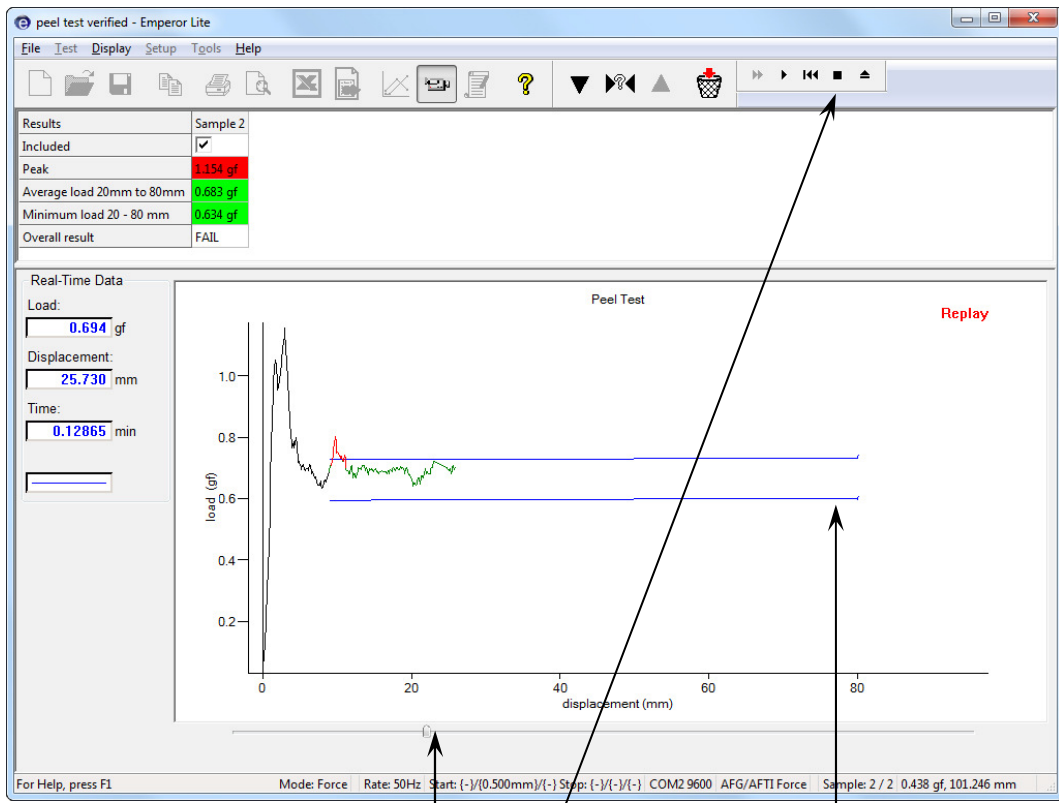
Replay

This button switches on test replay mode, with the corresponding control toolbar:

Play, Fast forward and Return to start, or pause (the Stop button). Alternatively, below the graph, there is a slider to progress through the test. This enables you to examine the course of a test in detail. Use Exit Replay, or click the Replay button to resume normal graph view.
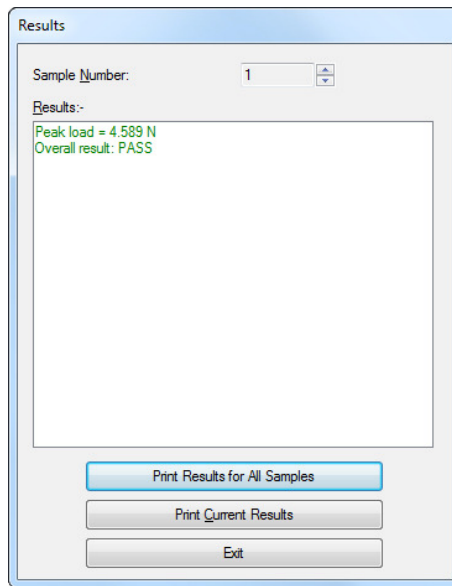

Use the slider, or replay controls

Here a tolerance reference is being used

Results

Click the **Results** button to view all results lines per sample, print any or all. **Note:** this sends results straight to the designated printer without any further print dialog.

Sample tools (Specimen toolbar)
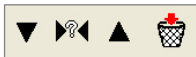
The down and up arrows take you to previous and next sample, the **?** allows you to select a sample by number:
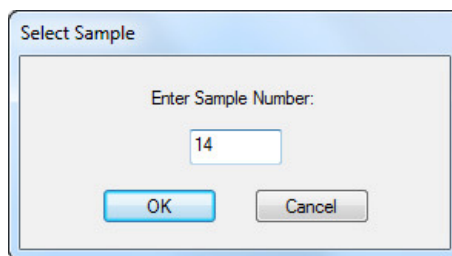
The basket button will delete the sample, i.e. remove the data. (This is a permission that has to be given explicitly to an operator in their profile.)

6. Preferences

Preferences define how Emperor Lite acquires and displays results. These parameters can only be edited by Master users, under *Set-up* > *Preferences*.

Preferences include:

Measurement

- choice of units for force, displacement, angle and time
- data acquisition rate and start/stop triggers by time or from the loadcell

Results

- settings for the display of results and graphs

Control

- what happens on test completion.

6.1 Default settings

As Emperor Lite arrives 'out of the box', there are default settings, but your requirements may well be different, so you can edit and save your own default set of most common preferences. The parameters set in the Preference tabs will be the settings used for the current activity, and may be saved as default settings: Save as Defaults . These new defaults are the values to which Restore Defaults will go (i.e. not 'factory settings').

6.2 General preferences

Units

Units	Force instruments	Torque instruments
Force/torque	kN, N, mN, kgf, gf lbf, ozf	mN.m, N.cm, N.m, gf.cm, kgf.cm, lbf.ft, lbf.in, ozf.in
Displacement	mm, in	rev, deg
Time	h, min, sec	h, min, sec

Select the required units and precision (number of decimal places). Scaling for other units such as radians or non-SI units is best done across a whole data file in Excel after export, rather than factoring each result by calculation within Emperor.
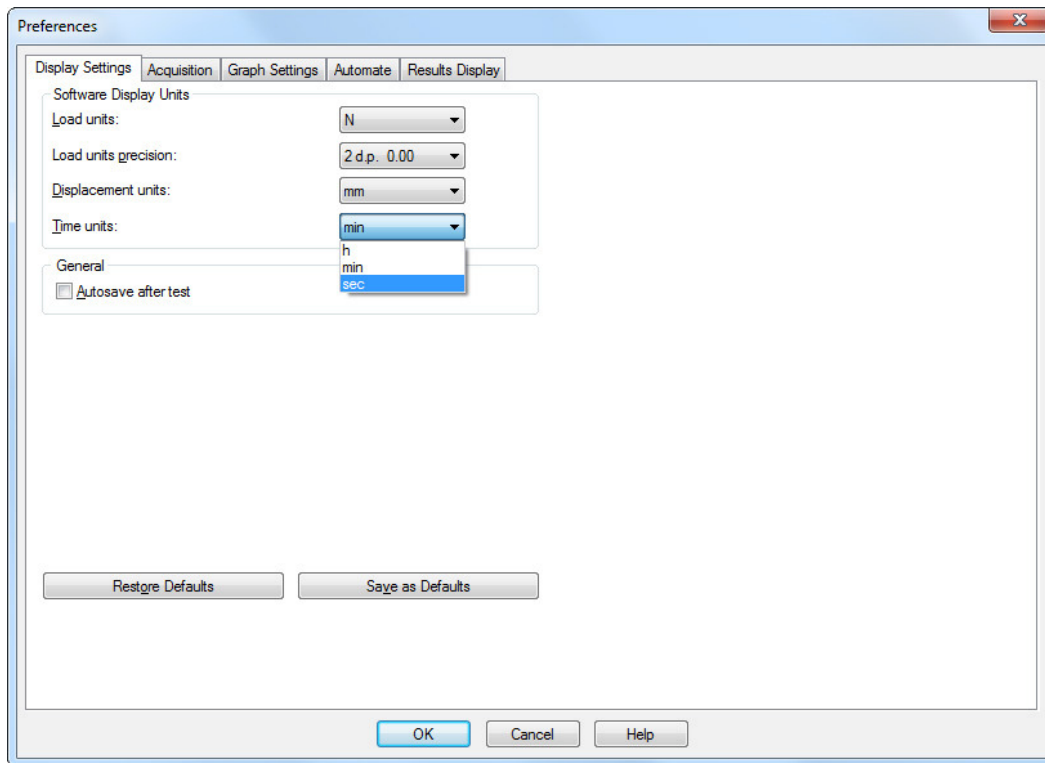
> **What happens if you view test results on a different PC?**
>
> Units of measurement remain as recorded, even if viewed with Emperor Lite on a PC with different default units. The second user can, if they wish, edit the results to read in other compatible units, and resave the file.

General

Autosave   ensures that results files are saved after each test, as protection against data loss in the event of power interruptions.

6.3 Data Acquisition

To obtain more detail from that part of a test that is of most interest, Emperor allows you to optimise your data acquisition.

Acquisition Rate   Select, in data points per second.

Conversion Factor   Unless you are using a motorised test stand that can feed back displacement data to Emperor Lite, you can use a stand speed setting (Conversion Factor) multiplied by time, as an approximation for displacement.

Conversion Factor Units These are the units for the speed value entered.
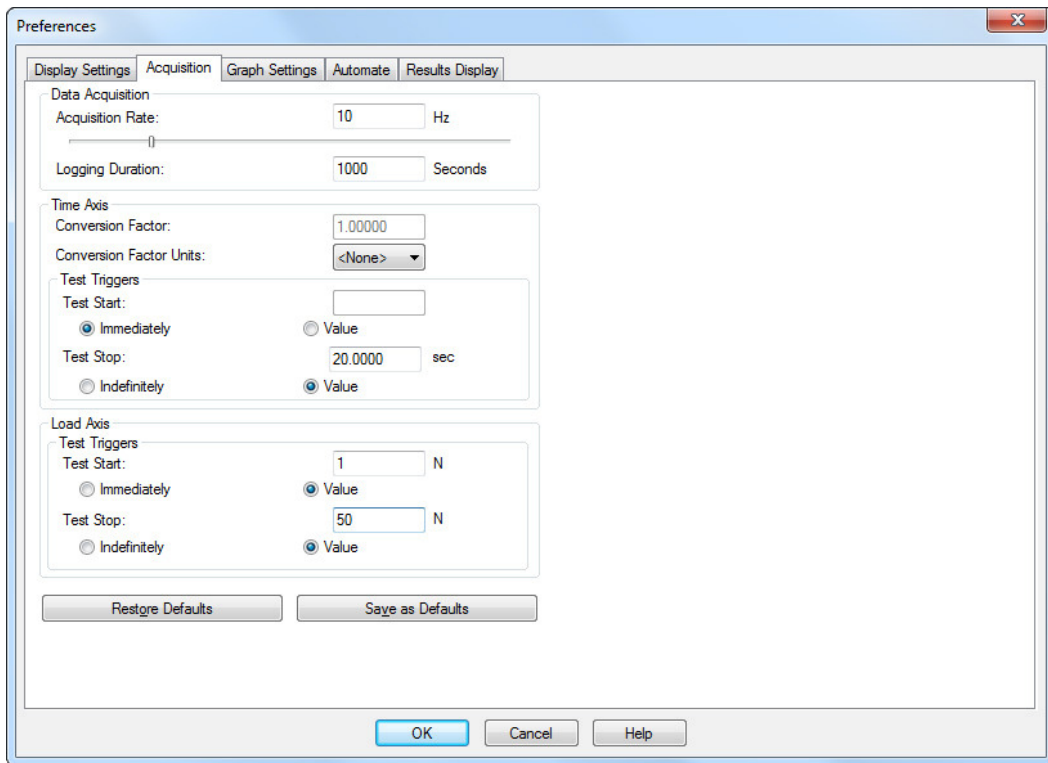
Triggers   Decide when data acquisition will start and stop. Acquisition will begin at the first trigger point, and will continue to the second value of that trigger, or until another trigger end point is reached, or until the test stops, whichever is reached first.

Example (illustrated above):
Start when 1 N force is detected, and continue for 20 seconds or until 50 N force is detected.

6.4 Graph Settings

This tab is used to set the options for how the results will be presented graphically. Use the radio buttons and drop-down boxes to choose the graph axes. This tab is also available under *Display > Preferences* so that operators who have also been granted permission to alter Graph Settings, have access for individual tests.

Display accumulative displacement. Ticking the check box will plot the displacement on the graph from the beginning of the test, i.e. displacement (or angle) will be shown as increasing regardless of the direction of force or torque. This is useful when calculating area, average and slope, and in cyclic tests.

Positive and negative sign values

By default, compressive (or anti-clockwise) forces are signed negative and tensile (or clockwise) forces positive. When looking at a graph based on positive axes, this may seem confusing. By **inverting** load and/or displacement/angle, a graph can look more natural.
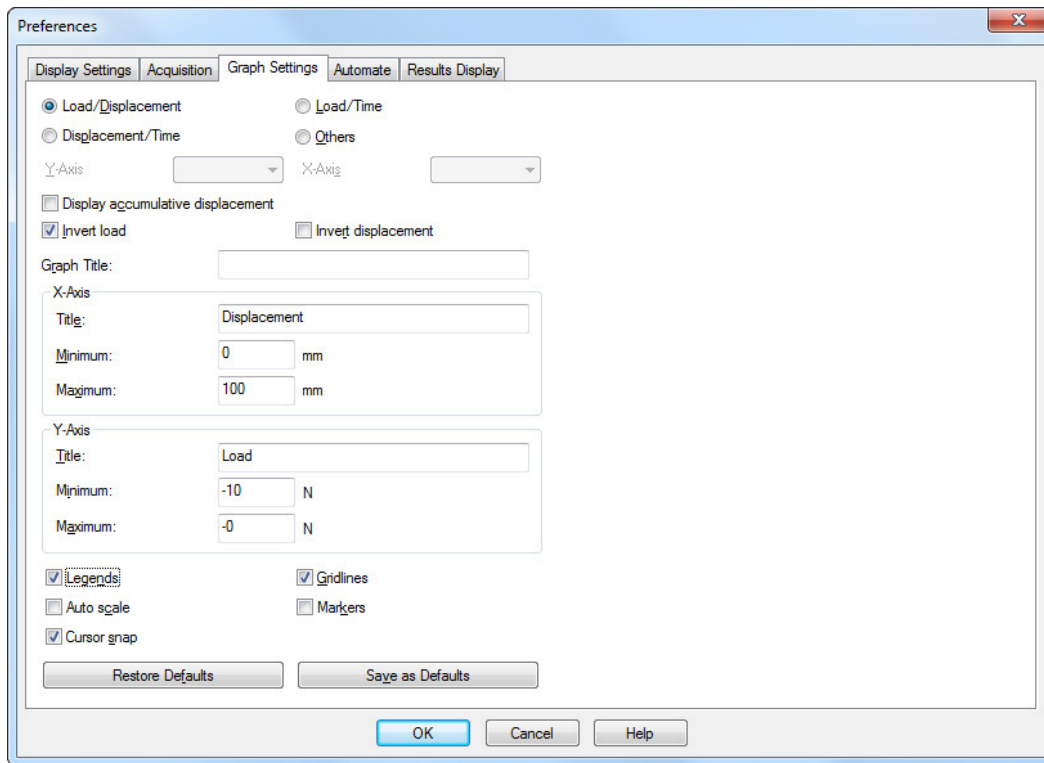
| Graph title	is optional. The X and Y **axis titles** will be filled in according to the radio button selected, but you can overwrite these if preferred. (See Conversion Factor under the Acquisition tab regarding actual or derived displacement.)
Legends	for multi-trace graphs can be added as required.
Gridlines and scale	Check to display gridlines.
Auto scale	When a test is running, the graph is auto-ranging—it will be re-drawn so that the trace is always visible. Ticking the Auto scale check box will cause the graph to be re-drawn *at the end of the test* with the axes scaled to display all the data collected (and the min/max settings here will be greyed out). If you un-tick the **Auto Scale** check box, the greyed-out boxes become available and you can manually enter the X and Y axes maximum and minimum scales. At the end of the test, the graph will be re-drawn using these scales.
Markers	adds a marker for every data point, which can be useful when zooming in on a trace.
Cursor snap	will make the cursor snap to the nearest data point, which makes visually obtaining exact co-ordinates easier.

6.5 Automate
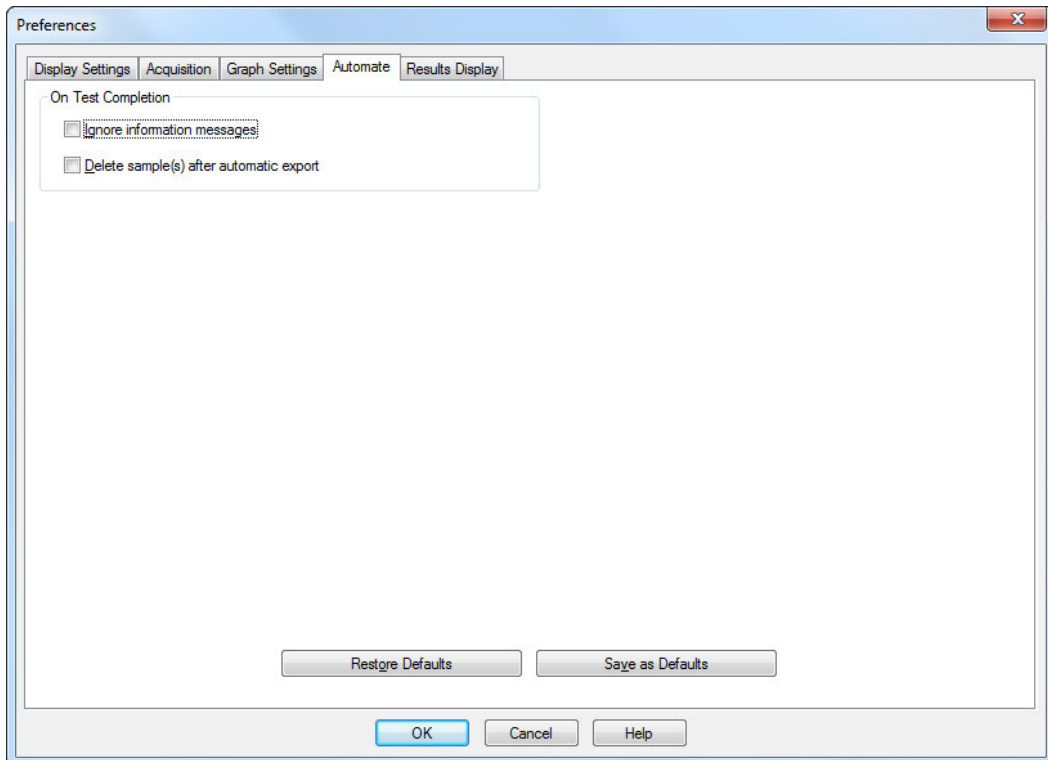
These preferences take place on completion of a successful test.

Ignore information messages

During an automated process, information messages may not be required or useful.

Delete sample(s) after automatic export

If you are automatically exporting data after test completion, instead of saving them in a results file, you can also automatically delete the sample data. **Note:** deleted samples cannot be recovered.

6.6 Results Display

In the results display panel above the test/graph area (*Display* > *Summary View*), Results can be seen, by default, one sample at a time or all at once, by choosing between 'Current Sample' and 'All Samples'. This default does not prevent any or all samples being viewed, only that if a large number of samples is usual, the statistical averages may all that are required.

For statistical analysis of all samples selected, tick any of: mean; standard deviation; minimum; maximum; to be displayed to the right of the result(s). By default, only the first two: 'Display Mean' and 'Display Standard Deviation' are ticked.
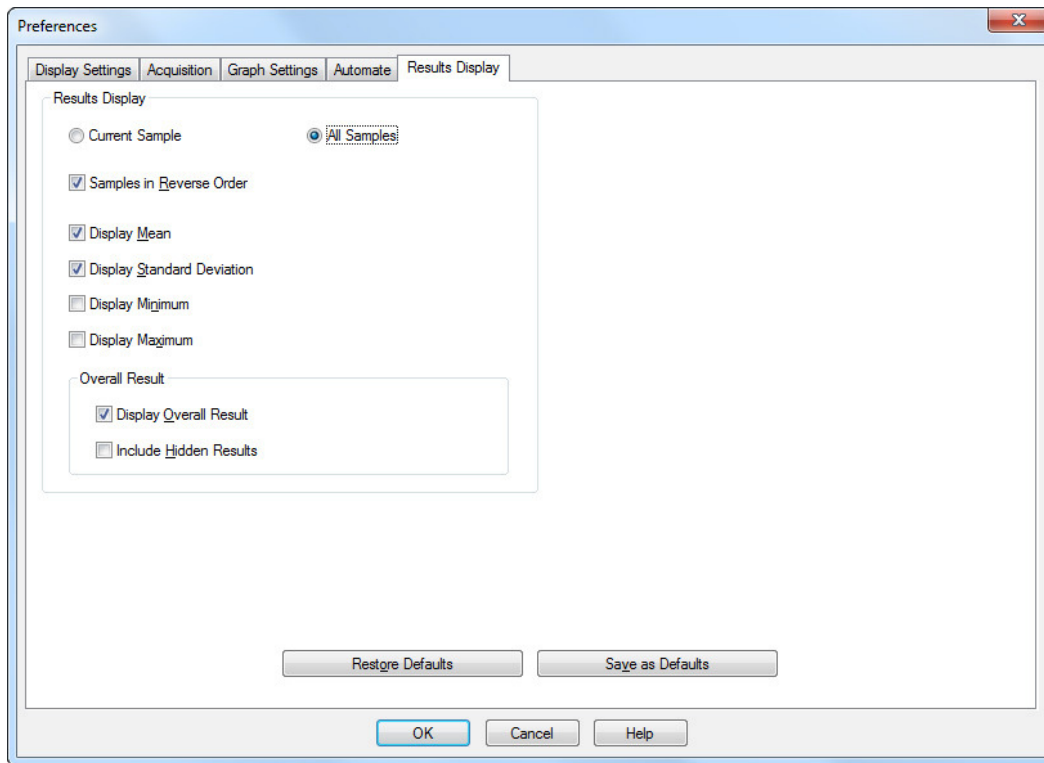
Display Overall Result Overall result is the accumulated pass/fail assessments of all verified and included calculations. If only one verified calculation is crucial for pass/fail and others merely indicative, then the overall result may not be needed.

Include Hidden Results Hidden results are usually hidden for a reason, but if some are verified, this can make an overall result appear confusing. Showing them can clarify this.

For Overall and Hidden results, see Appendix B: *A Note on Overall result and Hidden Results*.

7. Report and Data Export

Choose how you want to share the results of a test run. Reporting (printed sheets or PDF) may be all you need, or you may need delimited files of results, or of raw data, or to transmit directly to another system (e.g. SPC).

7.1 Report

Reports are straightforward and use templates you have already set up (*Setup* > *System* > [Report Templates]). Choose the detail you want to add: Title, page Header and Footer, the Results text and/or the graph. With a maximum eight samples per graph, if you want to overlay more samples they will be split over several graphs.
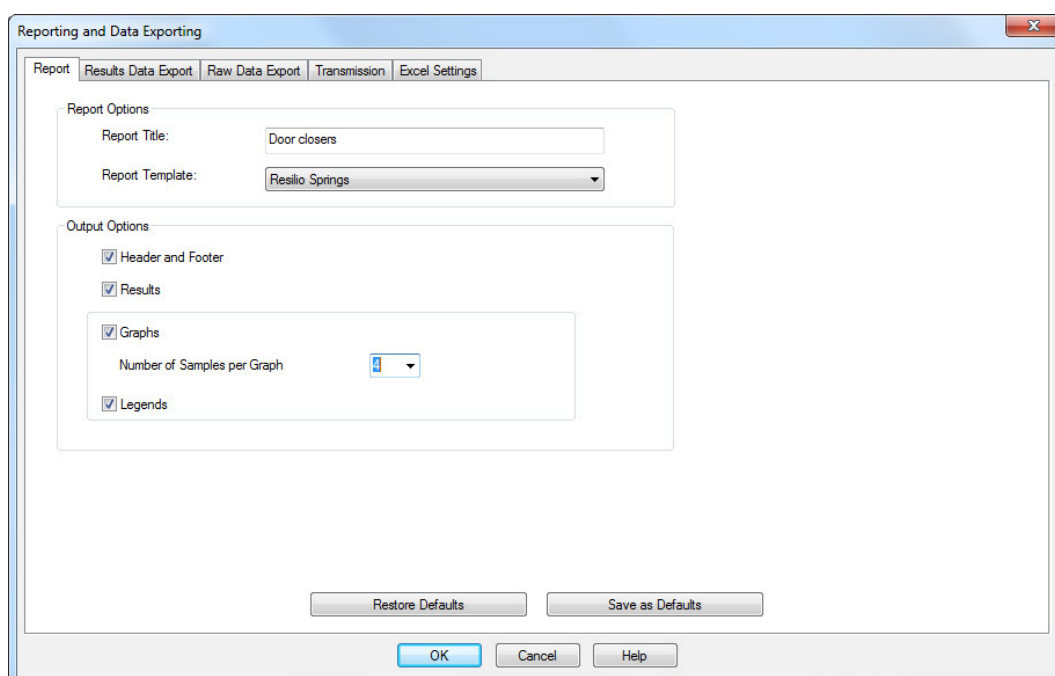
7.2 Results Data Export

If you are exporting data, decide if you want just the results of calculations per sample, or the raw data. Raw data means x/y figures for every data point. At 50 data points per second, data files can be large, so options are added to Raw Data Export to cut down the amount of data.
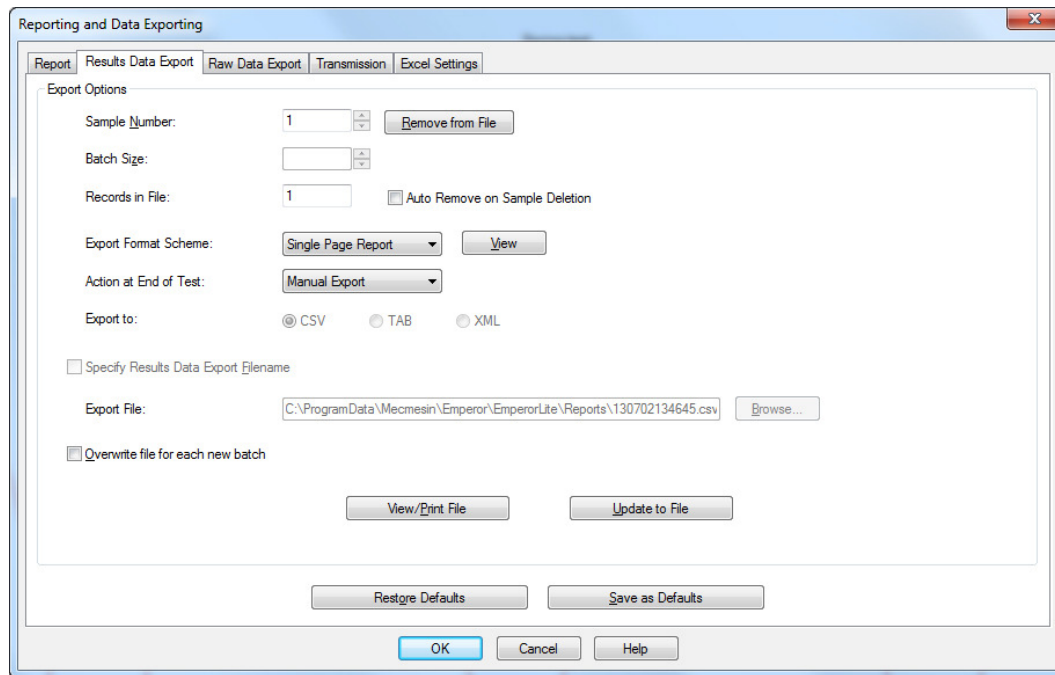
The sequence for setting up a non-default results export (or a new default profile) is:

1. Specify the File Type (CSV, TAB, XML)

2. Specify a file name (browse to destination folder and select or type a new file name, or allow an automatic filename to be applied).

3. Select Manual or Automatic as the end-of-test action

4. Select the export Scheme (View show the features from *System* > *Setup* > [Schemes])

5. Specify, or leave blank, the batch size (groups of samples)

6. Add samples to export.

When compiling your results export, the samples are listed by number. Select each one you want and click Add to File . Added samples may be removed. As you add samples, 'Records in File' will increment and the export file will be updated.

If a sample is deleted after export, **Auto Remove on Sample Deletion** will remove it from the export file automatically.

Batch results handling

When performing a number of tests on samples from a batch, you may want to limit how many are in one results file. Set your batch size, and when you have added the number of samples specified as a batch size, you will be alerted to start a new batch:
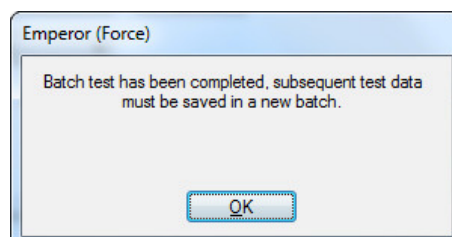
Click OK . If you now try to add a new sample:
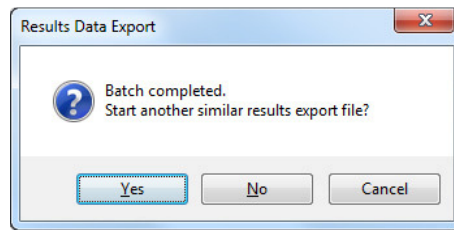
Click Yes to start a new batch, and, if you are specifying your own file names, *begin by specifying or ensuring a new file name* that will not overwrite the first.

If you return to add new samples, click Update to File .

7.3 Raw Data Export

Raw data export is similar, but there are no batches or selective sample adding, because it is assumed that the data are for full analysis elsewhere.

Choose if you want sample data exported in column groups across (arranged horizontally), rather than sequential samples in one set of time, displacement and load columns.

Choose if you want to be prompted about modification at the time of export.

Here you will rely on a Raw Data Export Scheme (*Setup* > *System* > [Schemes]). However, because the file size may be very large, you may choose to modify the content. See Appendix A.2, *Managing File Size*.
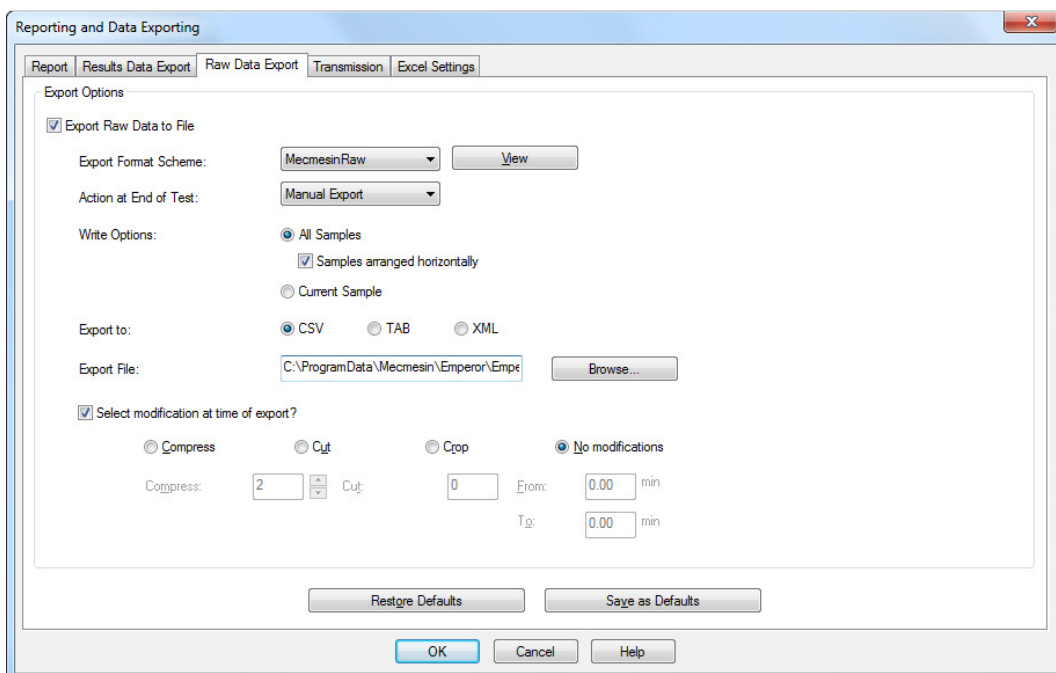
7.4 Transmission

Direct transmission to a communications port allows you to export Results, or Raw data, directly to another system. If you need to do this, set the parameters here, using a data export scheme as profiled in *Setup* > *System* > [Schemes]. The View button will show the structure of your selected Export Scheme.
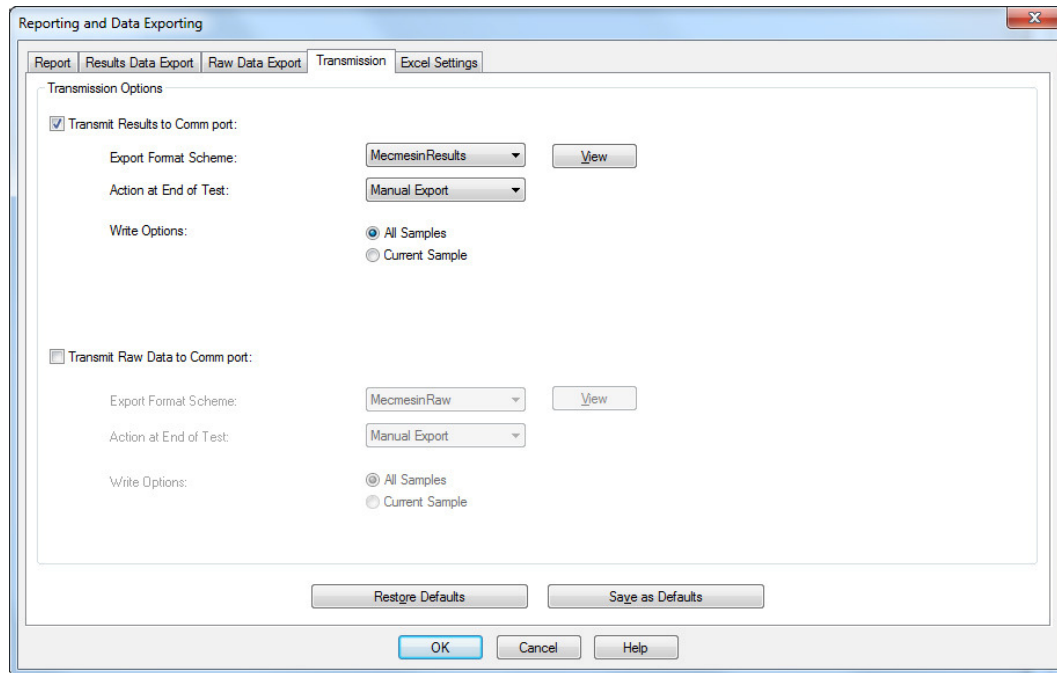

7.5 Excel settings

If you want to export data to Excel, either set defaults here, or amend the default for the particular set of results. Note that the format of an Excel cell address is A1, not the absolute referencing style A1.

Things to remember

- A default filename and worksheet will be overwritten if you have set a default and just use *File* > *Send to Excel* after running a test. Either open and resave Excel files to new files, or use this dialog always before exporting to Excel, *and* make the export action 'Manual after test'.

- Excel has limits to number of rows and columns that are easily exceeded by multi-sample raw data at higher data rates. Use Compress and Cut to reduce the data down (see Appendix: *Managing File Size*).

- Incrementing results start cell: unless you are repeatedly running a single sample test and discarding the Excel data, you will want to ensure each sample begins a new row in Excel, rather than overwriting the last.
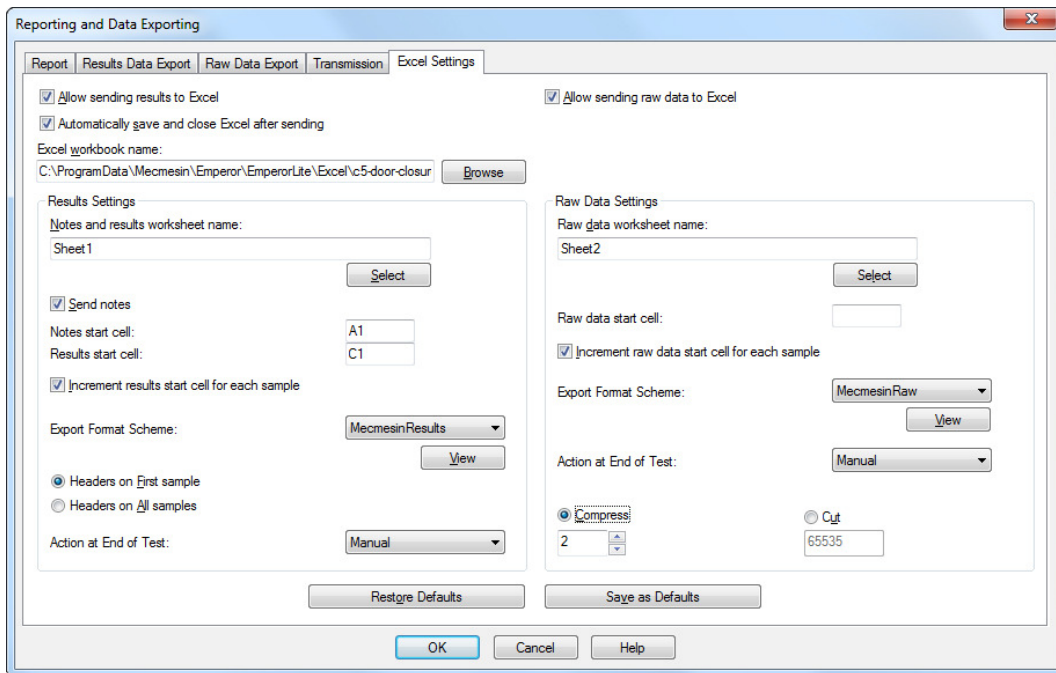
8. Test Calculations

## 8.1 About multi-valued functions

Consider the general equation:

y = f(x)

In a simple situation, when given the value of 'x' and asked to calculate 'y' there may be only one result—in this case the function is called 'monotonic'. For example:

y = ax + b

has only one solution, because for any value of 'x' there is only one possible value of 'y'.

Most functions, however, are either inherently multi-valued, or else noise on a signal can make an inherently single-valued dataset multi-valued. Consider a peel adhesion curve:
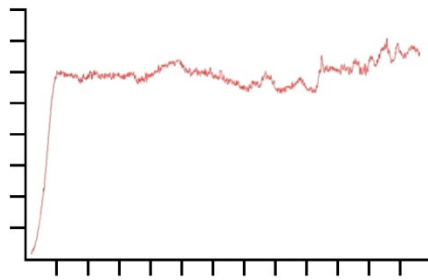
Load is on the 'y' axis and displacement is on the 'x' axis. If you need to know the displacement {x} at a certain load {y}, there may be more than one solution.

Similarly, consider the case of a cyclic test:
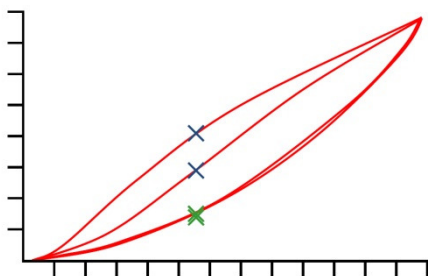
This graph shows load/displacement data obtained by applying two compression cycles to a block of polyurethane foam. For each value of load, there are four corresponding displacement values, and for each value of displacement there are four corresponding load values (illustrated). This is most obvious for the compression stroke (i.e. the top two curves) where, for a given displacement, the load on the first cycle was significantly greater than the load on the second, as illustrated by the blue crosses. It is not so obvious

on the return cycle, as illustrated by the lower green crosses. The difference is due to the plastic deformation of the foam.

8.2 Selecting calculations

From the top menu, *Test* > *Calculations* these calculations are available:
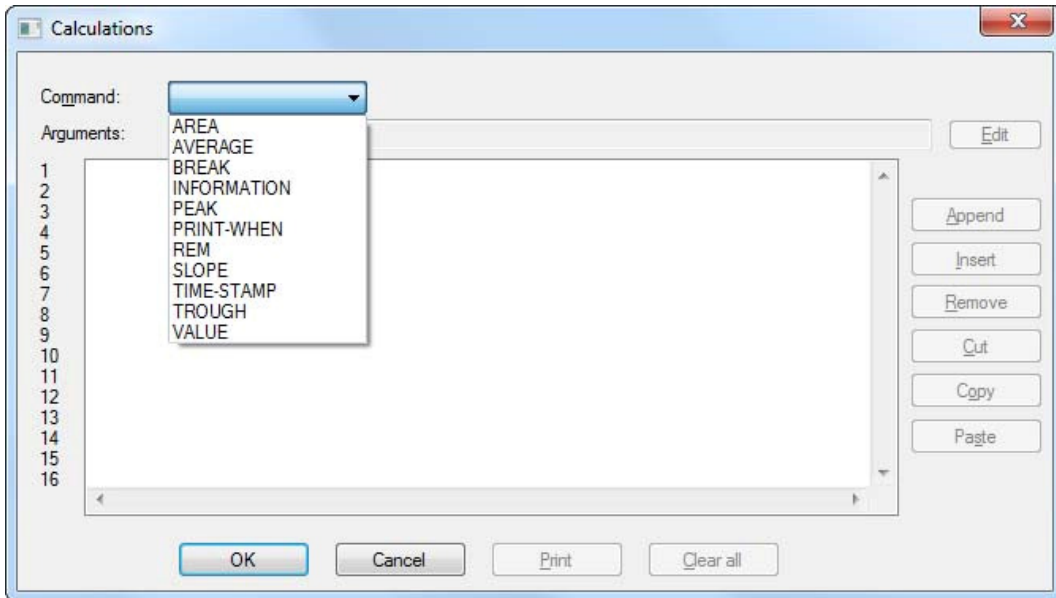
Select a calculation command from the drop-down box, and press `Edit` to add the calculation parameters. Here, for example is the Average command:
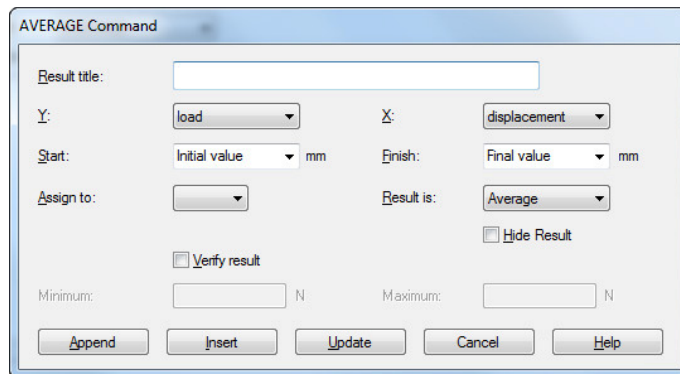
`Append` adds the calculation to the end row.

`Insert` adds the calculation to line above the selected row.

`Update` overwrites the selected row with the new edit.

When all calculation lines are complete, press `OK` to save, `Cancel` to revert to last save, `Clear all` to remove all calculation lines, or `Print` to send direct to the printer allocated under *File* > *Print Setup …*

8.2.1 Command functions

Trend lines   BEST-FIT; SLOPE

Change points   BREAK; KINK; STEP

Max./Min.   PEAK; TROUGH

Averages   AVERAGE; RMS

Explanation   REM; INFORMATION; PRINT-WHEN; TIME-STAMP; VALUE

Process   AREA; DO-SUM; SET; VARIABLE

8.2.2 Parameters common to many calculations

Result title

This will identify the line in the Results Grid (there may be more than one average in this overall calculation). It is also about the *reason* for the calculated line, so a SLOPE command used to determine a spring rate, is better described as that than the default title 'SLOPE'.

{X} and {Y}

These are assigned to load, displacement or time (displacement is 'angle' in torque systems). In some cases {X} can also be assigned to an event.

Start and Finish

are initial and final values for **X** (in the above example, this is the average load Y for **displacement span** X). Units are assigned accordingly for force and torque load, and for displacement/angle. Left blank, the value from the start and/or end of the test will be used. You may not know the best values for these until you have run some tests, so they are adjustable once you have some results, from the graphical display:

> **Drag-enabled points:** Start and Finish points may subsequently be dragged in *Display > Interrogate > Time Line* to adjust the original settings in the results file calculation. This file may then be saved with the adjustments. If you use this feature, when you exit Emperor you will be asked if you want to also save the changes to your library file, under the same or a new name.
>
> **Note:** if you use Variables for the values in Start and Finish points in your library file, these will be overwritten with numerical values if interrogated *and* the slider points are moved. Be careful not to overwrite your original file.

Assign to (Variables)

In most calculation commands, results can be **assigned to variables** (V0 to V99 are available), on which further calculations can be performed.

Hide Result

If the result is only a part of an extended calculation, and has no particular importance in itself, use **Hide Result** and it will not appear in the Results Grid.

Verify result

Ticking this check box and entering **minimum** and **maximum** values, allows the calculation line to also yield a true/false result, which can be interpreted as a pass/fail marker. If the calculated result lies between the minimum and maximum, the result will be printed with a green background in the Results Grid, and in green text in a report. Results that are below the minimum or greater than the maximum will be printed with a red background in the Results Grid, and in red text in a report.

Overall result

If at least one calculation is to be Verified, then a final row can be added to the list of calculations on the Results Grid, called **Overall Result**. Overall result is 'Pass' if all the included verified results are met. If *any* of the included verified results are not met, then Overall Result is also 'Fail'. Whether to show the Overall result, and whether to include hidden results in the overall result for a particular results file, are set up in *Setup* > *Preferences* > [Results Display]. These settings can also be made for **Report Templates** and **Export Schemes**. (See Appendix: *A Note on Overall result and Hidden Results*.)
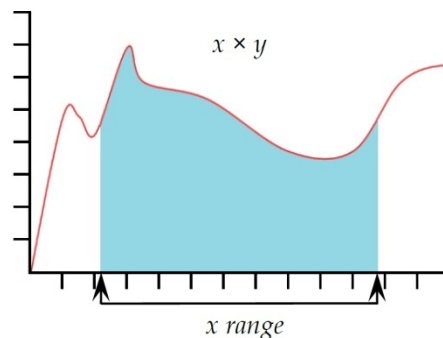
8.3 Calculations

| Command	Argument and use
AREA	The AREA calculation returns the area under the curve for defined 'start and 'finish' values of {X}, for example to measure total energy exchange over a period of time or for a given change in displacement.

$x \times y$

x range

Note: if the curve drops below a zero value of {Y}, the area does not become negative. All area is regarded as accumulative.

AVERAGE	The **AVERAGE** calculation returns the average value of {Y} for chosen 'start' and 'finish' values of {X}. You can derive the

result as the 'Average', i.e. the arithmetic mean, or as the 'RMSE' value from Average (see next below).
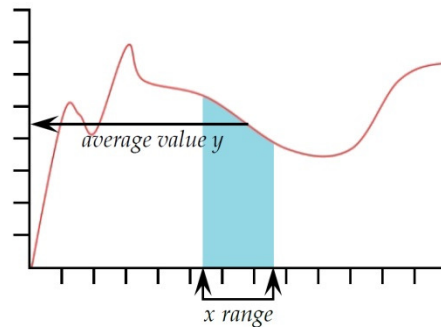
Result is: Choose between Average (Units) and RMSE (unitless)

RMSE: The root mean square error (RMSE) is a frequently-used measure of the differences between values predicted by a model or an estimator and the values actually observed. RMSE is a good measure of accuracy. These individual differences are also called residuals, and the RMSE serves to aggregate them into a single measure of predictive power.

BREAK

This returns the value (of load, displacement or time) when a sample break has been detected. The break can be defined as either a 'sharp' break, or as a 'percentage' break. A sharp break is typically chosen when the sample suffers a sudden fracture or the break occurs near-instantaneously. A percentage break is more suitable when the sample stretches slowly, and the break occurs progressively over time (explained more fully below).

Calculations after a break are made by comparing consecutive data points, according to the criteria given below. This may not necessarily be at the same point as where the break detector has operated.

Result is: Choose 'Load' or 'Displacement/Angle' or 'Time'.

Type: Choose 'Sharp' or 'Percentage'.

Sharp:
    Change factor—default value is 5 (range 2 to 20)
    Threshold %—default value is 3 (range 1 to 90)

Percentage:
    % Drop—default value is 40 (range 1 to 99)
    Elongation—default value is 1.25 (range 0.01 to 1,000)

Sharp break
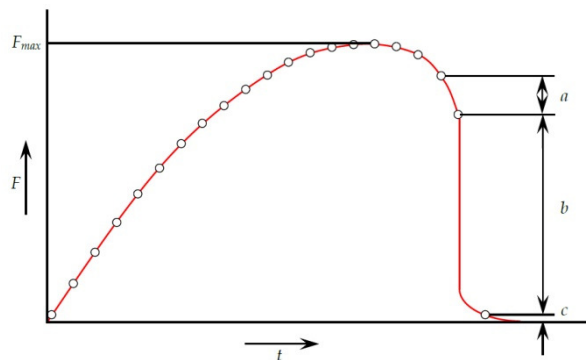
Sharp break is detected when analysing a set of three data points a, b, c, and the following criteria are met:

b > {change factor} × a

c < {break %} × F$_{max}$

Where

a = the change in load between the first set of data points

b = the change in load between the second set of data points

c = the load value above zero of the last data point

F$_{max}$ = maximum load

Percentage break
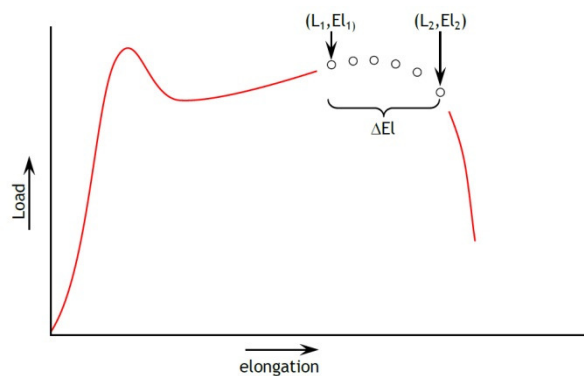
Percentage break is detected when analysing a set of data points and the following criteria are met:

$El_2 \geq El_1 + \Delta El$

$L_2 \leq L_1 \times (1 - \%drop/100)$

Where

L_1 = first load point

L_2 = second load point

El_1 = Elongation at L_1

El_2 = Elongation at L_2

ΔEl = required change in elongation = {elongation}

%drop = percentage drop in load required between L_1 and L_2. = {%drop}

INFORMATION   This will add additional information to the sample results.

Information: Use the drop-down box to select:

Bad sample reason: This will give the reason why a test run was not completed satisfactorily, e.g. 'Emergency Stop button pressed'.

Operator's name: This is taken from the User name logged on when the sample was run. It links the sample result to the operator.

SDC Status: Whether a system deflection calculation was included in the results.
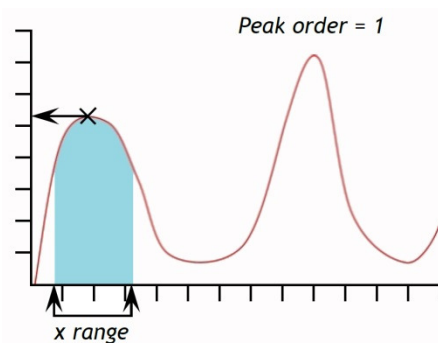
PEAK

Returns the maximum {Y} value of the chosen parameter, 'Load', 'Displacement' or 'Time', for a defined range of {X} values. You can choose to report the highest of all the {Y} values, or select a peak of interest by setting 'Start' and 'Finish' values, and by inserting values in the 'Order' and '%' boxes.

Order: Order 0 = max. value within the range of {X}, which may or may not be a peak with downturn.

Order 1 = highest peak value within the range of {X}, defined as a peak with downturn, by the % value.

Order 2 = second highest peak value within the range of {X}, defined as a peak with downturn, by the % value, and so on.

%: The per cent field allows the PEAK calculation to distinguish between small spikes that are a genuine signal, and background noise. If after the peak the {Y} value does not fall

by at least the selected percentage of the total range of {Y} values, then that spike is not a genuine peak. If, however, there are two peaks that are very close together, it may be necessary to experiment with different values in the '%:' box.

PRINT-WHEN The PRINT WHEN calculation applies a test to the value of the result from a line number in the Selected Calculations list and returns text that depends on the result of a conditional test. **Note:** the PRINT-WHEN calculation must be used after the calculation to be tested.

Result title: This is a free-form text entry field that allows you to re-name the test result. This title will appear as the row header in the results grid.

Calculation no.: This is the line number of the calculation to be tested as they appear in the 'Selected Calculations' list on the [Calculations] tab.

Condition: Choose the Boolean test to be applied from the drop-down list:

<, <=, <>, =, >, >=

Test value: Enter the test value

True text: Enter the text to be displayed if the test condition is met.

False text: Enter the text to be displayed if the test condition is not met.

REM REM is the facility to add a comment (remark) line in the calculations, typically to explain a subsequent calculation step.

SLOPE **Result is**: From the SLOPE command you can obtain a result for the straight line joining the first and last data points within an x-range, that will give the **gradient**, the **y-intercept**, or the **RMSE** (see under 0 ovan).

The BEST-FIT command is similar, but BEST-FIT is the gradient of a line passing equally through all the data points.

y intercept

x range
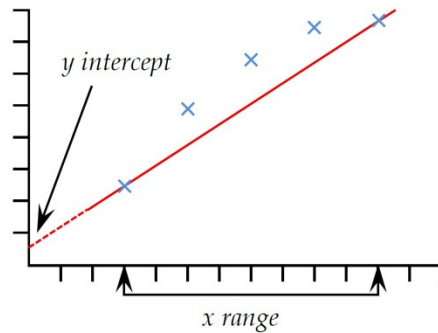
| TIME-STAMP	Used to add the date and time the test started and/or finished. Use the Radio button to select the time: Start time is taken when the blue 'Start' button is pressed. The End time is recorded when the test has finished, or if terminated by pressing the red 'Stop' button. You can display both start and end times by adding two Time-Stamp calculations.
TROUGH	The TROUGH calculation returns the minimum value of {Y} of the chosen parameter of 'Load' or 'Displacement' or 'Time' within a defined 'Start' and 'Finish' value of {X}. You can choose to report the lowest of all the {Y} values (deepest trough), or select the area or trough of interest by setting the 'Start' and 'Finish' values, and by inserting values in the 'Order' and '%' boxes.
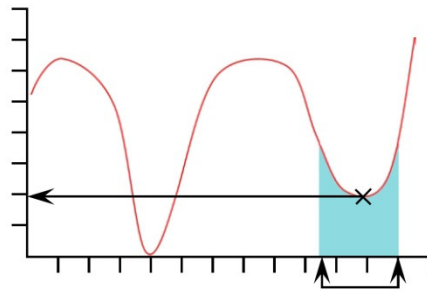
Order: Order 0 = min. value within the range of {X}, which may or may not be a trough with upturn.

Order 1 = lowest trough value within the range of {X}, defined as a trough with upturn, by the % value.

Order 2 = second lowest trough value within the range of {X}, defined as a trough with upturn, by the % value, and so on.

%: The per cent field allows the TROUGH command to distinguish between small dips, which are a genuine signal, and background noise. If after the trough the {Y} value does not climb by at least the selected percentage of the total range of {Y} values, then that dip is not a genuine trough. If, however, there are two troughs that are very close together, it may be necessary to experiment with different values in the '%:' box.

VALUE

The VALUE calculation returns the value of {Y} for a specified value of {X}. {Y} can be 'Load', Displacement/Angle' or 'Time'. {X} can be 'Load', Displacement/Angle', 'Time' or an 'Event'. See the discussion at the beginning of this section, on Multi-valued functions.
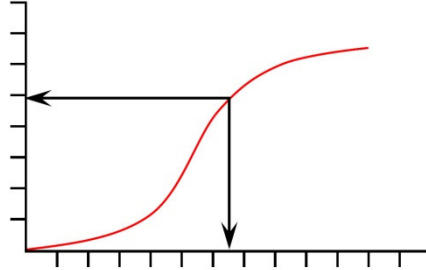
VALUE Command

Result title:		
Y:	load	X:	displacement
Value:	mm	Start time:	Zero	min
Finish time:	End of test	min	Occurrence:	1
Assign to:			Hide Result
	Verify result		
Minimum:	N	Maximum:	N

Append   Insert   Update   Cancel   Help

Value: Enter the desired value of {X} at which point the Value of {Y} will be recorded. If 'Event' has been chosen for the {X} parameter, then the options for value are on 'open' or on 'close'. In this case, when an I/O event signal changes from 0 to 1 (open) or from 1 to 0 (close), the Value will be recorded.

Drag-enabled: Value may be dragged in Graphical display

Occurrence: Enter a number to return the value of {Y} corresponding to the occurrence of the {Y} value of interest. E.g. if you want to find the load {Y}, at its third occurrence, at a displacement of {X}, then enter 3 in the occurrence entry box.

Appendix A
Handling Data Files

A.1 Where Results Go

Familiarise yourself with the movement of data and its destination, so that you can establish a way of working that organises your files well.

Action with results	Destination of data
RUN a test	Sample results accumulate in memory.
Save results of run 1	A default filename is presented comprising the test name and a current date-time stamp. You may choose an alternative file name. The file is saved to the Emperor Lite \Results folder.
Export results of run 1	Sample data are sent to file *as specified for the test* (*Setup > Report and Data Export*). You may not choose a new file name, and an existing file of this name will be overwritten. The file is saved to the Emperor Lite \Export folder.
RUN a test again	Sample results accumulate in Console memory.
Save results of run 2	A default filename is presented comprising the test name and a current date-time stamp. You may choose an alternative file name. The file is saved to the Emperor Lite \Results folder.
Export results of run 2	Sample data are sent to file *as specified for the test* (*Setup > Report and Data Export*). You may not choose a new file name, and an existing file of this name will be overwritten. The file is saved to the Emperor Lite \Export folder.
OPEN results file	Select a file from the Results library and Edit or Run.
RUN the test again	The test file is loaded with the previous results, and further samples tested will be *added to* the previous results.
Save results after run 3	The previous filename as opened is presented. Save to this file to overwrite the previous version, or choose a different filename. A new date-time stamp is not offered. The file is saved to the Emperor Lite \Results folder.
Export results after run 3	Sample data are sent to file *as specified for the test* (*Setup > Report and Data Export*). You may not choose a new file name, and an existing file of this name will be overwritten. The file is saved to the Emperor Lite \Export folder.

A.2 Managing File Size

File size is directly proportional to the total number of data points acquired. The higher the data acquisition rate (*Setup* > *Preferences* > [Data Acquisition]) and the longer the test duration, the larger the Results file becomes.

Data acquisition should be selected for the degree of detail required and precision of interpretation. For exporting results, however, or after seeing test results, less detail may be required and a smaller file can be obtained by compressing, cutting or cropping the data.

Data acquisition rate

Determines the total number of data points per sample test (sample tests may have different durations). This and the number of samples per results file, dictates the saved file size.

Compress

To reduce file size, if some detail can be sacrificed, every third or fourth data point (for example) can be saved. In the data modification dialogs, 3 means only include 1 in 3 data points, 4 means 1 in 4 (a quarter of the file size) and so on.

Cut

Enter the number of data points (span) to which you want to limit the raw results. This may eliminate a long tail but be careful not to lose essential features or individual samples with more data points than the rest.

Crop

Define a time span that limits the data to an area of interest (e.g. the last 30 seconds).

Appendix B
A Note on Overall result and Hidden Results

A **verified calculation** is one where upper and lower criteria are set, and the result is a Pass (within limits) or Fail (outside limits).

An **Overall Result** is a Pass or Fail status based on all *included* verified calculations.

A **Hidden Result** is one that you choose not to *show* in the results. Perhaps its value is not of importance in itself, but where also verified, it can still influence the Overall Result if you choose, in which case you must **Include Hidden Results** in calculating the Overall Result. If you hide some verified results but not others, this could potentially be confusing. Here is an example of five calculation steps and an Overall Result.

● = 'yes', ○ = 'no', ⌐ = contributes to overall result

Calculation step	verified	hidden	where the result is:	Result visible	☒ do not include hidden results	☑ include hidden results
1	●	●	Fail	○		⌐
2	○	○	–	●		
3	○	●	–	○		
4	●	○	Pass	●	⌐	⌐
5	●	○	Pass	●	⌐	⌐
Overall Result					Pass	Fail

This feature is mainly useful for hiding all the verified criteria whilst leaving the Overall Result visible. There are three locations where this matters:

Set-up > *Preferences* > [Results display]

Set-up > *System* > [Schemes] (for data export)

Set-up > *System* > [Report Templates] (for printing results as reports)

In each, you decide whether to show an overall result, and in each, any hidden results will not be shown.

Note: inclusion of samples in a results file or display is quite separate; individual samples can be included or not in the statistics of a batch, in export and in reporting. This is not the same as hiding calculation results.

Now examine the following Results Grids carefully. We hide verified result 2 and then don't include it. This affects the overall result, but in the second grid we can't see why the sample has failed.

Example Results Grid: if any verified result fails, the overall result is fail:

Results	Sample 3	Sample 2	Sample 1
Included	☑	☑	☑
unverified result	### Units	### Units	### Units
verified result 1	🟩	🟩	🟥
verified result 2	🟩	🟥	🟩
verified result 3	🟩	🟩	🟩
Overall result	PASS	FAIL	FAIL

The second verified result is now hidden; hidden results have been included, sample 2 fails:

Results	Sample 3	Sample 2	Sample 1
Included	☑	☑	☑
unverified result	### Units	### Units	### Units
verified result 1	🟩	🟩	🟥
verified result 3	🟩	🟩	🟩
Overall result	PASS	FAIL	FAIL

The second verified result is hidden; hidden results are now *not* included, sample 2 passes:

Results	Sample 3	Sample 2	Sample 1
Included	☑	☑	☑
unverified result	### Units	### Units	### Units
verified result 1	🟩	🟩	🟥
verified result 3	🟩	🟩	🟩
Overall result	PASS	PASS	FAIL

You may choose to hide all verified results, but still include them:

Results	Sample 3	Sample 2	Sample 1
Included	☑	☑	☑
unverified result	### Units	### Units	### Units
Overall result	PASS	FAIL	FAIL

Note:

- In the Results Grid view, Overall result for bad samples are always set to fail, but automatically not included.

- For digital output (e.g. set output on FAIL) the digital output is synchronised to the Overall Result as displayed in the Results Grid view.

Appendix C
Tolerance Bands

Test data can be visually compared with a reference specimen by using the Tolerance Band overlay option (*Display > Overlays*). This requires a tab- or comma-delimited text file containing the reference data. There must be two columns representing the y-axis and x-axis respectively, with units in row 2 and data beginning in row 3, as in this example:

```
y-axis,x-axis
mm,N
0.30,1.00
0.50,1.40
0.70,1.85
etc.
```

The data may be derived from theoretical results, or from a reference test, and must be in the same units as the results to be compared. There should be no more than 100 data points.

With a Results file open, browse to the reference file in *Display > Overlays*:
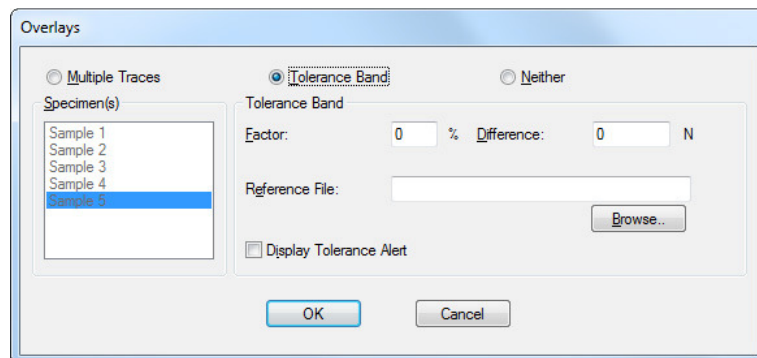
Two types of tolerance bands can be generated. Typing a number into the **Factor** box (20%, for example) will generate a factor-based tolerance band:
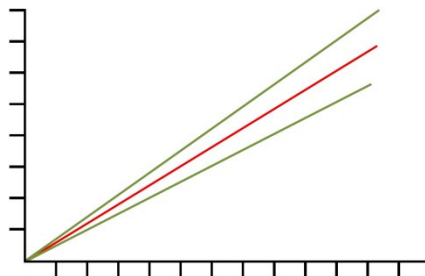
The data in the reference file are shown in red, and the tolerance limits that will appear on the graph are shown in green.

Typing a number into the **Difference** box (5 N/N.m, for example) will generate a difference-based tolerance band:
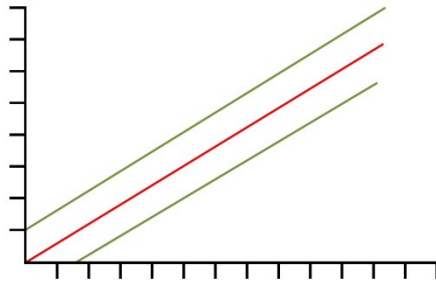
Note: tolerance bands are calculated on the basis of there being an acceptable range of values for the parameter plotted on the y-axis. If, for example, data have been plotted as Load/Displacement(Angle), but you need to work with a specification that requires test data to be within ± 5 mm(degrees) of the data for a reference specimen, then use the 'Others' option in *Display* > *Settings* to generate a Displacement(Angle)/Load plot.

It can be awkward to devise the calculation(s) necessary to detect when a sample is not within tolerance, but Emperor can do this automatically. Check the 'Display Tolerance Alert' box, to display a warning in the Results screen when tolerances are exceeded.

Data that 'fail' (i.e. fall outside the y-axis limits of the tolerance band) are plotted in red, but data that 'pass' (i.e. fall within the y-axis limits of the tolerance band) are plotted in green. Data that fall outside the x-axis limits of the tolerance band) are plotted in black.

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