



# FIRECEL

## INSTRUCTION MANUAL

Version 1.4.3.X

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**PFP Specialists**

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## INTRODUCTION

FIRECEL version 1.3.0.X is a tool for analysing raw fire test data. It is intended to allow a competent and qualified user to quickly import, analyse and report large numbers of sections within a fire test. For information on the underlying calculations and assumptions inherent to the software refer to this manual.

## ABOUT FIRECEL VERSION 1.3.0.X

FIRECEL is developed and maintained by PFP Specialists UK. Use of the software constitutes acceptance of the terms of the license agreement. It must be recognised that product assessments should be performed by a competent user and calculation software alone cannot address all the complexities and considerations present in the assessment process. The programme should always be used by a qualified professional capable of exercising sound engineering judgement. PFP Specialists UK takes no responsibility for the accuracy or manner of use of the software.

## SOFTWARE DEVELOPMENT REQUESTS AND FEEDBACK

While under license, FIRECEL will be subject to regular updates. Please send all suggestions or bug reports to [ian.bradley@pfp-specialists.uk](mailto:ian.bradley@pfp-specialists.uk) with the subject as "FIRECEL".

## INSTALLATION AND COMPATIBILITY

FIRECEL v1.3.0.X is provided in an application format (.exe) and requires Microsoft Excel version 2007 through to 2016 to be present on the computer in order to run.

Note that commercially available third party anti-virus software can prevent .exe files from functioning correctly. To prevent this please refer to the user guide of the anti-virus software, and add FIRECEL as an exempted programme.

FIRECEL is typically distributed as a standalone excel file. Multiple versions of FIRECEL can be ran on the same PC, however it is recommended that the old versions are deleted to prevent accidental use. Any shortcuts will require recreation to link to the correct version.

NOTE: The default location should be set to C:\FIRECEL\

The user can manually change the installation directory; however the folder created must be in a location which does not require admin rights as default. Saved files are handled through the creation of a hidden .dat file in the FIRECEL folder. A requirement for Administrator rights prevents the background creation of this file, hence preventing access to saved files.

## ACTIVATION

On first execution of FIRECEL the user will be required to input an activation code. The code can be obtained through clicking on the Get Key Online button using the hardware specific code shown in the box. Users will be required to enter the company specific username and password given to them.

Following correct entry of the password, if applicable, the user will be prompted to enter their hardware-specific code and their email address, and will receive an activation code.

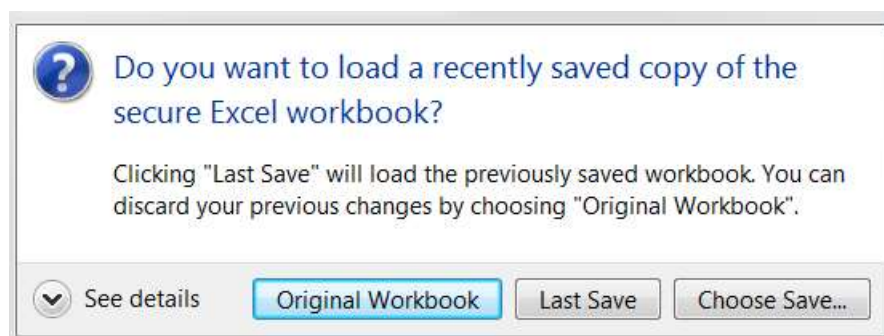
NOTE: the activation code remains valid until the end of the yearly license period, after which the user will be required to repeat the above process

## SAVING SIMULATIONS

The application file can be saved in a similar manner to an excel file. Note it is not possible to overwrite the original programme, only to save duplicates. Files are saved in a .xlsc secure format and are incapable of being opened except from within the original application. FIRECEL uses a .dat file created in the programme root directory as a means of tracking the last save and prompting the open save simulation box below.

## OPENING SAVED SIMULATIONS

After a user has first saved a file, on opening the programme the following load option dialogue box will be displayed:



Select Last Save to open the most recently saved workbook, or Choose Save to open a file dialog window and navigate to the required file.

## VBE ACCESS

FIRECEL has security features that prevent access to the Visual Basic Editor during operation of excel. Opening the VBE will result in automatic closure of the VBE itself, possibly causing FIRECEL to stop working. Closing and re-opening FIRECEL will resolve any issues caused in this manner.

## **SPEED OF OPERATION**

FIRECEL runs in an MS Excel shell and is sensitive to all factors that affect the normal operational speed of excel. Having other MS Excel applications or workbooks open at the same time greatly reduces the calculation speed and should be avoided.

## **GLOSSARY OF TERMS**

### *Analysis method*

The calculation methodology used by FIRECEL for determination of the time to a given CCT. The differences between the methods are explained elsewhere in this manual.

### *CCT*

An abbreviation of *critical core temperature*. It refers to an elevated temperature reached by the section. Raw data is input, and results presented, over a range of CCT values. CCT may refer to a temperature rise or absolute value, FIRECEL makes no distinction between these cases.

### *Characteristic temperature*

The average of the section average temperature and section maximum temperature. Used for the purposes of loaded (stickability) correction factors for EN13381 compliant assessments.

### *Duration*

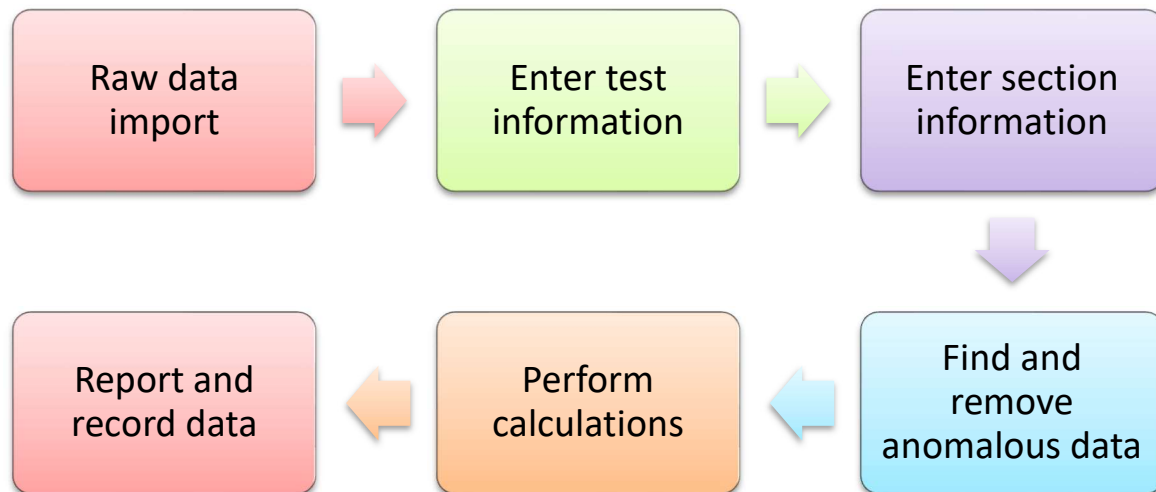
The time taken for the section to reach a given CCT value

### *Section*

An individual test specimen within a fire test. Typically a steel section, but this refers to any item being tested (such as divisions, jet fire boxes etc.)

## OVERVIEW

Product assessment optimisation is performed by way of the following steps:



## USING FIRECEL – THE BASICS

FIRECEL is sold in customised form, hence the fields and options present will reflect the requests of the client. Example screen-grabs are shown in the manual and although they may differ somewhat from the user version the principles discussed remain the same.

### Navigation

The user should use navigation buttons at the top of the screen to switch between pages. Progressing through the steps shown above is generally performed by clicking the button with **NEXT** in the caption. The excel environment also allows for switching via sheet tabs at the bottom of the window, however, navigation buttons must be used if present as they execute procedures required by the software. Tabs should only be used for navigation when buttons are not present (e.g. for navigating away from raw data sheets or reports).

### Field Entry

Light grey cells represent field inputs. Unless otherwise specified by the client, all database fields in FIRECEL remain as optional inputs. Good practice dictates that as much information be captured and stored about a test for future analysis, however it is recognised that in some instances data is not available. To facilitate productivity gains most fields can be left blank, and if done so simply will leave a blank entry in the database.

To prevent the occurrence of typographical errors within the database an option to select from existing fields is given. This feature is explained further in the *Field Prompt* section.

### Copying data and reports from FIRECEL

Users can copy information or reports directly into Excel, Word or other applications by using the copy and paste function, or by copying entire sheets into other workbooks.

### Locked sheets

Most pages (sheets) within FIRECEL are locked without a password. This is not a security feature, but instead is designed to prevent user error by restricting the ability to change or remove critical areas of the application.

## UNDERSTANDING ANALYSIS METHODS

### Positions and bands (or zones)

Standards and guidance notes stipulate a variety of ways to calculate either the average temperature of a test specimen at a given time, or the time for a test specimen to reach a specified CCT.

Accommodating these various methods requires a detailed knowledge of the location of each thermocouple. FIRECEL fulfils this requirement by describing each TC location in terms of a positions and bands (note that some standards are better described in terms of zones, and hence the term is used interchangeably here).

Positions and bands must be assigned to every thermocouple to allow for detailed and accurate calculations. FIRECEL assigns each thermocouple a position and a band automatically, however additional thermocouples added by the user must be manually assigned. All positions and bands can be manually altered or left blank by assigning the character "-".

#### Positions

Describes the position of the thermocouple in relation to a physical aspect of the test specimen, for example: Flange, Web, Toe etc. For sections that have no distinguishable positions (such as pipe) the symbol "-" is used to denote not applicable.

#### Bands

Describes a group of thermocouples defined solely for the purpose of analysis, and not relating to a steel feature. For example, the horizontal planes of thermocouples used in EN and UL column tests.



## Analysis Methods

Calculating the average temperature of a section at a given time is explained in full in the relevant standards or guidance notes (where applicable). A summary is given below:

Method	Average temperature calculated as:	Additional criteria applied to calculate time to a given CCT:
<b>YB</b>	Average of the web average and the flange average	N/A
<b>EN</b>	Average of all band averages (excluding any edge thermocouples)	N/A
<b>UL1709</b>	Maximum band average	The time until the maximum band average reaches the given CCT, or until a single TC records 20% greater than the CCT, whichever occurs the earliest.
<b>ISO JF / Simple</b>	Average of all TCs	N/A
<b>Positions</b>	An average of all position averages	N/A

A default analysis method can be set individually for each section. The default average is used for advanced analysis features such as the DFT corrected time. In addition, various reporting formats allow for inclusion of additional analysis methods. It is therefore possible to analyse the same section multiple times using different methods in the same report without duplicating the section.

NOTE: when a part or zone is required for the calculation yet has no valid data (in the instance of thermocouple failure, as an example) the section average will be blank at that time instance.

### Cell beam analysis

From version 1.4.2.0 cellular beams were added to FIRECEL. The web post weighted average is calculated using the appropriate formulas in the yellow book / EN 13381-9 based on the analysis method selected (in section detail, and set by default based on the type of fire test selected on the home page).

For this function to work correctly zone calculations must be enabled, and the zone and position names should not be changed from the in-built defaults.

NOTE: if a web post TC fails the calculation method will fail and the results will be blank

NOTE: the 130/160 60 minute cell beam with rectangular holes described in 13381-9 is, in the opinion of PFPS, a mistake. It has been added as 130/225.

## Position Naming Rules:

The section library within FIRECEL has standard names for thermocouple positions. Although these can be changed, the user is warned this may affect the calculations. The following position name rules should be considered when modifying positions:

### YB analysis:

Includes only thermocouples with positions names beginning with "Flange" or "Web" (case sensitive).

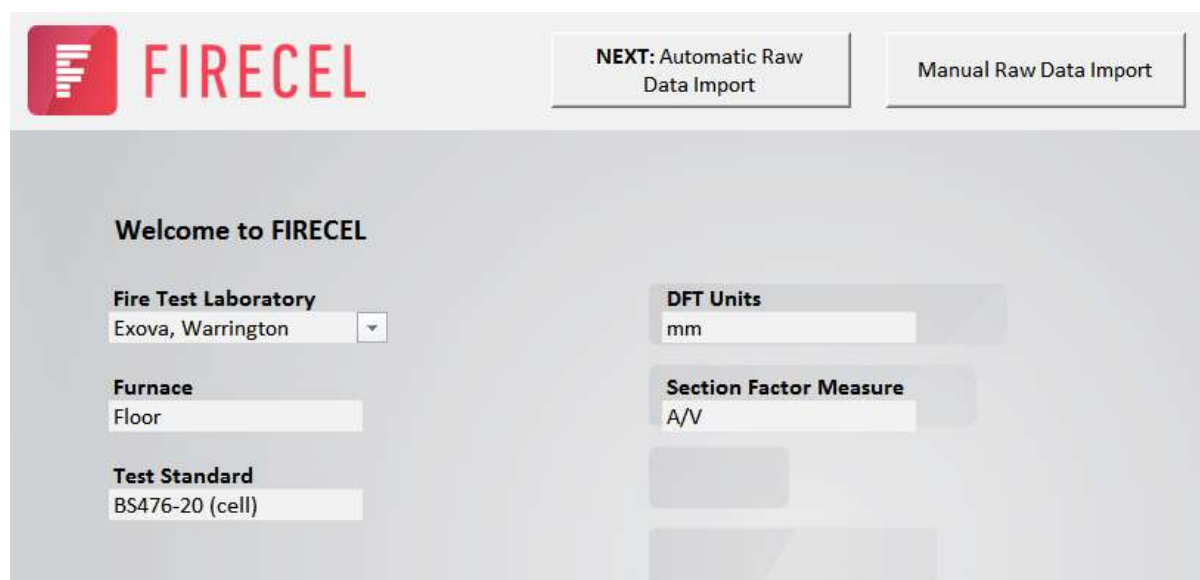
### EN analysis:

Ignores thermocouples with position names beginning with "Edge" (case sensitive).

In all cases additional terms can be added after the above to allow for further distinction, e.g. "Flange (bottom)", "Edge (top flange)" etc.

## HOME

The 'Home' page of FIRECEL is the starting point for building a test analysis. There are three fields to be completed before raw data is imported into the software. FIRECEL will automatically select the appropriate raw data configuration from the three inputs provided at this stage.



The screenshot shows the FIRECEL interface. At the top left is the FIRECEL logo. To the right are two buttons: "NEXT: Automatic Raw Data Import" and "Manual Raw Data Import". Below the logo, the text "Welcome to FIRECEL" is displayed. The main area contains several input fields:

- Fire Test Laboratory:** A dropdown menu with "Exova, Warrington" selected.
- Furnace:** A text input field with "Floor" entered.
- Test Standard:** A text input field with "BS476-20 (cell)" entered.
- DFT Units:** A text input field with "mm" entered.
- Section Factor Measure:** A text input field with "A/V" entered.

The user can choose to automatically import raw data and allow FIRECEL to choose the layout and detailed settings, or to manually import data and review the detailed settings themselves. If *Automatic Raw Data Import* is selected the user may be prompted to navigate to the appropriate file and select the relevant worksheet (if more than one worksheet with data is detected in the raw data file). Following a successful import the *Test Overview* page will be displayed.

Compatible Raw Data File Types:  
.txt, .csv, .xls, .xlsx, .xlsm

### **DFT Units**

Select from mm, microns or inches. This will modify the headings in the relevant tables, but will not change values previously entered into FIRECEL. Users of DATACEL should note that information is always posted to the database in millimetres, and that a conversion is performed if "mm" is not the units selected.

### **Section Factor Measure**

Select from A/V or W/D. This will modify the headings in the relevant tables, and change the standard section factor values used by FIRECEL when selecting from the in-built section library, however it will not change values previously entered in FIRECEL. Users of DATACEL should note that information is always posted to the database as A/V ( $m^{-1}$ ), and that a conversion is performed if "A/V" is not the selected.

## **MANUAL RAW DATA IMPORT**

The Data Import page contains parameters that describe the layout of the raw fire test data. To facilitate easy import the parameters can be set to in-built defaults using the drop down *Default Options* menu. Users can also choose to manually overwrite any field to accommodate non-standard layouts or other test labs not currently built into the library.

### **Select raw data to import**

On clicking this button a window will open allowing the user to navigate to the raw data file required. If a .txt file is selected the import will be completed without further user input. If a .csv or .xls, .xlsx, .xlsm file is selected then the user will be prompted to identify which worksheet contains the raw data.

Note that if an excel or .csv file is selected FIRECEL opens and closes excel in the background during the import process. Any issue caused by the raw data file or existing open files that force excel to prompt user input (for example a prompt to allow macros) may cause FIRECEL to 'hang'. In such cases the user should click the Excel icon on the taskbar, maximise the window that includes the user input prompt, and deal with this accordingly.

The various fields are described below

Field Title	Description	Format and Notes
<b>Time column</b>	As stated	Refer to the column in the MS Excel style using letters. E.g. the first column is A.
<b>Time increment</b>	The raw data time increment	Use seconds regardless of raw data time format
<b>Test starts at</b>	Optional – tells FIRECEL to ignore all data prior to this time	Enter in seconds, leave blank for 0s
<b>Test ends at</b>	Optional – tells FIRECEL to ignore all data subsequent to this time	Enter in seconds, leave blank to include up to the last row of data.
<b>TC prefix</b>	The prefix to the channel number	Enter without quotation marks. Note raw data files generally report channel numbers and not TC numbers (although these may be the same).
<b>TC# row</b>	The row on which the channel numbers (with prefix) are located	See below for note on automatic heading detection
<b>Data 1<sup>st</sup> row</b>	The row on which the first line of actual data is located	See below for note on automatic heading detection
<b>Section 1<sup>st</sup> channel</b>	The channel number from which data starts	See below for note on automatic updating
<b>Data zeroed</b>	Has the data already	This is used in conjunction with the ambient

	been zeroed?	temperature to allow FIRECEL to report either temperature rises or absolute temperatures.
<b>Furnace TC# channel min</b>	The lower furnace TC channel number	
<b>Furnace TC# channel max</b>	The upper furnace TC channel number	
<b>Deflection channel</b>	As stated	Enter the full channel name without quotation marks. See below for note on FIND option
<b>Furnace TC prefix</b>	The prefix to the furnace temperature control channel numbers	Enter without quotation marks.
<b>Pressure channel</b>	As stated	Enter the full channel name without quotation marks. See below for note on FIND option
<b>Convert from Fahrenheit</b>	As stated	Compatible with UL raw data files only. Converts all temperature columns from Fahrenheit to Celsius

### FIND Feature for the Deflection and Pressure Channels

Some test laboratories (for example BRE) do not fix the channel number of the deflection and pressure channels, but instead use the next available channels after the thermocouples. As this causes the channel numbers to vary from test to test an algorithm has been included to locate the appropriate channels and automatically correct the corresponding *Deflection channel* and *Pressure channel* fields. This feature is compatible only with test reports that include a row underneath the channel number row stating the units of measurement.

### Auto Update of Section 1<sup>st</sup> Channel

If the pressure or deflection channel number found using the feature above is equal to the channel usually used as the first thermocouple then FIRECEL will increase the value of the section 1<sup>st</sup> channel number to the next used channel.

**NOTE**

importing raw data can result in adjustments to the in-built default settings when the features described on this page are applied. If data is to be re-imported the user should re-select the appropriate default beforehand, even if the same one is to be used

### Auto detection of header rows

On occasion a test lab may add a header row with client and test information before sending the raw data file to a client. FIRECEL checks the default TC row number for cells containing the TC prefix. If none are found it will count the number of additional rows until the prefix is first present, and increase the value of the TC# row and the Data 1<sup>st</sup> row fields by this value

### Convert from Fahrenheit

This feature is only compatible with UL reports from Northbrook. The units that underpin calculations in FIRECEL are metric, and hence degrees Celsius are used for temperature. To facilitate a consistent and simple method of comparing results across different tests and laboratories the option is included to convert all temperature columns to centigrade.

### Auto check of furnace TCs

The number of furnace control TCs, or the channels to which they are allocated, is known to vary for some test labs. FIRECEL will check the maximum and minimum channels pre-set as furnace TCs. If it finds that the temperature of those channels is greater than 400°C five minutes into the test, then it will check the 3 channels immediately lower (than the minimum) and higher (than the maximum) in the same way. If the adjoining channels also read greater than 400°C five minutes into the test, it will automatically extend the furnace TC numbers accordingly. Increasing the maximum furnace TC number by one will also increase the first section channel number by one, if necessary, to avoid overlap.

### Optimise Raw Data

Some test laboratories capture excessive amounts of unrequired data, leading to very large raw data files. Optimise raw data runs an algorithm that performs four functions to rationalise the raw data set and optimise calculation speed:

1. Remove all test data before the *Test starts at time*
2. Remove all test data after the *Test ends at time*
3. Discards all data that lies between the time intervals specified. Note, if the exact time step has not been recorded FIRECEL will linearly interpolate between the two temperatures at the time increments on either side
4. Round to the number of decimal places specified and discard the additional precision.

The *Optimise Raw Data* routine may perform additional procedures depending on client requirements.

### TEST OVERVIEW

This page serves two functions: it allows input of basic test information for future records and reporting, and it allows the user to set some default section information to facilitate rapid data entry further along the process.

The screenshot shows the FIRECEL software interface. At the top left is the FIRECEL logo. To the right are three navigation buttons: 'PREVIOUS: Raw Data Import', 'NEXT: Enter Section Details', and 'Field Prompt OFF (Click to toggle)'. Below these are two main sections: 'TEST INFORMATION' and 'DEFAULT SECTION INFORMATION'. The 'TEST INFORMATION' section contains fields for 'Fire Test Reference Number', 'Date of Test', 'Operator (set-up)', 'Operator (run)', 'Sponsor/Chemist', and 'Test Notes'. The 'DEFAULT SECTION INFORMATION' section contains fields for 'Project Reference', 'Product', 'Batch code', 'Preconditioning', 'Primer Type', 'Topcoat Type', 'Mesh type', 'Mesh depth', and 'Mesh coverage'.

### Test Information Fields

Information captured in these fields is test applicable, and hence is automatically assigned to all sections within the test. Data captured is limited to 255 characters.

Field Title	Description	Further Notes
<b>Fire Test Laboratory</b>	Laboratory name	Used in conjunction with Furnace and Test Standard to determine default Raw Data Layout setting
<b>Furnace</b>	Furnace name	
<b>Fire Test Ref Number</b>	Test ID number	Preferably a unique number
<b>Operator (set-up)</b>	Person responsible	
<b>Operator (run)</b>	Person responsible	
<b>Sponsor</b>	Client/Sponsor of Test	
<b>Test Standard</b>	Primary test standard	
<b>Date of Test</b>	As stated	Required format: DD/MM/YY
<b>Test Notes</b>	Free text field allowing for any comments	
<b>Ambient Temperature</b>	At the commencement of test	Used when the data is zeroed for generation of absolute temperature values

## Default Section Information Fields

Data entered in these fields is not automatically assigned to the database. These fields are used solely for the purpose populating the identical fields on each individual section detail page (see subsequent sections of this document). If a field is left blank here no value will be automatically entered on the section detail page, however the user can still manually enter a value. Equally, even if default values are entered automatically the user can manually overwrite or delete these.

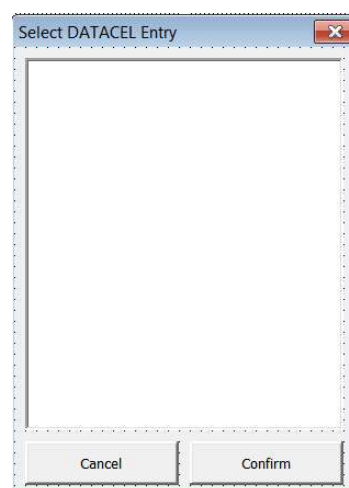
All these fields relate to section specific properties, assigned to sections individually within the database.

## FIELD PROMPT

This feature reduces the opportunities for typographical errors to clutter the database, and saves time over manual entry. When the Field Prompt button is set to ON, selecting a field tied to the database will display a list box with all existing distinct entries in the database. The user can then select one and click Confirm to import it into the cell.

Note: If no entries are present in the field then an error message will be displayed.

Fields compatible with this feature include the Operator (set-up), Operator (run), Sponsor and all Default Section Information fields.



## VIEW RAW DATA

Displays the imported raw data. A button allow for quick return to the Test Overview page.

## ENTER SECTION DETAILS

Following import of raw data, optimisation (if applicable) and setting of the anomalous data detection settings, the user should click *Enter Section Details* on the *Test Overview* sheet.

The user should first type the number of sections in the test into the relevant fields and hit Enter. The table will update to display the appropriate number of lines, with each section is given a unique identifying number (shown in the # column). Up to 30 sections can be included in any one test.



#	Reference	Section Type	Chan. min	Chan. max	TC Detail Check	Product	DFT (µm)	Target DFT (µm)	Serial size (dimensions)	A/V (m <sup>-1</sup> )	Length (m)	Section notes
1	chs1	CHS column 1m (new)	3	8	OK						1	
2	chs2	CHS column 1m (new)	24	29	OK						1	

Four fields are mandatory on this page. These are described in the following table

Field Title	Description	Format and Notes
<b>Reference</b>	A (preferably) unique identifying code specified by the user	Text up to 255 characters
<b>Section Type</b>	A user specified but FIRECEL specific identifying code	Select from the in-built list, or select CUSTOM or CUSTOM (Loaded)
<b>Chan. min</b>	The lowest channel number assigned to the test specimen	Integer
<b>Chan. max</b>	The highest channel number assigned to the test specimen	Integer

### Procedure for Entering Sections

1. Set the number of sections to the exact number. Rows in this table cannot be empty. Note that reducing and increasing this number will hide existing entries, not delete them.
2. Enter the sections in order of increasing channel assignment. FIRECEL will predict the appropriate channels numbers based on the next available valid channel and the number of thermocouples in the section. The user can manually overwrite the automatically assigned numbers.
3. FIRECEL performs a sense-check of the automatically assigned channel numbers. If it suspects an error the TC Detail Check button will state *Please Check*. See the next chapter for further detail.

### Additional Fields on Section Overview

The fields to the right hand side of the TC detail check button are there to provide rapid entry of properties commonly recorded for all sections in a test. Completing this table will cause these values to be copied across to the individual section detail pages (see next chapter) and any changes made on the individual section detail pages will be copied across to this table on returning to this page.

The properties recorded on the Section Overview and Section Detail pages are section specific, assigned to sections individually in the database. With a few exceptions, all fields are text fields limited to 255 characters. The exceptions are DFT and A/V, which are numeric, and section notes, which can handle significantly longer text strings.

## SECTION DETAILS

The user can check and modify the thermocouple and channel properties, and enter additional information for capture in the database, for each section by clicking on the appropriate *TC Detail Check* button.

Any properties that have been entered as defaults on the Test Overview page or on the Section overview page will be imported. These can be manually altered on this page. Note that users should ensure they click *Return to TC Overview* after making any modifications as this updates the master table on the Section Overview page, from which the database is populated. Properties not listed on the Section Overview page are populated directly from the section detail pages.

### Display TC graph

This feature allows the user to perform a quick sense-check of the channel assignment by plotting the temperature of all assigned channels as a function of time.

### Number of TCs

Users can modify the number of TCs by manually overwriting this value. The table of channels will then be modified accordingly. Additional TCs beyond the number assigned to the section in the library will require manual specification of the position and band. Changing the number of TCs will prompt the user whether to discard any manual changes made in the thermocouple detail. The prompt shown below allows the user to keep all existing user-inputs (by clicking No), or to reset all to the library defaults (by clicking Yes).

**Section 1**

Reference:	ref1	Section Factor:		Preconditioning:
Section Type:	BS SB	Serial size or dimensions:		Primer type:
Number of TCs:	8	Intumescent DFT:		Primer DFT:
Product/formula.:		Mesh type:		Topcoat type:
Project name:		Mesh depth:		Topcoat DFT:
Batch code A:		Mesh coverage:		Cure time
Batch code B:		Application method:		Number of coats:

TC#	Channel	Position	Band	Valid
1	9	Flange	-	Y
2	10	Flange	-	Y
3	11	Flange	-	Y
4	12	Flange	-	Y
5	13	Web	-	Y
6	14	Web	-	Y

FIRECEL

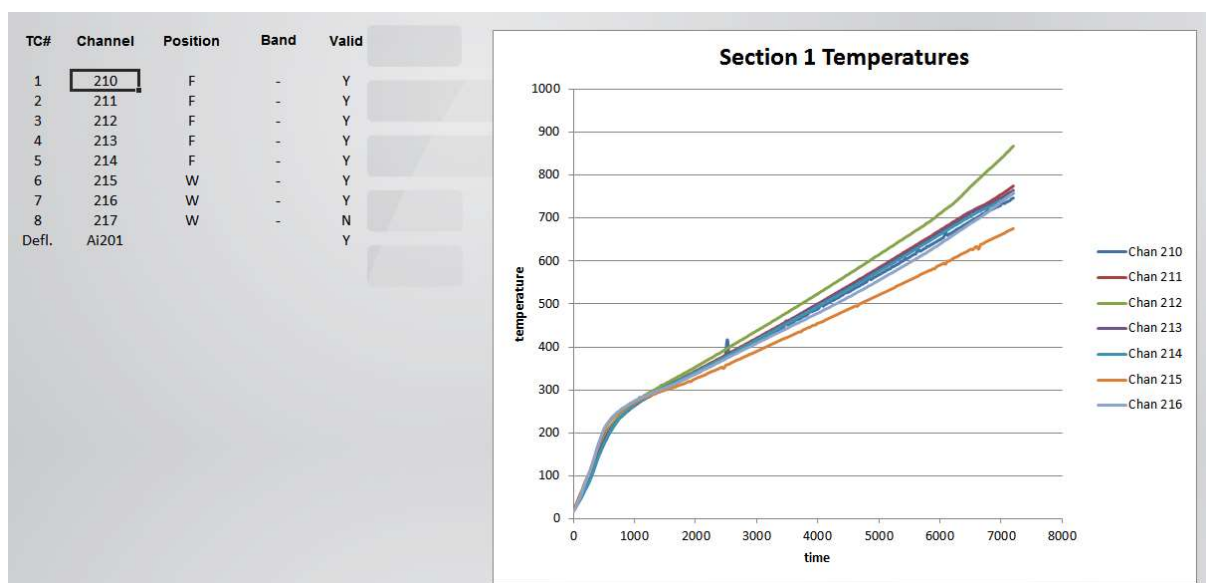
Over-write existing TC information?

Yes No

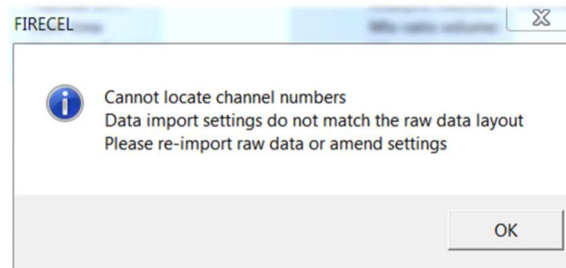
NOTE: changes made on the *Section Overview* page will continue to overwrite any manual settings. If the user wishes to keep customisations they should make changes using the detail page.

**Invalid channels**

Channel numbers referring to channels missing altogether will be skipped by FIRECEL, but on occasion a connected channel may malfunction to the point whereby the entire channel can be considered invalid and should be removed from the analysis. Rather than reduce the number of thermocouples on the section it is possible simply to set a channel as invalid by changing "Y" to "N" in the *Valid* column. An example of this situation is shown by Channel 217 in the above example. By setting the thermocouple to invalid and clicking *Update TC graph* it can be seen that 217 is removed from the scope.



Note that FIRECEL automatically checks for discrepancies between the raw data and the channel assignment. If the message below occurs, it is probable that the TC channel prefix, the TC channel row, or the data first row, are set incorrectly. Please amend the settings or re-import the raw data (as FIRECEL will automatically set a number of parameters for certain laboratories).



NOTE: It is good practice to check at least one section on the TC detail page by displaying a TC graph. Some discrepancies can produce incorrect results that may not be detected by the built-in FIRECEL routines.

## Deflection

If a section is loaded the deflection channel will be stated. This can be manually over-written as per any other channel, or set to invalid if the user does not wish to analyse deflection.

Note that the appearance of the deflection option is governed by the section type selected in the *Section Overview* table. To prevent or force the deflection option from appearing for various section type see the chapter on modifying the *Section Library*.

## Section Detail Quick Entry

This feature allows users to quickly add detailed information to all sections without the need to click on each section individually.

1. On the *Section Overview* page click **OPTION: Section Detail Quick Entry**
2. Any existing data already entered in the *Section Detail* pages will be displayed. In cases where a field is blank but has a default value entered on the *Test Overview* page, the default value will be entered automatically
3. Complete the relevant parts of the table. Note that users may leave fields blanks
4. When finished, click **NEXT: Update and Return to Section Overview**. Any new or modified values will be automatically copied to the relevant *Section Detail* page.

#	Reference	Project ref	Raw mat. Changes	Manufacture location	Substrate type	Surface prep	Primer type	Primer DFT (µm)	Preconditioning	Condition of cure	Mesh type	Topcoat type	Topcoat DFT (µm)	Application Method
1	chs1													
2	chs2													

### Postburn Detail Entry

This feature brings together various postburn fields, and provides a tool for automatic char expansion calculations. Users can directly enter measured char thickness values and FIRECEL will automatically calculate the expansion at various parts of the section.

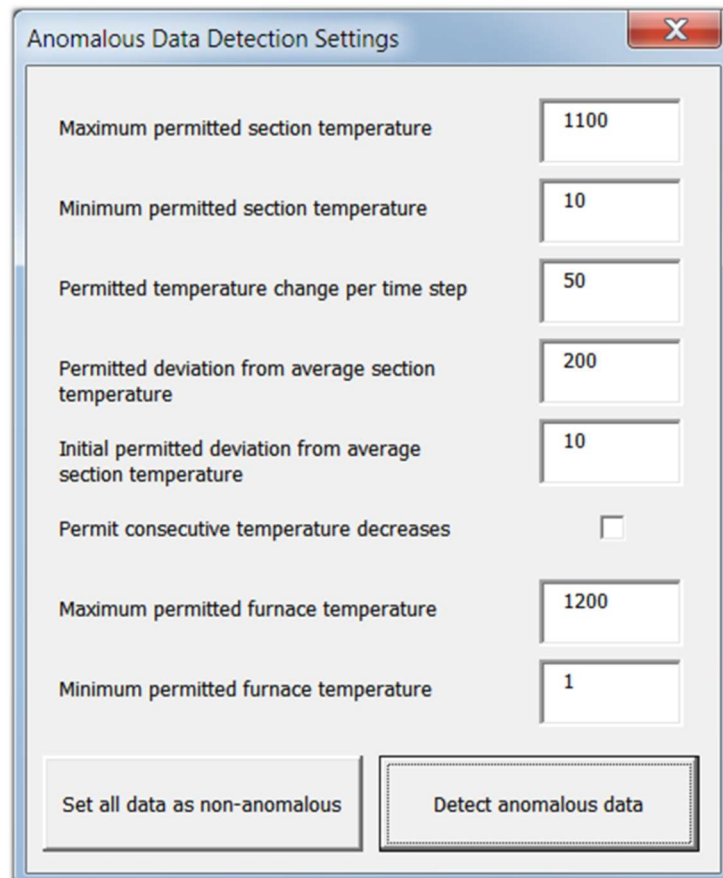
1. On the *Section Overview* page click **OPTION: Post-Burn Detail Entry**
2. Select the number of char measurement thickness readings taken at each of the 4 locations. FIRECEL will automatically redraw the table when this value is changed
3. Complete the relevant parts of the table. Note that the thickness units must be the same as those selected on the *Home* page for the expansion calculation to be correct.
4. When finished, click **NEXT: Update and Return to Section Overview**.

#	Shore D Value	Char structure	Char thickness 1 Front (bottom)	Char thickness 2 Left	Char thickness 3 Back (top)	Char thickness 4 Right	Char expansion 1 Flange	Char expansion 2 Web	Overall char expansion
1									
2									

The postburn information can be included in Excel reports by selecting the appropriate option (discussed further under the Analysis & Reporting section).

## REVIEW ANOMALOUS DATA

Once the section information is completed the user should click Review Anomalous Data. This step is a pre-requisite to performing analysis and generating reports. If an anomalous data analysis has already been performed FIRECEL will prompt the user to over-write or retain existing identification of anomalous data, including any adjustments made by the user.



The screenshot shows a dialog box titled "Anomalous Data Detection Settings" with a close button (X) in the top right corner. The dialog contains several input fields and a checkbox, arranged in a list. At the bottom, there are two buttons: "Set all data as non-anomalous" and "Detect anomalous data".

Parameter	Value
Maximum permitted section temperature	1100
Minimum permitted section temperature	10
Permitted temperature change per time step	50
Permitted deviation from average section temperature	200
Initial permitted deviation from average section temperature	10
Permit consecutive temperature decreases	<input type="checkbox"/>
Maximum permitted furnace temperature	1200
Minimum permitted furnace temperature	1

### Anomalous Data Detection Settings

Prior to reviewing anomalous data the user can manually adjust the parameters used by FIRECEL to detect data considered anomalous. Anomalous data is detected and removed by an algorithm that checks each thermocouple in turn, then each section against a series of mathematical criteria.

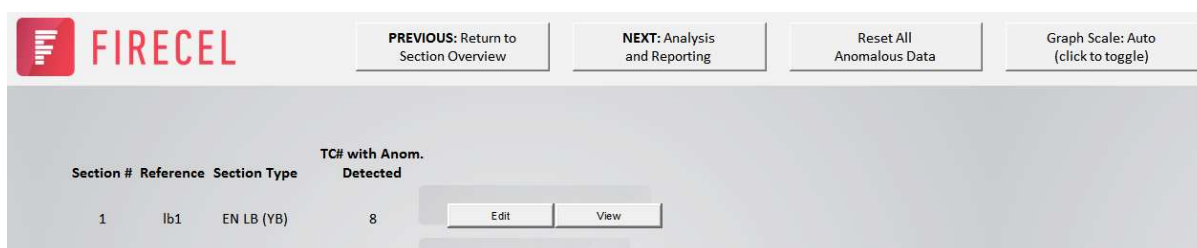
The sequence of checks performed is as follows:

1. remove any individual data points that lie outside the acceptable maximum and minimum values specified;
2. remove any data points that have a temperature change from the previous time increment greater than the limit specified;
3. calculate the average of the remaining valid section thermocouples and remove and data point that deviates from the average by more than the specified limit;

4. remove any consecutive temperature decreases, if applicable, and mark as anomalous all data points with a temperature below that of the last valid point;
5. separately consider the first line of data (at the time of the commencement of the test) and apply a more stringent deviation from the section average criteria.

Following parameter adjustment the user can then select *Detect anomalous data* or *Set all data as non-anomalous*. This latter feature marks every data point as non-anomalous, however it does not switch invalid thermocouples to valid.

The status bar will indicate the progress of FIRECEL as it considers each thermocouple and section in turn. On completion the *Anomalous Data* page will be displayed.



Each section in the test is listed, along with the TC number of any valid thermocouples which FIRECEL has detected any anomalous data in (whether it is at one single time step, or all).

The user can then click *View* to view a simple graph of the valid thermocouple data (with different channels colour coded for reference), or they can click *Edit* to launch the manual adjustment mode.

### Invalid vs Anomalous

The *Section Detail* pages and the manual adjustment box (see below) allow the user to set thermocouples as invalid. Doing so completely removes thermocouples from consideration in the analysis. Setting data to anomalous removes the data point from the analysis, but not the thermocouple as a whole. Valid thermocouple channels will still be assigned columns in report tables or series on graphs even if every data point is anomalous. Reporting options allow separate consideration of anomalous data and invalid data, allowing the user to include or exclude them as appropriate. Note that when a thermocouple is set as invalid all data points are automatically set as anomalous. Should a user choose to include invalid TCs in reports they will be displayed on graphs, but will not be considered within the analysis.

### Reset all anomalous data

On clicking this button the *Anomalous Data Detection Settings* window is loaded, allowing the user to change the detection parameters and repeat the detection routine.

### Graph Scale (click to toggle)

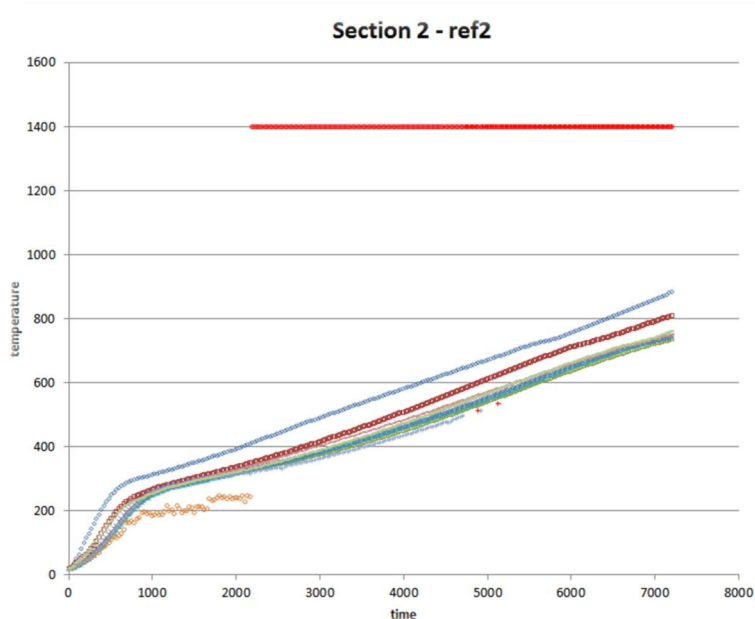
The y-axis of the anomalous data charts is by default scaled automatically to the data point range. In cases where a thermocouple includes extreme erroneous values (e.g. -999,999), the y-axis scale can

be toggled to display only the valid data range by clicking this button. The change is applied when the graph is next re-drawn.

### Manual adjustment of anomalous data

Manual adjustment mode displays a graph of the individual data points. Different channels are distinguished by different colours and marker shapes, however in order to allow resolution of each data point these are necessarily small. Data set automatically as anomalous is highlighted red. An edit box is displayed, showing the individual data points of a particular channel. The currently selected channel is highlighted blue on the graph, with anomalous data changed from red to orange to distinguish it from anomalous data of other channels (see below).

The edit box displays the temperature at every time step and allows manual fine tuning of the anomalous data identified automatically. Each row in the list box corresponds to a time step. Highlighted data is considered anomalous and is removed from the analysis, conversely non-highlighted is considered non-anomalous and is included in the analysis. The user can toggle individual time steps as anomalous/non-anomalous simply by clicking on them.



Section 1 TC Details

TC number:  ◀ ▶

(Channel number)

TC Valid:

Time	Recorded Value
0	17
30	23
60	33
90	43
120	53
150	65
180	78
210	89
240	99
270	110
300	122
330	136
360	151
390	166
420	178
450	191
480	202
510	212
540	219
570	225
600	231
630	236
660	240
690	244
720	248
750	251
780	255
810	258
840	260

Range Modification Tool    Next TC with anomalies

Accept changes    Accept changes and close

**EDIT MODE GRAPH COLOUR CODING**

Red: anomalous data

Blue: currently selected channel, non-anomalous data

Orange: currently selected channel, anomalous data

Black: previously modified channel

Other: as yet unmodified channel



## Navigation between channels

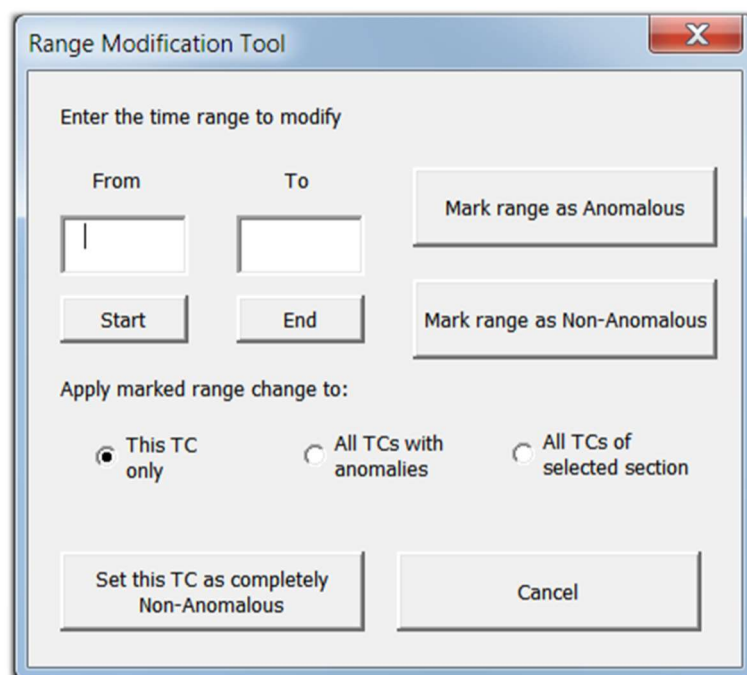
On loading, the manual adjustment window will jump straight to the first TC in the section which FIRECEL identified as having anomalous data. If no anomalous data was detected anywhere in the section TC1 will be displayed. The user can switch between channels by using the spinner button, or by directly writing the either TC or channel number into the appropriate box and hitting Enter. Alternatively they can click the *Next TC with anomalous* button (see below).

## TC Valid

For channels that are clearly anomalous there is the option to set the TC as invalid ("N"). This removes it completely from the analysis.

## Range modification tool

This feature allows for rapid setting of a continuous range of time steps. The user should manually enter the *From* and *To* time they intend to modify, and then click *Mark range as Anomalous* or *Mark range as Non-anomalous*. Clicking the *Start* or *End* button will automatically populate the appropriate text box with the start or end time step.



The range modification can be made to only the channel selected, all the channels assigned to the selected section with identified anomalies (as listed on the Anomalous Data page), or to all channels assigned to section. The radar buttons are used to select the required option.

Clicking the *Mark all as Non-Anomalous* button is a rapid way of setting the entire channel as non-anomalous (there is no need to enter the *From* and *To* times when using this button).

**Next Tc with anomalous**

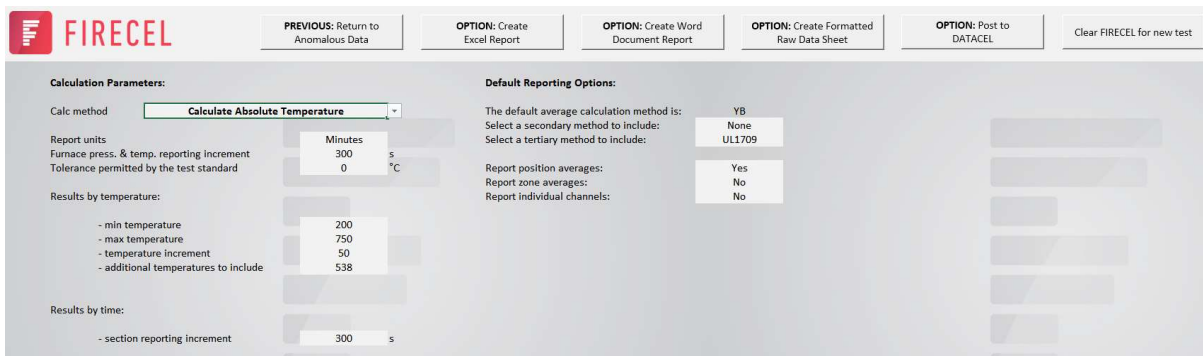
Jumps to the next TC in the section which has been identified by FIRECEL as having anomalous data. If there are no other thermocouples with anomalous data identified this button will have no effect.

**Accept changes**

Note that the user must click accept changes after directly modifying the list box or after using any of the above features, otherwise changes will be lost.

**ANALYSIS & REPORTING**

The *Analysis Options* page (shown below) is accessed via the *Anomalous Data* page. From this page three different types of reports can be generated, or results posted to the database (DATACEL). A number of options common to all three types of reports must be set on this page. These are described in the tables below.



**Calculation Parameters**

The calculation limits and intervals applicable to all report types can be adjusted as required.

Field Title	Description	Format and Notes
<b>Calc method</b>	Choose whether to calculate the temperature rise (zeroes the temperature to 0°C at 0 seconds) or an absolute temperature	Calc method
<b>Report units</b>	Specify either minutes or seconds	Select from combo box
<b>Furnace pressure and temperature reporting increment</b>	The time step at which the furnace pressure and temperature will be tabulated. Note graphs will be plotted at all available time increments	Integer, seconds

<b>Tolerance permitted by the test standard</b>	A temperature added to the CCT when calculating the time to a given temperature. This feature accounts for tolerances given in some standards (e.g. an additional 5°C in ISO22899:1-2007). Note the CCT is reported without the tolerance, despite the calculated time taking it into account.	Number, centigrade
<b>Min temperature</b>	The lowest CCT to report in the results by temperature tables	Number, centigrade
<b>Max temperature</b>	The highest CCT to report in the results by temperature tables	Number, centigrade
<b>Temperature increment</b>	The step between the minimum and maximum CCTs entered above	
<b>Additional temperatures to include</b>	Additional CCT values that are not covered by the range and steps entered above	Numbers (centigrade) separated by commas without spaces. E.g. "427,538"
<b>Section reporting increment</b>	The time step at which the test specimen results by time will be tabulated. Note graphs will be plotted at all available time increments.	Integer, seconds

It is important to understand the difference between results by time and results by temperature:

### Results by time

Displayed the calculated temperature at specified time increments. Graphically this is displayed as Temperature (y-axis) as a function of time (x-axis).

### Results by temperature

Displays the calculated time to specified CCT values. When displayed graphically in DATACEL the Time (y-axis) is a function of temperature (x-axis).

### Default Reporting Options

On first activation of the *Analysis Options* page, FIRECEL will assess which calculation method is set as the default method for the sections. This value is used to set a secondary and tertiary calculation method and to set default reporting of positions and zones on or off. If more than one default calculation method is detected then *Varied* will be returned, and the other default reporting options will not be adjusted.

NOTE: the defaults here simply change the relevant settings on the detailed report option pages (discussed below). These can be manually changed as required.

## CREATE EXCEL REPORT

An excel report is the most detailed type of report produced by FIRECEL. A large range of standard options are available and explained below, additional options may be included depending on client requirements. On completion, the report will be displayed automatically. A button will appear allowing quick return to the *Analysis Options* page.

### Calculation and Overview Options

Field Title	Description
<b>Include test overview info</b>	Displays headers rows with the test information captured on the Home and Test Overview pages
<b>Refer to sections by Section information summary table</b>	Choose the formatting of each test specimen reference in the report Displays a summary table with the information displayed on the <i>Section Overview</i> page (section reference, type, product, DFT, serial size, A/V, length)
<b>Full coating system information table</b>	Displays a summary table with additional information displayed on the <i>Section Detail</i> pages (e.g. full system information)
<b>Graph of furnace T-t curve</b>	Display a graph of the furnace time-temperature data against the standard curve
<b>Table of furnace T-t curve</b>	Display a table of the furnace time-temperature data against the standard, including the % deviation
<b>Graph of furnace pressure history</b>	Display a graph of the furnace pressure measurements
<b>Table of furnace pressure history</b>	Display a table of the furnace pressure measurements
<b>Include invalid TCs</b>	Determines whether or not invalid TCs are included on graphs and in tables. Applicable to all tables and graphs in the report. Note the data will still be excluded from calculations as anomalous.

### Results Summary Options

Field Title	Description
<b>Section average comparison table (by temperature)</b>	Displays a table of the time for the average temperature of each section to reach the specified CCTs
<b>Section average comparison graph (by time)</b>	Displays a graph of the average temperature (y-axis) against time (x-axis) for every section
<b>- display actual or corrected</b>	Toggles whether to plot the actual temperature or the DFT corrected temperature on the Section average comparison Graph (by time)
<b>Section average comparison table (by time)</b>	Displays a table of the average temperature of every section at the specified time interval
<b>- display actual or corrected</b>	Toggles whether to report the actual temperature or the DFT corrected temperature in the Section average comparison table (by time)

## Individual section graphs

Individual section graphs of temperature (y-axis) against time (x-axis).

Field Title	Description
<b>Individual section graphs (by time)</b>	Toggles whether to include these graphs in the report
- include section average	Plot the average temperature (calculated per the default analysis method)
- include secondary average	Plot an average temperature calculated per the selected method (or select None to omit this option)
- include tertiary average	Plot an average temperature calculated per the selected method (or select None to omit this option)
- include max temperature	Plot the maximum temperature of any thermocouple
- anomalous data to be	Select whether to plot (included) or omit (excluded) anomalous data points
- graph min temp	Manually set the graph y-axis lower scale (leave blank for auto scaling)
- graph max temp	Manually set the graph y-axis upper scale (leave blank for auto scaling)
- deflection	Plot the deflection on a separate y-axis added to the right hand side of the graph
- include position averages	Plot the individual position average temperatures
- include zone averages	Plot the individual zone average temperatures
- include individual channels	Plot each valid individual channel

## Individual section tables

### Results by temperature

Field Title	Description
<b>Individual section table (by temperature)</b>	Toggles display of detailed results table for each individual test specimen, displaying the time to given CCT values
- include individual channels	Adds a column for each individual channel
- include section average	Add a column for the average temperature (calculated per the default analysis method)
- include secondary average	Add a column for an average temperature calculated per the selected method (or select None to omit this option)
- include tertiary average	Add a column for an average temperature calculated per the selected method (or select None to omit this option)
- include max temperature	Adds a column for the maximum temperature
- include position averages	Adds a column for each position (the time given is that for the average of all thermocouples in the zone to equal to given CCT)
- include zone averages	Adds a column for each zone (the time given is that for the average of all thermocouples in the zone to equal to given CCT)
- include characteristic temperatures	Adds a column for the characteristic temperature

## Results by time

Field Title	Description
<b>Individual section tables (by time)</b>	Toggles display of detailed results table for each individual test specimen, displaying the temperature at a specified time interval
- <b>include individual channels</b>	Adds a column for each individual channel
- <b>include section average</b>	Add a column for the average temperature (calculated per the default analysis method)
- <b>include secondary average</b>	Add a column for an average temperature calculated per the selected method (or select None to omit this option)
- <b>include tertiary average</b>	Add a column for an average temperature calculated per the selected method (or select None to omit this option)
- <b>include max temperature</b>	Adds a column for the maximum temperature
- <b>include position averages</b>	Adds a column for each position and calculates the average of all thermocouples in that position
- <b>include zone averages</b>	Adds a column for each zone and calculates the average of all thermocouples in that zone
- <b>deflection</b>	Adds a column for the characteristic temperature
- <b>include DFT corrected average</b>	Adds a column with a modified section average, accounting for deviation from the target DFT (see below)

## DFT corrected temperatures

The option for correcting the temperature or time to the DFT corrected value is only available if the user has entered both a test specimen DFT and Target DFT. If one of these values is missing the reported results will be blank.

Calculations are performed on the basis of a linear correction, using the equation below:

$$\text{Corrected temperature} = \text{Actual temperature} * (\text{Target DFT} / \text{Actual DFT})$$

## FORMATTED RAW DATA SHEET

This feature creates a copy of the raw data with basic analysis and formatting applied. It is provided to allow data users to share and store the basic data for their own analysis or other future use. On completion, the report will be displayed automatically. A button will appear allowing quick return to the *Analysis Options* page. The optional features included as standard are as follows:

Field Title	Description
<b>Insert header row</b>	Toggles whether or not to insert a new line at the top, merge the cells over channels for a given test specimen, and then add a description
- <b>section reference</b>	Determines the composition of the description added if the Insert header

- section type	row is set to "Yes". The five options can be toggled on or off, and multiple items are concatenated into a string separated by commas
- section A/V	
- product	
- DFT	
Insert position name header row	Toggles insertion of a row stating the position name assigned to each individual channel
Insert zone name header row	Toggles insertion of a row stating the zone name assigned to each individual channel
Colour code furnace TCs	Toggles colour coding of the furnace channels on or off
Colour code sections	Toggles colour coding of the test specimen channels on or off. Four different colours are cycled through, with specimens coloured in the order they are entered in the <i>Section Overview</i> table
Anomalous data to be	Select from the three options whether to delete the anomalous data from the formatted sheet ("excluded"), whether to keep it unchanged ("included") or whether to include it but highlight it in red ("highlighted red")
Insert average temp columns	Toggles insertion of a column after the last channel assigned to a test specimen populated with the average temperature calculated per the default method (excludes invalid TCs or anomalous data points).
Insert secondary average column	Toggles insertion of a column after the last channel (or average above) assigned to a test specimen populated with the average temperature calculated per the analysis method selected (excludes invalid TCs or anomalous data points).
Insert tertiary average column	As above
Insert zone average columns	Toggles insertion of a column that shows the average of all TCs in a given zone (excludes invalid TCs or anomalous data points).
Individual section graphs	Toggles insertion of a graph of the temperature (y-axis) as a function of time (x-axis) for each test specimen. These are added below the first line of data at the first column associated with channels assigned to a test specimen.
- include section averages	Displays the average temperature of the test specimen on the individual section graphs. Secondary, tertiary, position, zone and maximum averages can also be selected.
- include invalid TCs	Determines whether or not invalid TCs are included on the individual section graphs. Note the data will still be excluded from calculations as anomalous.
- anomalous data to be	Determines whether or not anomalous data points are included on the individual section graphs. Note the data will still be excluded from calculations as anomalous.
- graph axis limits	Choose from <i>Automatic</i> or <i>Valid data range only</i> . The latter will limit the y-axis scale of the graph to the limits set within the <i>Anomalous Data Detection Settings</i> .
- label channels with	Select whether to display in the graph legend the channel number alone or both channel number and position.
- deflection	Determines whether or not the deflection and rate of deflection are plotted on a second chart below the primary section graph. Note this is applicable to loaded section only.
All sections average	Toggles insertion of a graph of the average temperature (y-axis) as a

<b>temperature graph</b>	function of time (x-axis) for all test specimens. This is added below the first line of data at the first column near the leftmost side of the data.
<b>Furnace temperature graph</b>	Toggles insertion of a graph showing the furnace TCs as a function of time.

## CREATE WORD DOCUMENT REPORT

FIRECEL is supplied with a blank MS Word test report to be placed in the same folder as the FIRECEL.exe application. On clicking the button to create a word document report this document will be opened in the background and the relevant data copied across to the appropriate locations.

Users should note that creation of a word document can take up to a few minutes and in this time they should not switch between applications, or change the pages displayed in FIRECEL. Doing so will interrupt the copying process between FIRECEL and MS Word.

On completion of the word document the user should Save As under a new filename. Overwriting the template will prevent FIRECEL from creating new word document reports correctly.

If a user intends to create more than one word report they must Save As and close the existing completed report before proceeding. Failing to do so will force MS Word to prompt the user to open the file as read-only, and FIRECEL will hang until the user has maximised the word window (from the task bar) and dealt with the user input prompt.

The word document report is designed to produce an ISO 17025 accredited compatible test report. Each report is customised to the client requirements, however they include as standard:

- Details on the test properties
- Section summary and property tables
- Channel and thermocouple allocation
- Furnace temperature and pressure graphs and tables
- Individual section graphs and tables of temperature as a function of time
- Individual section tables of time to reach specified CCT values

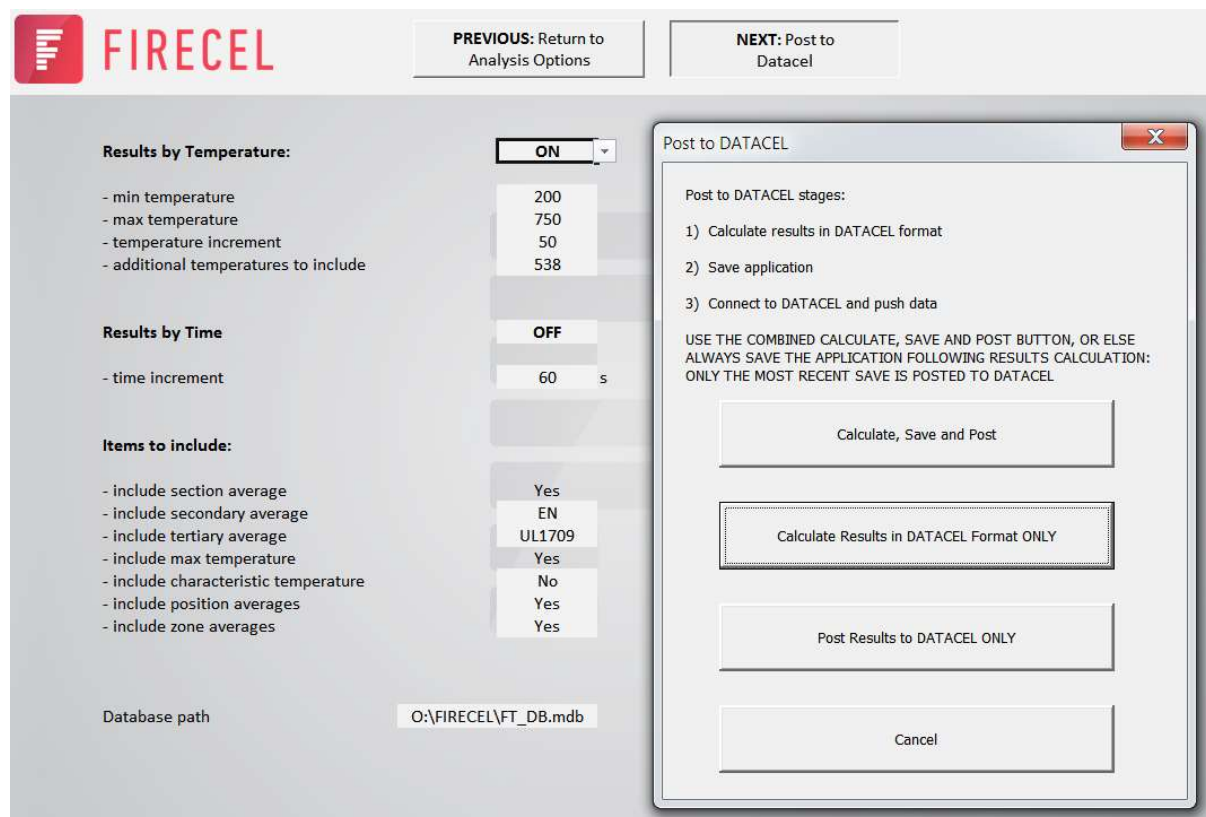
Users should note that MS Word reports are not designed for highly intensive analysis purposes (choose the Excel Report option for this purpose) and so a standard Word report does not include the following features:

- Tolerances applied to result by temperature calculations
- Calculate DFT corrected temperature (the actual temperature is calculated in all cases)
- Test times are not zeroed to the user-defined *Test starts at* parameter. Instead the actual time is reported.



## POST TO DATACEL

This option is present for users who have purchased DATACEL as part of the FIRECEL Suite. Users must note that connecting to DATACEL involves creating a connection between a saved FIRECEL file and the DATACEL database. In order for this feature to work users must be online and connected to the network on which the Database resides, and must have saved a copy of the FIRECEL file after performing the required calculations.



To perform all calculate, save and post steps in one go, users should click *Calculate, Save and Post*. A save file dialogues box will be displayed mid-way through the process prompting user input. The options are also given for advanced users to calculate only and post only, allowing check of calculated data before manually saving and posting.

The results posted to DATACEL are calculated independently from the three different available report types. This allows different data to be captured for future use, and which can be either more detailed or less detailed but more tailored to future intended use.

Two primary data formats can be stored. These are *Results by Temperature* and *Results by Time*. One or both of these settings should be toggled ON before calculating results in the DATACEL format. Both the calculated section average results and the section maximum temperature results are stored as standard. Users can also toggle whether to include position and zone averages. Characteristic temperatures are typically used for stickability calculations for EN assessments; it is recommended these are not stored for other tests.

**NOTE**  
CCT values and the time increment recorded in DATACEL are set independently to those stated on the Analysis Options sheet.

Depending on the type of DATACEL database provided there may be the option to modify the database file path. If the path is not correct an error message will be displayed and no results can be posted to the database.

Advanced users can check the exact records that will be posted to DATACEL by right-clicking on any tab at the bottom of the Excel window and choosing to unhide the DBexport sheets (1-5). Note these will be blank before the user has calculated results in the DATACEL format. If changes are necessary it is recommended users do not modify these tables directly, but instead change the appropriate fields in FIRECEL and recalculate.

Users should note that DFT, Target DFT, Primer DFT and Topcoat DFT will always be posted to the database in millimetres. Section factor will always be posted as A/V (m<sup>-1</sup>).

### **Include deflection info for correction factor calc**

This feature stores the information required by PROCEL to calculate stickability correction factors taking into account when a loaded section fails the deflection criteria defined in EN 1363-1. It is recommended that all BS/YB and EN tests enable this option.

If this setting is set to *Yes* FIRECEL will attempt to identify the loaded beam in the tested. It will take the first section with "LB" or "loaded" in the section type. It will then extract the depth of the loaded beam if it is a UB type section, or will assume a depth of 406 mm if other, to calculate a permitted deflection. The time to this deflection will be automatically entered into the cell below: *confirm time to deflection limit*. Users should check the calculated deflection failure time and overwrite this value if appropriate.

The time for every section in the test to the average temperature of the loaded section at the moment of deflection failure, along with the times to 100°C below this temperature and all intermediate values in 10°C increments, are calculated accordingly.

The calculations are performed four times, for the YB, EN UL and characteristic temperatures. All are stored in DATACEL, with selection of the appropriate method done by the user when importing into PROCEL.

NOTE: that if multiple loaded sections were in the test it will only consider the first one. This feature is not compatible with multiple loaded sections.

### **CLEAR FIRECEL FOR NEW TEST**

This button will wipe all existing data from FIRECEL and return the user to the *Home* page to commence entry of a new test. Note that it will not automatically save the current file. On clicking this button, the user will have the option to retain the test information (which may save time if the new test is similar in set-up).

## SECTION LIBRARY

The number of thermocouples assigned to a pre-set section, and the location of each Thermocouple, is contained within the Section Library. Advanced users can modify the section library by right-clicking on any tab at the bottom of the Excel window and choosing to unhide the sheet.

Note that users should not add or delete lines from the library, as this will cause the section input box on the *Section Overview* page to function incorrectly.

Any changes made should be done immediately after opening a version of FIRECEL, and the revised file saved under a name that clearly allows the user to navigate to it on next opening of FIRECEL. For permanent changes, or the addition and removal of specimens, users should notify PFP Specialists, who will build it into the next version of the client's programme.

## **FURTHER INFORMATION**

For further information please contact

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