SPECIFIC PROCEDURE (S.P)

DOCUMENT NUMBER: CHS-MPLT-SP003

SOP TITLE	MPLT INTERPRETATION AND REPORTING
CLIENT	NOT APPLICABLE

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NOTE:
The table below will record all amendment of the SP. All particulars of the amendments shall be stated clearly. The CHS- Quality Services Committee shall be responsible for the maintenance and update of this record sheet.

CLASSIFICATION	DATE	REVISION PART	REVISION REASON
Original Issue	2/06/2009	Establishment of SOP	Nil

1. Create Emeraude document

1.1 Create new document

- The main program window is displayed with a control panel to the left, several toolbars at the top, and an empty area that will subsequently be used for plotting the logs. Every toolbar has a “grip control” (shown with 2 vertical lines) that can be used to drag the toolbar and dock it at a different position, or leave it as a “floating” toolbar inside the plotting area.

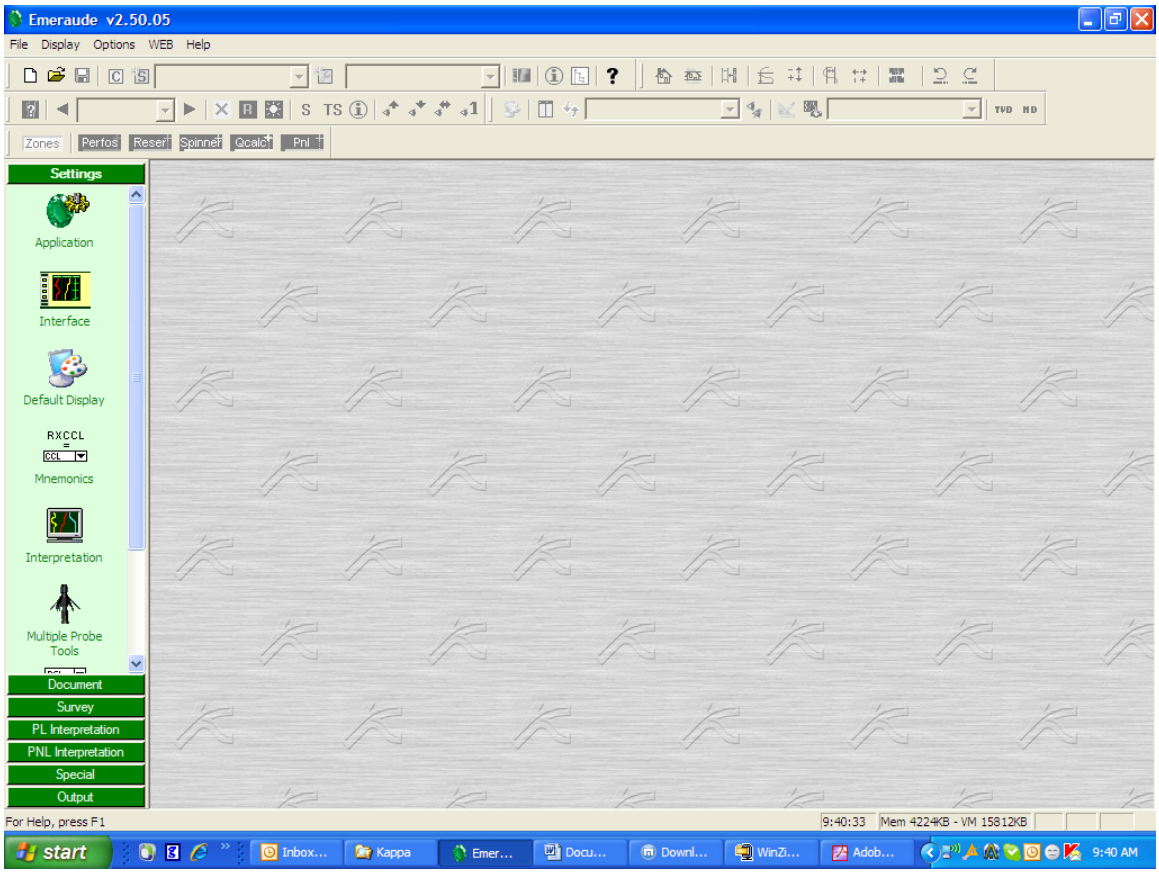


Figure 1.1: Setting screen.

- The control panel contains 7 different “pages” that may be activated by clicking on the corresponding button: **Settings, Document, Survey, PL Interpretation, PNL Interpretation, Special** and **Output.**

- **Application:** Autosave option, path to external user DLL's (for user editions in the browser) and a "Licenses" tab to browse, define and update your license settings.
- **Interface:** Color of the control panel buttons and the background aspect.
- **Default Display:** Define all other display options: passes aspect, views aspects, view templates, etc...
- **Mnemonics:** Edit/create a list of user defined mnemonics.
- **Interpretation**: Define subsets and defaults for PVT, slippage correlations and calibration options. Activate some specific modeling options.
- **Multi Probe Tools:** Specify the tool definition and color scale for imaging tool processing.
- **Default Units:** System of units at program startup and for new documents.
- **Default Print Setup:** Define the default print settings.

1.2 Create a new document using the "New" icon in the toolbar (or the "New" option in the "File" menu).

- The "Job Information" dialog is opened, Fig. 1.2. This dialog has 3 tabs:
  - **Information**: Basic information on the job as it will appear in the report.
  - **Comments**: They can be typed in or pasted from the clipboard. They are printed on the first report page.
  - **Units**: Display and edit the system of units to be used in the active document.

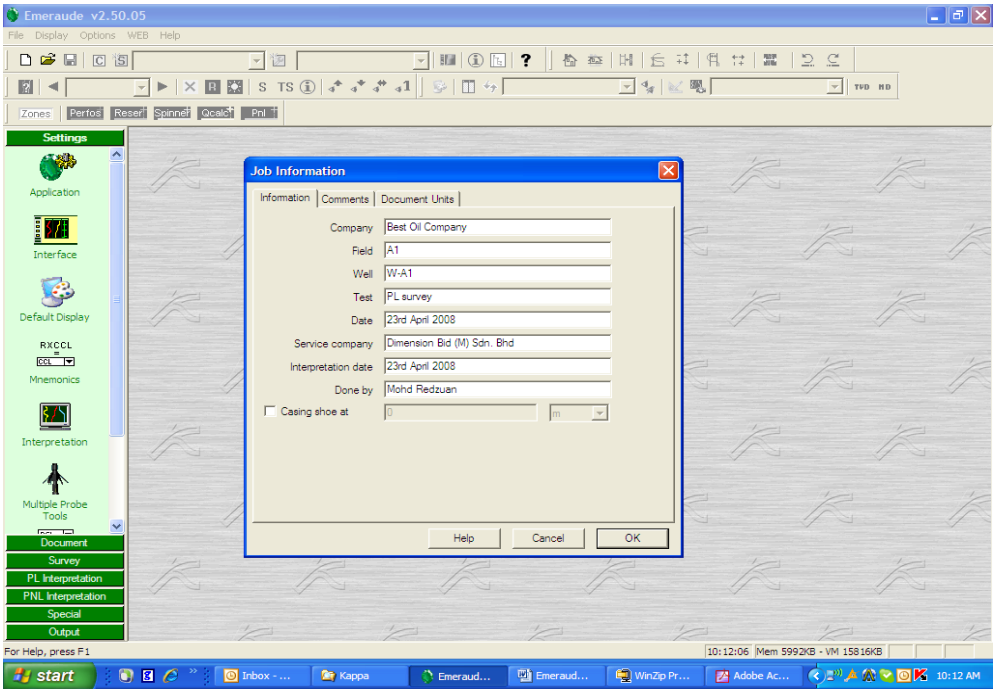


Figure 1.2: Job information dialog

1.3 Enter the required information and validate with “OK”.

2) Emeraude document mode.

2.1 After creating a new interpretation file the Document page is opened, Fig. 2.1. From top to bottom, the icons in the Document mode are:

- **Information**: accesses the initialization dialog with the Information, Comments and Units pages.
- **Load Well Data**: loads general well logs e.g. open-hole gamma ray, deviation survey, caliper, etc.
- **Well Details**: accesses a series of tables where the following information can be typed in manually: Deviation (or TVD), Internal diameter (steps), Roughness, Perfos and Reservoir Zones, Markers.
- **Well sketch**: is used to create and edit a Well Sketch view. If a deviation survey or a TVD curve is available, they should be loaded using the "Load Well Data" option. The "Well Details" option is really for manual input.

Figure 2.1: Doument page

2.2 Setting job information.

- Click on the Icon "Information", in the displayed dialog.
- The first tab corresponds to the information dialog called at the document creation
- The second tab can be used to enter 'Comments'.
- The third tab, "Units", allows the user to adjust the unit system for the current document (when creating a new document the assigned unit system is the default one defined in the Settings page). There are 3 preset systems: SI, Oil field, and Hydro-geology. One can also customize a system and store it, or load an existing system. The system of units can be changed at any time during the interpretation process. Always setup the unit as required by Client.

2.3 Load well data.

- Click on the Icon “load well data”, in the displayed dialog.
- Load general well logs. Typically this will include reference gamma ray (GR), Deviation, TVD and caliper data. The format can be *.LIS, *.LAS or *.ASCII.
- Click on Add button in ‘from file’ tab and select the data that contain information of general well data.
- Usually, Emeraude will recognize automatically the mnemonics on the load file. Otherwise the users have to define manually the mnemonics and only select the applicable data for interpretation. Skip unnecessary data by skip the column.
- After all the columns are defined, click import button.

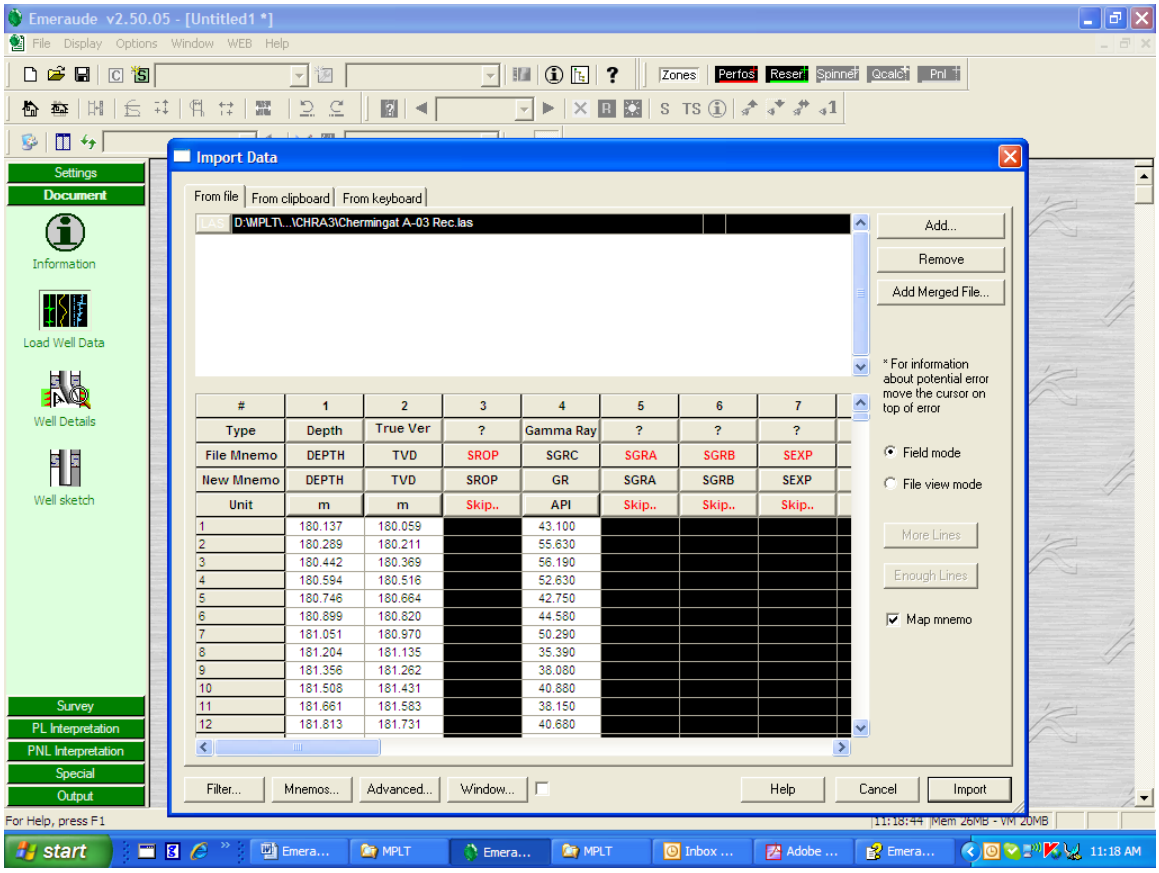


Figure 2.3: Load well data screen

2.4 Load well details

- Click on the icon “load well details”, in the displayed dialog.This option is used for the manual input of the following components of the General Well Data: Internal Diameter, Deviation/TVD, roughness, Perforations, Reservoir zones. When a log is available, you should use the “Load Well Data” option instead. For instance, use the "Well Details" dialog to enter a constant deviation value, but if you have a deviation or TVD log, load it using "Load Well Data".
- Load Deviation / TVD data. If the TVD and deviation data already loaded from “load well data” option, the data will be displayed in the both parameters column. If no TVD and deviation is entered, the well is assume vertical.
- Load perforation interval. The perforations can be viewed/edited in this dialog. When they are created, they are displayed as **red markers** in the "Z track". They influence the calculations as they are used to define the initial position of the inflow zones, the zones to which Emeraude assigns the contributions.
- Load reservoir Zone.The reservoir zones can be viewed/edited in this dialog. When they are created, they are displayed as **green markers** in the "Z-track". The reservoir zones do not influence the rate calculations but they are essential if the SIP option is used.
- Load roughness. The user can input in the displayed spreadsheet the roughness values versus the depth at the top of each zone. If no roughness is entered it is assumed to be 0 at all depths. Usually the default value of roughness used is 6e-6.

2.5 Draw well schematic

- The Well Sketch option of the Document panel is used to create and edit a Well Sketch view. The view is attached to a Survey, and thus needs that at least one Survey exists. When you have a Document with multiple surveys, and you have created a Well Sketch in one of them, call the Well Sketch option in any other Survey to activate the view in this Survey as well. The well sketch is made of the components in the list below:

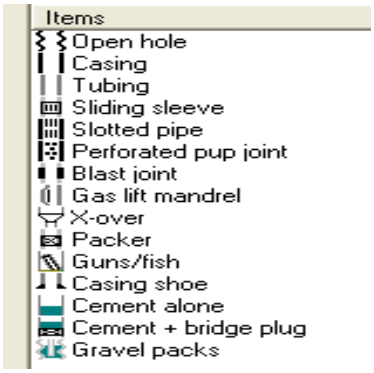


Figure 2.5 (a): Well sketch components

- The logical levels are indicated below. When you add elements you should comply with this hierarchy (no element/level is compulsory).

- Well
  - Open-Hole
    - Casing
      - [Casing: contained in parent]
      - Tubing [Multiple instances at same level = next to each other]
      - [Tubing: contained in parent]
      - Sliding Sleeve , Slotted pipe, Perforated pup joint, Blast joint, Gas lift mandrel, X-over, Cement alone, Cement + bridge plug, Gravel packing
      - Casing shoe, Cement alone, Cement + bridge plug, Guns/fish, X-over, Packer, Gravel packing

- Elements are given dimensions as follows:

  Casing/Tubing/Open-hole: Two lines are required for a single ID: the first line gives the "from" and the second line the "to" depth. When more than two lines are entered, segments are from depth N to depth N+1, with the ID of line N."

  Sleeve, slotted pipe, perforated joint, gas lift mandrel, blast joint: a "from" and "to" depth are entered. The component is drawn with the ID of the parent tubing element.

  X-over: "from" and "to" depths are entered. The ID's (from to) are those of the tubing elements found at the "from" and "to" depths.

  Packer: "from" and "to" depths are entered. Emeraude will find out which elements are present at those depths and "fill" the appropriate gap with the packer schematic.

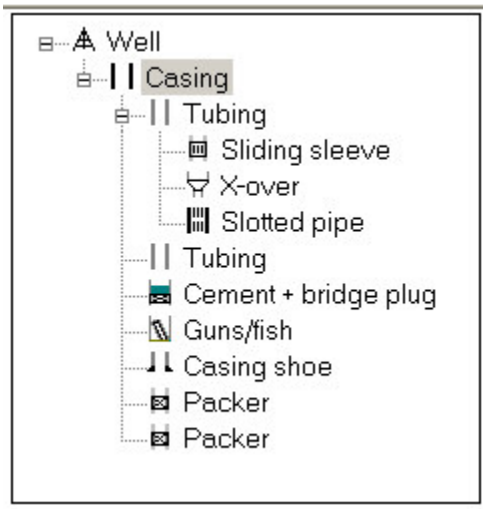
  Guns/fish: "from" and "to" depths are entered.

  Cement alone , Cement + bridge plug: "from" and "to" depths are entered.

  Gravel pack: "from" and "to" depths are entered. The gravel packing will fill in the space between the parent and whatever relevant descendants.

- Well sketch example

This example illustrates the logic of the well sketch components/options. The Figure on the left shows the overall completion definition, while the table below gives the geometry details for each item. The figure on the right shows the corresponding sketch (with the Fill area option activated and without).



The geometry of the various elements for this example are given below:

Casing: [Depth ft, ID in]: [3000,10]-[3220,10]

Tubing 1: [Depth ft, ID in]:

[3000,3.5]-[3160,3.5]-[3162,2.8]-[3180, 2.8]

Sliding sleeve [From ft, To ft]: [3120 - 3124]

X-over [From ft, To ft]: [3160 - 3162]

Slotted pipe [From ft, To ft]: [3170 - 3180]

Tubing 2: [Depth ft, ID in]: [3000, 2.8] – [3140, 2.8]

Packer 1 [From ft, To ft]: [3130-3134]

Packer 2 [From ft, To ft]: [3166-3168]

Cement + plug [From ft, To ft]: [3190-3200]

Fish [From ft, To ft]: [3210-3220]

Casing shoe [Depth ft, ID in]: [3220, 14]

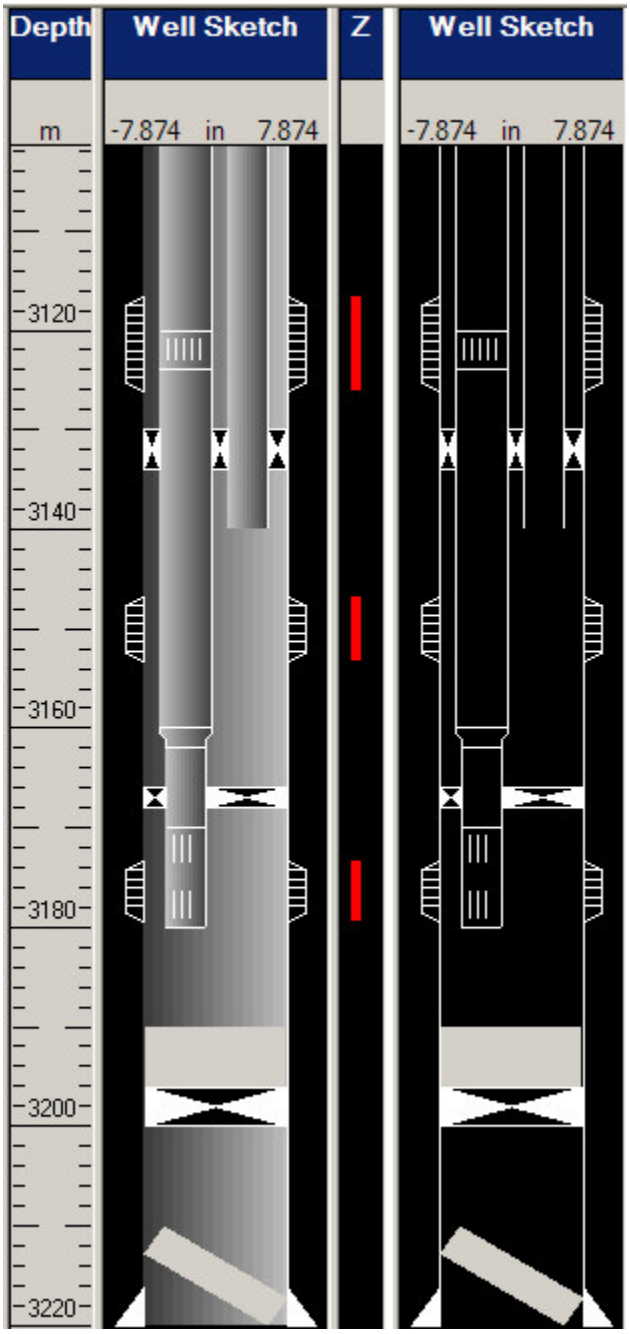


Figure 2.5(b): Well sketch example

3) Survey mode

3.1 Create survey information

- The first time this option is called in a session, Emeraude automatically creates a first survey, called "Survey#1". Normally it will be name based on survey condition, for example Flowing 100%, shut in and etc.
- Enter the short name to represent survey condition above.
- Enter surface parameters and well test result conducted during survey.

3.2 Load survey data

- The Load option uses the same generic dialog as the General well data on Emeraude document mode as mentioned above.
- All the LAS data from different passes can be imported in one time by selecting all files on add button function.
- Ensure the type, unit, logging direction for each pass are defined correctly before imported for next analysis steps.

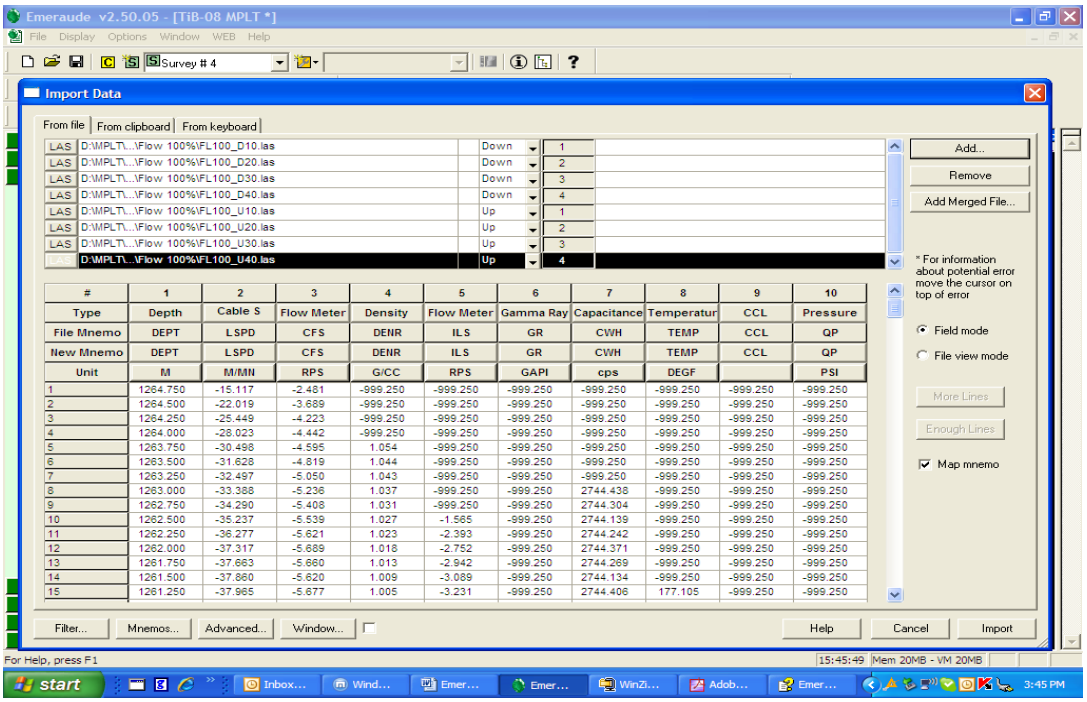


Figure 3.2: Load dialog after files selection

3.3 Perform depth correction on PL data

- After loading the log data, operations such as Depth shifting can be applied to a whole pass.These operations are accessed through the pass toolbar, fig 3.3(a).

Figure 3.3(a): Pass toolbar

- From left to right: **Nearest curve, Go to Previous pass, Active pass, Go to next pass, Hide, Reference, Highlight, Depth Shift, Tool Shift**, **Info, Show/Hide all Up passes,Show/Hide all Down passes, Show/Hide Stationnay passes, Show only the active pass.**
- Depth correction can be made on logging data either using original GR or base on well's completion accessories.
- In this example, the correction will be made with reference to original GR. However the process is similar if you wants to use CCL for depth matching by tie the CCL log carefully to completion accessories. After selecting a depth interval with well correlated features, and possibly after maximizing the gamma ray plot by a double click on its title bar, the depth matching proceeds as follows (all referenced icons are found in the pass toolbar).

- To make the tie in depth process easy, show only 1 active pass in one time in the log plot together with original GR log. This can be done by hide the rest of passes one by one using “hide” button in the pass tool bar.
- Zoom on depth of both GR plots so that the area with same curve pattern or same peak is on the screen. It will give a better view for good tie in process. Highlight the active pass by using “highlight” button on the pass toolbar.
- Click the shift button and drag PL GR log to match with original GR. The movement can be up and down depending to the off depth either deeper or shallower.
- The others type of logs in same active pass will be shifted automatically.
- Repeat the same process to another passes until they are correctly position to the right depth.
- You can click on the “Pass Info” icon to view, for any pass, the value of the shift after depth matching.

Note:
Ensure the log depth is corrected before proceed with further analysis steps.

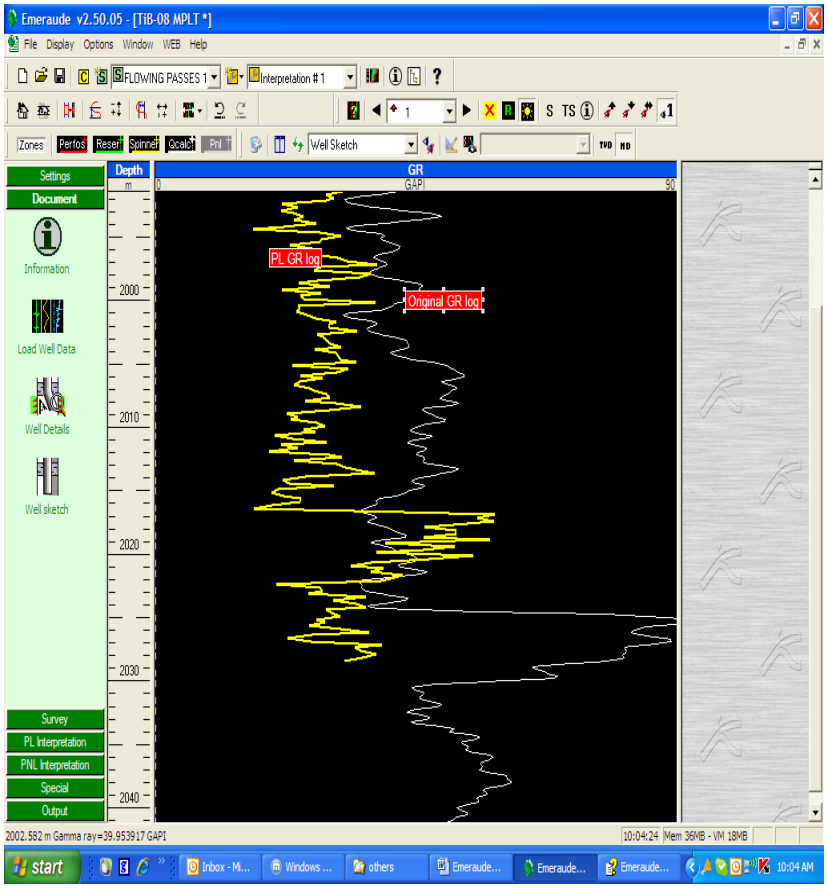


Figure 3.3(b): Uncorrected GR log

3.4 Load station data

- Loading stations is very similar to loading vs depth data, the main difference being that no specific X column is required by Emeraude. If a Depth column is found in the file, then Emeraude will use this information to assign the appropriate depth to the measurements. When no depth information is found, you can input the station depth in the box for the station performed.

3.5 Define tool info.

- This dialog is used to enter additional parameters required for some tools (spinner, density, and capacitance).

➢ **Tool O.D.**

Used for friction calculation when relevant.

➢ **Density**

The list shows all available density mnemonics in the survey. The density section is used to characterize the type of density tool(s) used. For a gradio, a drop list indicates the response type. If fluid radioactive density is used, select nuclear tool and no deviation correction is required for density measurement.

➢ **Spinner**

Spinner blade diameter: the ratio of this diameter with the pipe I.D. is used in the determination of the average mixture velocity.

➢ **Capacitance**

A capacitance calibration is defined by a calibration chart together with in-situ measurements in 100%water and 100%Hydrocarbons. There are two possible calibration modes in Emeraude:

- Chart is counts/sec vs. the dielectric values ; in-situ values are dielectric
- Chart is Water holdup vs normalized tool response; in-situ values are count/sec.

4) PL interpretation mode

4.1 Click on the "PL interpretation" button of the control panel

- The options in this mode are:
  - **Information**: edits properties of the active interpretation or creates the first interpretation for the active survey.
  - **Calibrate**: spinner calibration.
  - **V apparent**: generates an apparent velocity channel.
  - **PVT**: Input PVT parameters by phase.
  - **Zone rates**: Zonal rate calculations.
  - **Log**: generates schematic of zonal results or complete (continuous) rate logs.
  - **Time Lapse**: The objective of this option is to produce at the end of the report an additional log presenting in chronological order, the past and present productions in terms of schematic rates QZT or ratios QZTR

4.2 Click on the first button labelled "Information".

- This option is primarily used to edit the active interpretation properties. It also automatically creates a first interpretation when none exists. Beware that to create a new interpretation after one exists, you need to use the icon  in front of the interpretation drop list of the main toolbar and to specify if it is a PL or PNL interpretation. When an interpretation is created the only required entry is a name and a short name. Some components may be copied directly from existing interpretations (if any in the session).Note that such copy operations can also be executed at any time inside the data browser. Some components may be copied directly from existing interpretations (if any in the session).
- Validate with "OK"
- The interpretation setting dialog will appear as shown in figure 4.2(a) below.

- The first tab allows to specify the spinner calibration. The “Calibration” drop list gives access to the calibration mode [None –Individual – SAT – FSI]. The “Individual” spinner calibration mode is the default and allows selecting individually the spinners to calibrate.
- Normally the most bottom spinner will be considered as a main spinner and choosed for the analysis. Unless the data is poor in quality then in line spinner will be selected for analysis.

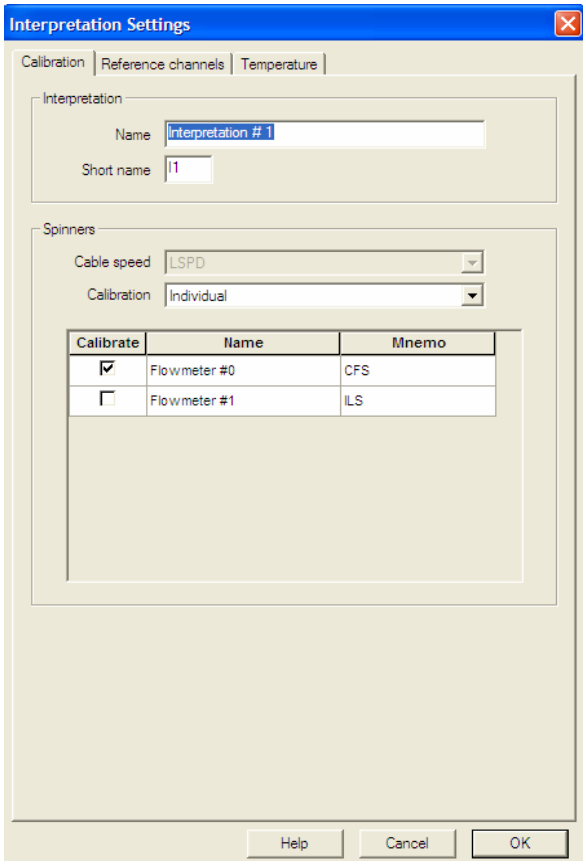


Figure 4.2(a): Interpretation setting

- The reference channels can be defined in the second tab of the Interpretation settings dialog, Fig. 4.2(b).
- If the well internal diameter has not been defined, a red warning appears in the Interpretation Settings dialog, in front of the internal diameter information string, to warn the user.
- Click on the “Define” button next to “Temperature”. This opens a dialog listing all the temperature passes in the current survey.
- Select the pass “Down 1” and validate with “OK”, Fig. 4.2(c). The check box on the Temperature line is now checked and the mnemonic displayed. Clicking on the trash icon allows to undefine the channel.
- Click on the “Define” button next to “Pressure”.
- This time, in the Average dialog tree view, click on the “Log Data” node to select the pressure data of all the passes in the survey and then press “OK”. Emeraude creates a lateral average of the selected channels inside the interpretation (Hodges – Lehman averaging).
- For “Density” and “capacitance” select the “Down 1” channel and validate with “OK”.
- The “Temperature” option is used when a temperature model is required for complex conditions and injection. Exit the dialog with “OK”, and “Save”.
- Fig. 4.3(d) illustrates the screen after the definition of the reference channels. The rightmost track, called “Density match” and “Capacitance match” view will be used to overlay the measured and simulated density resulting from the diagnostic at a later stage of the interpretation.

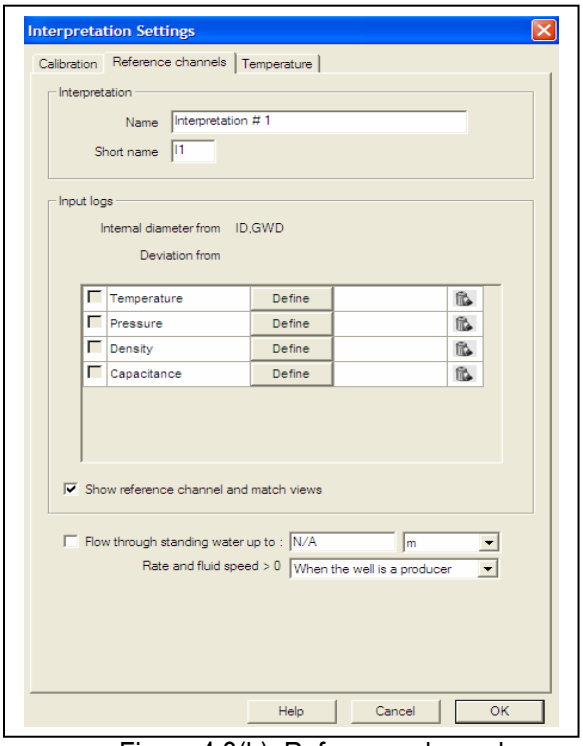


Figure 4.3(b): Reference channel

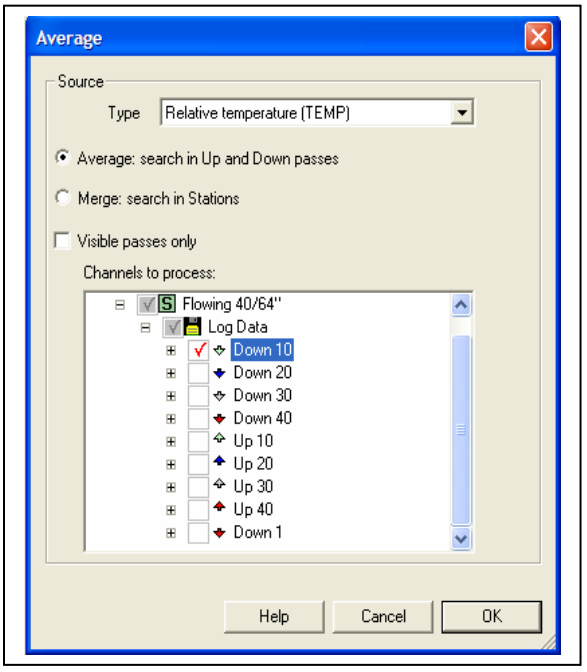


Figure 4.3(c): Reference channel definition / average dialog

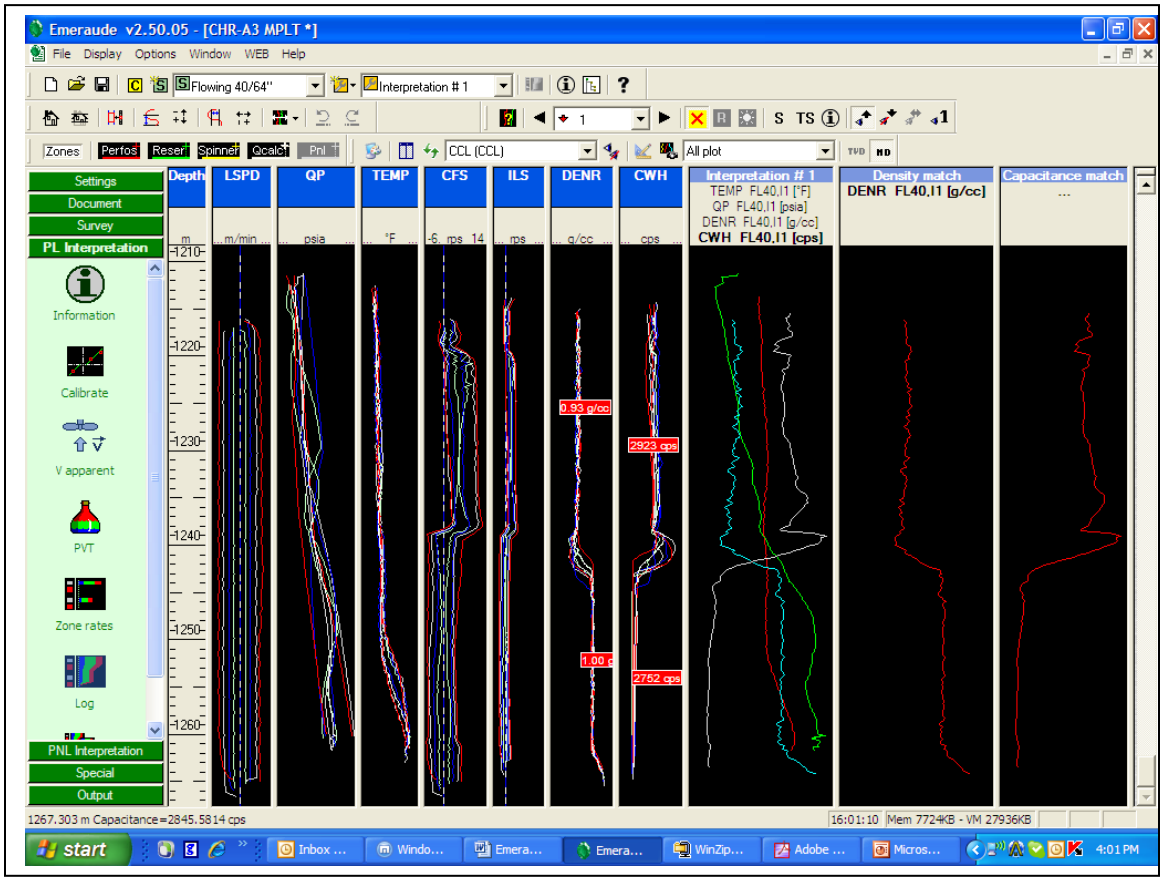


Figure 4.3(d): Interpretation main screen.

4.3 Return to the “PL Interpretation” panel. Select “Calibrate” button, which is the second option of the panel, Emeraude will indicate that calibration zones should first be created using the “Zones toolbar”:

Figure 4.3(a): Zones toolbar icons

- This toolbar gathers the following options: Tabular Zones edition, Interactive Perfos Interactive Reservoir zone, Interactive Spinner calibration zone, Interactive rate (Q) calculation zone, interactive Pnl crossplot zone.

- Display line speed, well diagram, selected spinner, zone display and one fluid identifier log in the screen. Spinner calibration zones should be selected where the spinner and cable speed responses are reasonably stable.
- Select “spinner” button in Zones Toolbar. Interactive creation is done zone-by-zone, clicking for the first limit, then dragging and releasing for the second limit. Calibrate the spinner for every inflow section where significant changing on spinner and density reading can be observed. Calibrate the spinner in between each inflow area for better fluid velocity calculation interpolation.

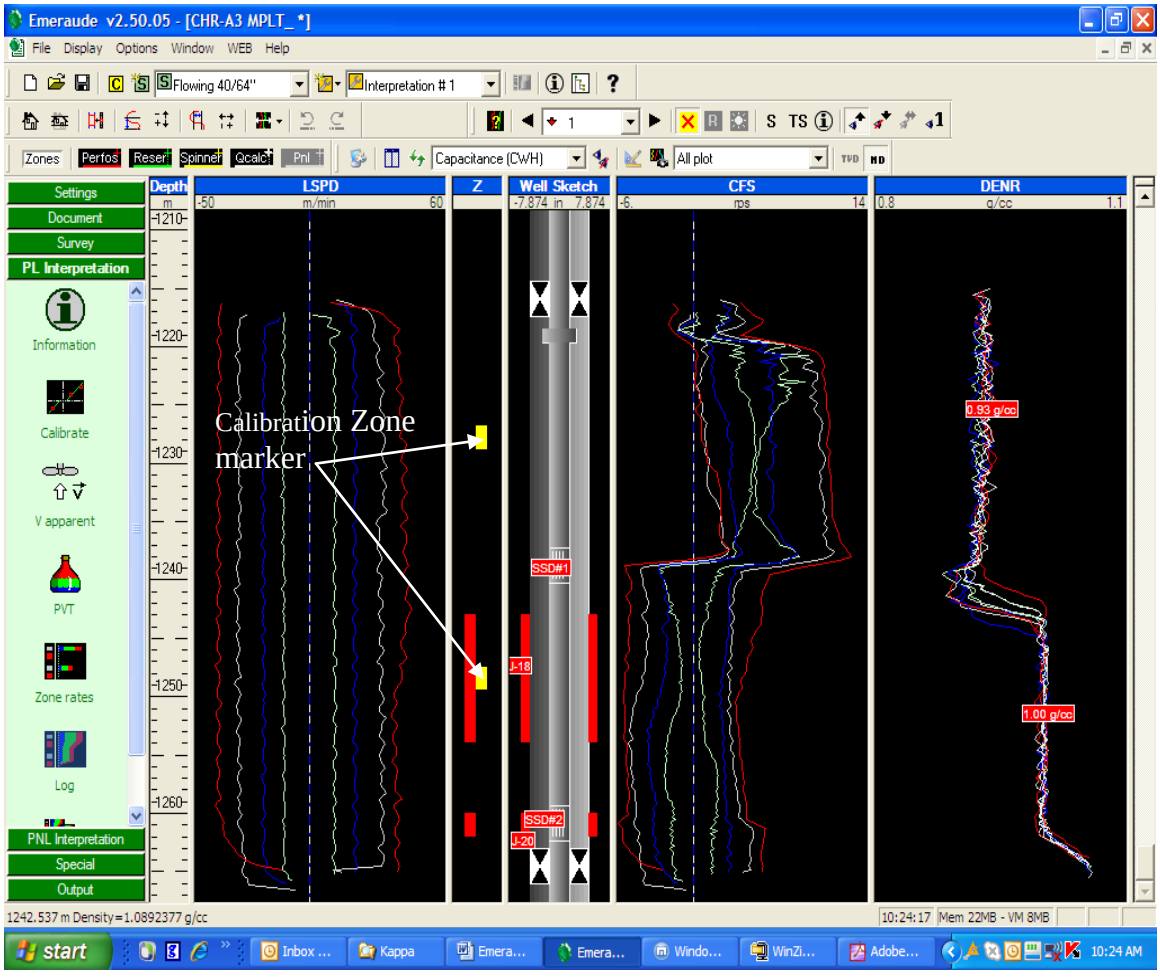


Figure 4.3(b): Calibration Zones defined.

- The calibration zones will be shown as yellow markers on the Z plot.
- Once created, they can be edited manually using the first icon of the Zones toolbar 

, or interactively in the Z track. On this track a single click make a zone active; a subsequent “Del” deletes it, or the zone can be resized by grabbing and dragging handles appearing at each extremity.

4.4 Click on the “Calibrate” icon.

- The calibration plot is displayed (Fig. 4.4(a)). Right click in the plot window and a zoom menu is available.

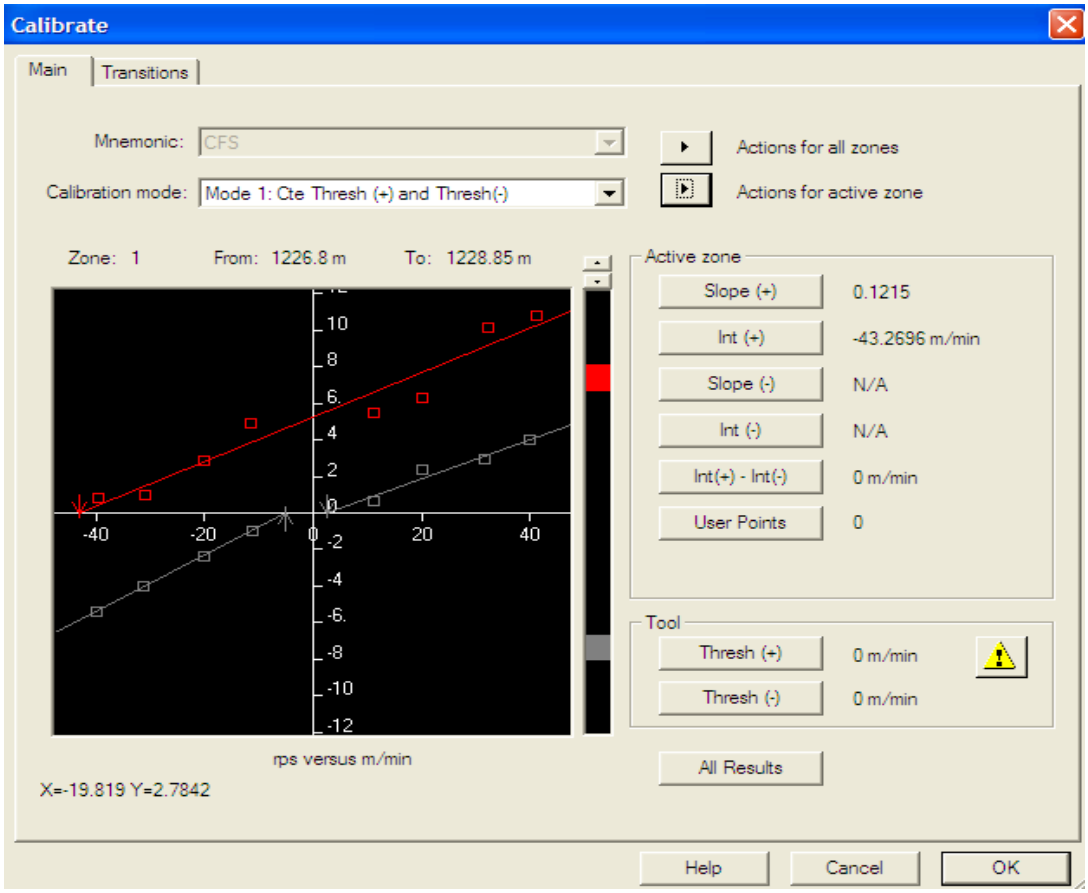


Figure 4.4(a): Calibration plot

- The active zone is highlighted in red. To activate a different zone, you may click on the vertical schematic showing the 2 zones, or use the up / down arrows above.
- The slopes and intercepts can be modified manually or copied from one zone to another. The two buttons at the top labelled “Actions for all zones” and “Actions for active zone” give additional options:
  - In the “Actions for all zones” button select: “Set all positive slopes to average”.
  - In the “Actions for all zones” button select: “Set all negative slopes to average”.
  - Click on the “Thresh (+)” button. A drop list to the right gives access to the possible no flowzones. This option is used when the calibration in made in the sump area.
  - Select “Copy” and the positive intercept value is copied as the tool threshold. Validate with “OK”.
  - Do the same for the negative threshold “Thresh (-)”.

- Get the best regression line on the plot. Sometimes it was unable to get smooth regression from calibration points due non-uniform flow regime, unsteady line speed and etc. In this case, we can de-select the irrelevant points by click on that point in active zone and unclick in the box “use for regression”. Then click OK. When all the irrelevant points are take out from regression, go to the “Actions for active zones” button and select: “recompute positive line” or “recompute negative line” depending where the line are, either in the +ve Y axis or –ve Y axis.
- Define the spinner threshold. If the spinner is calibrated in sump area or in shut in condition, the value of +ve and –ve threshold can be copied directly from +ve and –ve intercept from calibrated line of no flow zone. Otherwise just key in typical spinner threshold as recommended by tool manufacturer.

Note: by default, a linear interpolation will take place in the region between two consecutive calibration zones. The “Transition” tab allows introducing more flexibility: you can define calibration application zones different from the calibration zones. In this case, the regions where the linear interpolation applies can be reduced as far as a sharp transition is considered between the calibrations.

- Validate the calibration with "OK" after calibration plot is finalised.

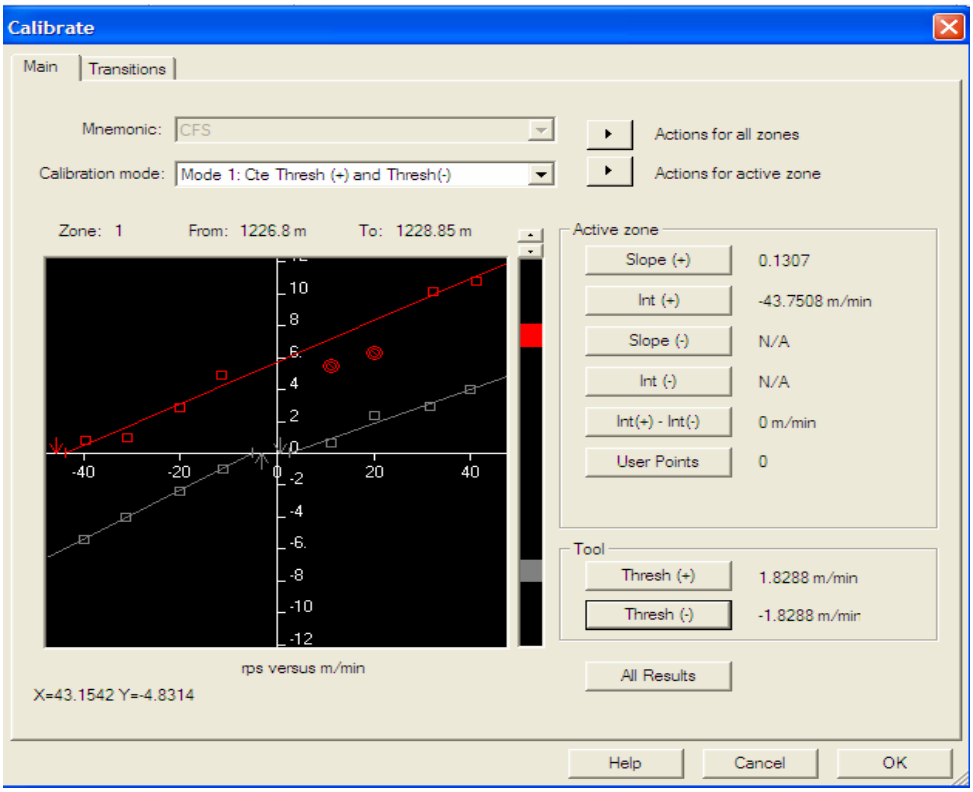


Figure 4.4(b): Final calibration plot

- When the calibration is accepted, Emeraude automatically calls the "V apparent" option. This is called V apparent because it only corresponds to the speed of the fluid seen from the spinner location in the wellbore. This is different from the average fluid velocity.

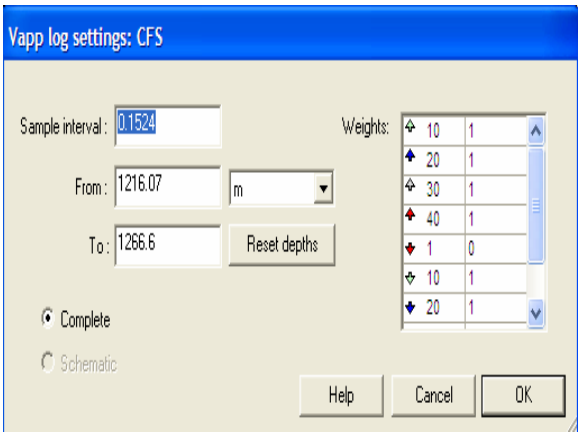


Figure 4.4(c): Apparent velocity calculation setting

- In this dialog the interval for the generation as well as the depth increment can be set. At each depth, the default pass with weight "1" will be take into account to compute a V apparent channel.
- This default can be changed by assigning with weight "0" to some passes that you may don't want to include in the V apparent computation due to some reason, eg: poor spinner respond, unsteady line speed and etc.

- After V apparent setting has done, validate with OK. A velocity match view is added to the interpretation, showing the V Apparent channel just added inside the interpretation. The mnemonic associated with a V apparent channel is automatically built by Emeraude: it associates "VA" to the mnemonic of the spinner tool of interest. In the present case, VACFS.

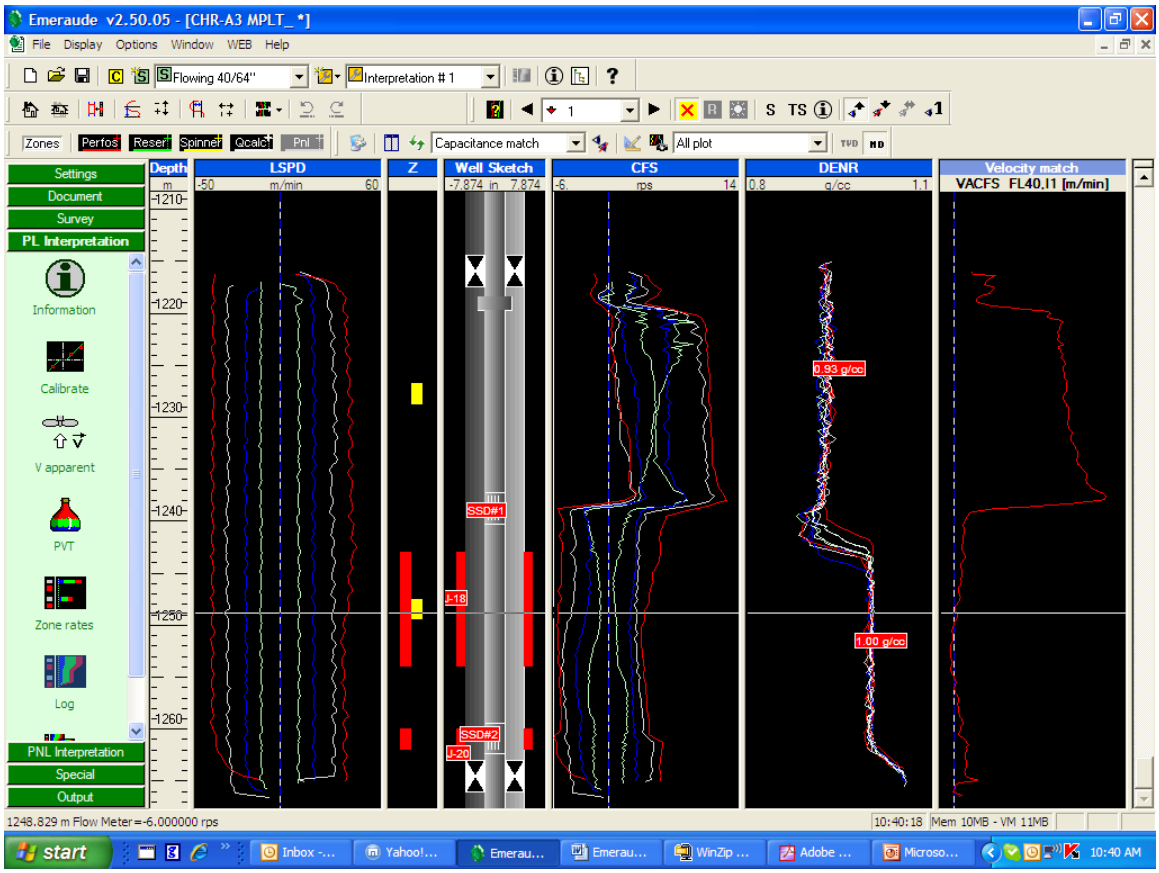


Figure 4.4(d): Apparent velocity calculated.

4.5 If you wish to change apparent velocity setting, select "V apparent" on PL interpretation control panel.

4.6 Entering PVT information

- Click on the "PVT" icon: the main PVT dialog pops up. Define fluid type from the well.
- Enter the solution gas oil ratio.

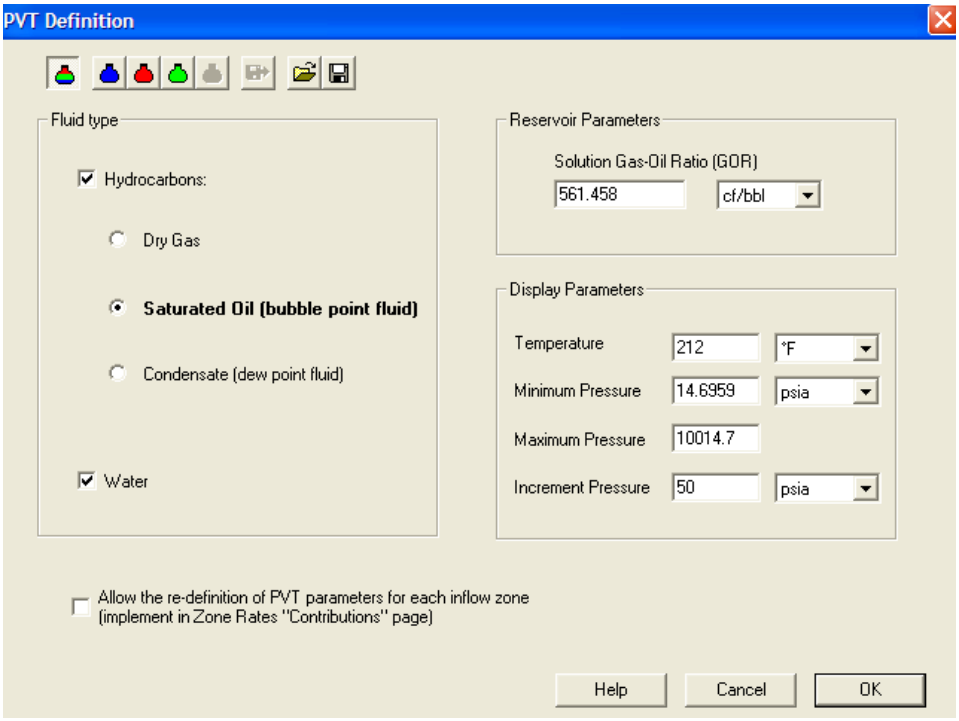


Figure 4.6: PVT definition screen.

When the PVT model is created or changed, each phase present should be defined from left to right, using the corresponding toolbar. For each phase dialog, input data are entered and correlations are selected in the first page; each additional page is assigned a property. The list of correlations as well as the default correlation can be changed permanently with the "Interpretation" option of the "Settings" panel.

- Click on the adequate phase icon ( ,  , ), the used correlations can be viewed and matched to fit defined "Constraints".

- The "Constraints" icon  opens a grid where measurements of the property can be entered for a set of (T, P) values.
- The "Match Constraints" icon  runs a non-linear regression on the constraints; the original correlation shows in blue and the fitted one appears in yellow.
- The "Reset Constraints" icon  returns to the original correlation.
- Most correlations give a PVT property as a function of T and P. PVT plots show the property as a function of P, at a given T. If case correlation is constrained, the display T can be set to the main display temperature or to the temperature of the first constraint. This temperature value has no influence on the calculations, it only affects the display.

- After all PVT data are defined, validate the PVT and return to main screen.

4.7 Zone rates.

- Click on the "Zone rates" icon.

- The first time this icon is pressed (or if all existing calculation zones have been deleted) a dialog appears with the default parameters for creating the zones. The zones can either match the spinner calibration zones or be located above all the perfos (plus one zone below the last perfo). The user can also choose to interactively create the zones using the mouse with click and drag. The initialization based on the perfs defines a position above the perfs (default 0) and size (default 1 m).
- Display Zone display, well diagram, velocity match, density match and capacitance match on the main screen to ease the operation

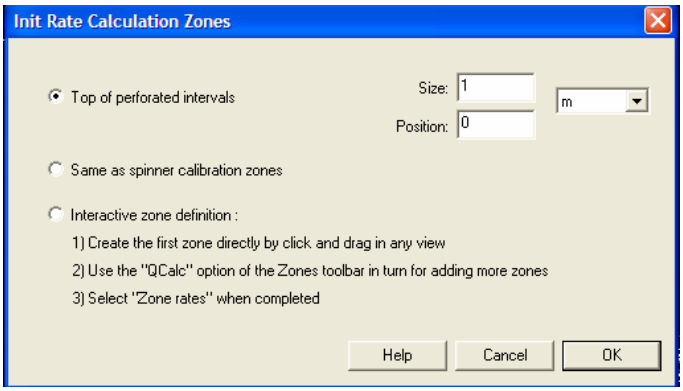


Figure 4.7(a): Init rate calculation zones dialog

- Click on the “Interactive Zone definition” and click OK. Interactive creation is done zone-by-zone, clicking for the first limit, then dragging and releasing for the second limit similar with the spinner calibration. Create the calculation zone definition for every inflow Zone at the area which apparent velocity look reasonably stable and one at the sump or no flow area.

- In the Z view, gray markers will be added to represent the newly created rate calculation zones. In the Z track, a zone can be activated by a single click and its limits changed by dragging its top and bottom handles.
- An activated zone can be deleted by pressing the “Del” key. When calculation zones exist, the “Qcalc” 

, option of the Zones toolbar can be used to define new zones interactively, in a similar way as for the spinner calibration zones.
- As will be seen later, Emeraude automatically creates one inflow zone between each 2 consecutive calculation zones. By default in this case, the inflow zones are identical to the perforation zones, but they can be resized as needed, to adapt/correct the shape of the schematic logs for instance at SSD area in this example.

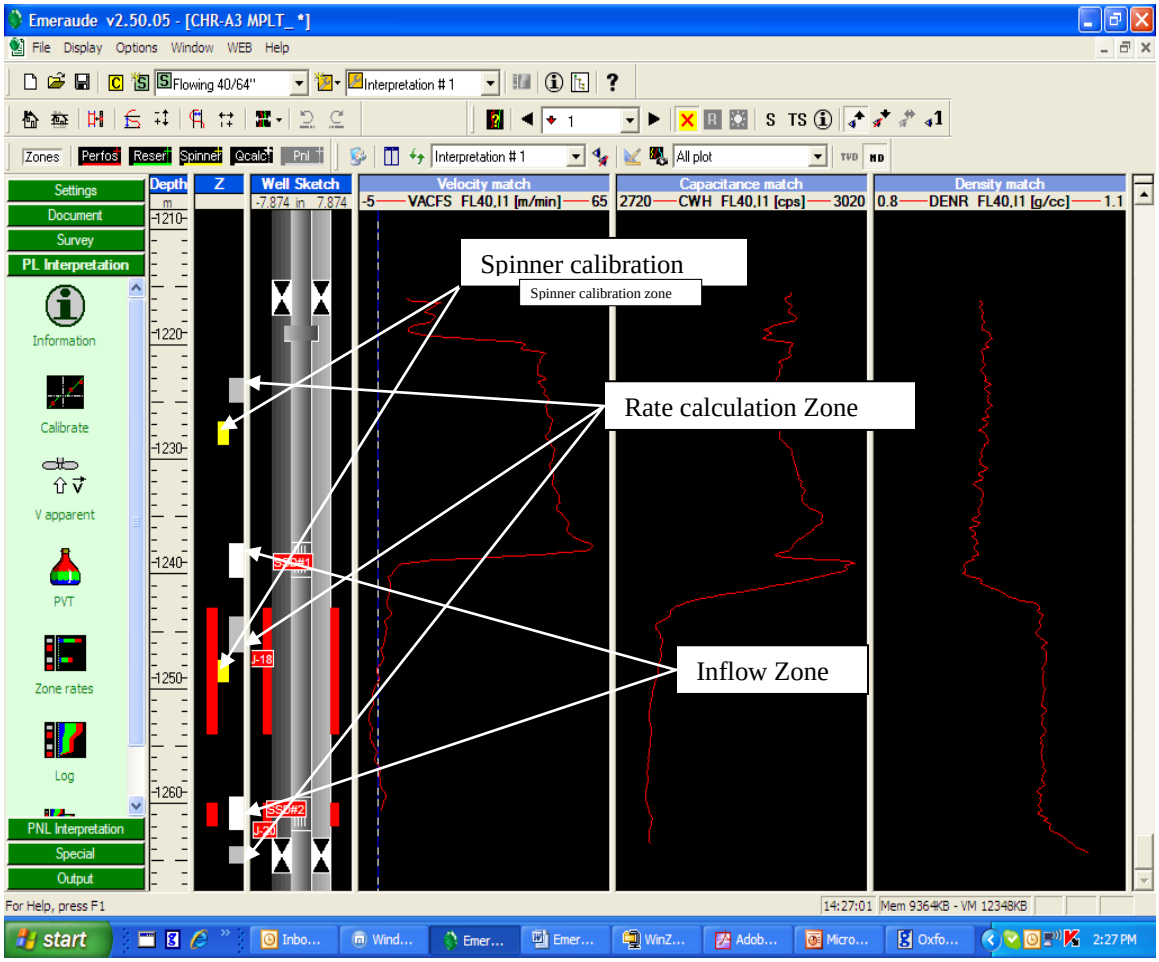


Figure 4.7(b): Definition of rate calculation and inflow Zones.

- Click on the "Zone rates" icon again.

- The first time the Zone Rate option is called it is necessary to set-up the calculation by choosing an initial flow model and associated flow correlation. The offered models are based on the fluid type, as defined by the PVT.
- The suggested model is based on available measurements, as well as user defaults. When the Init dialog is first displayed, all calculations have already been run for the suggested model. The Set/Reset all zones button is disabled in this case. Pressing **OK** when in the Init page for the first time, or when modifications have been made, sets/resets all zones if necessary and moves to the Rate calculations tab. The Set/Reset all zones button is especially useful if the user wants to reset all zones for the currently selected model/correlation.

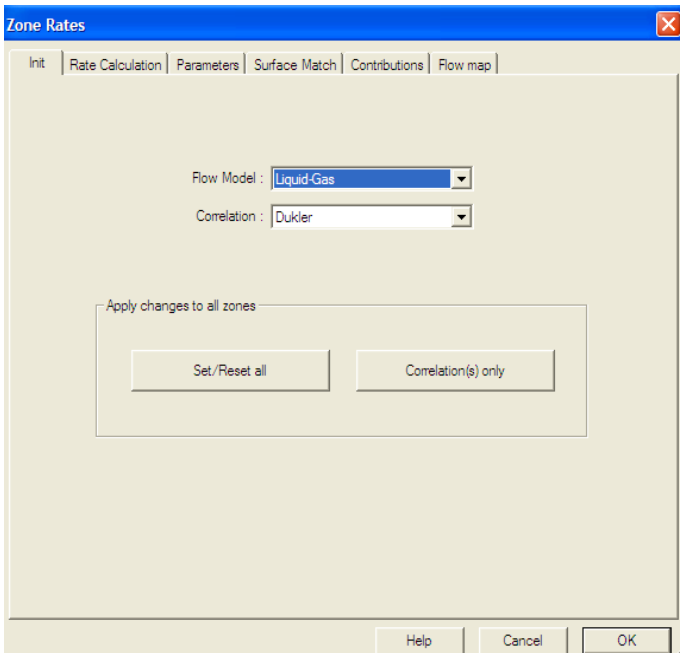


Figure 4.7(c): Zone rate init

- By clicking on “Set/Reset all zones”, it passes directly to the next tab, or, at the top of the dialog, click on “Rate Calculation” tab (Fig. 4.3(d)).
- Declare no flow for Q calculation Zone if it defined in the static / sump area if any.

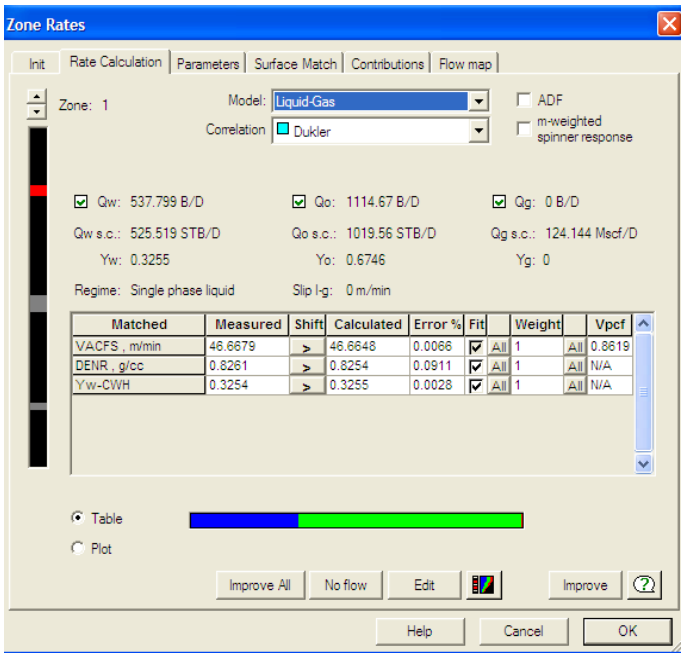


Figure 4.7(d): Rate calculation dialog

- The values displayed in the dialog correspond to a given calculation zone. Similar to the spinner calibration dialog, a small schematic shows the active zone and can be used to change the zone under investigation.
- The first time this dialog is called, of after resetting the model/correlation in the Zone rate init page, Emeraude automatically solves for each zone by calling the non-linear regression (Improve).
- At the top of the dialog, the Model, and correlations are displayed, and could be changed for the current zone only. Below are the values of rates, slippage velocities, and holdups. A green check mark in front of a variable indicates that this variable can be determined by the non-linear regression. The display in this page is set to either **Table** or **Plot**.

Table mode

- For the current zone, the dialog gives a summary of the results as well as several controls of the non-linear regression that can be accessed in a grid as shown in figure xx above

Measured value.

Calculated value. *This integrates any relevant function such as frictions for a gradio, inverse calibration for a capacitance, etc.*

Error %: relative error between simulated and measured values. The background color of the cells gives an indication (from white to red).

Shift option: Measurement offset. This button shifts the measured channel (using the y -> a.y + b option) and the error with the predicted value becomes 0. This can be used, for instance in a shut-in interpretation, when the nature of the fluid in a given zone is known. In case of a capacitance, Emeraude back-calculates the shift to be applied to the raw cps values.

Fit: Enable or disable the use of the particular measurement in the non-linear regression. This option is enabled only when redundant measurements exist, i.e. when there are more information than unknowns.

Weight value: Sets for the non-linear regression, the weight for the error term corresponding to the particular measurement.

All option: Set the current weight or fit for the particular measurement, in all the calculation zones.

Vpcf: Velocity profile correction factor - Apparent velocity residuals only.

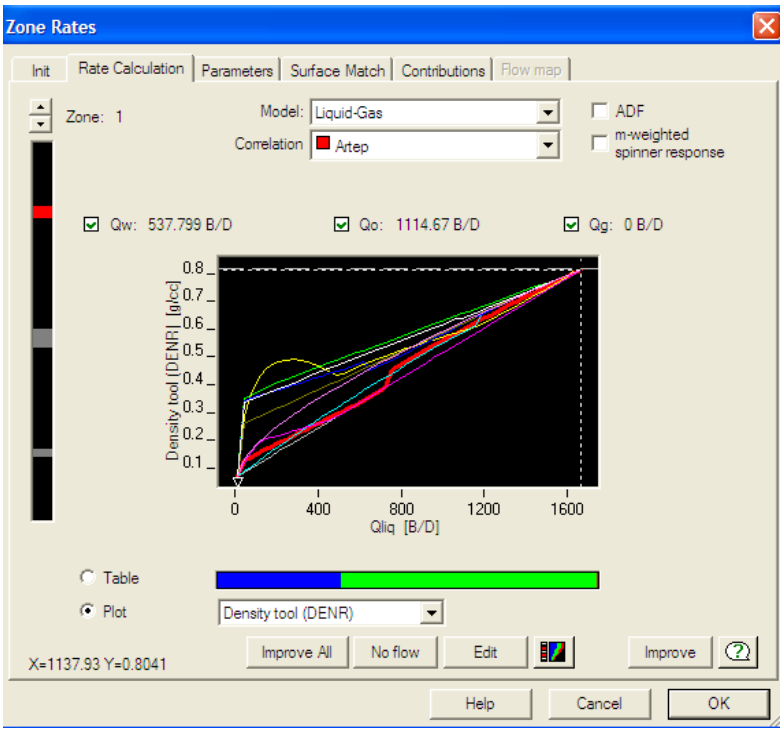


Figure 4.7(e): Rate calculation dialog, plot mode

Plot mode

- The default plot shows the density tool response vs. possible values of Qh (heavy phase rate) for the current Qt (total rate). Values on the X-axis are between 0 and Qt. The value Qt-Qh represents Ql (light phase rate). The following indications are plotted:
  - Vertical dashed line: current value of Qt
  - Horizontal dashed line: measured density tool response for the zone
  - Colored curves: simulated density tool responses for the applicable flow correlations
  - Vertical dotted line: Vsh for the current solution
  - Horizontal dotted line: simulated density tool response for current solution

- Also if the survey surface rates have been defined, and the zone in view is the top calculation zone:
  - White triangle pointing down on the X-axis: downhole mixture rate as computed from the surface rates (and the PVT model).
  - Colored squares: the density tool response the correlations would predict if the downhole rates were those corresponding to surface conditions.

- When a water holdup or a gas holdup measurement is available, it is possible to change the plot to a display of Water holdup or Gas holdup vs. Vsh. The description of the plot symbols above still applies, replacing density tool response by water holdup or gas holdup.

- The plot pop up menu includes a "Legend" option describing the meaning of each of the specific lines/symbols displayed on the plot.

- All input parameters, other than those used in the matching can be viewed in the “Parameters” page. It will display the PVT properties, well characteristics, and input channel values, as calculated for the zone. Values of interpretation reference channels are the result of an average across the calculation zone. Other measurements come from the general well data (e.g. deviation, roughness).

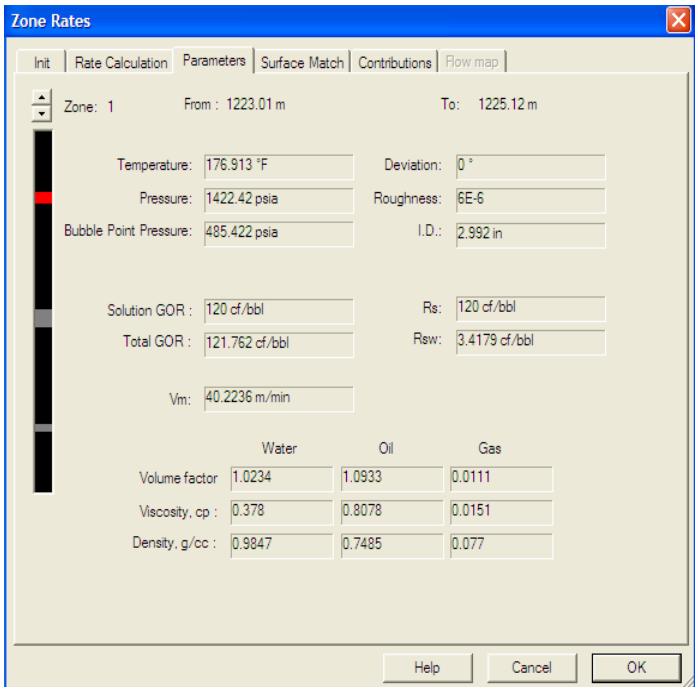


Figure 4.7(f): Parameters page

- Select “surface macth” tab button.

- In this dialog it is possible to enter the value of the surface rates (and their T & P conditions). The simulated rates are displayed and can be compared to the measured ones.
- The “Match Surface” option will computes the value of the Vpcf multiplier, and Vslip multiplier(s) in multiphase, to match the surface conditions, and the measured values. This option is enabled when surface rates have been entered, Temperature and Pressure are values are available on the top zone, and the rates on that zone are not null. Downhole rates are set to comply with the surface rates. A non-linear regression is then re-run on all zones with the new multipliers.
- 1 This button will reset the Vpcf multiplier and the Vslip multiplier(s) to for Vslip L-G and Vslip W-O in case of 3 phase with 2 slippage velocities. Affects all rate results. Vslip multiplier only: automatic improve for all zones, except top one- using the considered flow correlation. These two or three coefficients are applied to the Vpcf model and the current slip correlation(s). They are used for matching surface conditions. When not equal to 1, can be reset to 1 with the button beside them.

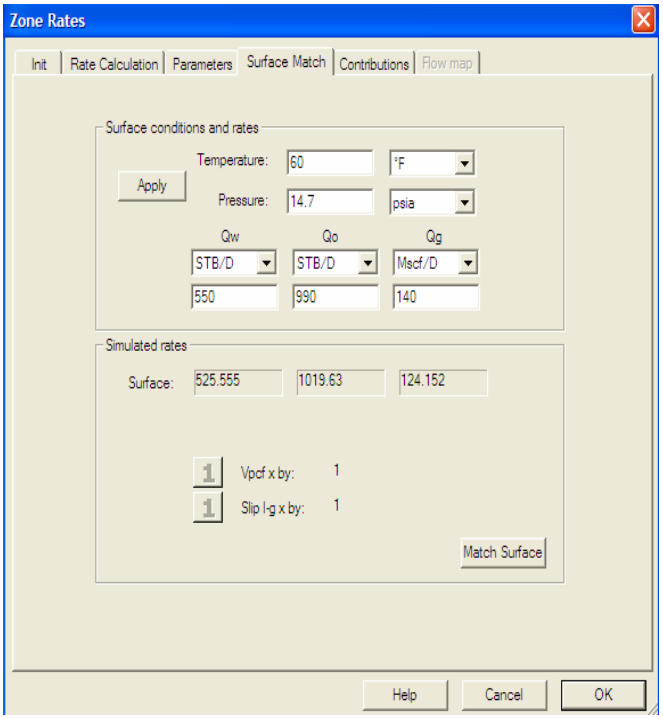


Figure 4.7(g): Surface match screen

- Click on “contribution” tab button.

- The Contribution dialog displays the value of the rate contributions, calculated for each inflow zones. The values can be edited directly inside the table, or a global regression can be called.

Global regression

- The global regression solves at once for the contributions (rather than cumulative rates) with the objective, not only to match the measurements, but also to satisfy some constraints. Emeraude never calls the global regression automatically.
- The possible constraints are Positive or Negative contribution, for each zone. Also, contribution values can be locked. Surface conditions can be included in the constraints, with a user-defined weight. Also, when Temperature is matched, the heat loss coefficient can be made a variable.
- Once the choices are made the global regression is called with the Global Improve option. Right after the run, the value of the final objective function is displayed below the Improve button.
- Constrained regression will provide local errors (i.e. at calculation zone level) larger than a local unconstrained regression. The match views can be used to visualize the fit on the logs. In extreme cases, imposed constraints might not be compatible with the data and the algorithm will give up after a few iterations.
- It is recommended to use Global Regression whenever the Temperature is matched. See Temperature.

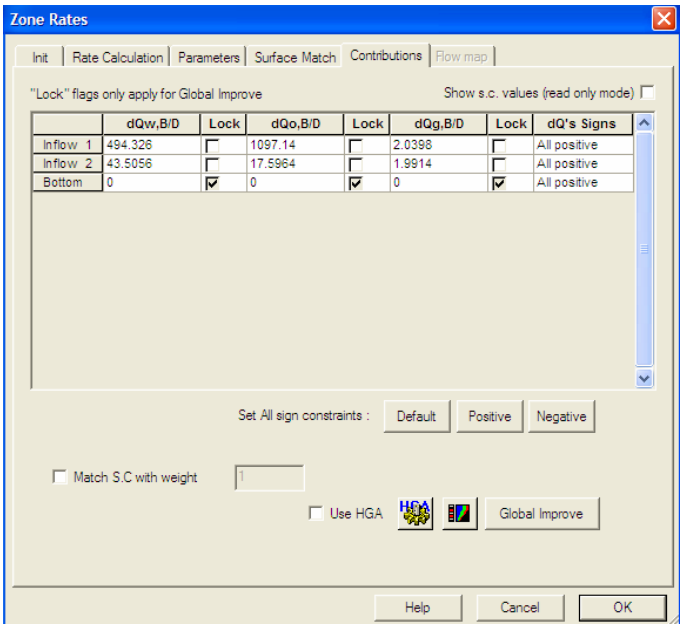


Figure 4.7(h): Contribution dialog

HGA

- It is possible to couple the Global Regression with a pre-processing called HGA, for "Hybrid Genetic Algorithm". This pre-processing is particularly suited at avoiding local traps or finding a better starting point for the regression. Access to HGA is enabled in the Interpretation option of the Settings panel. When enabled, the Global regression dialog shows 2 additional controls:

- A check box to use HGA in the next run (off by default)
- A button to view/edit the HGA parameters. *This should normally not be changed.*

- Click on “flow map” tab button.

- For Liquid-Gas models, it is possible to view the flow map describing the boundary between the considered flow regimes.
- The flow map is displayed as Vsh vs Vsl on log-log scale. The gray line on the plot is for Vsh + Vsl = Vm. The white triangle shows the current solution.
- It is possible to change the resolution of the flowmap with the Number of point button.
- Most Liquid-Gas models consider the flow regimes described by the figure 4.7(j).
- They provide a mean of calculating a flow map for the determination of the regime for a particular condition, together with slip or holdup correlation’s or each. Some models do handle near horizontal flow conditions and incorporate several additional regimes for stratified flow. Details are given in the corresponding section.

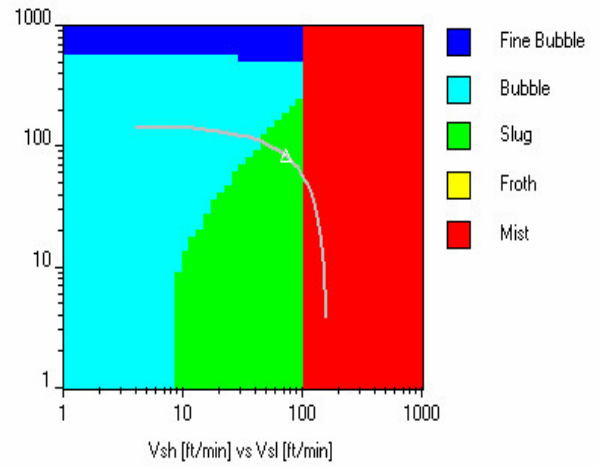


Figure 4.7(i): Flow map plot

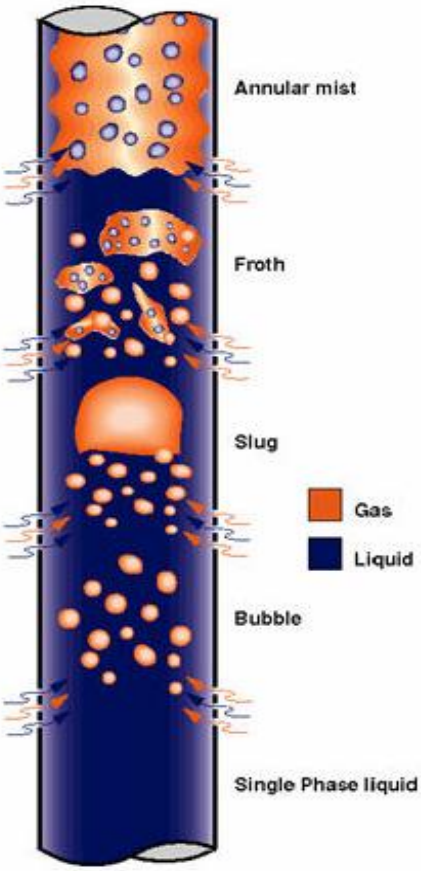


Figure 4.7(j): Flow regime models

- After all setting is OK and the rate calculation is reasonably reliable, validate the zones rate calculation with “OK”. The “Rate Log Settings” option of the control panel is called directly and the dialog in Fig. 4.7(k) appears.

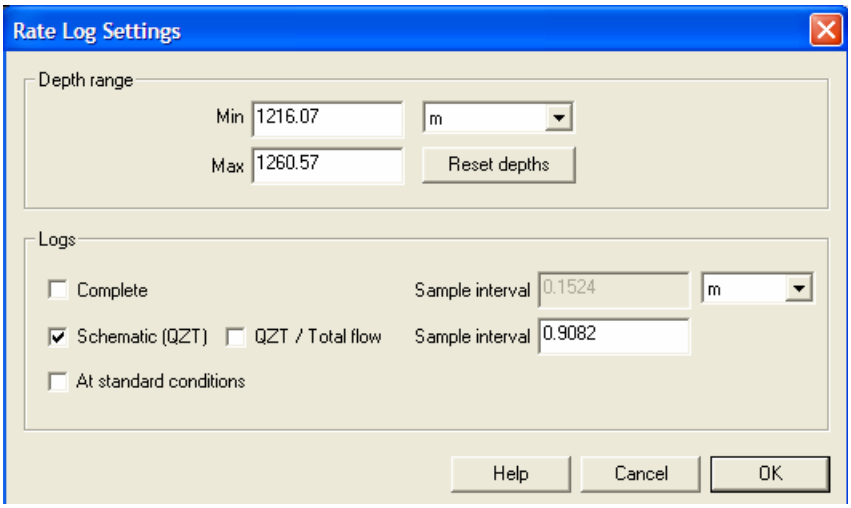


Figure 4.7(k): Rate log setting dialog

- Leave “Schematic” checked and uncheck “Complete”. Do not change the other settings. Validate with “OK”.
- Emeraude generates 4 new logs in the interpretation: QOZT, QGZT, QOZI, QGZI. “O” stands for oil and “G” for gas. “Z” stands for “zoned”. “T” stands for total (or cumulative) and “I” for incremental. Two plots are automatically added to the main screen, one for cumulative rates, and the other for incremental contributions. The simulated density, capacitance and velocity are added to the match plots as shown by figure 4.7(l) below.

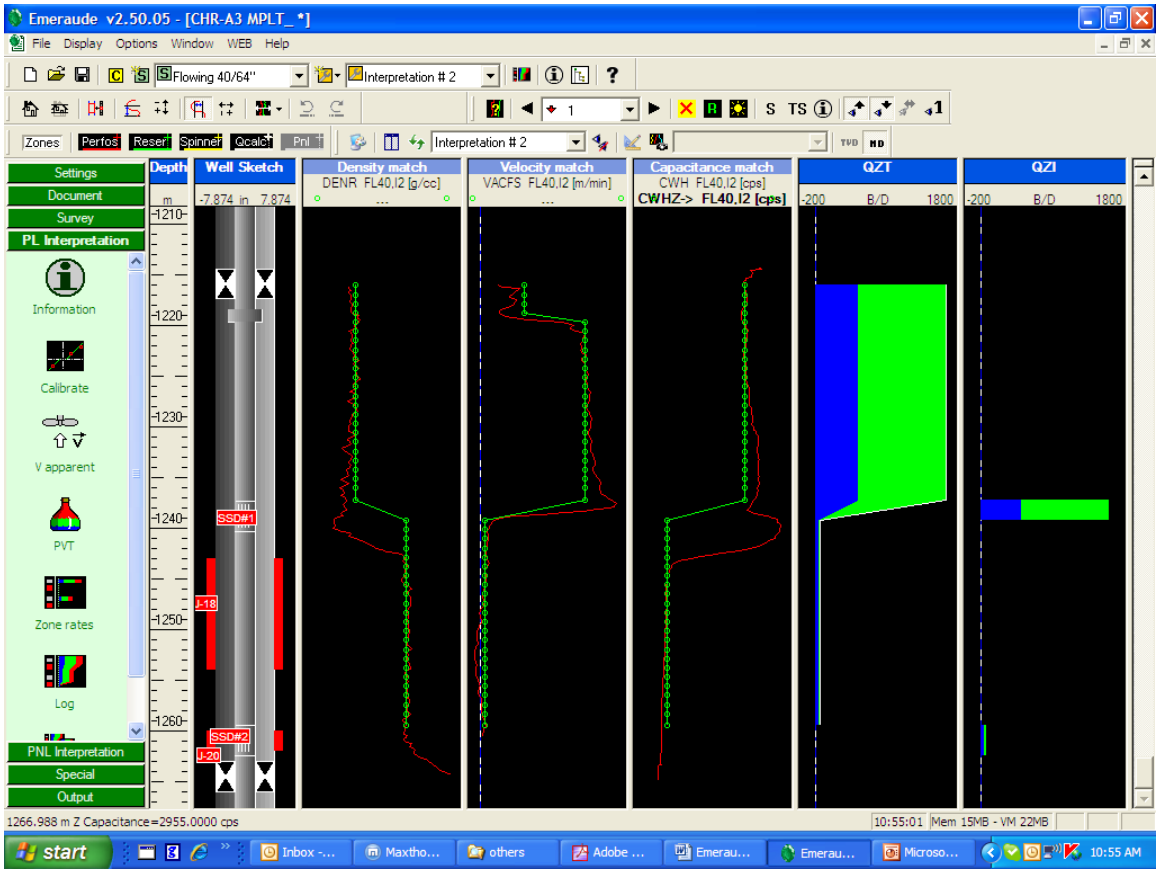


Figure 4.7(l): Velocity, density, capacitance match and production profile log generated from complete interpretation.

5 Outputs mode

5.1 Moves to the “output” page in the control panel. There are 5 possible types of outputs in Emeraude: Log, Report, Summary table, Export and MSWord report.

Log

The Log printout shows by default the plots present on the screen when the option is called. The Log output can be checked with the corresponding Preview option. Note that fonts, margins, lines, and the type of output can be changed in the “Setup” and the “Display” options of “Preview”. In the Setup dialog one can also create API layout that can be recalled at any later stage (see the on-line help in the Print Setup dialog). The log output is made by default to the installed printer drivers. Note that a CGM, or TIFF output can also be generated with the last option of the output panel (*the CGM output option is not part of the standard distribution*).

Report

The report consists of the following pages (depending on the level of the interpretation): Job Information, PVT, Calibration, Incremental zone contributions at S.C.; Incremental zone contributions at reservoir conditions; Cumulative zone contributions (standard and reservoir conditions); Detailed Results (multi-phase interpretation only). Use the Preview option to check the report.

Summary Table

Provides, in tabular format, the zones results. The results can be copied to the clipboard.

Export

Creates an output file (LIS, LAS, or plain ASCII) of the current interpretation contents. Note that export options in the data browser can be used to generate customized report files.

MSWord report

Emeraude is provided with a template Word report, “SampleReport.doc” which reproduces the Emeraude built-in report. With an opened document in Emeraude, open “SampleReport.doc”. At the top of the document, you will see the specific toolbar below: Assuming that your active Emeraude document shows a completed interpretation, click on the second icon (Reset Emeraude variables): all relevant information will be filled-in, rows will be added in all tables and completed, and a calibration plot will be created on page 3.