

V1.0

User Guide

Capacitance Resistance Modelling (CRM)

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DOCUMENT GOVERNANCE

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Overview

The **Capacitance Resistance Modelling (CRM)** module enables reservoir engineers to build, calibrate, and analyse Capacitance Resistance Models using historical production and injection data. The module estimates the connectivity between injectors and producers, evaluates production response, and visualises fluid flow behaviour to support reservoir surveillance and waterflood optimisation.

The CRM workflow consists of four primary stages:

- **Create CRM** – Configure a new CRM analysis by selecting the reservoir, defining calibration periods, choosing producer wells, and specifying modelling parameters such as Time Constant (τ), Connectivity Factor (λ), and Productivity Index (PI).
- **Run CRM** – Execute the CRM calculation using the configured parameters to generate the reservoir model.
- **Analyse Results** – Review the generated results through three analysis views:
 - **Production Fit** – Evaluates model performance using fit metrics (Weighted NRMSE, Median NRMSE, and P90 NRMSE) and compares actual versus modelled production trends.
 - **Connectivity** – Displays injector-to-producer connectivity strengths using charts, connectivity matrices, and time constant distributions.
 - **Spatial Network** – Visualises the connectivity network on an interactive map, illustrating the relationships between injectors and producers with configurable overlays and network gain settings.
- **CRM History** – Access previously executed CRM analyses, review execution status and performance metrics, reopen existing results, or remove obsolete CRM runs.

The CRM module provides an integrated environment for configuring, executing, and interpreting CRM analyses, enabling engineers to understand reservoir dynamics, evaluate injector-producer relationships, and support data-driven reservoir management decisions.

Definitions & Abbreviations

The following terms and abbreviations are used throughout this guide:

TERM	DEFINITION
CRM	Capacitance Resistance Modelling, the reservoir engineering method used by this module to estimate injector-producer connectivity from historical production and injection data.
NRMSE	Normalised Root Mean Square Error, a fit-quality metric describing how closely the CRM model matches actual production. Lower values indicate a better fit.
PI	Productivity Index, a measure of a producer well's ability to deliver fluids to surface for a given pressure drawdown.
τ (Time Constant)	Represents the characteristic delay between an injection event and its effect on a producer, expressed in months.
λ (Connectivity Factor)	Represents the strength of the flow connection between a given injector-producer pair.
UAT	User Acceptance Testing, the stage where end users validate the system against requirements before go-live.
SRS / URS	Software/User Requirements Specification, the requirements document produced earlier in the project lifecycle.

1. Access & Login

1.1 Login to CRM

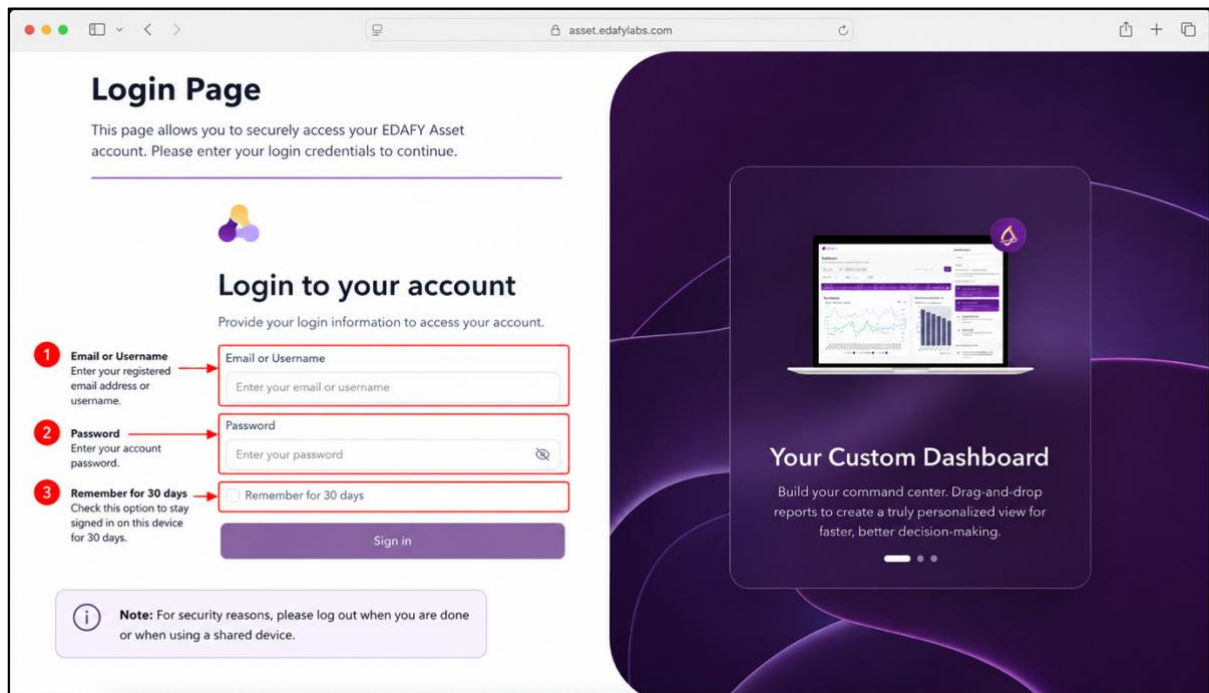


Figure 1. Login Page

Description:

The Login Page allows authorized users to securely access the Capacitance Resistance Modelling (CRM) Platform using their assigned credentials.

Steps:

1. Open the CRM Platform URL provided by the System Administrator.
2. Enter your Username or Email Address.
3. Enter your Password.
4. Click Sign In.

Expected Result:

The system authenticates the user credentials and redirects the user to the CRM Landing Page based on the user's assigned role and permissions.

Notes:

- Ensure your username and password are entered correctly.
- Passwords are case-sensitive.
- Click the Show Password (👁) icon to verify your password before signing in.
- If login fails, verify your credentials or contact the System Administrator for assistance.

- The features and data visible after login depend on the role and permissions assigned to your user account by the System Administrator. Contact the System Administrator if you need a password reset or a change to your access level.

2. Create CRM

2.1 Create CRM (Landing Page) Overview

2. After Successful Login
After you sign in successfully, you will be redirected to the CRM dashboard.

1 Overview
The dashboard provides all the tools and information you need to create, configure, and run Capacitance Resistance Models (CRM).

1 Sidebar Menu
Main navigation menu to access CRM modules and other system features.

2 Database Section
Displays available Reservoirs and Wells. Use "+" to expand and view the details or make selections.

3 Run CRM / Start Section
Displays the selected producers and provides the Start button to run the CRM calculation.

4 CRM Parameter Management
Create and manage CRM model details such as name, description, reservoir, producers, periods, time step, and injectors.

5 CRM Modelling Parameters
Configure modelling parameters for producers. You can fill in manually or click "Fill with defaults" to use default values.

6 Create CRM Tab
Active workspace to create a new CRM model.

7 Results Tab
View the results of completed CRM modelling.

8 History Tab
View previously executed CRM models and calculation history.

9 User Profile & Logout
Access your profile settings and log out from the system.

Capacitance Resistance Modelling (CRM)
Build and analyze capacitance resistance models

Database
Reservoirs: 1 +
Wells: 47 +

Ready to calculate
Producers: --

Create CRM
Name: e.g. ExampleCRM
Description: Describe this CRM model...
Select Reservoir*: -- Select a reservoir --
Select Producers*: -- Select producers --
Periods*: Add period
Period 1: Start End
Time Step: Daily Monthly
Select Injectors*: -- Select injectors --

CRM Modelling Parameters
Fill with defaults
PRODUCERS
☐ Use BHP
Select at least one producer to edit well parameters.

No.	Component	Description	Action / Notes
1	Sidebar Menu	Main navigation menu to access CRM modules and other system features.	Click the icon to expand/collapse the menu.
2	Database Section	Displays available Reservoirs and Wells.	Click "+" to expand and view or select items.
3	Run CRM / Start Section	Displays selected producers and provides the Start button.	Click "Start" to run the CRM calculation.
4	CRM Parameter Management	Create and manage CRM model details.	Fill in all required fields (*) to enable calculation.
5	CRM Modelling Parameters	Configure modelling parameters or use default values.	Edit values manually or click "Fill with defaults".
6	Create CRM Tab	Active workspace to create a new CRM model.	Currently selected tab.
7	Results Tab	View the results of completed CRM modelling.	Click to view calculation results and charts.
8	History Tab	View previously executed CRM models and calculation history.	Click to view past runs and details.
9	User Profile & Logout	Access your profile settings and log out.	Click avatar to open profile menu and log out.

Tip: Ensure all required fields (*) are completed in the CRM Parameter Management section before clicking Start.

Figure 2. CRM Landing Page (After Successful Login)

Description:

After successful authentication, users are redirected to the **CRM Landing Page**, which serves as the primary workspace for creating, configuring, executing, and reviewing Capacitance Resistance Models (CRM). The page provides quick access to the database, model configuration, modelling parameters, calculation execution, and historical results.

Steps:

1. Review the **Sidebar Menu** to access available CRM modules and navigation options.
2. Browse the Database section to view available **Reservoirs** and **Wells**.
3. The system defaults to the **Create CRM** tab, used to configure a new CRM model.
4. Complete the **CRM Parameter Management** section by entering:
 - a. CRM Name (Optional)
 - b. Description (Optional)
 - c. Reservoir
 - d. Analysis Period (Date)

- i. Add Period
 - ii. Remove Period
- e. Producers
- f. Injectors
- g. Time Step
5. Configure the **CRM Modelling Parameters** manually or click **Fill with defaults** to automatically populate recommended parameter values.
6. Verify that the selected producers are displayed in the **Ready to Calculate** section.
7. Click **Start** to begin the CRM calculation.
8. Navigate to the **Results** tab to review completed CRM analysis.
9. Navigate to the **History** tab to review previously executed CRM models.
10. Click the **User Profile** icon to access your profile options or **Log Out** of the system.

Expected Result:

The landing page is displayed successfully, allowing users to create and configure CRM models, execute calculations, review modelling results, access historical records, and manage their user session.

Notes:

- Fields marked with an asterisk (*) are mandatory and must be completed before starting the CRM calculation.
- The **Start** button is enabled only after all required information has been provided.
- The **Fill with defaults** buttons automatically applies recommended modelling parameters, which users may modify if necessary.
- **Time Constant (τ)** represents the characteristic delay between an injection event and its effect on a producer, expressed in months.
- **Connectivity Factor (λ)** represents the strength of the flow connection between a given injector-producer pair, ranging from 0 (no connectivity) to 1 (full connectivity).
- **Productivity Index (PI)** represents a producer well's ability to deliver fluids to surface for a given pressure drawdown.
- Users can switch between **Create CRM**, **Results**, and **History** tabs without leaving the CRM module.
- Click the **User Profile** icon to log out securely after completing your work.

3. Results

3.1 Results Tab (Production Fit)

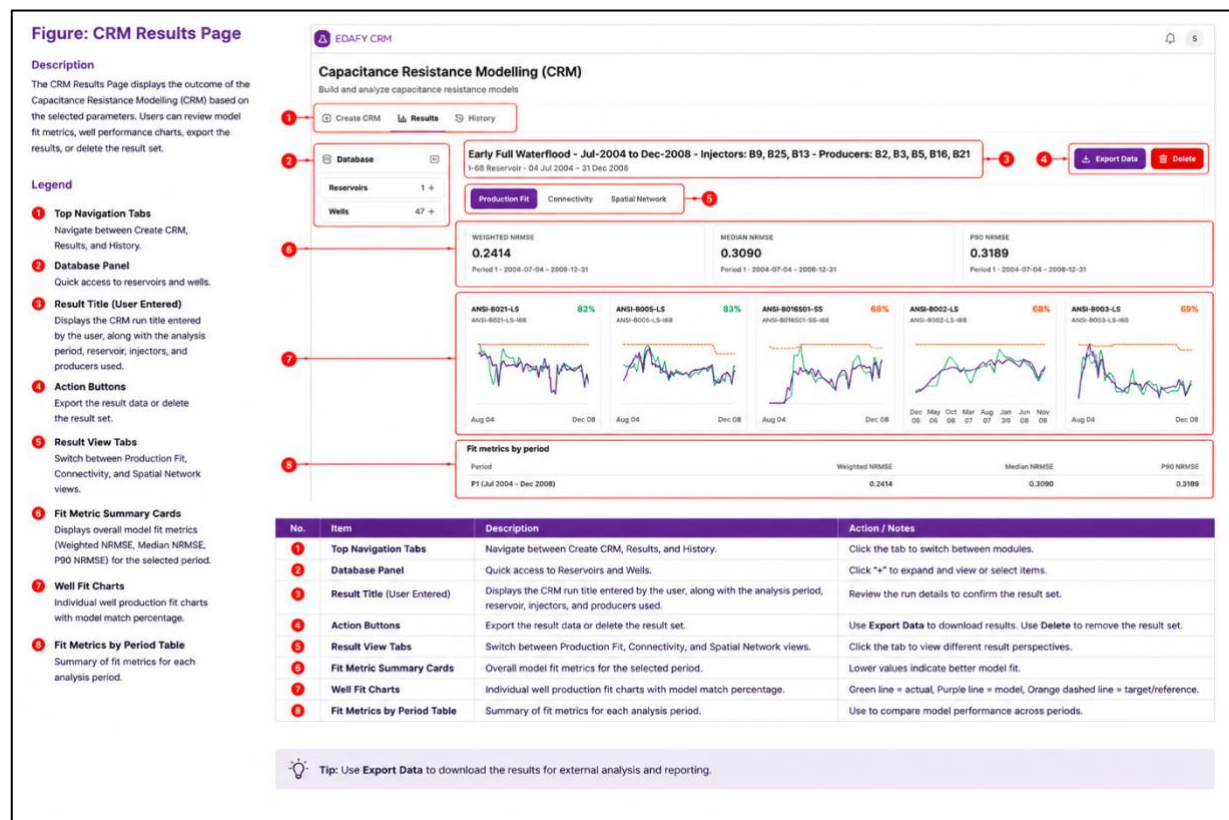


Figure 3. CRM Results Page

Description

The **CRM Results Page** displays the outcome of the Capacitance Resistance Modelling (CRM) analysis based on the configured parameters. Users can review model performance metrics, analyse production fit and connectivity results, compare well performance, export the results for further analysis, or delete the result set if no longer required.

Steps

1. Navigate to the **Results** tab to view completed CRM analyses.
2. Select the desired CRM result from the available list.
3. Review the **Result Title**, which displays the CRM name entered by the user together with the analysis period, reservoir, injectors, and producers included in the model.
4. (Optional) Click **Export Data** to download the CRM results for external analysis or reporting.
5. Select the desired **Result View**:

- **Production Fit** – Compare actual production against the CRM model prediction.
 - **Connectivity** – View connectivity relationships between injectors and producers.
 - **Spatial Network** – Visualise the spatial relationship and connectivity network of the selected wells.
6. Review the **Fit Metric Summary Cards**, which display the overall model performance, including:
 - Weighted NRMSE
 - Median NRMSE
 - P90 NRMSE
 7. Analyse the **Well Fit Charts** to compare actual production and model predictions for each producer well.
 8. Review the **Fit Metrics by Period** table for a summary of model performance across the configured analysis period(s).
 9. (Optional) Click **Delete** to remove the selected CRM result.

Expected Result

The system displays the CRM analysis results successfully, allowing users to evaluate model performance, review production fit, analyse connectivity between wells, export the results, or switch between different result views.

Notes

- The **Result Title** corresponds to the CRM Name entered during model creation and includes a summary of the selected reservoir, analysis period, injectors, and producers.
- Lower **NRMSE** values generally indicate a better model fit between the simulated and actual production data.
- The **Production Fit** charts compare actual production data against the CRM prediction for each producer well.
- The **Connectivity** and **Spatial Network** tabs provide alternative visualisations of the CRM analysis using the same calculation results.
- Use **Export Data** to download the results for reporting or further analysis outside the application.
- Clicking **Delete** permanently removes the selected CRM result from the system.

3.2 Results Tab (Connectivity)

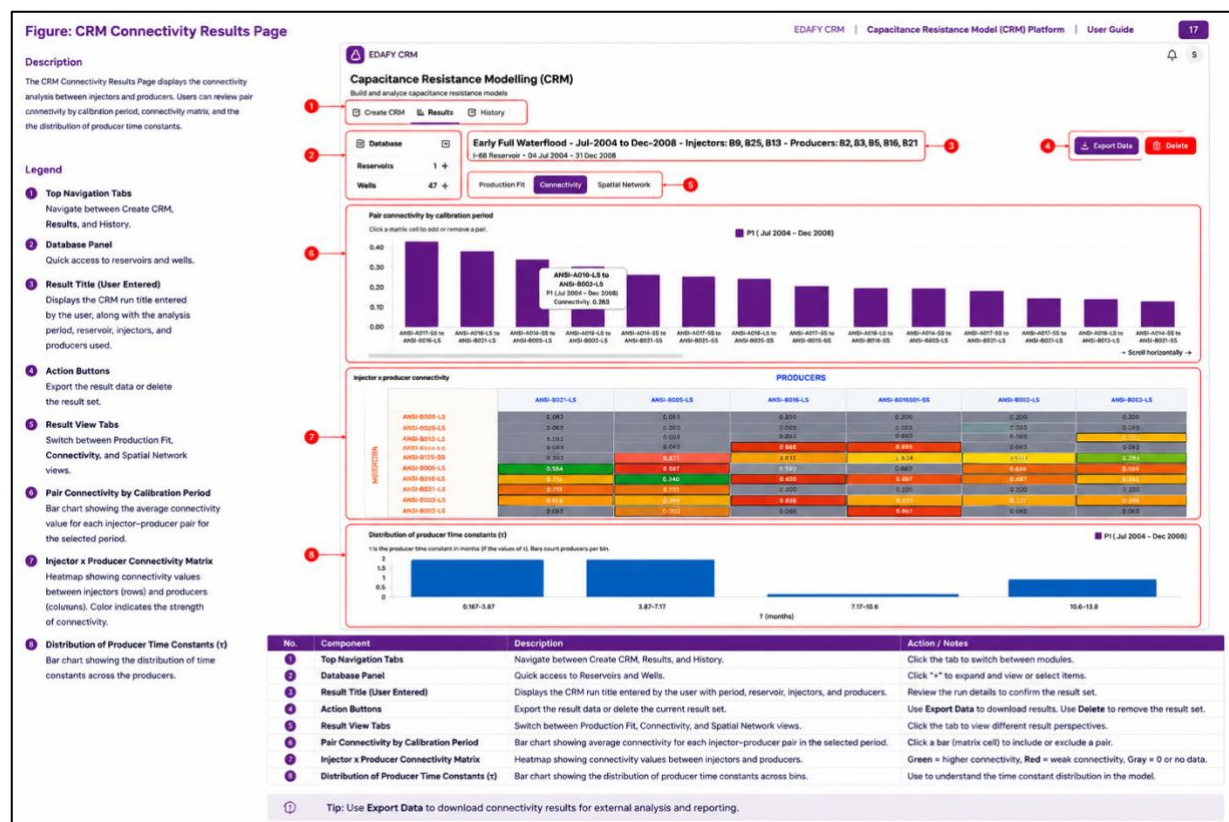


Figure 4. CRM Connectivity Results Page

Description

The **CRM Connectivity Results Page** displays the connectivity analysis generated from the Capacitance Resistance Modelling (CRM) calculation. Users can analyse the strength of connectivity between injectors and producers through graphical and matrix visualisations, review producer time constant distributions, and export the analysis results for further evaluation.

Steps

1. Navigate to the **Results** tab and select the **Connectivity** view, continuing from the CRM result selected in Section 3.1.
2. Review the **Result Title**, which displays the CRM name entered by the user together with the analysis period, reservoir, injectors, and producers included in the analysis.
3. Review the **Pair Connectivity by Calibration Period** chart to identify the strongest injector-producer relationships for the selected calibration period.
4. Review the **Injector x Producer Connectivity Matrix** to analyse the connectivity values between injectors and producers.
5. Interpret the colour-coded connectivity values to determine the relative strength of each injector-producer relationship.

6. Review the **Distribution of Producer Time Constants (τ)** to understand the distribution of producer response times within the CRM model.
7. (Optional) Click **Export Data** to download the connectivity analysis.
8. (Optional) Click **Delete** to remove the selected CRM result.

Expected Result

The system displays the connectivity analysis successfully, allowing users to evaluate injector–producer relationships, identify dominant flow influences, review producer time constant distributions, and export the results for reporting or further analysis.

Notes

- The **Connectivity** tab displays the interaction strength between injectors and producers calculated by the CRM model.
- Higher connectivity values indicate a stronger influence of an injector on a producer.
- The **Injector × Producer Connectivity Matrix** provides a consolidated view of all injectors-producer connectivity values for the selected analysis period.
- The colour scale in the matrix represents the relative magnitude of connectivity, enabling users to quickly identify stronger and weaker relationships, following the traffic light colours.
- The **Distribution of Producer Time Constants (τ)** illustrates how producer response times are distributed across the analysed wells.
- Use **Export Data** to download the connectivity results for further reporting or technical evaluation.

Figure: CRM Spatial Network Results Page

Capacitance Resistance Modelling (CRM)
Build and analyze capacitance resistance models

Description

The CRM Spatial Network Results Page visualises the spatial relationships between injectors and producers based on the CRM analysis. Users can explore connectivity strength, adjust the network display using the Gain control, and analyse the connectivity network through an interactive map.

Legend

- Top Navigation Tabs**
Navigate between Create CRM, Results, and History.
- Database Panel**
Displays the available Reservoirs and Wells for quick reference.
- Result Title (User Entered)**
Displays the CRM name entered by the user together with the selected analysis period, reservoir, injectors, and producers included in the model.
- Action Buttons**
Export the spatial network results or delete the selected result set.
- Result View Tabs**
Switch between Production Fit, Connectivity, and Spatial Network views.
- Gain Control**
Adjusts the connectivity gain to control the visibility and relative strength of the connectivity links displayed in the spatial network.
- Spatial Network Map**
Interactive map displaying the spatial locations of injectors and producers together with the connectivity relationships between them.

The screenshot shows the CRM Spatial Network Results Page. At the top, there's a title bar with 'Capacitance Resistance Modelling (CRM)' and a subtitle 'Build and analyze capacitance resistance models'. Below this is a navigation bar with 'Create CRM', 'Results' (selected), and 'History' tabs. A red box highlights the 'Results' tab. On the left, there's a 'Database' panel with 'Reservoirs' (1) and 'Wells' (47). A red box highlights the 'Reservoirs' section. The main content area shows the 'Early Full Waterflood - Jul-2004 to Dec-2008 - Injectors: B9, B25, B13 - Producers: B2, B3, B5, B16, B21' result. A red box highlights this title. Below the title, there are tabs for 'Production Fit', 'Connectivity', and 'Spatial Network' (selected). A red box highlights the 'Spatial Network' tab. Below the tabs, there's a 'Gain' control set to 0.05, and buttons for 'Network', 'Porosity', 'Permeability', and 'Upload overlay'. A red box highlights the 'Gain' control. On the right, there are buttons for 'Export Data' and 'Delete'. A red box highlights the 'Export Data' button. The main map area shows a spatial network of injectors (blue triangles) and producers (gray circles) connected by lines representing connectivity. A red box highlights the map area. At the bottom, there's a table with 7 columns: No., Component, Description, and Action / Notes. The table lists the components of the interface and their functions. A red box highlights the table.

No.	Component	Description	Action / Notes
1	Top Navigation Tabs	Navigate between Create CRM, Results, and History.	Click the tab to switch between modules.
2	Database Panel	Quick access to Reservoirs and Wells.	Click "+" to expand and view or select items.
3	Result Title (User Entered)	Displays the CRM run title entered by the user with period, reservoir, injectors, and producers.	Review the run details to confirm the result set.
4	Action Buttons	Export the spatial network results or delete the current result set.	Use Export Data to download results. Use Delete to remove the result set.
5	Result View Tabs	Switch between Production Fit, Connectivity, and Spatial Network views.	Click the tab to view different result perspectives.
6	Gain Control	Adjusts the connectivity gain to control the visibility and relative strength of links.	Slide the control to increase or decrease gain (2 value). Blue triangles = injectors. Gray circles = producers. Blue line thickness indicates connectivity strength.
7	Spatial Network Map	Interactive map showing spatial locations of injectors and producers and their connectivity links.	

Tip: Use the **Gain** control to filter connections. Increase the gain to focus on stronger connectivity links, or decrease it to display more connections.

Description

Steps

1. Navigate to the **Results** tab and select the **Spatial Network** view, continuing from the CRM result selected in Section 3.1.
2. Review the **Result Title**, which displays the CRM name entered by the user together with the analysis period, reservoir, injectors, and producers included in the analysis.
3. Adjust the **Gain** value to control the visibility and strength of the displayed connectivity links.
4. Select the desired network display option (**Network**, **Porosity**, or **Permeability**) as required.
5. (Optional) Upload an overlay map to provide additional geographical context.
6. Explore the **Spatial Network Map** to analyse the connectivity relationships between injectors and producers.
7. Use the **Zoom in** and **Zoom Out** controls to navigate the map.
8. (Optional) Click **Export Data** to download the spatial network results.
9. (Optional) Click **Delete** to remove the selected CRM result.

Expected Result

The system displays the spatial distribution of injectors and producers together with their connectivity relationships, allowing users to visualise flow influence and analyse the connectivity network across the reservoir.

Notes

- The **Gain** control adjusts the visibility and relative strength of the displayed connectivity links.
- Blue triangles represent **Injectors**.
- Grey circles represent **Producers**.
- Blue connection lines indicate connectivity between injectors and producers.
- Thicker connection lines represent stronger connectivity in the map.
- Users can zoom and pan the map to inspect specific wells or connectivity relationships.
- The **Network**, **Porosity**, and **Permeability** options provide different visualisation layers for analysing the reservoir.

3.4 Results Tab (Export Data)

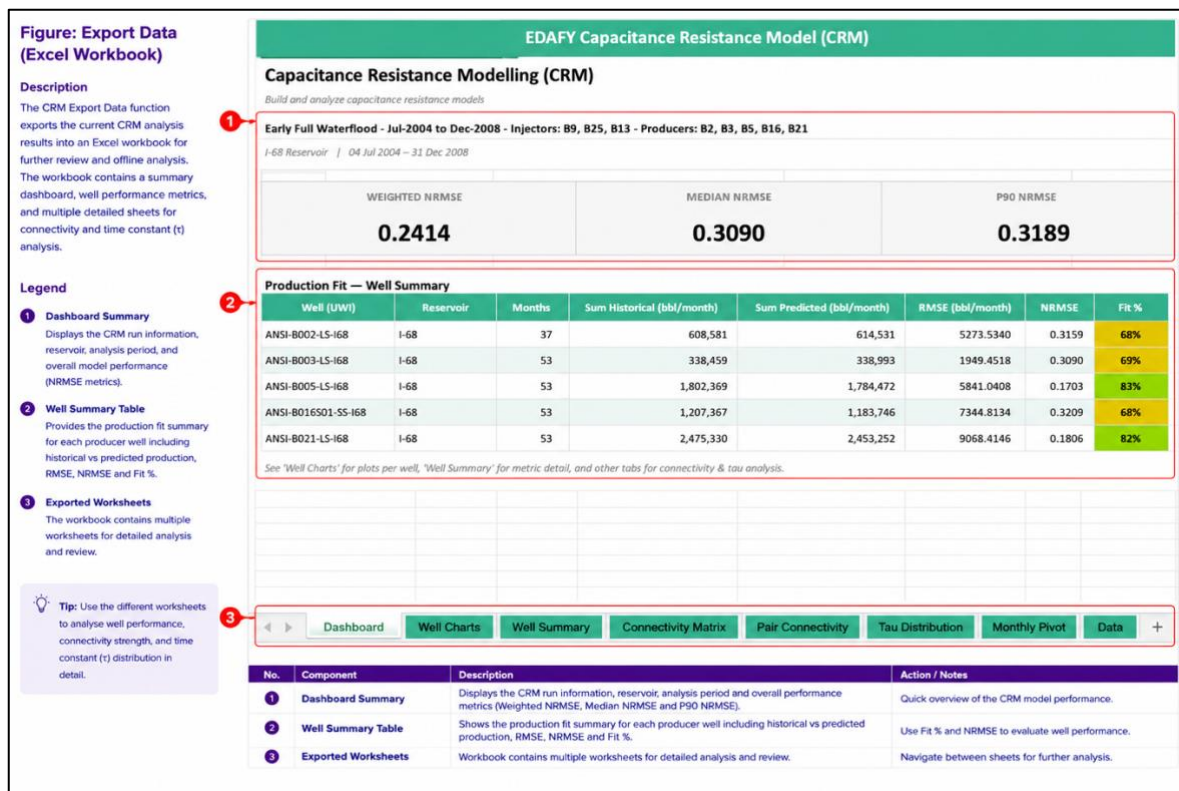


Figure 6. Export Data (Excel Workbook)

Description

The **Export Data** function allows users to download the CRM analysis results into a Microsoft Excel workbook for offline review, reporting, and further analysis.

Steps

1. Navigate to the **Results** tab after a CRM analysis has completed successfully.
2. Click **Export Data**.
3. The system generates and downloads the CRM results as an Excel workbook (.xlsx).
4. Open the downloaded workbook using Microsoft Excel or another compatible spreadsheet application.
5. Review the workbook summary and navigate between worksheets for detailed analysis.

Expected Result

The system downloads an Excel workbook containing the complete CRM analysis, including summary metrics, well performance statistics, connectivity analysis, and supporting datasets for further review.

4. History

4.1 CRM Run History

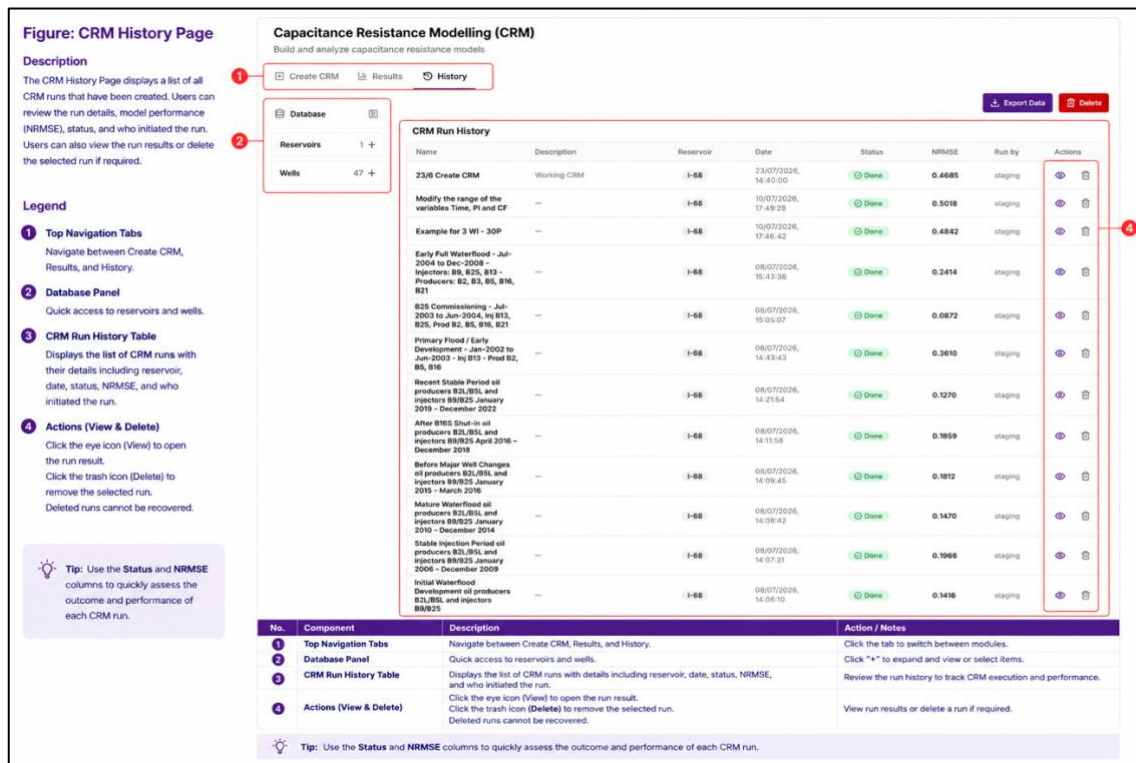


Figure 7. CRM History Page

Description

The **CRM History Page** displays a list of all previously executed CRM runs. Users can review the details of each CRM execution, including the CRM name, description, reservoir, execution date and time, execution status, model performance (NRMSE), and the user who initiated the run. Users can also open previously generated CRM results for further analysis or delete CRM runs that are no longer required.

Steps

1. Navigate to the **History** tab.
2. Browse the list of previously executed CRM runs.
3. Review the CRM run information, including:
 - CRM Name
 - Description
 - Reservoir
 - Execution Date and Time
 - Status
 - NRMSE
 - Run By

4. Click **View** to open the selected CRM result.
5. (Optional) Click **Delete** to permanently remove the selected CRM run from the history.

Expected Result

The system displays the complete CRM execution history. Users can review previous CRM runs, open existing results for further analysis, or delete obsolete CRM records.

Notes

- The **Status** column indicates whether the CRM execution completed successfully or failed.
- The **NRMSE** column provides a summary of the model performance for each CRM run.
- Clicking **View** opens the selected CRM result using the same result pages available after a successful CRM execution.
- Deleting a CRM run permanently removes it from the system and cannot be undone.
- The history list is ordered by the CRM execution date, allowing users to quickly locate recent analyses.

5. Troubleshooting

This section lists common issues encountered when using the CRM module, along with their likely causes and recommended resolutions.

ISSUE	POSSIBLE CAUSE	RESOLUTION
CRM run fails immediately after clicking Start	One or more mandatory fields (marked *) were left empty, or no producers/injectors were selected.	Return to the Create CRM tab and verify all mandatory fields are completed before clicking Start.
Execution status shows “Failed” in the History page	The selected analysis period may not overlap with the available production/injection data for the chosen wells.	Adjust the analysis period or reservoir selection and re-run the CRM calculation.
Fit metrics (NRMSE) are unexpectedly high	The modelling parameters may not suit the reservoir's connectivity behaviour.	Try Fill with defaults, or adjust Time Constant, Connectivity Factor, and Productivity Index manually, then re-run.
Export Data download does not start	A browser pop-up or download blocker may be preventing the file download.	Check your browser's download settings and permissions, then click Export Data again.
Cannot log in despite correct credentials	The account may not yet be provisioned, or the password may have expired.	Contact the System Administrator to verify your account status or reset your password.