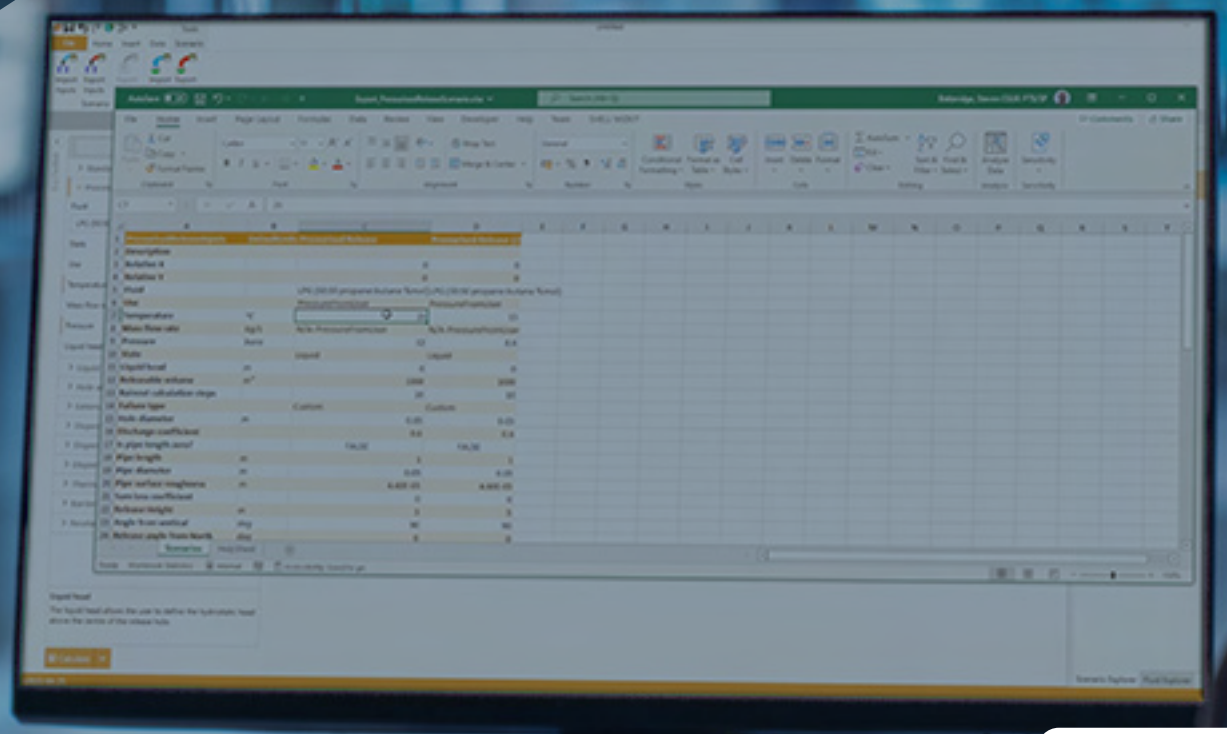
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Shell FRED 2023 Release Notes

A summary for the changes to FRED for v2023
June 2023



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FRED

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Shell FRED 2023 Release Notes

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Executive Summary

This release note documents the changes in V2023 of the FRED major hazard consequence software. This update includes some small modifications to the underlying science, including more realistic modelling of the dispersion of liquid hydrogen. There are two more significant updates to the user interface; the map view can now be connected to Bing and Open Street View and a facility to export and import scenario inputs to and from Excel has been implemented. This release note will also summarise several smaller enhancements to the user interface, as well as bugs that have been fixed in this release.

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1. Introduction

This release note documents the modifications to the FRED major hazard consequence software since the release of FRED 2022. The focus for this update is enhancements to the user interface to improve the usability of the software. The main enhancements are:

- Scenario Input import / export.
- Connection to geographic satellite views for background mapping
- Batch export of scenario results
- Improvements to variant operations
- SCOPE model representation

This update also includes several smaller changes to the underlying science. These changes include:

- Improved modelling of liquid hydrogen (H2) dispersion
- More realistic modelling of low vapour pressure fluids in pool fire scenario
- Calculation of receiver results for finite duration dispersion

This release note will also describe several smaller enhancements to the user interface that have been implemented in FRED 2023, as well as several bug fixes to the user interface and associated science models.

2. Science Updates

2.1 Modelling Liquid Hydrogen

Several changes were made to the thermodynamics models in AEROPLUME to improve the dispersion of liquid H2. These changes include:

- Adding two additional components to represent oxygen and nitrogen rather than the original “air” species, which was never designed to be condensable. This change enabled the latent heat of vaporisation of oxygen (O2) and nitrogen (N2) to be factored into the overall enthalpy of the dispersing plume.
- The vapour heat capacity of H2 was made a function of temperature; this was necessary to adequately predict the density of hydrogen/air mixtures even in the absence of air condensation
- The vapour pressure curves for water (H2O), and O2 and N2 in air were altered at extremely low temperatures essentially to avoid divide by zero errors.

These changes were applied generically to the AEROPLUME momentum dispersion model but will not affect the dispersion of other fluids in FRED, which will always have temperatures higher than the boiling point of O2 and N2.

2.2 General improvements to Dispersion

Two additional improvements were made to the release / dispersion models. These changes were also required for modelling liquid H2, but also improve the modelling of other fluids. These changes were:

- An update to the thermodynamics to give a better match between the liquid fraction at the expanded source and the value used as a source term in AEROPLUME.
- An improvement to the resolution of results in the near field and has the biggest impact when the plume extends less than 20 m.

2.3 Update Pool Fire Scenario for Low Vapour Pressure Fluids

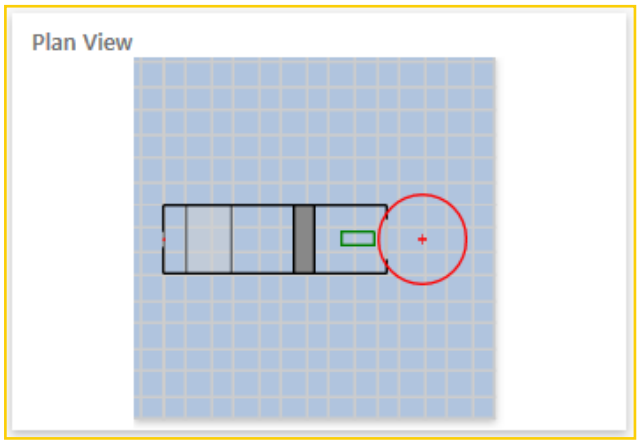
Adjust calculation of molecular weight in mixtures to ensure that only the fluid components with a measurable heat of combustion are included in the correlation based upon molecular weight.

2.4 Receiver calculation for finite duration dispersion

The finite duration dispersion sub-model can now be connected to receivers to determine the time to reach the chosen concentration and the toxic dose and % fatality if the released fluid is toxic.

2.5 Updates to SCOPE Scenario

The physical size and arrangement of the SCOPE module can now be visualised as a scaled representation as both a plan and side view perspective. This enhancement will help users to visualise if the module has been setup correctly, as well as highlight if features are overlapping (e.g., congestion and side vents) and hence if they will impact the calculations of internal and external overpressures.



A second improvement is that the radius of the external overpressure can now be displayed as an overlay on the map.

2.6 Improved Consistency in Use of Stoichiometry in CAM

The use of stoichiometry in the CAM scenario has been modified to follow the approach used in FRED 7.1 where a value of 1.0 was used. This means that in FRED 2023 new CAM scenarios will, by default, use a stoichiometry of 1.0. Although this is technically not the worst case, the reality is that the concentration across a congested volume within an actual release is likely to be highly variable and so using the maximum stoichiometry was considered an unrealistic precision. However, this modification does not stop the user selecting an alternative stoichiometry if this is required and, in addition, the value will also be set to a user defined stoichiometry when loading CAM scenarios saved in FRED 2020 and FRED 2022, to ensure that FRED 2023 gives the same predicted overpressure.

2.7 Minor Changes

- The absolute limits for minimum jet fire lengths have been reduced based upon the H2 jet fire experiments with a frustrum length smaller than 0.5 m.
- The absolute limit for lower process temperature in the Two-Phase Blowdown scenario has been reduced to -50°C to extend the model for some CCS cases.

3. Changes to User Interface

3.1 Import/Export Scenario Inputs

Functionality to export all the inputs of a scenario to Excel is now available in FRED. This functionality has been implemented for the following scenarios: Pressurised Release, Pool Fire, CAM, Gas Jet, Dense Gas, Vessel Burst, BLEVE.

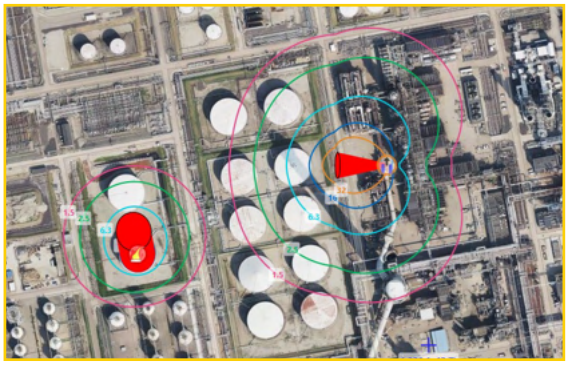
In the Excel sheet, each scenario is displayed in a separate column to enable either data assurance of each scenario, or modification of the input values so that they can be reimported back into FRED and hence allow the bulk update of scenarios.

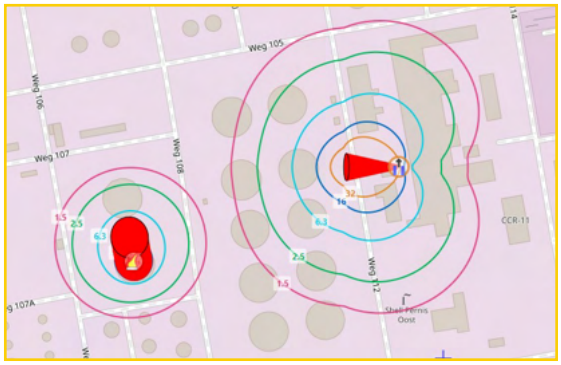
	A	B	C	D
1	PressurisedReleaseInputs	DefaultUnits	Stream 1	Stream 2
2	Description			
3	Relative X		0	0
4	Relative Y		0	0
5	Fluid		LPG (50:50 propane:b	Propane
6	Use		PressureFromUser	PressureFromUser
7	Temperature	°C	15	5
8	Mass flow rate	kg/s	N/A-PressureFromUs	N/A-PressureFromUs
9	Pressure	bara	8.6	12
10	State		Liquid	Liquid
11	Liquid head	m	0	0
12	Releasable volume	m^3	1000	1000
13	Rainout calculation steps		10	10
14	Failure type		Custom	Custom
15	Hole diameter	m	0.05	0.01
16	Discharge coefficient		0.6	0.6
17	Is pipe length zero?		FALSE	TRUE
18	Pipe length	m	1	0
19	Pipe diameter	m	0.05	0.05
20	Pipe surface roughness	m	4.60E-05	4.60E-05

The import/export functionality also allows new scenarios to be created, using the exported scenarios as a template.

3.2 Interface with satellite backgrounds

Scenarios and their consequences can now be superimposed onto satellite images using Bing or Open Street Map as demonstrated below. The Bing background also includes the facility to search for specific location to quickly find locations, alternatively the latitude / longitude controls under File | Info can be modified to reset the location of the site coordinates to the desired global location.





The satellite backgrounds are also integrated with the background map functionality to allow imported background map files to be superimposed on the satellite background.

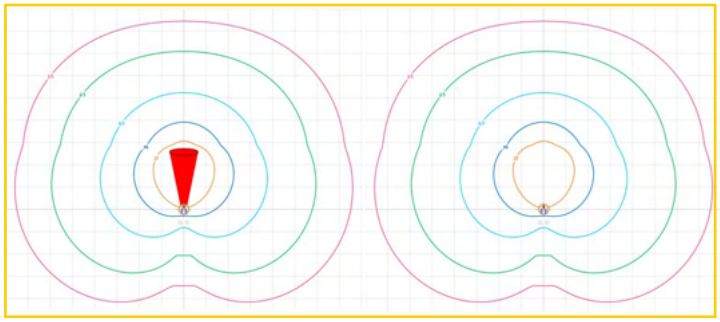
3.3 General updates to background maps

Along with the new functionality to display satellite backgrounds, there have also been improvements more generally to the background map functionality.

- It is possible to change the opacity of the loaded background map; either to make the hazard consequences or satellite background easier to visualise.



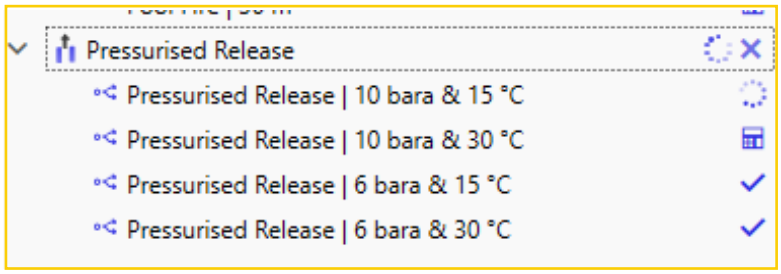
- DXF format files can now be loaded as a background image.
- FRED 2023 has a new functionality to allow the user to hide the jet fire frustrum or pool fire flame to emphasise the thermal radiation contour values.



3.4 Enhancements to Variants

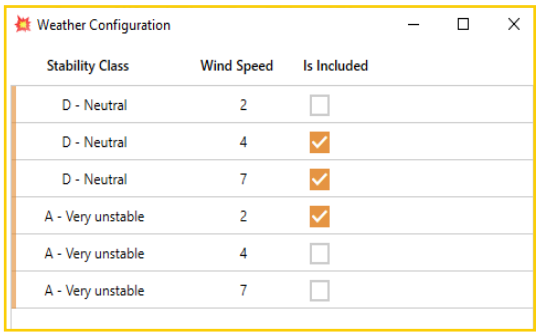
The following enhancements have been implemented for the variant functionality:

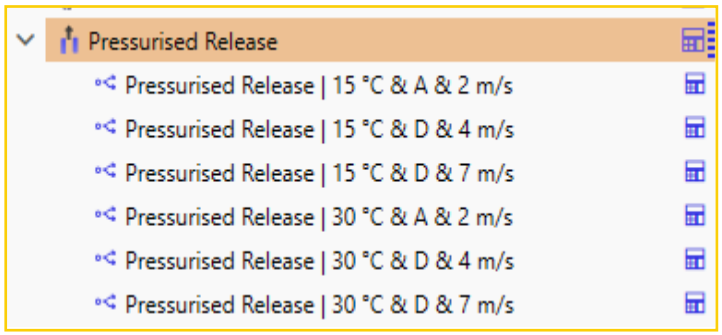
- Cancel variant calculation. It is now possible to cancel a series of variant calculations by selecting the 'X' adjacent to the parent scenario. This is useful if the user realises that they need to make a change to the inputs.



- The usability of the vertical scroll bars in charts, showing results for variants such as dispersion or thermal radiation results, has been modified so that the user does not accidently minimise the chart when selecting alternative values.

- It is now possible to specify specific weather combinations within variants of Pasquill stability class and wind speed. This enables users to limit variant calculations to the relevant weather combinations.



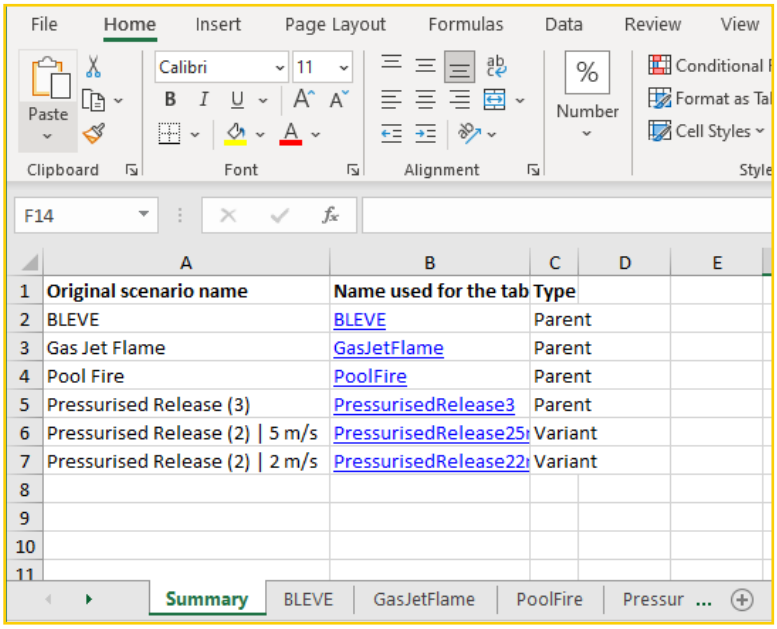


3.5 Updates to results and reports

The following enhancements to display results have been implemented:

- Functionality to export results from multiple scenarios to Excel if the user wants to manipulate the results outside FRED. This functionality will work for all scenario types. The results for each scenario are given on separate worksheets and are listed on a summary sheet that indicates whether the scenario is a variant scenario. The summary sheet also provides a hyperlink to the worksheet to provide easier navigation to the potentially many worksheets.

  The chart images can also be generated through this functionality if an option in File | Settings is enabled.



- Reports can now be generated in HTML format, instead of Word or PDF.
- The jet fire and dispersion results in the PRV scenario can now be exported in a 3D file format.
- The Combine Results functionality has been modified. This means that selecting multiple scenarios will no longer automatically combine the results and instead the user will need to press the combine results button (which can now be added to the Quick Access toolbar – see later). The functionality to automatically combine results can be re-enabled via an option in File | Settings.

3.6 File I/O

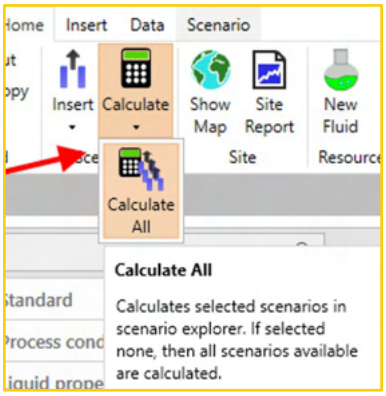
The list of enhancements to the File I/O of FRED are listed below.

- It is now possible to open a .fred file by selecting the file in Windows File Explorer and dragging the file into the FRED work area.
- Files created in FRED 6.0 and 6.1 (with a file extension .fr6) can now be opened in FRED 2023.
- The error handling for files that have been corrupted has been improved.
- The default name for an exported fluid in the Pressurised Release scenario has been modified to be based upon the scenario name, rather than the fluid name. The fluid name can be re-selected via an option in the File | Settings.

3.7 Improved usability

Several smaller enhancements were also implemented to improve the usability and workflow of FRED. They are:

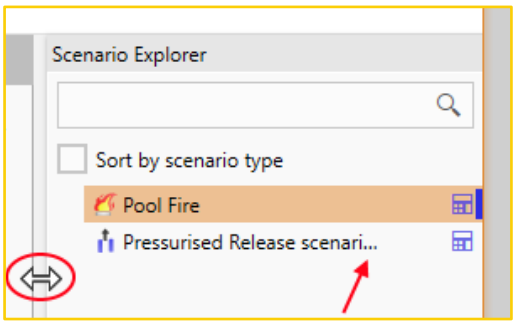
- Added a “Calculate all” button. This serves two purposes, it will calculate (i) all scenarios if no scenarios are selected, or (ii) only selected scenarios.



- An option has been added to File | Settings to allow the user to delete all local project fluids that are stored on the users PC. This will be useful if a user has built up a large collection of fluids for a specific project and wants to move to a different project and wants to focus on the new project.

- New functionality has been added to the Quick Assess Toolbar. Up to five shortcuts can now be added, including “map”, “combine results”, “dashboard” and “display help”

- The display of long scenario names in the Scenario Explorer is now dynamic to ensure the calculate/rename/delete buttons are always available. The full name can be visualised by making the window wider or viewing the tooltip by hovering over the scenario. The same improvement has also been implemented in the Fluid Explorer window.



- Improved error handling for multiple receivers. Previously if one receiver generated an error, then no receiver results were shown. In FRED 2023, the results for all successful receivers are always shown and the user is informed which receivers failed to calculate.

- The Scenario Name of a receiver can now be shown on a map.

4. Bug Fixes

4.1 User Interface – General

- Fixed problem where the user inputs become read only and could not be edited. This could occur if a scenario was opened as a permanent tab and at least one input value was modified. When the tab was closed and reopened, the values could be changed. The workflow always allows the input values to be editable.
- Fixed issue where the custom order of panels in the dashboard was reset when a scenario was calculated or after updating the global units.
- Resolved issue with calculation status of a Pool Fire scenario, which could remain in a permanent calculation state. This could occur in previous versions of FRED if the user pressed calculate after defining invalid input values corresponding to a circular pool and then selected a rectangular pool shape.
- The colour palette of 3D contours generated for Pool Fire scenarios was updated to match the colour palette used in its chart.
- Corrected the release location for the 3D representation of a Pressurised Release dispersion model, which was incorrectly set for some input configurations.
- Included concentration units in the top view chart when modelling pool dispersion in the Pressurised Release scenario that were missing in previous versions of FRED.
- Corrected legend for toxic fatality top view when modelling a toxic release in a finite duration dispersion model within the Pressurised Release scenario. Percentage fatality values smaller than 1%, such as 0.1% were rounded down to 0%.
- Ensured that the side (or top view) chart is shown even if the other chart cannot display data, for instance because the contour height is set too high.
- Fixed bug where the contour values on the map are not updated if the unit is changed, e.g. from kW/m2 to BTU/hr/ft2.
- Corrected display of dispersion contour values generated from Pressurised Release scenario that occurred within the map view after specific workflow that included changing global units.
- The methodology for scaling and offsetting background map files when the units are changed to feet rather than metres was improved in FRED 2023.
- Fixed issue where receiver results were not available in CAM when modelling with specific standard fluids.
- Resolved problem when importing a custom fluid where at least one of the components had a fraction = 0. In FRED 2023, components with a fraction of 0 are now skipped.
- Fixed crash that occurred when importing a custom fluid when a component was defined more than once. FRED will now report an error message.

- Improved the selection of custom fluids in a scenario after closing and reopening a scenario tab. In FRED 2022, the modified fuel was sometimes not remembered, and the original fuel was used in the calculation.
- Fixed bug introduced into FRED 2022, where standard fluids, such as crude oil, natural gas could not be copied.
- Fixed bug where an input in a table was not classified as “modified”. This affected PRV inputs in the Heat up Scenario and structure inputs in Temperature Rise Scenario.
- Improved the display of congestion level in the CAM Scenario. In FRED 2022, the congestion could be modified to show level 5 and although this was reset to the maximum value of 4 during calculation, it was confusing to the user why a higher value appeared to be selectable.
- Implemented internationalisation for vertical height and lateral distance associated with thermal radiation to allow the decimal separator to be represented as a ‘,’. This change was missed in the FRED 2022 release.
- Resolved crash that occurred when calculating a variant Pressurised Release scenario where one of the variants did not generate dispersion data.
- Resolved crash when using the finite duration dispersion model in Pressurised Release scenario. It is now possible to change the mass units for release inventory when the inventory is less than 1 kg.
- Improved data validation for plume travel times to ensure that only integer values can be defined. This avoids duplicate travel times being internally stored as the user defined numbers are rounded to a whole number.
- FRED 2023 will now display the dose level units correctly if the dose /fatality is defined to use ppm instead of mg/m3.
- Ensured that the legend for top view dispersion contours is always displayed in ascending order.
- Added unit conversion routines to the result panels in SCOPE that were not included in the release of FRED 2022.
- Fixed synchronisation between ribbon tool bar and right click scenario menu when selecting option to display hazard contours
- Line breaks in a scenario description are now displayed correctly after loading .fr7 files.
- Improved error trapping in scenario description input control to avoid FRED crashing if using invalid characters within the input.
- Fixed crash that occurred when a Pressurised Release scenario was connected to two or more receivers and the length units were changed.
- Fixed crash that could occur when a user modified a scenario’s inputs before all associated receivers had finished calculating.
- Removed misleading information in summary panel when Receivers are connected to a rectangular pool fire. Only maximum radiation is calculated for a Receiver connected to the Trench Fire sub-model

- Removed “Physical area” overlay option when a Receiver object is selected. A receiver does not have a physical area associated with it. Similarly, the calculate button shown against Receivers in the Scenario Explorer has been removed to avoid confusion.

- The receiver distance shown in the Receiver group of a Scenario input window are now shown correctly when the user modifies the global units from metres to feet.

4.2 Science

- Fixed crash in the Unified Scenario, when a user selected the option to use a bunded area.

- Corrected the Jet Fire methodology that is used for releases of H2S, ethanol, methanol and CO, so that it now uses the generalised jet fire model, rather than Sandia jet fire correlation that was implemented for H2 releases.

- Fixed numerical error issue in BLEVE where the calculated vessel and flash overpressure values were reported as infinite and hence caused FRED to crash. This occurred for a very small sub-set of cases that were dependent on a specific set of input values.

- Improved the error checks when modelling a release in the Unified Scenario to avoid starting the transient pool sub-model when the fluid is a vapour. FRED now shows an appropriate calculation message.

- Fixed issue in finite duration dispersion where concentration can exceed 100% within a few metres of orifice.

5. Backwards Compatibitlity

FRED 2023 will load files created using FRED 6, 7 or versions of FRED created using the new user interface: FRED 2020 and FRED 2022.

If files are saved in older versions of FRED, these can be loaded into FRED 7.1.1 and saved as .fr7 files to make them compatible with FRED 2023. Please contact the helpdesk to request support if FRED 7.1.1. is not available.

Bibliographic Information

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About Shell

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