Kenexis® Consequence Modeling

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1 Introduction

1.1 About Kenexis Consequence Modeling

Kenexis Consequence Modeling is the consequence modeling module of the Kenexis Integrated Safety Suite (KISS). It is a browser-based, multi-user application for quantifying the physical effects of loss-of-containment events at process facilities: how fast material escapes, how far a flammable or toxic cloud travels, and how much thermal radiation or blast overpressure reaches people and equipment. Typical uses include facility siting studies, quantitative risk assessment support, emergency planning, and documenting the consequence severities used in PHA and LOPA studies.

A Kenexis Consequence Modeling study is organized around sources — the process streams that can lose containment — and cases, the individual scenarios evaluated against a source. Kenexis Consequence Modeling models five case types:

Table 1-1. The five Kenexis Consequence Modeling case types.

Case type	What it models
BLEVE	The fireball from a boiling-liquid expanding-vapor explosion of a pressurized vessel: thermal flux, absorbed energy, and dose versus distance.
VCE	A vapor cloud explosion: side-on blast overpressure versus distance, using either the BST (Baker-Strehlow-Tang) or the QMEFS method.
Pool Fire	Thermal radiation from a burning liquid pool: flux versus distance plus overhead and side-view isopleths at three endpoints.
Jet Fire	Thermal radiation from an ignited pressurized jet: flux versus distance plus overhead and side-view isopleths at three endpoints.
Dispersion	The release model provides transient discharge rates along with resulting material properties predictions to develop the source term for the dispersion models. A liquid pool generation and vaporization model provides source term predictions for the portion of the release that forms a liquid pool. Vapor dispersion is modeled from momentum-based and pool-based sources independently; results are presented as concentration versus distance, side view, and overhead view for each type of dispersion (where applicable).

1.2 Powered by CANARY by Quest

The consequence calculations are powered by the CANARY by Quest® consequence modeling package developed by Quest Consultants Inc. (www.questconsult.com). Kenexis Consequence Modeling builds the case, sends it to the CANARY engine, and presents the results — so the predicted hazard distances come from an established, independently developed and maintained modeling package rather than from a reimplementation of it.

CANARY by Quest supplies the rigorous multicomponent thermodynamics and the discharge, dispersion, fire, and blast models, each validated against the published literature for hydrocarbon process hazards. Kenexis Consequence Modeling supplies the study structure, the multi-user browser interface, unit handling, result storage, and reporting. The engine, its chemical component library, and the result store are managed for you — a browser and a KISS account are the only requirements.

1.3 About Kenexis

Kenexis is an independent engineering consulting firm specializing in the integrity of instrumented safeguards and industrial networks. Kenexis applies skills in risk analysis, reliability engineering, and process engineering to help establish the design and maintenance specifications of instrumented safeguards such as safety instrumented systems (SIS), alarm systems, and fire and gas systems. The Kenexis Integrated Safety Suite is the software platform that supports this work.

1.4 About Quest Consultants

Founded in 1989, Quest Consultants Inc. is an independent engineering consulting firm specializing in consequence and risk analysis, facility siting, fire protection, and other process safety concerns. Quest's work is supported by the CANARY by Quest consequence analysis package as well as its extension into quantitative risk analysis with the CANARY+ tools.

2 Getting Started

2.1 Signing In

Kenexis Consequence Modeling runs inside KISS and requires a KISS account. Point your browser at your organization's KISS address and sign in with your username and password, or with a configured single sign-on provider (Azure AD or Okta). Every Kenexis Consequence Modeling page requires authentication; if your session expires you will be returned to the sign-in screen.

2.2 The KISS Manager — Facilities and Studies

After signing in you land on the KISS Manager. Facilities are listed on the left; selecting a facility loads its studies and folders on the right. Kenexis Consequence Modeling studies are marked with the Kenexis Consequence Modeling icon and the type “Consequence Modeling”. The toolbar above the study list creates, organizes, and shares studies.

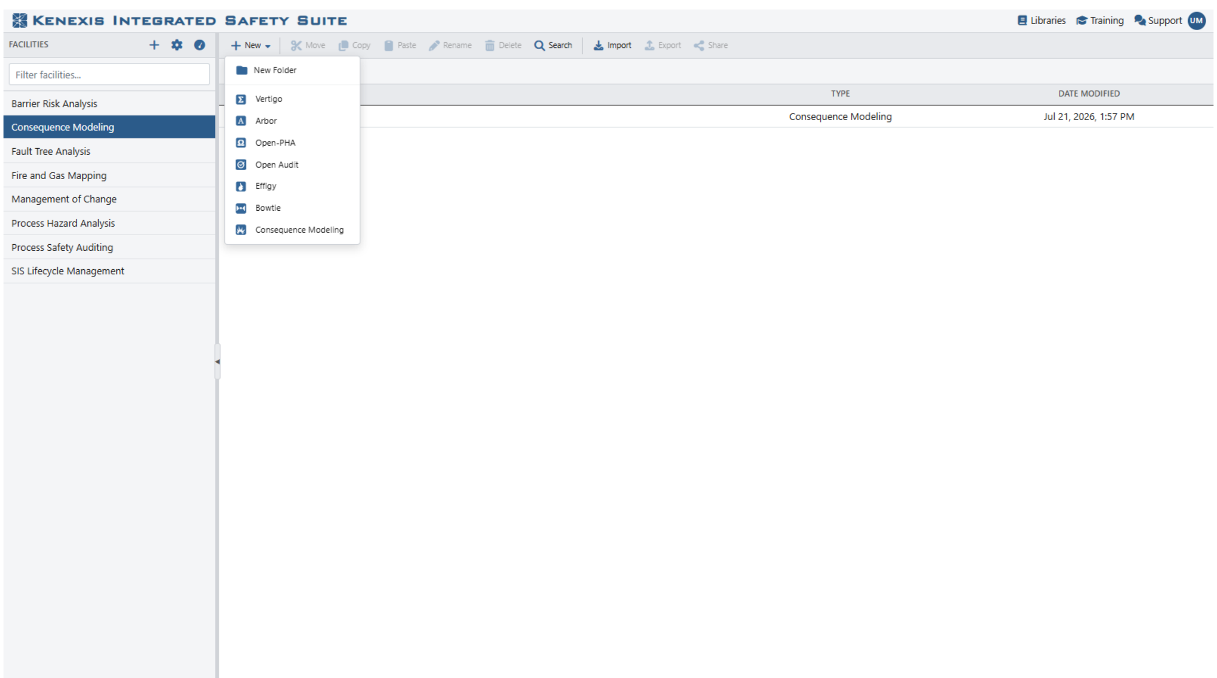

Figure 2-1. The KISS Manager with the New menu open. Choosing Consequence Modeling creates a new consequence modeling study in the selected facility or folder.

2.3 Creating a Kenexis Consequence Modeling Study

With a facility (or a folder within it) selected, choose New › Consequence Modeling and give the study a name. Kenexis Consequence Modeling creates the study and opens it immediately. Every new study starts with three ready-to-use weather conditions covering the conventional bounding cases — a calm stable wind, a calm neutral wind, and a typical wind (Chapter 4) — so weather-dependent cases can be run right away.

2.4 Managing Studies

The KISS Manager toolbar acts on the selected study. Copy, Paste, Move, Rename, and Delete behave as elsewhere in KISS; deleting is a soft delete that moves the study to the organization Recycle Bin, and Share produces a link that opens the study directly. A study copy duplicates the sources, mixtures, weather conditions, spill surfaces, and cases; the copied cases reference the copy's own spill surfaces and start in the not-yet-calculated state, ready to be run.

2.5 The Kenexis Consequence Modeling Workspace

Opening a study shows the Kenexis Consequence Modeling workspace. The header carries the study name on the left and three commands on the right:

- Calculate All (runs every case that needs calculation — Chapter 6)
- Reports (Chapter 8), and
- Settings (Chapter 9).

Users with view-only access see a Read Only badge instead of the editing controls.

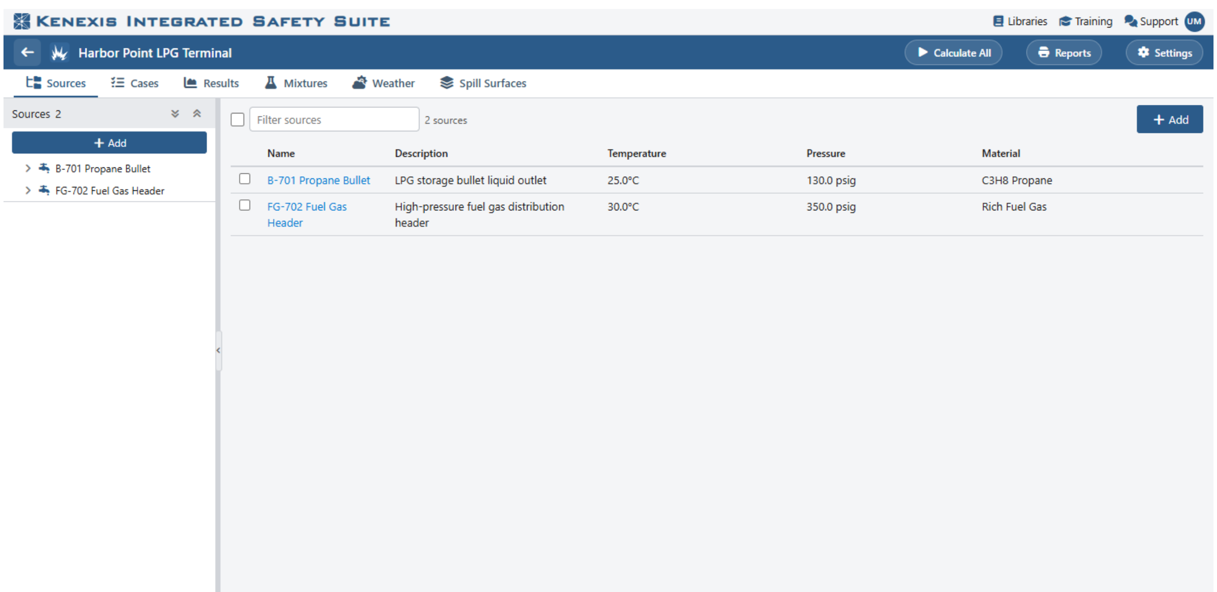

Figure 2-2. The Kenexis Consequence Modeling workspace. The sidebar (left) lists each source with its cases grouped underneath; the tab bar lists the workspace tabs.

The sidebar lists every source as an expandable node whose children are its cases, each tagged with a colored dot and a short type badge. A single click selects and navigates; a double click opens the item's editor. The sidebar can be resized by dragging its edge or collapsed entirely, and your choice is remembered.

Below the header sits the tab bar:

Table 2-1. The six Kenexis Consequence Modeling workspace tabs.

Workspace Tab	Description
Sources	The study's process streams — material, temperature, and pressure (Chapter 3).

Workspace Tab	Description
Cases	The scenarios defined for each source, one table per case type (Chapter 5).
Results	Charts, summaries, and data for calculated cases (Chapter 7).
Mixtures	Reusable multicomponent compositions (Chapter 3).
Weather	The weather conditions available to the study (Chapter 4).
Spill Surfaces	Surfaces defined for liquid spills, and any impoundment (Chapter 4).

3 Sources and Materials

3.1 Sources

A source is a process stream that can lose containment: a material (a pure component or a mixture) at a given temperature and pressure. Every case belongs to exactly one source and takes its material and process conditions from it, so a change to a source automatically flags the results of its cases as out of date (section 6.4).

The Sources tab lists each source with its description, material, temperature, and pressure. A single click selects a source; a double click opens the editor. The checkbox column drives bulk operations: Copy duplicates the selected sources together with all of their cases, and Delete removes the selected sources after confirming how many dependent cases will be removed with them.

3.2 The Source Editor

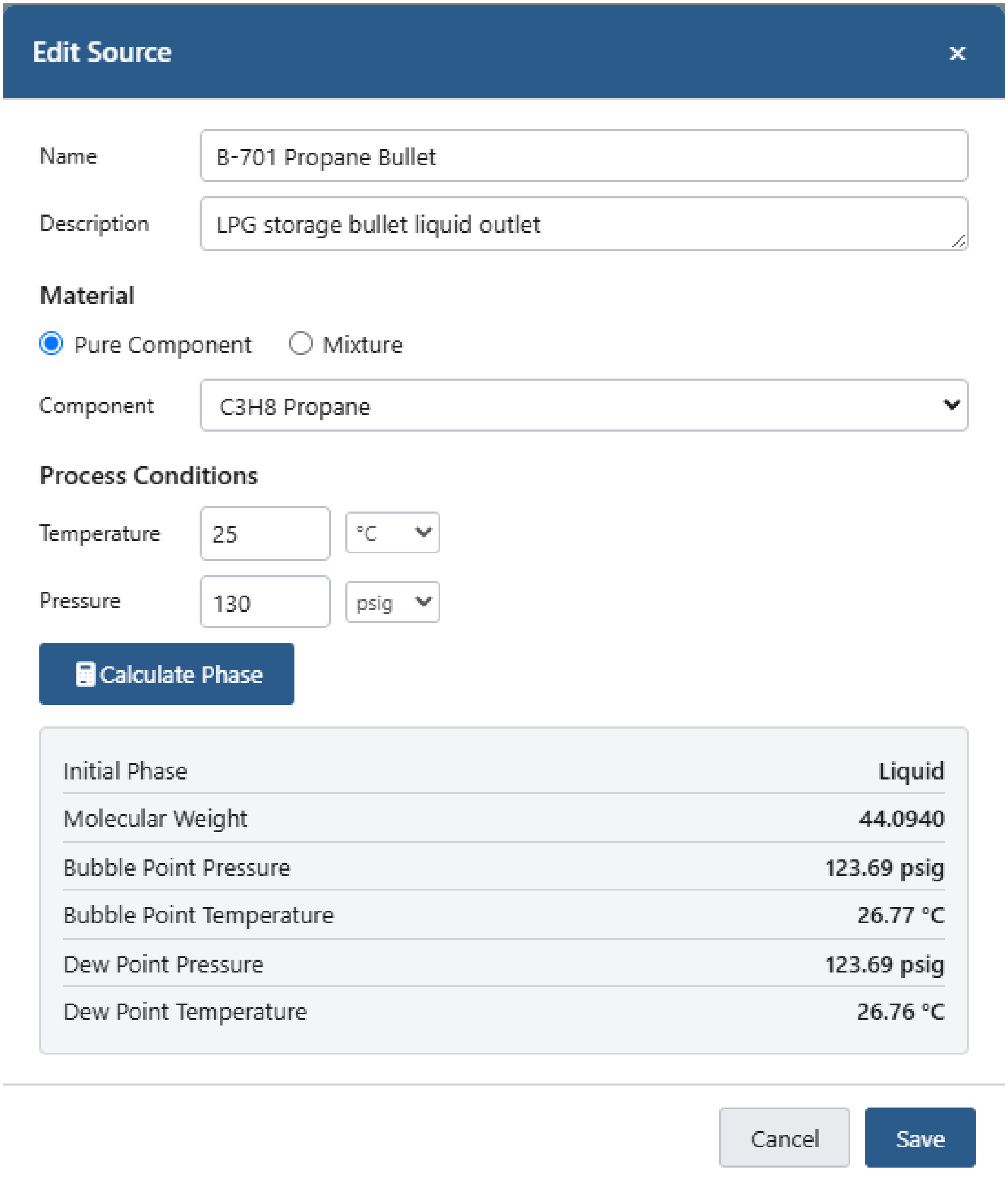

Figure 3-1. The Source editor. The material is a pure component or a mixture; Calculate Phase reports the phase, molecular weight, and bubble and dew points at the entered conditions.

- **Name / Description** — the source's label and free-text description.

- **Material** — choose Pure Component to pick from the chemical component library, or Mixture to reference a mixture from the Mixtures tab. For mixtures, Add New Mixture and View Mixture Details open the mixture editor without leaving the dialog.
- **Process Conditions** — the stream temperature and pressure, each with its own unit selector. Changing a unit converts the value in place.
- **Calculate Phase** — sends the material and conditions to the calculation engine and reports the initial phase (Liquid, Vapor, or Two-Phase), the molecular weight, and the bubble-point and dew-point pressures and temperatures. Use it to confirm the stream is in the phase you expect before defining cases — a VCE case, for example, requires a vapor-phase source (section 5.3).

3.3 Mixtures

A mixture is a reusable multicomponent material defined once on the Mixtures tab and referenced by any number of sources. The grid shows each mixture's composition and a Places Used column listing the sources that reference it.

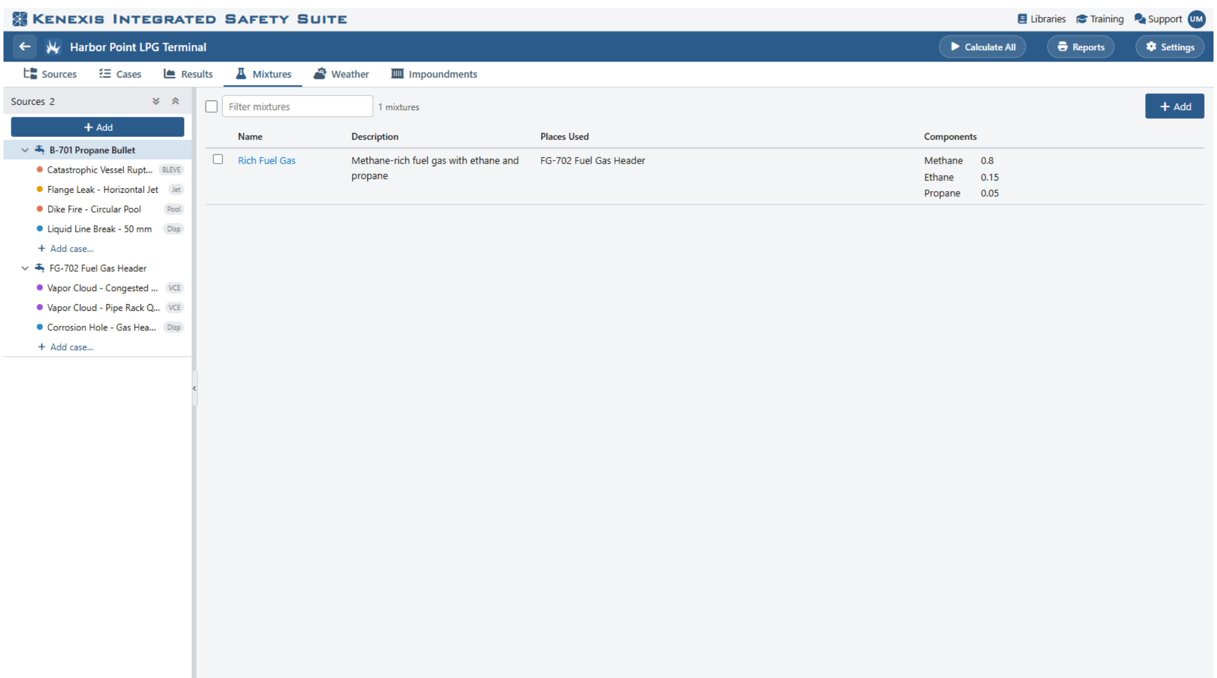

Figure 3-2. The Mixtures tab. The Components column shows each component with its mole fraction; Places Used lists the sources that reference the mixture.

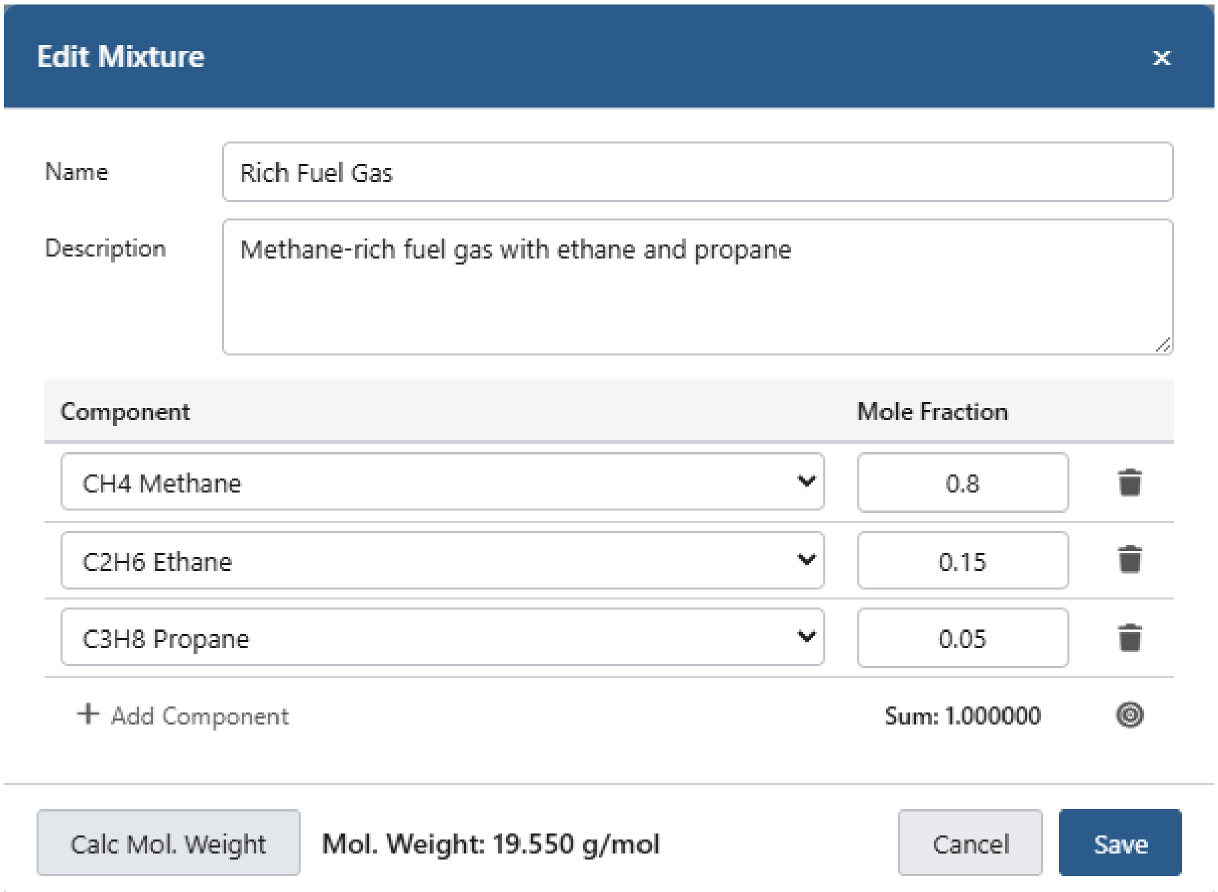

Figure 3-3. The Mixture editor. Components are chosen from the library and given mole fractions; Calc Mol. Weight reports the mixture molecular weight from the calculation engine.

A mixture holds up to ten components, each with a mole fraction. The running Sum readout shows the current total; Normalize (button to the right of Sum) rescales every fraction proportionally so the total is exactly 1. Saving requires each row to have a component and a positive fraction, no duplicate components, and fractions that sum to 1.00. The Calc Mol. Weight button computes the mixture molecular weight from the composition alone — a quick sanity check that the composition is entered correctly.

3.4 The Component Library

The component picker offers the engine's chemical library of over 250 components: the full light-hydrocarbon series, olefins and aromatics, common toxic industrial chemicals (ammonia, chlorine, hydrogen sulfide, hydrogen fluoride, and many more), refrigerants, and inerts. Components are listed by chemical formula and name.

4 Weather and Spill Surfaces

4.1 Weather Conditions

Fire and dispersion behavior depend on the atmosphere, so Pool Fire, Jet Fire, and Dispersion cases are evaluated once per weather condition (BLEVE and VCE results are weather-independent). The Weather tab lists the study's conditions with their wind speed and Pasquill stability class.

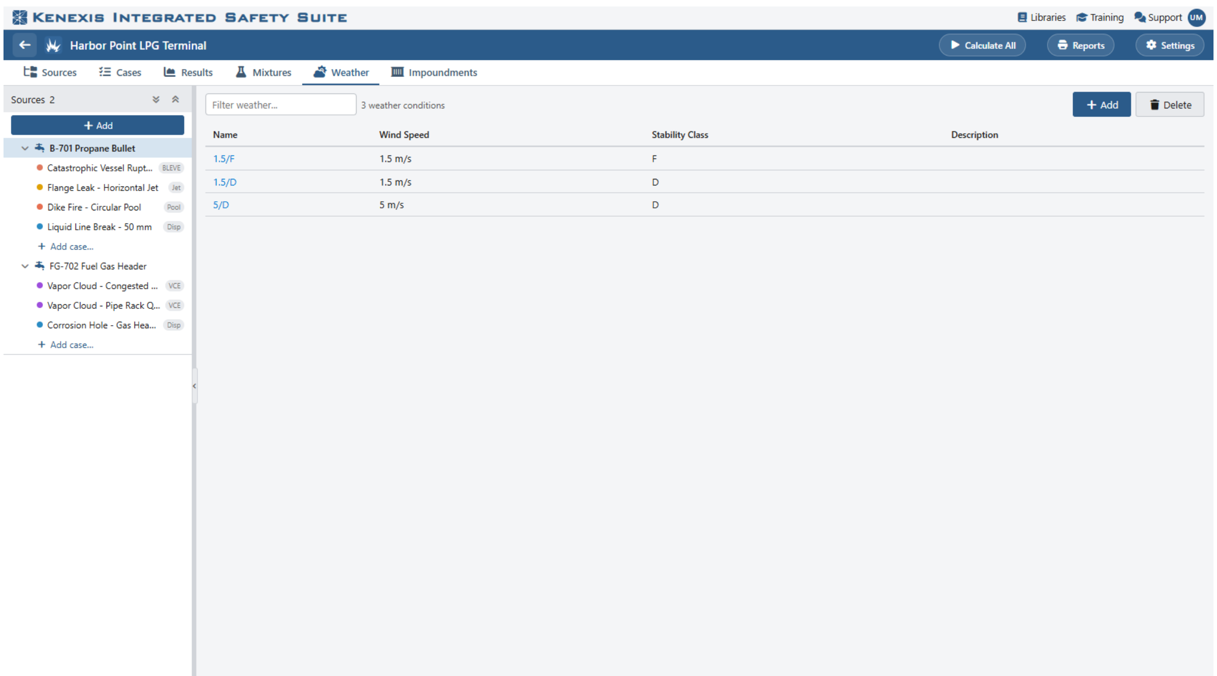

Figure 4-1. The Weather tab. A new study starts with three conditions spanning a calm stable night, a light neutral wind, and a fresh neutral wind.

Each condition pairs a reference wind speed with a Pasquill-Gifford stability class from A (extremely unstable) to F (moderately stable). The conventional worst case for dispersion distance is a low wind speed with F stability; a moderate wind with D stability represents typical daytime conditions.

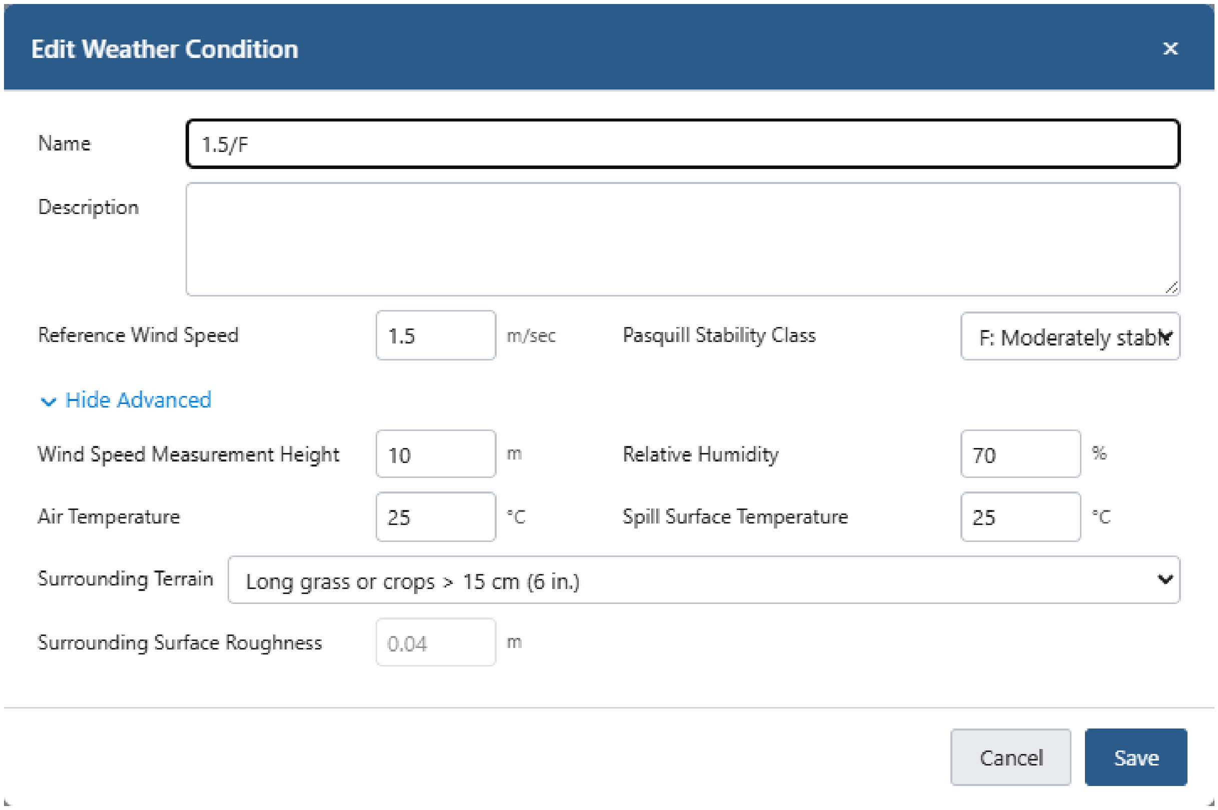

Figure 4-2. The Weather editor with the advanced parameters shown. Preset terrain types fill in the surface roughness; User Defined unlocks it for direct entry.

- **Basic parameters** — Name, Description, Reference Wind Speed (m/sec), and the Pasquill Stability Class.
- **Advanced parameters** — Show Advanced reveals the wind speed measurement height, relative humidity, the air and spill-surface temperatures, and the surrounding terrain (which sets the surface roughness used by the dispersion model).

Weather and surface are separate

A weather condition carries the spill-surface temperature, because that is an atmospheric quantity varying with the weather. The surface itself — what the liquid lands on and how that material conducts heat — is a property of the site rather than of the weather, and is defined separately on the Spill Surfaces tab.

New conditions start from the defaults on the study Settings dialog (Chapter 9). Editing a weather condition marks the results of every weather-dependent case out of date; BLEVE and VCE results are unaffected.

4.2 Spill Surfaces

A spill surface describes what a liquid release spills on. The thermal properties of the spill surface govern how quickly a spreading pool draws heat from the surface and vaporizes. In addition, there is the option to describe an impoundment — a dike or bund that contains the pool. A Dispersion case that references a spill surface models the pool: its growth, its vaporization rate over time, and the vapor it feeds back into the dispersing cloud.

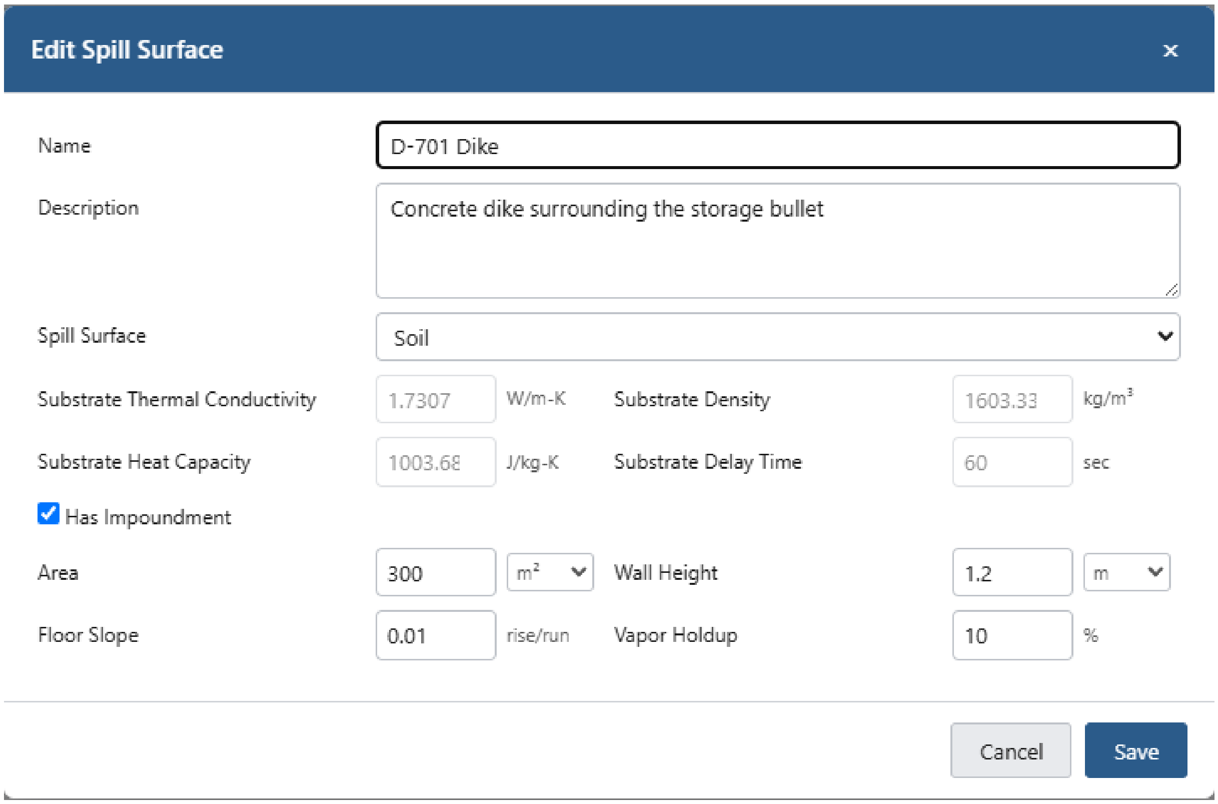

Figure 4-3. The Spill Surface editor. Choosing a surface type fills in the four substrate properties; Has Impoundment adds the containment dimensions.

- **Spill Surface** — the surface type. Choosing a preset such as concrete, soil, or water fills in the substrate thermal conductivity, density, heat capacity, and delay time and locks them; User Defined unlocks the four properties for direct entry.
- **Has Impoundment** — set when the surface is diked. It enables the containment dimensions: floor area, wall height, floor slope, and the vapor holdup fraction. Cleared, the release spreads on an unbounded surface and only the substrate properties apply.

A study can define as many spill surfaces as the site needs — a concrete pad, a diked tank farm, and open ground can each be described once and reused across cases. Deleting a spill surface detaches it from any dispersion cases that reference it and flags those cases for recalculation.

5 Cases

5.1 The Cases Tab

The Cases tab shows the scenarios defined against the active source — the source selected in the sidebar or the Sources tab, whose name appears as the table heading. Cases are grouped into one collapsible table per case type, each with columns tailored to that type, so the parameters that matter are visible without opening a dialog. Name and description columns sort on click.

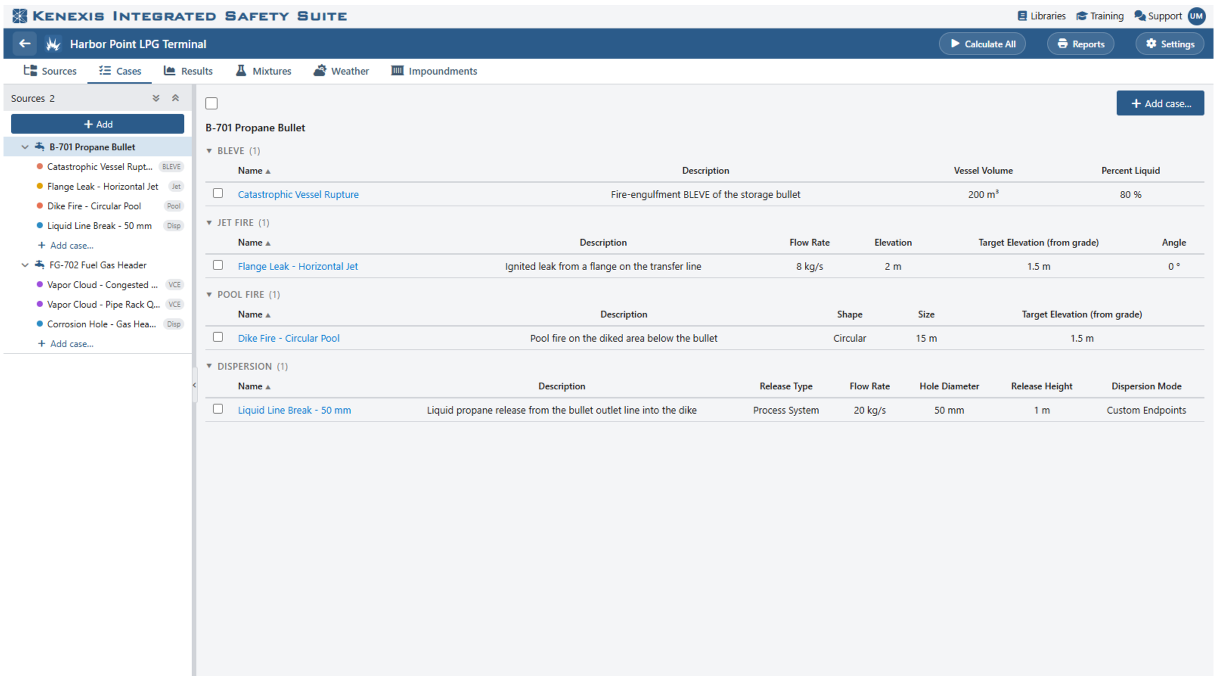

Figure 5-1. The Cases tab. One table per case type with type-specific columns; the Add case menu creates a new case of the chosen type against the active source.

The Add case menu offers the five types: BLEVE, Jet Fire, Pool Fire, VCE, and Dispersion. The checkbox column drives bulk Copy and Delete; Copy opens a picker so the copies can be pasted into any source in the study. Copies pasted into a different source keep their names; copies within the same source gain a "(Copy)" suffix. A single click selects a row (Shift and Ctrl extend the selection); a double click, or a click on the case name, opens the editor.

> **Where calculation happens**
>
> Cases are defined here and run from the header's Calculate All button or from the Results tab (Chapter 6). Every case editor validates its inputs on Save and lists any values that are missing or outside the accepted engineering range in a banner at the top of the dialog.

5.2 BLEVE Cases

A BLEVE case models the fireball from the catastrophic failure of a pressure vessel holding a superheated liquid. The source supplies the material and its storage conditions; the case adds the vessel and ambient parameters.

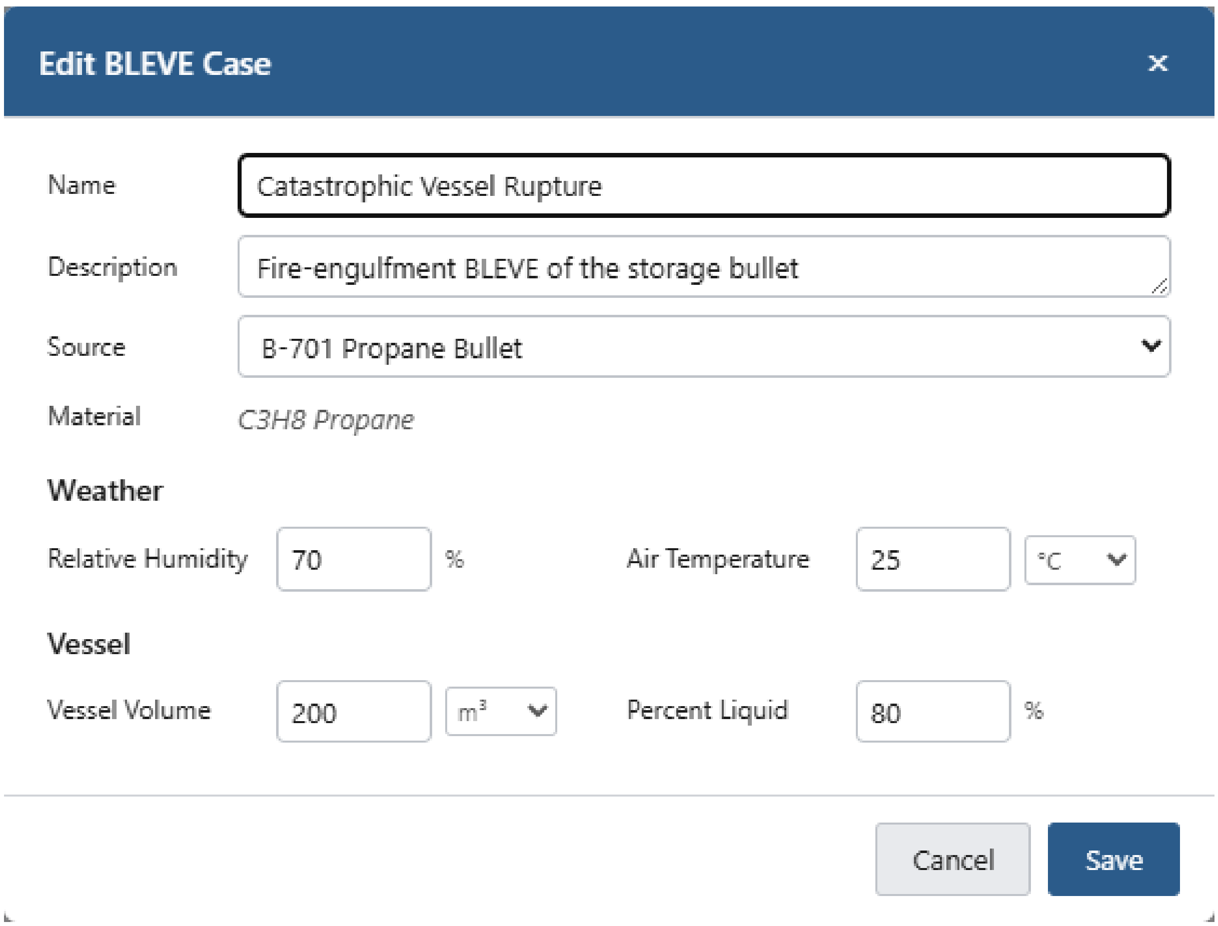

Figure 5-2. The BLEVE case editor: ambient conditions (relative humidity and air temperature) and vessel parameters (volume and percent liquid).

- **Relative Humidity / Air Temperature** — the ambient conditions used for the thermal-radiation calculation. Humidity matters because water vapor absorbs radiant heat along the path to the target.
- **Vessel Volume / Percent Liquid** — the vessel size and its liquid fill fraction at failure, which together set the mass of fuel in the fireball.

BLEVE results are weather-independent: the case carries its own ambient parameters and is computed once, regardless of the study's weather conditions.

5.3 VCE Cases

A VCE case models the blast from the delayed ignition of a flammable vapor cloud in a congested volume. Two explosion models are available, chosen with the Model selector; the dialog shows the inputs for the selected model.

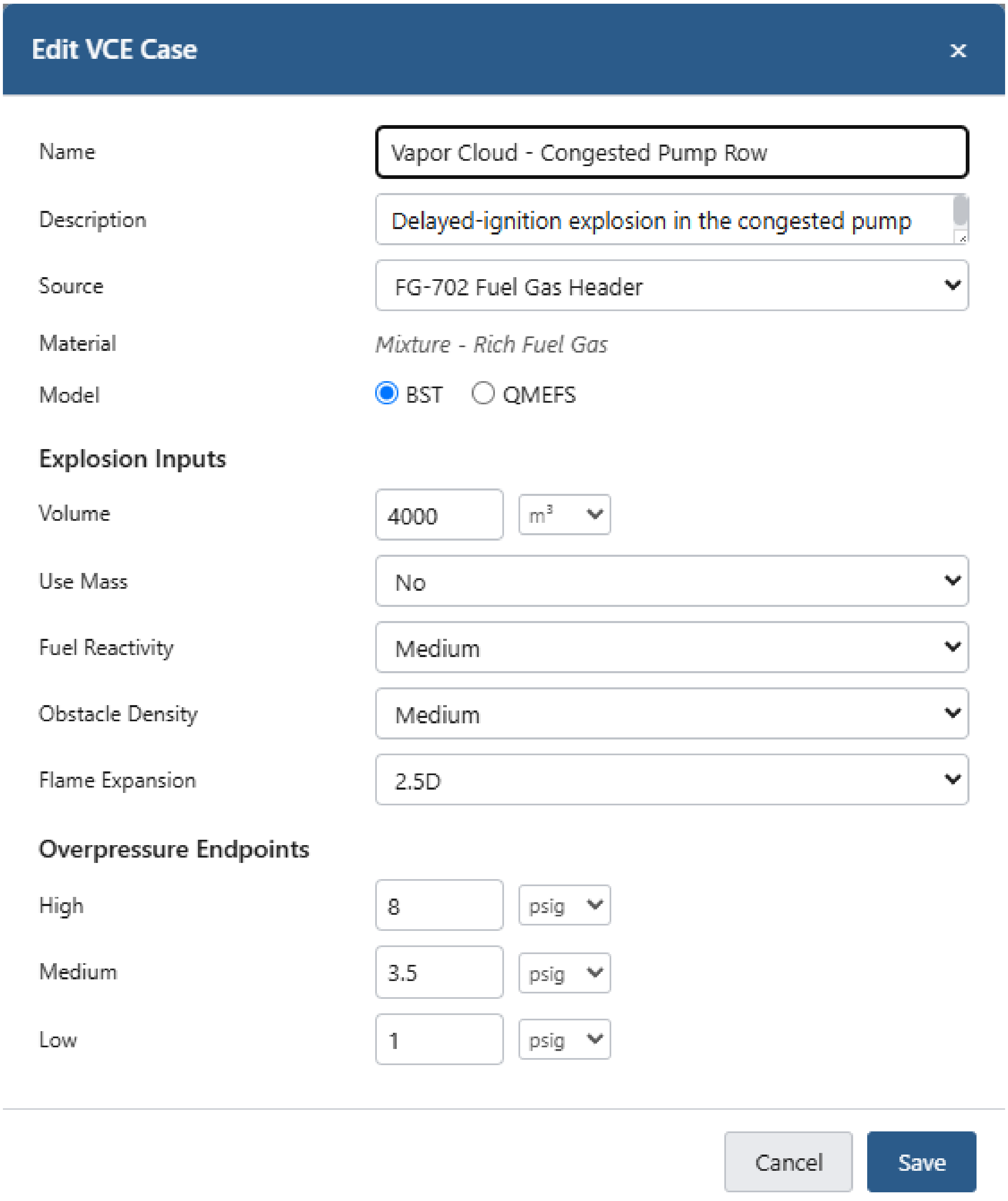

Figure 5-3. The VCE case editor with the BST model selected: cloud volume (or mass), fuel reactivity, obstacle density, and flame expansion geometry.

- **BST** — the Baker-Strehlow-Tang flame-speed correlation. Enter the congested volume (or switch Use Mass to Yes and enter the fuel mass directly), then characterize the congestion with Fuel Reactivity (Low / Medium / High), Obstacle Density (Low / Medium / High), and Flame Expansion (2D / 2.5D / 3D — the degrees of freedom available to the expanding flame front).

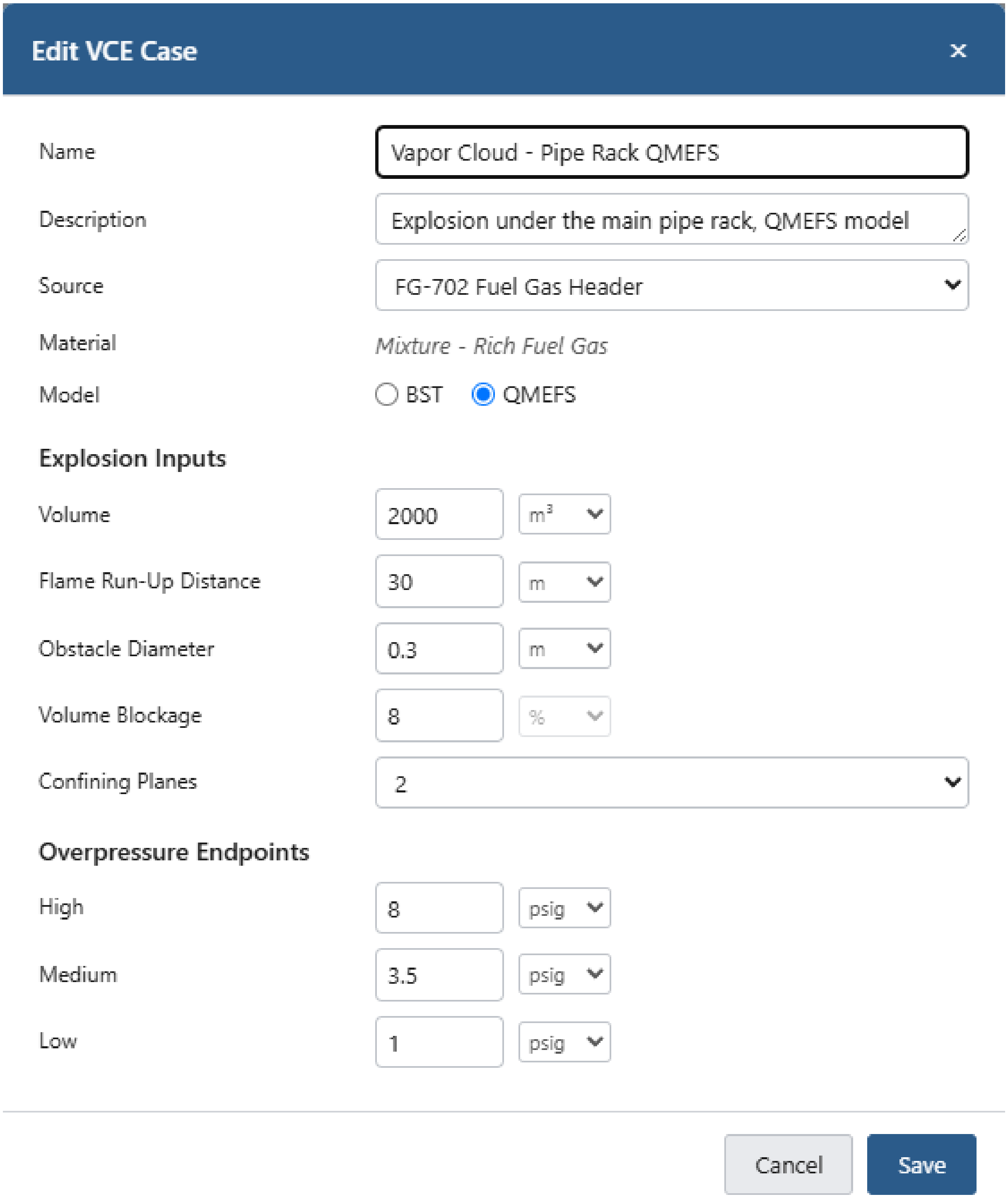

Figure 5-4. The VCE case editor with the QMEFS model selected: volume, flame run-up distance, obstacle diameter, volume blockage, and confining planes.

- **QMEFS** — a flame-speed model driven by the geometry of the congested region: the Flame Run-Up Distance through the congestion, the characteristic Obstacle Diameter, the Volume Blockage percentage, and the number of Confining Planes (1, 2, or 3).

Both models share the three Overpressure Endpoints — the thresholds at which the Results tab draws blast contours (section 7.3). Defaults come from the study Settings dialog.

A VCE Needs a Vapor Cloud

The explosion models evaluate overpressure from an ignited flammable vapor cloud, so the case's source must be vapor at its stated temperature and pressure. Use the Source editor's Calculate Phase button to confirm the phase; for a liquefied gas or vaporizing liquid, establish a source whose conditions provide vapor at atmospheric pressure. It may be useful to first define and run a Dispersion case, then use the released fluid behavior and composition information (see the case Summary sub-tab, section 7.5) to define the vapor that would be involved in a VCE.

5.4 Pool Fire Cases

A Pool Fire case models the thermal radiation from a burning liquid pool of fixed size.

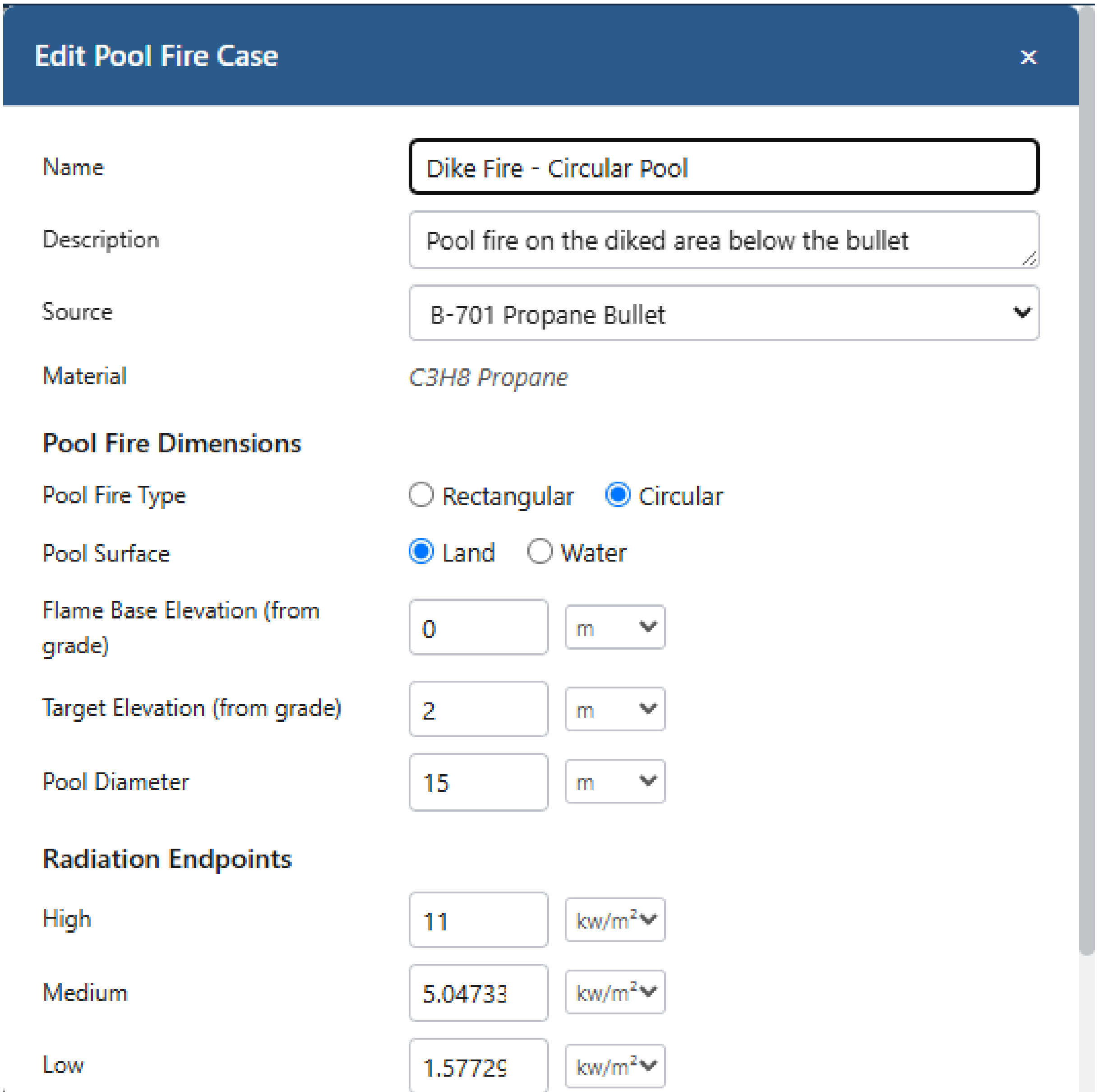

Figure 5-5. The Pool Fire case editor. The pool is circular or rectangular; the type selects which dimension fields appear.

- **Pool Fire Type** — Circular (enter the Pool Diameter) or Rectangular (enter the crosswind Pool Width and downwind Pool Length).
- **Pool Surface** — Land or Water, describing what the pool sits on. The choice reaches the engine directly, so a spill onto water burns with the heat transfer of water rather than of ground.
- **Flame Base Elevation / Target Elevation** — both measured from grade: the height of the pool surface (for example, the top of a tank in a full-surface fire) and the height at which the radiation flux is evaluated.
- **Radiation Endpoints** — the three heat-flux thresholds at which the Results tab draws isopleths, defaulted from the study Settings.

5.5 Jet Fire Cases

A Jet Fire case models the thermal radiation from an ignited pressurized release — a momentum-driven flame rather than a buoyant pool fire.

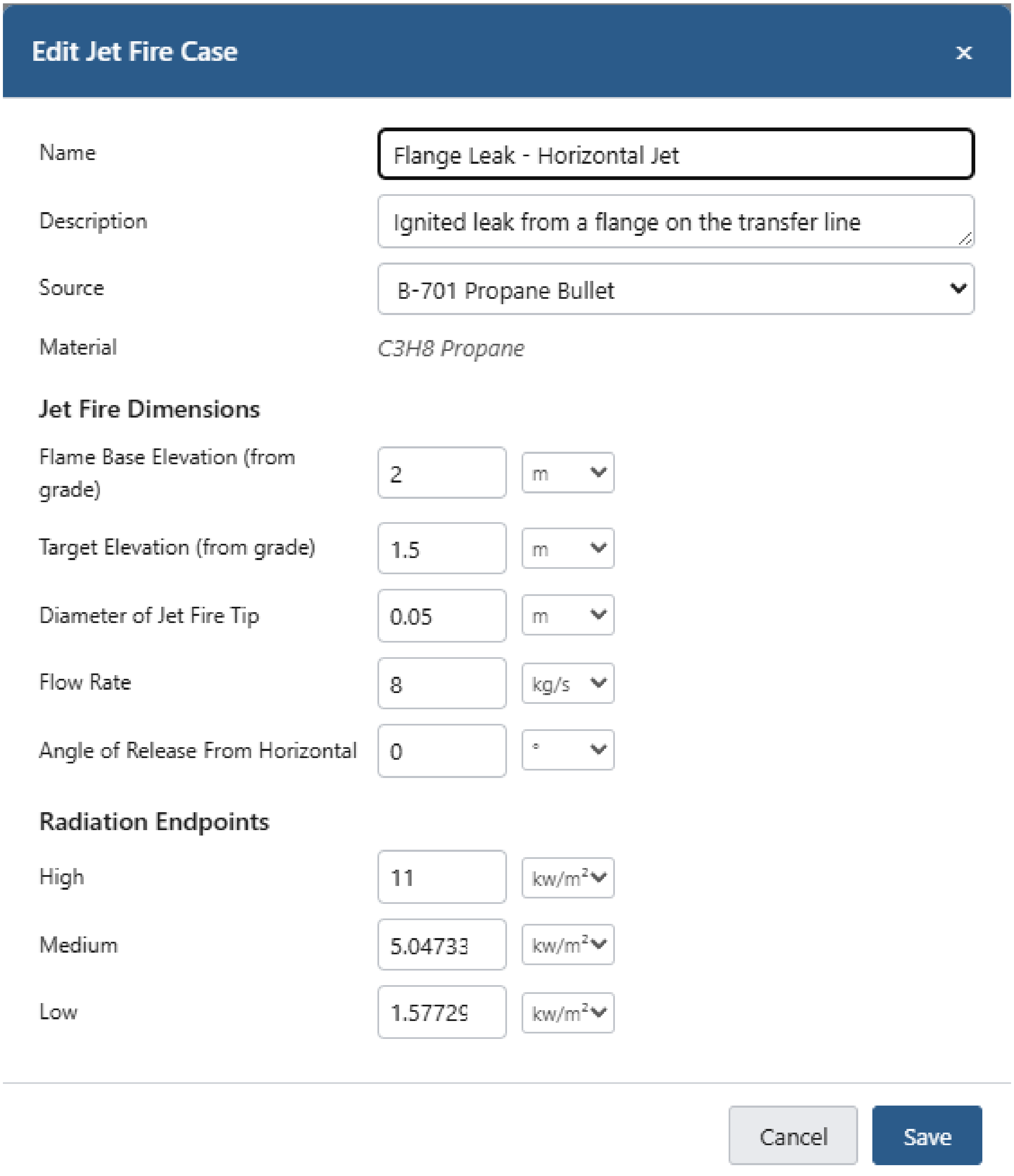

Figure 5-6. The Jet Fire case editor: flame base and target elevations, the jet tip diameter, the mass flow rate, and the release angle from horizontal.

The Diameter of Jet Fire Tip and the Flow Rate size the flame; the Angle of Release From Horizontal orients it (zero is horizontal, positive angles point upward). Elevations and radiation endpoints behave exactly as in a pool fire case. Jet fire and pool fire cases are weather-dependent: flame tilt and downwind flux follow the wind, so results are computed per weather condition.

A Jet Fire Needs Vapor

The jet fire model is based on a momentum-dominated release of flammable material. The source definition for jet fires must either be vapor or will need to produce sufficient vapor as it is released (the material must be adequately volatile). If the jet fire model gives an error about insufficient vapor, it is possible that a jet fire would not be possible (in this case the liquid falls to the ground and could form a pool fire). If a released liquid is expected to create a jet fire due to aerosolization, a separate source may need to be established that better represents the post-release conditions of the fluid.

5.6 Dispersion Cases

A Dispersion case models the release itself: how fast material escapes, how the resulting jet or cloud disperses downwind, and — when a liquid pool forms — how the pool vaporizes over time. It is the most richly parameterized case type, so its editor is organized into three tabs.

Release Conditions

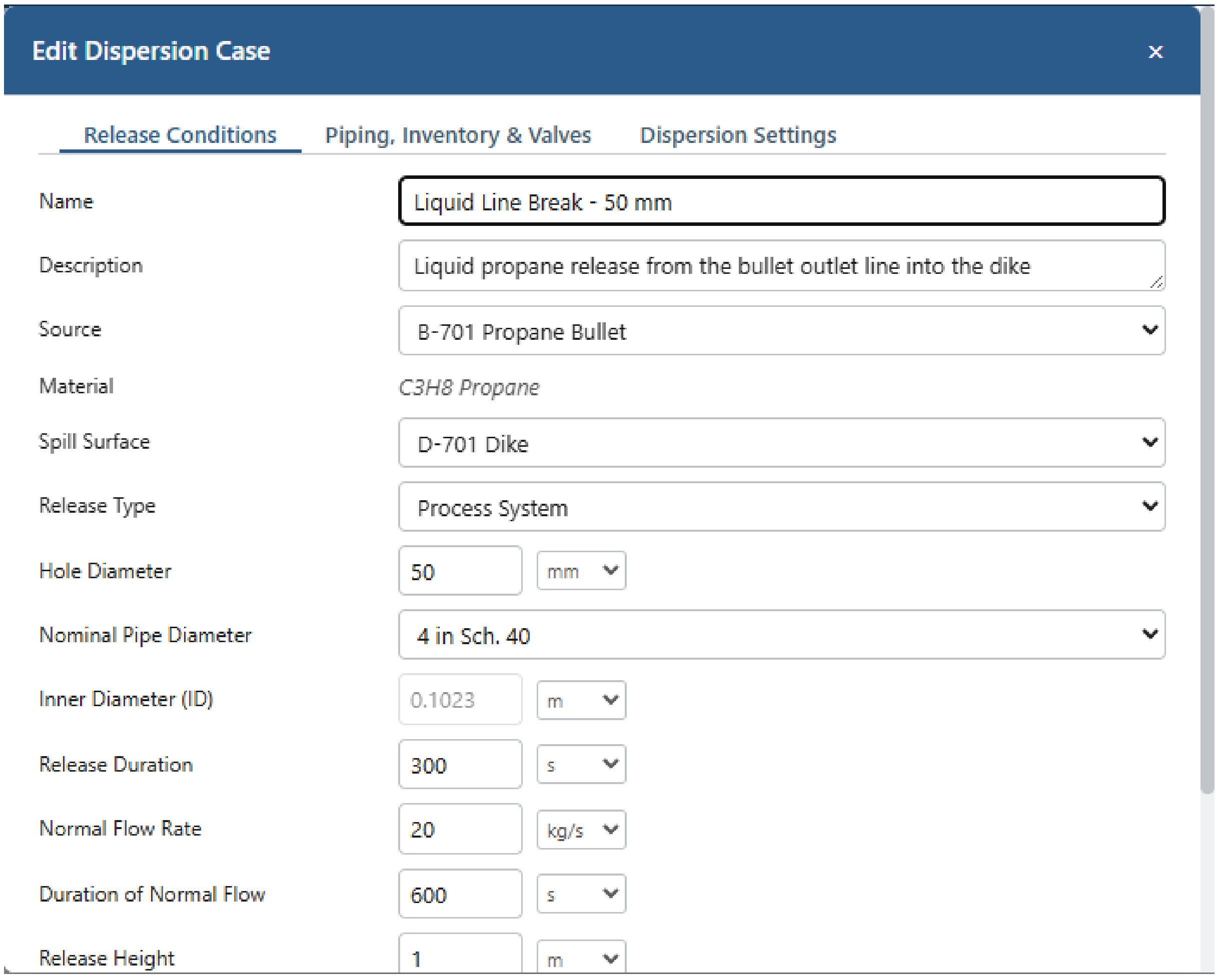

Figure 5-7. The Dispersion case editor, Release Conditions tab: release type, hole and pipe geometry, durations and flow rates, and the release height and angle.

- **Release Type** — how the inventory feeds the hole: Process System (a vessel and its connected piping), Regulated (a constant, externally regulated flow), Pipeline (a long line with inventory on both sides of the break), or Wellbore (flow from a reservoir). The selected type decides which inventory fields appear on the second tab.
- **Spill Surface** — the surface any rained-out liquid lands on, which drives the pool-vaporization part of the model. Choose one of the study's spill surfaces, or Study defaults to use the surface and substrate properties set on the study Settings dialog (Chapter 9).
- **Hole Diameter / Nominal Pipe Diameter / Inner Diameter** — the breach size and the pipe bore feeding it. Choosing a standard nominal pipe size fills in the inner diameter; choosing User Input unlocks it for direct entry.
- **Release Duration / Flow Rates** — the modeled duration, plus the type-specific flows: a Regulated release takes a Regulated Flow Rate, and the other types take the Normal Flow Rate through the line and the Duration of Normal Flow.
- **Release Height / Angle of Release From Horizontal** — where the jet starts and where it points.

Piping, Inventory and Valves

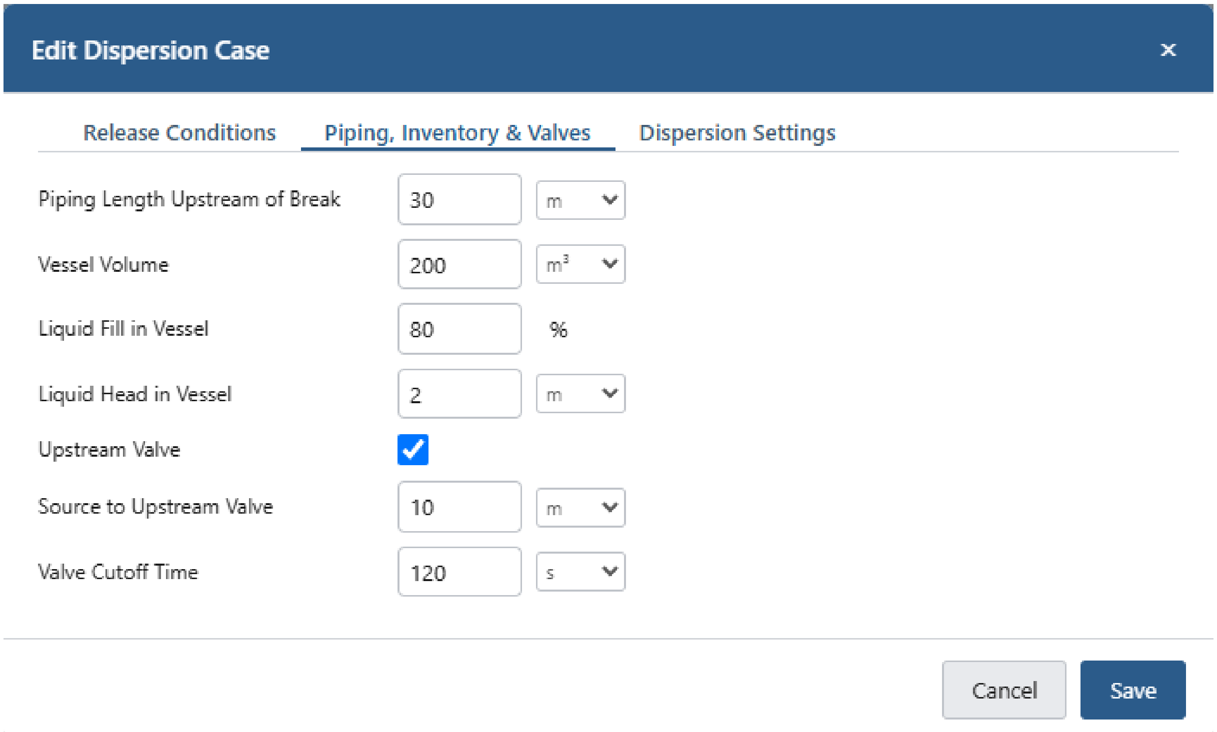

Figure 5-8. The Piping, Inventory and Valves tab for a Process System release: upstream piping length, vessel volume, liquid fill and head, and an optional upstream isolation valve with its cutoff time.

This tab quantifies the inventory that sustains the release, and it adapts to the release type. A Process System release describes the vessel volume, its liquid fill percentage, the liquid head above the hole, and the upstream piping; a Pipeline release adds the total line length, the elevation change, and the downstream side; a Wellbore release describes the reservoir volume and depth. Isolation valves can be placed upstream (and, for pipelines, downstream) of the break with a distance and a cutoff time — after the valve closes, only the inventory between the valve and the hole continues to feed the release. A Regulated release needs no inventory description, so the tab is shown only for the other three types.

Dispersion Settings

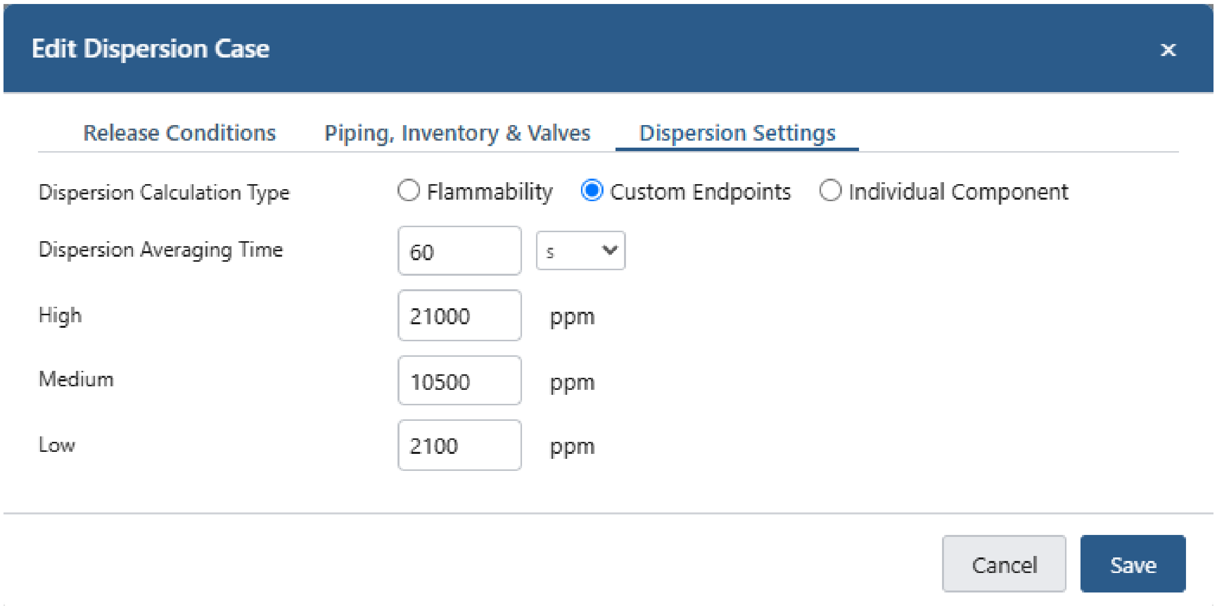

Figure 5-9. The Dispersion Settings tab with Custom Endpoints selected: the averaging time and three concentration thresholds in ppm.

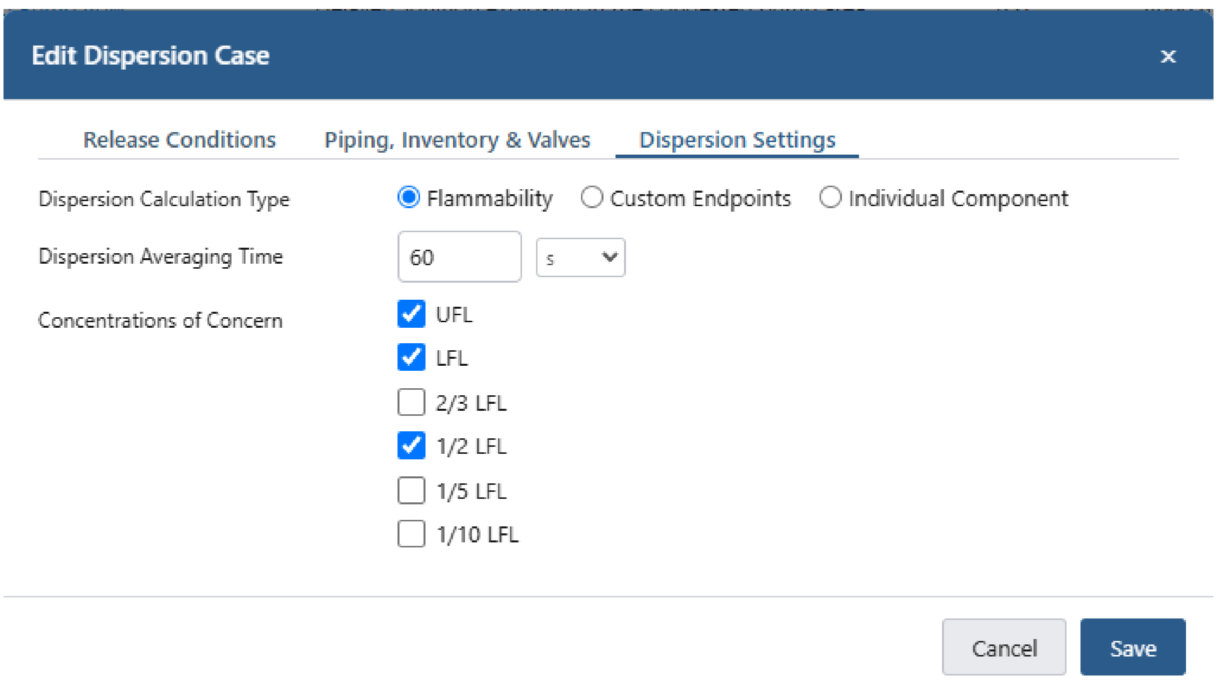

Figure 5-10. The same tab with Flammability selected: choose exactly three concentrations of concern from the flammable-limit fractions.

- **Dispersion Calculation Type** — what the concentration endpoints mean. Flammability tracks fractions of the material's flammable range: pick exactly three of UFL, LFL, 2/3 LFL, 1/2 LFL, 1/5 LFL, and 1/10 LFL. Custom Endpoints tracks three absolute concentrations in ppm. Individual Component tracks a single component of a mixture — the toxic species of interest — through the dispersing cloud.

- **Dispersion Averaging Time** — the time over which concentrations are averaged. Short averaging times suit flammability questions (an ignitable pocket needs only an instant); longer times suit toxic-exposure questions.

5.7 Input Validation

Every case editor checks its inputs on Save: required fields must be present, and each numeric value must fall within the engineering range the engine accepts (converted through the field's selected unit). Values that fail are listed in a banner at the top of the dialog, and the case is not saved until they are corrected. A second validation pass runs when a case is calculated, confirming the combination of inputs is complete for the selected model.

6 Running Calculations

6.1 The Calculation Model

Each case is calculated individually by the cloud engine, and the result is stored with the study. Stored results are reused: opening a calculated case on the Results tab is instant, and calculation only happens when a case is new or its inputs have changed. Weather-dependent case types (Pool Fire, Jet Fire, Dispersion) store one result per weather condition; BLEVE and VCE store a single result.

6.2 Calculate All

Calculate All in the header evaluates everything the study needs: every case that has never been run or whose results are out of date, across every weather condition that applies. The dialog first shows how many individual calculations will run and an estimated duration, then tracks progress with the name of the case currently running. Calculation can be cancelled between units; completed results are kept.

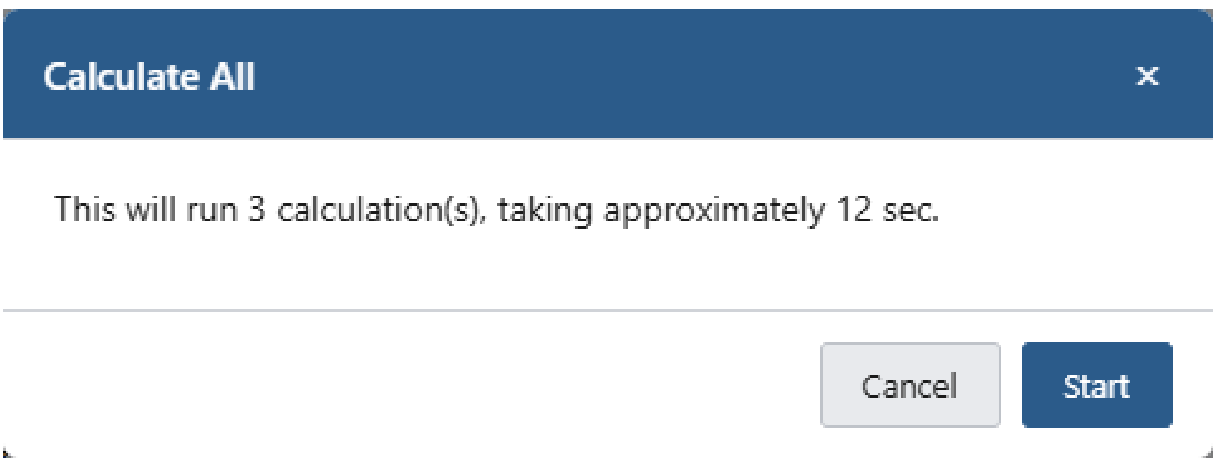

Figure 6-1. Calculate All. The dialog counts one calculation per case, and one per weather condition for the weather-dependent types.

The Results tab offers the same operation scoped to a single source — the Calculate button above the case list runs just that source's pending work.

6.3 Weather-Dependent Runs

Running a weather-dependent case computes it for every weather condition in the study in one operation, so the Results tab's weather selector can switch between conditions instantly. The case is marked up to date once all of its weather conditions have completed successfully; if any condition fails, the case remains flagged for recalculation and the failure is reported.

6.4 Result Freshness

Kenexis Consequence Modeling tracks whether each stored result still matches its inputs. Editing a case marks that case out of date; editing a source, mixture, or spill surface marks every dependent case out of date; editing a weather condition marks the weather-dependent cases out of date. The Results sidebar shows the state at a glance: a green check for a current result, an amber warning for a stored result whose inputs have since changed, and no badge for a case that has never been run.

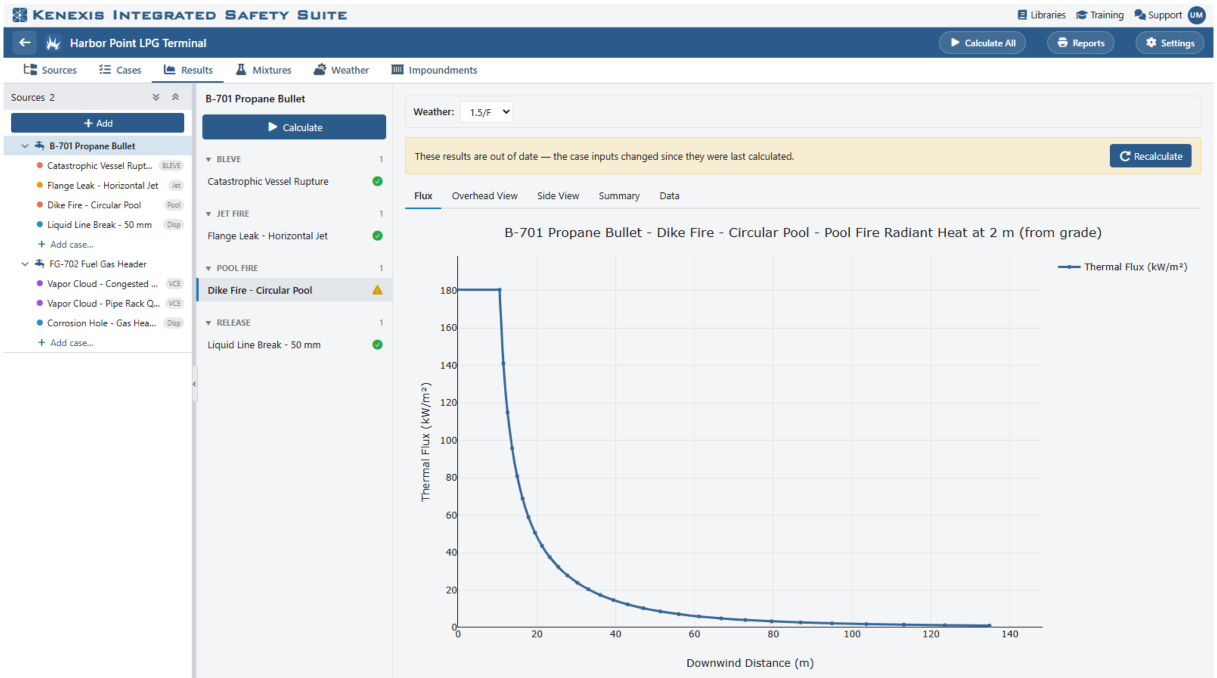

Figure 6-2. An out-of-date case. The stored result is still shown, with a banner explaining that the inputs have changed and a Recalculate button to refresh it.

Out-of-date results are never discarded or silently recalculated: the stored charts remain available for reference, and recalculation is always an explicit action — the banner's Recalculate button, the source-level Calculate button, or Calculate All.

7 Results

7.1 The Results Tab

The Results tab is split into a case list and a viewing pane. The list covers the active source, with cases grouped by type and carrying their freshness badges; clicking a case loads its result. For weather-dependent cases a Weather selector above the pane switches the displayed condition. Every result panel is organized into sub-tabs: one per chart, a Summary of headline values, and a Data tab holding the underlying table with an Export CSV button.

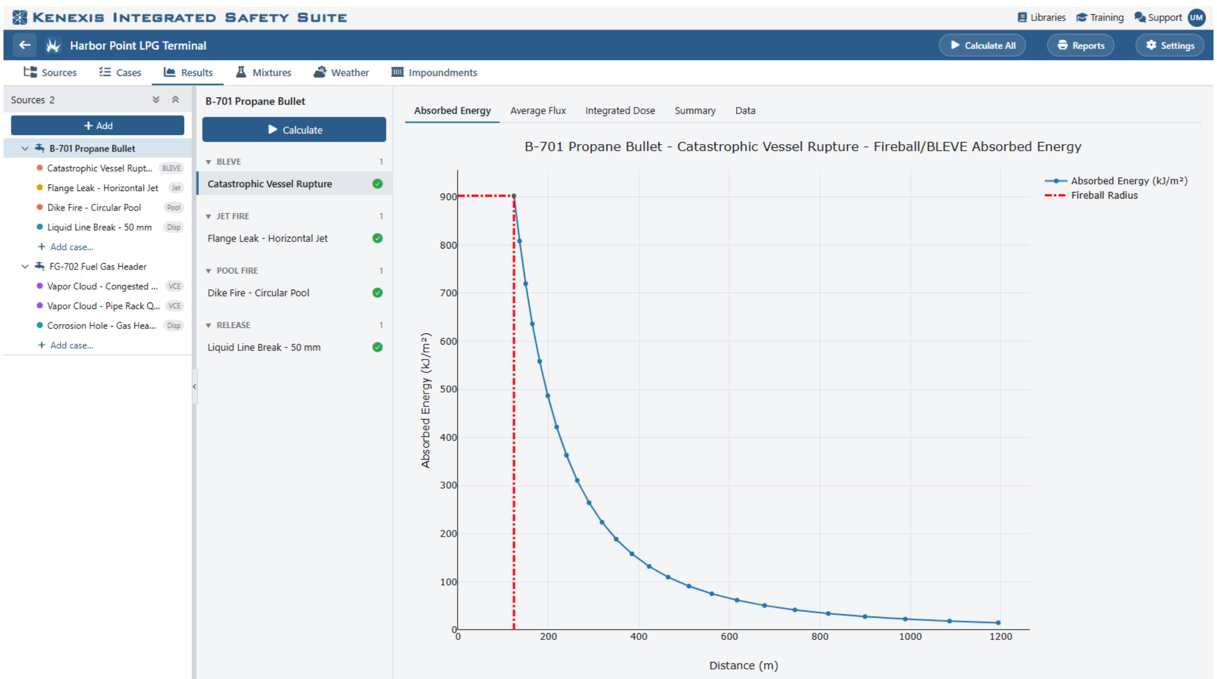

Figure 7-1. The Results tab showing a BLEVE case. The case list (left) carries the freshness badges; the pane shows the panel's sub-tabs and chart.

7.2 BLEVE Results

The BLEVE panel plots three measures of thermal radiation against distance from the fireball center, each on its own sub-tab, with the fireball radius marked on the chart:

- **Absorbed Energy** — the total radiant energy absorbed per unit area (kJ/m²) over the fireball's life.
- **Average Flux** — the mean incident heat flux (kW/m²) during the fireball.
- **Integrated Dose** — the thermal dose measure used for injury correlations.

The Summary reports the mass of fuel in the fireball, its maximum radius, liftoff time and duration, and the distances to the 99 %, 50 %, and 1 % mortality levels.

7.3 VCE Results

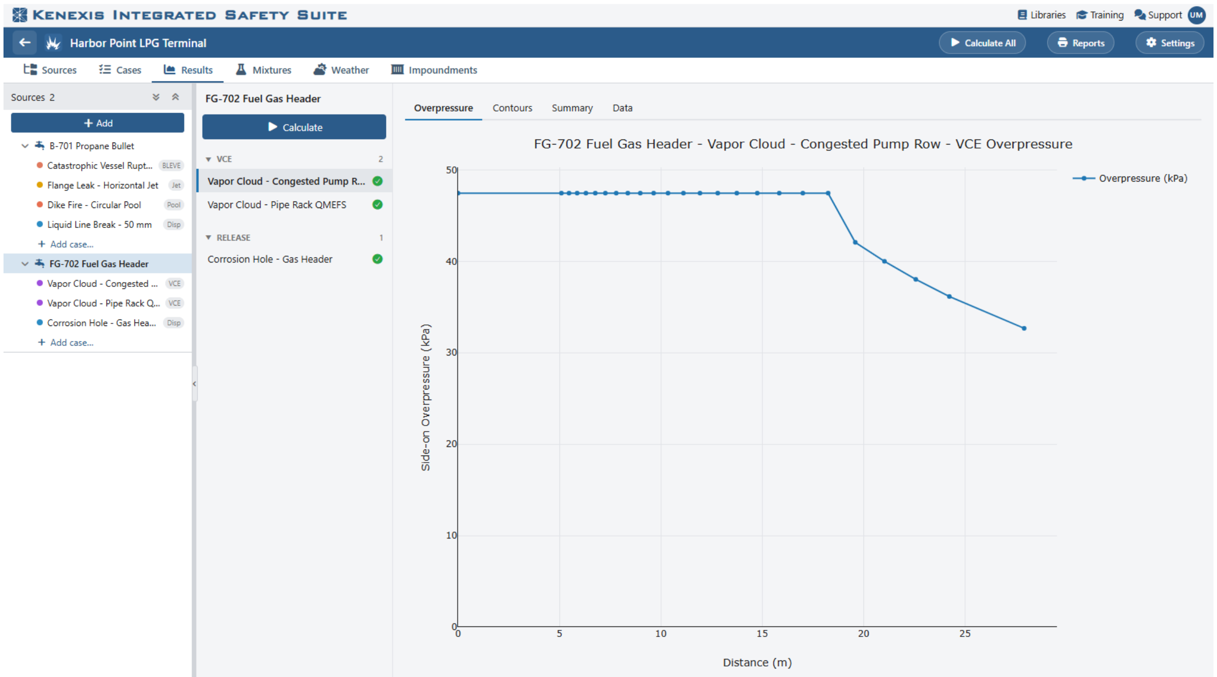

Figure 7-2. A VCE result: side-on overpressure versus distance from the cloud center.

Figure 7-3. The Contours sub-tab: concentric rings at the distances where the blast curve crosses each configured overpressure endpoint.

The Overpressure sub-tab plots the blast curve — side-on overpressure against distance. The Contours sub-tab reads the same curve at the case's three overpressure endpoints and draws the resulting radii as concentric rings, a plan view ready for overlaying on a plot plan. The Summary reports the flame speed, the mass of fuel in the cloud, and the distance to each endpoint.

7.4 Pool Fire and Jet Fire Results

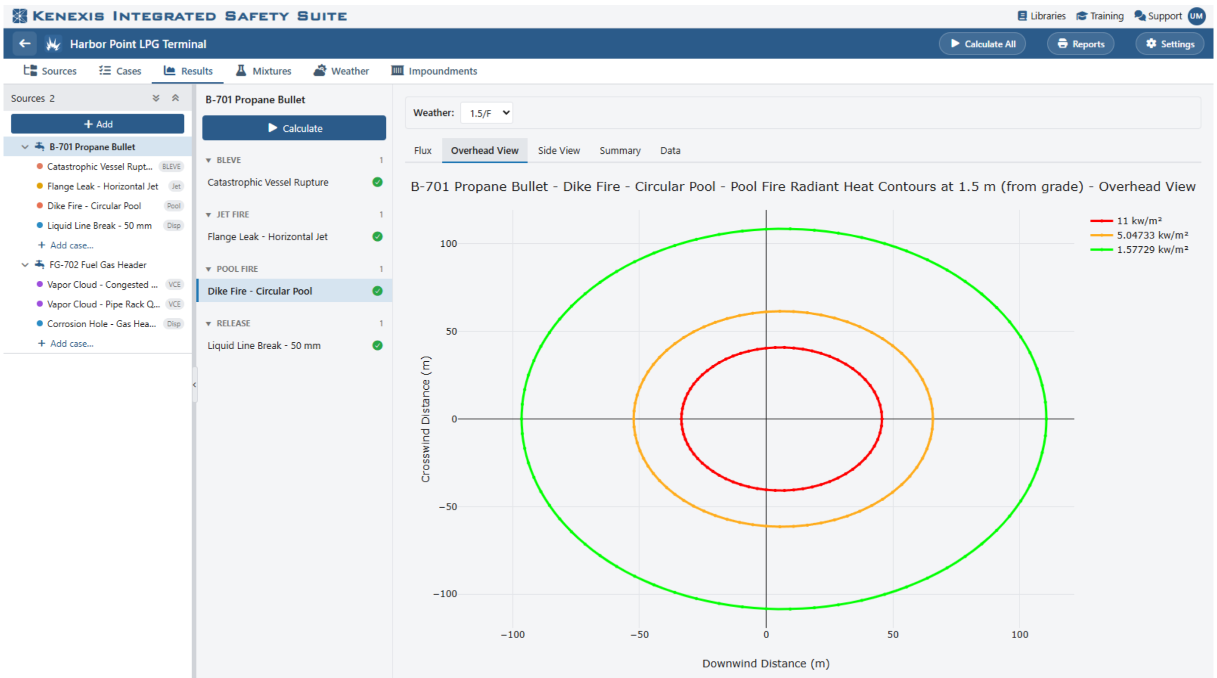

Figure 7-4. A pool fire result, Overhead View: radiation isopleths at the three configured heat-flux endpoints, with the wind blowing along the positive downwind axis. The Weather selector above the pane switches conditions.

The fire panels share four views: Flux (heat flux versus downwind distance at the target elevation), Overhead View (isopleths at the three radiation endpoints seen from above, showing the flame's downwind tilt), Side View (the same isopleths in elevation), and the Summary — flame length, flame tilt, the governing wind speed, and the distance to each endpoint. Both panels are weather-dependent; switching the Weather selector redraws every view for the chosen condition.

7.5 Dispersion Results

The Release panel adapts its sub-tabs to what the scenario produced. Every release shows the transient discharge; a momentum-jet release adds dispersion views; a release that rains out onto a spill surface adds pool vaporization data.

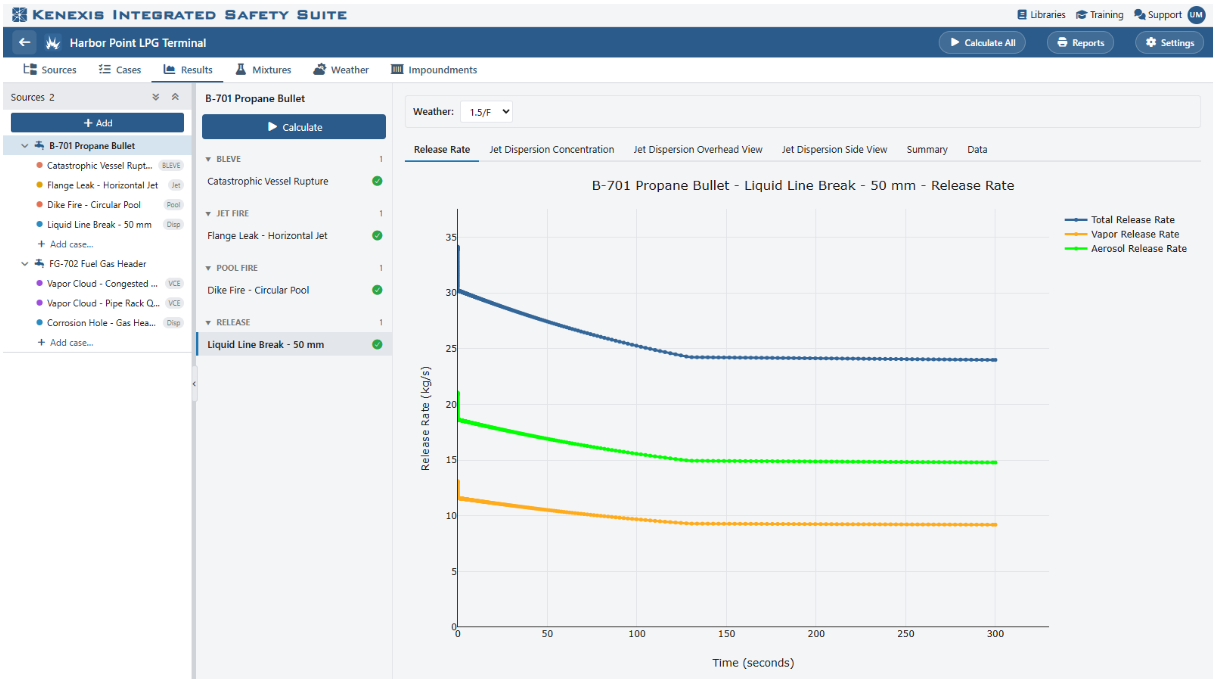

Figure 7-5. Release Rate: the total discharge and its vapor, liquid, and aerosol components over time.

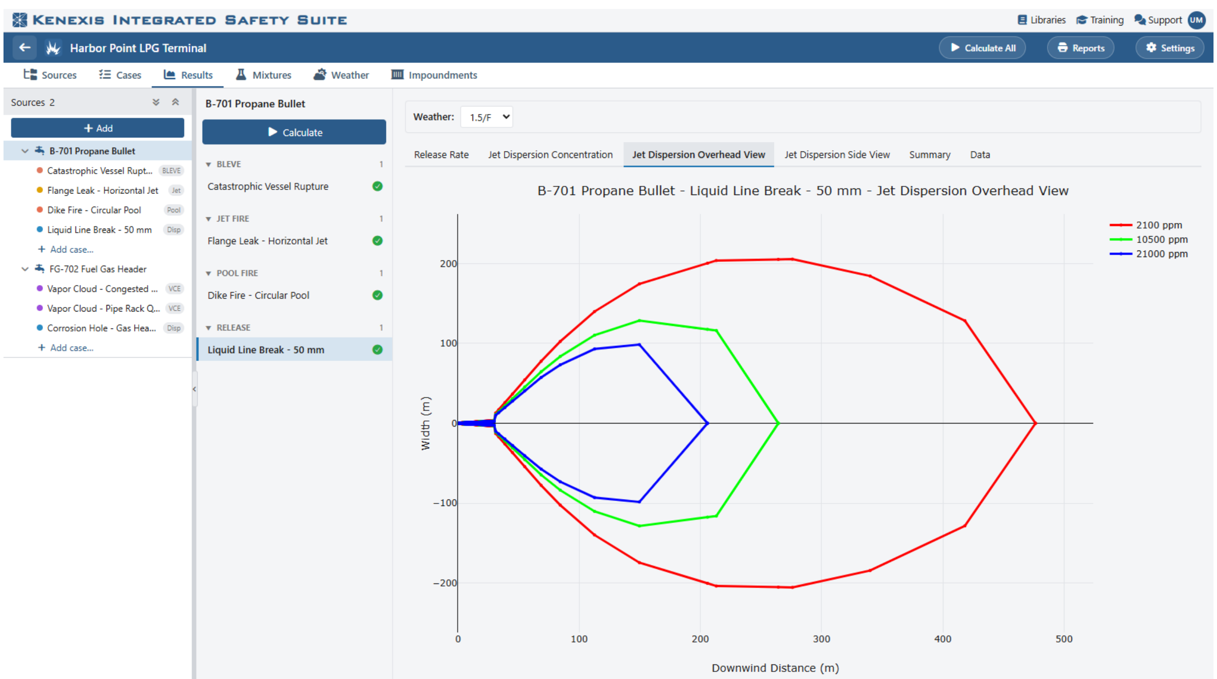

Figure 7-6. Jet Dispersion Overhead View: the plan-view footprint of the dispersing cloud at each configured concentration endpoint.

- **Release Rate** — the discharge rate over time, split into total, vapor, liquid, and aerosol streams. A separate Downstream Release sub-tab appears for pipeline breaks with inventory on both sides.
- **Jet Dispersion Concentration** — ground-level and centerline concentration versus downwind distance, in ppm.

- **Jet Dispersion Overhead and Side Views** — the cloud footprint to each concentration endpoint in plan and in elevation.

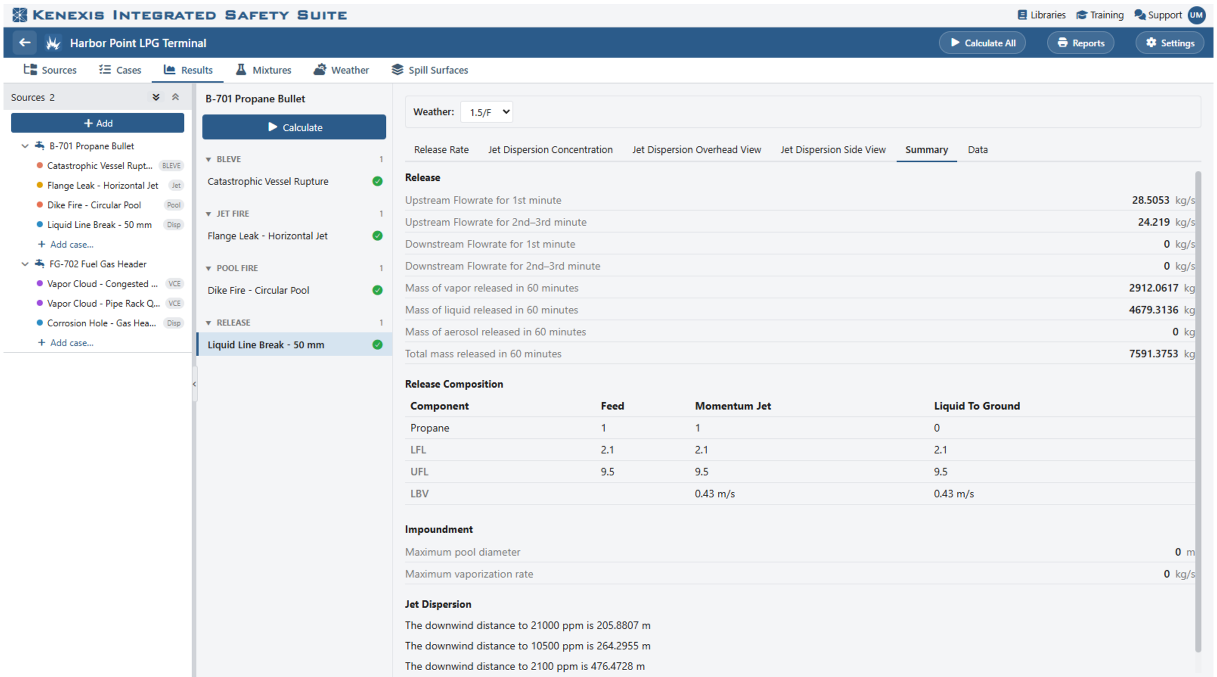

Figure 7-7. A release Summary: discharge flows for the first minutes, the mass released by phase, the release composition with its flammable limits, pool statistics, and the downwind distance to each concentration endpoint.

The composition table always lists each component's mole fraction in the feed, momentum jet, and liquid-to-ground streams. The three flammable limit rows beneath it — LFL, UFL, and burning velocity — appear only when the calculation engine reports those limits. A case tracking a toxic component has no flammable limits to report, so those rows are omitted and the component rows are shown on their own.

The Data tab collects the underlying tables in collapsible sections — upstream and downstream discharge, jet dispersion, and pool vaporization — each with its own Export CSV button.

8 Reports

The Reports button in the header generates a Word document from the study's calculated results — a client-ready record of the scenarios and their consequences.

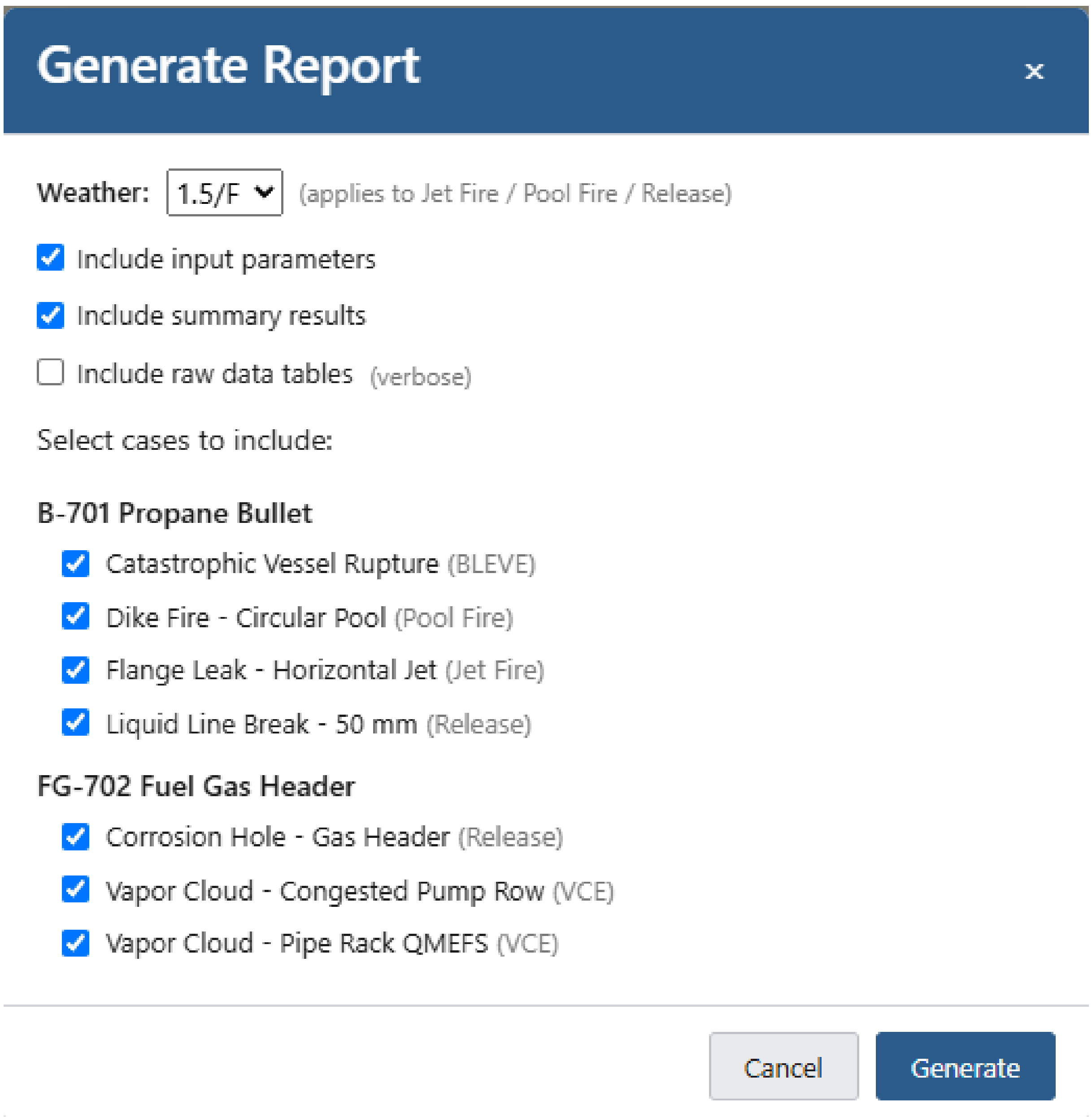

Figure 8-1. The Generate Report dialog: the weather condition to report, three content toggles, and the cases to include, grouped by source.

- **Weather** — the weather condition whose results are reported for the weather-dependent case types (BLEVE and VCE results are weather-independent).

- **Content toggles** — Include input parameters and Include summary results are on by default; Include raw data tables adds the full numeric tables and is off by default to keep reports compact.
- **Case selection** — every case with results is listed, grouped by source and pre-checked; untick any to exclude.

The document opens with a cover page naming the study and listing the included cases, then devotes a section to each case in order: its input parameters, its summary values, its charts, and — when enabled — its raw data tables. The file downloads with the study's name.

9 Study Settings

The Settings button in the header opens the study-wide defaults, in three tabs.

9.1 Environmental Conditions

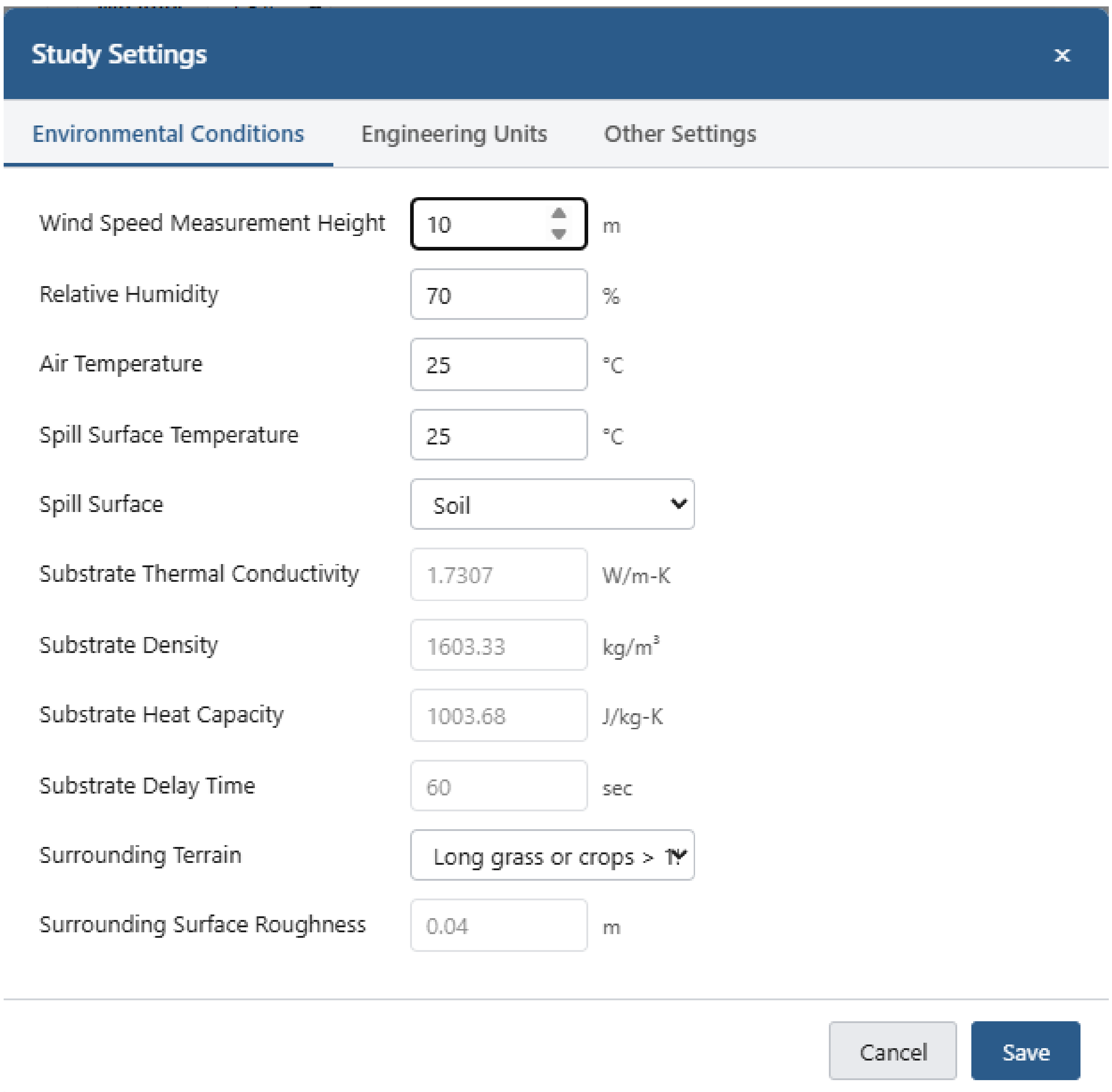

Figure 9-1. Environmental Conditions: the study's atmospheric defaults and its fallback spill surface.

The atmospheric values here — measurement height, humidity, temperatures, and the surrounding terrain with its surface roughness — are the defaults a new weather condition starts from. Existing weather conditions keep their own values; the settings shape what new conditions inherit.

The spill surface and its four substrate properties serve a second purpose: they are the study fallback for a Dispersion case whose Spill Surface is left as Study defaults (Chapter 5). A study that models one consistent ground condition can therefore set it once here and leave the Spill Surfaces tab empty, while a study that needs several defines them on the tab and selects one per case.

9.2 Engineering Units

The Engineering Units tab sets the study's default display unit for each quantity — pressure, temperature, mass, length, area, volume, energy, percent, angle, mass flow, heat flux, and time. Every editor opens its unit selectors at these defaults, and each field's unit can still be changed on the spot; changing a unit converts the value in place. Appendix A lists the available units for every category.

9.3 Default Endpoints

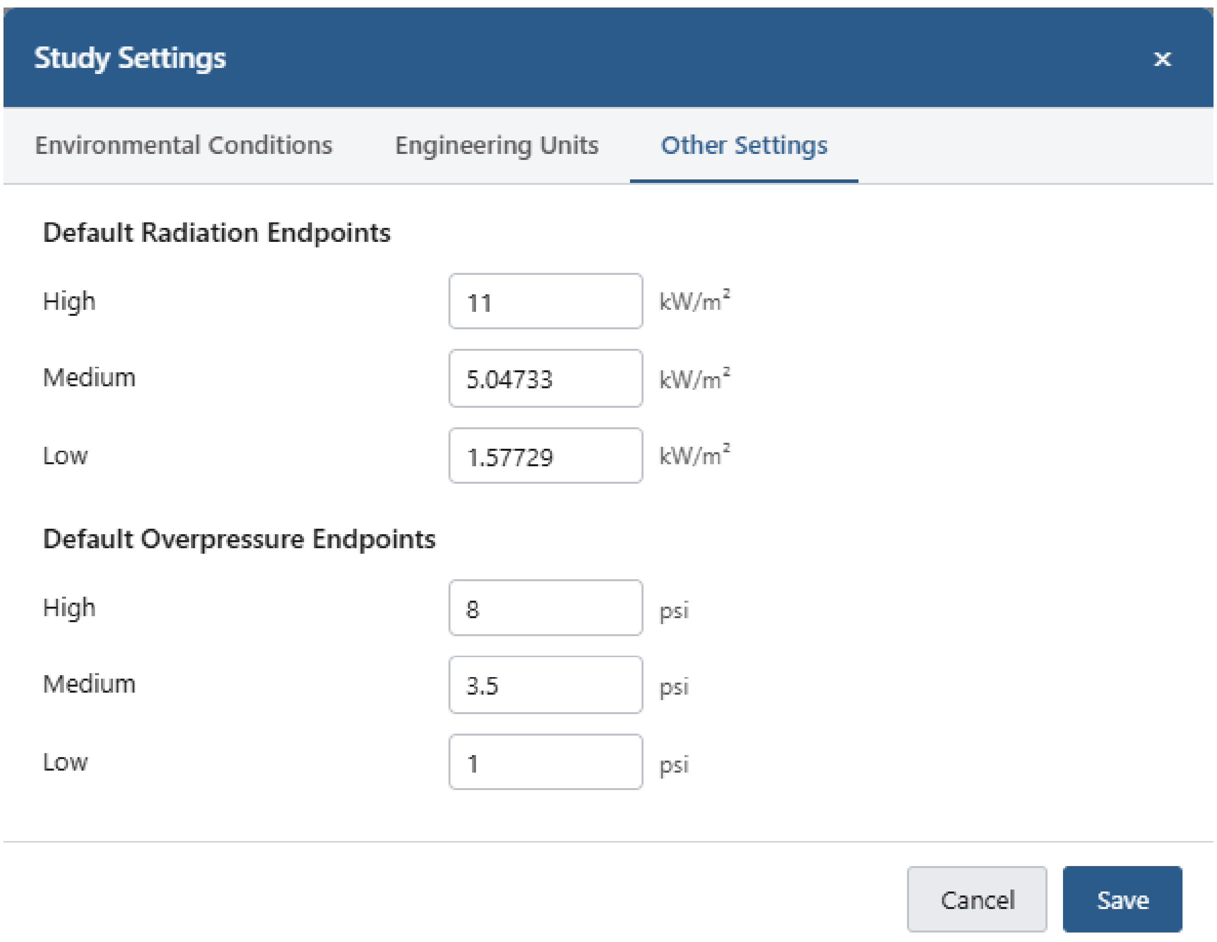

Figure 9-2. Other Settings: the default radiation endpoints (kW/m²) and overpressure endpoints (psi) seeded into new fire and VCE cases.

The default radiation endpoints pre-fill the High / Medium / Low thresholds of new pool fire and jet fire cases, and the default overpressure endpoints pre-fill new VCE cases. The pre-defined defaults are conventional consequence thresholds: 11, 5.05, and 1.58 kW/m² for thermal radiation, and 8, 3.5, and 1 psi for blast overpressure. Each case can have a unique set of endpoints defined.

10 The Calculations Behind Kenexis Consequence Modeling

This chapter describes what the calculation engine computes for each case type and documents the conversions Kenexis Consequence Modeling applies to your inputs. The consequence models themselves — thermodynamics, release, dispersion, fire, and VCE — are implemented in the engine and validated against the published literature for hydrocarbon process hazards.

> **The calculation engine**
>
> Every result in this chapter is produced by **CANARY by Quest**, the consequence modeling package developed and maintained by Quest Consultants Inc. (www.questconsult.com). Kenexis Consequence Modeling assembles each case from your inputs, submits it to the CANARY engine, converts the returned quantities into your chosen display units, and stores the result. The physical models, correlations, and component property data described in the sections that follow are CANARY's. Consult the CANARY documentation for the full model formulations and their validation basis.

10.1 Thermodynamics and Phase Behavior

Every material calculation starts from the mixture composition, even when modeling pure components. The engine's thermodynamics package computes the mixture molecular weight, the phase split at the stream's temperature and pressure, and the bubble-point and dew-point envelope — the values surfaced by the Source editor's Calculate Phase button. The thermodynamic calculations underpin every case: they predict the properties of the mixture immediately after release.

10.2 Release and Vaporization

The release model solves for transient outflow through a given hole size, from the inventory you describe — vessel, piping, pipeline, or reservoir, with isolation valves closing at their cutoff times. The results are presented as time-dependent release rates for vapor, liquid, and aerosol portions of the scenario.

- Vapor is the portion of the original mixture that flashes upon release, as well as any vapors that evaporate as liquid falls to the ground.
- Aerosol is predicted based on the disruption of a released liquid stream due to flashing and shear with the surrounding air. Aerosol liquids are that portion of the liquid stream that are predicted to remain airborne, and will travel downwind with the vapor.
- Liquid is the portion of the mixture that reaches the ground and forms a pool.

The release model only runs for vapor dispersion cases. To generate inputs for fire cases, it is often helpful to input and run a dispersion case so that the post-release properties, flow rates, and behaviors are better understood.

When a liquid pool is predicted, a separate model provides predictions of the liquid pool growth and vaporization, including when impoundment (sumps, curbing, diking, or bunding) is provided.

10.3 Dispersion

CANARY's dispersion models operate separately, on two portions of the released material. The momentum jet dispersion model predicts the downwind extent of the airborne material (vapor+aerosol). The heavier-than-air dispersion model predicts how vaporization from liquid pools will disperse downwind. Each model provides concentration vs. distance as well as the hazard footprints for each concentration endpoint under the selected weather condition.

In cases where the dispersing airborne material loses its momentum and is close to grade level, the momentum jet model will couple to an instance of the heavy gas dispersion model to complete the dispersion to the given concentration endpoint(s).

10.4 Fire Radiation Models

CANARY provides three fire radiation models, each based on a solid flame approach:

- Pool fire;
- Jet fire; and
- BLEVE fireball.

The pool fire model computes the flame geometry — length and wind-driven tilt — over the specified pool size (rectangular or circular), then evaluates incident thermal flux at the target elevation as a function of distance. The jet fire model does the same for a momentum-driven flame with the important parameters being the release diameter and mass flow rate. Both report the distance to each radiation endpoint and draw the endpoint isopleths in plan and elevation. The BLEVE fireball model computes the fireball's diameter, duration, and liftoff from the flashing mass, then integrates the radiant exposure at ground level, attenuated by atmospheric humidity, to produce the absorbed energy, average flux, and dose curves, providing mortality-level distances.

10.5 Explosion Models

CANARY includes two models for predictions of vapor cloud explosion overpressure (blast):

- The Baker-Strehlow-Tang model; and
- QMEFS (the Quest model for estimating flame speed).

Both VCE methods produce a curve of side-on overpressure against distance from the source vapor cloud. The BST method selects a flame speed from its correlations using the fuel reactivity, obstacle density, and flame-expansion geometry, then scales the corresponding blast curve by the energy of the confined cloud. The QMEFS method derives the flame speed from the congestion geometry itself — run-up distance, obstacle diameter, volume blockage, and confining planes, and then uses the BST blast curves to predict overpressure and impulse vs. distance.

10.6 Units and Conversions

Inputs are entered in whichever display units you choose; Kenexis Consequence Modeling converts them to a consistent SI basis before sending them to the engine and converts results back for display.

Two conversions are worth knowing explicitly. Gauge pressures are converted to absolute by adding one standard atmosphere:

$$P_{\mathrm{abs}} = P_{\mathrm{barg}} + 1.01325\ \mathrm{bar}$$
$$P_{\mathrm{abs}} = P_{\mathrm{psig}} + 14.6959\ \mathrm{psi}$$

Temperatures convert between the four supported scales with the standard relations:

$$T_{\mathrm{K}} = T_{^\circ\mathrm{C}} + 273.15$$
$$T_{^\circ\mathrm{F}} = T_{^\circ\mathrm{C}} \cdot \frac{9}{5} + 32$$

All other categories — length, area, volume, mass, flow, heat flux, energy, angle, and time — convert by fixed multiplicative factors between the units listed in Appendix A.

10.7 Result Storage

Each calculation's complete output is stored with the study, keyed to the case (and, for weather-dependent types, the weather condition). Stored results are what the Results tab, the Summary values, and the report generator read, so a study can be reviewed and reported at any time without recalculation. Kenexis Consequence Modeling tracks the dependency chain from every input to every stored result (section 6.4), so a result is either current, or visibly flagged as out of date with its inputs.

Appendix A Engineering Units Reference

Units available in each category. The study default for each category is set on the Settings dialog's Engineering Units tab (section 9.2).

Table A-1. Units available in each engineering-unit category.

Category	Units
Pressure	Pa(a), kPa(a), atm(a), barg, bara, psig, psia, torr(a), inHg(a), mmHg(a)
Temperature	°C, °F, °K, °R
Mass	g, kg, lb, tonne, ton
Length	m, cm, mm, dm, km, in, ft, yd, mi
Area	m^2, cm^2, mm^2, dm^2, km^2, in^2, ft^2, yd^2, mi^2
Volume	m^3, ft^3, gal, L, bbl
Energy	J, kJ, cal, kcal, BTU, kWh
Angle	° (degrees), rads, revs
Mass Flow	kg/s, kg/min, kg/hr, lb/s, lb/min, lb/hr
Heat Flux	kw/m^2, $btu/hr.ft^2$, $cal/sec.cm^2$, w/cm^2
Time	s, min, hr
Concentration	ppm (fixed)

Appendix B Case Type Reference

Table B-1. Case types, their key inputs, and their principal outputs.

Case type	Key inputs	Weather	Principal outputs
BLEVE	Vessel volume, percent liquid, humidity, air temperature	Independent	Absorbed energy, average flux, and dose vs. distance; fireball radius and duration; mortality distances
VCE	Model (BST or QMEFS), cloud volume or mass, congestion parameters, overpressure endpoints	Independent	Overpressure vs. distance; endpoint contour; flame speed
Pool Fire	Pool shape and size, elevations, radiation endpoints	Per condition	Flux vs. distance; overhead and side isopleths; flame length and tilt
Jet Fire	Tip diameter, flow rate, angle, elevations, radiation endpoints	Per condition	Flux vs. distance; overhead and side isopleths; flame length and tilt
Dispersion	Release type, hole and piping geometry, inventory, valves, endpoints, spill surface	Per condition	Transient release rates by phase; concentration vs. distance; cloud footprints; pool vaporization

End of manual.