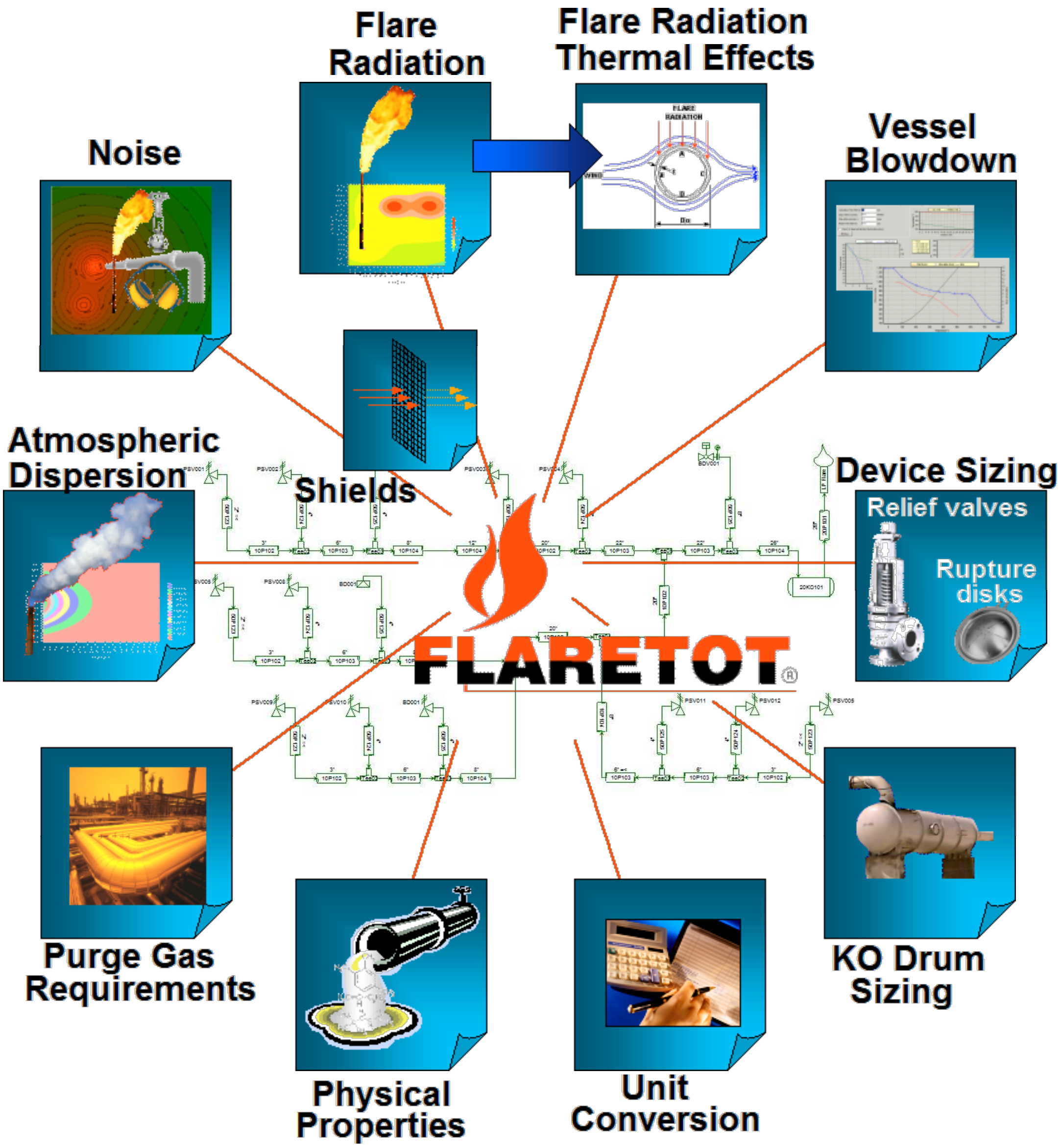
PRODUCT SPEC SHEET

The Flaretot program is designed to solve flare network problems, either for revamp, new networks or system auditing.

- Flaretot is much more than just a flare hydraulic program.
- It includes detailed modules for other aspects of flare and safety related calculations
- These typically require more than one software package to accomplish, but Flaretot achieves this in one software solution.
- The main interface defines the flare network and allows hydraulics to be evaluated for multiple scenarios.
- The data from a solved case is linked to the other surrounding calculation modules.
- The interface and reporting allows for all locale based numerical formats.



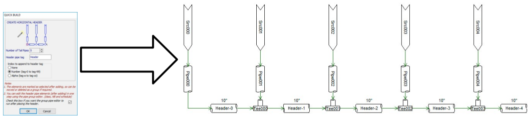
FLARETOT

PRODUCT SPEC SHEET

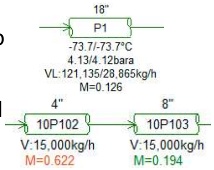
FLARE NETWORK HYDRAULICS

The flare network is defined in the main interface using a network drawing. This means a minimal amount of user training is required to start using Flaretot.

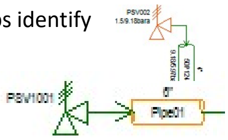
- ❑ Uses a windows style drag & drop interface with on screen connectivity on a fully expandable drawing space.
- ❑ Supports move / copy / paste and grouped operations.
- ❑ Rapid build header tools help quickly define the network.



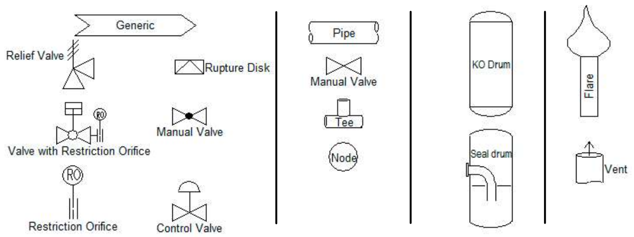
- ❑ Edit pipe common pipe properties as a group to speed up data entry.
- ❑ Provides on screen key properties to help reach a suitable design.
- ❑ Mach number is colour coded based on sizing criteria compliance.



- ❑ On screen colour coded feedback helps identify units with errors or missing data.
- ❑ Pipes exceeding design criteria can be highlighted by colour on the drawing.

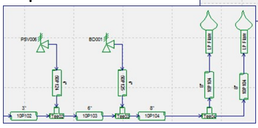


- ❑ Wide choice of units to define the network:

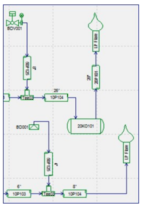


- ❑ Allows looped connections:
  For example parallel headers

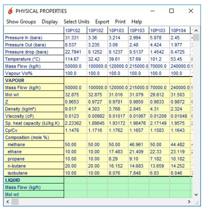
and split flow



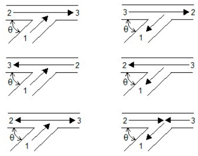
- ❑ Multiple trains can be solved in one file.



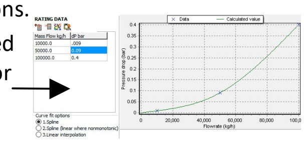
- ❑ Comprehensive reporting on all streams is provided and data can be exported in a spreadsheet (csv) format.
- ❑ Data units for all input and output are fully customisable and can be switched at any time without data reentry.
- ❑ Sizing criteria which exceed design are highlighted in red on the summary.



- ❑ Pipe pressure loss calculations address all possible conditions of flow likely in flare networks, (compressible, two-phase flashing flow & potential for sonic conditions at pipe exits).
- ❑ Effects of pipe heat transfer to atmosphere (including insulation if present) can be modelled.
- ❑ Network piping pressure loss can be calculated for either relief valve source case design flow or rated valve flow. The relief valve rated flow can be calculated automatically from installed valves.
- ❑ Includes rigorous Diers method for pipe pressure loss.
- ❑ Fluid properties for pressure loss calculations generated from composition/ thermodynamics, not by mixing rules.
- ❑ Comprehensive Tee pressure loss calculations covering all combinations and directions of flow.

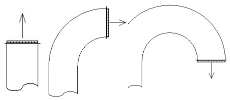


- ❑ Uses Beggs Brill methods for 2 phase loss which is applicable for all pipe inclinations.
- ❑ Flare tip pressure loss calculated as pipe flare, multiple nozzles or pressure loss curves from user data.

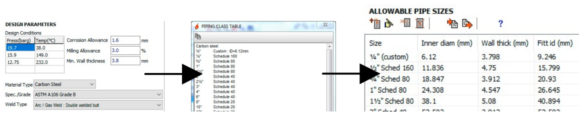


  Loss over purge seals can be included.

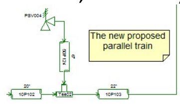
- ❑ Atmospheric vents with 90° bends can be modelled as well as detailed wire mesh screen loss.



- ❑ ASMEVIII, BS5500 and user specified codes are included to calculate allowable overpressure in sources and for device sizing calculations.
- ❑ Design piping individually or a group, to meet any combination of velocity, Mach number, ρv^2, ρv^3 or maximum pipe pressure.
- ❑ Uses pipe classes for automatic selection of pipe size.
- ❑ Mechanical design criteria based classes allow selection from the database of standard pipe sizes. Two typical classes are included in new networks. These classes allow for accurate pipe selection even for study projects.
- ❑ User table pipe classes allow for any allowable pipe sizes and can easily be edited, exported or imported from other sources or even a created directly from a design class



- ❑ Results from the flare network simulation are linked into the calculation modules (such as radiation, noise etc).
- ❑ Notes can easily be added to the network drawing .



IMPORT/EXPORT AND LINK FEATURES

To speed up the build process,Flaretot allows existing network models built in Flarenet ™ to be imported using XML files.

Flaretot models can also be exported to Flarenet ™.

Stream data required to define network sources can be imported and linked to data from process simulators. Supports data from:

- ➢ Hysys ®
- ➢ Pro/II ™
- ➢ Petro-SIM ™

Note that Flarenet™ and Hysys® are registered trademarks of Aspentech. PRO/II™ is a registered trademark of Invensys plc. Petro-SIM ™ KBC Advanced Technologies plc. Reference to these trademarks does not imply any affiliation to, nor endorsement from, any of these products.

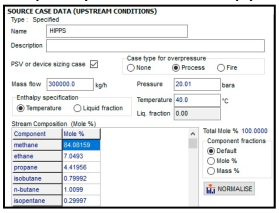
CASE MANAGEMENT

Flaretot has full case management for evaluation of all possible loading on the flare network.

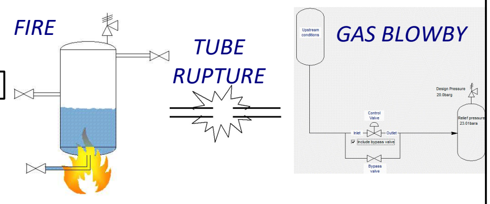
Each network source can contain multiple load cases, (defining flow rate, composition, pressure, temperature or condition)

Source case data can be entered manually

- ❑ Mole or mass % can be used for composition
- ❑ Either temperature or liquid fraction can be used to specify stream enthalpy



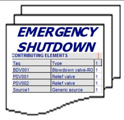
Source cases data can be derived from a linked relief load calculation



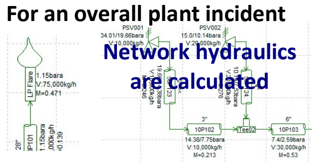
Selected source case data is used for device sizing (relief valves or rupture disks).

Source case data is mapped to an overall plant incident case

For each incident cases, one (or none) of the source cases is active.



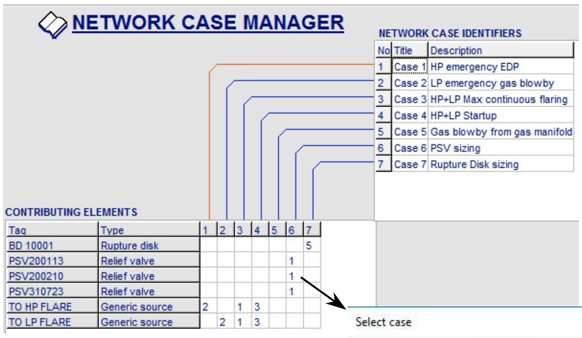
For an overall plant incident



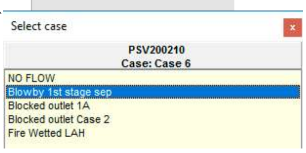
Solved data is linked to calculation modules

- ❑ FLARE RADIATION
- ❑ DISPERSON
- ❑ FLARE/VENT NOISE

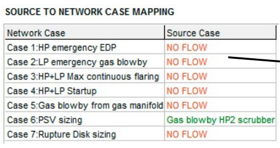
- ❑ Overall plant incident cases are easily defined in a grid based user interface.

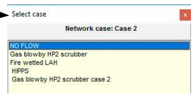


- ❑ Clicking on the grid allows the active source case for a network case to be set easily.

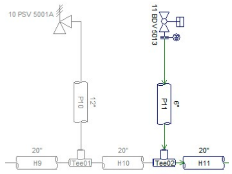


- ❑ Mapping to a network case can also be set in the source properties.





- ❑ Colour coding is used on the drawing to show active / inactive elements in a network case when it is selected.

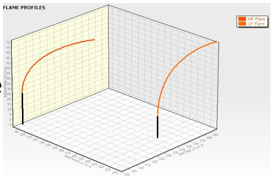


- ❑ Network cases mean flare network hydraulics and environmental impact (radiation, dispersion and noise) can be evaluated for all possible incidents.

FLARETOT	**PRODUCT SPEC SHEET**

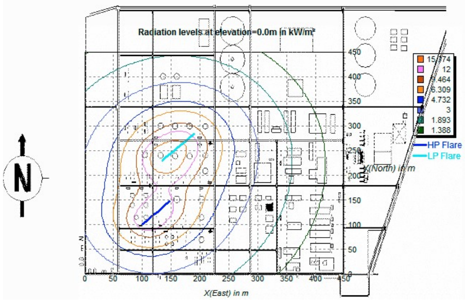
FLARE RADIATION MODULE

Calculates combined contour or point radiation levels and surface temperatures, in 3D space for any number of selected flares using detailed models.

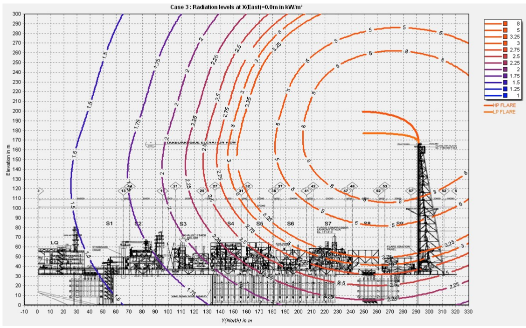


- Calculate flame profiles accurately using a choice of models for both flame profile and flame length. Includes API models for flame profile & length, Brzustowski & Sommer model, and Kaldair /Indair sonic profile & length models.
- Select from 7 models for heat fraction radiated based on gas properties and exit velocity. Provides the Kent, Tan, Cook, Chamberlain, combinations of these, and a proprietary model.
  Comparative values for all methods are presented during selection. Also optionally correct for steam injection.
- Use the IDS (opaque flame) or IPS (transparent flame) models or any combination of the two models (IMS model) for radiation from each section of the flare flame.
- Use up to 100 radiation points along the flame to ensure accurate calculation of radiation contribution from each flame segment (in 3D space) to total target point radiation.
- Takes account of radiation shields attenuation.
- Calculate radiation levels / surface temperatures at any number of target points.
- Surface temperature calculations use linked user definable surfaces, so properties only need to be entered once.
- Surfaces support variable emissivity with temperature. Important for steel, as ε varies significantly in the range of typical flare radiation/ temperatures. Ensures more accurate temperature predictions.
- Temperature calculations use detailed natural and forced convection heat transfer coefficient calculations.

- Sources gas properties data are derived directly from the flare network.
- Size flare stack height to required radiation levels at any target point.
- Generate plan and side view contours of radiation or surface temperatures, with overlay onto equipment layouts or plot plans.



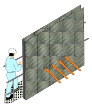
- Contour plots include the flame profile
- Side view can be from East or North direction.

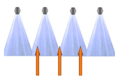


SHIELD MODULE

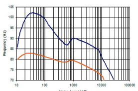
Allows definition of shields in 3D space which contribute to radiation and noise attenuation.

- Allows both fixed (mesh) and water spray type shields

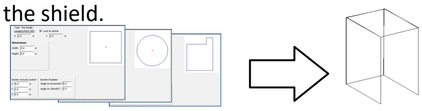




- Models frequency dependent noise attenuation

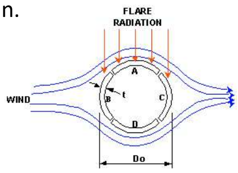


- Build the shields from basic shapes rotated into 3D space.
- Use square, circular or polygon shapes to define the shield.



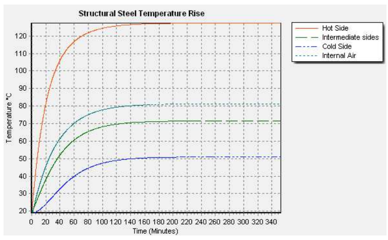
MODULE FOR RADIATION EFFECTS ON STRUCTURAL STEEL

Predicts the temperature rise with time of a tubular structural steel element resulting from flare radiation.



- Uses a rigorous four quadrant model to calculate all aspects of heat transfer (radiant, conductive, forced and natural convection).
- Heat transfer coefficients and air physical properties are calculated internally so minimises user input.

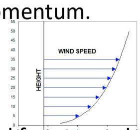
- Results are presented in both chart and tabular form.



FLARE AND VENT DISPERSION MODULE

Calculates combined pollutant concentrations and % of LEL (lower explosive limit) in 3D space for any number of flares or vents.

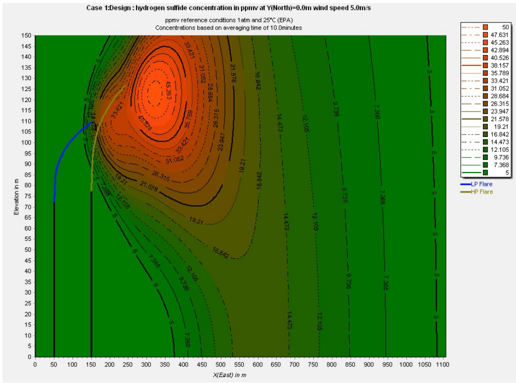
- ❑ Uses a combination of the Briggs equations to determine the plume profile, accounting for both buoyancy and momentum.
- ❑ Wind speed is corrected for elevation with adjustment for terrain type.



- ❑ Uses a 3D gaussian dispersion model corrected for atmospheric and terrain conditions.
- ❑ Atmospheric conditions are specified by Pasquill stability class which can be determined by the SRDT method or temperature gradient. Specified stability classes are validated for wind speed.
- ❑ Both flame-out and flared conditions are supported.
- ❑ Flared gas temperature is calculated from gas composition and excess air.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$: NHV = 802909.35J/mol
$C_3H_4 + 4O_2 \rightarrow 3CO_2 + 2H_2O$: NHV = 1857700.0J/mol
$C_6H_{14} + 9.5O_2 \rightarrow 6CO_2 + 7H_2O$: NHV = 3889532.34J/mo
$H_2S + 1.5O_2 \rightarrow H_2O + SO_2$: NHV = 518920.0J/mol

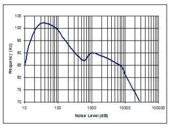
- ❑ Several pollutant concentration reporting standards are supported as well as correction for sampling time.
- ❑ Sources gas properties data directly from the flare network.
- ❑ Calculate pollutant concentration and % of LEL at any number of target points.
- ❑ Generate plan and side view contours with overlay onto plot plans or terrain maps.



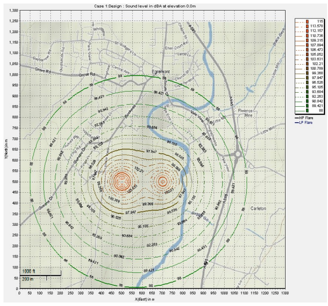
FLARE AND VENT NOISE MODULE

Calculates combined noise in 3D space from any number of flares or vents

- ❑ Calculates both jet and combustion noise (for flares)
- ❑ Takes account variation of noise power with frequency.
- ❑ Typical flare noise spectrum for flare combustion noise included, but can be user supplied



- ❑ Calculates frequency dependent attenuation due to atmosphere by ISO 9613.
- ❑ Use either A or C frequency weighting standards.
- ❑ Size flare stack to meet maximum allowable noise.
- ❑ Generate plan and side view contours with overlay onto plot plans or terrain maps.



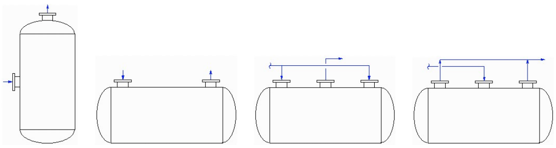
PRODUCED NOISE MODULES

- ❑ Calculate noise power level exceeding the design limit.
- ❑ Calculate noise generation due to high velocity in piping.

KNOCK OUT DRUM SIZING MODULE

Size knockout drums in piping network / standalone calculations.

- ❑ Size vertical or horizontal drums, including 3 nozzle horizontal drums with centre or outer feed.



- ❑ Calculate required nozzle sizes.
- ❑ Calculate required vessel wall thickness from stress data. Typical library of stress data provided.
- ❑ Horizontal drum sizing tabulates shell weight for various L/D ratios to allow optimisation of the cost based on material requirements.

FLARE SYSTEM PURGE RATE MODULE

Calculates required flare network purge rates using 3 methods (Husa, Tan and alternative modified methods).

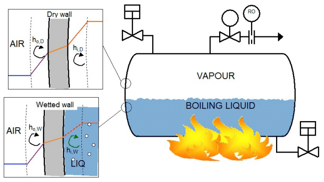
UNIT CONVERSION MODULE

Aside from the ability to select custom units for the flare network, Flaretot also offers a unit conversion module covering conversion from a wide range of other units.

VESSEL BLOWDOWN MODULE

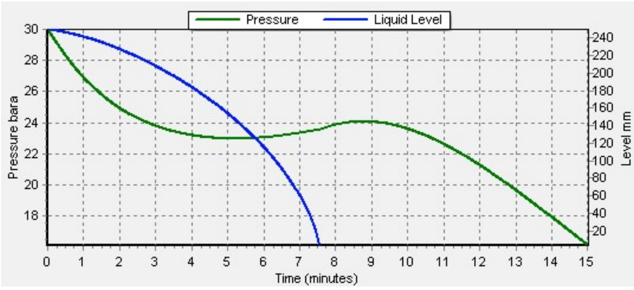
Calculates depressurisation of pressure vessels to assess blowdown time and vessel wall temperatures.

- ❑ Uses a rigorous component property and phase model with unsteady state wall and insulation heat conduction.

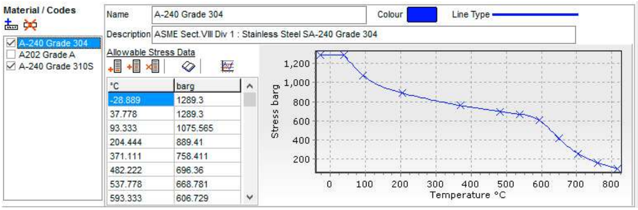


- ❑ Heat transfer coefficients can be calculated or derived from API521 equations for heat input.
- ❑ Depressurisation of vertical, horizontal and spherical vessels can be modelled, including associated piping & equipment.
- ❑ Where liquid or water is present, the initial inventory is calculated based on liquid levels rather than specifying the overall system composition. This makes it easy to evaluate alternative liquid level cases (since liquid and especially water has a significant effect on the system behaviour).
- ❑ Depressurisation device can be modelled as:
  - ➢ A restriction orifice with calculated or specified Cd. Includes adjustment for pipe and orifice thermal expansion.
    Tailpipe can be included but must be > orifice.
  - ➢ Control valve, modelled using the ISA equation. Cv can be calculated from % open and valve recovery factor can be from a C1,Cg or Xt value. Database of typical control valves is provided for quick estimates.
    Control valve integral fittings can be modelled.
    Tailpipe can be included and allows use of reduced diameter pipes.
  - ➢ The depressurisation device can be omitted and modelled as a reduced size pipe arrangement only.

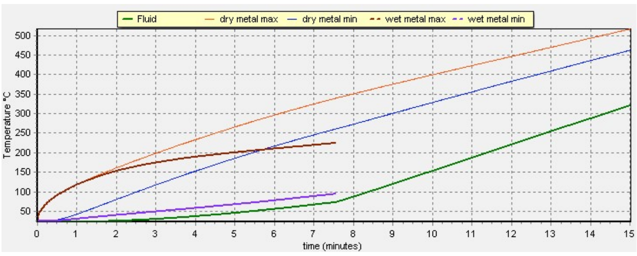
  Device flow calculations use detailed sizing equations rather than generic.
- ❑ Where an orifice is used, a quick estimate of approximate size can be made based on blowdown time required.
- ❑ Fire conditions and normal blowdown conditions are supported to evaluate both minimum and maximum possible wall temperatures. Fire exposure to vessel can be adjusted based on vessel elevation.
- ❑ Possibility of liquid entrainment in the vapour during depressurisation can be included.
- ❑ A library of wall and insulation material properties for heat conduction is provided to minimise data requirements.
- ❑ Comprehensive output is given in chart and tabular form.



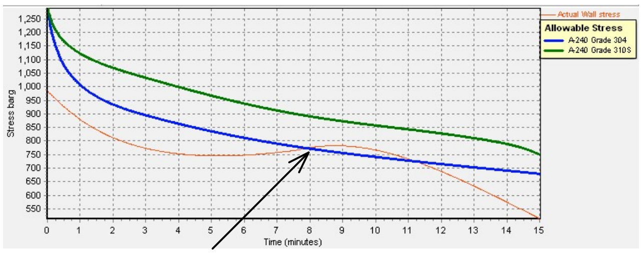
- ❑ Metal wall stress calculations are included to indicate possible wall failure during depressurisation due to elevated wall temperatures resulting from fire exposure.
- ❑ Multiple materials can be selected for stress evaluation and a library of typical material stress is provided.



- ❑ Based on wall temperatures and pressure:



Allowable stress for selected materials, based on wall temperature (as above), is charted with actual wall stress.

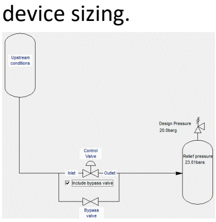


This highlights possibility of wall failure. As in the above example, where wall stress exceeds that allowable for SS304.

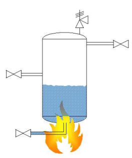
RELIEF LOAD MODULE

The detailed relief load calculations provide load flow rate and properties for cases in network sources and device sizing.

- ❑ **Gas blowby** calculation is defined on a graphic interface.
  - ➢ Uses rigorous control valve rating
  - ➢ Bypass valve can be included
  - ➢ Has library of typical control and bypass valve data.



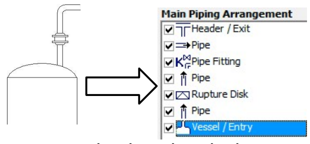
- ❑ **Tube rupture** calculation includes rigorous DIERS method for all phases, allowing for flashing flow or retrograde condensation.
- ❑ **Fire relief** calculation covers vessel and surrounding equipment and includes standard API512 methods as well as a more detailed heat transfer based model.



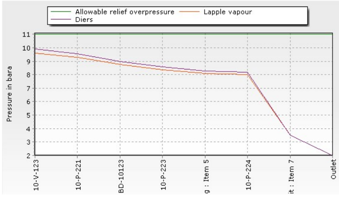
RUPTURE DISK SIZING MODULE

Sizes rupture disks and associated piping for multiple cases.

- ❑ Includes coefficient of discharge (Kd) and flow resistance (Kr) methods.
- ❑ Kr method uses detailed pipe installation model (not combined K)



- ❑ Covers all flow regimes with DIERS method and includes ideal adiabatic gas and incompressible flow methods.
- ❑ Beggs Brill 2 phase method allows for all pipe inclinations.
- ❑ Piping pressure profile can be viewed in chart form.

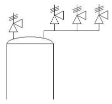


- ❑ Outlet header pressure can be linked to network hydraulic calculation.

RELIEF VALVE SIZING MODULE

Sizes relief valves and associated piping for multiple cases.

- ❑ Supports ASME VIII multiple set pressure arrangements & supplemental fire valves.



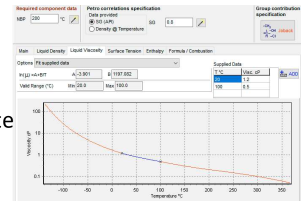
- ❑ Allows user specification of case overpressure (process, fire & multiple valves) for non ASME VIII / BS5500 codes.
- ❑ Relief valve set pressure can be specified for secondary valves in multiple valve arrangements. (Allows for non ASME VIII codes)
- ❑ Rigorous sizing using enthalpy integration (DIERS) method with HEM or frozen composition models.
- ❑ Includes API520 ideal sizing methods & liquid capacity certification.
- ❑ Valve selection from API526 database provided with service (Service temperature/set pressure) suitability check.
- ❑ Relief valves specification can be edited for valves which do not conform to API526, including non standard orifice sizes.
- ❑ Smart selection of valve configuration includes alternative arrangements to minimise excess area.
- ❑ Rigorous pipe installation rating (from inlet to header) as per rupture disk sizing.
- ❑ Pipe installation rating can be calculated with relief valve rated flow or case design flow and outlet header pressure can be linked to network hydraulic calculation.
- ❑ Pipe installation rating includes check on inlet piping loss based on % of recoverable loss .
- ❑ Produces datasheets in API or custom format.

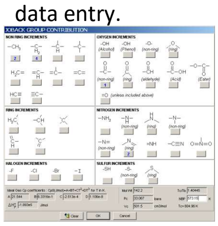
PHYSICAL PROPERTIES

Flaretot uses a built in component based physical property calculator with 312 library components to generate all physical properties, phase and thermodynamic data.

- ❑ Library components can be located easily using name/synonyms, formula or CAS number.
- ❑ Uses Peng-Robinson EOS for vapour liquid equilibria and vapour density.
- ❑ Uses Lee-Kesler for enthalpy and entropy.
- ❑ Supports petro / user components with a flexible user/petro component interface.
- ❑ Combine Petro, API and Joback group contribution methods for key user component properties.
- ❑ User component temperature dependent data can be calibrated with known data.

This data is presented in chart form to provide the user with an insight into the predicted data to help prevent inaccurate data entry.





- ❑ The Joback group contribution method is presented in a clear diagrammatic form.

PHYSICAL PROPERTY CALCULATOR MODULE

Displays physical properties for a specified composition.

- ❑ Generate 17 mixture properties and 8 vapour / liquid properties for a composition, temperature & pressure.

PROPERTIES (Overall)

Property	Unit	Value
1. Molecular Weight		43.564
2. Critical Pressure	bara	46.76
3. Critical Temperature	°C	73.37
4. Critical Volume	cm3/mol	184.54
5. Acentric Factor		0.155
6. Normal boiling point	°C	-55.09
7. Liquid fraction(molar)		0.5706
8. Liquid fraction(mass)		0.6434
9. Bubble point	°C	-4.4
10. Dew point	°C	86.64
11. Vapour pressure	bara	55.85
12. Net Calorific Value(gas)	kJ/kg	39425.186
13. Gross Calorific Value(gas)	kJ/kg	42832.748
14. Lower Flammability Limit (in air)	%	2.72
15. Upper Flammabilty Limit (in air)	%	11.63
16. Stoichiometric Air for combustion	mol/mol	20.0654
17. Enthalpy	kJ/kg	232.087

Properties of vapour and liquid

Property	Unit	Vapour	Liquid
1. Molecular Weight		36.177	49.123
2. Compressibility		0.7865	0.11011
3. Density	kg/m³	50.576	490.536
4. Viscosity	cP	0.0123	0.0719
5. Specific Heat Capacity	kJ/kg.K	2.03	2.692
6. Cp/Cv		1.354	
7. Surface tension	dynes/cm		5.53
8. Enthalpy	kJ/kg	390.279	144.413

- ❑ Create tables of physical property data for temperature and pressure ranges, isenthalpic , isentropic or polytropic paths.
- ❑ Create standard phase envelopes or full 3 phase maps.