

in:Flux - Intelligent CFD Software

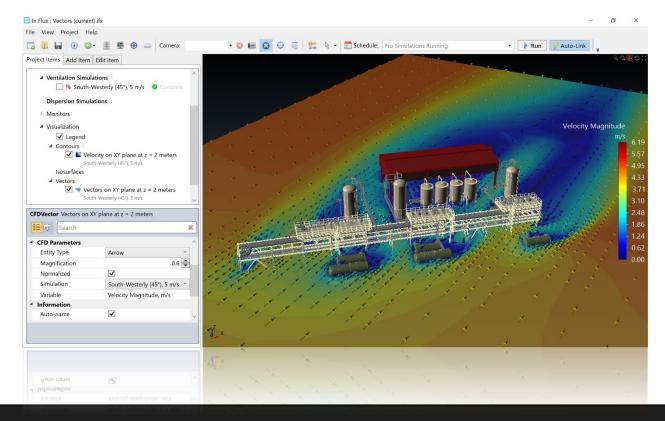
Developed by Insight Numerics

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insight numerics

Introduction to in:Flux

in:Flux is an automated and intuitive CFD software product to be used for dispersion and ventilation studies. It is developed entirely by Insight Numerics.





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Where is Insight Numerics used?

• Our software has been used on projects worldwide for BP, Shell, Chevron, Petronas, ADNOC, Petrobras, Maersk and many more.

The Americas

TechInt – Pluspetrol Plant ALPEK – FGRU Indelpro SOFEC – several projects Petrobras/MODEC – FPSO Cidade de Caraguatatuba Petrobras/MODEC – FPSO Carioca MV30 Petrobras – FPSO Cidade de Marica Petrobras – FPSO Cidade de Ilhabela

Asia

BP – South Caucasus Pipeline Expansion Chevron/TCO – Kazaskhstan Project GAZPROM – Badra-Zubaida Pipeline

Europe

Equinor (Statoil) – Johan Sverdrup Platform Maersk – Culzean Platform & FSO Ineos – Grangemouth Apache – multiple projects Technip/JGC – Coral South Development Project BP – West Sole Charlie Platform Perenco – several projects Novo Nordisk – API Manufacturing Maersk (Total) – Tyra Platform

East Asia

COSCO Shipyard – FPSO HHI – multiple projects Seoul National University

SE Asia

PETRONAS - FLNG 2 ThaiOil – Clean Fuels Project Vestigo - MaMPU FPSO Pertamina – PPP JX Nippon – Helang Project HESS – Anggerik WHP Platform Linde/Petronas – Marlin BOG LNG

GCC Countries

KNPC – Clean Fuels Project KNPC – Al-Zour Refinery KOC – multiple projects ADNOC – Abu Dhabi Airport Exp. ADNOC – UZ750 GASCO – Habshan Plant GASCO – ICAD Gas Treatment GASCO – Taweelah TGC Project Dubai Petroleum – Fateh Complex BP – Khazzan Project ORPIC – Liwa Plastics Complex ORPIC – Mina Al Faha Refinery Takreer – Ruwais Refinery DUQM – Package 3 EgyptianLNG – reassessment project

Africa Shell – SSAGS Total – CLOV FPSO Chevron – Cabinda Platform Eni – Coral South Development

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Why use in:Flux?

- Virtually all setup is automated, including domain sizing, meshing, boundary conditions, numerical setup and post-processing.
- Over 100 simulations can be set up in less than 5 minutes.
- in:Flux is very fast compared to other CFD software ventilation simulations take 2-10 minutes, while dispersion simulations are typically 10-30 minutes.
- Once simulations have started, they require no additional monitoring.
- On a single analysis machine, more than 100 CFD simulations can be run in a single day.
- All simulations are saved in a single compact file, which makes data management easy. No CFD expertise is required – the automatic setup ensures very high quality CFD simulations.



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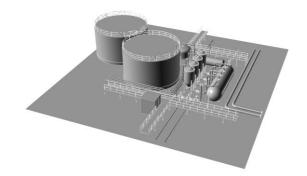
in:Flux Capability Overview

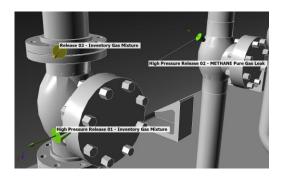


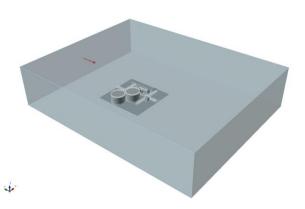
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in:Flux Inputs

- The required user inputs are:
 - 1. 3D CAD file
 - 2. Knowledge of process conditions (pressure, temperature, inventory) and required leak locations.
 - 3. Knowledge of the site atmospheric conditions, such as a wind direction and wind speed
- All of the above user inputs are typically required for CFD projects, even if the project is outsourced.





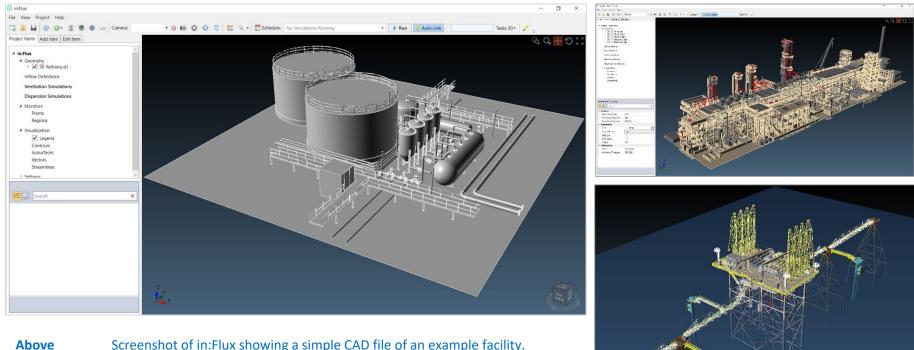


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CAD Import

Via the DGN file import, in:Flux can load CAD from **PDMS** and **SmartPlant3D**. **Navisworks** (NWD) files can be imported via DWF files and AutoCAD DWG, DXF and other standard CAD formats (STEP, IGES, OBJ and STL) are also accepted.



Right

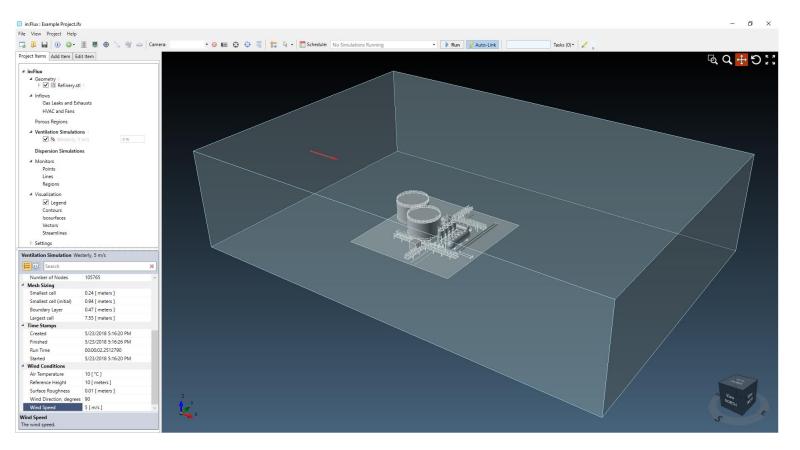
Screenshot of in:Flux showing a simple CAD file of an example facility. Other examples of CAD models loaded into in:Flux. There is no limitation to size or complexity of the CAD model which can be loaded.





Automatic Domain Sizing

Once CAD has been loaded into the software, ventilation simulations can be defined simply by choosing a wind direction and wind speed.

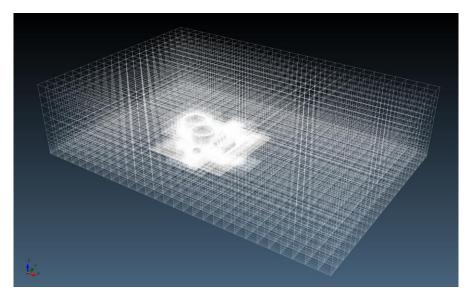


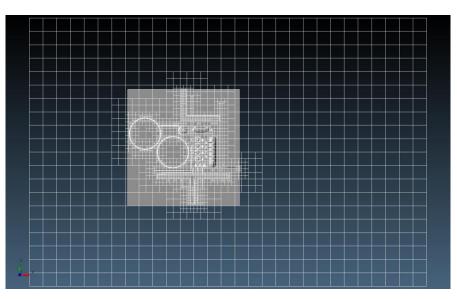


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Automatic Meshing

The mesh initially refines around the geometry, and includes boundary-layer grading from the ground to capture the high gradients.



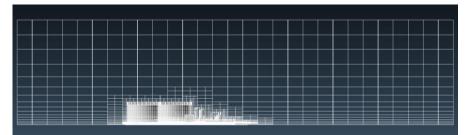


Above and Upper Right

Top and isometric views of the mesh around the CAD model.

Right

Side view of the auto-generated mesh around a CAD model. Showing refinement at the base to accurately calculate the boundary layer.

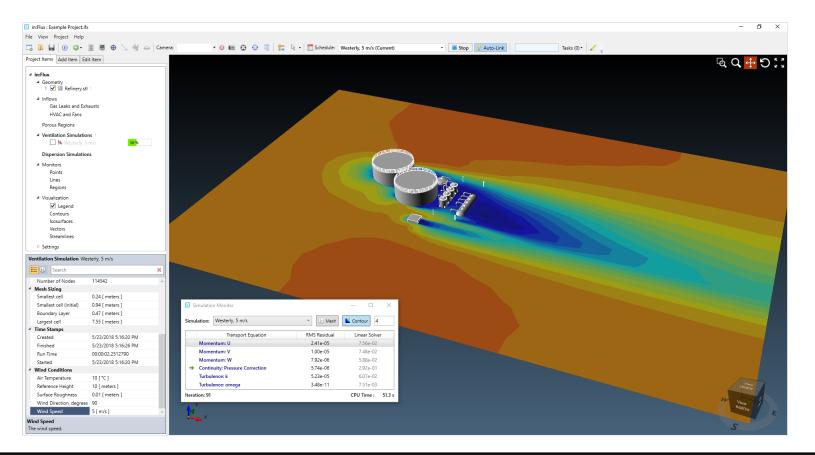




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Running a Ventilation Simulation

The simulation will automatically start – there is no need for any additional setup. Residuals, and flow, can be monitored as the simulation progresses.

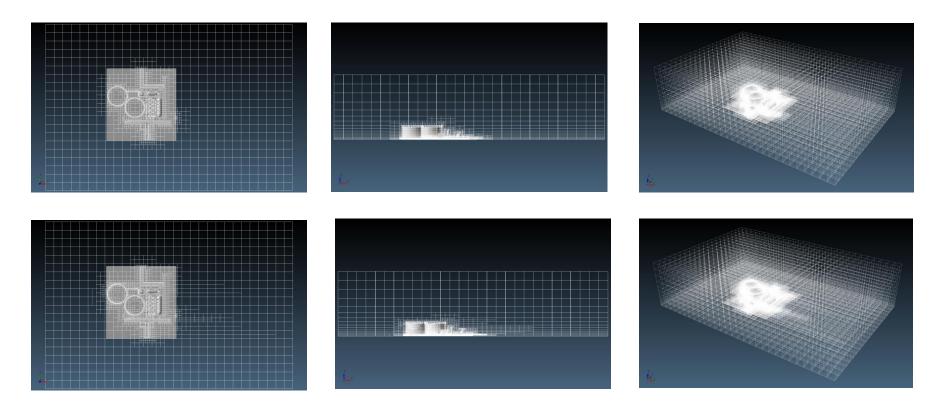




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Adaptive Meshing - Ventilation

• While the simulation is running, the mesh automatically refines around regions of high gradient. Below are screenshots of before the simulation starts and after it has finished.

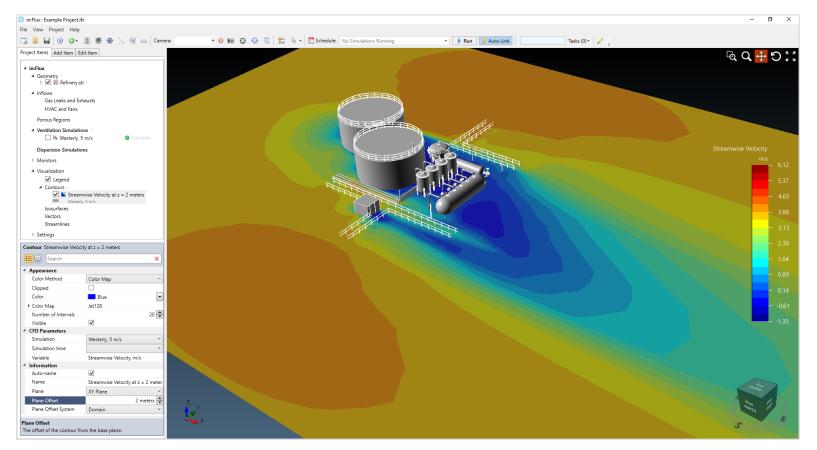




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Post-Processing: Contours

When the simulation is complete, a variety of post-processing options are available, including contours:

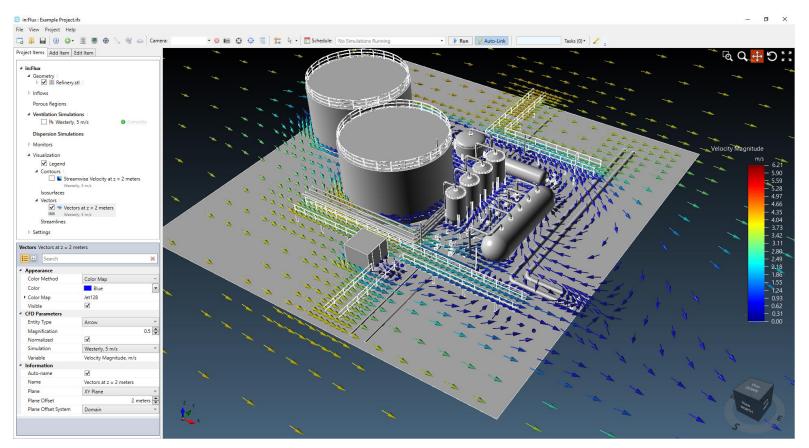




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Post-Processing: Vectors

The vector field shows local flow regions around the equipment and are colored corresponding to the magnitude value.

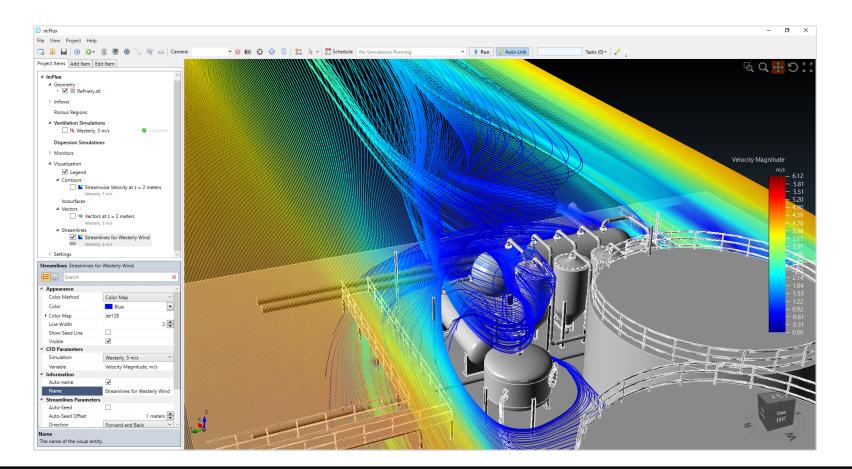




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Post-Processing: Streamlines

Streamlines are useful to show circulation regions and flow through the domain:

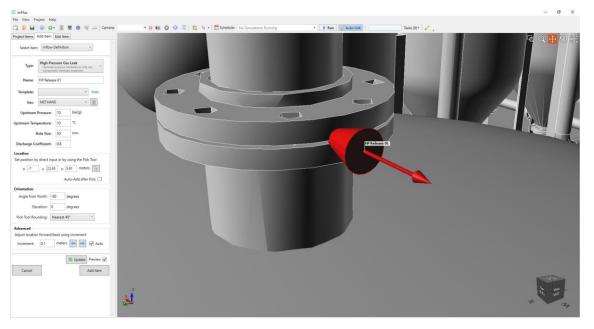




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Defining Leak Sources

- Gas leaks can be defined by clicking anywhere on the CAD model and entering an upstream pressure value, temperature and composition.
- Alternatively, HVAC fans and emission sources such as exhaust plumes and can be set.
- Multi-component gases can be defined. The gas properties use the DIPPR database.

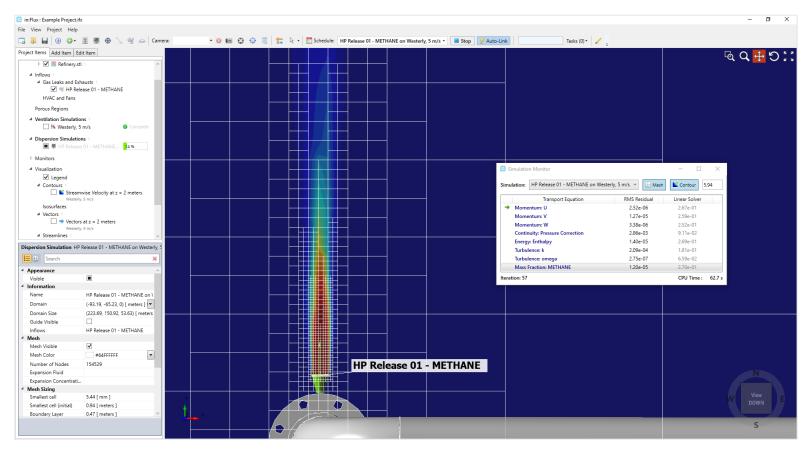




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Running a Dispersion Simulation

A dispersion simulation is defined simply as a combination of a leak source and a wind simulation. No further setup is required.

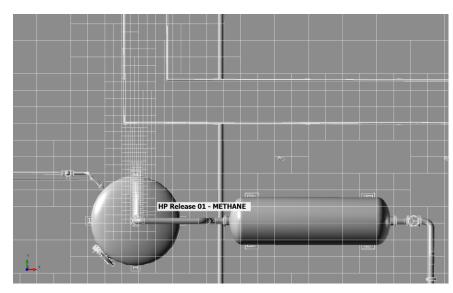




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Dispersion Simulation Meshing

For dispersion simulations, the mesh adapts around regions of high concentration gradient. The mesh can be set to automatically expand to include certain concentrations. Minimum mesh size is 0.1 times the diameter of the leak.

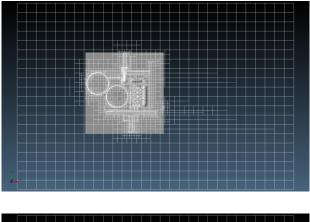


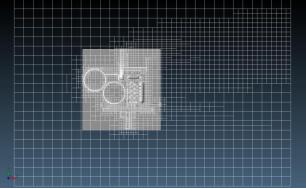
Above

Zoomed in view of mesh at leak location. The mesh will refine itself as the calculation progresses

Upper Right and Right

Top view of the auto-generated mesh at start of dispersion simulation (upper right) and after the simulation has completed (right).



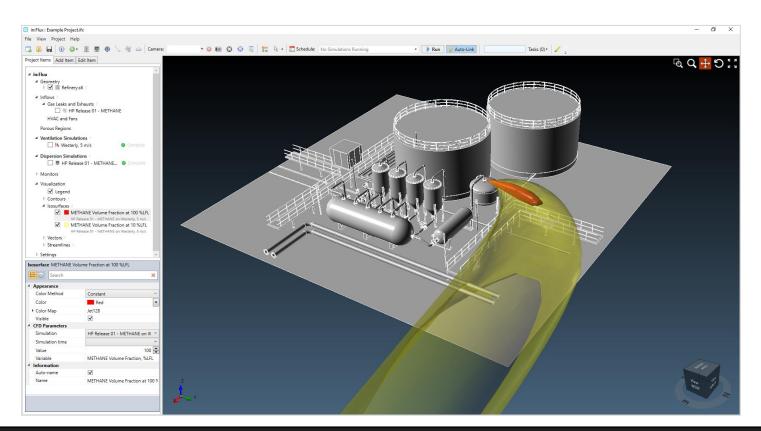




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Post-Processing: Isosurfaces

Isosurfaces are useful to show the dispersed gas clouds. These can be set up as concentrations of %volume, ppm, %LEL and %UEL. The below image shows a 100% LFL cloud in red and a 10%LFL cloud in transparent yellow.

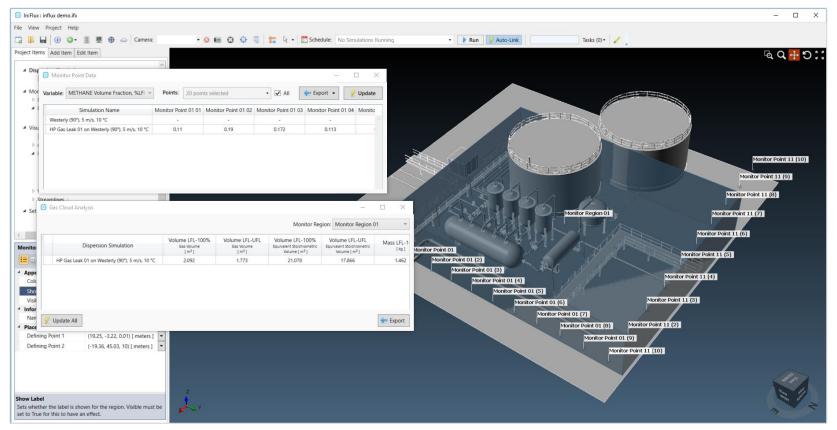




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Post-Processing: Gas Monitors

Monitor points provide spot measurements of concentrations, while monitor regions can be used to calculate cloud volumes. All data is exportable to Excel. There is no limit to the number of monitors in an in:Flux project.







Multi-Run Project

The example simulation in this presentation has shown one ventilation and one dispersion. However, with just a few clicks, it is easy to setup over 100 simulations. Multiple simulations will run sequentially using the simulation scheduler, shown below, without the need of scripting.

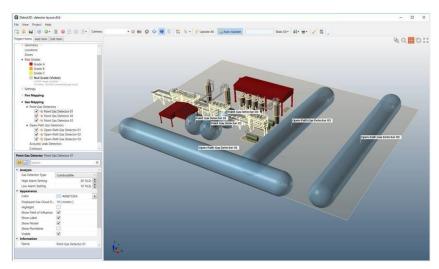
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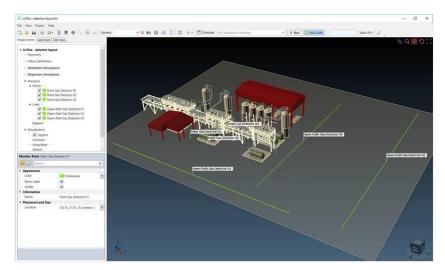
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Detect3D and in:Flux Integration

- Once a CAD file has been loaded in either software, it can be transferred without the need to import the original CAD file
- For scenario gas mapping, point and open path gas detectors can be imported from Detect3D to in:Flux as monitor point and monitor lines to received %LFL and LEL.m data



Detect3D – CAD model, point and open path gas detectors positioned in project



in:Flux – CAD model imported from Detect3D as well as the gas detectors. Detectors now show up as monitor points and monitor lines, shown in yellow above.



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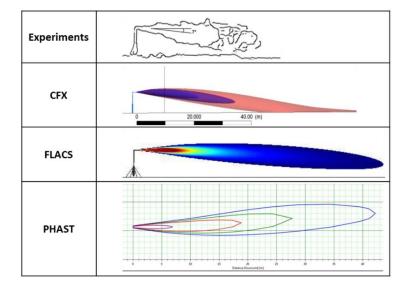
Validation

- in:Flux has been compared to known data for jet leaks, and performs as well as other CFD software such as Ansys-CFX and OpenFOAM.
- A variety of experimental data has been used to validate in:Flux, and it has performed as well, or better, than other CFD software.



Above - Experimental rig for LNG vapor release (18" vertical plume shown), Ref [1].
Top Right - Plume paths for various models tested in Ref [1], horizontal 6" diameter release.
Bottom Right – Results from . Plume path for in:Flux, horizontal 6" diameter release.

Ref [1] - Quillatre, P. Relevance of the current modeling methods for the prediction of LNG vapor dispersion and development to be carried on. IChemE Symposium Series No. 162, Hazards 27 Conference, 2017.







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in:Flux Technical Details

- in:Flux solves the 3D Reynolds-Averaged Navier Stokes (RANS) equations.
- The RANS equations are closed using the SST turbulence model with standard wall functions.
- Pressure-velocity coupling uses the SIMPLE algorithm.
- Buoyancy effects due composition and temperature are included using a full buoyancy model.
- Numerical discretization is second-order, using second-order upwind for convection and central differencing for diffusion.
- The Immersed Boundary Method (IBM) is used to account for geometry. Porous regions are not used.



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Recent and Future Developments

- As of January 2019, in:Flux now comes included with:
 - Navisworks (NWD) import via .dwf files
 - Risk-based CFD analysis
 - Gas Detector Optimization Capability using CFD
 - Internal Ventilation capabilities (including HVAC and flow-through fans)
 - Transient Simulations, including shut-down
- Future developments planned for in:Flux include:
 - Multi-phase leaks (sprays, rain-out etc.) and associated physics.
 - Modeling for jet and pool fires
 - Much more...
- The long term goal for Insight Numerics is to develop an explosion capability within in:Flux.
- As the sole developers of in:Flux, Insight welcomes feedback from its users to further develop the software.



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Next Steps...

- in:Flux can be downloaded by registering on <u>www.insightnumerics.com</u>
- Upon registration, approved users receive a free 10-day evaluation license which give access to tutorials, user guides, and example CAD files
- Check out our <u>YouTube Channel</u> for how-to videos and descriptions
- To hear about Insight Numerics and our products' capabilities, sign up for our newsletter or contacts us at

info@insightnumerics.com





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