

in:Flux for F&G Mapping

Developed by Insight Numerics

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Implementation of in:Flux

- in:Flux has been designed to enable safety engineers to quickly and efficiently perform CFD studies for dispersion and ventilation analysis which can be used for F&G mapping (FGM).
 - Many performance standards are now requiring scenario or performance based methods for F&G mapping, e.g. TR84.00.07 and BP GP 30-85 (v2018).
- It is important to identify areas where gas clouds might accumulate when performing FGM analyses.
 - Ventilation simulations can assist in determining stagnant regions.
- Gas leaks can be simulated in any direction on flanges, valves, etc. to determine the resulting gas cloud.



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Implementation of in:Flux

- Data such as %LFL, %UFL, %vol, and ppm of the gas cloud can be viewed at defined gas detector locations.
- Probability data can be associated with simulations to perform riskbased mapping. Detectors can be placed in optimal areas to reduce the overall risk of hazardous events.
 - Automatic optimization algorithms can be applied to maximize detector effectiveness.
- Analyses can be combined with **Detect3D** to assess both flame detector and gas detectors using the geographic mapping method.



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in:Flux FGM Analysis Steps

- 1. Import or create 3D model.
- 2. Create ventilation simulations to determine stagnant regions.
- 3. Define inventory (gas composition).
- 4. Define gas leaks (location, orientation, leak size, etc.).
- 5. Create dispersion simulations
- 6. Define monitor points (point gas detectors), monitor lines (open-path gas detectors), and monitor regions to analyze gas cloud volumes.
- 7. Review completed simulation data.
 - a. 100% LFL gas cloud isosurface
 - b. 10% LFL gas cloud isosurface
 - c. LFL, %vol, and ppm data at Monitor Points
 - d. LFL, %vol, and ppm data at Monitor Lines
 - e. Stoichiometric Gas cloud volumes for Monitor Regions
- 8. Output results to Excel and screenshots of visuals.
- 9. (Optional) Implement risk data for simulations to generate risk matrix and optimize gas detector placements to reduce overall risk.



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1. 3D Model Import

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





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1. 3D Model Creation

• Geometry can be created directly in in:Flux – simple models can be built from drawings or plot plans when CAD files are not available. The created geometry can also be merged with CAD imported into the project.





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2. Ventilation Analysis

- Wind speed and direction are the only inputs necessary for ventilation simulations.
 - Complexities of the simulation are handled automatically (meshing, boundary conditions, numerical setup, etc.).



in: Flux interface displaying a contour and simulation monitor of the currently calculated ventilation for a westerly wind case.



 $\label{eq:sometric} Isometric view of the automatically generated mesh around the CAD model$



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2. Ventilation Results

- Post processing visualization such as contours and vectors provide information on regions with low or stagnant wind speeds in the facility.
 - Stagnant regions are often good locations for detectors.



Contour showing the streamwise velocity at a 3m height across the facility for a westerly wind at 5m/s



Vectors indicating direction of the wind flow at a 3m height for a westerly wind at 5m/s $\,$



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3. Gas Inventory Definition

- Many standard fluids are included from the AIChE DIPPR database.
- Custom gases and multi-component gases can also be defined.

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I Eluid Databases - X
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Select Item: Gas Definition HYDROGEN CHLORIDE, CIH Molecular Mass: 36.46 kg/mol LFL: 0.00 %vol Certific Mass: 36.46 kg/mol LFL: 0.00 %vol Certific Mass: 36.46 kg/mol LFL: 0.00 %vol
Type: Multi-Component Gas Mixture V Molecular Viscosity: 1.44e-05 Pa.s at NTP OFE 000 %V01 Thermal Conductivity: 0.0142 W/m.K at NTP CASN: 7647-01-0
Name: Example Mixture HYDROGEN FLUORIDE, FH Molecular Mass: 20.01 kg/mol LFL: 0.00 %vol Specific Heat Capacity: 1456 J/kg.K at NTP UFL: 0.00 %vol UFL: 0.00 %vol
Mixture: METHANE 90 [%vol] Molecular Molecular Viscosity: 1.08e-05 Pa.s at NTP Stoichiometric: 0.00 %vol ETHANE 5 [%vol] Thermal Conductivity: 0.0191 W/m.K at NTP CASN: 7664-39-3
PROPANE 4 [%vol] HYDROGEN SU 1 [%vol] Molecular Mass: 127.91 kg/mol LFL: 0.00 %vol Specific Heat Capacity: 228 J/kg.K at NTP UFL: 0.00 %vol Molecular Viscosity: 1.87e-05 Pa.s at NTP Stoichiometric: 0.00 %vol Thermal Conductivity: 0.006 W/m.K at NTP CASN: 10034-85-2
Add Gas: HYDROGEN SULFIDE Image: Superscript of the second
LFL: 4.59 %vol HYDROGEN SULFIDE, H2S UFL: 14.61 %vol Molecular Mass: 34.08 kg/mol LFL: 4.30 %vol Stoichiometric: 9.12 %vol Specific Heat Capacity: 1001 J/kg.K at NTP UFL: 45.50 %vol Molecular Viscosity: 1.24e-05 Pas at NTP Stoichiometric: 0.00 %vol Thermal Conductivity: 0.0141 W/m.K at NTP
Cancel Add Item



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4. Definition of Gas Leak Locations

- Gas leaks are defined by clicking anywhere on the CAD model and entering an upstream pressure value, temperature and composition.
 - Leaks can be positioned in ANY direction or angle
- HVAC fans and emission sources such as exhaust plumes can also be set.





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5. Dispersion Analysis – Setup and Calculation

- A dispersion simulation is created by combining a gas leak with a wind simulation. No further setup is required.
- The mesh will adapt itself throughout the domain and can be set to automatically expand to include certain concentrations.



Above - Zoomed in view of mesh and mass fraction contour at a 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).







6. Monitor Definition

- Monitors provide measurements of concentrations and cloud volumes. All data is exportable to Excel. There is no limit to the number of monitors in an in:Flux project.
 - Monitor Points (top) can be used to represent point gas detectors and provide spot measurements of variables such as %LFL, %UFL, %vol, and ppm
 - Monitor Lines (middle) can be used to represent open-path gas detectors and provide min, max, averaged and integrated variable data such as LFL.m
 - Monitor Regions (bottom) provide stoichiometric gas cloud volumes as well as ventilation data such as air changes per hour
- Monitors can be added to the project before, during or after the dispersion calculation has finished.







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7. Review Dispersion Data - Isosurface

• Isosurfaces are useful to show the dispersed gas clouds. These can be set up as concentrations of %volume, ppm, %LFL and %UFL.



100% LFL cloud (red), 10% LFL cloud (blue)



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7. Review Dispersion Data - Isosurface

• For multi-component mixtures, isosurfaces can be generated for any component in the gas individually or as the bulk mixture.



10ppm H2S cloud



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7. Review Dispersion Data - Monitors

- In addition to the visualizations, concentration and volume data (e.g. LFL, %vol, and ppm) at each of the monitors can be obtained and exported to Excel.
 - Monitor Point Data (top window) shows the bulk %LFL value at each point for each dispersion case completed
 - Monitor Line Data (middle window) shows the bulk LFL.m for each line and each case
 - Monitor Region Data (bottom window) shows the calculated gas cloud volumes





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8. Output and Assess Results

- Monitor Data exported to excel will display monitor information about each case simulated.
- Below shows conditional formatting applied to the Monitor Point data indicating which point detectors had the highest %LFL values for the cases simulated.
 - This information can then be used to run more cases and/or reposition monitor points to detect more cases.

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1	Simulation Name	Inflow Name	Hole Size, mm	Flow Rate, kg/s	Wind Speed, m/s	Wind Direction, *	Monitor Point 01 %LFL	Monitor Point 02 %LFL	Monitor Point 03 %LFL	Monitor Point 04 %LFL	Monitor Point 05 %LFL	Monitor Point 06 %LFL	Monitor Point 07 %LFL	Monitor Point 08 %LFL	Monitor Point 0 %LFL	9 Monitor Point 10 %LFL	Monitor Point 11 %LFL
3	Westerly, 5 m/s				5	270											
4	HP Release 01 on Westerly, 5 m/s	HP Release 01	50	3.18043828	5	270	2.409182763	22.61052019	77.99378151	0.020735963	0.154567168	0.763389912	2.21893172	5.656410217	19.95905256	0.182697449	0.029217824
5	HP Release 02 on Westerly, 5 m/s	HP Release 02	50	3.18043828	5	270	47.40753091	37.62643369	37.0607273	48.19993734	0.523824679	2.791966243	14.25900215	30.60463512	29.4719193	0.425870964	0.04350278
6	HP Release 03 on Westerly, 5 m/s	HP Release 03	50	3.18043828	5	270	0.032325342	4.049193212	15.56610416	5.945600893	0.002885689	0.867280243	0.527330595	0.270062519	0.393245133	0.643110947	0.09880251
7 8 9 10	HP Release 04 on Westerly, 5 m/s	HP Release 04	50	3.18043828	5	270	0.081918597	0.247616001	0.049741729	0.009695634	0.009576749	0.017305241	0.027189637	0.138643015	0.381063066	0.001911887	0.001236517



8. Output Screenshots

- Any view in the 3D window of Detect3D can be saved to the clipboard as a screenshot.
- Camera positions of the 3D window can be saved to quickly return to the exact views of exported figures or images.





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8. Output to Detect3D

 For comparison to geographic gas mapping, monitor points and monitor lines can be imported to Detect3D to view achieved coverage percentages.



in:Flux – CAD model, monitor points, monitor lines, and monitor regions defined using in:Flux



Detect3D – in:Flux project imported to Detect3D. Monitors now show up as point gas detectors, open-path gas detectors, and zones.



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- Use the Risk Manager to create all simulations needed for risk analysis:
 - Input wind data from the site (speed, direction, probability)
 - Create leaks and assign frequency data
 - Simulations will be automatically generated to cover all scenarios

K Risk Manager					1.48	<u> </u>							• ×	
eak Frequencies Wind Co	inditions Simulation Summary													A second
High Pressure Leaks														· · · · · ·
HP Release 01	(47 - 17.08 - 0.39) meters	Dr	180	0	10 mm	10 barlol	10 °C	METHANE	v	PIOW Kate	Flange 001	BODE-06 [1/yr]	^ D	
HP Release 02	(4.69, 17.36, 0.79) meters	- Pa	180	90	10 mm	10 bar(g)	10 °C	METHANE	÷	0.121 kg/s	Flange 001 V	8.00E-06 [1/yr]	æ	
HP Release 03	(4.71, 17.67, 0.31) meters	Pg .	0	0	10 mm	10 bar(g)	10 °C	METHANE	÷	0.121 kg/s	Flange 001	8.00E-06 [1/yr]	×	
HP Release 04	(4.69, 13.43, 0.39) meters	Dg	180	0	10 mm	10 bar(g)	10 °C	METHANE	v	0.121 kg/s	Flange 002 v	8.00E-06 [1/yr]		
HP Release 05	(4.69, 13.69, 0.78) meters	Da	180	90	10 mm	10 bar(g)	10 °C	METHANE	÷	0.121 kg/s	Flange 002 ~	8.00E-06 [1/yr]		
HP Release 06	(4.7 . 14.05 . 0.39) meters	L _g	0	0	10 mm	10 bar(g)	10 °C	METHANE	~	0.121 kg/s	Flange 002 ~	8.00E-06 [1/yr]		620 I fr
HP Release 07	(4.7 , 9.91 , 0.45) meters	Da	180	0	25 mm	10 bar(g)	10 °C	METHANE	×	0.755 kg/s	Flange 003 V	9.50E-06 [1/yr]		211
HP Release 08	(4.69, 10.23, 0.82) meters	Da	0	90	25 mm	10 bar(g)	10 °C	METHANE	v	0.755 kg/s	Flange 003 ~	9.50E-06 [1/yr]		HP Release 09
HP Release 09	(4.68, 10.53, 0.38) meters	Dg	0	0	25 mm	10 bar(g)	10 °C	METHANE	×	0.755 kg/s	Flange 003 ~	9.50E-06 [1/yr]		
HP Release 10	(4.68 . 6.12 . 0.46) meters	Dg	180	0	10 mm	10 bar(g)	10 °C	METHANE	¥	0.121 kg/s	Range 004 ~	1.00E-05 [1/yr]		1000
HP Release 11	(4.69 , 6.47 , 0.78) meters	Dg -	0	90	10 mm	10 bar(g)	10 °C	METHANE	×	0.121 kg/s	Flange 004 v	1.00E-05 [1/yr]		
HP Release 12	(4.69, 6.77, 0.48) meters	Dg .	0	0	10 mm	10 bar(g)	10 °C	METHANE	×	0.121 kg/s	Flange 004 v	1.00E-05 [1/yr]		2 12
Property Editor														

Above – Risk Manager Window showing a series of defined leaks, cases can be quickly duplicated and edited in bulk

Upper Right - The Wind Rose tab can be used to set the environmental conditions on the site.

Lower Right - The full scenario matrix combining all leaks and wind data is shown on the final tab. The example shows the 858 simulations to be run.

			410 11110 1010		
	Direction	Probability	<u>e</u>	NORTH	
Southerly (180*)		2.1%	^		
South-Westerly (225	in)	7.0 %		- 208	
Westerly (270*)		8.7 %			
North-Westerly (319	i'')	13.9 %		20.0 %	
1 m/s 5 m/s	5 (m/s) 10 (m/s)	39.0 %	WEST	EAST	
10 m/s		24.4 %	.		
15 m/s		5.5 %	×		

AII S	cenarios								Project Manager
	Name	Wind Condition	Leak	Frequency	Consequence	Risk	In Project		Total Scenarios: 858
	HP Release 01 on Northerly; 3 m/s	Northerly, 3 m/s	HP Release 01	5.43E-07 [1/yr]	1	5.43E-07 [1/yr]	No	^	In Project: 0 (0.0%)
	HP Release 01 on Northerly: 7.5 m/s	Northerly, 7.5 m/s	HP Release 01	4.073E-07 [1/yr]	1	4.073E-07 [1/yr]	No		Selected: 0 (0.0 %)
	HP Release 01 on Northerly. 12.5 m/s	Northerly. 12.5 m/s	HP Release 01	3.394E-07 [1/yr]	1	3.394E-07 [1/yr]	No		Total Frequency: 1055E-04 [10y]
	HP Release 01 on Northerly. 15 m/s	Northerly, 15 m/s	HP Release 01	7.619E-08 [1/yr]	1	7.619E-08 [1/yr]	No		In Depicert, 0110er1 (009)
	HP Release 01 on North-Easterly, 3 m/	North-Easterly, 3 m/s	HP Release 01	6.516E-07 [1/yr]	1	6.516E-07 [1/yr]	No		Felerade 0116x1 2040
	HP Release 01 on North-Easterly, 7.5 r	North-Easterly, 7.5 m/s	HP Release 01	4.887E-07 [1/yr]	1	4.887E-07 [1/yr]	No		Selected: 0 [1/3/] (and we
	HP Release 01 on North-Easterly, 12.5	North-Easterly, 12.5 m/s	HP Release 01	4.0738-07 [1/yr]	1	4.073E-07 [1/yr]	No		Total Risk: 1.065E-04 [1/yr]
	HP Release 01 on North-Easterly, 15 n	North-Easterly, 15 m/s	HP Release 01	9.143E-08 [1/yr]	1	9.143E-08 [1/yr]	No		In Project: 0.00E00 [1/yr] (0.0
	HP Release 01 on Easterly, 3 m/s	Easterly, 3 m/s	HP Release 01	6.082E-07 [1/yr]	1	6.082E-07 [1/yr]	No		Selected: 0.00E00 [1/yr] (0.0
	HP Release 01 on Easterly. 7.5 m/s	Easterly. 7.5 m/s	HP Release 01	4.561E-07 (1/yr)	1	4.561E-07 [1/yr]	No		
	HP Release 01 on Easterly. 12.5 m/s	Easterly. 12.5 m/s	HP Release 01	3.801E-07 [1/yr]	1	3.801E-07 [1/yr]	No		
	HP Release 01 on Easterly, 15 m/s	Easterly, 15 m/s	HP Release 01	8.533E-08 [1/yr]	1	8.533E-08 [1/yr]	No		
	HP Release 01 on South-Easterly, 3 m/	South-Easterly, 3 m/s	HP Release 01	3.258E-07 [1/yr]	1	3.258E-07 [1/yr]	No		
	HP Release 01 on South-Easterly, 7.5 r	South-Easterly, 7.5 m/s	HP Release 01	2.444E-07 [1/yr]	1	2.444E-07 [1/yr]	No		
	HP Release 01 on South-Easterly, 12.5	South-Easterly, 12.5 m/s	HP Release 01	2.036E-07 [1/yr]	1	2.036E-07 [1/yr]	No		
	HP Release 01 on South-Easterly, 15 n	South-Easterly, 15 m/s	HP Release 01	4.571E-08 [1/yr]	1	4.571E-08 [1/yr]	No		
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 Once the simulations have completed, risk-based visualizations such as exceedance of gas concentrations can be displayed with contours or isosurfaces.



20% LFL methane concentration by frequency



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- Optimal gas detector layouts are created using the optimization tool for a given zone.
 - Input alarm levels for point/open-path, coverage targets, and the basis for the optimization (scenario/frequency/risk)



Optimized gas detector layout for specified alarm settings



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• For each optimized layout, the associated detector matrix or Detect3D project file can be exported. The matrix shows which detectors go into alarm for each of the completed simulations in the in:Flux project.

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	з	HP-007 on Northerly, 7.5 m	/s 20	0.482891738	2.35294E-05	2.353E-05	YES	YES	0						0				
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19 H - 004 on faster/h, 75 m/s 20 0.482801748 7,7547.650 NO NO 21 H - 006 on faster/h, 75 m/s 20 0.482801738 7,7547.650 YES NO O O O 21 H - 006 on faster/h, 75 m/s 20 0.482801738 7,7547.650 YES NO O	18	HP-006 on Northerly, 7.5 m	/s 20	0.482891738	2.35294E-05	2.353E-05	YES	YES	0			0				0			
20/2 H+0010 nt batch/, 75 m/s 20 0.48289178 3.765-05 YES 0 0 0 21 H+0005 nt botch/m, 75 m/s 20 0.48289178 3.765-05 YES 0 0 0 0 21 H+0005 nt botch/m, 75 m/s 20 0.48289178 9.4112-65 3.765-05 YES VES 0 <t< td=""><td>19</td><td>HP-004 on Easterly, 7.5 m/s</td><td>20</td><td>0.482891738</td><td>3.76471E-05</td><td>3.765E-05</td><td>NO</td><td>NO</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	19	HP-004 on Easterly, 7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	NO	NO											
21 HP-006 in Staterly, 75 m/s 20 0.44289/73 9.1176/66 </td <td>20</td> <td>HP-011 on Easterly, 7.5 m/s</td> <td>20</td> <td>0.482891738</td> <td>3.76471E-05</td> <td>3.765E-05</td> <td>YES</td> <td>NO</td> <td></td> <td></td> <td></td> <td></td> <td>0</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	20	HP-011 on Easterly, 7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	YES	NO					0						
22 HP-001 on Southerly, 75 m/s 20 0.482801738 9.4112660 9/55 0 0 0 0 0 0 24 HP-003 on Southerly, 75 m/s 20 0.482801738 9.4112660 9/55 NO 0	21	HP-006 on Easterly, 7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	YES	YES	0			0				0			
23 HP-005 on Westerly, 75 m/s 20 0.482891738 0 0 YS YS 0 0 </td <td>22</td> <td>HP-011 on Southerly, 7.5 m,</td> <td>/s 20</td> <td>0.482891738</td> <td>9.41176E-06</td> <td>9.412E-06</td> <td>YES</td> <td>YES</td> <td></td> <td></td> <td>0</td> <td></td> <td></td> <td></td> <td>0</td> <td></td> <td></td> <td></td> <td></td>	22	HP-011 on Southerly, 7.5 m,	/s 20	0.482891738	9.41176E-06	9.412E-06	YES	YES			0				0				
24 HP-003 on Souther(Y, 75 m/s 20 0.482891738 9.41176-06 9.4126-06 YES NO 25 HP-003 on Wester(Y, 75 m/s 20 0.482891738 0 0 YES 0 0 26 HP-004 on Souther(Y, 75 m/s 20 0.482891738 9.41176-06 9.4126-06 YES YES 0 0 0 28 HP-004 on Souther(Y, 75 m/s 20 0.482891738 9.41176-06 9.4126-06 YES YES 0 0 0 28 HP-004 on Souther(Y, 75 m/s 20 0.482891738 9.41176-06 9.4126-06 YES YES 0 0 0 YES 0 0 0 YES 0 0 0 YES 0 0 0 YES YES 0 0 YES YES 0 0 YES 0 0 YES YES 0 0 YES 0 0 YES <td< td=""><td>23</td><td>HP-006 on Westerly, 7.5 m/</td><td>s 20</td><td>0.482891738</td><td>0</td><td>0</td><td>YES</td><td>YES</td><td>0</td><td></td><td></td><td>0</td><td>0</td><td></td><td></td><td>0</td><td></td><td></td><td></td></td<>	23	HP-006 on Westerly, 7.5 m/	s 20	0.482891738	0	0	YES	YES	0			0	0			0			
25 HP-010 on Northerly, 75 m/s 20 0.442821738 0.3538-05 VES 0 0 27 HP-005 on Southerly, 75 m/s 20 0.442821738 9.41176E-06 9.4122-05 NO 0 VES 0 0 21 HP-005 on Southerly, 75 m/s 20 0.442821738 9.41176E-06 9.4122-05 NO NO NO 0 21 HP-004 on Southerly, 75 m/s 20 0.442821738 3.76712-05 3.7562-05 VES VES 0 0 0 21 HP-004 on Seaterly, 75 m/s 20 0.442821738 3.76712-05 3.7567-05 VES VES 0 0 0 31 HP-001 on Mesterly, 75 m/s 20 0.442821738 3.76712-05 3.7567-05 VES VES 0 0 0 31 HP-001 on Mesterly, 75 m/s 20 0.442821738 3.76712-05 3.7567-05 VES NO 0 0 0 31 HP-001 on Mesterly, 75 m/s 20 0.442821738 3.76712-05 3.7567-05 VES NO 0 0 0 <th< td=""><td>24</td><td>HP-003 on Southerly, 7.5 m</td><td>/s 20</td><td>0.482891738</td><td>9.41176E-06</td><td>9.412E-06</td><td>YES</td><td>NO</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></th<>	24	HP-003 on Southerly, 7.5 m	/s 20	0.482891738	9.41176E-06	9.412E-06	YES	NO											
26 HP 003 on Westerly, 75 m/s 20 0.482891738 0 0 YES 0 0 0 VES VES 0	25	HP-010 on Northerly, 7.5 m	/s 20	0.482891738	2.35294E-05	2.353E-05	YES	NO						0					
27 M POOG on Southerly, 75 m/s 20 0 442821738 9 41176-06 9 41276-06 W POOG on Southerly, 75 m/s 20 0 442821738 3 74176-06 9 41276-06 W POOG on Southerly, 75 m/s 20 0 442821738 3 7467716-05 3 7567-05 V ES 0 0 0 29 HPOOG on Southerly, 75 m/s 20 0 442821738 3 7467716-05 3 7567-05 V ES V ES 0 0 V ES 0 0 V ES 0 0 V ES V ES 0 0 V ES 0 0 V ES V ES 0 0 V ES 0 0 V ES V ES 0 0 V ES 0 0 0 0 V ES V ES 0 0 0 0 0 0	26	HP-003 on Westerly, 7.5 m/	s 20	0.482891738	0	0	YES	YES						0					
28 HP-004 on Southerly, 75 m/s 20 0.482891738 9.41176-06 9.41276-06<	27	HP-006 on Southerly, 7.5 m,	/s 20	0.482891738	9.41176E-06	9.412E-06	YES	YES	0			0				0			
29 HP-009 on faster/v, 75 m/s 20 0.442391738 3.76471260 3.755605 YES 0 0 11 HP-010 on Wester/v, 75 m/s 20 0.442391738 0 0 YES 0 0 31 HP-010 on Wester/v, 75 m/s 20 0.442391738 0 0 YES 0 0 31 HP-010 on Wester/v, 75 m/s 20 0.442391738 3.76471260 3.756505 YES 0 0 31 HP-003 on Easter/v, 75 m/s 20 0.442391738 3.76471260 3.756505 YES 0 0 0 31 HP-003 on Netter/v, 75 m/s 20 0.442391738 3.76471260 3.756505 YES NO 0 0 31 HP-003 on Netter/v, 75 m/s 20 0.442391738 2.53246-50 YES NO 0	28	HP-004 on Southerly, 7.5 m,	/s 20	0.482891738	9.41176E-06	9.412E-06	NO	NO											
00 HP-001 on Southerly, 75 m/s 20 0.482891738 0 0 YES VES 0 0 YES NO 0 YES NO 0 YES YES 0	29	HP-009 on Easterly, 7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	YES	YES				0				0			
at H+0100 on Wester(r), 75 m/s 20 0.4482891738 0 0 YES VES 0 0 YES 0 0 YES 0 0 YES 0 0 YES VES 0 0 VES YES 0 0 YES 0 0 YES 0 0 0 YES 0 0 VES 0 0 <t< td=""><td>30</td><td>HP-001 on Southerly, 7.5 m,</td><td>/s 20</td><td>0.482891738</td><td>9.41176E-06</td><td>9.412E-06</td><td>YES</td><td>YES</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>0</td><td></td><td></td></t<>	30	HP-001 on Southerly, 7.5 m,	/s 20	0.482891738	9.41176E-06	9.412E-06	YES	YES									0		
22 HP-001 on Westerly, 75 m/s 20 0.482891738 3.76471260 3.756505 YES 0 0 YES VES 0 0 YES YES 0 0	31	HP-010 on Westerly, 7.5 m/	s 20	0.482891738	0	0	YES	NO					0						
33 m+0005 of baster(r), 75, m/s 20 0442891788 3, 049742609 3, 0596760 155 155 0 0 34 m+0005 of baster(r), 75, m/s 20 0442891788 3, 049742609 3, 059742605 755 NO 0 35 m+0005 on Wester(r), 75, m/s 20 0442891788 3, 049742609 7, 05505 YES NO 0 36 m+0005 on Wester(r), 75, m/s 20 0442891788 2, 5594656 2, 5594656 YES NO 0 0 37 H+0005 on Wester(r), 75, m/s 20 0442891738 2, 5594656 2, 5594656 YES NO 0 0 38 H+0005 on Souther(r), 75, m/s 20 0442891738 3, 76471266 7, 755 YES 0 0 0 39 H+002 on Sauther(r), 75, m/s 20 0442891738 3, 76471266 7, 755 YES 0 0 0 41 H+002 on Sauther(r), 75, m/s 20 0442891738 3, 76471266 YES YES 0 0 0 0 0 41 H+002 on Souther(r),	32	HP-001 on Westerly, 7.5 m/	s 20	0.482891738	0	0	YES	YES									0		
and metode of tasker(r), 75 m/s 20 0428291738 0 0 YE 0 0 YE 0 0 YE 0 0 0 YE YE 0 0	33	HP-005 on Easterly, 7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	TES	TES			0							0	
a) m+0006 in Wester (v, 7.5 m/s) 20 0.482291738 2.353E+05 YES 0 0 0 1 m+0006 in Wester (v, 7.5 m/s) 20 0.482291738 2.352E+05 YES 0 0 0 31 m+0006 in Wester (v, 7.5 m/s) 20 0.482291738 2.352E+05 YES 0 0 31 H+0006 in Wester (v, 7.5 m/s) 20 0.482291738 2.352E+05 YES 0 0 31 H+002 in Startev, 7.5 m/s 20 0.482291738 0 0 VES VES 0 0 41 H+002 in Startev, 7.5 m/s 20 0.482291738 3.76471E-05 3.756E+05 YES VES 0 0 0 41 H+002 in Startev, 7.5 m/s 20 0.482291738 3.76471E-05 3.756E+05 YES VES 0 0 0 41 H+002 in Startev, 7.5 m/s 20 0.482291738 9.41176E+06 9.412E+06 YES VES 0 0 0 0 0 0 41 H+002 in Startev/r, 75 m/s 20 0.482291738<	25	HP-008 on Easterly, 7.5 m/s	20	0.482891758	5./64/12-05	5.7652-05	TES	NO						0					
and microsoft molarity / 25 m/s 20 0-462891738 23582655 YES 0 30 mH-003 on Molarity / 25 m/s 20 0-462891738 25594656 YES 0 31 mH-003 on Molarity / 25 m/s 20 0-462891738 37412666 9412266 YES 0 40 mH-003 on Sutherly / 25 m/s 20 0-462891738 374721605 3756565 YES 0 0 41 mH-003 on Sutherly / 25 m/s 20 0-462891738 374721605 3756565 YES 0 0 42 mH-003 on Sutherly / 25 m/s 20 0-462891738 374712605 3756565 YES NO 0 41 mH-002 on Sutherly / 25 m/s 20 0-462891738 374712605 3756565 YES NO 0 42 mH-002 on Sutherly / 25 m/s 20 0-462891738 374176605 9412666 YES NO 41 mH-002 on Sutherly / 25 m/s 20 0-482891738 941176606 9412666 YES NO 42 mH-002 on Sutherly / 25 m/s 20 0-482891738 941176606 9412666 YES NO 44 mH-002 on Sutherly / 25 m/s 20 0-482891738 941176606 9412666 <td>26</td> <td>HP-008 on Westerly, 7.5 m/</td> <td>5 20</td> <td>0.462691736</td> <td>2 252045.05</td> <td>2 2525 05</td> <td>VEC</td> <td>VEC</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>0</td> <td></td> <td></td> <td></td> <td></td> <td></td>	26	HP-008 on Westerly, 7.5 m/	5 20	0.462691736	2 252045.05	2 2525 05	VEC	VEC						0					
1 1	27	HP-005 on Northerly, 7.5 m	/s 20	0.482891738	2.332946-05	2.3332-05	VEC	VEC				0				0			
39 HP-012 on Westerly, 75 m/s 20 0.482391738 3.764716-05 YES 0 0 40 HP-002 in Starterly, 75 m/s 20 0.482291738 3.764716-05 YES 0 41 HP-002 in Sutherly, 75 m/s 20 0.482291738 3.764716-05 YES 0 42 HP-002 in Sutherly, 75 m/s 20 0.482291738 9.41176-06 9.41176-06 9.41176-06 41 HP-002 in Sutherly, 75 m/s 20 0.482291738 9.41176-06 9.41176-06 9.41176-06 41 HP-002 in Sutherly, 75 m/s 20 0.482291738 9.41176-06 9.41176-06 9.41176-06 42 HP-002 in Sutherly, 75 m/s 20 0.482291738 9.41176-06 9.41176-06 9.41176-06 41 HP-002 in Sutherly, 75 m/s 20 0.482291738 9.41176-06 9.4122-06 YES 0 42 HP-002 in Sutherly, 75 m/s 20 0.482291738 9.41176-06 9.4122-06 YES 0 41 HP-002 in Sutherly, 75 m/s 20 0.482291738 9.41176-06 9.4122-06 YES 0 42 HP-002 in Sutherly, 75 m/s 20 0.482291738 9.41176-06 9.4122-06 YES 0 44 <td>38</td> <td>HP-002 on Southerly, 7.5 m</td> <td>/s 20</td> <td>0.482891738</td> <td>9.411765-06</td> <td>9.4125-05</td> <td>VES</td> <td>NO</td> <td></td> <td></td> <td>0</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>0</td> <td></td> <td></td>	38	HP-002 on Southerly, 7.5 m	/s 20	0.482891738	9.411765-06	9.4125-05	VES	NO			0						0		
40 HP-001 on Easterly, 75 m/s 20 0.482891738 3.765E-05 YES 0 11 HP-002 on Easterly, 75 m/s 20 0.482891738 3.76471E-05 3.756E-05 YES 0 41 HP-002 on Easterly, 75 m/s 20 0.482891738 3.76471E-05 3.756E-05 YES NO 0 41 HP-002 on Sutherly, 75 m/s 20 0.482891738 9.1176E-06 9.122-06 YES 0 0 43 HP-005 on Southerly, 75 m/s 20 0.482891738 9.1176E-06 9.1176E-06 9.122-06 YES 0 0 44 HP-002 on Southerly, 75 m/s 20 0.482891738 9.1176E-06 9.122-06 YES 0 0 41 HP-002 on Southerly, 75 m/s 20 0.482891738 9.1176E-06 9.122-06 YES 0 0 41 HP-002 on Southerly, 75 m/s 20 0.482891738 9.1176E-06 9.122-06 YES 0 0 41 HP-002 on Southerly, 75 m/s 20 0.482891738 9.126-06 YES 0 0 0 41<	39	HP-012 on Westerly, 7.5 m/	5 20	0.482891738	0	0.4120.00	YES	YES			0		0						
41 HP-002 on Easterly, 75 m/s 20 0.482891738 376971665 3758505 YES 0 0 42 HP-002 on Sutherly, 75 m/s 20 0.482891738 9.41176506 9.412606 YES 0 41 HP-002 on Southerly, 75 m/s 20 0.482891738 9.41176506 9.412606 YES 0 0 41 HP-002 on Southerly, 75 m/s 20 0.482891738 9.41176506 9.412606 YES NO 0 0 41 HP-002 on Southerly, 75 m/s 20 0.482891738 9.41176506 9.412606 YES NO 0 0 0 41 HP-002 on Southerly, 75 m/s 20 0.482891738 9.41176506 9.412606 YES NO 0 0 0 41 HP-002 on Southerly, 75 m/s 20 0.482891738 9.41176506 9.412606 YES 0 <	40	HP-001 on Easterly, 7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	YES	YES			~		5				0		
42 HP-009 on Southerly, 75 m/s 20 0.482891738 9.41176E-06 9.412E-06 YES 0 0 43 HP-005 on Southerly, 75 m/s 20 0.482891738 9.41176E-06 9.412E-06 YES 0 0 41 HP-005 on Southerly, 75 m/s 20 0.482891738 9.41176E-06 9.412E-06 YES 0 0 41 HP-005 on Southerly, 75 m/s 20 0.482891738 9.41176E-06 9.412E-06 YES 0 0 41 HP-002 on Monthly 75 m/s 20 0.482891738 9.41176E-06 9.412E-06 YES 0 0 45 HP-002 on Monthly 75 m/s 20 0.482891738 9.41176E-06 9.412E-06 YES 0 0 45 HP-002 on Monthly 75 m/s 20 0.482891738 9.4176E-06 9.412E-06 YES 0 0 45 HP-002 on Monthly 75 m/s 20 0.482891738 9.4176E-06 9.412E-06 YES YES 0 46 HP-002 on Monthly 75 m/s 20 0.482891738 9.4176E-06 9.412E-06 YES YES 47 HP-002 on Monthly 75 m/s 20 0.483801138 0.428491738 YES 0	41	HP-002 on Easterly, 7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	YES	NO		0									
43 HP-005 on Southerly, 75 m/s 20 0.482891738 9.41176F.06 9.412F.06 9.412F	42	HP-009 on Southerly, 7.5 m	/s 20	0.482891738	9.41176E-06	9.412E-06	YES	YES		-		0				0			
44 HP-002 on Southerly, 75 m/s 20 0.482891738 9.41176E-06 9.412E-06 YES 0 45 HD-002 on Southerly, 75 m/s 0 VEE VEE 1 45 Cover Sheet Matrix ⊕ I I	43	HP-005 on Southerly, 7.5 m	/s 20	0.482891738	9.41176E-06	9.412E-06	YES	NO				-				-		0	
AE up 002 a Workshu 2 E m² 10 0.483801328 0 0 VEE 1 (··) Cover Sheet Matrix ⊕ ·· ·	44	HP-002 on Southerly, 7.5 m	/s 20	0.482891738	9.41176E-06	9.412E-06	YES	YES		0					0				
Cover Sheet Matrix (+)	45	HD 007 on Westerlu 7 E m/	- 10-	0.401001720			VEC	VEC	•						•				
田 回 巴 + 100%		Cover Sheet	Matrix	(+)									•						Þ
																	III II II		+ 100%





Summary

- Ventilation simulations highlight stagnant regions in the facility likely locations for gas accumulation.
- Dispersion simulations show gas cloud sizes and results for a specific leak.
- Monitor points, lines, and regions collect data at defined locations and can be exported to excel or Detect3D.
- Given risk data (leak frequency and consequence, wind probability, etc.), layouts can be created to mitigate risk throughout the site.
 - Using the gas detector optimization tool, these layouts can be generated automatically.

For questions about in:Flux or licensing options, please visit <u>www.insightnumerics.com</u> or email us at <u>info@insightnumerics.com</u>



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