

in:Flux – Gas Mapping Optimization

Developed by Insight Numerics

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insight numerics

Gas Detector Optimization

- in:Flux has many in-built capabilities for performance-based gas mapping, including:
 - Interface for assigning leak frequencies
 - Input of wind rose with associated probabilities
 - Generation of the full matrix of simulations, each with a scenario frequency
 - Automatic setup, generation and run of the full matrix
 - Risk-based visualizations, such as exceedance of gas concentrations
 - Gas detector optimization using the Greedy Algorithm and the Genetic Algorithm to minimize detector counts while providing appropriate coverage.
- The gas detector layout can be exported to Detect3D for comparison between scenario and geographic methods.



Slide 2

Risk Manager: Leak Frequencies

• The Risk Manager window coordinates the leaks frequencies, wind rose, and scenario matrices. Here, leaks are shown for the simulation.

Ri	sk Manager					- UL										
Leal	k Frequencies Wind Co	onditions Simulation Summary													A COLORED OF	
Hig	gh Pressure Leaks															
	Name	Location		Rotation	Elevation	Hole Size	Pressure	Temperature	Fluid		Flow Rate	Leak Group	Leak Frequency			
	HP Release 01	(4.7, 17.08, 0.39) meters	ß	-180	0	10 mm	10 bar(g)	10 °C	METHANE	v	0.121 kg/s	Flange 001 V	8.00E-06 [1/yr]	^		
	HP Release 02	(4.69 , 17.36 , 0.79) meters	2	-180	90	10 mm	10 bar(g)	10 °C	METHANE	v	0.121 kg/s	Flange 001 V	8.00E-06 [1/yr]	(D)		
	HP Release 03	(4.71, 17.67, 0.31) meters	6	0	0	10 mm	10 bar(g)	10 °C	METHANE	v	0.121 kg/s	Flange 001 V	8.00E-06 [1/yr]	×		
	HP Release 04	(4.69 , 13.43 , 0.39) meters	2	-180	0	10 mm	10 bar(g)	10 °C	METHANE	v	0.121 kg/s	Flange 002 V	8.00E-06 [1/yr]	5		7
	HP Release 05	(4.69, 13.69, 0.78) meters	6	-180	90	10 mm	10 bar(g)	10 °C	METHANE	v	0.121 kg/s	Flange 002 V	8.00E-06 [1/yr]			ų,
	HP Release 06	(4.7 , 14.05 , 0.39) meters	2	0	0	10 mm	10 bar(g)	10 °C	METHANE	v	0.121 kg/s	Flange 002 V	8.00E-06 [1/yr]		Care There	Ľ
	HP Release 07	(4.7 , 9.91 , 0.45) meters	ß	-180	0	25 mm	10 bar(g)	10 °C	METHANE	v	0.755 kg/s	Flange 003 V	9.50E-06 [1/yr]	~	254	
	HP Release 08	(4.69, 10.23, 0.82) meters	\mathbb{R}	0	90	25 mm	10 bar(g)	10 °C	METHANE	v	0.755 kg/s	Flange 003 V	9.50E-06 [1/yr]	<u> 78</u>	HP Release 09	
	HP Release 09	(4.68, 10.53, 0.38) meters	ß	0	0	25 mm	10 bar(g)	10 °C	METHANE	v	0.755 kg/s	Flange 003 V	9.50E-06 [1/yr]	3		
	HP Release 10	(4.68, 6.12, 0.46) meters	ß	-180	0	10 mm	10 bar(g)	10 °C	METHANE	v	0.121 kg/s	Flange 004 v	1.00E-05 [1/yr]			2
ſ	HP Release 11	(4.69, 6.47, 0.78) meters	2	0	90	10 mm	10 bar(g)	10 °C	METHANE	v	0.121 kg/s	Flange 004 V	1.00E-05 [1/yr]			÷
Γ	HP Release 12	(4.69, 6.77, 0.48) meters	2	0	0	10 mm	10 bar(g)	10 °C	METHANE	v	0.121 kg/s	Flange 004 v	1.00E-05 [1/yr]	1	5 6	
Pro	operty Editor															
3 ite	ems selected															



Slide 3

Risk Manager: Wind Rose

• The Wind Rose tab can be used to set the environmental conditions on the site. Wind speed data can be entered for all directions, or for each direction individually.

eak Frequencies Wind Co	onditions Simulation Sur	mmary		
Wind Direction			4 8 Wind Rose	
Di	rection	Probability	NORTH	
Southerly (180°)		2.1 %	^ · · · · · · · · · · · · · · · · · · ·	
South-Westerly (225°)		7.0 %		
Westerly (270°)		8.7 %		
North-Westerly (315°)		13.9 %		
1 m/s	5 [m/s]	39.0 %	WEST EAST	
5 m/s		29.2 %	EAST EAST	
10 m/s		24.4 %		
15 m/s	∞ [m/s]	5.5 %		
roperties			Calidate	
	: 2 % R	eference Height: 10 n	meters	
Calm Wind Probability				



Slide 4

Risk Manager: Scenario Matrix

• The full scenario matrix is shown on the final tab. The user can select all simulations to be added, or a sub-set containing only the highest frequency events.

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: 1065E-04 [1/yr]
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 Project: 0 [1/yr] (0.0 %)
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		Selected: 0 [1/yr] (0.0%)
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		
HP Release 01 on North-Easterly, 12.5	North-Easterly, 12.5 m/s	HP Release 01	4.073E-07 [1/yr]	1	4.073E-07 [1/yr]	No		Iotal 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		
UD Deleges 04 and Coutherdy 2 m/s	Courthards 2 mls	LID Deleges 01	0.5465.00.546-1	1	C F4CF 00 F44-1	N-	\sim	



Slide 5

Risk CFD Simulations

• Once the simulations are added to the project, they are automatically scheduled and need no further input from the user. Thousands of CFD simulations can be added at this time.

in:Flux											- 6	ı x
File View Project H	elp											
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Geometry 1				N.S.	1-		Southerly, 3 m/s	25%	Running on I	DESKTOP-EHQ8V	25	^ 4
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▷ Inflows 26					F		Southerly, 12.5 m/s	0%	Scheduled to	run on DESKTOP	-EHQ8V25	
✓ Ventilation Simula	ations 33				15-		Southerly, 15 m/s	0%	Scheduled to	run on DESKTOP	-EHQ8V25	
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🗌 🔕 Southe		Scheduled					South-Westerly, 7.5 m/s	0%	Scheduled to	run on DESKTOP	-EHQ8V25	
🗌 🔕 Southe		Scheduled					South-Westerly, 12.5 m/s	0%	Scheduled to	run on DESKTOP	-EHQ8V25	
🗌 🔕 Southe		Scheduled					South-Westerly, 15 m/s	0%	Scheduled to	run on DESKTOP	-EHQ8V25	
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South-V		Scheduled					Completed Simulations					
South-V		Scheduled	A STATE									
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4 Information				M. S.								
Name	Southerly 3 n	n/s										
Domain	(-91 71 -103)	63. 0) [meters •										
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Slide 6

Post-Processing

• Once the simulations are complete, a risk data-set can be added to the project. This combines the data from all the selected simulations and allows for further analysis.





Slide 7

Exceedance Contours

• Contours of exceedance of the selected property in the risk data set can be used. The contour below shows exceedance of 20% LFL methane concentration by frequency.





Slide 8

Gas Detector Optimization

• The Greedy Algorithm or Genetic Algorithm can be used to output the scenario coverage dependency on the number of detectors. The analysis is instant, and the graph can be read to get the proposed detector layout.





Slide 9

Gas Detector Optimization

• The layout is based on the optimization algorithm chosen, which takes proposed detector locations and calculates the optimal arrangement.





Slide 10

Gas Detector Matrix

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

Auto	oSave 💽 🖁	5.6	й~ а							C)etecto	or Matrix - Excel						Edward A. Miller	b –	o ×
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2	HD 007 on Norther		20	0.493901739	2 252045 05	2 2525 05	Detection	Detection	20 %LEL	20 %LEL		20 %LEL	20 %LEL	20 %LE	20 %LEL	20 %LEL	20 %LEL	20 %LEL	20 %LEL	
4	HP-005 on Westerl	v. 7.5 m/s	20	0.482891738	2.332946-03	2.5552-05	YES	NO	0							0			0	
5	HP-003 on Norther	v. 7.5 m/s	20	0.482891738	2.35294E-05	2.353E-05	YES	NO												
6	HP-011 on Westerl	. 7.5 m/s	20	0.482891738	0	0	YES	NO						0						
7	HP-003 on Easterly	75 m/s	20	0 482891738	3 76471E-05	3 765E-05	YES	NO												
8	HP-010 on Souther	v. 7.5 m/s	20	0.482891738	9.41176E-06	9.412E-06	YES	YES				0				0				
9	HP-007 on Easterly	7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	YES	YES	0	0									0	
10	HP-004 on Westerl	, 7.5 m/s	20	0.482891738	0	0	YES	YES		0								0		
11	HP-011 on Norther	v. 7.5 m/s	20	0.482891738	2.35294E-05	2.353E-05	YES	NO							0					
12	HP-007 on Souther	v. 7.5 m/s	20	0.482891738	9.41176E-06	9.412E-06	YES	YES	0	0									0	
13	HP-009 on Westerl	.7.5 m/s	20	0.482891738	0	0	YES	YES					0				0			
14	HP-012 on Norther	v. 7.5 m/s	20	0.482891738	2.35294E-05	2.353E-05	YES	NO							0					
15	HP-002 on Westerl	.7.5 m/s	20	0.482891738	0	0	YES	YES		0						0				
16	HP-010 on Easterly	7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	YES	YES						0						
17	HP-004 on Norther	v. 7.5 m/s	20	0.482891738	2.35294E-05	2.353E-05	NO	NO												
18	HP-006 on Norther	v. 7.5 m/s	20	0.482891738	2.35294E-05	2.353E-05	YES	YES	0				0				0			
19	HP-004 on Easterly	7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	NO	NO												
20	HP-011 on Easterly	7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	YES	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			
22	HP-011 on Souther	y, 7.5 m/s	20	0.482891738	9.41176E-06	9.412E-06	YES	YES				0				0				
23	HP-006 on Westerl	.7.5 m/s	20	0.482891738	0	0	YES	YES	0				0	0			0			
24	HP-003 on Souther	y, 7.5 m/s	20	0.482891738	9.41176E-06	9.412E-06	YES	NO												
25	HP-010 on Norther	y, 7.5 m/s	20	0.482891738	2.35294E-05	2.353E-05	YES	NO							0					
26	HP-003 on Westerl	, 7.5 m/s	20	0.482891738	0	0	YES	YES							0					
27	HP-006 on Souther	y, 7.5 m/s	20	0.482891738	9.41176E-06	9.412E-06	YES	YES	0				0				0			
28	HP-004 on Souther	y, 7.5 m/s	20	0.482891738	9.41176E-06	9.412E-06	NO	NO												
29	HP-009 on Easterly	7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	YES	YES					0				0			
30	HP-001 on Souther	y, 7.5 m/s	20	0.482891738	9.41176E-06	9.412E-06	YES	YES										0		
31	HP-010 on Westerl	, 7.5 m/s	20	0.482891738	0	0	YES	NO						0						
32	HP-001 on Westerl	, 7.5 m/s	20	0.482891738	0	0	YES	YES										0		
33	HP-005 on Easterly	7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	YES	YES				0							0	
34	HP-008 on Easterly	, 7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	YES	NO							0					
35	HP-008 on Westerl	, 7.5 m/s	20	0.482891738	0	0	YES	NO							0					
36	HP-009 on Norther	y, 7.5 m/s	20	0.482891738	2.35294E-05	2.353E-05	YES	YES					0				0			
37	HP-001 on Norther	y, 7.5 m/s	20	0.482891738	2.35294E-05	2.353E-05	YES	YES										0		
38	HP-008 on Souther	y, 7.5 m/s	20	0.482891738	9.41176E-06	9.412E-06	YES	NO				0								
39	HP-012 on Westerl	, 7.5 m/s	20	0.482891738	0	0	YES	YES				0		0						
40	HP-001 on Easterly	, 7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	YES	YES										0		
41	HP-002 on Easterly	, 7.5 m/s	20	0.482891738	3.76471E-05	3.765E-05	YES	NO		0										
42	HP-009 on Souther	y, 7.5 m/s	20	0.482891738	9.41176E-06	9.412E-06	YES	YES					0				0			
43	HP-005 on Souther	y, 7.5 m/s	20	0.482891738	9.41176E-06	9.412E-06	YES	NO											0	
44	HP-002 on Souther	y, 7.5 m/s	20	0.482891738	9.41176E-06	9.412E-06	YES	YES		•						0				-
1	Cover	Sheet	Matrix	(+)			N.L.V	wer.		-				: 4		•			-	
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Slide 11

Conclusions

- The optimized gas detector layout can be exported to Excel or Detect3D (.d3d) project files.
- Both point and open-path detectors can be used.
- Many different layouts can be generated, to compare variables such as performance target and alarm settings.
- Users can compare optimization results from the Greedy Algorithm and the Genetic Algorithm
- Just like Detect3D which included optimization algorithms for flame detection, in:Flux bases the layout on user input for potential locations for detectors.
- This analysis does not require any expertise in CFD, and typical setup times are less than 1 hour.



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