

TOP EVENT 2



**Audit Number: 180**

**Date: 01/09/2023 Time: 17:11**

# Discharge Report

**Workspace: pm\_rev0**

**Study: Study**

**Equipment Item: T2**

**pm\_rev0\Study\T2**

Material	ISOBUTANE	
East	0	m
North	0	m

**Scenario (Leak) : Leak 2" - vertical**

**pm\_rev0\Study\T2\Leak 2" - vertical**

**Weather: Category 2/F**

## INPUT DATA

<b>Inventory data</b>		
Mass in vessel	2789,35	kg

## Stagnation Data (upstream end for long pipe)

Initial pressure (gauge)	10	bar
Initial temperature	20	degC
Fluid state	Non-saturated liquid	

## Scenario data

Phase to be released	Liquid	
Tank head	0	m
Hole diameter	50,8	mm

## OUTPUT DATA

Mass flow rate	42,0713	kg/s
Release duration	66,3005	s

## Orifice or pipe exit data (before atmospheric expansion)

Pressure	1,01325	bar
Temperature	19,3938	degC
Liquid mass fraction	1	fraction
Velocity at vena contracta (at exit for pipe releases)	61,9312	m/s
Discharge coefficient	0,6	

## Final Data (after atmospheric expansion)

Temperature	-11,9098	degC
Liquid mass fraction	0,815225	fraction
Droplet diameter	206,597	um
Expanded diameter	0,181616	m
Velocity	108,933	m/s

**Weather: Category 5/D**

**INPUT DATA**

<b>Inventory data</b>		
Mass in vessel	<b>2789,35</b>	kg

**Stagnation Data (upstream end for long pipe)**

Initial pressure (gauge)	<b>10</b>	bar
Initial temperature	<b>20</b>	degC
Fluid state	<b>Non-saturated liquid</b>	

**Scenario data**

Phase to be released	Liquid	
Tank head	0	m
Hole diameter	<b>50,8</b>	mm

**OUTPUT DATA**

Mass flow rate	42,0713	kg/s
Release duration	66,3005	s

**Orifice or pipe exit data (before atmospheric expansion)**

Pressure	1,01325	bar
Temperature	19,3938	degC
Liquid mass fraction	<b>1</b>	fraction
Velocity at vena contracta (at exit for pipe releases)	61,9312	m/s
Discharge coefficient	0,6	

**Final Data (after atmospheric expansion)**

Temperature	-11,9098	degC
Liquid mass fraction	0,815225	fraction
Droplet diameter	206,597	um
Expanded diameter	<b>0,181616</b>	m
Velocity	108,933	m/s



Audit Number: 180  
Date: 01/09/2023 Time: 17:12

# Explosion Report

## Workspace: pm\_rev0

Study: Study  
Equipment Item: T2  
pm\_rev0\Study\T2

Material **ISOBUTANE**  
East 0 m  
North 0 m

### Scenario (Leak) : Leak 2" - vertical

pm\_rev0\Study\T2\Leak 2" - vertical

Weather: Category 2/F

Explosion location criterion Cloud front (LFL fraction)  
Explosion height criterion Centreline height  
Explosion method Multi-Energy: Uniform confined

Uniform confined method explosion efficiency **12,5 %**  
Uniform confined method explosion strength 10

Time of explosion [s]	Distance to centre of mass [m]	Distance to explosion centre [m]	Distance to ignition point [m]	Flammable mass [kg]	Overpressures (input) [bar]	Distance to specified overpressures [m]
0,801216	5,28482	10	10	0,566837	0,02068 0,1379 0,2068	46,0269 17,0021 15,2499
2,78614	9,17051	20	20	3,48939	0,02068 0,1379 0,2068	86,0274 32,8329 29,6216
7,65521	13,0948	30	30	12,2994	0,02068 0,1379 0,2068	130,485 49,53 44,6428
13,556	16,9002	40	40	28,3919	0,02068 0,1379 0,2068	172,802 65,8111 59,3521
20,6421	20,7578	50	50	51,5583	0,02068 0,1379 0,2068	212,022 81,4901 73,6101
30,5633	24,6745	60	60	86,7545	0,02068 0,1379 0,2068	252,711 97,4546 88,082
44,0713	29,0962	70	70	130,128	0,02068 0,1379 0,2068	290,597 112,874 102,146
60,1534	34,2273	80	80	223,717	0,02068 0,1379 0,2068	344,266 131,362 118,509

77,1117	35,2817	90	90	350,971	0,02068 0,1379 0,2068	397,066 149,68 134,746
94,5265	38,8707	100	100	502,542	0,02068 0,1379 0,2068	446,098 167,266 150,434

#### Weather: Category 5/D

Explosion location criterion Cloud front (LFL fraction)

Explosion height criterion Centreline height

Explosion method Multi-Energy: Uniform confined

Uniform confined method

explosion efficiency **12,5 %**

Uniform confined method explosion strength 10

Time of explosion [s]	Distance to centre of mass [m]	Distance to explosion centre [m]	Distance to ignition point [m]	Flammable mass [kg]	Overpressures (input) [bar]	Distance to specified overpressures [m]
0,655985	5,96019	10	10	0,579014	0,02068 0,1379 0,2068	46,2831 17,0519 15,2872
2,05968	11,602	20	20	3,94697	0,02068 0,1379 0,2068	88,7959 33,3709 30,025
4,68528	18,1446	30	30	16,7062	0,02068 0,1379 0,2068	141,284 51,6289 46,2165
8,28371	23,6833	40	40	37,2949	0,02068 0,1379 0,2068	185,442 68,2677 61,1941
12,6234	26,7021	50	50	55,201	0,02068 0,1379 0,2068	215,751 82,2149 74,1535
17,8881	27,1365	60	60	66,6686	0,02068 0,1379 0,2068	236,515 94,3069 85,722
28,5476	26,9747	70	70	87,5665	0,02068 0,1379 0,2068	263,31 107,571 98,1694
63,446	25,7089	80	80	156,474	0,02068 0,1379 0,2068	314,579 125,592 114,183



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## Jet Fire

Workspace: pm\_rev0

Study: Study

Equipment Item: T2

pm\_rev0\Study\T2

Material ISOBUTANE

East 0 m

North 0 m

Scenario (Leak) : Leak 2'' - vertical

pm\_rev0\Study\T2\Leak 2'' - vertical

Weather: Category 2/F

Wind speed

[m/s] 2

Pasquill

stability F stable - night with moderate clouds and light/moderate wind

Atmospheric

temperature

[degC] 20

Relative

humidity

[fraction] 0,7

Solar radiation

flux [kW/m2] 0,5

### Jet fire model results

#### INPUT DATA

##### Scenario

Elevation	1 m
Release angle from horizontal	0 deg

##### Jet Fire Parameters

Jet fire method	Cone model	
Wind orientation about the z-axis (anti-clockwise from the East)	0 deg	
Rotation about the z-axis (anti-clockwise from the east)	0 deg	

Rate modification factor	3
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#### Calculated inputs

Mass flow rate	23,3212	kg/s
Temperature after atmospheric expansion	-11,9098	degC
Liquid fraction	0,815225	fraction
Velocity after atmospheric expansion (input)	<b>108,933</b>	m/s
Rainout fraction time averaged	<b>0,815225</b>	fraction

#### OUTPUT DATA

Flame emissive power	231,594	kW/m2
Fraction of emissivity	0,42874	fraction
Jet velocity	108,933	m/s
Flame length	55,162	m
Frustum length	54,3346	m
Frustum base width	0,704719	m
Frustum tip width	18,812	m
Frustum lift-off distance	0,827431	m
Flame length in still air	49,6046	m
Hole to flame angle	0	deg
Expanded diameter	0,135218	m
Plane angular rotation	0	deg

#### Flame on ground impingement with partial truncation

##### Radiation Intensity Ellipse Results

#### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction Variable  
Exposure duration 20 s  
Height of interest 1 m

#### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^Prob itN.s]	Ellipse half-length [m]	Ellipse half-width [m]	Ellipse centre downwind distance [m]	Effect downwind distance [m]	Ellipse area [m2]
3	0	0,0129537	-1,38321	865119	69,2302	91,1284	0	91,1284	19819,8
5	0,000174704	0,0215895	0,360367	1709491	55,5383	70,4674	0	70,4674	12295,1
7	0,02405	0,0302253	1,50883	2677313	49,9991	59,8929	0	59,8929	9407,79
12,5	6,52536	0,0539737	3,48789	5800162	43,3369	46,1527	0	46,1527	6283,54

## Radiation v Distance Results

### INPUT DATA

Maximum distance	121,809	m
Observer type		
radiation modelling flag	Planar	
Observer direction	Variable	
Height of interest	1	m

### OUTPUT DATA

Downwind distance [m]	Maximum incident radiation [kW/m2]	Lethality level [fraction]
-48,5109	34,1125	0,972227
-46,025	231,594	1
-43,5391	231,594	1
-41,0532	231,594	1
-38,5673	231,594	1
-36,0814	231,594	1
-33,5955	231,594	1
-31,1096	231,594	1
-28,6237	231,594	1
-26,1378	231,594	1
-23,6519	231,594	1
-21,166	231,594	1
-18,6802	231,594	1
-16,1943	231,594	1
-13,7084	231,594	1
-11,2225	231,594	1
-8,73657	231,594	1
-6,25067	231,594	1
-3,76478	231,594	1
-1,27888	231,594	1
1,20702	231,594	1
3,69291	231,594	1
6,17881	231,594	1
8,6647	156,259	1
11,1506	93,1193	1
13,6365	68,7406	0,999992
16,1224	54,7297	0,999791
18,6083	44,6666	0,997706
21,0942	36,6059	0,984433
23,5801	30,2939	0,934396
26,066	25,3198	0,815183
28,5519	21,3681	0,624752
31,0378	18,201	0,409207
33,5237	15,6389	0,227401
36,0096	13,5473	0,107954
38,4955	11,8241	0,0443922
40,9814	10,3916	0,0160713
43,4672	9,1918	0,00521267
45,9531	8,17853	0,00153796
48,439	7,31645	0,000418566
50,9249	6,57816	0,000106428



53,4108	5,94174	2,55532E-05
55,8967	5,38986	5,84773E-06
58,3826	4,9086	1,28583E-06
60,8685	4,48676	2,73556E-07
63,3544	4,11517	5,66442E-08
65,8403	3,78637	1,14745E-08
68,3262	3,49418	0
70,8121	3,23349	0
73,298	3,00001	0

#### Weather: Category 5/D

Wind speed [m/s]	5
Pasquill stability	D neutral - little sun and high wind or overcast/windy night
Atmospheric temperature [degC]	20
Relative humidity [fraction]	0,7
Solar radiation flux [kW/m2]	0,5

#### Jet fire model results

##### INPUT DATA

##### Scenario

Elevation	1 m
Release angle from horizontal	0 deg

##### Jet Fire Parameters

Jet fire method	Cone model	
Wind orientation about the z-axis (anti-clockwise from the East)	0 deg	
Rotation about the z-axis (anti- clockwise from the east)	0 deg	
Rate modification factor	3	

##### Calculated inputs

Mass flow rate	23,3212	kg/s
Temperature after atmospheric expansion	-11,9098	degC
Liquid fraction	0,815225	fraction
Velocity after atmospheric expansion (input)	108,933	m/s

Rainout fraction time averaged	<b>0,815225</b>	fraction
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#### OUTPUT DATA

Flame emissive power	304,154	kW/m2
Fraction of emissivity	0,42874	fraction
Jet velocity	108,933	m/s
Flame length	42,879	m
Frustum length	42,2358	m
Frustum base width	1,17822	m
Frustum tip width	17,4392	m
Frustum lift-off distance	0,643184	m
Flame length in still air	49,6046	m
Hole to flame angle	0	deg
Expanded diameter	0,135218	m
Plane angular rotation	0	deg

#### Flame on ground impingement with partial truncation

##### Radiation Intensity Ellipse Results

#### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction Variable  
Exposure duration 20 s  
Height of interest 1 m

#### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^Prob itN.s]	Ellipse half- length [m]	Ellipse half- width [m]	Ellipse centre downwind distance [m]	Effect downwind distance [m]	Ellipse area [m2]
3	0	0,00986343	-1,38321	865119	72,959	91,4714	0	91,4714	20965,9
5	0,000174704	0,0164391	0,360367	1709491	57,1747	70,7783	0	70,7783	12713,2
7	0,02405	0,0230147	1,50883	2677313	49,0064	59,6899	0	59,6899	9189,75
12,5	6,52536	0,0410976	3,48789	5800162	39,6976	44,8997	0	44,8997	5599,61

##### Radiation v Distance Results

#### INPUT DATA

Maximum distance 113,705 m  
Observer type radia Planar  
Observer direction Variable  
Height of interest 1 m

#### OUTPUT DATA

Downwind distance [m]	Maximum incident radiation [kW/m2]	Lethality level [fraction]
-39,3533	135,658	1
-37,0328	304,154	1
-34,7123	304,154	1
-32,3918	304,154	1
-30,0713	304,154	1
-27,7508	304,154	1
-25,4303	304,154	1
-23,1098	304,154	1
-20,7893	304,154	1
-18,4688	304,154	1
-16,1483	304,154	1
-13,8278	304,154	1
-11,5073	304,154	1
-9,18677	304,154	1
-6,86626	304,154	1
-4,54576	304,154	1
-2,22526	304,154	1
0,0952442	304,154	1
2,41575	304,154	1
4,73625	275,624	1
7,05675	139,551	1
9,37726	97,7187	1
11,6978	76,9335	0,999999
14,0183	61,991	0,999961
16,3388	50,4866	0,999428
18,6593	41,5551	0,995176
20,9798	34,5682	0,974994
23,3003	29,0537	0,914138
25,6208	24,659	0,790138
27,9413	21,1215	0,609633
30,2618	18,2466	0,412527
32,5823	15,8872	0,243948
34,9028	13,9332	0,126809
37,2233	12,3005	0,0585558
39,5438	10,9261	0,024336
41,8643	9,75969	0,00921716
44,1848	8,76277	0,00321955
46,5053	7,90527	0,00104888
48,8258	7,16302	0,000321793
51,1463	6,51684	9,37784E-05
53,4668	5,95127	2,61571E-05
55,7873	5,45379	7,02913E-06
58,1078	5,01414	1,83035E-06
60,4283	4,6239	4,64146E-07
62,7488	4,27611	1,1512E-07
65,0693	3,96494	2,8033E-08
67,3898	3,68553	0
69,7103	3,43379	0
72,0308	3,20625	0
74,3513	2,99996	0



Audit Number: 180

Date: 01/09/2023 Time: 17:13

## Early Pool Fire Report

Workspace: pm\_rev0

Study: Study

Equipment Item: T2

pm\_rev0\Study\T2

Material            **ISOBUTANE**  
East                            0 m  
North                           0 m

Scenario (Leak) : Leak 2" - vertical

pm\_rev0\Study\T2\Leak 2" - vertical

Weather: Category 2/F

Wind speed [m/s]	2
Pasquill stability	F   stable - night with moderate clouds and light/moderate wind
Atmospheric temperature [degC]	20
Relative humidity [fraction]	0,7
Solar radiation flux [kW/m2]	0,5

### Pool fire model results

Early pool fires are assumed to occur at a time when the initial PVAP rainout rate equals the pool fire burn rate, unless the thus calculated pool fire radius exceeds the maximum PVAP pool radius. For the latter case the early pool fire radius is assumed to be the maximum PVAP pool radius. The pool fire centre is located at the rainout point.

### INPUT DATA

Correlation Type: Thomas / Johnson

Surface type	Land	
Pool fire elevation	0 m	
Maximum exposure duration	20 s	

Downwind distance of liquid rainout	0 m	
Use two zone pool fire model	Yes	

#### OUTPUT DATA

Pool fire diameter	19,0764	m
Downwind distance of pool fire centre	0	m
Pool fire flame length	39,9467	m
Angle between pool fire axis and vertical	30,1902	deg
Luminous flame emissive power	169,835	kW/m2
Smoky flame emissive power	0	kW/m2
Ratio of luminous flame length to the total flame length	1	fraction
Total burn rate	34,2976	kg/s
Radiative fraction	0,291256	fraction

#### Radiation Intensity Ellipse Results

##### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction Variable  
Exposure duration 20 s  
Height of interest 1 m

##### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^ProbitN.s]	Hazard Information	Ellipse half-length [m]	Ellipse half-width [m]	Ellipse centre downwind distance [m]	Effect downwind distance [m]	Ellipse area [m2]
3	0	0,0176642	-1,38321	865119	-	93,4367	95,6899	14,0598	107,497	28088,8
5	0,000174704	0,0294404	0,360367	1709491	-	72,5297	74,1558	13,6839	86,2136	16897,1
7	0,02405	0,0412165	1,50883	2677313	-	61,4159	62,2523	13,676	75,0919	12011,2
12,5	6,52536	0,0736009	3,48789	5800162	-	45,4739	45,0189	13,0462	58,52	6431,42

#### Radiation v Distance Results

##### INPUT DATA

Maximum distance	107,497	m
Angle from wind direction	0	deg
Observer direction	Variable	
Height of interest	1	m

##### OUTPUT DATA

Downwind distance [m]	Maximum incident radiation [kW/m2]	Lethality level [fraction]
0	169,835	1
2,19381	169,835	1
4,38761	169,835	1
6,58142	169,835	1
8,77523	169,835	1
10,969	137,099	1
13,1628	100,463	1
15,3566	82,3251	1
17,5505	70,276	0,999994
19,7443	61,7264	0,999959
21,9381	54,9771	0,999803
24,1319	49,6229	0,999298
26,3257	45,171	0,997967
28,5195	41,3981	0,994992
30,7133	38,0959	0,989034
32,9071	34,8941	0,976809
35,1009	31,9232	0,954311
37,2947	29,1921	0,916654
39,4885	26,6895	0,859257
41,6823	24,4008	0,779637
43,8761	22,3115	0,67919
46,0699	20,4079	0,56397
48,2637	18,6768	0,443734
50,4576	17,1053	0,32942
52,6514	15,6808	0,230166
54,8452	14,3911	0,151211
57,039	13,2243	0,0934445
59,2328	12,1693	0,0543988
61,4266	11,2154	0,0299012
63,6204	10,3527	0,0155631
65,8142	9,572	0,00769529
68,008	8,86505	0,00362721
70,2018	8,22422	0,0016356
72,3956	7,64265	0,00070806
74,5894	7,11416	0,000295286
76,7832	6,63325	0,000119024
78,977	6,19497	4,65164E-05
81,1708	5,79492	1,76785E-05
83,3647	5,4292	6,55168E-06
85,5585	5,09431	2,37381E-06
87,7523	4,79207	8,5767E-07
89,9461	4,52939	3,23323E-07
92,1399	4,28602	1,20093E-07
94,3337	4,06029	4,40201E-08
96,5275	3,85066	1,59468E-08
98,7213	3,65575	0
100,915	3,4743	0
103,109	3,3052	0
105,303	3,14741	0
107,497	3	0

Weather: Category 5/D

Wind speed [m/s]	5
Pasquill stability	D neutral - little sun and high wind or overcast/windy night
Atmospheric temperature [degC]	20
Relative humidity [fraction]	0,7
Solar radiation flux [kW / m2]	0,5

#### Pool fire model results

Early pool fires are assumed to occur at a time when the initial PVAP rainout rate equals the pool fire burn rate, unless the thus calculated pool fire radius exceeds the maximum PVAP pool radius. For the latter case the early pool fire radius is assumed to be the maximum PVAP pool radius. The pool fire centre is located at the rainout point.

#### INPUT DATA

Correlation Type: Thomas / Johnson

Surface type	Land	
Pool fire elevation	0 m	
Maximum exposure duration	20 s	
Downwind distance of liquid rainout	0 m	
Use two zone pool fire model	Yes	

#### OUTPUT DATA

Pool fire diameter	19,0764 m	
Downwind distance of pool fire centre	0 m	
Pool fire flame length	39,9467 m	
Angle between pool fire axis and vertical	47,6622 deg	
Luminous flame emissive power	169,835 kW/m2	
Smoky flame emissive power	0 kW/m2	

Ratio of luminous flame length to the total flame length		1 fraction
Total burn rate	34,2976	kg/s
Radiative fraction	0,291256	fraction

### Radiation Intensity Ellipse Results

#### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction	Variable	
Exposure duration	20	s
Height of interest	1	m

#### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^ProbitN.s]	Hazard Information	Ellipse half-length [m]	Ellipse half-width [m]	Ellipse centre downwind distance [m]	Effect downwind distance [m]	Ellipse area [m2]
3	0	0,0176642	-1,38321	865119	-	88,9015	94,1911	20,4697	109,371	26306,9
5	0,000174704	0,0294404	0,360367	1709491	-	70,0543	73,6744	20,0769	90,1313	16214,4
7	0,02405	0,0412165	1,50883	2677313	-	59,8004	62,3874	19,6203	79,4207	11720,6
12,5	6,52536	0,0736009	3,48789	5800162	-	45,2232	46,1334	18,162	63,3852	6554,31

### Radiation v Distance Results

#### INPUT DATA

Maximum distance	109,371	m
Angle from wind direction	0	deg
Observer direction	Variable	
Height of interest	1	m

#### OUTPUT DATA

Downwind distance [m]	Maximum Incident radiation [kW/m2]	Lethality level [fraction]
0	169,835	1
2,23207	169,835	1
4,46413	169,835	1
6,6962	169,835	1
8,92826	169,835	1
11,1603	135,682	1
13,3924	107,021	1
15,6245	91,3256	1
17,8565	80,4992	0,999999
20,0886	72,6556	0,999997
22,3207	65,6125	0,999983
24,5527	60,4014	0,999944
26,7848	55,265	0,999816
29,0168	51,3914	0,999539
31,2489	48,0094	0,998968
33,481	44,8588	0,997809



35,713	42,2714	0,995934
37,9451	39,9018	0,99285
40,1772	37,2937	0,986753
42,4092	34,2026	0,972796
44,6413	31,0423	0,944382
46,8734	27,9922	0,892447
49,1054	25,134	0,808403
51,3375	22,5081	0,689833
53,5696	20,13	0,545478
55,8016	17,9993	0,394498
58,0337	16,1052	0,258769
60,2658	14,4304	0,153406
62,4978	12,9547	0,0822416
64,7299	11,8742	0,0457611
66,962	10,9112	0,0240722
69,194	10,039	0,0118965
71,4261	9,25044	0,00554759
73,6582	8,53804	0,00245241
75,8902	7,89448	0,0010326
78,1223	7,31284	0,000416034
80,3544	6,78665	0,000161105
82,5864	6,31005	6,02123E-05
84,8185	5,87773	2,18044E-05
87,0505	5,48492	7,67788E-06
89,2826	5,12741	2,63755E-06
91,5147	4,80144	8,86583E-07
93,7467	4,50366	2,92398E-07
95,9788	4,23116	9,48487E-08
98,2109	3,98131	3,03285E-08
100,443	3,75181	9,57857E-09
102,675	3,54064	0
104,907	3,34597	0
107,139	3,16621	0
109,371	2,99995	0



Audit Number: 180

Date: 01/09/2023 Time: 17:11

## Consequence Summary Report

Workspace: pm\_rev0

Study: Study  
Summary Basis

These tables will only report global values set in the parameters. Values that are modified in the study tree will not be reported.

The report is context sensitive, and filters up to the study level. You will need to generate multiple summary reports if you have multiple studies in your workspace.

The results in this report are from the non-CFD calculations only.

### Discharge Results (after atmospheric expansion)

Path	Scenario	Weather	Peak Flowrate [kg/s]	Temperature [degC]	Liquid mass fraction in material [fraction]	Droplet diameter [um]	Expanded diameter [m]	Velocity [m/s]	End time of release [s]
Study\T2	Leak 2" - vertical	Category 2/F	42,0713	-11,9098	0,815225	206,597	0,181616	108,933	66,3005
		Category 5/D	42,0713	-11,9098	0,815225	206,597	0,181616	108,933	66,3005

### Dispersion Results

#### Input dispersion parameters

Core averaging time	18,75 s
Flammable averaging time	18,75 s
Toxic averaging time	600 s
Height of interest	1 m

#### Distance downwind to defined concentrations

The reported concentration of interest is defined at the scenario

Path	Scenario	Weather	Distance to UFL [m]	Distance to LFL [m]	Distance to LFL fraction [m]
Study\T2	Leak 2" - vertical	Category 2/F	8,22773	93,034	139,408
		Category 5/D	n/a	52,4806	80,6637

### Jet Fire Results

#### Distance downwind to defined radiation levels

The reported radiations are defined in the parameters

Path	Scenario	Weather	Flame length [m]	Distance downwind to intensity level 1 (3 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 2 (5 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 3 (7 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 4 (12,5 kW/m <sup>2</sup> ) [m]
Study\T2	Leak 2" - vertical	Category 2/F	55,162	91,1284	70,4674	59,8929	46,1527
		Category 5/D	42,879	91,4714	70,7783	59,6899	44,8997

### Early Pool Fire Results

#### Distance downwind to defined radiation levels

The reported radiations are defined in the parameters

Path	Scenario	Weather	Pool diameter [m]	Distance downwind to intensity level 1 (3 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 2 (5 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 3 (7 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 4 (12,5 kW/m <sup>2</sup> ) [m]
Study\T2	Leak 2" - vertical	Category 2/F	19,0764	107,497	86,2136	75,0919	58,52
		Category 5/D	19,0764	109,371	90,1313	79,4207	63,3852

### Late Pool Fire Results

#### Distance downwind to defined radiation levels

The reported radiations are defined in the parameters

Path	Scenario	Weather	Pool diameter [m]	Distance downwind to intensity level 1 (3 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 2 (5 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 3 (7 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 4 (12,5 kW/m <sup>2</sup> ) [m]
Study\T2	Leak 2" - vertical	Category 2/F	28,2841	146,711	117,869	102,453	79,5572
		Category 5/D	27,7665	147,465	121,21	106,586	84,8808

### Flash Fire Results

#### Distance downwind to defined concentrations

The reported LFL and LFL fraction are defined in the respective material property

Path	Scenario	Weather	Distance downwind to LFL [m]	Distance downwind to LFL Fraction [m]
Study\T2	Leak 2" - vertical	Category 2/F	93,034	139,408
		Category 5/D	52,4806	80,6637

#### Maximum distance to LFL fraction at any height

Path	Scenario	Weather	Max flash fire distance [m]	Height of the max flash fire distance [m]	Time [s]
Study\T2	Leak 2" - vertical	Category 2/F	109,919	0	111,801
		Category 5/D	82,7777	0	75,6216

### Explosion Results

#### Explosion scenarios for worst-case maximum downwind distance to defined overpressures.

The reported overpressures are defined in the explosion parameters

Path	Scenario	Weather	Overpressure level [bar]	Maximum distance [m]	Diameter [m]
Study\T2	Leak 2" - vertical	Category 2/F	0,02068	446,098	692,196
			0,1379	167,266	134,533
			0,2068	150,434	100,868
		Category 5/D	0,02068	314,579	469,158
			0,1379	125,592	91,184
			0,2068	114,183	68,3663

#### Supplementary data for worst-case explosion scenarios

Path	Scenario	Weather	Overpressure level [bar]	Explosion flammable mass [kg]	Ignition time [s]	Ignition source [m]	Cloud centre [m]	Explosion centre [m]
Study\T2	Leak 2" - vertical	Category 2/F	0,02068	502,542	94,5265	100	38,8707	100
			0,1379	502,542	94,5265	100	38,8707	100
			0,2068	502,542	94,5265	100	38,8707	100
		Category 5/D	0,02068	156,474	63,446	80	25,7089	80
			0,1379	156,474	63,446	80	25,7089	80
			0,2068	156,474	63,446	80	25,7089	80

TOP EVENT 3



**Audit Number: 205**

**Date: 03/09/2023 Time: 15:38**

# Discharge Report

**Workspace: pm\_rev0**

**Study: Study**

**Equipment Item: T3**

**pm\_rev0\Study\T3**

Material	ISOBUTANE	
East	0	m
North	0	m

**Scenario (Leak) : T3-2"leak vertical**

**pm\_rev0\Study\T3\T3-2"leak vertical**

**Weather: Category 2/F**

## INPUT DATA

### Inventory data

Mass in vessel	323,909	kg
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### Stagnation Data (upstream end for long pipe)

Initial pressure (gauge)	10	bar
Initial temperature	130	degC
Fluid state	Pressurized gas	

### Scenario data

Phase to be released	Vapour	
Hole diameter	50,8	mm

## OUTPUT DATA

Mass flow rate	5,29752	kg/s
Release duration	61,1436	s

### Orifice or pipe exit data (before atmospheric expansion)

Pressure	6,64072	bar
Temperature	113,979	degC
Liquid mass fraction	0	fraction
Velocity at vena contracta (at exit for pipe releases)	227,422	m/s
Discharge coefficient	0,884235	

### Final Data (after atmospheric expansion)

Temperature	77,6943	degC
Liquid mass fraction	0	fraction

Droplet diameter	0	um
Expanded diameter	<b>0,0887376</b>	m
Velocity	417,804	m/s

### Weather: Category 5/D

#### INPUT DATA

##### Inventory data

Mass in vessel	<b>323,909</b>	kg
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##### Stagnation Data (upstream end for long pipe)

Initial pressure (gauge)	<b>10</b>	bar
Initial temperature	<b>130</b>	degC
Fluid state	<b>Pressurized gas</b>	

##### Scenario data

Phase to be released	Vapour	
Hole diameter	<b>50,8</b>	mm

#### OUTPUT DATA

Mass flow rate	5,29752	kg/s
Release duration	61,1436	s

##### Orifice or pipe exit data (before atmospheric expansion)

Pressure	6,64072	bar
Temperature	113,979	degC
Liquid mass fraction	<b>0</b>	fraction
Velocity at vena contracta (at exit for pipe releases)	227,422	m/s
Discharge coefficient	0,884235	

##### Final Data (after atmospheric expansion)

Temperature	77,6943	degC
Liquid mass fraction	0	fraction
Droplet diameter	0	um
Expanded diameter	<b>0,0887376</b>	m
Velocity	417,804	m/s



Audit Number: 205

Date: 03/09/2023 Time: 15:39

## Explosion Report

Workspace: pm\_rev0

Study: Study

Equipment Item: T3

pm\_rev0\Study\T3

Material	ISOBUTANE	
East	0	m
North	0	m

Scenario (Leak) : T3-2"leak vertical

pm\_rev0\Study\T3\T3-2"leak vertical

Weather: Category 2/F

Explosion location criterion	Cloud front (LFL fraction)
Explosion height criterion	Centreline height
Explosion method	Multi-Energy: Uniform confined
Uniform confined method explosion efficiency	12,5 %
Uniform confined method explosion strength	10

Time of explosion [s]	Distance to centre of mass [m]	Distance to explosion centre [m]	Distance to ignition point [m]	Flammable mass [kg]	Overpressures (input) [bar]	Distance to specified overpressures [m]
0,777801	5,9722	10	10	1,03301	0,02068 0,1379 0,2068	54,0058 18,5528 16,4126
2,32082	10,097	20	20	4,81029	0,02068 0,1379 0,2068	93,485 34,2823 30,7083
7,10753	15,3039	30	30	17,5621	0,02068 0,1379 0,2068	143,153 51,9921 46,4888
15,2939	21,4828	40	40	49,2325	0,02068 0,1379 0,2068	199,548 71,0093 63,2496
26,611	27,0647	50	50	92,473	0,02068 0,1379 0,2068	246,855 88,2601 78,686
39,9183	31,9017	60	60	132,742	0,02068 0,1379 0,2068	282,064 103,16 92,3594
57,554	36,3488	70	70	166,737	0,02068 0,1379 0,2068	309,599 116,568 104,915
83,8044	47,3013	80	80	100,542	0,02068 0,1379 0,2068	282,422 119,342 109,497

Weather: Category 5/D

Explosion location criterion	Cloud front (LFL fraction)
Explosion height criterion	Centreline height
Explosion method	Multi-Energy: Uniform confined
Uniform confined method explosion efficiency	12,5 %
Uniform confined method explosion strength	10



Time of explosion [s]	Distance to centre of mass [m]	Distance to explosion centre [m]	Distance to ignition point [m]	Flammable mass [kg]	Overpressures (input) [bar]	Distance to specified overpressures [m]
0,777801	8,64158	10	10	1,7648	0,02068 0,1379 0,2068	62,6065 20,2244 17,6659
1,52868	11,8003	20	20	4,35423	0,02068 0,1379 0,2068	91,0851 33,8159 30,3586
3,43932	17,8677	30	30	11,4267	0,02068 0,1379 0,2068	128,05 49,0567 44,288
6,32522	23,4406	40	40	20,0075	0,02068 0,1379 0,2068	158,179 62,9688 57,2212
10,1067	27,4721	50	50	26,6992	0,02068 0,1379 0,2068	180,109 75,2876 68,9597
15,021	28,5302	60	60	28,2034	0,02068 0,1379 0,2068	192,508 85,7538 79,3092
27,4718	28,9163	70	70	28,7451	0,02068 0,1379 0,2068	203,351 95,9176 89,4321



Audit Number: 205

Date: 03/09/2023 Time: 15:39

## Jet Fire

Workspace: pm\_rev0

Study: Study

Equipment Item: T3

pm\_rev0\Study\T3

Material	ISOBUTANE	
East	0	m
North	0	m

Scenario (Leak) : T3-2"leak vertical

pm\_rev0\Study\T3\T3-2"leak vertical

Weather: Category 2/F

Wind speed  
[m/s]

2

Pasquill  
stability

F stable - night with moderate clouds and light/moderate wind

Atmospheric  
temperature  
[degC]

20

Relative  
humidity  
[fraction]

0,7

Solar radiation  
flux [kW/m2]

0,5

### Jet fire model results

#### INPUT DATA

##### Scenario

Elevation	1	m
Release angle from horizontal	0	deg

##### Jet Fire Parameters

Jet fire method	Cone model	
Wind orientation about the z-axis (anti-clockwise from the East)	0	deg

Rotation about the z-axis (anti-clockwise from the east)	0	deg
Rate modification factor	3	

#### Calculated inputs

Mass flow rate	5,29752	kg/s
Temperature after atmospheric expansion	77,6943	degC
Liquid fraction	0	fraction
Velocity after atmospheric expansion (input)	417,804	m/s
Rainout fraction time averaged	0	fraction

#### OUTPUT DATA

Flame emissive power	214,162	kW/m2
Fraction of emissivity	0,159841	fraction
Jet velocity	417,804	m/s
Flame length	24,6458	m
Frustum length	17,6227	m
Frustum base width	1,57712	m
Frustum tip width	4,31414	m
Frustum lift-off distance	7,25696	m
Flame length in still air	30,4878	m
Hole to flame angle	17,3059	deg
Expanded diameter	0,0887376	m
Plane angular rotation	0	deg

#### Radiation Intensity Ellipse Results

##### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction	Variable	
Exposure duration	20	s
Height of interest	1	m

##### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^Prob ltN.s]	Ellipse half-length [m]	Ellipse half-width [m]	Ellipse centre downwind distance [m]	Effect downwind distance [m]	Ellipse area [m2]
3	0	0,0140081	-1,38321	865119	22,376	29,5568	0	29,5568	2077,73
5	0,000174704	0,0233468	0,360367	1709491	18,4313	22,8952	0	22,8952	1325,71
7	0,02405	0,0326855	1,50883	2677313	16,4252	19,2704	0	19,2704	994,377

12,5	6,52536	0,058367	3,48789	5800162	13,7244	14,043	0	14,043	605,482
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## Radiation v Distance Results

### INPUT DATA

Maximum distance	48,1637	m
Observer type radiation modelling flag	Planar	
Observer direction	Variable	
Height of interest	1	m

### OUTPUT DATA

Downwind distance [m]	Maximum incident radiation [kW/m2]	Lethality level [fraction]
-19,1257	4,11726	5,7183E-08
-18,1427	4,9292	1,37894E-06
-17,1598	6,11134	3,83532E-05
-16,1769	7,98479	0,00117557
-15,1939	11,3691	0,0331944
-14,211	19,2088	0,481798
-13,2281	49,543	0,999284
-12,2451	175,024	1
-11,2622	214,162	1
-10,2793	214,162	1
-9,29634	214,162	1
-8,31341	214,162	1
-7,33048	178,186	1
-6,34755	153,959	1
-5,36461	136,656	1
-4,38168	124,123	1
-3,39875	115,162	1
-2,41582	107,013	1
-1,43288	100,803	1
-0,449951	95,4928	1
0,532982	90,6845	1
1,51591	85,9148	1
2,49885	80,4862	0,999999
3,48178	73,2723	0,999997
4,46471	62,8501	0,999968
5,44765	48,8739	0,999161
6,43058	34,6215	0,9753
7,41351	30,0246	0,930415
8,39644	26,0491	0,83991
9,37938	21,8361	0,652446
10,3623	18,2053	0,40952
11,3452	15,2212	0,2005
12,3282	12,8083	0,0765116
13,3111	10,8629	0,0232268
14,294	9,28921	0,00577811
15,277	8,00815	0,00121509
16,2599	6,95941	0,00022324
17,2428	6,0899	3,64751E-05
18,2258	5,36545	5,4456E-06

19,2087	4,75692	7,5662E-07
20,1916	4,24188	9,93647E-08
21,1746	3,80293	1,25001E-08
22,1575	3,42626	0
23,1404	3,101	0
24,1234	2,81848	0
25,1063	2,57171	0
26,0892	2,35506	0
27,0722	2,16393	0
28,0551	1,99455	0
29,038	1,8438	0

Weather: Category 5/D

Wind speed [m/s]	5
Pasquill stability	D neutral - little sun and high wind or overcast/windy night
Atmospheric temperature [degC]	20
Relative humidity [fraction]	0,7
Solar radiation flux [kW/m2]	0,5

Jet fire model results

INPUT DATA

Scenario

Elevation	1	m
Release angle from horizontal	0	deg

Jet Fire Parameters

Jet fire method	Cone model	
Wind orientation about the z-axis (anti-clockwise from the East)	0	deg
Rotation about the z-axis (anti- clockwise from the east)	0	deg
Rate modification factor	3	

Calculated inputs

Mass flow rate	5,29752	kg/s
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Temperature after atmospheric expansion	77,6943	degC
Liquid fraction	0	fraction
Velocity after atmospheric expansion (input)	<b>417,804</b>	m/s
Rainout fraction time averaged	<b>0</b>	fraction

#### OUTPUT DATA

Flame emissive power	204,213	kW/m2
Fraction of emissivity	0,155392	fraction
Jet velocity	417,804	m/s
Flame length	26,3521	m
Frustum length	19,2188	m
Frustum base width	1,57712	m
Frustum tip width	4,0119	m
Frustum lift-off distance	7,25696	m
Flame length in still air	30,4878	m
Hole to flame angle	12,4294	deg
Expanded diameter	0,0887376	m
Plane angular rotation	0	deg

#### Radiation Intensity Ellipse Results

##### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction	Variable	
Exposure duration	20	s
Height of interest	<b>1</b>	m

##### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^ProbitN.s]	Ellipse half-length [m]	Ellipse half-width [m]	Ellipse centre downwind distance [m]	Effect downwind distance [m]	Ellipse area [m2]
3	0	0,0146906	-1,38321	865119	21,2828	29,2651	0	29,2651	1956,73
5	0,000174704	0,0244843	0,360367	1709491	18,0855	22,6389	0	22,6389	1286,28
7	0,02405	0,034278	1,50883	2677313	16,4435	19,0058	0	19,0058	981,817
12,5	6,52536	0,0612107	3,48789	5800162	14,2303	13,7307	0	14,2303	613,841

#### Radiation v Distance Results

##### INPUT DATA

Maximum distance	52,0507	m
Observer type radiation modelling flag	Planar	
Observer direction	Variable	

Height of interest	1 m
--------------------	-----

# OUTPUT DATA

Downwind distance [m]	Maximum incident radiation [kW/m2]	Lethality level [fraction]
-19,8633	3,11896	0
-18,801	3,86155	1,68471E-08
-17,7387	5,0248	1,89547E-06
-16,6765	7,07861	0,000277188
-15,6142	11,6319	0,0393913
-14,552	26,1826	0,84412
-13,4897	87,3016	1
-12,4274	204,213	1
-11,3652	204,213	1
-10,3029	204,213	1
-9,24066	204,213	1
-8,1784	204,213	1
-7,11614	194,765	1
-6,05388	172,539	1
-4,99162	155,345	1
-3,92936	141,683	1
-2,86711	131,162	1
-1,80485	122,792	1
-0,742586	115,941	1
0,319674	110,723	1
1,38193	105,335	1
2,44419	100,26	1
3,50645	94,9635	1
4,56871	87,2755	1
5,63097	72,874	0,999997
6,69323	48,6522	0,999115
7,75549	38,4603	0,989938
8,81775	31,3832	0,948443
9,88001	24,5842	0,787139
10,9423	19,2472	0,484516
12,0045	15,2394	0,201649
13,0668	12,2438	0,0567345
14,129	9,98409	0,011328
15,1913	8,25692	0,00170855
16,2536	6,91738	0,000206495
17,3158	5,86399	2,10661E-05
18,3781	5,02396	1,89026E-06
19,4403	4,34561	1,54332E-07
20,5026	3,79209	1,18199E-08
21,5649	3,33395	0
22,6271	2,95175	0
23,6894	2,62998	0
24,7516	2,35682	0
25,8139	2,12312	0
26,8762	1,92177	0
27,9384	1,74717	0
29,0007	1,59483	0
30,0629	1,46121	0
31,1252	1,3434	0

32,1875	1,23901	0
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Audit Number: 205

Date: 03/09/2023 Time: 15:38

## Consequence Summary Report

Workspace: pm\_rev0

Study: Study

Summary Basis

These tables will only report global values set in the parameters. Values that are modified in the study tree will not be reported.

The report is context sensitive, and filters up to the study level. You will need to generate multiple summary reports if you have multiple studies in your workspace.

The results in this report are from the non-CFD calculations only.

### Discharge Results (after atmospheric expansion)

Path	Scenario	Weather	Peak Flowrate [kg/s]	Temperature [degC]	Liquid mass fraction in material [fraction]	Droplet diameter [um]	Expanded diameter [m]	Velocity [m/s]	End time of release [s]
Study\T3	T3-2"leak vertical	Category 2/F	5,29752	77,6943	0	0	0,0887376	417,804	61,1436
		Category 5/D	5,29752	77,6943	0	0	0,0887376	417,804	61,1436

### Dispersion Results

#### Input dispersion parameters

Core averaging time	18,75	s
Flammable averaging time	18,75	s
Toxic averaging time	600	s
Height of interest	1	m

#### Distance downwind to defined concentrations

The reported concentration of interest is defined at the scenario

Path	Scenario	Weather	Distance to UFL [m]	Distance to LFL [m]	Distance to LFL fraction [m]
Study\T3	T3-2"leak vertical	Category 2/F	14,0553	52,6454	74,3412
		Category 5/D	n/a	46,7761	67,7593

### Jet Fire Results

#### Distance downwind to defined radiation levels

The reported radiations are defined in the parameters

Path	Scenario	Weather	Flame length [m]	Distance downwind to Intensity level 1 (3 kW/m2) [m]	Distance downwind to Intensity level 2 (5 kW/m2) [m]	Distance downwind to Intensity level 3 (7 kW/m2) [m]	Distance downwind to Intensity level 4 (12,5 kW/m2) [m]
Study\T3	T3-2"leak vertical	Category 2/F	24,6458	29,5568	22,8952	19,2704	14,043

		Category 5/D	26,3521	29,2651	22,6389	19,0058	14,2303
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## Flash Fire Results

### Distance downwind to defined concentrations

The reported LFL and LFL fraction are defined in the respective material property

Path	Scenario	Weather	Distance downwind to LFL [m]	Distance downwind to LFL Fraction [m]
Study\T3	T3-2"leak vertical	Category 2/F	52,6454	74,3412
		Category 5/D	46,7761	67,7593

### Maximum distance to LFL fraction at any height

Path	Scenario	Weather	Max flash fire distance [m]	Height of the max flash fire distance [m]	Time [s]
Study\T3	T3-2"leak vertical	Category 2/F	80,8147	0	86,1281
		Category 5/D	71,9888	0	36,6862

## Explosion Results

### Explosion scenarios for worst-case maximum downwind distance to defined overpressures.

The reported overpressures are defined in the explosion parameters

Path	Scenario	Weather	Overpressure level [bar]	Maximum distance [m]	Diameter [m]
Study\T3	T3-2"leak vertical	Category 2/F	0,02068 0,1379 0,2068	309,599 119,342 109,497	479,199 78,684 58,9943
		Category 5/D	0,02068 0,1379 0,2068	203,351 95,9176 89,4321	266,702 51,8353 38,8641

### Supplementary data for worst-case explosion scenarios

Path	Scenario	Weather	Overpressure level [bar]	Explosion flammable mass [kg]	Ignition time [s]	Ignition source [m]	Cloud centre [m]	Explosion centre [m]
Study\T3	T3-2"leak vertical	Category 2/F	0,02068 0,1379 0,2068	166,737 100,542 100,542	57,554 83,8044 83,8044	70 80 80	36,3488 47,3013 47,3013	70 80 80
		Category 5/D	0,02068 0,1379 0,2068	28,7451 28,7451 28,7451	27,4718 27,4718 27,4718	70 70 70	28,9163 28,9163 28,9163	70 70 70

TOP EVENT 4



**Audit Number: 218**

**Date: 03/09/2023 Time: 15:45**

# Discharge Report

**Workspace: pm\_rev0**

**Study: Study**

**Equipment Item: T4**

**pm\_rev0\Study\T4**

Material	ISOBUTANE	
East	0	m
North	0	m

**Scenario (Leak) : T4-2"leak vertical**

**pm\_rev0\Study\T4\T4-2"leak vertical**

**Weather: Category 2/F**

## INPUT DATA

### Inventory data

Mass in vessel	209,566	kg
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### Stagnation Data (upstream end for long pipe)

Initial pressure (gauge)	8	bar
Initial temperature	80	degC
Fluid state	Pressurized gas	

### Scenario data

Phase to be released	Vapour	
Hole diameter	50,8	mm

## OUTPUT DATA

Mass flow rate	4,6861	kg/s
Release duration	44,7208	s

### Orifice or pipe exit data (before atmospheric expansion)

Pressure	5,45055	bar
Temperature	63,8725	degC
Liquid mass fraction	0	fraction
Velocity at vena contracta (at exit for pipe releases)	208,723	m/s
Discharge coefficient	0,882598	

### Final Data (after atmospheric expansion)

Temperature	29,3506	degC
Liquid mass fraction	0	fraction

Droplet diameter	0	um
Expanded diameter	<b>0,0811152</b>	m
Velocity	378,113	m/s

### Weather: Category 5/D

#### INPUT DATA

##### Inventory data

Mass in vessel	<b>209,566</b>	kg
----------------	----------------	----

##### Stagnation Data (upstream end for long pipe)

Initial pressure (gauge)	<b>8</b>	bar
Initial temperature	<b>80</b>	degC
Fluid state	<b>Pressurized gas</b>	

##### Scenario data

Phase to be released	Vapour	
Hole diameter	<b>50,8</b>	mm

#### OUTPUT DATA

Mass flow rate	4,6861	kg/s
Release duration	44,7208	s

##### Orifice or pipe exit data (before atmospheric expansion)

Pressure	5,45055	bar
Temperature	63,8725	degC
Liquid mass fraction	<b>0</b>	fraction
Velocity at vena contracta (at exit for pipe releases)	208,723	m/s
Discharge coefficient	0,882598	

##### Final Data (after atmospheric expansion)

Temperature	29,3506	degC
Liquid mass fraction	0	fraction
Droplet diameter	0	um
Expanded diameter	<b>0,0811152</b>	m
Velocity	378,113	m/s



Audit Number: 218

Date: 03/09/2023 Time: 15:48

## Explosion Report

Workspace: pm\_rev0

Study: Study

Equipment Item: T4

pm\_rev0\Study\T4

Material	ISOBUTANE	
East	0	m
North	0	m

### Scenario (Leak) : T4-2"leak vertical

pm\_rev0\Study\T4\T4-2"leak vertical

Weather: Category 2/F

Explosion location criterion	Cloud front (LFL fraction)	
Explosion height criterion	Centreline height	
Explosion method	Multi-Energy: Uniform confined	
Uniform confined method explosion efficiency	12,5	%
Uniform confined method explosion strength	10	

Time of explosion [s]	Distance to centre of mass [m]	Distance to explosion centre [m]	Distance to ignition point [m]	Flammable mass [kg]	Overpressures (input) [bar]	Distance to specified overpressures [m]
0,690752	5,63633	10	10	0,711591	0,02068 0,1379 0,2068	48,8644 17,5536 15,6634
2,59059	10,2275	20	20	4,66408	0,02068 0,1379 0,2068	92,7327 34,1361 30,5987
7,90332	15,3669	30	30	16,5962	0,02068 0,1379 0,2068	141,04 51,5813 46,1808
16,3315	20,5447	40	40	41,1786	0,02068 0,1379 0,2068	190,325 69,2167 61,9056
27,535	25,7797	50	50	73,3916	0,02068 0,1379 0,2068	232,259 85,4234 76,5591
46,4173	31,5629	60	60	106,846	0,02068 0,1379 0,2068	266,567 100,148 90,1012
70,0215	46,2995	70	70	76,5183	0,02068 0,1379 0,2068	254,812 105,919 96,931

Weather: Category 5/D

Explosion location criterion	Cloud front (LFL fraction)	
Explosion height criterion	Centreline height	
Explosion method	Multi-Energy: Uniform confined	
Uniform confined method explosion efficiency	12,5	%
Uniform confined method explosion strength	10	

Time of explosion [s]	Distance to centre of mass [m]	Distance to explosion centre [m]	Distance to ignition point [m]	Flammable mass [kg]	Overpressures (input) [bar]	Distance to specified overpressures [m]
0,690752	8,06321	10	10	1,26712	0,02068 0,1379 0,2068	57,1065 19,1555 16,8644
1,58311	11,947	20	20	3,80748	0,02068 0,1379 0,2068	87,9757 33,2115 29,9055
3,69592	18,4675	30	30	11,1928	0,02068 0,1379 0,2068	127,377 48,9258 44,1899
7,0598	23,8873	40	40	19,3973	0,02068 0,1379 0,2068	156,965 62,7329 57,0443
11,6618	25,663	50	50	21,8307	0,02068 0,1379 0,2068	171,665 73,6463 67,7291
19,8107	26,0828	60	60	22,3994	0,02068 0,1379 0,2068	182,712 83,8499 77,8817



Audit Number: 218

Date: 03/09/2023 Time: 15:48

## Jet Fire

Workspace: pm\_rev0

Study: Study

Equipment Item: T4

pm\_rev0\Study\T4

Material	ISOBUTANE	
East	0	m
North	0	m

Scenario (Leak) : T4-2"leak vertical

pm\_rev0\Study\T4\T4-2"leak vertical

Weather: Category 2/F

Wind speed [m/s]	2
Pasquill stability	F stable - night with moderate clouds and light/moderate wind
Atmospheric temperature [degC]	20
Relative humidity [fraction]	0,7
Solar radiation flux [kW/m2]	0,5

### Jet fire model results

#### INPUT DATA

##### Scenario

Elevation	1	m
Release angle from horizontal	0	deg

##### Jet Fire Parameters

Jet fire method	Cone model	
Wind orientation about the z-axis (anti-clockwise from the East)	0	deg



Rotation about the z-axis (anti-clockwise from the east)	0 deg
Rate modification factor	3

#### Calculated inputs

Mass flow rate	4,6861 kg/s
Temperature after atmospheric expansion	29,3506 degC
Liquid fraction	0 fraction
Velocity after atmospheric expansion (input)	378,113 m/s
Rainout fraction time averaged	0 fraction

#### OUTPUT DATA

Flame emissive power	198,867 kW/m2
Fraction of emissivity	0,166038 fraction
Jet velocity	378,113 m/s
Flame length	23,8676 m
Frustum length	17,5941 m
Frustum base width	1,51678 m
Frustum tip width	4,31927 m
Frustum lift-off distance	6,49305 m
Flame length in still air	29,4685 m
Hole to flame angle	17,4612 deg
Expanded diameter	0,0811153 m
Plane angular rotation	0 deg

#### Radiation Intensity Ellipse Results

##### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction	Variable
Exposure duration	20 s
Height of interest	1 m

##### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^ProbitN.s]	Ellipse half-length [m]	Ellipse half-width [m]	Ellipse centre downwind distance [m]	Effect downwind distance [m]	Ellipse area [m2]
3	0	0,0150854	-1,38321	865119	21,6222	28,3175	0	28,3175	1923,56
5	0,000174704	0,0251424	0,360367	1709491	17,8603	21,9209	0	21,9209	1229,98
7	0,02405	0,0351993	1,50883	2677313	15,9418	18,4294	0	18,4294	922,994
12,5	6,52536	0,062856	3,48789	5800162	13,3531	13,3628	0	13,3628	560,571

## Radiation v Distance Results

### INPUT DATA

Maximum distance	46,5528	m
Observer type radiation modelling flag	Planar	
Observer direction	Variable	
Height of interest	1	m

### OUTPUT DATA

Downwind distance [m]	Maximum Incident radiation [kW/m <sup>2</sup> ]	Lethality level [fraction]
-18,2815	4,2635	1,09071E-07
-17,3314	5,18035	3,11421E-06
-16,3813	6,56981	0,000104622
-15,4313	8,91619	0,00384596
-14,4812	13,5959	0,110239
-13,5312	28,2075	0,897207
-12,5811	92,1266	1
-11,631	198,867	1
-10,681	198,867	1
-9,73093	198,867	1
-8,78088	198,867	1
-7,83082	177,375	1
-6,88076	151,753	1
-5,9307	133,203	1
-4,98065	120,019	1
-4,03059	110,185	1
-3,08053	102,518	1
-2,13047	96,4522	1
-1,18042	91,1769	1
-0,23036	86,6871	1
0,719698	82,5354	1
1,66976	78,3287	0,999999
2,61981	73,4443	0,999997
3,56987	66,9236	0,999987
4,51993	57,6163	0,999894
5,46999	45,3043	0,998031
6,42004	32,3621	0,95861
7,3701	27,9174	0,890748
8,32016	24,4984	0,783655
9,27022	20,7222	0,58442
10,2203	17,404	0,351076
11,1703	14,6375	0,165204
12,1204	12,3764	0,0610501
13,0704	10,5379	0,0180893
14,0205	9,0404	0,00442127
14,9706	7,81459	0,00091845
15,9206	6,8066	0,00016742
16,8707	5,9674	2,72075E-05
17,8207	5,26591	4,04893E-06
18,7708	4,67503	5,61564E-07
19,7208	4,17371	7,36869E-08
20,6709	3,74557	9,26843E-09
21,621	3,37752	0

22,571	3,05921	0
23,5211	2,78234	0
24,4711	2,54022	0
25,4212	2,32742	0
26,3712	2,13952	0
27,3213	1,97285	0
28,2714	1,82441	0

Weather: Category 5/D

Wind speed [m/s]	5
Pasquill stability	D neutral - little sun and high wind or overcast/windy night
Atmospheric temperature [degC]	20
Relative humidity [fraction]	0,7
Solar radiation flux [kW/m2]	0,5

Jet fire model results

INPUT DATA

Scenario

Elevation	1	m
Release angle from horizontal	0	deg

Jet Fire Parameters

Jet fire method	Cone model	
Wind orientation about the z-axis (anti-clockwise from the East)	0	deg
Rotation about the z-axis (anti- clockwise from the east)	0	deg
Rate modification factor	3	

Calculated inputs

Mass flow rate	4,6861	kg/s
Temperature after atmospheric expansion	29,3506	degC
Liquid fraction	0	fraction

Velocity after atmospheric expansion (input)	<b>378,113</b>	m/s
Rainout fraction time averaged	<b>0</b>	fraction

#### OUTPUT DATA

Flame emissive power	188,547	kW/m2
Fraction of emissivity	0,161074	fraction
Jet velocity	378,113	m/s
Flame length	25,7574	m
Frustum length	19,3696	m
Frustum base width	1,51678	m
Frustum tip width	3,9953	m
Frustum lift-off distance	6,49305	m
Flame length in still air	29,4685	m
Hole to flame angle	11,9324	deg
Expanded diameter	0,0811153	m
Plane angular rotation	0	deg

#### Radiation Intensity Ellipse Results

##### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction	Variable	
Exposure duration	20	s
Height of interest	<b>1</b>	m

##### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^ProbitN.s]	Ellipse half-length [m]	Ellipse half-width [m]	Ellipse centre downwld distance [m]	Effect downwld distance [m]	Ellipse area [m2]
3	0	0,0159112	-1,38321	865119	20,5535	28,0214	0	28,0214	1809,37
5	0,000174704	0,0265186	0,360367	1709491	17,5899	21,6508	0	21,6508	1196,43
7	0,02405	0,037126	1,50883	2677313	16,0611	18,1472	0	18,1472	915,662
12,5	6,52536	0,0662965	3,48789	5800162	13,9978	13,0266	0	13,9978	572,849

#### Radiation v Distance Results

##### INPUT DATA

Maximum distance	50,8882	m
Observer type radiation modelling flag	Planar	
Observer direction	Variable	
Height of interest	<b>1</b>	m

##### OUTPUT DATA

Downwind distance [m]	Maximum incident radiation [kW/m2]	Lethality level [fraction]
-19,1008	3,13826	0
-18,0623	3,98688	3,11479E-08
-17,0238	5,40571	6,12278E-06
-15,9852	8,21774	0,00162145
-14,9467	16,1113	0,259189
-13,9082	44,8797	0,99782
-12,8696	169,182	1
-11,8311	188,547	1
-10,7925	188,547	1
-9,75401	188,547	1
-8,71548	188,547	1
-7,67694	188,547	1
-6,63841	174,881	1
-5,59987	155,304	1
-4,56134	141,341	1
-3,5228	130,166	1
-2,48427	121,406	1
-1,44573	114,335	1
-0,407195	108,471	1
0,63134	103,475	1
1,66987	99,0395	1
2,70841	94,8115	1
3,74695	90,0816	1
4,78548	83,047	1
5,82402	69,37	0,999993
6,86255	45,6491	0,998187
7,90109	36,5034	0,984055
8,93962	29,8146	0,927156
9,97816	23,2733	0,728901
11,0167	18,1891	0,408342
12,0552	14,394	0,151373
13,0938	11,5582	0,0375815
14,1323	9,42122	0,00662001
15,1708	7,78881	0,000883945
16,2094	6,5233	9,50472E-05
17,2479	5,52846	8,67417E-06
18,2864	4,73535	7,00053E-07
19,325	4,09506	5,16782E-08
20,3635	3,57278	0
21,402	3,14052	0
22,4406	2,77999	0
23,4791	2,47653	0
24,5176	2,21895	0
25,5562	1,99863	0
26,5947	1,80884	0
27,6333	1,64429	0
28,6718	1,50074	0
29,7103	1,37485	0
30,7489	1,26387	0
31,7874	1,16555	0



Audit Number: 218

Date: 03/09/2023 Time: 15:44

## Consequence Summary Report

Workspace: pm\_rev0

Study: Study

Summary Basis

These tables will only report global values set in the parameters. Values that are modified in the study tree will not be reported.

The report is context sensitive, and filters up to the study level. You will need to generate multiple summary reports if you have multiple studies in your workspace.

The results in this report are from the non-CFD calculations only.

### Discharge Results (after atmospheric expansion)

Path	Scenario	Weather	Peak Flowrate [kg/s]	Temperature [degC]	Liquid mass fraction in material [fraction]	Droplet diameter [um]	Expanded diameter [m]	Velocity [m/s]	End time of release [s]
Study\T4	T4-2"leak vertical	Category 2/F	4,6861	29,3506	0	0	0,0811152	378,113	44,7208
		Category 5/D	4,6861	29,3506	0	0	0,0811152	378,113	44,7208

### Dispersion Results

#### Input dispersion parameters

Core averaging time	18,75	s
Flammable averaging time	18,75	s
Toxic averaging time	600	s
Height of interest	1	m

#### Distance downwind to defined concentrations

The reported concentration of interest is defined at the scenario

Path	Scenario	Weather	Distance to UFL	Distance to LFL	Distance to LFL
Study\T4	T4-2"leak vertical	Category 2/F	n/a	42,5961	68,628
		Category 5/D	n/a	39,9793	59,1425

### Jet Fire Results

#### Distance downwind to defined radiation levels

The reported radiations are defined in the parameters

Path	Scenario	Weather	Flame length [m]	Distance downwind to intensity level 1 (3 kW/m2) [m]	Distance downwind to intensity level 2 (5 kW/m2) [m]	Distance downwind to intensity level 3 (7 kW/m2) [m]	Distance downwind to intensity level 4 (12,5 kW/m2) [m]
Study\T4	T4-2"leak vertical	Category 2/F	23,8676	28,3175	21,9209	18,4294	13,3628
		Category 5/D	25,7574	28,0214	21,6508	18,1472	13,9978

## Flash Fire Results

### Distance downwind to defined concentrations

The reported LFL and LFL fraction are defined in the respective material property

Path	Scenario	Weather	Distance downwind to LFL [m]	Distance downwind to LFL Fraction [m]
Study\T4	T4-2"leak vertical	Category 2/F	42,5961	68,628
		Category 5/D	39,9793	59,1425

### Maximum distance to LFL fraction at any height

Path	Scenario	Weather	Max flash fire distance [m]	Height of the max flash fire distance [m]	Time [s]
Study\T4	T4-2"leak vertical	Category 2/F	74,1449	0	98,7416
		Category 5/D	63,7166	0	31,3045

## Explosion Results

### Explosion scenarios for worst-case maximum downwind distance to defined overpressures.

The reported overpressures are defined in the explosion parameters

Path	Scenario	Weather	Overpressure level [bar]	Maximum distance [m]	Diameter [m]
Study\T4	T4-2"leak vertical	Category 2/F	0,02068 0,1379 0,2068	266,567 105,919 96,931	413,133 71,8389 53,862
		Category 5/D	0,02068 0,1379 0,2068	182,712 83,8499 77,8817	245,424 47,6998 35,7635

### Supplementary data for worst-case explosion scenarios

Path	Scenario	Weather	Overpressure level [bar]	Explosion flammable mass [kg]	Ignition time [s]	Ignition source [m]	Cloud centre [m]	Explosion centre [m]
Study\T4	T4-2"leak vertical	Category 2/F	0,02068 0,1379 0,2068	106,846 76,5183 76,5183	46,4173 70,0215 70,0215	60 70 70	31,5629 46,2995 46,2995	60 70 70
		Category 5/D	0,02068 0,1379 0,2068	22,3994 22,3994 22,3994	19,8107 19,8107 19,8107	60 60 60	26,0828 26,0828 26,0828	60 60 60

TOP EVENT 7





**Audit Number: 231**

**Date: 03/09/2023 Time: 15:56**

# Discharge Report

**Workspace: pm\_rev0**

**Study: Study**

**Equipment Item: T7**

**pm\_rev0\Study\T7**

Material	ISOBUTANE	
East	0	m
North	0	m

**Scenario (Leak) : T7-2"leak vertical**

**pm\_rev0\Study\T7\T7-2"leak vertical**

**Weather: Category 2/F**

## INPUT DATA

### Inventory data

Mass in vessel	2789,35	kg
----------------	---------	----

### Stagnation Data (upstream end for long pipe)

Initial pressure (gauge)	10	bar
Initial temperature	20	degC
Fluid state	Non-saturated liquid	

### Scenario data

Phase to be released	Liquid	
Tank head	0	m
Hole diameter	50,8	mm

## OUTPUT DATA

Mass flow rate	42,0713	kg/s
Release duration	66,3005	s

### Orifice or pipe exit data (before atmospheric expansion)

Pressure	1,01325	bar
Temperature	19,3938	degC
Liquid mass fraction	1	fraction
Velocity at vena contracta (at exit for pipe releases)	61,9312	m/s
Discharge coefficient	0,6	

### Final Data (after atmospheric expansion)

Temperature	-11,9098	degC
-------------	----------	------

Liquid mass fraction	0,815225	fraction
Droplet diameter	206,597	um
Expanded diameter	<b>0,181616</b>	m
Velocity	108,933	m/s

### Weather: Category 5/D

#### INPUT DATA

##### Inventory data

Mass in vessel	<b>2789,35</b>	kg
----------------	----------------	----

##### Stagnation Data (upstream end for long pipe)

Initial pressure (gauge)	<b>10</b>	bar
Initial temperature	<b>20</b>	degC
Fluid state	<b>Non-saturated liquid</b>	

##### Scenario data

Phase to be released	Liquid	
Tank head	0	m
Hole diameter	<b>50,8</b>	mm

#### OUTPUT DATA

Mass flow rate	42,0713	kg/s
Release duration	66,3005	s

##### Orifice or pipe exit data (before atmospheric expansion)

Pressure	1,01325	bar
Temperature	19,3938	degC
Liquid mass fraction	<b>1</b>	fraction
Velocity at vena contracta (at exit for pipe releases)	61,9312	m/s
Discharge coefficient	0,6	

##### Final Data (after atmospheric expansion)

Temperature	-11,9098	degC
Liquid mass fraction	0,815225	fraction
Droplet diameter	206,597	um
Expanded diameter	<b>0,181616</b>	m
Velocity	108,933	m/s



Audit Number: 231

Date: 03/09/2023 Time: 15:57

## Explosion Report

Workspace: pm\_rev0

Study: Study

Equipment Item: T7

pm\_rev0\Study\T7

Material	ISOBUTANE	
East	0	m
North	0	m

### Scenario (Leak) : T7-2"leak vertical

pm\_rev0\Study\T7\T7-2"leak vertical

Weather: Category 2/F

Explosion location criterion	Cloud front (LFL fraction)	
Explosion height criterion	Centreline height	
Explosion method	Multi-Energy: Uniform confined	
Uniform confined method explosion efficiency	12,5	%
Uniform confined method explosion strength	10	

Time of explosion [s]	Distance to centre of mass [m]	Distance to explosion centre [m]	Distance to ignition point [m]	Flammable mass [kg]	Overpressures (input) [bar]	Distance to specified overpressures [m]
0,801216	5,28482	10	10	0,566837	0,02068 0,1379 0,2068	46,0269 17,0021 15,2499
2,78614	9,17051	20	20	3,48939	0,02068 0,1379 0,2068	86,0274 32,8329 29,6216
7,65521	13,0948	30	30	12,2994	0,02068 0,1379 0,2068	130,485 49,53 44,6428
13,556	16,9002	40	40	28,3919	0,02068 0,1379 0,2068	172,802 65,8111 59,3521
20,6421	20,7578	50	50	51,5583	0,02068 0,1379 0,2068	212,022 81,4901 73,6101
30,5633	24,6745	60	60	86,7545	0,02068 0,1379 0,2068	252,711 97,4546 88,082
44,0713	29,0962	70	70	130,128	0,02068 0,1379 0,2068	290,597 112,874 102,146
60,1534	34,2273	80	80	223,717	0,02068 0,1379 0,2068	344,266 131,362 118,509
77,1117	35,2817	90	90	350,971	0,02068 0,1379 0,2068	397,066 149,68 134,746
94,5265	38,8707	100	100	502,542	0,02068 0,1379 0,2068	446,098 167,266 150,434

Weather: Category 5/D

Explosion location criterion	Cloud front (LFL fraction)	
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Explosion height criterion	Centreline height	
Explosion method	Multi-Energy: Uniform confined	
Uniform confined method explosion efficiency	<b>12,5</b> %	
Uniform confined method explosion strength	10	

Time of explosion [s]	Distance to centre of mass [m]	Distance to explosion centre [m]	Distance to ignition point [m]	Flammable mass [kg]	Overpressures (Input) [bar]	Distance to specified overpressures [m]
0,655985	5,96019	10	10	0,579014	0,02068 0,1379 0,2068	46,2831 17,0519 15,2872
2,05968	11,602	20	20	3,94697	0,02068 0,1379 0,2068	88,7959 33,3709 30,025
4,68528	18,1446	30	30	16,7062	0,02068 0,1379 0,2068	141,284 51,6289 46,2165
8,28371	23,6833	40	40	37,2949	0,02068 0,1379 0,2068	185,442 68,2677 61,1941
12,6234	26,7021	50	50	55,201	0,02068 0,1379 0,2068	215,751 82,2149 74,1535
17,8881	27,1365	60	60	66,6686	0,02068 0,1379 0,2068	236,515 94,3069 85,722
28,5476	26,9747	70	70	87,5665	0,02068 0,1379 0,2068	263,31 107,571 98,1694
63,446	25,7089	80	80	156,474	0,02068 0,1379 0,2068	314,579 125,592 114,183



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## Jet Fire

Workspace: pm\_rev0

Study: Study

Equipment Item: T7

pm\_rev0\Study\T7

Material	ISOBUTANE	
East	0	m
North	0	m

Scenario (Leak) : T7-2"leak vertical

pm\_rev0\Study\T7\T7-2"leak vertical

Weather: Category 2/F

Wind speed [m/s]	2
Pasquill stability	F stable - night with moderate clouds and light/moderate wind
Atmospheric temperature [degC]	20
Relative humidity [fraction]	0,7
Solar radiation flux [kW/m2]	0,5

### Jet fire model results

#### INPUT DATA

##### Scenario

Elevation	1	m
Release angle from	0	deg

##### Jet Fire Parameters

Jet fire method	Cone model	
Wind orientation about the z-axis (anti-clockwise from the East)	0	deg

Rotation about the z-axis (anti-clockwise from the east)	0	deg
Rate modification factor	3	

#### Calculated inputs

Mass flow rate	23,3212	kg/s
Temperature after atmospheric expansion	-11,9098	degC
Liquid fraction	0,815225	fraction
Velocity after atmospheric expansion (input)	108,933	m/s
Rainout fraction time averaged	0,815225	fraction

#### OUTPUT DATA

Flame emissive power	231,594	kW/m2
Fraction of emissivity	0,42874	fraction
Jet velocity	108,933	m/s
Flame length	55,162	m
Frustum length	54,3346	m
Frustum base width	0,704719	m
Frustum tip width	18,812	m
Frustum lift-off distance	0,827431	m
Flame length in still air	49,6046	m
Hole to flame angle	0	deg
Expanded diameter	0,135218	m
Plane angular rotation	0	deg

#### Flame on ground impingement with partial truncation

##### Radiation Intensity Ellipse Results

#### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction	Variable	
Exposure duration	20	s
Height of interest	1	m

#### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^ProbitN.s]	Ellipse half-length [m]	Ellipse half-width [m]	Ellipse centre downwind distance [m]	Effect downwind distance [m]	Ellipse area [m2]
3	0	0,0129537	-1,38321	865119	69,2302	91,1284	0	91,1284	19819,8
5	0,000174704	0,0215895	0,360367	1709491	55,5383	70,4674	0	70,4674	12295,1

7	0,02405	0,0302253	1,50883	2677313	49,9991	59,8929	0	59,8929	9407,79
12,5	6,52536	0,0539737	3,48789	5800162	43,3369	46,1527	0	46,1527	6283,54

## Radiation v Distance Results

### INPUT DATA

Maximum distance	121,809	m
Observer type		
radiation modelling flag	Planar	
Observer direction	Variable	
Height of interest	1	m

### OUTPUT DATA

Downwind distance [m]	Maximum incident radiation [kW/m2]	Lethality level [fraction]
-48,5109	34,1125	0,972227
-46,025	231,594	1
-43,5391	231,594	1
-41,0532	231,594	1
-38,5673	231,594	1
-36,0814	231,594	1
-33,5955	231,594	1
-31,1096	231,594	1
-28,6237	231,594	1
-26,1378	231,594	1
-23,6519	231,594	1
-21,166	231,594	1
-18,6802	231,594	1
-16,1943	231,594	1
-13,7084	231,594	1
-11,2225	231,594	1
-8,73657	231,594	1
-6,25067	231,594	1
-3,76478	231,594	1
-1,27888	231,594	1
1,20702	231,594	1
3,69291	231,594	1
6,17881	231,594	1
8,6647	156,259	1
11,1506	93,1193	1
13,6365	68,7406	0,999992
16,1224	54,7297	0,999791
18,6083	44,6666	0,997706
21,0942	36,6059	0,984433
23,5801	30,2939	0,934396
26,066	25,3198	0,815183
28,5519	21,3681	0,624752
31,0378	18,201	0,409207
33,5237	15,6389	0,227401
36,0096	13,5473	0,107954
38,4955	11,8241	0,0443922
40,9814	10,3916	0,0160713
43,4672	9,1918	0,00521267

45,9531	8,17853	0,00153796
48,439	7,31645	0,000418566
50,9249	6,57816	0,000106428
53,4108	5,94174	2,55532E-05
55,8967	5,38986	5,84773E-06
58,3826	4,9086	1,28583E-06
60,8685	4,48676	2,73556E-07
63,3544	4,11517	5,66442E-08
65,8403	3,78637	1,14745E-08
68,3262	3,49418	0
70,8121	3,23349	0
73,298	3,00001	0

Weather: Category 5/D

Wind speed [m/s]	5
Pasquill stability	D neutral - little sun and high wind or overcast/windy night
Atmospheric temperature [degC]	20
Relative humidity [fraction]	0,7
Solar radiation flux [kW/m2]	0,5

Jet fire model results

INPUT DATA

Scenario

Elevation	1	m
Release angle from	0	deg

Jet Fire Parameters

Jet fire method	Cone model	
Wind orientation about the z-axis (anti-clockwise from the East)	0	deg
Rotation about the z-axis (anti- clockwise from the east)	0	deg
Rate modification factor	3	

Calculated inputs



Mass flow rate	23,3212	kg/s
Temperature after atmospheric expansion	-11,9098	degC
Liquid fraction	0,815225	fraction
Velocity after atmospheric expansion (input)	<b>108,933</b>	m/s
Rainout fraction time averaged	<b>0,815225</b>	fraction

#### OUTPUT DATA

Flame emissive power	304,154	kW/m2
Fraction of emissivity	0,42874	fraction
Jet velocity	108,933	m/s
Flame length	42,879	m
Frustum length	42,2358	m
Frustum base width	1,17822	m
Frustum tip width	17,4392	m
Frustum lift-off distance	0,643184	m
Flame length in still air	49,6046	m
Hole to flame angle	0	deg
Expanded diameter	0,135218	m
Plane angular rotation	0	deg

#### Flame on ground impingement with partial truncation

##### Radiation Intensity Ellipse Results

#### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction	Variable	
Exposure duration	20	s
Height of interest	1	m

#### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^ProbitN.s]	Ellipse half-length [m]	Ellipse half-width [m]	Ellipse centre downwind distance [m]	Effect downwind distance [m]	Ellipse area [m2]
3	0	0,00986343	-1,38321	865119	72,959	91,4714	0	91,4714	20965,9
5	0,000174704	0,0164391	0,360367	1709491	57,1747	70,7783	0	70,7783	12713,2
7	0,02405	0,0230147	1,50883	2677313	49,0064	59,6899	0	59,6899	9189,75
12,5	6,52536	0,0410976	3,48789	5800162	39,6976	44,8997	0	44,8997	5599,61

##### Radiation v Distance Results

#### INPUT DATA

Maximum distance	113,705	m
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Observer type radiation modelling flag	Planar	
Observer direction	Variable	
Height of interest	<b>1</b>	m

#### OUTPUT DATA

Downwind distance [m]	Maximum incident radiation [kW/m2]	Lethality level [fraction]
-39,3533	135,658	1
-37,0328	304,154	1
-34,7123	304,154	1
-32,3918	304,154	1
-30,0713	304,154	1
-27,7508	304,154	1
-25,4303	304,154	1
-23,1098	304,154	1
-20,7893	304,154	1
-18,4688	304,154	1
-16,1483	304,154	1
-13,8278	304,154	1
-11,5073	304,154	1
-9,18677	304,154	1
-6,86626	304,154	1
-4,54576	304,154	1
-2,22526	304,154	1
0,0952442	304,154	1
2,41575	304,154	1
4,73625	275,624	1
7,05675	139,551	1
9,37726	97,7187	1
11,6978	76,9335	0,999999
14,0183	61,991	0,999961
16,3388	50,4866	0,999428
18,6593	41,5551	0,995176
20,9798	34,5682	0,974994
23,3003	29,0537	0,914138
25,6208	24,659	0,790138
27,9413	21,1215	0,609633
30,2618	18,2466	0,412527
32,5823	15,8872	0,243948
34,9028	13,9332	0,126809
37,2233	12,3005	0,0585558
39,5438	10,9261	0,024336
41,8643	9,75969	0,00921716
44,1848	8,76277	0,00321955
46,5053	7,90527	0,00104888
48,8258	7,16302	0,000321793
51,1463	6,51684	9,37784E-05
53,4668	5,95127	2,61571E-05
55,7873	5,45379	7,02913E-06
58,1078	5,01414	1,83035E-06
60,4283	4,6239	4,64146E-07
62,7488	4,27611	1,1512E-07

65,0693	3,96494	2,8033E-08
67,3898	3,68553	0
69,7103	3,43379	0
72,0308	3,20625	0
74,3513	2,99996	0



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## Early Pool Fire Report

Workspace: pm\_rev0

Study: Study

Equipment Item: T7

pm\_rev0\Study\T7

Material **ISOBUTANE**

East 0 m

North 0 m

Scenario (Leak) : T7-2"leak vertical

pm\_rev0\Study\T7\T7-2"leak vertical

Weather: Category 2/F

Wind speed [m/s]	2
Pasquill stability	F stable - night with moderate clouds and light/moderate wind
Atmospheric temperature [degC]	20
Relative humidity [fraction]	0,7
Solar radiation flux [kW/m2]	0,5

### Pool fire model results

Early pool fires are assumed to occur at a time when the initial PVAP rainout rate equals the pool fire burn rate, unless the thus calculated pool fire radius exceeds the maximum PVAP pool radius. For the latter case the early pool fire radius is assumed to be the maximum PVAP pool radius. The pool fire centre is located at the rainout point.

#### INPUT DATA

Correlation Type: Thomas / Johnson

Surface type	Land
Pool fire elevation	0 m
Maximum exposure duration	20 s

Downwind distance of liquid rainout	0 m
Use two zone pool fire model	Yes

#### OUTPUT DATA

Pool fire diameter	19,0764 m
Downwind distance of pool fire centre	0 m
Pool fire flame length	39,9467 m
Angle between pool fire axis and vertical	30,1902 deg
Luminous flame emissive power	169,835 kW/m2
Smoky flame emissive power	0 kW/m2
Ratio of luminous flame length to the total flame length	1 fraction
Total burn rate	34,2976 kg/s
Radiative fraction	0,291256 fraction

#### Radiation Intensity Ellipse Results

##### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction Variable  
Exposure duration 20 s  
Height of interest 1 m

##### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^ProbitN.s]	Hazard Information	Ellipse half-length [m]	Ellipse half-width [m]	Ellipse centre downwind distance [m]	Effect downwind distance [m]	Ellipse area [m2]
3	0	0,0176642	-1,38321	865119	-	93,4367	95,6899	14,0598	107,497	28088,8
5	0,000174704	0,0294404	0,360367	1709491	-	72,5297	74,1558	13,6839	86,2136	16897,1
7	0,02405	0,0412165	1,50883	2677313	-	61,4159	62,2523	13,676	75,0919	12011,2
12,5	6,52536	0,0736009	3,48789	5800162	-	45,4739	45,0189	13,0462	58,52	6431,42

#### Radiation v Distance Results

##### INPUT DATA

Maximum distance	107,497 m
Angle from wind direction	0 deg
Observer direction	Variable
Height of interest	1 m

##### OUTPUT DATA

Downwind distance [m]	Maximum incident radiation [kW/m2]	Lethality level [fraction]
0	169,835	1
2,19381	169,835	1
4,38761	169,835	1
6,58142	169,835	1
8,77523	169,835	1
10,969	137,099	1
13,1628	100,463	1
15,3566	82,3251	1
17,5505	70,276	0,999994
19,7443	61,7264	0,999959
21,9381	54,9771	0,999803
24,1319	49,6229	0,999298
26,3257	45,171	0,997967
28,5195	41,3981	0,994992
30,7133	38,0959	0,989034
32,9071	34,8941	0,976809
35,1009	31,9232	0,954311
37,2947	29,1921	0,916654
39,4885	26,6895	0,859257
41,6823	24,4008	0,779637
43,8761	22,3115	0,67919
46,0699	20,4079	0,56397
48,2637	18,6768	0,443734
50,4576	17,1053	0,32942
52,6514	15,6808	0,230166
54,8452	14,3911	0,151211
57,039	13,2243	0,0934445
59,2328	12,1693	0,0543988
61,4266	11,2154	0,0299012
63,6204	10,3527	0,0155631
65,8142	9,572	0,00769529
68,008	8,86505	0,00362721
70,2018	8,22422	0,0016356
72,3956	7,64265	0,00070806
74,5894	7,11416	0,000295286
76,7832	6,63325	0,000119024
78,977	6,19497	4,65164E-05
81,1708	5,79492	1,76785E-05
83,3647	5,4292	6,55168E-06
85,5585	5,09431	2,37381E-06
87,7523	4,79207	8,5767E-07
89,9461	4,52939	3,23323E-07
92,1399	4,28602	1,20093E-07
94,3337	4,06029	4,40201E-08
96,5275	3,85066	1,59468E-08
98,7213	3,65575	0
100,915	3,4743	0
103,109	3,3052	0
105,303	3,14741	0
107,497	3	0

Weather: Category 5/D

Wind speed [m/s]	5
Pasquill stability	D neutral - little sun and high wind or overcast/windy night
Atmospheric temperature [degC]	20
Relative humidity [fraction]	0,7
Solar radiation flux [kW/m2]	0,5

#### Pool fire model results

Early pool fires are assumed to occur at a time when the initial PVAP rainout rate equals the pool fire burn rate, unless the thus calculated pool fire radius exceeds the maximum PVAP pool radius. For the latter case the early pool fire radius is assumed to be the maximum PVAP pool radius. The pool fire centre is located at the rainout point.

#### INPUT DATA

Correlation Type: Thomas / Johnson

Surface type	Land	
Pool fire elevation	0	m
Maximum exposure duration	20	s
Downwind distance of liquid rainout	0	m
Use two zone pool fire model	Yes	

#### OUTPUT DATA

Pool fire diameter	19,0764	m
Downwind distance of pool fire centre	0	m
Pool fire flame length	39,9467	m
Angle between pool fire axis and vertical	47,6622	deg
Luminous flame emissive power	169,835	kW/m2
Smoky flame emissive power	0	kW/m2
Ratio of luminous flame length to the total flame length	1	fraction

Total burn rate	34,2976	kg/s
Radiative fraction	0,291256	fraction

### Radiation Intensity Ellipse Results

#### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction	Variable	
Exposure duration	20	s
Height of interest	1	m

#### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^ProbitN.s]	Hazard information	Ellipse half-length [m]	Ellipse half-width [m]	Ellipse centre downwind distance [m]	Effect downwind distance [m]	Ellipse area [m2]
3	0	0,0176642	-1,38321	865119	-	88,9015	94,1911	20,4697	109,371	26306,9
5	0,000174704	0,0294404	0,360367	1709491	-	70,0543	73,6744	20,0769	90,1313	16214,4
7	0,02405	0,0412165	1,50883	2677313	-	59,8004	62,3874	19,6203	79,4207	11720,6
12,5	6,52536	0,0736009	3,48789	5800162	-	45,2232	46,1334	18,162	63,3852	6554,31

### Radiation v Distance Results

#### INPUT DATA

Maximum distance	109,371	m
Angle from wind direction	0	deg
Observer direction	Variable	
Height of interest	1	m

#### OUTPUT DATA

Downwind distance [m]	Maximum incident radiation [kW/m2]	Lethality level [fraction]
0	169,835	1
2,23207	169,835	1
4,46413	169,835	1
6,6962	169,835	1
8,92826	169,835	1
11,1603	135,682	1
13,3924	107,021	1
15,6245	91,3256	1
17,8565	80,4992	0,999999
20,0886	72,6556	0,999997
22,3207	65,6125	0,999983
24,5527	60,4014	0,999944
26,7848	55,265	0,999816
29,0168	51,3914	0,999539
31,2489	48,0094	0,998968
33,481	44,8588	0,997809
35,713	42,2714	0,995934
37,9451	39,9018	0,99285
40,1772	37,2937	0,986753



42,4092	34,2026	0,972796
44,6413	31,0423	0,944382
46,8734	27,9922	0,892447
49,1054	25,134	0,808403
51,3375	22,5081	0,689833
53,5696	20,13	0,545478
55,8016	17,9993	0,394498
58,0337	16,1052	0,258769
60,2658	14,4304	0,153406
62,4978	12,9547	0,0822416
64,7299	11,8742	0,0457611
66,962	10,9112	0,0240722
69,194	10,039	0,0118965
71,4261	9,25044	0,00554759
73,6582	8,53804	0,00245241
75,8902	7,89448	0,0010326
78,1223	7,31284	0,000416034
80,3544	6,78665	0,000161105
82,5864	6,31005	6,02123E-05
84,8185	5,87773	2,18044E-05
87,0505	5,48492	7,67788E-06
89,2826	5,12741	2,63755E-06
91,5147	4,80144	8,86583E-07
93,7467	4,50366	2,92398E-07
95,9788	4,23116	9,48487E-08
98,2109	3,98131	3,03285E-08
100,443	3,75181	9,57857E-09
102,675	3,54064	0
104,907	3,34597	0
107,139	3,16621	0
109,371	2,99995	0



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## Consequence Summary Report

Workspace: pm\_rev0

Study: Study

Summary Basis

These tables will only report global values set in the parameters. Values that are modified in the study tree will not be reported.

The report is context sensitive, and filters up to the study level. You will need to generate multiple summary reports if you have multiple studies in your workspace.

The results in this report are from the non-CFD calculations only.

Discharge Results (after atmospheric expansion)

Path	Scenario	Weather	Peak Flowrate [kg/s]	Temperature [degC]	Liquid mass fraction in material [fraction]	Droplet diameter [um]	Expanded diameter [m]	Velocity [m/s]	End time of release [s]
Study\T7	T7-2"leak vertical	Category 2/F	42,0713	-11,9098	0,815225	206,597	0,181616	108,933	66,3005
		Category 5/D	42,0713	-11,9098	0,815225	206,597	0,181616	108,933	66,3005

### Dispersion Results

Input dispersion parameters

Core averaging time	18,75 s
Flammable averaging time	18,75 s
Toxic averaging time	600 s
Height of interest	1 m

Distance downwind to defined concentrations

The reported concentration of interest is defined at the scenario

Path	Scenario	Weather	Distance to UFL [m]	Distance to LFL [m]	Distance to LFL fraction [m]
Study\T7	T7-2"leak vertical	Category 2/F	8,22773	93,034	139,408
		Category 5/D	n/a	52,4806	80,6637

### Jet Fire Results

Distance downwind to defined radiation levels

The reported radiations are defined in the parameters

Path	Scenario	Weather	Flame length [m]	Distance downwind to Intensity level 1 (3 kW/m2) [m]	Distance downwind to Intensity level 2 (5 kW/m2) [m]	Distance downwind to Intensity level 3 (7 kW/m2) [m]	Distance downwind to Intensity level 4 (12,5 kW/m2) [m]
Study\T7	T7-2"leak vertical	Category 2/F	55,162	91,1284	70,4674	59,8929	46,1527

		Category 5/D	42,879	91,4714	70,7783	59,6899	44,8997
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### Early Pool Fire Results

#### Distance downwind to defined radiation levels

The reported radiations are defined in the parameters

Path	Scenario	Weather	Pool diameter [m]	Distance downwind to intensity level 1 (3 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 2 (5 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 3 (7 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 4 (12,5 kW/m <sup>2</sup> ) [m]
Study\T7	T7-2"leak vertical	Category 2/F	19,0764	107,497	86,2136	75,0919	58,52
		Category 5/D	19,0764	109,371	90,1313	79,4207	63,3852

### Late Pool Fire Results

#### Distance downwind to defined radiation levels

The reported radiations are defined in the parameters

Path	Scenario	Weather	Pool diameter [m]	Distance downwind to intensity level 1 (3 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 2 (5 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 3 (7 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 4 (12,5 kW/m <sup>2</sup> ) [m]
Study\T7	T7-2"leak vertical	Category 2/F	28,2841	146,711	117,869	102,453	79,5572
		Category 5/D	27,7665	147,465	121,21	106,586	84,8808

### Flash Fire Results

#### Distance downwind to defined concentrations

The reported LFL and LFL fraction are defined in the respective material property

Path	Scenario	Weather	Distance downwind to LFL [m]	Distance downwind to LFL Fraction [m]
Study\T7	T7-2"leak vertical	Category 2/F	93,034	139,408
		Category 5/D	52,4806	80,6637

#### Maximum distance to LFL fraction at any height

Path	Scenario	Weather	Max flash fire distance [m]	Height of the max flash fire distance [m]	Time [s]
Study\T7	T7-2"leak vertical	Category 2/F	109,919	0	111,801
		Category 5/D	82,7777	0	75,6216

### Explosion Results

#### Explosion scenarios for worst-case maximum downwind distance to defined overpressures.

The reported overpressures are defined in the explosion parameters

Path	Scenario	Weather	Overpressure level [bar]	Maximum distance [m]	Diameter [m]
Study\T7	T7-2"leak vertical	Category 2/F	0,02068 0,1379 0,2068	446,098 167,266 150,434	692,196 134,533 100,868

		Category 5/D	0,02068 0,1379 0,2068	314,579 125,592 114,183	469,158 91,184 68,3663
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**Supplementary data for worst-case explosion scenarios**

Path	Scenario	Weather	Overpressure level [bar]	Explosion flammable mass [kg]	Ignition time [s]	Ignition source [m]	Cloud centre [m]	Explosion centre [m]
Study\T7	T7-2"leak vertical	Category 2/F	0,02068 0,1379 0,2068	502,542 502,542 502,542	94,5265 94,5265 94,5265	100 100 100	38,8707 38,8707 38,8707	100 100 100
		Category 5/D	0,02068 0,1379 0,2068	156,474 156,474 156,474	63,446 63,446 63,446	80 80 80	25,7089 25,7089 25,7089	80 80 80

TOP EVENT 8



**Audit Number: 247**

**Date: 03/09/2023 Time: 16:01**

# Discharge Report

**Workspace: pm\_rev0**

**Study: Study**

**Equipment Item: T8**

**pm\_rev0\Study\T8**

Material	<b>ISOBUTANE</b>	
East	0	m
North	0	m

**Scenario (Leak) : T8-2"leak vertical**

**pm\_rev0\Study\T8\T8-2"leak vertical**

**Weather: Category 2/F**

## INPUT DATA

### Inventory data

Mass in vessel	<b>1115,74</b>	kg
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### Stagnation Data (upstream end for long pipe)

Initial pressure (gauge)	<b>4</b>	bar
Initial temperature	<b>20</b>	degC
Fluid state	<b>Non-saturated liquid</b>	

### Scenario data

Phase to be released	Liquid	
Tank head	0	m
Hole diameter	<b>50,8</b>	mm

## OUTPUT DATA

Mass flow rate	26,6182	kg/s
Release duration	41,9164	s

### Orifice or pipe exit data (before atmospheric expansion)

Pressure	1,01325	bar
Temperature	19,7539	degC
Liquid mass fraction	<b>1</b>	fraction
Velocity at vena contracta (at exit for pipe releases)	39,2143	m/s
Discharge coefficient	0,6	

### Final Data (after atmospheric expansion)

Temperature	-11,9098	degC
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Liquid mass fraction	0,813109	fraction
Droplet diameter	222,347	um
Expanded diameter	<b>0,152556</b>	m
Velocity	98,7702	m/s

### Weather: Category 5/D

#### INPUT DATA

##### Inventory data

Mass in vessel	<b>1115,74</b>	kg
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##### Stagnation Data (upstream end for long pipe)

Initial pressure (gauge)	<b>4</b>	bar
Initial temperature	<b>20</b>	degC
Fluid state	<b>Non-saturated liquid</b>	

##### Scenario data

Phase to be released	Liquid	
Tank head	0	m
Hole diameter	<b>50,8</b>	mm

#### OUTPUT DATA

Mass flow rate	26,6182	kg/s
Release duration	41,9164	s

##### Orifice or pipe exit data (before atmospheric expansion)

Pressure	1,01325	bar
Temperature	19,7539	degC
Liquid mass fraction	<b>1</b>	fraction
Velocity at vena contracta (at exit for pipe releases)	39,2143	m/s
Discharge coefficient	0,6	

##### Final Data (after atmospheric expansion)

Temperature	-11,9098	degC
Liquid mass fraction	0,813109	fraction
Droplet diameter	222,347	um
Expanded diameter	<b>0,152556</b>	m
Velocity	98,7702	m/s



Audit Number: 250

Date: 06/09/2023 Time: 09:01

# Explosion Report

Workspace: pm\_rev0

Study: Study

Equipment Item: T8

pm\_rev0\Study\T8

Material	ISOBUTANE	
East	0	m
North	0	m

## Scenario (Leak) : T8-2"leak vertical

pm\_rev0\Study\T8\T8-2"leak vertical

Weather: Category 2/F

Explosion location criterion	Cloud front (LFL fraction)	
Explosion height criterion	Centreline height	
Explosion method	Multi-Energy: Uniform confined	
Uniform confined method explosion efficiency	12,5	%
Uniform confined method explosion strength	10	

Time of explosion [s]	Distance to centre of mass [m]	Distance to explosion centre [m]	Distance to ignition point [m]	Flammable mass [kg]	Overpressures (input) [bar]	Distance to specified overpressures [m]
0,854895	4,43267	10	10	0,337674	0,02068 0,1379 0,2068	40,3138 15,8917 14,4174
4,09357	8,99735	20	20	3,43014	0,02068 0,1379 0,2068	85,6516 32,7598 29,5668
10,1151	13,2371	30	30	12,5572	0,02068 0,1379 0,2068	131,183 49,6655 44,7445
17,967	16,1865	40	40	25,0786	0,02068 0,1379 0,2068	167,421 64,7652 58,568
29,5873	21,4436	50	50	48,938	0,02068 0,1379 0,2068	209,23 80,9473 73,2031
44,4614	23,8197	60	60	91,9197	0,02068 0,1379 0,2068	256,462 98,1836 88,6286
60,8709	26,2278	70	70	205,417	0,02068 0,1379 0,2068	326,854 119,921 107,429
80,1194	35,8068	80	80	199,318	0,02068 0,1379 0,2068	334,287 129,422 117,055
99,3679	45,3858	90	90	193,218	0,02068 0,1379 0,2068	341,666 138,913 126,673

Weather: Category 5/D

Explosion location criterion	Cloud front (LFL fraction)	
Explosion height criterion	Centreline height	



Explosion method	Multi-Energy: Uniform confined	
Uniform confined method explosion efficiency	<b>12,5</b> %	
Uniform confined method explosion strength	10	

Time of explosion [s]	Distance to centre of mass [m]	Distance to explosion centre [m]	Distance to ignition point [m]	Flammable mass [kg]	Overpressures (input) [bar]	Distance to specified overpressures [m]
0,69348	5,03313	10	10	0,401108	0,02068 0,1379 0,2068	42,1042 16,2397 14,6783
2,60781	11,943	20	20	3,85134	0,02068 0,1379 0,2068	88,2358 33,2621 29,9434
5,86626	18,5447	30	30	16,388	0,02068 0,1379 0,2068	140,573 51,4907 46,1129
10,0918	21,7719	40	40	27,4098	0,02068 0,1379 0,2068	171,253 65,5099 59,1264
15,8581	22,5301	50	50	35,3235	0,02068 0,1379 0,2068	192,833 77,7606 70,8139
27,4193	22,2002	60	60	47,4698	0,02068 0,1379 0,2068	217,621 90,6347 82,9687



Audit Number: 247

Date: 03/09/2023 Time: 16:01

## Jet Fire

Workspace: pm\_rev0

Study: Study

Equipment Item: T8

pm\_rev0\Study\T8

Material	ISOBUTANE	
East	0	m
North	0	m

Scenario (Leak) : T8-2"leak vertical

pm\_rev0\Study\T8\T8-2"leak vertical

Weather: Category 2/F

Wind speed [m/s]	2
Pasquill stability	F stable - night with moderate clouds and light/moderate wind
Atmospheric temperature [degC]	20
Relative humidity [fraction]	0,7
Solar radiation flux [kW/m2]	0,5

### Jet fire model results

#### INPUT DATA

##### Scenario

Elevation	1	m
Release angle from horizontal	0	deg

##### Jet Fire Parameters

Jet fire method	Cone model	
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Wind orientation about the z-axis (anti-clockwise from the East)	0	deg
Rotation about the z-axis (anti-clockwise from the east)	0	deg
Rate modification factor	3	

#### Calculated inputs

Mass flow rate	14,9242	kg/s
Temperature after atmospheric expansion	-11,9098	degC
Liquid fraction	0,813109	fraction
Velocity after atmospheric expansion (input)	98,7702	m/s
Rainout fraction time averaged	0,813109	fraction

#### OUTPUT DATA

Flame emissive power	210,581	kW/m2
Fraction of emissivity	0,43694	fraction
Jet velocity	98,7702	m/s
Flame length	46,1914	m
Frustum length	45,4985	m
Frustum base width	0,627371	m
Frustum tip width	16,0433	m
Frustum lift-off distance	0,692871	m
Flame length in still air	41,5377	m
Hole to flame angle	0	deg
Expanded diameter	0,114231	m
Plane angular rotation	0	deg

#### Flame on ground impingement with partial truncation

#### Radiation Intensity Ellipse Results

##### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction	Variable	
Exposure duration	20	s
Height of interest	1	m

##### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^ProbitN.s]	Ellipse half-length [m]	Ellipse half-width [m]	Ellipse centre downwind distance [m]	Effect downwind distance [m]	Ellipse area [m2]
3	0	0,0142463	-1,38321	865119	56,8399	74,1861	0	74,1861	13247,2
5	0,000174704	0,0237439	0,360367	1709491	45,8305	57,3745	0	57,3745	8260,83
7	0,02405	0,0332414	1,50883	2677313	41,3977	48,7715	0	48,7715	6342,97
12,5	6,52536	0,0593597	3,48789	5800162	35,9417	37,619	0	37,619	4247,72

## Radiation v Distance Results

### INPUT DATA

Maximum distance	100,866	m
Observer type	Planar	
radiation modelling flag		
Observer direction	Variable	
Height of interest	1	m

### OUTPUT DATA

Downwind distance [m]	Maximum incident radiation [kW/m2]	Lethality level [fraction]
-40,3803	34,6453	0,975435
-38,3218	210,581	1
-36,2634	210,581	1
-34,2049	210,581	1
-32,1464	210,581	1
-30,0879	210,581	1
-28,0294	210,581	1
-25,9709	210,581	1
-23,9124	210,581	1
-21,8539	210,581	1
-19,7955	210,581	1
-17,737	210,581	1
-15,6785	210,581	1
-13,62	210,581	1
-11,5615	210,581	1
-9,50302	210,581	1
-7,44453	210,581	1
-5,38604	210,581	1
-3,32755	210,581	1
-1,26906	210,581	1
0,789424	210,581	1
2,84791	210,581	1
4,9064	210,581	1
6,96489	184,825	1
9,02338	100,588	1
11,0819	71,63	0,999996
13,1404	55,3169	0,999818
15,1988	45,0243	0,997894
17,2573	36,9366	0,985594
19,3158	30,5845	0,938456
21,3743	25,564	0,823794
23,4328	21,5689	0,636796

25,4913	18,3638	0,421056
27,5498	15,7697	0,236071
29,6083	13,652	0,112907
31,6667	11,9076	0,0466895
33,7252	10,4584	0,0169705
35,7837	9,24436	0,0055121
37,8422	8,22008	0,00162656
39,9007	7,34914	0,000442093
41,9592	6,60374	0,000112127
44,0177	5,9616	2,68255E-05
46,0762	5,40509	6,11183E-06
48,1346	4,9201	1,33705E-06
50,1931	4,49522	2,82844E-07
52,2516	4,12118	5,82109E-08
54,3101	3,79039	1,17162E-08
56,3686	3,49659	0
58,4271	3,23459	0
60,4856	3,00005	0

Weather: Category 5/D

Wind speed [m/s]	5
Pasquill stability	D neutral - little sun and high wind or overcast/windy night
Atmospheric temperature [degC]	20
Relative humidity [fraction]	0,7
Solar radiation flux [kW/m2]	0,5

Jet fire model results

INPUT DATA

Scenario

Elevation	1	m
Release angle from horizontal	0	deg

Jet Fire Parameters

Jet fire method	Cone model	
Wind orientation about the z-axis (anti-clockwise from the East)	0	deg

Rotation about the z-axis (anti-clockwise from the east)	0	deg
Rate modification factor	3	

#### Calculated inputs

Mass flow rate	14,9242	kg/s
Temperature after atmospheric expansion	-11,9098	degC
Liquid fraction	0,813109	fraction
Velocity after atmospheric expansion (input)	98,7702	m/s
Rainout fraction time averaged	0,813109	fraction

#### OUTPUT DATA

Flame emissive power	276,789	kW/m2
Fraction of emissivity	0,43694	fraction
Jet velocity	98,7702	m/s
Flame length	35,9058	m
Frustum length	35,3672	m
Frustum base width	1,03645	m
Frustum tip width	14,8514	m
Frustum lift-off distance	0,538587	m
Flame length in still air	41,5377	m
Hole to flame angle	0	deg
Expanded diameter	0,114231	m
Plane angular rotation	0	deg

#### Flame on ground impingement with partial truncation

##### Radiation Intensity Ellipse Results

#### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction	Variable	
Exposure duration	20	s
Height of interest	1	m

#### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^ProbitN.s]	Ellipse half-length [m]	Ellipse half-width [m]	Ellipse centre downwind distance [m]	Effect downwind distance [m]	Ellipse area [m2]
3	0	0,0108386	-1,38321	865119	59,8424	74,4905	0	74,4905	14004,2
5	0,000174704	0,0180643	0,360367	1709491	46,8782	57,5812	0	57,5812	8480,11

7	0,02405	0,02529	1,50883	2677313	40,2726	48,5485	0	48,5485	6142,35
12,5	6,52536	0,0451608	3,48789	5800162	32,8104	36,591	0	36,591	3771,69

## Radiation v Distance Results

### INPUT DATA

Maximum distance	93,9945	m
Observer type		
radiation modelling flag	Planar	
Observer direction	Variable	
Height of interest	1	m

### OUTPUT DATA

Downwind distance [m]	Maximum incident radiation [kW/m2]	Lethality level [fraction]
-32,8649	131,059	1
-30,9466	276,789	1
-29,0284	276,789	1
-27,1101	276,789	1
-25,1919	276,789	1
-23,2736	276,789	1
-21,3553	276,789	1
-19,4371	276,789	1
-17,5188	276,789	1
-15,6006	276,789	1
-13,6823	276,789	1
-11,7641	276,789	1
-9,84582	276,789	1
-7,92757	276,789	1
-6,00931	276,789	1
-4,09106	276,789	1
-2,1728	276,789	1
-0,254548	276,789	1
1,66371	276,789	1
3,58196	276,789	1
5,50022	156,242	1
7,41847	103,261	1
9,33672	74,7674	0,999998
11,255	62,5949	0,999966
13,1732	51,0267	0,999497
15,0915	42,0198	0,995682
17,0097	34,9542	0,977129
18,928	29,3688	0,919767
20,8463	24,9137	0,800099
22,7645	21,3267	0,622236
24,6828	18,4109	0,424481
26,601	16,0191	0,252883
28,5193	14,0391	0,132259
30,4375	12,3854	0,06135
32,3558	10,9943	0,0255756
34,274	9,81451	0,00970253
36,1923	8,80678	0,0033902
38,1105	7,94057	0,00110363

40,0288	7,19125	0,000338011
41,9471	6,53932	0,000098257
43,8653	5,96908	2,73192E-05
45,7836	5,46777	7,3141E-06
47,7018	5,02498	1,89663E-06
49,6201	4,63217	4,78787E-07
51,5383	4,28226	1,18184E-07
53,4566	3,96935	2,86357E-08
55,3748	3,68851	0
57,2931	3,43559	0
59,2113	3,20708	0
61,1296	2,99999	0





Audit Number: 247

Date: 03/09/2023 Time: 16:01

## Early Pool Fire Report

Workspace: pm\_rev0

Study: Study

Equipment Item: T8

pm\_rev0\Study\T8

Material	ISOBUTANE	
East	0	m
North	0	m

Scenario (Leak) : T8-2"leak vertical

pm\_rev0\Study\T8\T8-2"leak vertical

Weather: Category 2/F

Wind speed [m/s]	2
Pasquill stability	F stable - night with moderate clouds and light/moderate wind
Atmospheric temperature [degC]	20
Relative humidity [fraction]	0,7
Solar radiation flux [kW/m2]	0,5

### Pool fire model results

Early pool fires are assumed to occur at a time when the initial PVAP rainout rate equals the pool fire burn rate, unless the thus calculated pool fire radius exceeds the maximum PVAP pool radius. For the latter case the early pool fire radius is assumed to be the maximum PVAP pool radius. The pool fire centre is located at the rainout point.

#### INPUT DATA

Correlation Type: Thomas / Johnson

Surface type	Land	
Pool fire elevation	0	m
Maximum exposure duration	20	s

Downwind distance of liquid rainout	0	m
Use two zone pool fire model	Yes	

#### OUTPUT DATA

Pool fire diameter	15,154	m
Downwind distance of pool fire centre	0	m
Pool fire flame length	34,0411	m
Angle between pool fire axis and vertical	31,6572	deg
Luminous flame emissive power	169,313	kW/m2
Smoky flame emissive power	0	kW/m2
Ratio of luminous flame length to the total flame length	1	fraction
Total burn rate	21,6435	kg/s
Radiative fraction	0,309226	fraction

#### Radiation Intensity Ellipse Results

##### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction	Variable	
Exposure duration	20	s
Height of interest	1	m

##### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^ProbitN.s]	Hazard information	Ellipse half-length [m]	Ellipse half-width [m]	Ellipse centre downwind distance [m]	Effect downwind distance [m]	Ellipse area [m2]
3	0	0,0177187	-1,38321	865119	-	77,1057	79,0922	12,4112	89,5169	19158,9
5	0,000174704	0,0295312	0,360367	1709491	-	59,7828	61,2126	12,0225	71,8052	11496,5
7	0,02405	0,0413437	1,50883	2677313	-	50,5967	51,3333	11,9639	62,5606	8159,65
12,5	6,52536	0,073828	3,48789	5800162	-	37,5041	37,038	11,3757	48,8798	4363,91

#### Radiation v Distance Results

##### INPUT DATA

Maximum distance	89,5169	m
Angle from wind direction	0	deg
Observer direction	Variable	
Height of interest	1	m

**OUTPUT DATA**

Downwind distance [m]	Maximum incident radiation [kW/m2]	Lethality level [fraction]
0	169,313	1
1,82688	169,313	1
3,65375	169,313	1
5,48063	169,313	1
7,3075	169,313	1
9,13438	131,582	1
10,9613	99,5482	1
12,7881	81,9115	1
14,615	70,2153	0,999994
16,4419	61,5765	0,999958
18,2688	55,002	0,999804
20,0956	49,5643	0,999288
21,9225	44,9916	0,997878
23,7494	41,3564	0,994942
25,5763	38,1646	0,98921
27,4031	35,0672	0,977721
29,23	32,1302	0,956389
31,0569	29,4105	0,920486
32,8838	26,9072	0,865359
34,7106	24,6105	0,788198
36,5375	22,5085	0,689858
38,3644	20,5892	0,575831
40,1913	18,8407	0,455539
42,0182	17,2511	0,339973
43,845	15,8086	0,238667
45,6719	14,5014	0,157406
47,4988	13,3183	0,0975426
49,3257	12,248	0,0568691
51,1525	11,2803	0,0312621
52,9794	10,4051	0,0162497
54,8063	9,61335	0,00801254
56,6332	8,89663	0,00376109
58,46	8,24725	0,00168671
60,2869	7,65825	0,000725312
62,1138	7,12335	0,000300123
63,9407	6,63692	0,000119908
65,7675	6,19393	4,64071E-05
67,5944	5,78989	1,74516E-05
69,4213	5,42079	6,39514E-06
71,2482	5,0893	2,33606E-06
73,075	4,80335	8,92594E-07
74,9019	4,53878	3,35344E-07
76,7288	4,29374	1,24096E-07
78,5557	4,0665	4,5307E-08
80,3826	3,85553	1,63441E-08
82,2094	3,65943	0
84,0363	3,47694	0
85,8632	3,30691	0
87,6901	3,14829	0
89,5169	3,00016	0

Weather: Category 5/D

Wind speed [m/s]	5
Pasquill stability	D neutral - little sun and high wind or overcast/windy night
Atmospheric temperature [degC]	20
Relative humidity [fraction]	0,7
Solar radiation flux [kW/m2]	0,5

#### Pool fire model results

Early pool fires are assumed to occur at a time when the initial PVAP rainout rate equals the pool fire burn rate, unless the thus calculated pool fire radius exceeds the maximum PVAP pool radius. For the latter case the early pool fire radius is assumed to be the maximum PVAP pool radius. The pool fire centre is located at the rainout point.

#### INPUT DATA

Correlation Type: Thomas / Johnson

Surface type	Land	
Pool fire elevation	0	m
Maximum exposure duration	20	s
Downwind distance of liquid rainout	0	m
Use two zone pool fire model	Yes	

#### OUTPUT DATA

Pool fire diameter	15,154	m
Downwind distance of pool fire centre	0	m
Pool fire flame length	34,0411	m
Angle between pool fire axis and vertical	49,0031	deg
Luminous flame emissive power	169,313	kW/m2
Smoky flame emissive power	0	kW/m2
Ratio of luminous flame length to the total flame length	1	fraction
Total burn rate	21,6435	kg/s

Radiative fraction	0,309226	fraction
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### Radiation Intensity Ellipse Results

#### INPUT DATA

For ellipses 'observer direction' refers to whether inclination is 'fixed' or 'variable'. Orientation is always variable.

Observer direction	Variable	
Exposure duration	20	s
Height of interest	1	m

#### OUTPUT DATA

##### Radiation intensity

Incident radiation [kW/m2]	Lethality [%]	View factor	Probit	Dose [(W/m2)^ProbitN.s]	Hazard information	Ellipse half-length [m]	Ellipse half-width [m]	Ellipse centre downwind distance [m]	Effect downwind distance [m]	Ellipse area [m2]
3	0	0,0177187	-1,38321	865119	-	73,2985	77,776	17,6461	90,9446	17909,8
5	0,000174704	0,0295312	0,360367	1709491	-	57,7986	60,7597	17,2836	75,0822	11032,7
7	0,02405	0,0413437	1,50883	2677313	-	49,3858	51,402	16,8717	66,2575	7975,01
12,5	6,52536	0,073828	3,48789	5800162	-	37,4538	37,9362	15,5808	53,0346	4463,74

### Radiation v Distance Results

#### INPUT DATA

Maximum distance	90,9446	m
Angle from wind direction	0	deg
Observer direction	Variable	
Height of interest	1	m

#### OUTPUT DATA

Downwind distance [m]	Maximum incident radiation [kW/m2]	Lethality level [fraction]
0	169,313	1
1,85601	169,313	1
3,71202	169,313	1
5,56803	169,313	1
7,42405	169,313	1
9,28006	131,989	1
11,1361	106,646	1
12,9921	91,2305	1
14,8481	80,7274	0,999999
16,7041	72,8099	0,999997
18,5601	65,7643	0,999984
20,4161	59,9882	0,999939
22,2721	55,594	0,999829
24,1281	51,6676	0,999568
25,9842	48,2702	0,999031
27,8402	44,9866	0,997875
29,6962	42,2846	0,995947
31,5522	39,8132	0,992698
33,4082	37,6106	0,987705
35,2642	34,7638	0,976099

37,1202	31,6437	0,951357
38,9762	28,5708	0,904814
40,8322	25,6601	0,82709
42,6883	22,968	0,713766
44,5443	20,5198	0,571313
46,4003	18,3211	0,417953
48,2563	16,3643	0,276703
50,1123	14,634	0,164998
51,9683	13,1354	0,0896582
53,8243	12,0506	0,0508071
55,6803	11,0643	0,0268933
57,5364	10,1707	0,0133467
59,3924	9,36304	0,00623792
61,2484	8,63378	0,00275874
63,1044	7,97549	0,00116012
64,9604	7,38105	0,000466127
66,8164	6,84382	0,00017977
68,6724	6,35771	6,68396E-05
70,5284	5,91723	2,40554E-05
72,3844	5,51743	8,41154E-06
74,2405	5,15394	2,86753E-06
76,0965	4,82285	9,56004E-07
77,9525	4,52071	3,12576E-07
79,8085	4,24447	1,00485E-07
81,6645	3,99144	3,18344E-08
83,5205	3,75923	9,9595E-09
85,3765	3,54574	0
87,2325	3,34911	0
89,0885	3,16768	0
90,9446	2,99999	0



Audit Number: 247

Date: 03/09/2023 Time: 16:01

## Consequence Summary Report

Workspace: pm\_rev0

Study: Study

Summary Basis

These tables will only report global values set in the parameters. Values that are modified in the study tree will not be reported.

The report is context sensitive, and filters up to the study level. You will need to generate multiple summary reports if you have multiple studies in your workspace.

The results in this report are from the non-CFD calculations only.

Discharge Results (after atmospheric expansion)

Path	Scenario	Weather	Peak Flowrate [kg/s]	Temperature [degC]	Liquid mass fraction in material [fraction]	Droplet diameter [um]	Expanded diameter [m]	Velocity [m/s]	End time of release [s]
Study\T8	T8-2"leak vertical	Category 2/F	26,6182	-11,9098	0,813109	222,347	0,152556	98,7702	41,9164
		Category 5/D	26,6182	-11,9098	0,813109	222,347	0,152556	98,7702	41,9164

### Dispersion Results

Input dispersion parameters

Core averaging time	18,75 s
Flammable averaging time	18,75 s
Toxic averaging time	600 s
Height of interest	1 m

### Distance downwind to defined concentrations

The reported concentration of interest is defined at the scenario

Path	Scenario	Weather	Distance to UFL [m]	Distance to LFL [m]	Distance to LFL fraction [m]
Study\T8	T8-2"leak vertical	Category 2/F	n/a	53,8315	95,3043
		Category 5/D	n/a	39,7427	62,1487

### Jet Fire Results

Distance downwind to defined radiation levels

The reported radiations are defined in the parameters

Path	Scenario	Weather	Flame length [m]	Distance downwind to Intensity level 1 (3 kW/m2) [m]	Distance downwind to Intensity level 2 (5 kW/m2) [m]	Distance downwind to Intensity level 3 (7 kW/m2) [m]	Distance downwind to Intensity level 4 (12,5 kW/m2) [m]
Study\T8	T8-2"leak vertical	Category 2/F	46,1914	74,1861	57,3745	48,7715	37,619

		Category 5/D	35,9058	74,4905	57,5812	48,5485	36,591
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### Early Pool Fire Results

#### Distance downwind to defined radiation levels

The reported radiations are defined in the parameters

Path	Scenario	Weather	Pool diameter [m]	Distance downwind to intensity level 1 (3 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 2 (5 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 3 (7 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 4 (12,5 kW/m <sup>2</sup> ) [m]
Study\T8	T8-2"leak vertical	Category 2/F	15,154	89,5169	71,8052	62,5606	48,8798
		Category 5/D	15,154	90,9446	75,0822	66,2575	53,0346

### Late Pool Fire Results

#### Distance downwind to defined radiation levels

The reported radiations are defined in the parameters

Path	Scenario	Weather	Pool diameter [m]	Distance downwind to intensity level 1 (3 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 2 (5 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 3 (7 kW/m <sup>2</sup> ) [m]	Distance downwind to intensity level 4 (12,5 kW/m <sup>2</sup> ) [m]
Study\T8	T8-2"leak vertical	Category 2/F	18,2318	103,707	83,1583	72,4499	56,4871
		Category 5/D	18,0993	104,871	86,4572	76,2114	60,8628

### Flash Fire Results

#### Distance downwind to defined concentrations

The reported LFL and LFL fraction are defined in the respective material property

Path	Scenario	Weather	Distance downwind to LFL [m]	Distance downwind to LFL Fraction [m]
Study\T8	T8-2"leak vertical	Category 2/F	53,8315	95,3043
		Category 5/D	39,7427	62,1487

#### Maximum distance to LFL fraction at any height

Path	Scenario	Weather	Max flash fire distance [m]	Height of the max flash fire distance [m]	Time [s]
Study\T8	T8-2"leak vertical	Category 2/F	96,954	0	112,753
		Category 5/D	63,01	0	45,6207

### Explosion Results

#### Explosion scenarios for worst-case maximum downwind distance to defined overpressures.

The reported overpressures are defined in the explosion parameters

Path	Scenario	Weather	Overpressure level [bar]	Maximum distance [m]	Diameter [m]
Study\T8	T8-2"leak vertical	Category 2/F	0,02068	341,666	503,331
			0,1379	138,913	97,8258
			0,2068	126,673	73,3461
		Category 5/D	0,02068	217,621	315,242
			0,1379	90,6347	61,2694
			0,2068	82,9687	45,9374



Supplementary data for worst-case explosion scenarios

Path	Scenario	Weather	Overpressure level [bar]	Explosion flammable mass [kg]	Ignition time [s]	Ignition source [m]	Cloud centre [m]	Explosion centre [m]
Study\T8	T8-2"leak vertical	Category 2/F	0,02068	193,218	99,3679	90	45,3858	90
			0,1379	193,218	99,3679	90	45,3858	90
			0,2068	193,218	99,3679	90	45,3858	90
		Category 5/D	0,02068	47,4698	27,4193	60	22,2002	60
			0,1379	47,4698	27,4193	60	22,2002	60
			0,2068	47,4698	27,4193	60	22,2002	60