

## **ANNESSO TECNICO 6.**

### **Elaborati di calcolo Scenari incidentali ragionevolmente credibili**

#### ***Ipotesi N. 11***

TRR S.r.l.

Il Direttore Generale

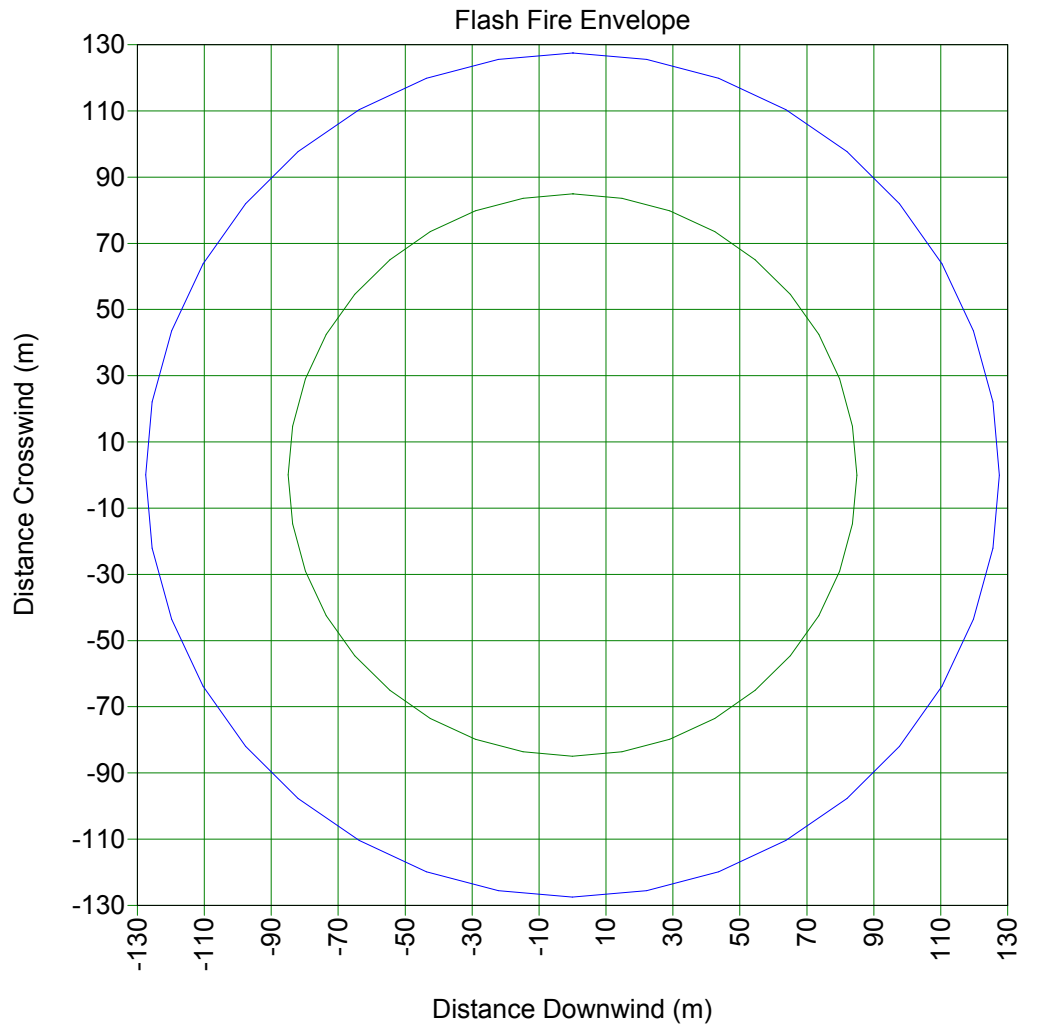
Ing. *Alfredo Romano*





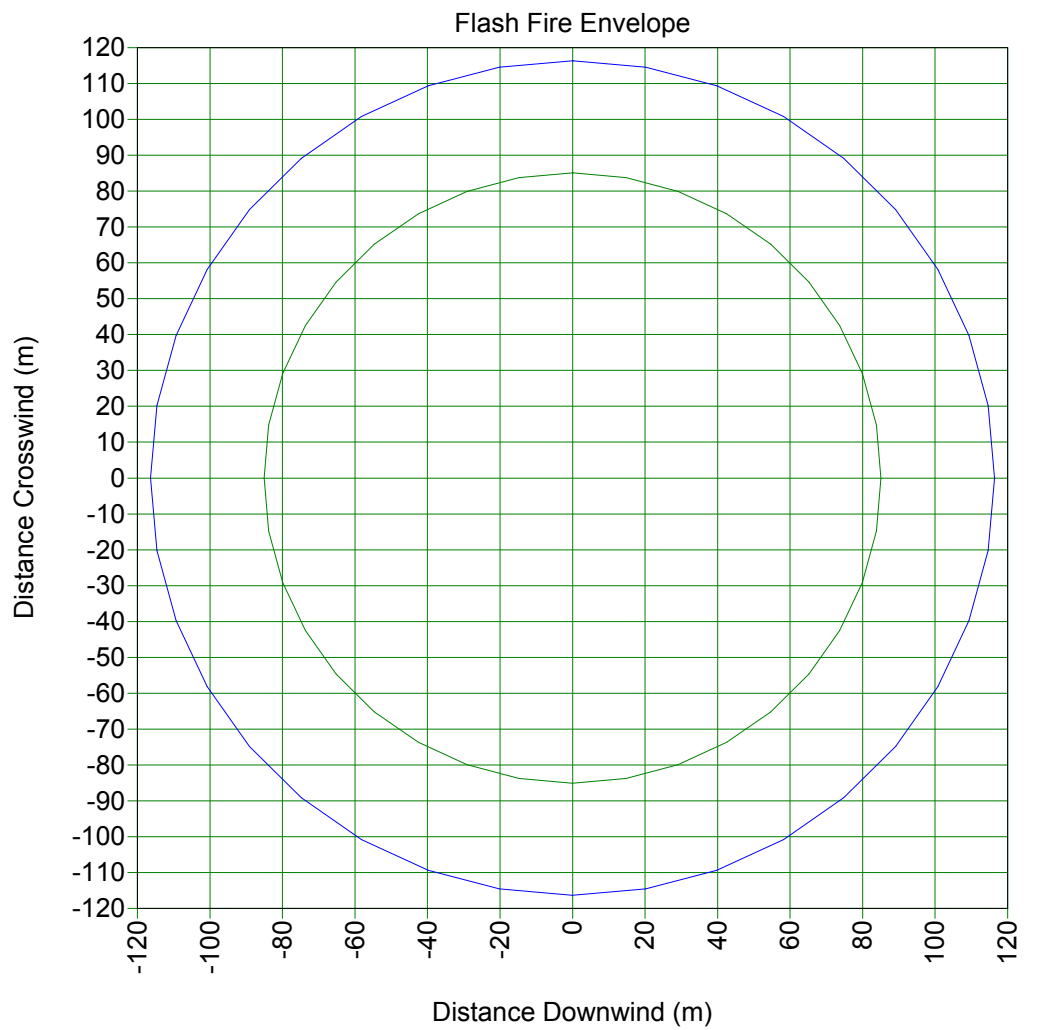
Study Folder: 70977-Fase  
1-lp11  
Audit No: 65866  
Model: 90mm  
Weather: Category 5/D  
Material: METHANE  
Concentration

— 2.2e+004 ppm  
— 4.4e+004 ppm



Study Folder: 70977-Fase  
1-lp11  
Audit No: 65866  
Model: 90mm  
Weather: Category 2/F  
Material: METHANE  
Concentration

— 2.2e+004 ppm  
— 4.4e+004 ppm



# JET FIRE REPORT

Study Folder: 70977-Fase 1-Ip11

Unique Audit Number: 65.866



Phast 6.6

70977-Fase 1-Ip11

Misura Fiscale - Erogazione

90mm

Base Case

Data



Weather: Global Weathers\Category 2/F

Speed: 2,00 m/s

Stability: F

\70977-Fase 1-Ip11\Misura Fiscale - Erogazione\90mm

## Flame Data

### User-Defined Quantities

	API	
Model Correlation Type	METHANE	
Material		
Ambient Temperature	25,00	degC
Ambient Relative Humidity	0,75	fraction
Ambient Wind Speed	2,00	m/s
Maximum Exposure Duration	20,00	s
Elevation	1,00	m
Expanded Temperature	0,67	degC
Release Rate	41,35	kg/s

	Input	Output	
Flame Emissive Power		130,62	kW/m2
Fraction of Emissivity		0,15	fraction
Expanded Radius		0,19	m
Jet Velocity	500,00	500,00	m/s
Flame Length		92,84	m
Maximum Flame Radius		5,77	m

### Flame Co-ordinates

X	Z	R	Phi
m	m	m	deg
0,00	1,00	0,19	90,00
10,32	1,00	2,22	90,00
20,63	1,00	3,67	90,00
30,95	1,00	4,70	90,00
41,26	1,00	5,39	90,00
51,58	1,00	5,73	90,00
61,89	1,00	5,71	90,00
72,21	1,00	5,25	90,00
82,52	1,00	4,11	90,00
92,84	1,00	0,00	90,00



**Radiation Intensity Ellipse**

**User-Defined Quantities**

Observer Inclination	Variable	deg
Observer Orientation	Variable	deg
Exposure Duration	20,00	s
Effect Height	0,00	m

**Calculated Quantities**

<b>Incident Radiation Level:</b>	<b>3,00</b>	<b>kW/m2</b>
Lethality Level	0,00	%
View Factor	0,02	
Dose Level	865.118,83	(W/m2)^Probit N.s

Downwind semi-axis (A)	54,95	m
Crosswind semi-axis (B)	79,57	m
Offset Ratio (D)	0,93	
Effect Distance	106,54	m
Area	13.736,18	m2

<b>Incident Radiation Level:</b>	<b>5,00</b>	<b>kW/m2</b>
Lethality Level	0,00	%
View Factor	0,04	
Dose Level	1.709.490,54	(W/m2)^Probit N.s

Downwind semi-axis (A)	51,50	m
Crosswind semi-axis (B)	60,27	m
Offset Ratio (D)	0,96	
Effect Distance	100,93	m
Area	9.750,51	m2

<b>Incident Radiation Level:</b>	<b>7,00</b>	<b>kW/m2</b>
Lethality Level	0,02	%
View Factor	0,05	
Dose Level	2.677.313,40	(W/m2)^Probit N.s

Downwind semi-axis (A)	49,74	m
Crosswind semi-axis (B)	49,60	m
Offset Ratio (D)	0,97	
Effect Distance	98,06	m
Area	7.751,56	m2

# JET FIRE REPORT

Study Folder: 70977-Fase 1-Ip11

Unique Audit Number: 65.866



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<b>Incident Radiation Level:</b>	<b>12,50</b>	kW/m2
Lethality Level	6,53	%
View Factor	0,10	
Dose Level	5.800.161,90	(W/m2)^Probit N.s
Downwind semi-axis (A)	47,42	m
Crosswind semi-axis (B)	34,34	m
Offset Ratio (D)	0,99	
Effect Distance	94,18	m
Area	5.115,81	m2

# JET FIRE REPORT

Study Folder: 70977-Fase 1-1p11

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## Radiation Distance

### User-Defined Quantities

Maximum Distance	500,00	m
Angle from Wind Direction	0,00	deg
Height above Origin	0,00	m
Observer Inclination	Variable	deg
Observer Orientation	Variable	deg

### Calculated Quantities

X Coordinates m	Y Coordinates m	Z Coordinates m	Incident Radiation kW/m2	Lethality Level %	View Factor
0,00			22,80		
10,20			130,62		
20,41			130,62		
30,61			130,62		
40,82			130,62		
51,02			130,62		
61,22			130,62		
71,43			130,62		
81,63			130,62		
91,84			61,23		
102,04			4,44		
112,24			1,88		
122,45			1,06		
132,65			0,71		
142,86			0,51		
153,06			0,38		
163,27			0,29		
173,47			0,24		
183,67			0,19		
193,88			0,16		
204,08			0,14		
214,29			0,12		
224,49			0,10		
234,69			0,09		
244,90			0,08		
255,10			0,07		
265,31			0,06		
275,51			0,06		
285,71			0,05		
295,92			0,05		
306,12			0,04		
316,33			0,04		
326,53			0,04		
336,73			0,03		
346,94			0,03		
357,14			0,03		
367,35			0,03		



# JET FIRE REPORT


Study Folder: 70977-Fase 1-1p11

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X Coordinates m	Y Coordinates m	Z Coordinates m	Incident Radiation kW/m2	Lethality Level %	View Factor
377,55			0,02		
387,76			0,02		
397,96			0,02		
408,16			0,02		
418,37			0,02		
428,57			0,02		
438,78			0,02		
448,98			0,02		
459,18			0,01		
469,39			0,01		
479,59			0,01		
489,80			0,01		
500,00			0,01		

 **Weather:** Global Weathers\Category 5/D  
**Speed:** 5.00 **m/s** **Stability:** D

\70977-Fase 1-1p11\Misura Fiscale - Erogazione\90mm

## Flame Data

### User-Defined Quantities

	API
Model Correlation Type	METHANE
Material	
Ambient Temperature	25,00 degC
Ambient Relative Humidity	0,75 fraction
Ambient Wind Speed	5,00 m/s
Maximum Exposure Duration	20,00 s
Elevation	1,00 m
Expanded Temperature	0,67 degC
Release Rate	41,35 kg/s

	Input	Output
Flame Emissive Power		130,62 kW/m2
Fraction of Emissivity		0,15 fraction
Expanded Radius		0,19 m
Jet Velocity	500,00	500,00 m/s
Flame Length		92,84 m
Maximum Flame Radius		5,77 m

# JET FIRE REPORT

Study Folder: 70977-Fase 1-Ip11

Unique Audit Number: 65.866



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## Flame Co-ordinates

<b>X</b>	<b>Z</b>	<b>R</b>	<b>Phi</b>
m	m	m	deg
0,00	1,00	0,19	90,00
10,32	1,00	2,22	90,00
20,63	1,00	3,67	90,00
30,95	1,00	4,70	90,00
41,26	1,00	5,39	90,00
51,58	1,00	5,73	90,00
61,89	1,00	5,71	90,00
72,21	1,00	5,25	90,00
82,52	1,00	4,11	90,00
92,84	1,00	0,00	90,00



**Radiation Intensity Ellipse**

**User-Defined Quantities**

Observer Inclination	Variable	deg
Observer Orientation	Variable	deg
Exposure Duration	20,00	s
Effect Height	0,00	m

**Calculated Quantities**

<b>Incident Radiation Level:</b>	<b>3,00</b>	<b>kW/m2</b>
Lethality Level	0,00	%
View Factor	0,02	
Dose Level	865.118,83	(W/m2)^Probit N.s

Downwind semi-axis (A)	54,95	m
Crosswind semi-axis (B)	79,57	m
Offset Ratio (D)	0,93	
Effect Distance	106,54	m
Area	13.736,18	m2

<b>Incident Radiation Level:</b>	<b>5,00</b>	<b>kW/m2</b>
Lethality Level	0,00	%
View Factor	0,04	
Dose Level	1.709.490,54	(W/m2)^Probit N.s

Downwind semi-axis (A)	51,50	m
Crosswind semi-axis (B)	60,27	m
Offset Ratio (D)	0,96	
Effect Distance	100,93	m
Area	9.750,51	m2

<b>Incident Radiation Level:</b>	<b>7,00</b>	<b>kW/m2</b>
Lethality Level	0,02	%
View Factor	0,05	
Dose Level	2.677.313,40	(W/m2)^Probit N.s

Downwind semi-axis (A)	49,74	m
Crosswind semi-axis (B)	49,60	m
Offset Ratio (D)	0,97	
Effect Distance	98,06	m
Area	7.751,56	m2

# JET FIRE REPORT

Study Folder: 70977-Fase 1-Ip11

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<b>Incident Radiation Level:</b>	<b>12,50</b>	kW/m2
Lethality Level	6,53	%
View Factor	0,10	
Dose Level	5.800.161,90	(W/m2)^Probit N.s
Downwind semi-axis (A)	47,42	m
Crosswind semi-axis (B)	34,34	m
Offset Ratio (D)	0,99	
Effect Distance	94,18	m
Area	5.115,81	m2

# JET FIRE REPORT

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## Radiation Distance

### User-Defined Quantities

Maximum Distance	500,00	m
Angle from Wind Direction	0,00	deg
Height above Origin	0,00	m
Observer Inclination	Variable	deg
Observer Orientation	Variable	deg

### Calculated Quantities

X Coordinates m	Y Coordinates m	Z Coordinates m	Incident Radiation kW/m2	Lethality Level %	View Factor
0,00			22,80		
10,20			130,62		
20,41			130,62		
30,61			130,62		
40,82			130,62		
51,02			130,62		
61,22			130,62		
71,43			130,62		
81,63			130,62		
91,84			61,23		
102,04			4,44		
112,24			1,88		
122,45			1,06		
132,65			0,71		
142,86			0,51		
153,06			0,38		
163,27			0,29		
173,47			0,24		
183,67			0,19		
193,88			0,16		
204,08			0,14		
214,29			0,12		
224,49			0,10		
234,69			0,09		
244,90			0,08		
255,10			0,07		
265,31			0,06		
275,51			0,06		
285,71			0,05		
295,92			0,05		
306,12			0,04		
316,33			0,04		
326,53			0,04		
336,73			0,03		
346,94			0,03		
357,14			0,03		
367,35			0,03		

# JET FIRE REPORT

Study Folder: 70977-Fase 1-Ip11

Unique Audit Number: 65.866



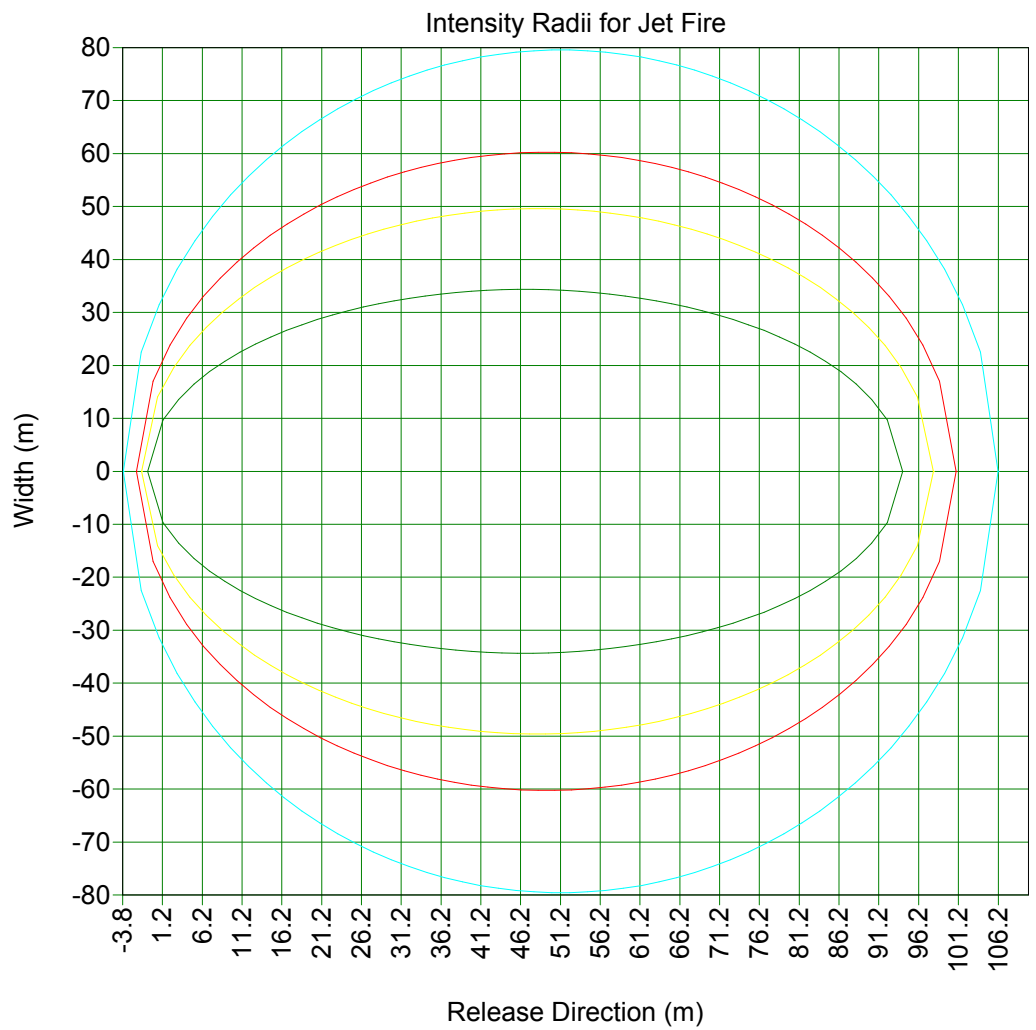
Phast 6.6

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X Coordinates m	Y Coordinates m	Z Coordinates m	Incident Radiation kW/m2	Lethality Level %	View Factor
377,55			0,02		
387,76			0,02		
397,96			0,02		
408,16			0,02		
418,37			0,02		
428,57			0,02		
438,78			0,02		
448,98			0,02		
459,18			0,01		
469,39			0,01		
479,59			0,01		
489,80			0,01		
500,00			0,01		

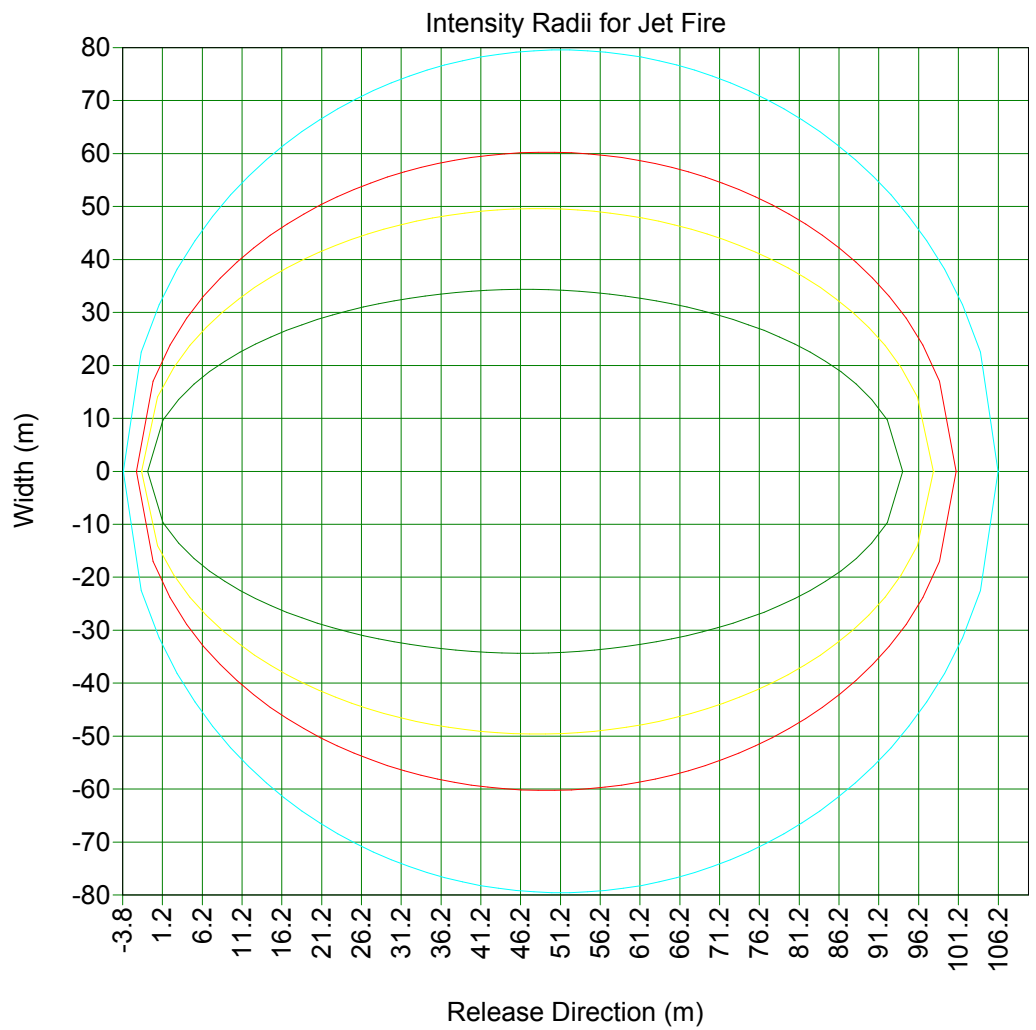
Study Folder: 70977-Fase  
1-lp11  
Audit No: 65866  
Model: 90mm  
Weather: Category 5/D  
Material: METHANE

- Ellipse @12.5 kW/m<sup>2</sup>
- Ellipse @7 kW/m<sup>2</sup>
- Ellipse @5 kW/m<sup>2</sup>
- Ellipse @3 kW/m<sup>2</sup>



Study Folder: 70977-Fase  
1-lp11  
Audit No: 65866  
Model: 90mm  
Weather: Category 2/F  
Material: METHANE

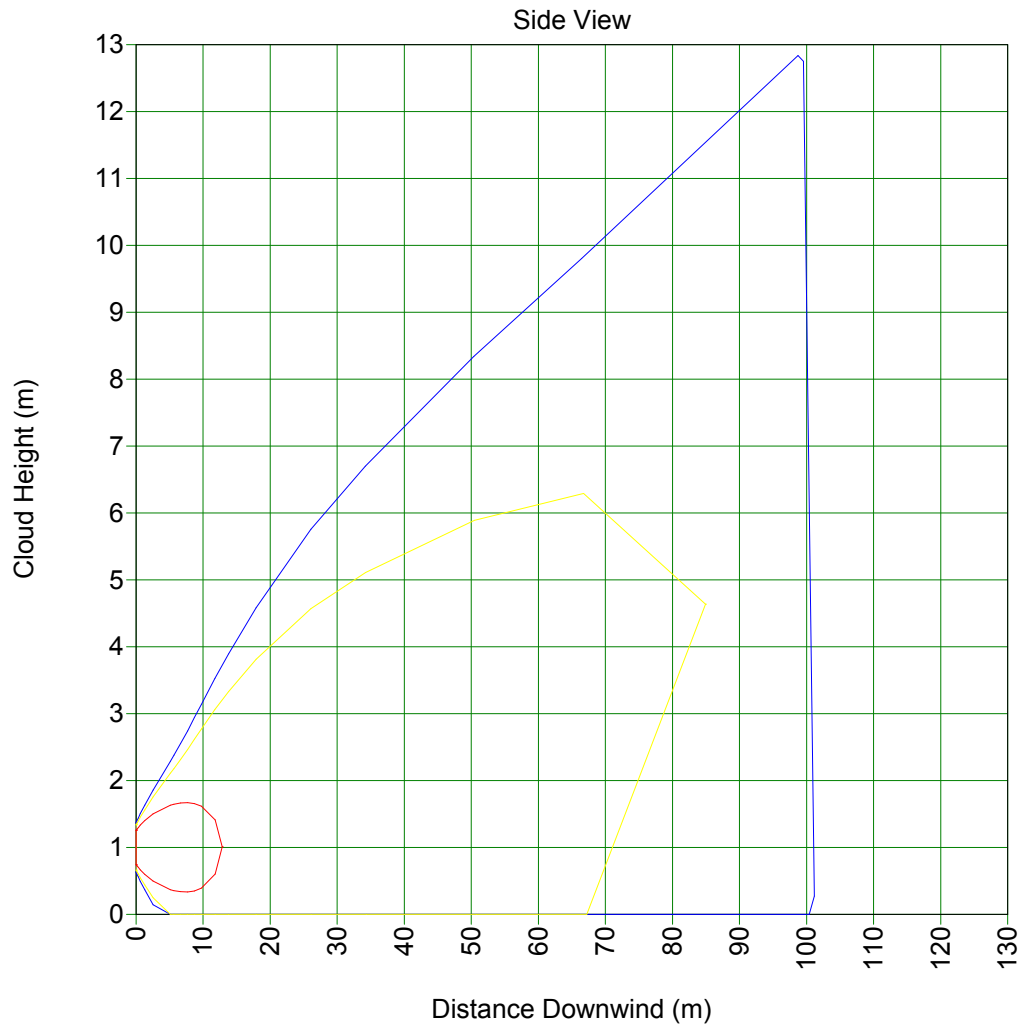
- Ellipse @12.5 kW/m<sup>2</sup>
- Ellipse @7 kW/m<sup>2</sup>
- Ellipse @5 kW/m<sup>2</sup>
- Ellipse @3 kW/m<sup>2</sup>





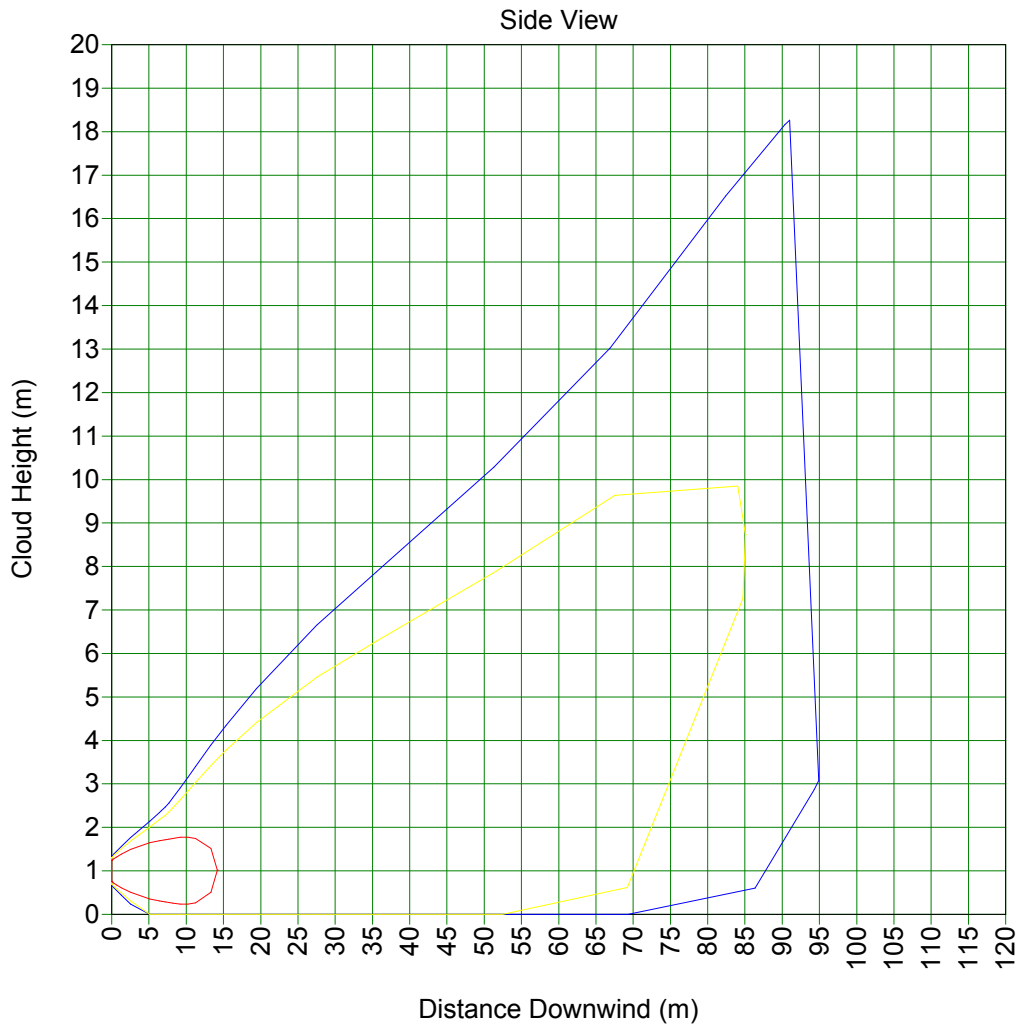
Study Folder: 70977-Fase  
1-lp11  
Audit No: 65866  
Model: 90mm  
Weather: Category 5/D  
Material: METHANE  
Averaging Time:  
Flammable(18.75 s)  
C/L Offset: 0 m  
Concentration  
Time: 7.856 s

- 2.2e+004 ppm
- 4.4e+004 ppm
- 1.65e+005 ppm



Study Folder: 70977-Fase  
1-lp11  
Audit No: 65866  
Model: 90mm  
Weather: Category 2/F  
Material: METHANE  
Averaging Time:  
Flammable(18.75 s)  
C/L Offset: 0 m  
Concentration  
Time: 10.13 s

— 2.2e+004 ppm  
— 4.4e+004 ppm  
— 1.65e+005 ppm



# SUMMARY REPORT

Unique Audit Number: 65.866



Study Folder: 70977-Fase 1-Ip11

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70977-Fase 1-Ip11

Misura Fiscale - Erogazione

90mm

Base Case

CASE Name: Data

Path: \70977-Fase 1-Ip11\Misura Fiscale - Erogazione\90mm

## User-Defined Data

### Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	70 bar
Temperature	50 degC

### Scenario

Scenario Type	Long Pipeline
Phase to be Released	Vapor
Building Wake Effect	None

### Pipe

Internal Diameter	450 mm
Line length	40 m
Distance To Break	1 m
Relative Aperture	0.2 fraction
Pumped Inflow	40 kg/s
Use Ambient Temperature	Use ambient temperature

### Vessel/Tank

Duration of Interest	300 s
Method Used for Time Varying Releases	Average Rates

### Location

[Elevation	1 m]
Concentration of Interest	2.2E4 ppm
Averaging time associated with Concentration	Flammable
Distances for Radiation Modeling and Dispersion Scope(1)	50 m
Distances for Radiation Modeling and Dispersion Scope(2)	250 m
Distances for Radiation Modeling and Dispersion Scope(3)	500 m
Use ERPG averaging time	ERPG not selected
Use IDLH averaging time	IDLH not selected
Use STEL averaging time	STEL not selected
Supply a user defined averaging time	Not supplied

### Bund

Status of Bund	No bund present
[Type of Bund Surface	Concrete]
[Bund Height	0 m]
[Bund Failure Modeling	Bund cannot fail]

### Indoor/Outdoor

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Study Folder: 70977-Fase 1-Ip11

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Location of release Open air release  
Outdoor Release Direction Horizontal

## Flammable

Explosion Method TNT  
Jet Fire Method API Model

## Dispersion

Late Ignition Location No ignition location

## Fireball Parameters

[Mass Modification Factor 3]  
[Calculation method for fireball DNV Recommended]  
[TNO model flame temperature 1727 degC]

## Toxic Parameters

[Indoor Calculations Unselected]  
[Wind Dependent Exchange Rate Case Specified]  
[Building Exchange Rate 4 /hr]  
[Tail Time 1800 s]  
[Set averaging time equal to exposure time Use a fixed averaging time]  
[Cut-off fraction of toxic load for exposure time calculation 0.05 fraction]  
[Cut-off concentration for exposure time calculations 0 fraction]

## Geometry

Shape Point  
Dimension 2D  
System Absolute  
East(1) 0 m  
North(1) 0 m

Path: \70977-Fase 1-Ip11\Misura Fiscale - Erogazione\90mm

## Discharge Data

### User-Defined Quantities

Material METHANE  
Temperature 25,00 degC  
Pressure 71,01 bar  
Inventory 14.000,00 kg  
Scenario Long Pipeline  
Fixed Duration n/a s

### Calculated Quantities

Weather: Global Weathers\Category 2/F

Mass Flow of Air (Vent from Vapor Space Only) n/a

Average Values for Segment Number 1

Liquid Fraction 0,00 fraction  
Final Temperature 0,67 degC  
Final Velocity 500,00 m/s  
Droplet Diameter 0,00 um

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Study Folder: 70977-Fase 1-Ip11

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## Continuous Release Data:

Mass Flowrate	4.13525E+001 kg/s
Release Duration	300,00 s
Orifice Velocity	n/a m/s
Exit Pressure	n/a bar
Exit Temperature	n/a degC
Discharge Coefficient	n/a
Expanded Radius	n/a m

**Weather:** Global Weathers\Category 5/D

Mass Flow of Air (Vent from Vapor Space Only) n/a

**Average Values for Segment Number 1**

Liquid Fraction	0,00 fraction
FinalTemperature	0,67 degC
Final Velocity	500,00 m/s
Droplet Diameter	0,00 um

## Continuous Release Data:

Mass Flowrate	4.13525E+001 kg/s
Release Duration	300,00 s
Orifice Velocity	n/a m/s
Exit Pressure	n/a bar
Exit Temperature	n/a degC
Discharge Coefficient	n/a
Expanded Radius	n/a m

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## Consequence Results

### Distance to Concentration Results

**Path:** \70977-Fase 1-IP11\Misura Fiscale - Erogazione\90mm

The height for user defined concentrations is the user defined height 0 m  
All toxic results are reported at the toxic effect height 0 m  
All flammable results are reported at the cloud centreline height

Concentration(ppm) Averaging Time				Distance (m)	
				Category 2/F	Category 5/D
User Conc (22000)	18.75	s		84.4503	104.375
UFL (165000)	18.75	s		14.1943	12.8234
LFL (44000)	18.75	s		85.0726	84.9262
LFL Frac (22000)	18.75	s		116.362	127.497

Concentration(ppm) Averaging Time				Heights (m) for above distances	
				Category 2/F	Category 5/D
User Conc (22000)	18.75	s		0	0
UFL (165000)	18.75	s		1.01543	1.0093
LFL (44000)	18.75	s		8.72998	4.63452
LFL Frac (22000)	18.75	s		16.8	9.7609

# SUMMARY REPORT

Study Folder: 70977-Fase 1-IP11

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## Concentration At Distance Results

Path: \70977-Fase 1-IP11\Misura Fiscale - Erogazione\90mm

The height for user defined concentrations is the user defined height 0 m  
All toxic results are reported at the toxic effect height 0 m  
All flammable results are reported at the cloud centreline height

Distance		Conc.(ppm) at Flammable Avg. Time of 18.75 s	
		Category 2/F	Category 5/D
50	m	77754.4	69784.7
250	m	4326.77	5095.51
500	m	1319.8	1913.89

Distance		Heights (m) for above concentrations	
		Category 2/F	Category 5/D
50	m	2.5801	1.74084
250	m	42.94	21.704
500	m	65.9303	37.377

Distance		Conc.(ppm) at Core Avg. Time of 18.75 s	
		Category 2/F	Category 5/D
50	m	77754.4	69784.7
250	m	4326.77	5095.51
500	m	1319.8	1913.89

Distance		Heights (m) for above concentrations	
		Category 2/F	Category 5/D
50	m	2.5801	1.74084
250	m	42.94	21.704
500	m	65.9303	37.377

## Jet Fire Hazard

Path: \70977-Fase 1-IP11\Misura Fiscale - Erogazione\90mm

Jet fire method used: API

	Category 2/F	Category 5/D
Jet Fire Status	Hazard	Hazard
Flame Direction	Horizontal	Horizontal

## Radiation Effects: Jet Fire Ellipse

Path: \70977-Fase 1-IP11\Misura Fiscale - Erogazione\90mm

This table gives the distances to the specified radiation levels  
for each jet fire listed in the above hazard table

			Distance (m)	
			Category 2/F	Category 5/D
Radiation Level	12.5	kW/m2	94.1834	94.1834
Radiation Level	7	kW/m2	98.0622	98.0622
Radiation Level	5	kW/m2	100.93	100.93
Radiation Level	3	kW/m2	106.544	106.544

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## Radiation Effects: Jet Fire Distance

Path: \70977-Fase 1-Ip11\Misura Fiscale - Erogazione\90mm

		Radiation Level (kW/m2)	
		Category 2/F	Category 5/D
Distance Of Interest 50	m	Engulfed	Engulfed
Distance Of Interest 250	m	0.0744049	0.0744049
Distance Of Interest 500	m	0.0118577	0.0118577

## Flash Fire Envelope

Path: \70977-Fase 1-Ip11\Misura Fiscale - Erogazione\90mm

All flammable results are reported at the cloud centreline height

		Distance (m)		Heights (m) for above distances		
			Category 2/F	Category 5/D	Category 2/F	Category 5/D
Furthest Extent	22000	ppm	116.362	127.497	16.8	9.7609
Furthest Extent	44000	ppm	85.0726	84.9262	8.72998	4.63452



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## Explosion Effects: Late Ignition

Path: \70977-Fase 1-Ip11\Misura Fiscale - Erogazione\90mm

Explosion Model Used : TNT

Explosion Location Criterion: Cloud Front (LFL Fraction)

All distances are measured from the Source

All flammable results are reported at the cloud centreline height

			Maximum Distance (m) at Overpressure Level	
			Category 2/F	Category 5/D
Overpressure	0.02068	bar	287.798	276.124
Overpressure	0.1379	bar	156.036	160.424
Overpressure	0.2068	bar	145.622	151.28

			Supplementary Data at 0.02068 bar	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		144.227	97.6516
Used Flammable Mass	kg		144.227	97.6516
Overpressure Radius	m		177.798	156.124
Distance to:				
- Ignition Source	m		110	120
- Cloud Front/Centre	m		110	120
- Explosion Centre	m		110	120

			Supplementary Data at 0.1379 bar	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		144.227	97.6516
Used Flammable Mass	kg		144.227	97.6516
Overpressure Radius	m		46.0363	40.4244
Distance to:				
- Ignition Source	m		110	120
- Cloud Front/Centre	m		110	120
- Explosion Centre	m		110	120

			Supplementary Data at 0.2068 bar	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		144.227	97.6516
Used Flammable Mass	kg		144.227	97.6516
Overpressure Radius	m		35.6218	31.2795
Distance to:				
- Ignition Source	m		110	120
- Cloud Front/Centre	m		110	120
- Explosion Centre	m		110	120

			Overpressures (bar gauge) at Distances	
			Category 2/F	Category 5/D
Distance	50	m	1	1
Distance	250	m	0.0280366	0.026073
Distance	500	m	0.00823094	0.00736278

			Supplementary Data at 50 m	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		52.768	51.2521

# SUMMARY REPORT

Study Folder: 70977-Fase 1-Ip11

Unique Audit Number: 65.866

Phast 6.6



Used Flammable Mass	kg	52.768	51.2521
		Supplementary Data at 250 m	
		Category 2/F	Category 5/D
Supplied Flammable Mass	kg	144.227	97.6516
Used Flammable Mass	kg	144.227	97.6516
		Supplementary Data at 500 m	
		Category 2/F	Category 5/D
Supplied Flammable Mass	kg	144.227	97.6516
Used Flammable Mass	kg	144.227	97.6516

## Weather Conditions

Path: \70977-Fase 1-Ip11\Misura Fiscale - Erogazione\90mm

		Category 2/F	Category 5/D
Wind Speed	m/s	2	5
Pasquill Stability		F	D
Surface Roughness Length	mm	1000	1000
Surface Roughness Parameter		0.173718	0.173718
Atmospheric Temperature	degC	25	25
Surface Temperature	degC	25	25
Relative Humidity	fraction	0.75	0.75