

ANNESSO TECNICO 6.

Elaborati di calcolo Scenari incidentali ragionevolmente credibili

Ipotesi N. 27

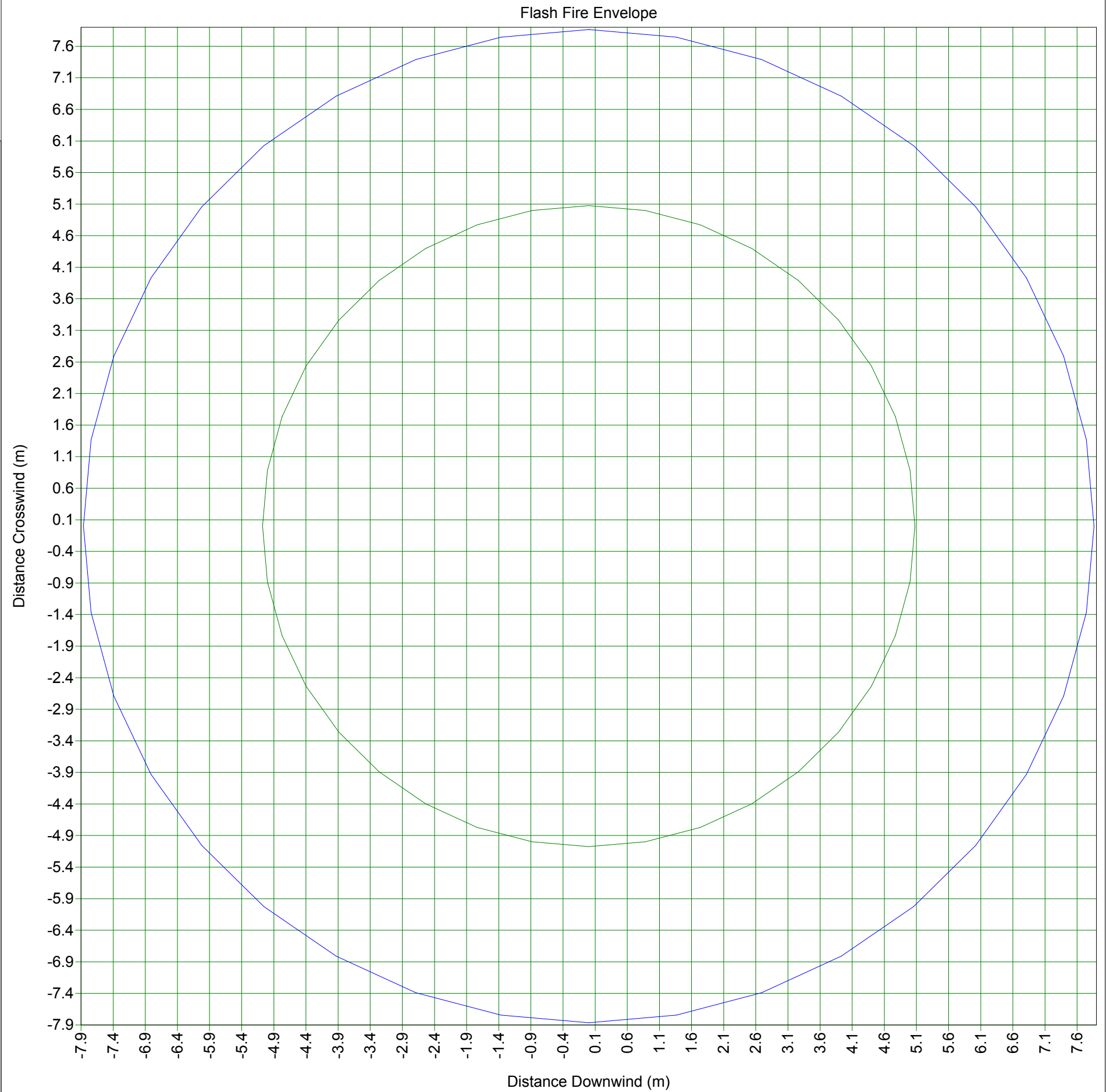
TRR S.r.l.

Il Direttore Generale

Ing. Alfredo Romano

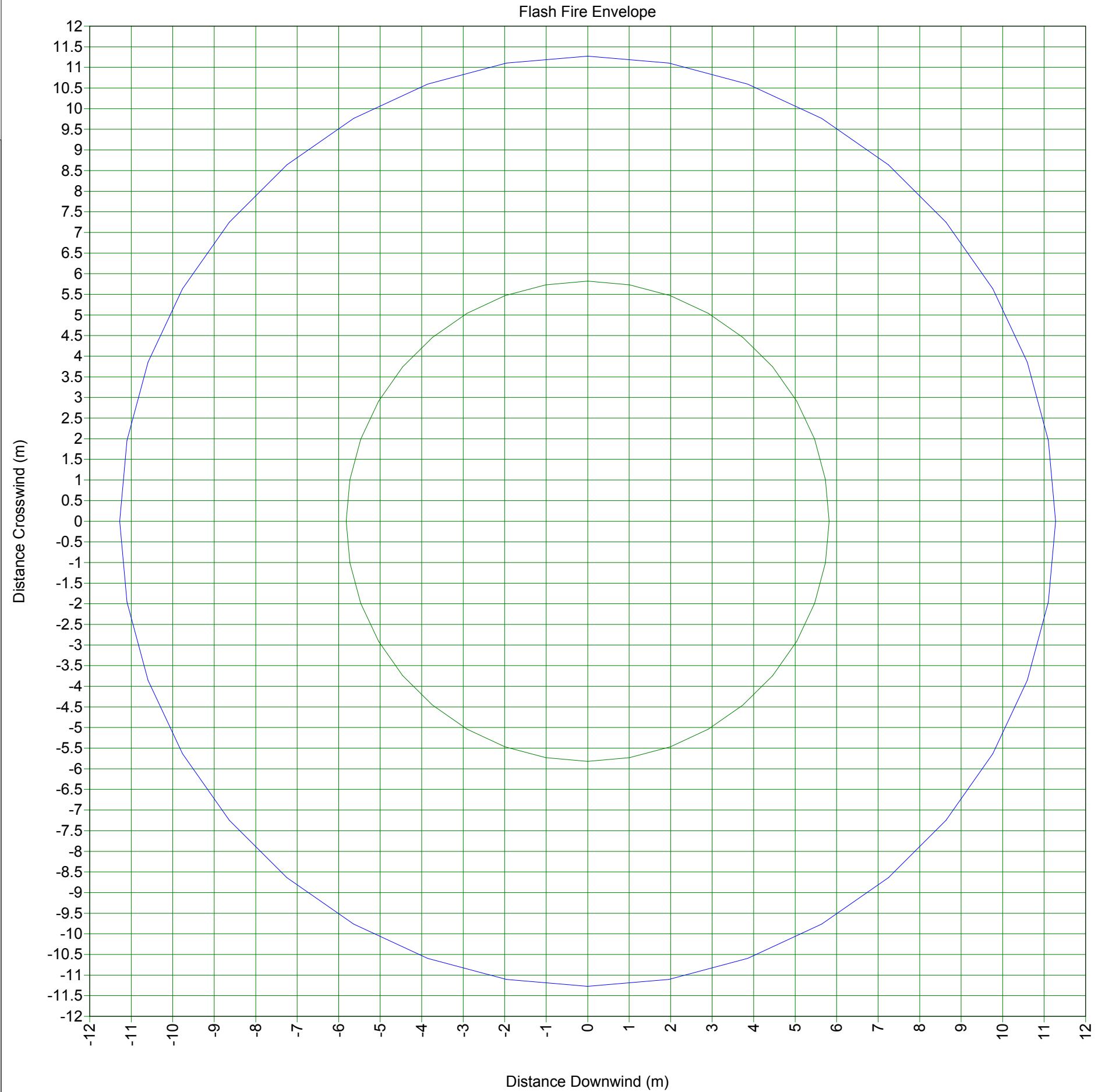

Study Folder: 70977-Fase
2-lp27
Audit No: 65846
Model: 10mm
Weather: Category 5/D
Material: METHANE
Concentration

— 2.2e+004 ppm
— 4.4e+004 ppm



Study Folder: 70977-Fase
2-lp27
Audit No: 65846
Model: 10mm
Weather: Category 2/F
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Concentration

— 2.2e+004 ppm
— 4.4e+004 ppm



JET FIRE REPORT

Unique Audit Number: 65.846



Study Folder: 70977-Fase 2-Ip27

Phast 6.6



70977-Fase 2-Ip27



Preriscaldatore Gas Combustibile

10mm

Base Case

Data



Weather: Global Weathers\Category 2/F

Speed: 2,00 m/s

Stability: F

\70977-Fase 2-Ip27\Preriscaldatore Gas Combustibile\10mm

Flame Data

User-Defined Quantities

Model Correlation Type	API
Material	METHANE
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	-30,70 degC
Release Rate	0,54 kg/s

Input

Output

Flame Emissive Power	107,94 kW/m2
Fraction of Emissivity	0,15 fraction
Expanded Radius	0,02 m
Jet Velocity	500,00 m/s
Flame Length	11,64 m
Maximum Flame Radius	0,72 m

Flame Co-ordinates

X	Z	R	Phi
m	m	m	deg
0,00	1,00	0,02	90,00
1,29	1,00	0,28	90,00
2,59	1,00	0,46	90,00
3,88	1,00	0,59	90,00
5,18	1,00	0,68	90,00
6,47	1,00	0,72	90,00
7,76	1,00	0,72	90,00
9,06	1,00	0,66	90,00
10,35	1,00	0,52	90,00
11,64	1,00	0,00	90,00

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip27

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Phast 6.6

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

Incident Radiation Level:	3,00	kW/m2
Lethality Level	0,00	%
View Factor	0,03	
Dose Level	865.118,83	(W/m2)^Probit N.s

Downwind semi-axis (A)	7,38	m
Crosswind semi-axis (B)	9,98	m
Offset Ratio (D)	0,83	
Effect Distance	13,53	m
Area	231,44	m2

Incident Radiation Level:	5,00	kW/m2
Lethality Level	0,00	%
View Factor	0,05	
Dose Level	1.709.490,54	(W/m2)^Probit N.s

Downwind semi-axis (A)	6,68	m
Crosswind semi-axis (B)	7,48	m
Offset Ratio (D)	0,91	
Effect Distance	12,79	m
Area	157,07	m2

Incident Radiation Level:	7,00	kW/m2
Lethality Level	0,02	%
View Factor	0,06	
Dose Level	2.677.313,40	(W/m2)^Probit N.s

Downwind semi-axis (A)	6,26	m
Crosswind semi-axis (B)	6,10	m
Offset Ratio (D)	0,98	
Effect Distance	12,36	m
Area	119,93	m2

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Study Folder: 70977-Fase 2-Ip27

Phast 6.6

Incident Radiation Level:	12,50	kW/m2
Lethality Level	6,53	%
View Factor	0,12	
Dose Level	5.800.161,90	(W/m2)^Probit N.s
Downwind semi-axis (A)	5,76	m
Crosswind semi-axis (B)	4,13	m
Offset Ratio (D)	1,05	
Effect Distance	11,80	m
Area	74,70	m2

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip27

Unique Audit Number: 65.846

Phast 6.6



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			8,58		
10,20			51,31		
20,41			0,33		
30,61			0,09		
40,82			0,04		
51,02			0,02		
61,22			0,01		
71,43			0,01		
81,63			0,01		
91,84			0,01		
102,04			0,00		
112,24			0,00		
122,45			0,00		
132,65			0,00		
142,86			0,00		
153,06			0,00		
163,27			0,00		
173,47			0,00		
183,67			0,00		
193,88			0,00		
204,08			0,00		
214,29			0,00		
224,49			0,00		
234,69			0,00		
244,90			0,00		
255,10			0,00		
265,31			0,00		
275,51			0,00		
285,71			0,00		
295,92			0,00		
306,12			0,00		
316,33			0,00		
326,53			0,00		
336,73			0,00		
346,94			0,00		
357,14			0,00		
367,35			0,00		

JET FIRE REPORT

Unique Audit Number: 65.846



Study Folder: 70977-Fase 2-IP27

Phast 6.6

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



Weather: Global Weathers\Category 5/D

Speed: 5,00

m/s

Stability: D

\70977-Fase 2-IP27\Preriscaldatore Gas Combustibile\10mm

Flame Data

User-Defined Quantities

Model Correlation Type	API
Material	METHANE
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	-30,70 degC
Release Rate	0,54 kg/s

	Input	Output
Flame Emissive Power		107,94 kW/m2
Fraction of Emissivity		0,15 fraction
Expanded Radius		0,02 m
Jet Velocity	500,00	500,00 m/s
Flame Length		11,64 m
Maximum Flame Radius		0,72 m

JET FIRE REPORT

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Study Folder: 70977-Fase 2-Ip27

Phast 6.6

Flame Co-ordinates

X	Z	R	Phi
m	m	m	deg
0,00	1,00	0,02	90,00
1,29	1,00	0,28	90,00
2,59	1,00	0,46	90,00
3,88	1,00	0,59	90,00
5,18	1,00	0,68	90,00
6,47	1,00	0,72	90,00
7,76	1,00	0,72	90,00
9,06	1,00	0,66	90,00
10,35	1,00	0,52	90,00
11,64	1,00	0,00	90,00

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip27

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Phast 6.6

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

Incident Radiation Level:	3,00	kW/m2
Lethality Level	0,00	%
View Factor	0,03	
Dose Level	865.118,83	(W/m2)^Probit N.s

Downwind semi-axis (A)	7,38	m
Crosswind semi-axis (B)	9,98	m
Offset Ratio (D)	0,83	
Effect Distance	13,53	m
Area	231,44	m2

Incident Radiation Level:	5,00	kW/m2
Lethality Level	0,00	%
View Factor	0,05	
Dose Level	1.709.490,54	(W/m2)^Probit N.s

Downwind semi-axis (A)	6,68	m
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Offset Ratio (D)	0,91	
Effect Distance	12,79	m
Area	157,07	m2

Incident Radiation Level:	7,00	kW/m2
Lethality Level	0,02	%
View Factor	0,06	
Dose Level	2.677.313,40	(W/m2)^Probit N.s

Downwind semi-axis (A)	6,26	m
Crosswind semi-axis (B)	6,10	m
Offset Ratio (D)	0,98	
Effect Distance	12,36	m
Area	119,93	m2

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Study Folder: 70977-Fase 2-Ip27

Phast 6.6

Incident Radiation Level:	12,50	kW/m2
Lethality Level	6,53	%
View Factor	0,12	
Dose Level	5.800.161,90	(W/m2)^Probit N.s
Downwind semi-axis (A)	5,76	m
Crosswind semi-axis (B)	4,13	m
Offset Ratio (D)	1,05	
Effect Distance	11,80	m
Area	74,70	m2

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip27

Unique Audit Number: 65.846

Phast 6.6



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			8,58		
10,20			51,31		
20,41			0,33		
30,61			0,09		
40,82			0,04		
51,02			0,02		
61,22			0,01		
71,43			0,01		
81,63			0,01		
91,84			0,01		
102,04			0,00		
112,24			0,00		
122,45			0,00		
132,65			0,00		
142,86			0,00		
153,06			0,00		
163,27			0,00		
173,47			0,00		
183,67			0,00		
193,88			0,00		
204,08			0,00		
214,29			0,00		
224,49			0,00		
234,69			0,00		
244,90			0,00		
255,10			0,00		
265,31			0,00		
275,51			0,00		
285,71			0,00		
295,92			0,00		
306,12			0,00		
316,33			0,00		
326,53			0,00		
336,73			0,00		
346,94			0,00		
357,14			0,00		
367,35			0,00		

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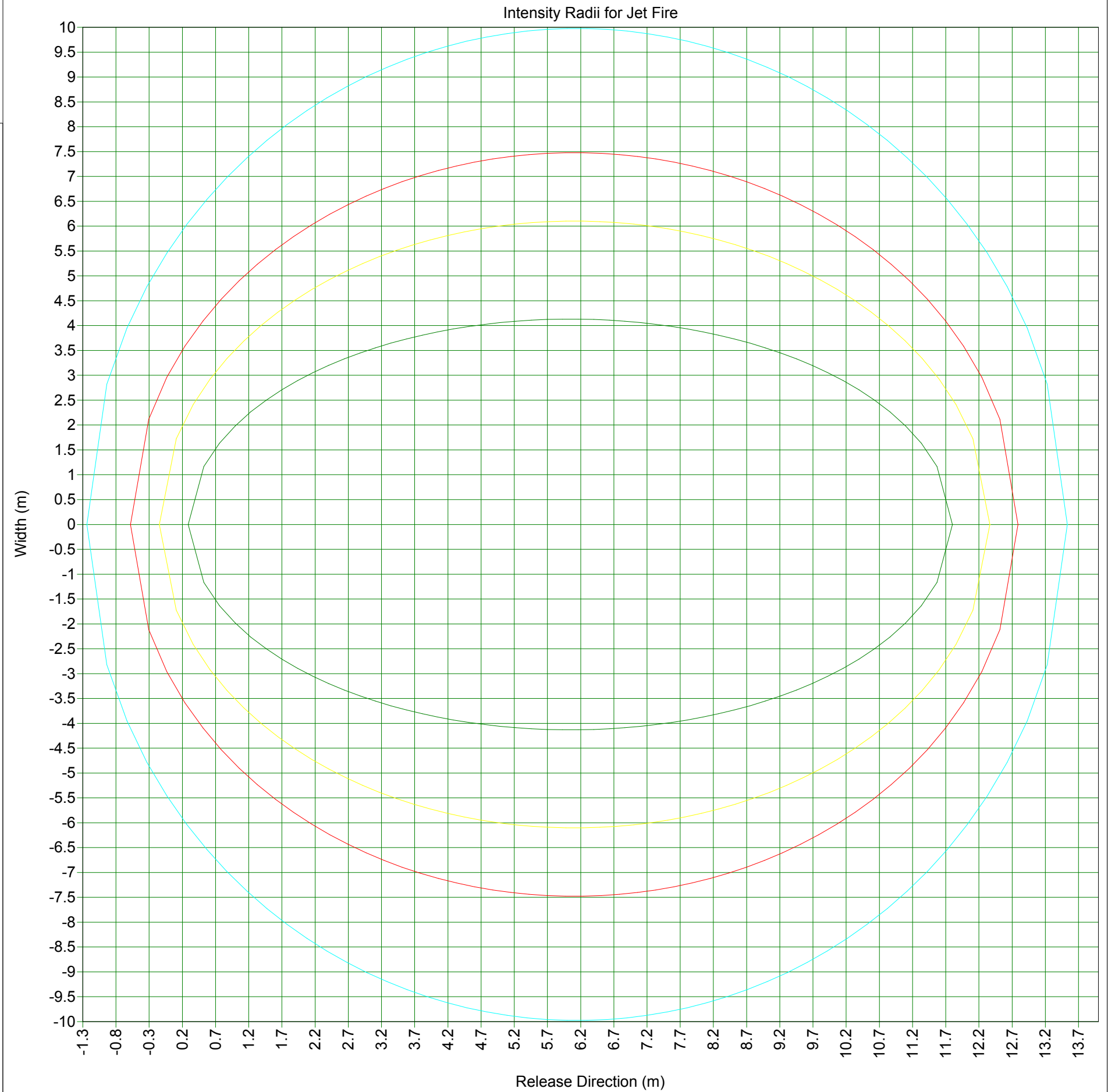
Study Folder: 70977-Fase 2-Ip27

Phast 6.6

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

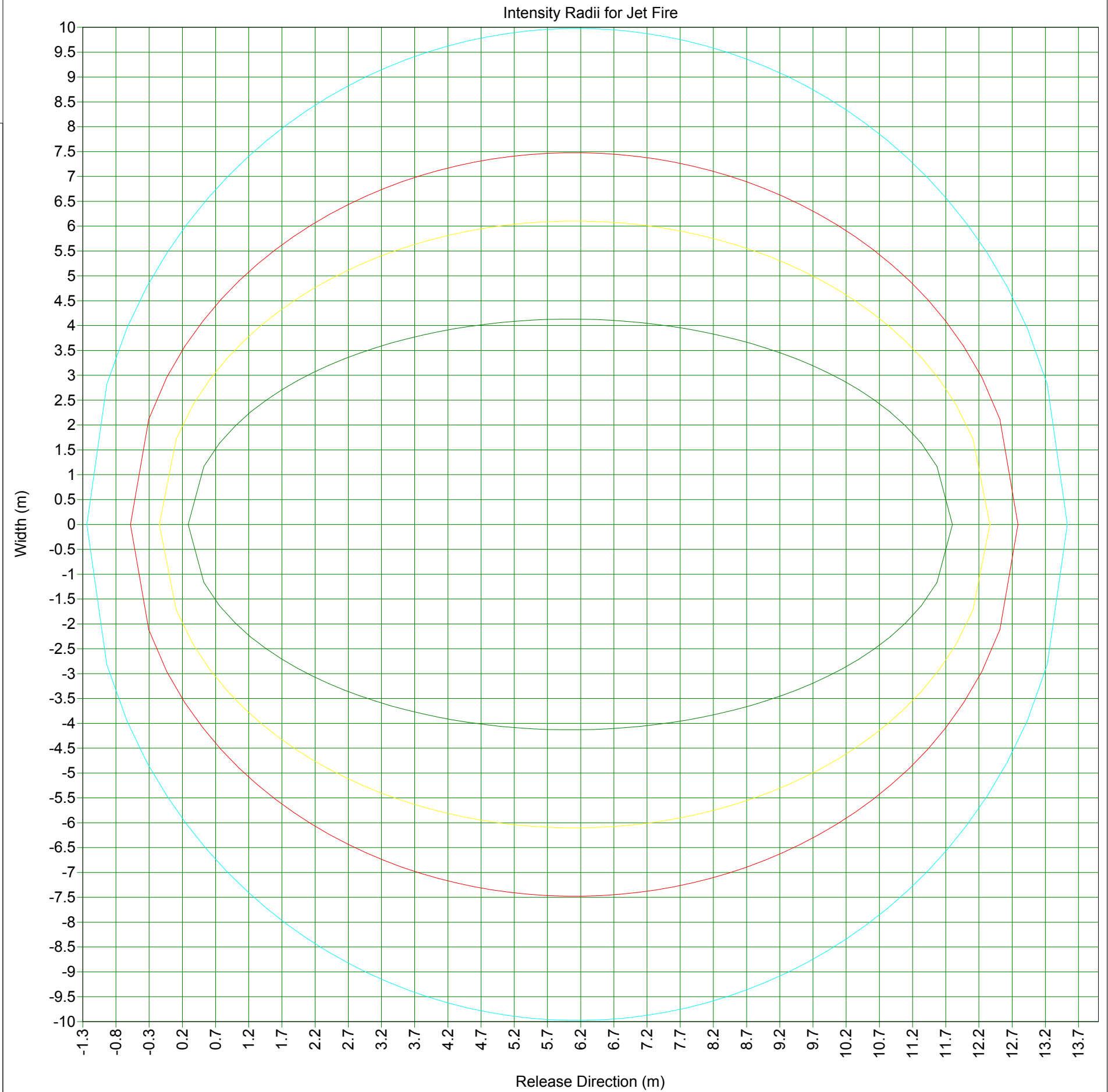
Study Folder: 70977-Fase
2-lp27
Audit No: 65846
Model: 10mm
Weather: Category 5/D
Material: METHANE

- Ellipse @12.5 kW/m2
- Ellipse @7 kW/m2
- Ellipse @5 kW/m2
- Ellipse @3 kW/m2



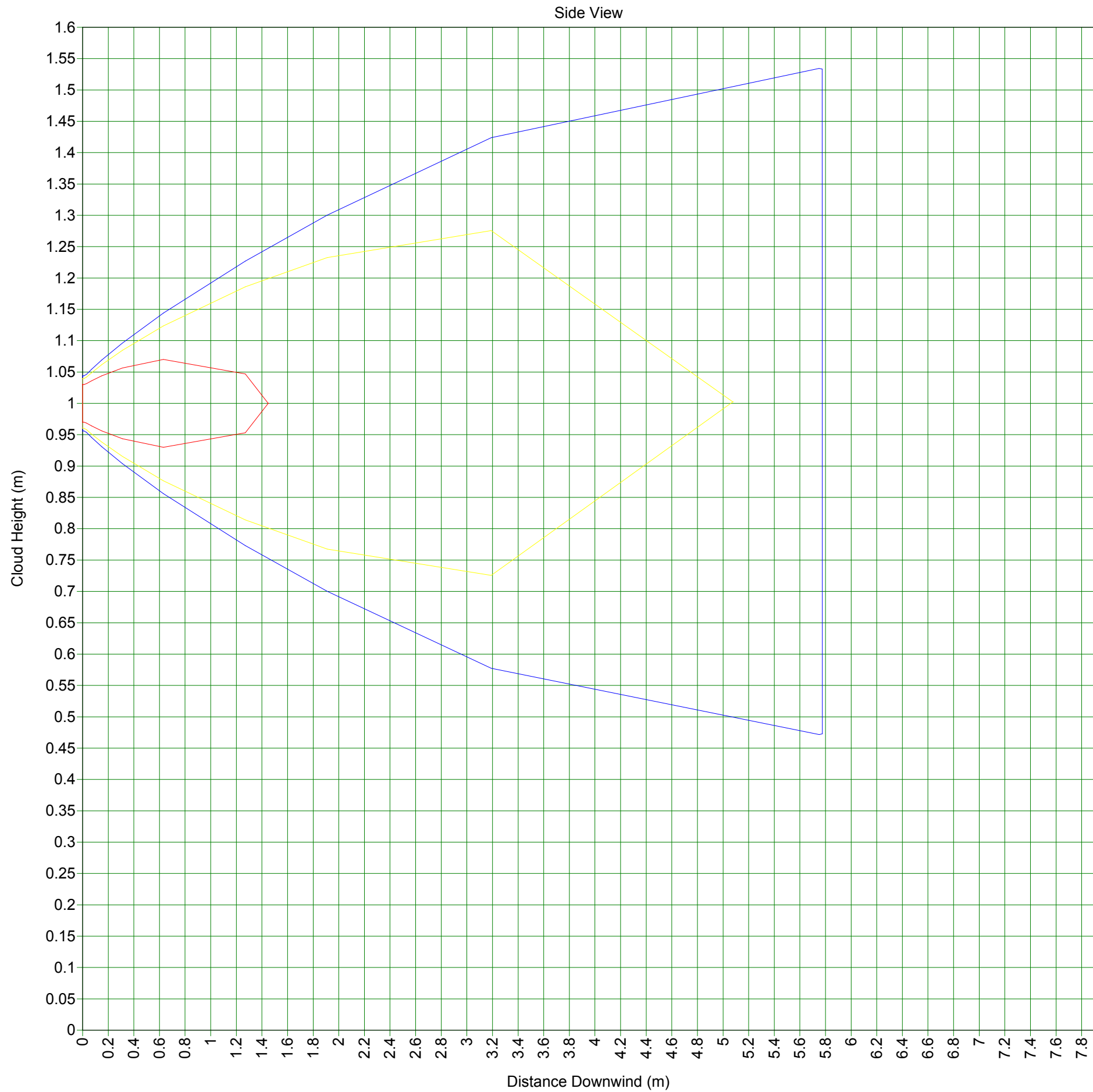
Study Folder: 70977-Fase
2-lp27
Audit No: 65846
Model: 10mm
Weather: Category 2/F
Material: METHANE

- Ellipse @12.5 kW/m2
- Ellipse @7 kW/m2
- Ellipse @5 kW/m2
- Ellipse @3 kW/m2



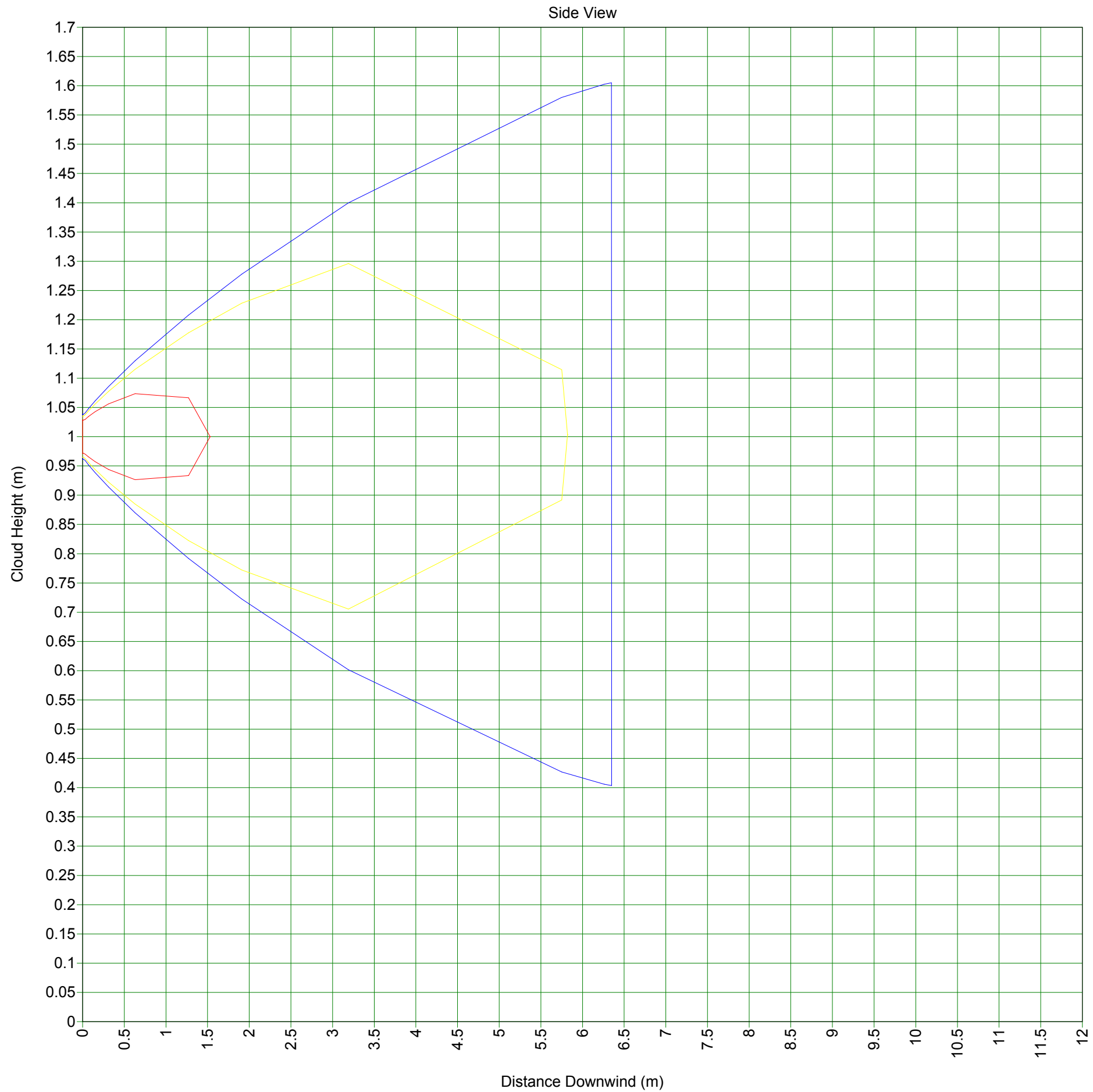
Study Folder: 70977-Fase
2-lp27
Audit No: 65846
Model: 10mm
Weather: Category 5/D
Material: METHANE
Averaging Time:
Flammable(18.75 s)
C/L Offset: 0 m
Concentration
Time: 0.2114 s

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



Study Folder: 70977-Fase
2-lp27
Audit No: 65846
Model: 10mm
Weather: Category 2/F
Material: METHANE
Averaging Time:
Flammable(18.75 s)
C/L Offset: 0 m
Concentration
Time: 0.2492 s

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



SUMMARY REPORT

Unique Audit Number: 65.846



Study Folder: 70977-Fase 2-Ip27

Phast 6.6



70977-Fase 2-Ip27



Preriscaldatore Gas Combustibile

10mm

Base Case

CASE Name: Data

Path: \70977-Fase 2-Ip27\Preriscaldatore Gas Combustibile\10mm

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	45 bar
Temperature	45 degC
Mass Inventory	175 kg

Scenario

Scenario Type	Leak
Phase to be Released	Vapor
Hole Diameter	10 mm
Building Wake Effect	None

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

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
Mass Inventory of material to Disperse	175 kg

SUMMARY REPORT

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Study Folder: 70977-Fase 2-Ip27

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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 2-Ip27\Preriscaldatore Gas Combustibile\10mm

Discharge Data

User-Defined Quantities

Material	METHANE
Temperature	45,00 degC
Pressure	46,01 bar
Inventory	175,00 kg
Scenario	Leak
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
FinalTemperature	-30,70 degC
Final Velocity	500,00 m/s
Droplet Diameter	0,00 um

Continuous Release Data:

Mass Flowrate	5.37416E-001 kg/s
Release Duration	325,63 s
Orifice Velocity	422,10 m/s
Exit Pressure	24,81 bar
Exit Temperature	-0,38 degC
Discharge Coefficient	0,87
Expanded Radius	0,02 m

SUMMARY REPORT

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Phast 6.6

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

Final Temperature -30,70 degC

Final Velocity 500,00 m/s

Droplet Diameter 0,00 um

Continuous Release Data:

Mass Flowrate 5.37416E-001 kg/s

Release Duration 325,63 s

Orifice Velocity 422,10 m/s

Exit Pressure 24,81 bar

Exit Temperature -0,38 degC

Discharge Coefficient 0,87

Expanded Radius 0,02 m

SUMMARY REPORT

Study Folder: 70977-Fase 2-IP27

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Phast 6.6



Consequence Results

Distance to Concentration Results

Path: \70977-Fase 2-IP27\Preriscaldatore Gas Combustibile\10mm

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		No Hazard	No Hazard
UFL (165000)	18.75	s		1.5302	1.44922
LFL (44000)	18.75	s		5.81923	5.07656
LFL Frac (22000)	18.75	s		11.2748	7.86342
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		1.0001	1.00009
LFL (44000)	18.75	s		1.00349	1.00239
LFL Frac (22000)	18.75	s		1.02613	1.00709

SUMMARY REPORT

Study Folder: 70977-Fase 2-IP27

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Phast 6.6



Concentration At Distance Results

Path: \70977-Fase 2-IP27\Preriscaldatore Gas Combustibile\10mm

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	5737.1	4165.36
250	m	653.072	258.725
500	m	281.757	73.8348

Distance		Heights (m) for above concentrations	
		Category 2/F	Category 5/D
50	m	4.19415	1.66188
250	m	17.873	3.88442
500	m	28.2493	4.76205

Distance		Conc.(ppm) at Core Avg. Time of 18.75 s	
		Category 2/F	Category 5/D
50	m	5737.1	4165.36
250	m	653.072	258.725
500	m	281.757	73.8348

Distance		Heights (m) for above concentrations	
		Category 2/F	Category 5/D
50	m	4.19415	1.66188
250	m	17.873	3.88442
500	m	28.2493	4.76205

Jet Fire Hazard

Path: \70977-Fase 2-IP27\Preriscaldatore Gas Combustibile\10mm

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 2-IP27\Preriscaldatore Gas Combustibile\10mm

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	11.8015	11.8015
Radiation Level	7	kW/m2	12.3636	12.3636
Radiation Level	5	kW/m2	12.7887	12.7887
Radiation Level	3	kW/m2	13.5307	13.5307

SUMMARY REPORT

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Phast 6.6



Radiation Effects: Jet Fire Distance

Path: \70977-Fase 2-IP27\Preriscaldatore Gas Combustibile\10mm

			Radiation Level (kW/m2)	
			Category 2/F	Category 5/D
Distance Of Interest 50	m		0.0229566	0.0229566
Distance Of Interest 250	m		0.000555085	0.000555085
Distance Of Interest 500	m		0.000119053	0.000119053

Flash Fire Envelope

Path: \70977-Fase 2-IP27\Preriscaldatore Gas Combustibile\10mm

All flammable results are reported at the cloud centreline height

			Distance (m)	
			Category 2/F	Category 5/D
Furthest Extent	22000	ppm	11.2748	7.86342
Furthest Extent	44000	ppm	5.81923	5.07656
			Heights (m) for above distances	
			Category 2/F	Category 5/D
Furthest Extent	22000	ppm	1.02613	1.00709
Furthest Extent	44000	ppm	1.00349	1.00239

SUMMARY REPORT

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Explosion Effects: Late Ignition

Path: \70977-Fase 2-IP27\Preriscaldatore Gas Combustibile\10mm

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
Overpressure	0.02068	bar	21.6171
Overpressure	0.1379	bar	13.0079
Overpressure	0.2068	bar	12.3275

			Supplementary Data at 0.02068 bar Category 2/F
Supplied Flammable Mass	kg		0.0402307
Used Flammable Mass	kg		0.0402307
Overpressure Radius	m		11.6171
Distance to:			
- Ignition Source	m		10
- Cloud Front/Centre	m		10
- Explosion Centre	m		10

			Supplementary Data at 0.1379 bar Category 2/F
Supplied Flammable Mass	kg		0.0402307
Used Flammable Mass	kg		0.0402307
Overpressure Radius	m		3.00795
Distance to:			
- Ignition Source	m		10
- Cloud Front/Centre	m		10
- Explosion Centre	m		10

			Supplementary Data at 0.2068 bar Category 2/F
Supplied Flammable Mass	kg		0.0402307
Used Flammable Mass	kg		0.0402307
Overpressure Radius	m		2.32748
Distance to:			
- Ignition Source	m		10
- Cloud Front/Centre	m		10
- Explosion Centre	m		10

			Overpressures (bar gauge) at Distances Category 2/F
Distance	50	m	0.00517545
Distance	250	m	0.00125596
Distance	500	m	0.001

			Supplementary Data at 50 m Category 2/F
Supplied Flammable Mass	kg		0.0402307

SUMMARY REPORT

Study Folder: 70977-Fase 2-Ip27

Unique Audit Number: 65.846

Phast 6.6



Used Flammable Mass	kg	0.0402307
Supplementary Data at 250 m Category 2/F		
Supplied Flammable Mass	kg	0.0402307
Used Flammable Mass	kg	0.0402307
Supplementary Data at 500 m Category 2/F		
Supplied Flammable Mass	kg	0.0402307
Used Flammable Mass	kg	0.0402307

Weather Conditions

Path: \70977-Fase 2-Ip27\Preriscaldatore Gas Combustibile\10mm

		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