

ANNESSO TECNICO 6.

**Elaborati di calcolo
Scenari incidentali ragionevolmente credibili**

Ipotesi N. 8

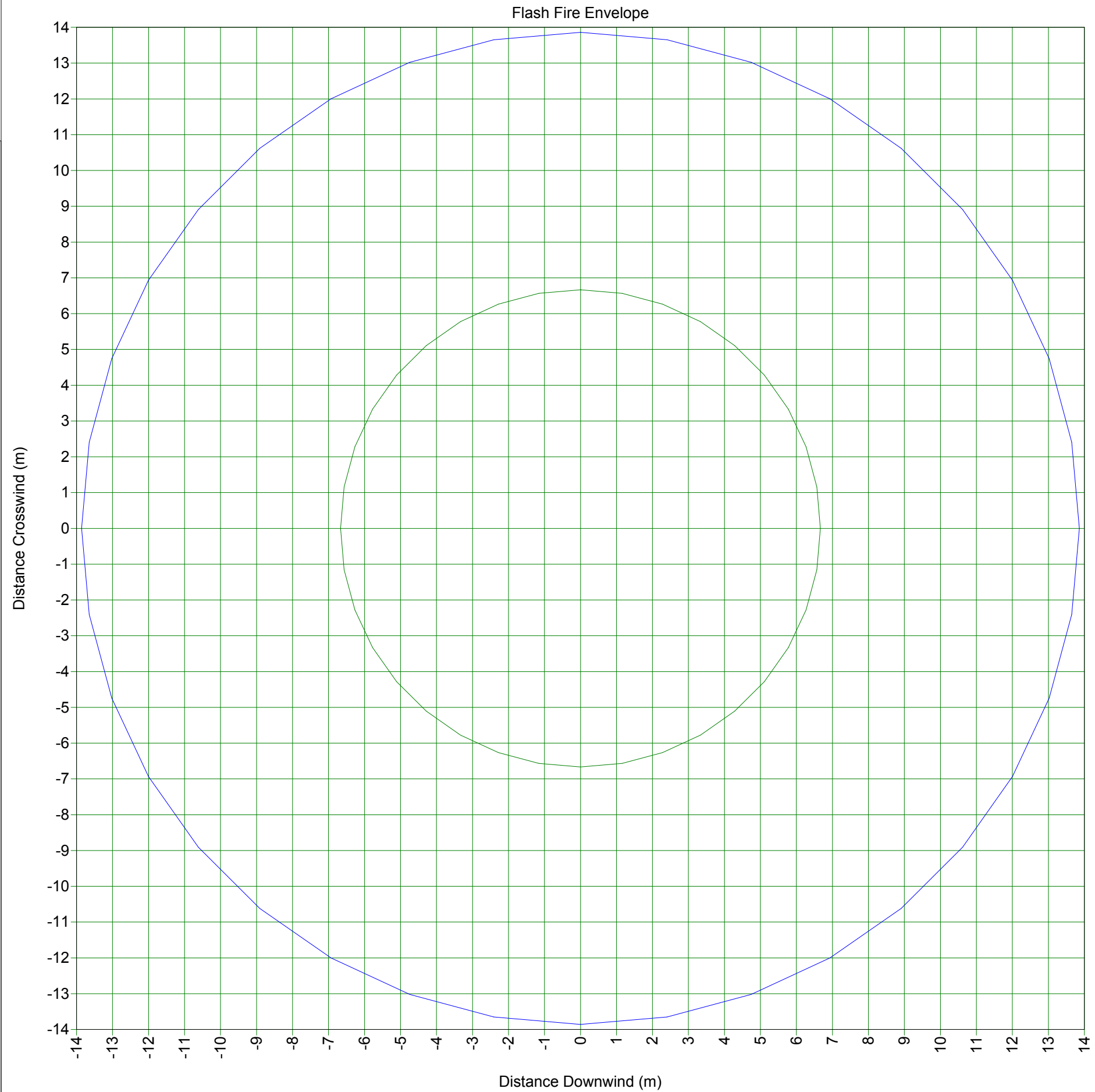
TRR S.r.l.

Il Direttore Generale

Ing. Alfredo Romano

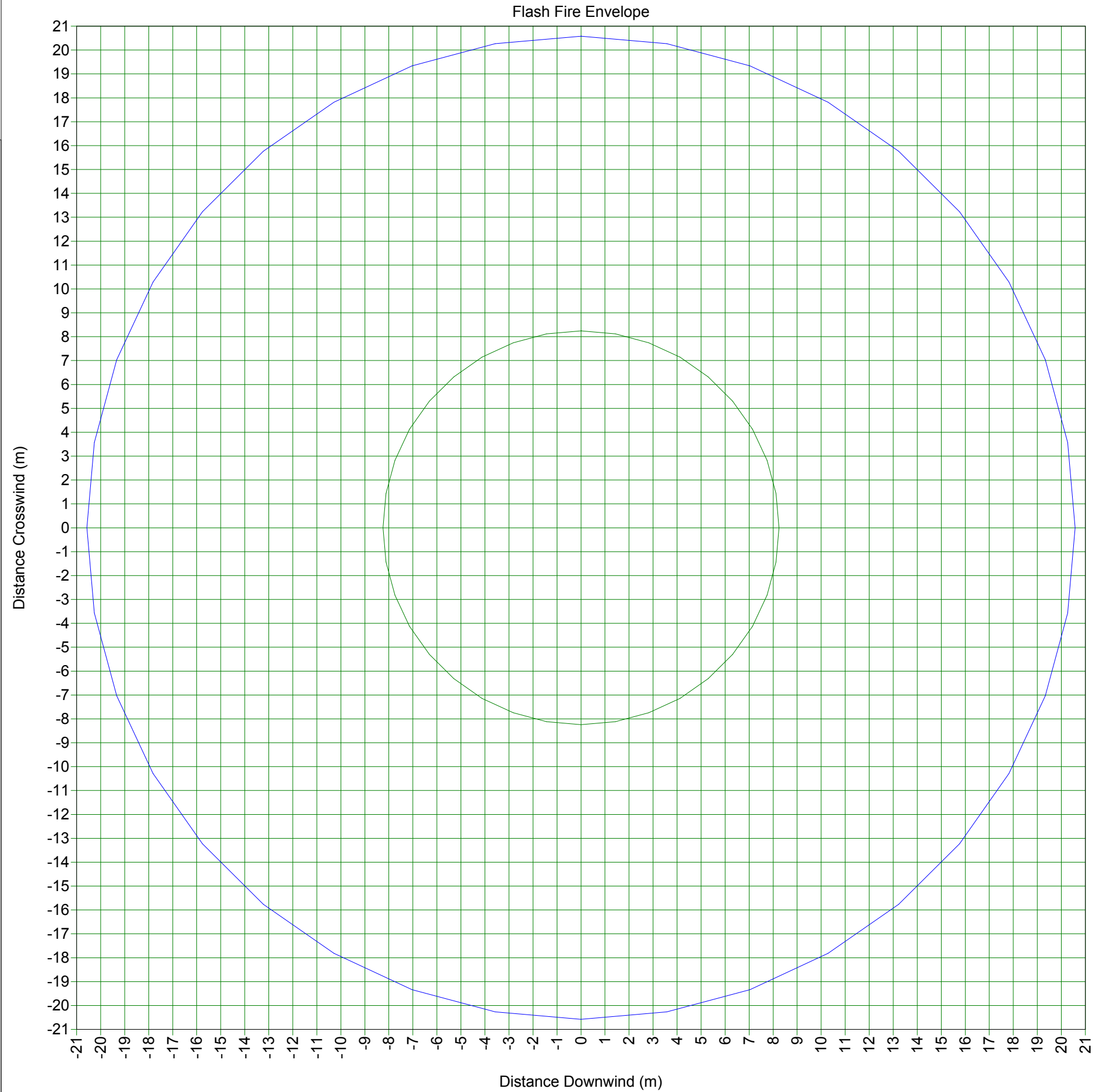

Study Folder: 70977-Fase
2-lp8
Audit No: 54136
Model: 10mm
Weather: Category 5/D
Material: METHANE
Concentration

— 2.2e+004 ppm
— 4.4e+004 ppm



Study Folder: 70977-Fase
2-lp8
Audit No: 54136
Model: 10mm
Weather: Category 2/F
Material: METHANE
Concentration

— 2.2e+004 ppm
— 4.4e+004 ppm



JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip8

Unique Audit Number: 54.136

Phast 6.6



70977-Fase 2-Ip8



Scambiatore Preriscaldo

10mm

Base Case

Data



Weather: Global Weathers\Category 2/F

Speed: 2,00 m/s

Stability: F

\70977-Fase 2-Ip8\Scambiatore Preriscaldo\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	-74,44 degC
Release Rate	1,10 kg/s

Input

Output

Flame Emissive Power	111,40 kW/m2
Fraction of Emissivity	0,15 fraction
Expanded Radius	0,03 m
Jet Velocity	500,00 m/s
Flame Length	16,37 m
Maximum Flame Radius	1,02 m

Flame Co-ordinates

X	Z	R	Phi
m	m	m	deg
0,00	1,00	0,03	90,00
1,82	1,00	0,39	90,00
3,64	1,00	0,65	90,00
5,46	1,00	0,83	90,00
7,28	1,00	0,95	90,00
9,10	1,00	1,01	90,00
10,92	1,00	1,01	90,00
12,73	1,00	0,93	90,00
14,55	1,00	0,72	90,00
16,37	1,00	0,00	90,00

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip8

Unique Audit Number: 54.136

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)	10,17	m
Crosswind semi-axis (B)	14,10	m
Offset Ratio (D)	0,85	
Effect Distance	18,85	m
Area	450,28	m2

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

Downwind semi-axis (A)	9,31	m
Crosswind semi-axis (B)	10,60	m
Offset Ratio (D)	0,92	
Effect Distance	17,86	m
Area	310,12	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)	8,81	m
Crosswind semi-axis (B)	8,68	m
Offset Ratio (D)	0,97	
Effect Distance	17,34	m
Area	240,00	m2

JET FIRE REPORT

Unique Audit Number: 54.136



Study Folder: 70977-Fase 2-Ip8

Phast 6.6

Incident Radiation Level:	12,50	kW/m2
Lethality Level	6,53	%
View Factor	0,11	
Dose Level	5.800.161,90	(W/m2)^Probit N.s
Downwind semi-axis (A)	8,21	m
Crosswind semi-axis (B)	5,92	m
Offset Ratio (D)	1,02	
Effect Distance	16,62	m
Area	152,74	m2

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip8

Unique Audit Number: 54.136

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			9,57		
10,20			111,40		
20,41			1,70		
30,61			0,25		
40,82			0,10		
51,02			0,05		
61,22			0,03		
71,43			0,02		
81,63			0,02		
91,84			0,01		
102,04			0,01		
112,24			0,01		
122,45			0,01		
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: 54.136



Study Folder: 70977-Fase 2-Ip8

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-Ip8\Scambiatore Preriscaldo\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	-74,44	degC
Release Rate	1,10	kg/s

	Input	Output
Flame Emissive Power		111,40 kW/m2
Fraction of Emissivity		0,15 fraction
Expanded Radius		0,03 m
Jet Velocity	500,00	500,00 m/s
Flame Length		16,37 m
Maximum Flame Radius		1,02 m

JET FIRE REPORT

Unique Audit Number: 54.136



Study Folder: 70977-Fase 2-Ip8

Phast 6.6

Flame Co-ordinates

X	Z	R	Phi
m	m	m	deg
0,00	1,00	0,03	90,00
1,82	1,00	0,39	90,00
3,64	1,00	0,65	90,00
5,46	1,00	0,83	90,00
7,28	1,00	0,95	90,00
9,10	1,00	1,01	90,00
10,92	1,00	1,01	90,00
12,73	1,00	0,93	90,00
14,55	1,00	0,72	90,00
16,37	1,00	0,00	90,00

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip8

Unique Audit Number: 54.136



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)	10,17	m
Crosswind semi-axis (B)	14,10	m
Offset Ratio (D)	0,85	
Effect Distance	18,85	m
Area	450,28	m2

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

Downwind semi-axis (A)	9,31	m
Crosswind semi-axis (B)	10,60	m
Offset Ratio (D)	0,92	
Effect Distance	17,86	m
Area	310,12	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)	8,81	m
Crosswind semi-axis (B)	8,68	m
Offset Ratio (D)	0,97	
Effect Distance	17,34	m
Area	240,00	m2

JET FIRE REPORT

Unique Audit Number: 54.136



Study Folder: 70977-Fase 2-Ip8

Phast 6.6

Incident Radiation Level:	12,50	kW/m2
Lethality Level	6,53	%
View Factor	0,11	
Dose Level	5.800.161,90	(W/m2)^Probit N.s
Downwind semi-axis (A)	8,21	m
Crosswind semi-axis (B)	5,92	m
Offset Ratio (D)	1,02	
Effect Distance	16,62	m
Area	152,74	m2

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip8

Unique Audit Number: 54.136

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			9,57		
10,20			111,40		
20,41			1,70		
30,61			0,25		
40,82			0,10		
51,02			0,05		
61,22			0,03		
71,43			0,02		
81,63			0,02		
91,84			0,01		
102,04			0,01		
112,24			0,01		
122,45			0,01		
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: 54.136



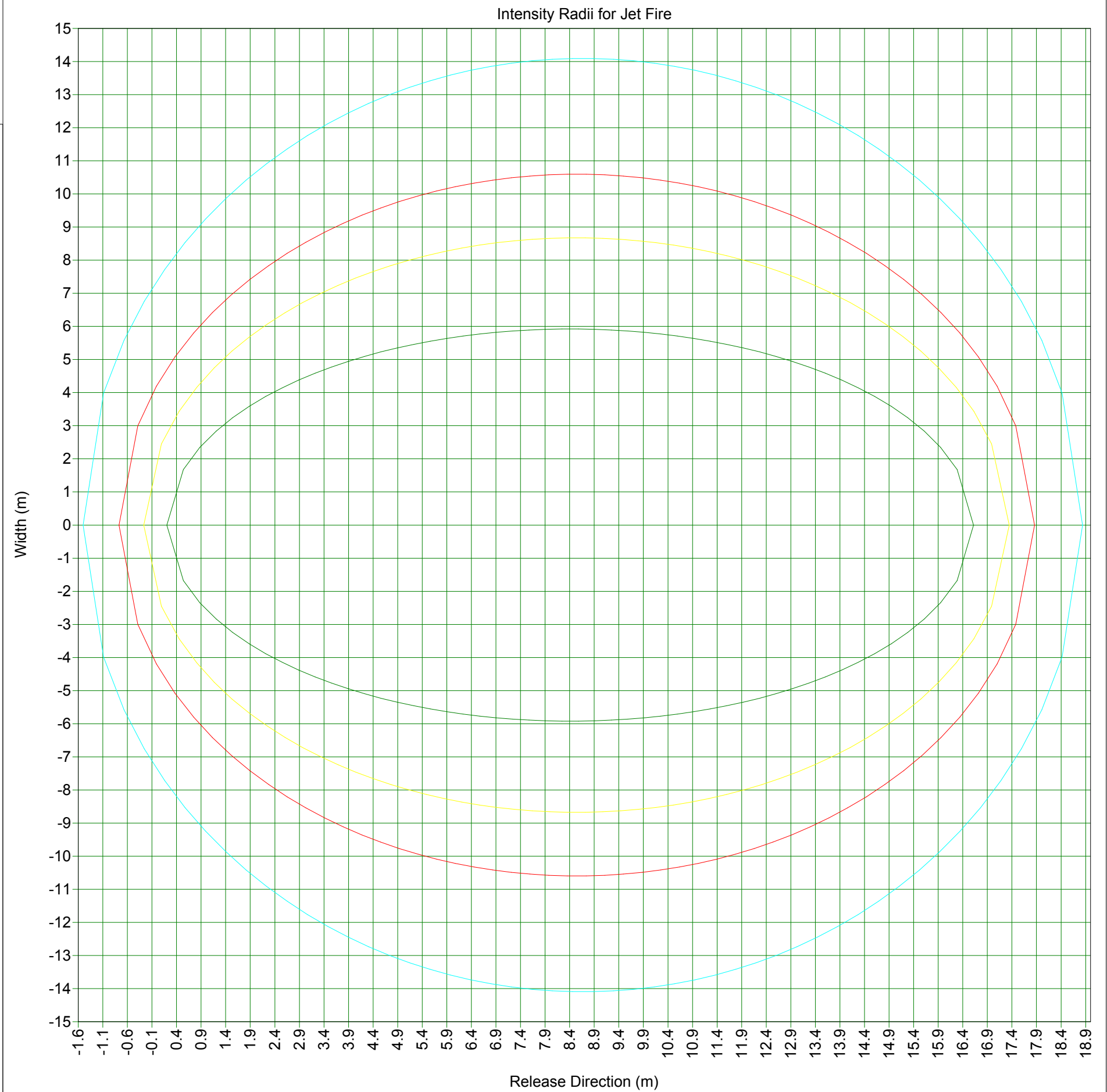
Study Folder: 70977-Fase 2-Ip8

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		

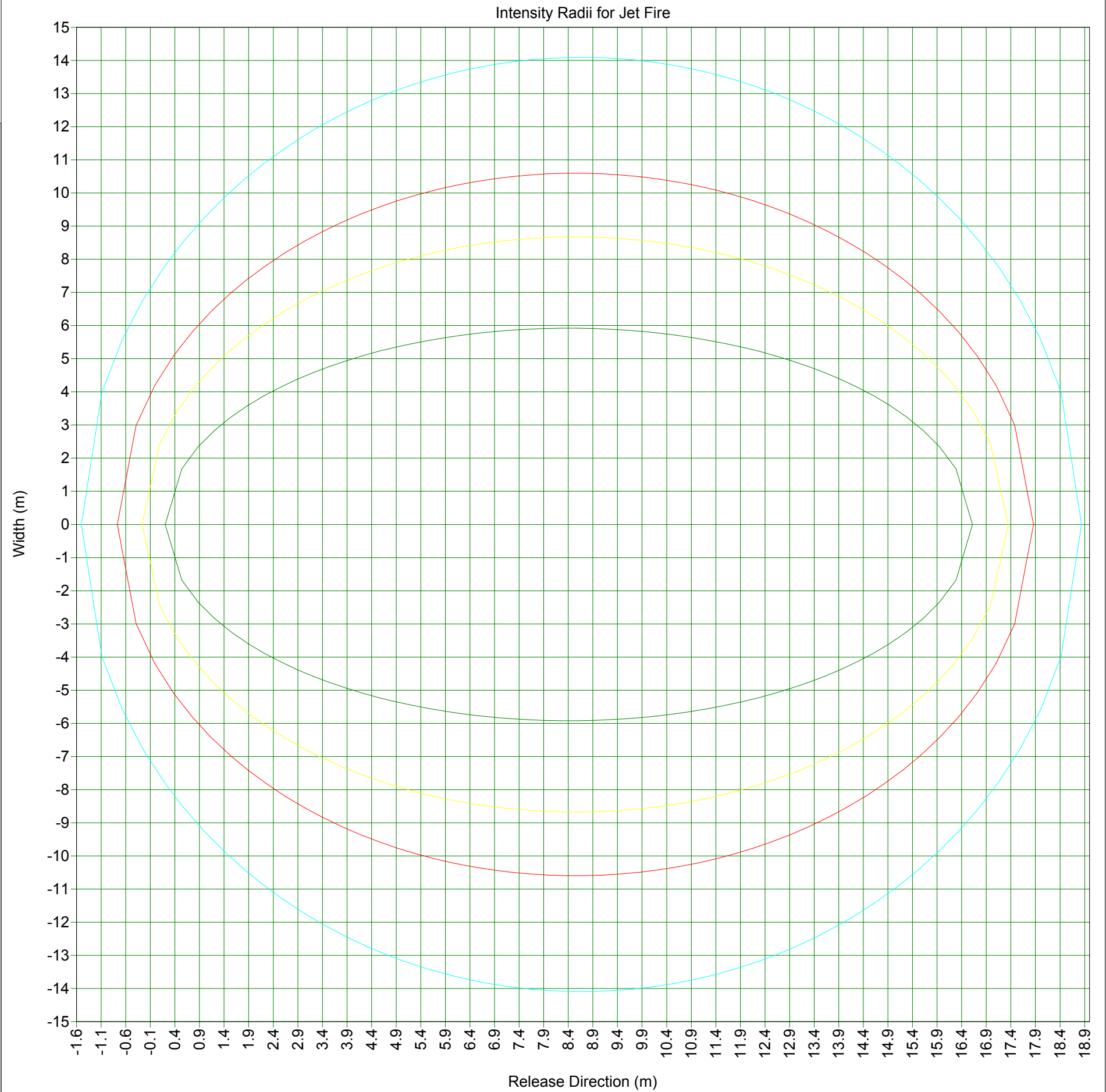
Study Folder: 70977-Fase
2-lp8
Audit No: 54156
Model: 10mm
Weather: Category 5/D
Material: METHANE

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



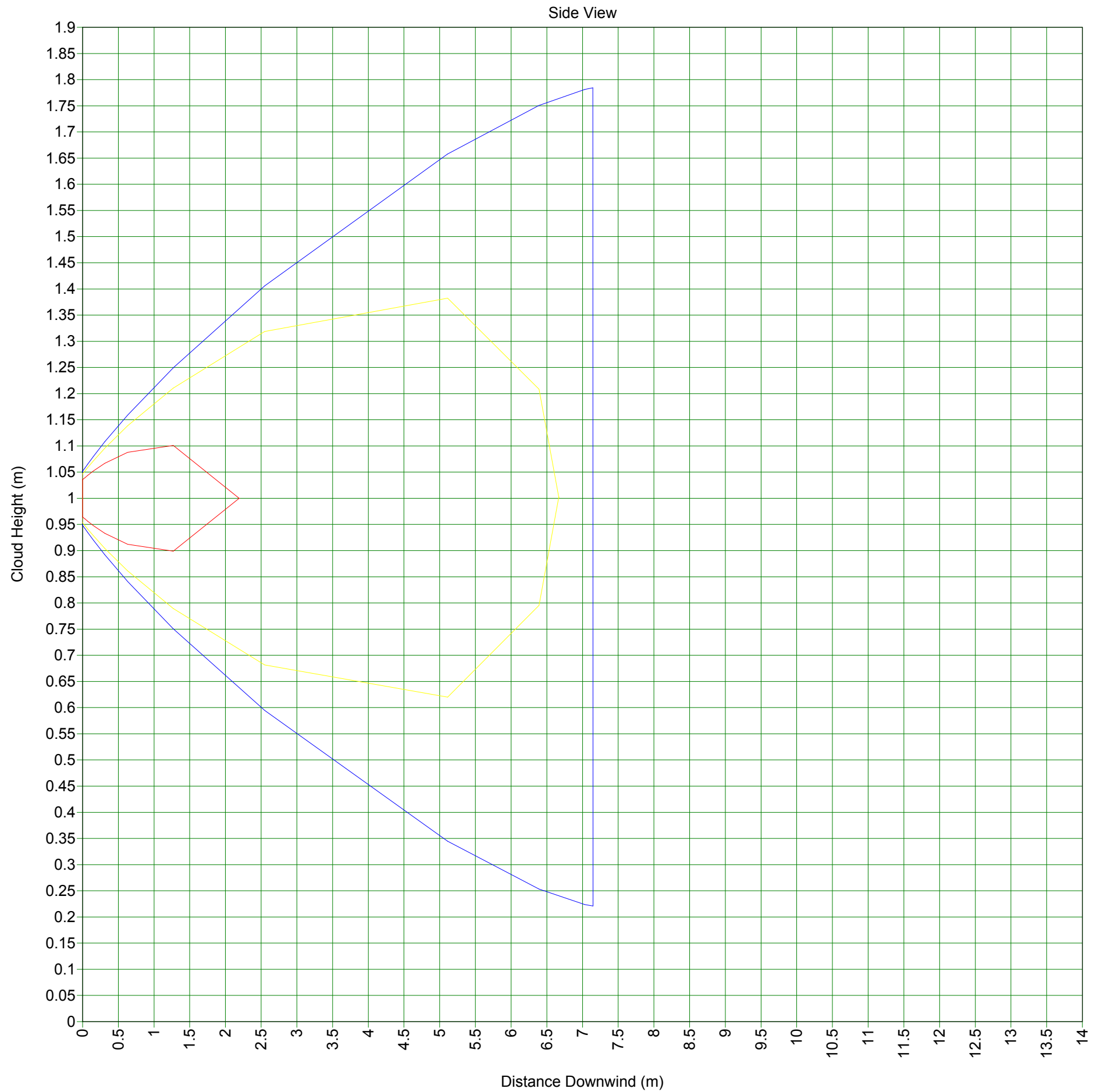
Study Folder: 70977-Fase
2-lp8
Audit No: 54156
Model: 10mm
Weather: Category 2/F
Material: METHANE

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



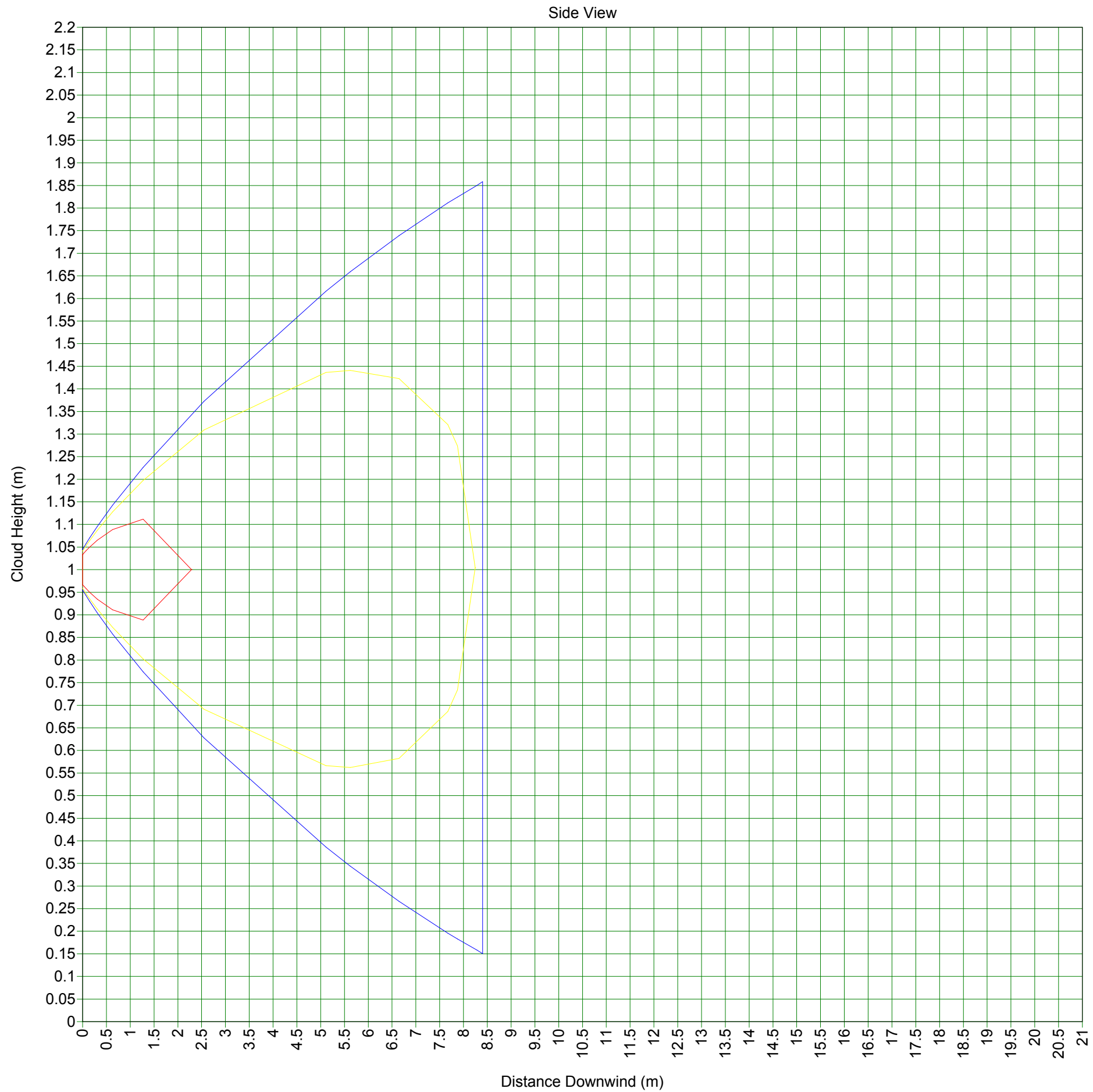
Study Folder: 70977-Fase
2-lp8
Audit No: 54136
Model: 10mm
Weather: Category 5/D
Material: METHANE
Averaging Time:
Flammable(18.75 s)
C/L Offset: 0 m
Concentration
Time: 0.2337 s

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



Study Folder: 70977-Fase
2-lp8
Audit No: 54136
Model: 10mm
Weather: Category 2/F
Material: METHANE
Averaging Time:
Flammable(18.75 s)
C/L Offset: 0 m
Concentration
Time: 0.3116 s

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



SUMMARY REPORT

Unique Audit Number: 54.136



Study Folder: 70977-Fase 2-Ip8

Phast 6.6



70977-Fase 2-Ip8



Scambiatore Preriscaldamento

10mm

Base Case

CASE Name: Data

Path: \70977-Fase 2-Ip8\Scambiatore Preriscaldamento\10mm

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	85 bar
Temperature	25 degC
Mass Inventory	100 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	100 kg

SUMMARY REPORT

Unique Audit Number: 54.136



Study Folder: 70977-Fase 2-Ip8

Phast 6.6

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-Ip8\Scambiatore Preriscaldo\10mm

Discharge Data

User-Defined Quantities

Material	METHANE
Temperature	25,00 degC
Pressure	86,01 bar
Inventory	100,00 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	-74,44 degC
Final Velocity	500,00 m/s
Droplet Diameter	0,00 um
Continuous Release Data:	
Mass Flowrate	1.09634E+000 kg/s
Release Duration	91,21 s
Orifice Velocity	395,56 m/s
Exit Pressure	45,60 bar
Exit Temperature	-20,99 degC
Discharge Coefficient	0,87
Expanded Radius	0,03 m

SUMMARY REPORT

Study Folder: 70977-Fase 2-Ip8

Unique Audit Number: 54.136

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 -74,44 degC

Final Velocity 500,00 m/s

Droplet Diameter 0,00 um

Continuous Release Data:

Mass Flowrate 1.09634E+000 kg/s

Release Duration 91,21 s

Orifice Velocity 395,56 m/s

Exit Pressure 45,60 bar

Exit Temperature -20,99 degC

Discharge Coefficient 0,87

Expanded Radius 0,03 m

SUMMARY REPORT

Study Folder: 70977-Fase 2-IP8

Unique Audit Number: 54.136

Phast 6.6



Consequence Results

Distance to Concentration Results

Path: \70977-Fase 2-IP8\Scambiatore Preriscaldo\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		16.4069	No Hazard
UFL (165000)	18.75	s		2.28551	2.19152
LFL (44000)	18.75	s		8.24446	6.66699
LFL Frac (22000)	18.75	s		20.5755	13.8599
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		1.00016	1.00014
LFL (44000)	18.75	s		1.00417	1.0022
LFL Frac (22000)	18.75	s		1.04947	1.01054

SUMMARY REPORT

Study Folder: 70977-Fase 2-IP8

Unique Audit Number: 54.136

Phast 6.6



Concentration At Distance Results

Path: \70977-Fase 2-IP8\Scambiatore Preriscaldo\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	13114.8	8752.95
250	m	1728.53	599.937
500	m	743.699	169.303

Distance		Heights (m) for above concentrations	
		Category 2/F	Category 5/D
50	m	1.80826	1.20436
250	m	11.8781	2.27982
500	m	19.5888	2.71893

Distance		Conc.(ppm) at Core Avg.Time of 18.75 s	
		Category 2/F	Category 5/D
50	m	13114.8	8752.95
250	m	1728.53	599.937
500	m	743.699	169.303

Distance		Heights (m) for above concentrations	
		Category 2/F	Category 5/D
50	m	1.80826	1.20436
250	m	11.8781	2.27982
500	m	19.5888	2.71893

Jet Fire Hazard

Path: \70977-Fase 2-IP8\Scambiatore Preriscaldo\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-IP8\Scambiatore Preriscaldo\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	16.6202	16.6202
Radiation Level	7	kW/m2	17.3442	17.3442
Radiation Level	5	kW/m2	17.8587	17.8587
Radiation Level	3	kW/m2	18.8509	18.8509

SUMMARY REPORT

Study Folder: 70977-Fase 2-Ip8

Unique Audit Number: 54.136

Phast 6.6



Radiation Effects: Jet Fire Distance

Path: \70977-Fase 2-Ip8\Scambiatore Preriscaldo\10mm

			Radiation Level (kW/m2)	
			Category 2/F	Category 5/D
Distance Of Interest 50	m		0.0552229	0.0552229
Distance Of Interest 250	m		0.00116392	0.00116392
Distance Of Interest 500	m		0.000246168	0.000246168

Flash Fire Envelope

Path: \70977-Fase 2-Ip8\Scambiatore Preriscaldo\10mm

All flammable results are reported at the cloud centreline height

			Distance (m)	
			Category 2/F	Category 5/D
Furthest Extent	22000	ppm	20.5755	13.8599
Furthest Extent	44000	ppm	8.24446	6.66699

			Heights (m) for above distances	
			Category 2/F	Category 5/D
Furthest Extent	22000	ppm	1.04947	1.01054
Furthest Extent	44000	ppm	1.00417	1.0022

SUMMARY REPORT

Study Folder: 70977-Fase 2-Ip8

Unique Audit Number: 54.136

Phast 6.6



Explosion Effects: Late Ignition

Path: \70977-Fase 2-Ip8\Scambiatore Preriscaldo\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	Category 5/D
Overpressure	0.02068	bar	36.4749	24.3352
Overpressure	0.1379	bar	24.2658	13.7117
Overpressure	0.2068	bar	23.3007	12.8721

			Supplementary Data at 0.02068 bar	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		0.114745	0.0755927
Used Flammable Mass	kg		0.114745	0.0755927
Overpressure Radius	m		16.4749	14.3352
Distance to:				
- Ignition Source	m		20	10
- Cloud Front/Centre	m		20	10
- Explosion Centre	m		20	10

			Supplementary Data at 0.1379 bar	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		0.114745	0.0755927
Used Flammable Mass	kg		0.114745	0.0755927
Overpressure Radius	m		4.26575	3.71174
Distance to:				
- Ignition Source	m		20	10
- Cloud Front/Centre	m		20	10
- Explosion Centre	m		20	10

			Supplementary Data at 0.2068 bar	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		0.114745	0.0755927
Used Flammable Mass	kg		0.114745	0.0755927
Overpressure Radius	m		3.30074	2.87206
Distance to:				
- Ignition Source	m		20	10
- Cloud Front/Centre	m		20	10
- Explosion Centre	m		20	10

			Overpressures (bar gauge) at Distances	
			Category 2/F	Category 5/D
Distance	50	m	0.010137	0.00639741
Distance	250	m	0.00161188	0.00142983
Distance	500	m	0.00103698	0.001

			Supplementary Data at 50 m	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		0.114745	0.0755927

SUMMARY REPORT

Study Folder: 70977-Fase 2-Ip8

Unique Audit Number: 54.136

Phast 6.6



Used Flammable Mass	kg	0.114745	0.0755927
Supplementary Data at 250 m			
		Category 2/F	Category 5/D
Supplied Flammable Mass	kg	0.114745	0.0755927
Used Flammable Mass	kg	0.114745	0.0755927
Supplementary Data at 500 m			
		Category 2/F	Category 5/D
Supplied Flammable Mass	kg	0.114745	0.0755927
Used Flammable Mass	kg	0.114745	0.0755927

Weather Conditions

Path: \70977-Fase 2-Ip8\Scambiatore Preriscaldo\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