

ANNESSO TECNICO 6.

**Elaborati di calcolo
Scenari incidentali ragionevolmente credibili**

Ipotesi N. 13

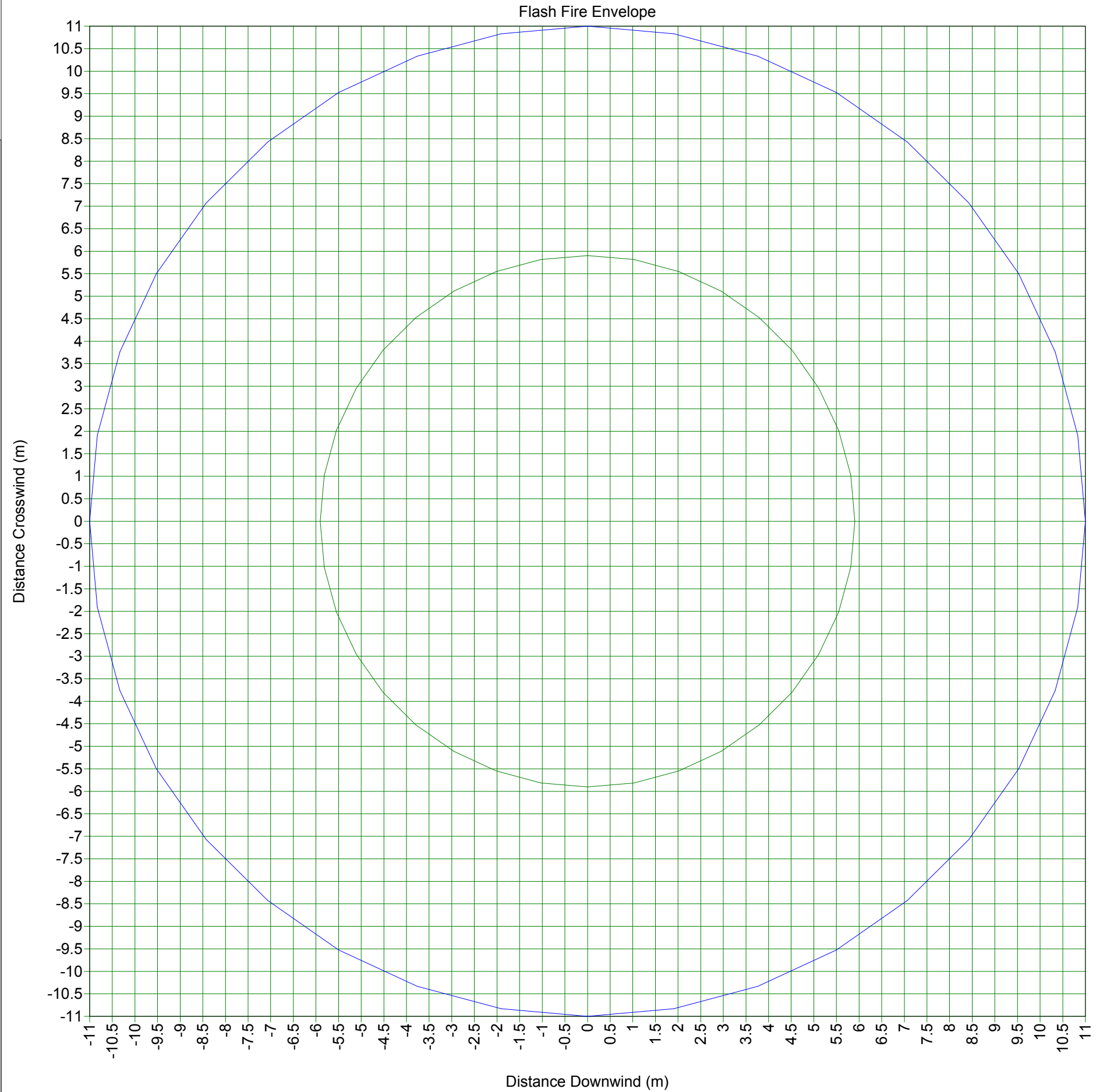
TRR S.r.l.

Il Direttore Generale

Ing. Alfredo Romano

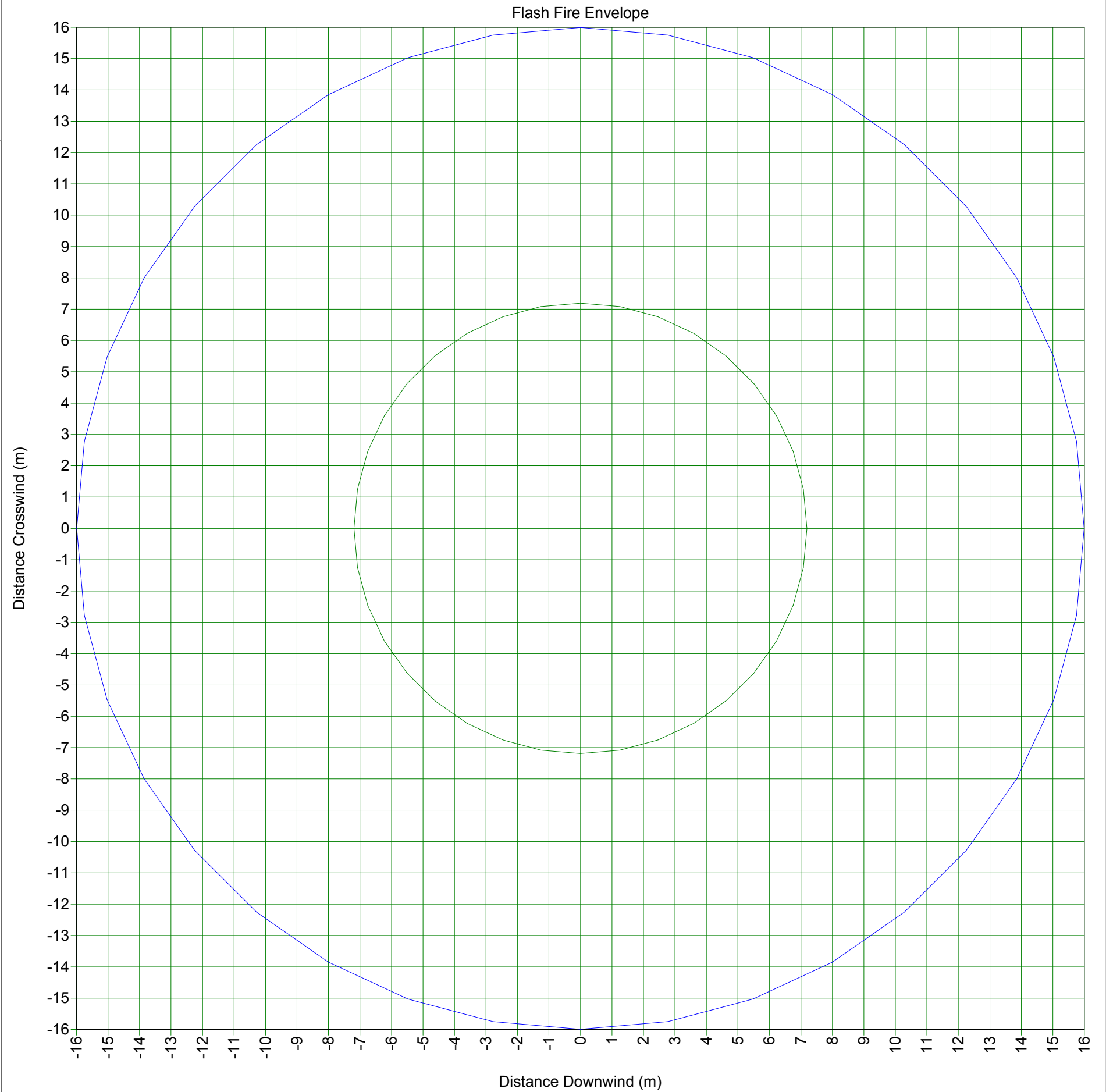

Study Folder: 70977-Fase
2-lp13
Audit No: 54096
Model: 10mm
Weather: Category 5/D
Material: METHANE
Concentration

— 2.2e+004 ppm
— 4.4e+004 ppm



Study Folder: 70977-Fase
2-lp13
Audit No: 54096
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-Ip13

Unique Audit Number: 54.096



Phast 6.6



70977-Fase 2-Ip13



Scambiatore TEG/GAS

10mm

Base Case

Data



Weather: Global Weathers\Category 2/F

Speed: 2,00 m/s

Stability: F

\70977-Fase 2-Ip13\Scambiatore TEG/GAS\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	-34,87 degC
Release Rate	0,84 kg/s

Input

Output

Flame Emissive Power	110,06 kW/m2
Fraction of Emissivity	0,15 fraction
Expanded Radius	0,03 m
Jet Velocity	500,00 m/s
Flame Length	14,39 m
Maximum Flame Radius	0,90 m

Flame Co-ordinates

X	Z	R	Phi
m	m	m	deg
0,00	1,00	0,03	90,00
1,60	1,00	0,34	90,00
3,20	1,00	0,57	90,00
4,80	1,00	0,73	90,00
6,40	1,00	0,84	90,00
8,00	1,00	0,89	90,00
9,59	1,00	0,89	90,00
11,19	1,00	0,81	90,00
12,79	1,00	0,64	90,00
14,39	1,00	0,00	90,00

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip13

Unique Audit Number: 54.096



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)	9,00	m
Crosswind semi-axis (B)	12,37	m
Offset Ratio (D)	0,84	
Effect Distance	16,61	m
Area	349,94	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)	8,22	m
Crosswind semi-axis (B)	9,29	m
Offset Ratio (D)	0,91	
Effect Distance	15,74	m
Area	239,94	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)	7,73	m
Crosswind semi-axis (B)	7,60	m
Offset Ratio (D)	0,97	
Effect Distance	15,26	m
Area	184,47	m2

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Unique Audit Number: 54.096



Study Folder: 70977-Fase 2-Ip13

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)	7,19	m
Crosswind semi-axis (B)	5,17	m
Offset Ratio (D)	1,03	
Effect Distance	14,61	m
Area	116,84	m2

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip13

Unique Audit Number: 54.096

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			9,23		
10,20			92,98		
20,41			0,83		
30,61			0,16		
40,82			0,07		
51,02			0,04		
61,22			0,02		
71,43			0,02		
81,63			0,01		
91,84			0,01		
102,04			0,01		
112,24			0,01		
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: 54.096



Study Folder: 70977-Fase 2-Ip13

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-Ip13\Scambiatore TEG/GAS\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	-34,87	degC
Release Rate	0,84	kg/s

	Input	Output
Flame Emissive Power		110,06 kW/m2
Fraction of Emissivity		0,15 fraction
Expanded Radius		0,03 m
Jet Velocity	500,00	500,00 m/s
Flame Length		14,39 m
Maximum Flame Radius		0,90 m

JET FIRE REPORT

Unique Audit Number: 54.096



Study Folder: 70977-Fase 2-Ip13

Phast 6.6

Flame Co-ordinates

X	Z	R	Phi
m	m	m	deg
0,00	1,00	0,03	90,00
1,60	1,00	0,34	90,00
3,20	1,00	0,57	90,00
4,80	1,00	0,73	90,00
6,40	1,00	0,84	90,00
8,00	1,00	0,89	90,00
9,59	1,00	0,89	90,00
11,19	1,00	0,81	90,00
12,79	1,00	0,64	90,00
14,39	1,00	0,00	90,00

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip13

Unique Audit Number: 54.096



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)	9,00	m
Crosswind semi-axis (B)	12,37	m
Offset Ratio (D)	0,84	
Effect Distance	16,61	m
Area	349,94	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)	8,22	m
Crosswind semi-axis (B)	9,29	m
Offset Ratio (D)	0,91	
Effect Distance	15,74	m
Area	239,94	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)	7,73	m
Crosswind semi-axis (B)	7,60	m
Offset Ratio (D)	0,97	
Effect Distance	15,26	m
Area	184,47	m2

JET FIRE REPORT

Unique Audit Number: 54.096



Study Folder: 70977-Fase 2-Ip13

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)	7,19	m
Crosswind semi-axis (B)	5,17	m
Offset Ratio (D)	1,03	
Effect Distance	14,61	m
Area	116,84	m2

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip13

Unique Audit Number: 54.096

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			9,23		
10,20			92,98		
20,41			0,83		
30,61			0,16		
40,82			0,07		
51,02			0,04		
61,22			0,02		
71,43			0,02		
81,63			0,01		
91,84			0,01		
102,04			0,01		
112,24			0,01		
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

Study Folder: 70977-Fase 2-Ip13

Unique Audit Number: 54.096

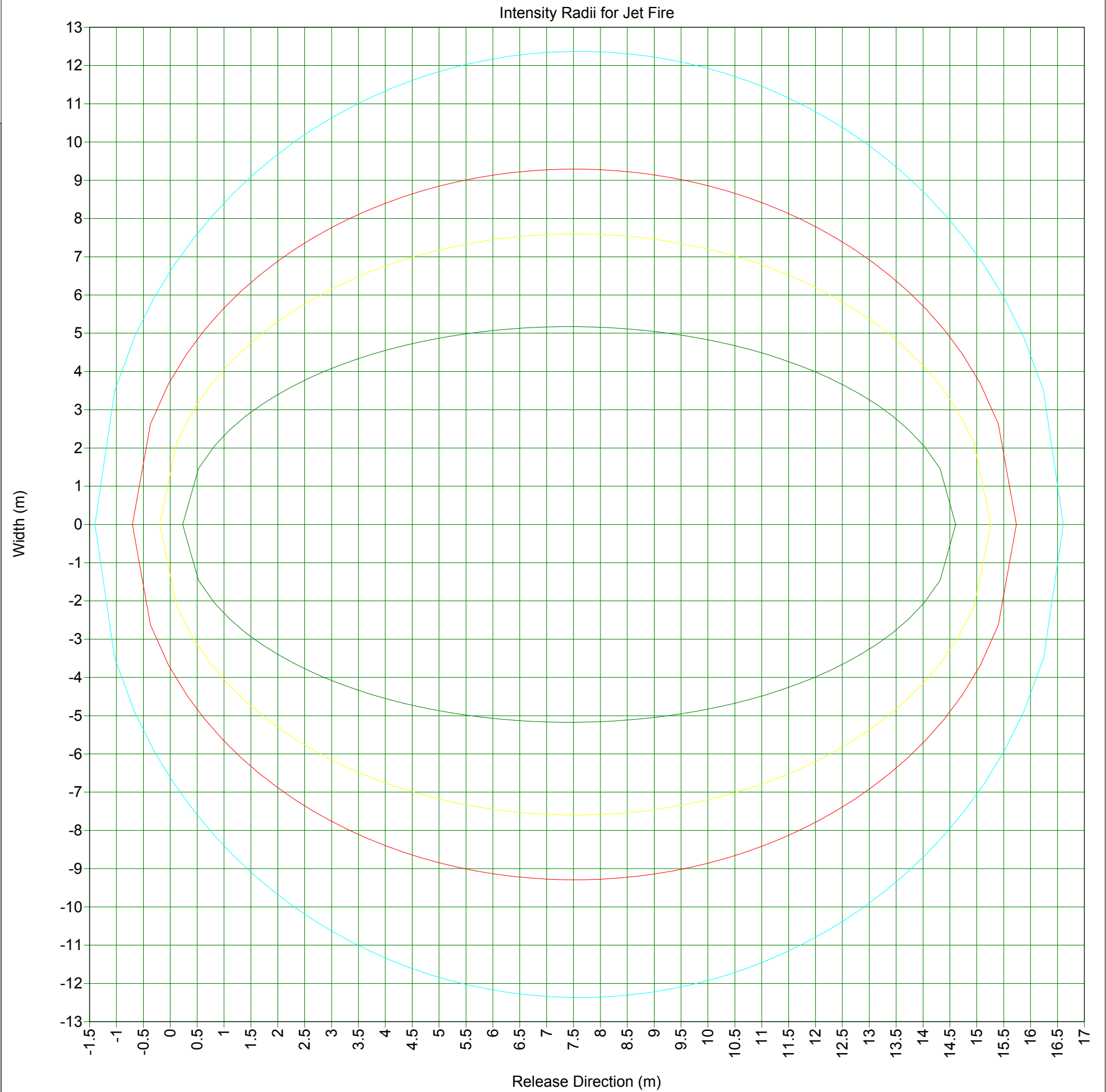
Phast 6.6



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		

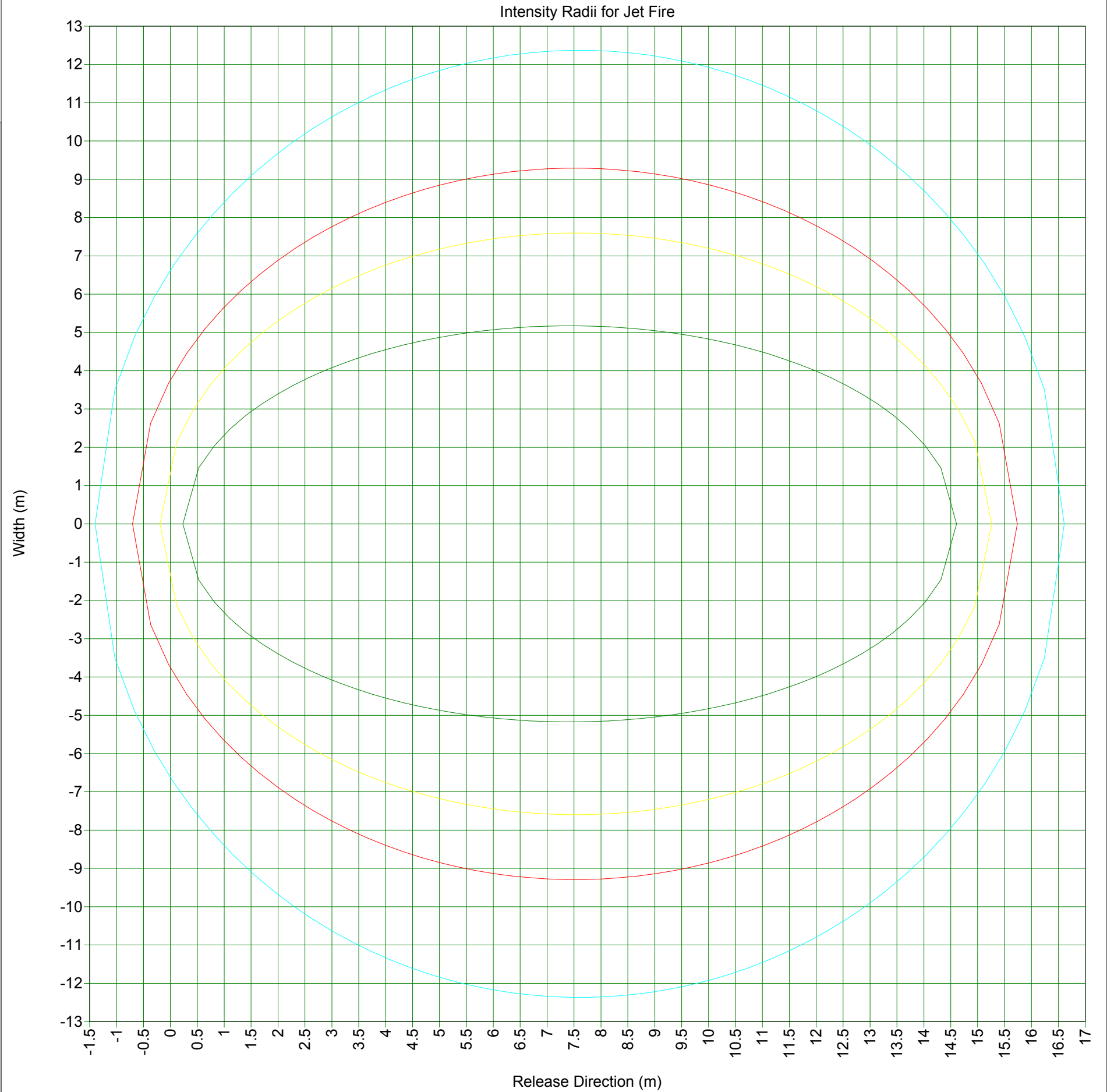
Study Folder: 70977-Fase
2-lp13
Audit No: 54116
Model: 10mm
Weather: Category 5/D
Material: METHANE

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



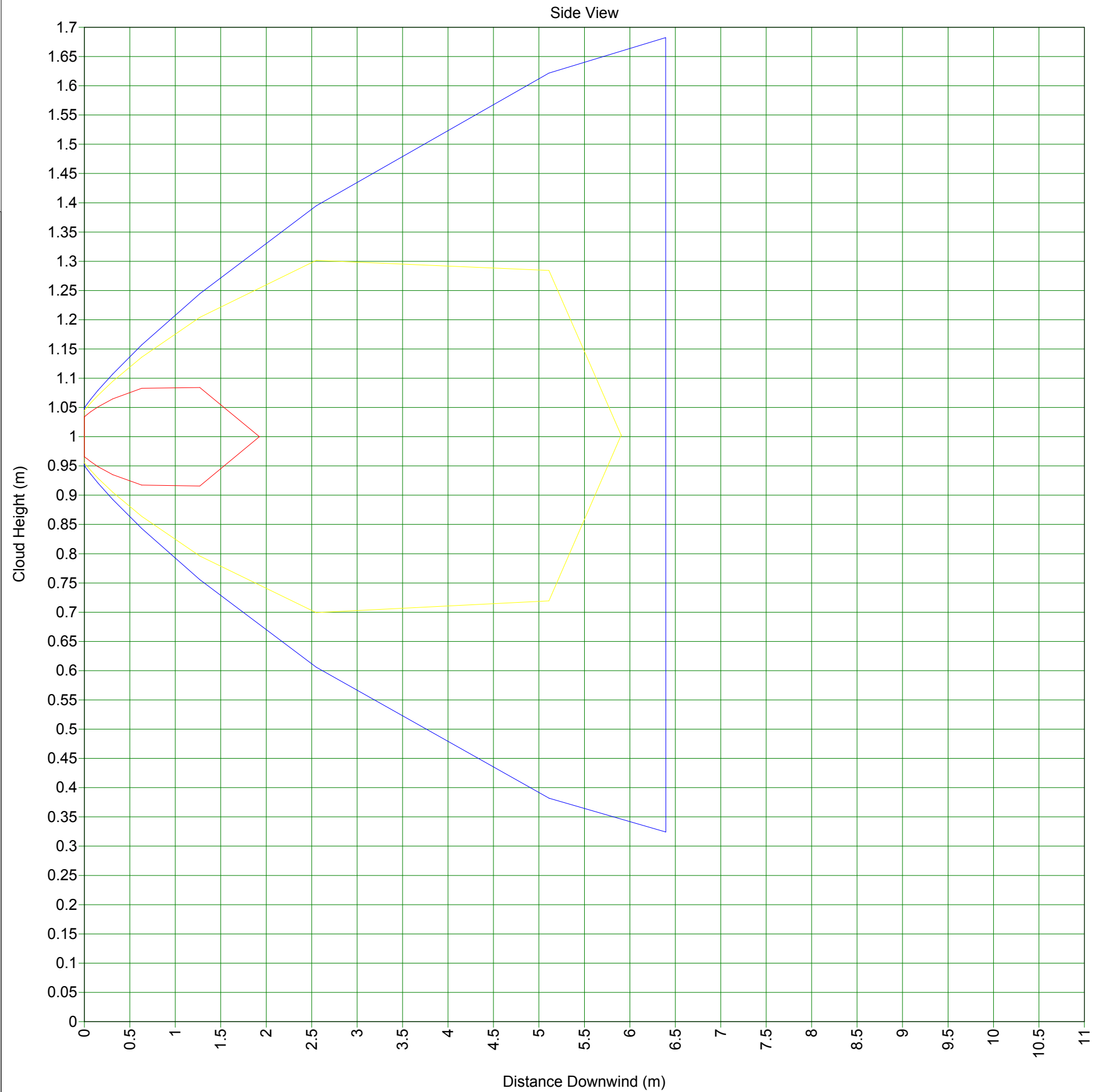
Study Folder: 70977-Fase
2-lp13
Audit No: 54116
Model: 10mm
Weather: Category 2/F
Material: METHANE

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



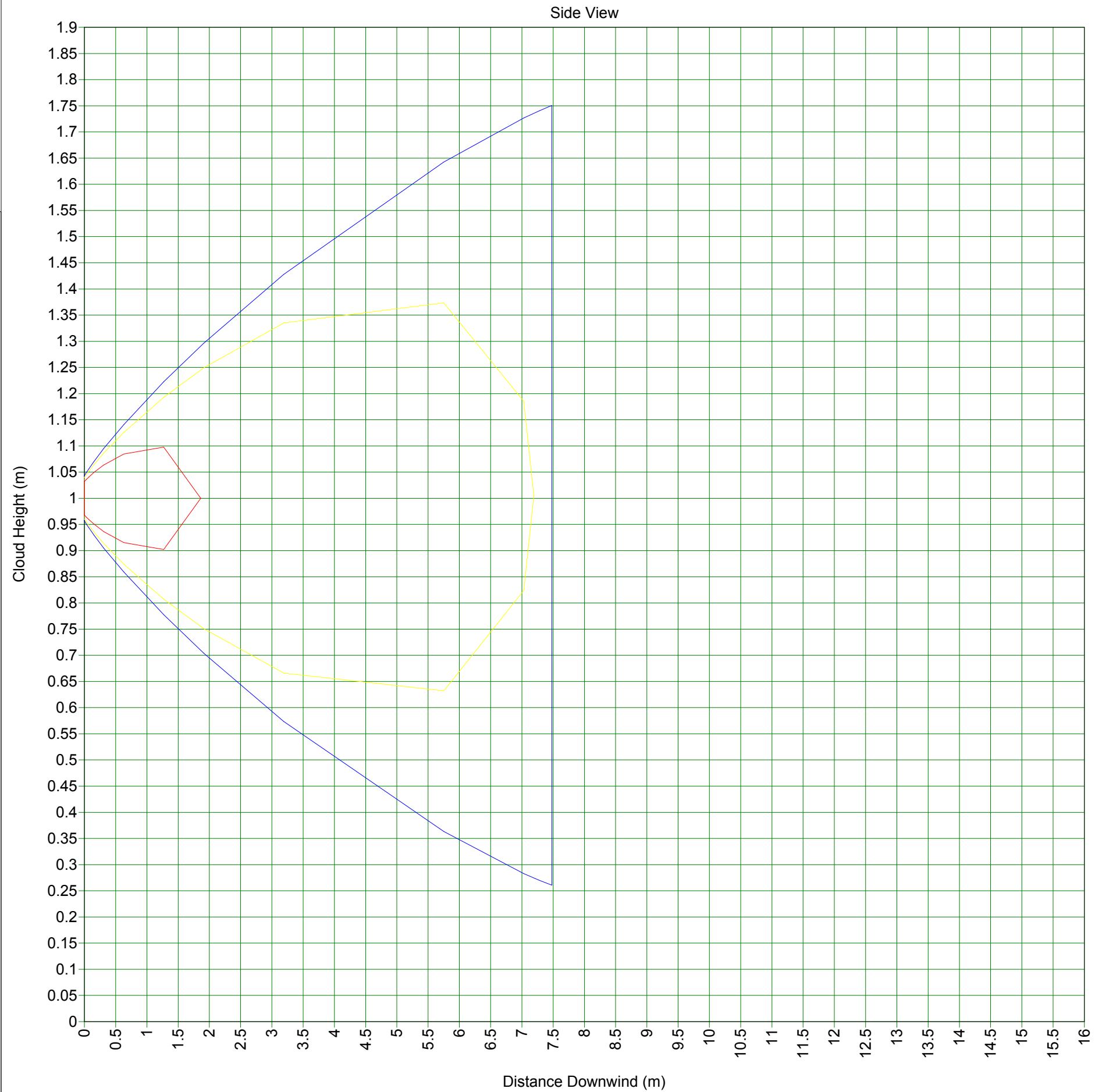
Study Folder: 70977-Fase
2-lp13
Audit No: 54096
Model: 10mm
Weather: Category 5/D
Material: METHANE
Averaging Time:
Flammable(18.75 s)
C/L Offset: 0 m
Concentration
Time: 0.2113 s

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



Study Folder: 70977-Fase
2-lp13
Audit No: 54096
Model: 10mm
Weather: Category 2/F
Material: METHANE
Averaging Time:
Flammable(18.75 s)
C/L Offset: 0 m
Concentration
Time: 0.2827 s

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



SUMMARY REPORT

Unique Audit Number: 54.096



Study Folder: 70977-Fase 2-Ip13

Phast 6.6



70977-Fase 2-Ip13



Scambiatore TEG/GAS

10mm

Base Case

CASE Name: Data

Path: \70977-Fase 2-Ip13\Scambiatore TEG/GAS\10mm

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	70 bar
Temperature	50 degC
Mass Inventory	170 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	170 kg

SUMMARY REPORT

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Study Folder: 70977-Fase 2-Ip13

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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-Ip13\Scambiatore TEG/GAS\10mm

Discharge Data

User-Defined Quantities

Material	METHANE
Temperature	50,00 degC
Pressure	71,01 bar
Inventory	170,00 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
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Average Values for Segment Number 1

Liquid Fraction	0,00 fraction
FinalTemperature	-34,87 degC
Final Velocity	500,00 m/s
Droplet Diameter	0,00 um
Continuous Release Data:	
Mass Flowrate	8.36968E-001 kg/s
Release Duration	203,11 s
Orifice Velocity	422,24 m/s
Exit Pressure	38,03 bar
Exit Temperature	2,81 degC
Discharge Coefficient	0,87
Expanded Radius	0,03 m

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Study Folder: 70977-Fase 2-Ip13

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

FinalTemperature -34,87 degC

Final Velocity 500,00 m/s

Droplet Diameter 0,00 um

Continuous Release Data:

Mass Flowrate 8.36968E-001 kg/s

Release Duration 203,11 s

Orifice Velocity 422,24 m/s

Exit Pressure 38,03 bar

Exit Temperature 2,81 degC

Discharge Coefficient 0,87

Expanded Radius 0,03 m

SUMMARY REPORT

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Study Folder: 70977-Fase 2-IP13

Phast 6.6

Consequence Results

Distance to Concentration Results

Path: \70977-Fase 2-IP13\Scambiatore TEG/GAS\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		1.86295	1.92516
LFL (44000)	18.75	s		7.19051	5.90471
LFL Frac (22000)	18.75	s		15.9948	10.9981
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		1.00013	1.00017
LFL (44000)	18.75	s		1.00505	1.00275
LFL Frac (22000)	18.75	s		1.06888	1.01507

SUMMARY REPORT

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Study Folder: 70977-Fase 2-IP13

Phast 6.6

Concentration At Distance Results

Path: \70977-Fase 2-IP13\Scambiatore TEG/GAS\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	8379.74	6107.07
250	m	942.217	389.688
500	m	406.733	111.025

Distance		Heights (m) for above concentrations	
		Category 2/F	Category 5/D
50	m	3.90024	1.69814
250	m	19.7772	4.55066
500	m	31.974	5.73577

Distance		Conc.(ppm) at Core Avg. Time of 18.75 s	
		Category 2/F	Category 5/D
50	m	8379.74	6107.07
250	m	942.217	389.688
500	m	406.733	111.025

Distance		Heights (m) for above concentrations	
		Category 2/F	Category 5/D
50	m	3.90024	1.69814
250	m	19.7772	4.55066
500	m	31.974	5.73577

Jet Fire Hazard

Path: \70977-Fase 2-IP13\Scambiatore TEG/GAS\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-IP13\Scambiatore TEG/GAS\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	14.6089	14.6089
Radiation Level	7	kW/m2	15.2624	15.2624
Radiation Level	5	kW/m2	15.7375	15.7375
Radiation Level	3	kW/m2	16.6144	16.6144

SUMMARY REPORT

Study Folder: 70977-Fase 2-IP13

Unique Audit Number: 54.096

Phast 6.6



Radiation Effects: Jet Fire Distance

Path: \70977-Fase 2-IP13\Scambiatore TEG/GAS\10mm

			Radiation Level (kW/m2)	
			Category 2/F	Category 5/D
Distance Of Interest 50	m		0.0391989	0.0391989
Distance Of Interest 250	m		0.000878206	0.000878206
Distance Of Interest 500	m		0.000186844	0.000186844

Flash Fire Envelope

Path: \70977-Fase 2-IP13\Scambiatore TEG/GAS\10mm

All flammable results are reported at the cloud centreline height

			Distance (m)	
			Category 2/F	Category 5/D
Furthest Extent	22000	ppm	15.9948	10.9981
Furthest Extent	44000	ppm	7.19051	5.90471
			Heights (m) for above distances	
			Category 2/F	Category 5/D
Furthest Extent	22000	ppm	1.06888	1.01507
Furthest Extent	44000	ppm	1.00505	1.00275

SUMMARY REPORT

Study Folder: 70977-Fase 2-Ip13

Unique Audit Number: 54.096

Phast 6.6



Explosion Effects: Late Ignition

Path: \70977-Fase 2-Ip13\Scambiatore TEG/GAS\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	24.4958	22.6681
Overpressure	0.1379	bar	13.7533	13.2801
Overpressure	0.2068	bar	12.9042	12.5381

			Supplementary Data at 0.02068 bar	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		0.078162	0.052168
Used Flammable Mass	kg		0.078162	0.052168
Overpressure Radius	m		14.4958	12.6681
Distance to:				
- Ignition Source	m		10	10
- Cloud Front/Centre	m		10	10
- Explosion Centre	m		10	10

			Supplementary Data at 0.1379 bar	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		0.078162	0.052168
Used Flammable Mass	kg		0.078162	0.052168
Overpressure Radius	m		3.75333	3.28009
Distance to:				
- Ignition Source	m		10	10
- Cloud Front/Centre	m		10	10
- Explosion Centre	m		10	10

			Supplementary Data at 0.2068 bar	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		0.078162	0.052168
Used Flammable Mass	kg		0.078162	0.052168
Overpressure Radius	m		2.90424	2.53806
Distance to:				
- Ignition Source	m		10	10
- Cloud Front/Centre	m		10	10
- Explosion Centre	m		10	10

			Overpressures (bar gauge) at Distances	
			Category 2/F	Category 5/D
Distance	50	m	0.00647142	0.00564111
Distance	250	m	0.00144008	0.00132332
Distance	500	m	0.001	0.001

			Supplementary Data at 50 m	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		0.078162	0.052168

SUMMARY REPORT

Study Folder: 70977-Fase 2-IP13

Unique Audit Number: 54.096

Phast 6.6



Used Flammable Mass	kg	0.078162	0.052168
Supplementary Data at 250 m			
		Category 2/F	Category 5/D
Supplied Flammable Mass	kg	0.078162	0.052168
Used Flammable Mass	kg	0.078162	0.052168
Supplementary Data at 500 m			
		Category 2/F	Category 5/D
Supplied Flammable Mass	kg	0.078162	0.052168
Used Flammable Mass	kg	0.078162	0.052168

Weather Conditions

Path: \70977-Fase 2-IP13\Scambiatore TEG/GAS\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