

ANNESSO TECNICO 6.

Elaborati di calcolo Scenari incidentali ragionevolmente credibili

Ipotesi N. 24

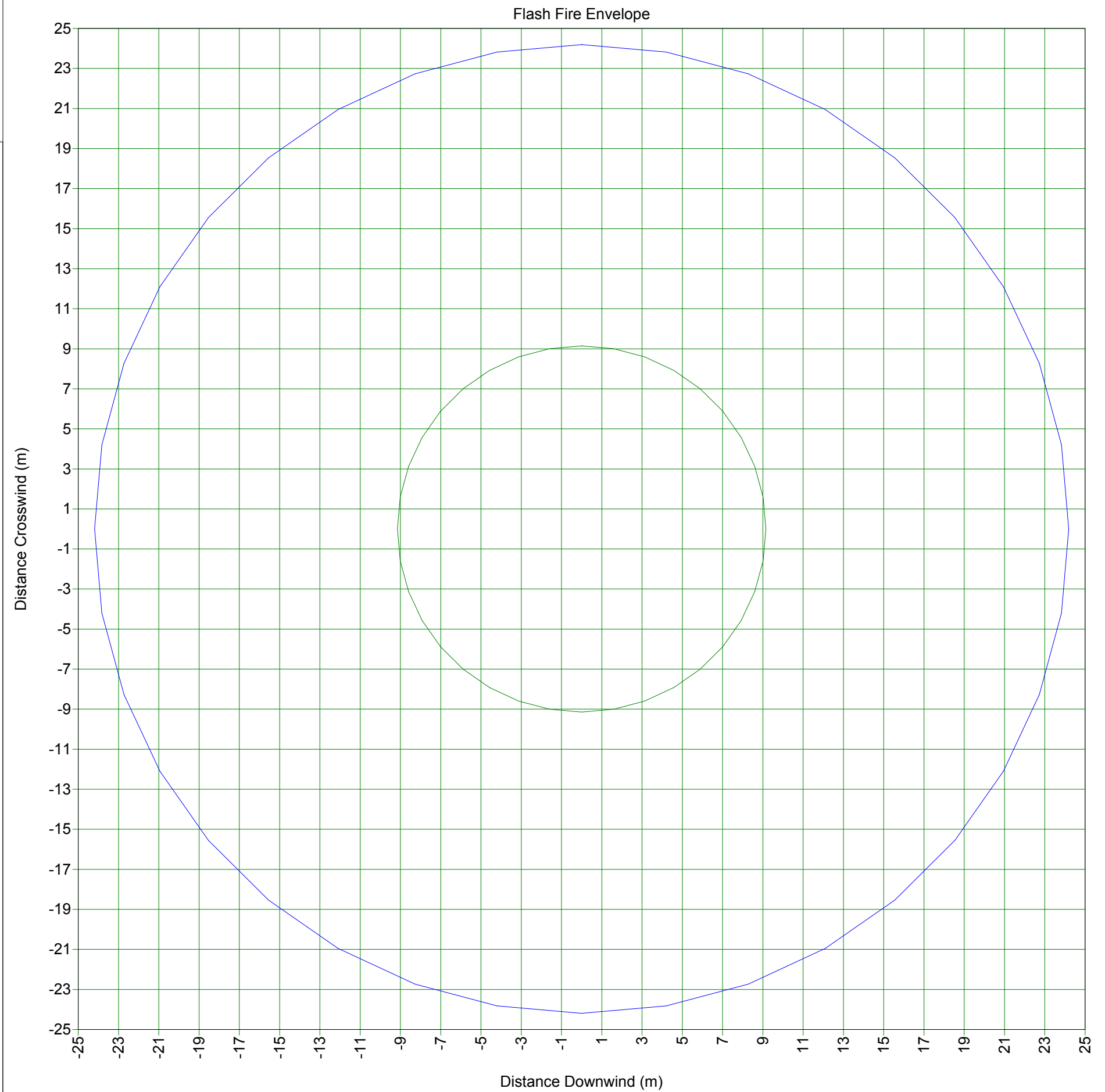
TRR S.r.l.

Il Direttore Generale

Ing. Alfredo Romano

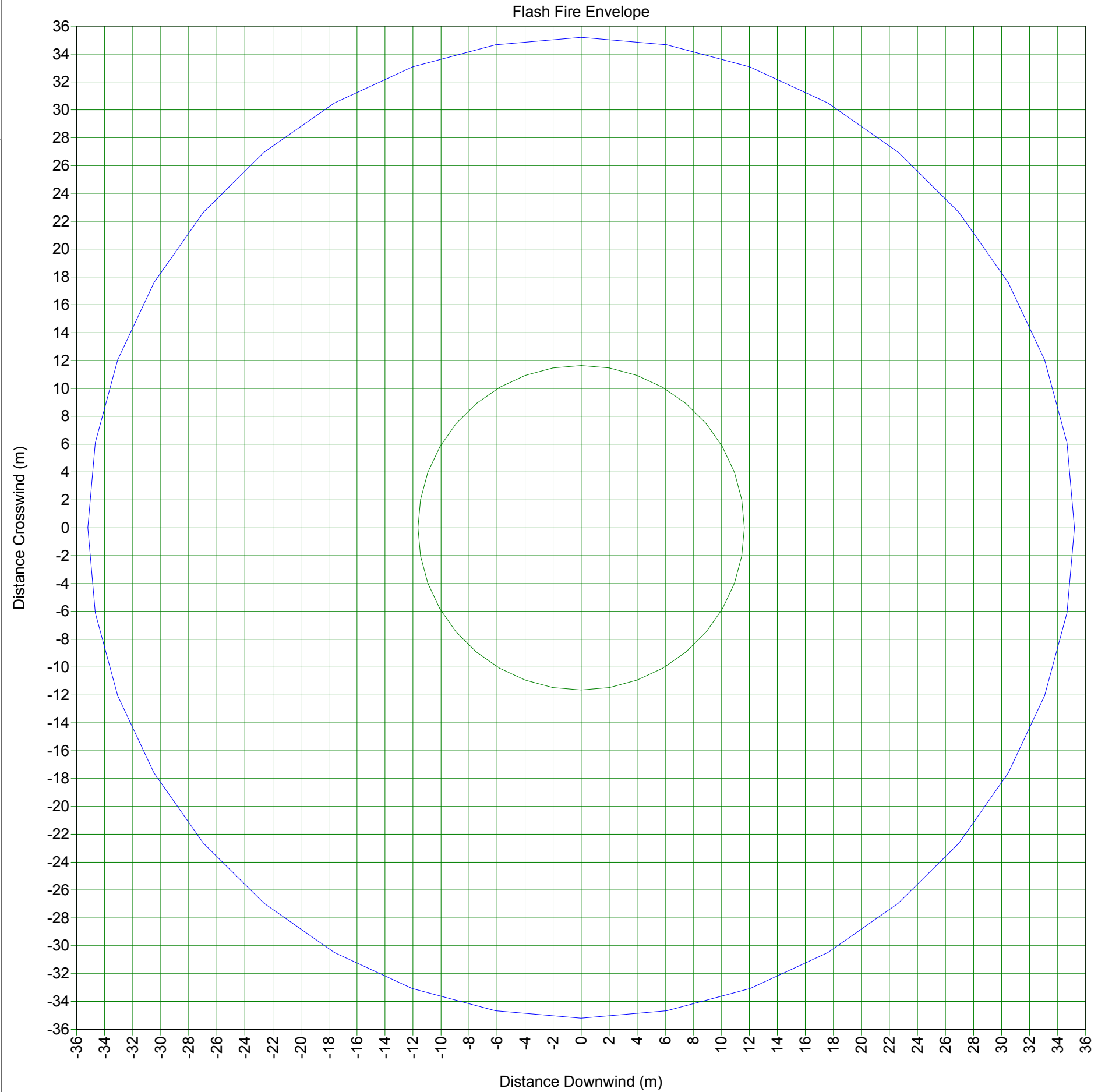

Study Folder: 70977-Fase
2-lp24
Audit No: 65745
Model: 10mm
Weather: Category 5/D
Material: METHANE
Concentration

— 2.2e+004 ppm
— 4.4e+004 ppm



Study Folder: 70977-Fase
2-lp24
Audit No: 65745
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-Ip24

Unique Audit Number: 65.745



Phast 6.6



70977-Fase 2-Ip24



Air-Cooler

10mm

Base Case

Data



Weather: Global Weathers\Category 2/F

Speed: 2,00 m/s

Stability: F

\\70977-Fase 2-Ip24\\Air-Cooler\\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	-72,16 degC
Release Rate	1,96 kg/s

Input

Output

Flame Emissive Power	114,27 kW/m2
Fraction of Emissivity	0,15 fraction
Expanded Radius	0,04 m
Jet Velocity	500,00 m/s
Flame Length	21,60 m
Maximum Flame Radius	1,34 m

Flame Co-ordinates

X	Z	R	Phi
m	m	m	deg
0,00	1,00	0,04	90,00
2,40	1,00	0,52	90,00
4,80	1,00	0,85	90,00
7,20	1,00	1,09	90,00
9,60	1,00	1,25	90,00
12,00	1,00	1,33	90,00
14,40	1,00	1,33	90,00
16,80	1,00	1,22	90,00
19,20	1,00	0,96	90,00
21,60	1,00	0,00	90,00

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip24

Unique Audit Number: 65.745



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)	13,26	m
Crosswind semi-axis (B)	18,63	m
Offset Ratio (D)	0,87	
Effect Distance	24,81	m
Area	776,01	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)	12,19	m
Crosswind semi-axis (B)	14,03	m
Offset Ratio (D)	0,92	
Effect Distance	23,44	m
Area	537,42	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)	11,63	m
Crosswind semi-axis (B)	11,50	m
Offset Ratio (D)	0,96	
Effect Distance	22,82	m
Area	420,22	m2

JET FIRE REPORT

Unique Audit Number: 65.745



Study Folder: 70977-Fase 2-Ip24

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)	10,89	m
Crosswind semi-axis (B)	7,89	m
Offset Ratio (D)	1,01	
Effect Distance	21,92	m
Area	269,93	m2

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip24

Unique Audit Number: 65.745

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			10,53		
10,20			114,27		
20,41			58,63		
30,61			0,78		
40,82			0,24		
51,02			0,12		
61,22			0,07		
71,43			0,04		
81,63			0,03		
91,84			0,02		
102,04			0,02		
112,24			0,01		
122,45			0,01		
132,65			0,01		
142,86			0,01		
153,06			0,01		
163,27			0,01		
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: 65.745



Study Folder: 70977-Fase 2-Ip24

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-Ip24\\Air-Cooler\\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	-72,16 degC
Release Rate	1,96 kg/s

	Input	Output
Flame Emissive Power		114,27 kW/m2
Fraction of Emissivity		0,15 fraction
Expanded Radius		0,04 m
Jet Velocity	500,00	500,00 m/s
Flame Length		21,60 m
Maximum Flame Radius		1,34 m

JET FIRE REPORT

Unique Audit Number: 65.745



Study Folder: 70977-Fase 2-Ip24

Phast 6.6

Flame Co-ordinates

X	Z	R	Phi
m	m	m	deg
0,00	1,00	0,04	90,00
2,40	1,00	0,52	90,00
4,80	1,00	0,85	90,00
7,20	1,00	1,09	90,00
9,60	1,00	1,25	90,00
12,00	1,00	1,33	90,00
14,40	1,00	1,33	90,00
16,80	1,00	1,22	90,00
19,20	1,00	0,96	90,00
21,60	1,00	0,00	90,00

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip24

Unique Audit Number: 65.745



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)	13,26	m
Crosswind semi-axis (B)	18,63	m
Offset Ratio (D)	0,87	
Effect Distance	24,81	m
Area	776,01	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)	12,19	m
Crosswind semi-axis (B)	14,03	m
Offset Ratio (D)	0,92	
Effect Distance	23,44	m
Area	537,42	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)	11,63	m
Crosswind semi-axis (B)	11,50	m
Offset Ratio (D)	0,96	
Effect Distance	22,82	m
Area	420,22	m2

JET FIRE REPORT

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Study Folder: 70977-Fase 2-Ip24

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)	10,89	m
Crosswind semi-axis (B)	7,89	m
Offset Ratio (D)	1,01	
Effect Distance	21,92	m
Area	269,93	m2

JET FIRE REPORT

Study Folder: 70977-Fase 2-Ip24

Unique Audit Number: 65.745

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			10,53		
10,20			114,27		
20,41			58,63		
30,61			0,78		
40,82			0,24		
51,02			0,12		
61,22			0,07		
71,43			0,04		
81,63			0,03		
91,84			0,02		
102,04			0,02		
112,24			0,01		
122,45			0,01		
132,65			0,01		
142,86			0,01		
153,06			0,01		
163,27			0,01		
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-Ip24

Unique Audit Number: 65.745

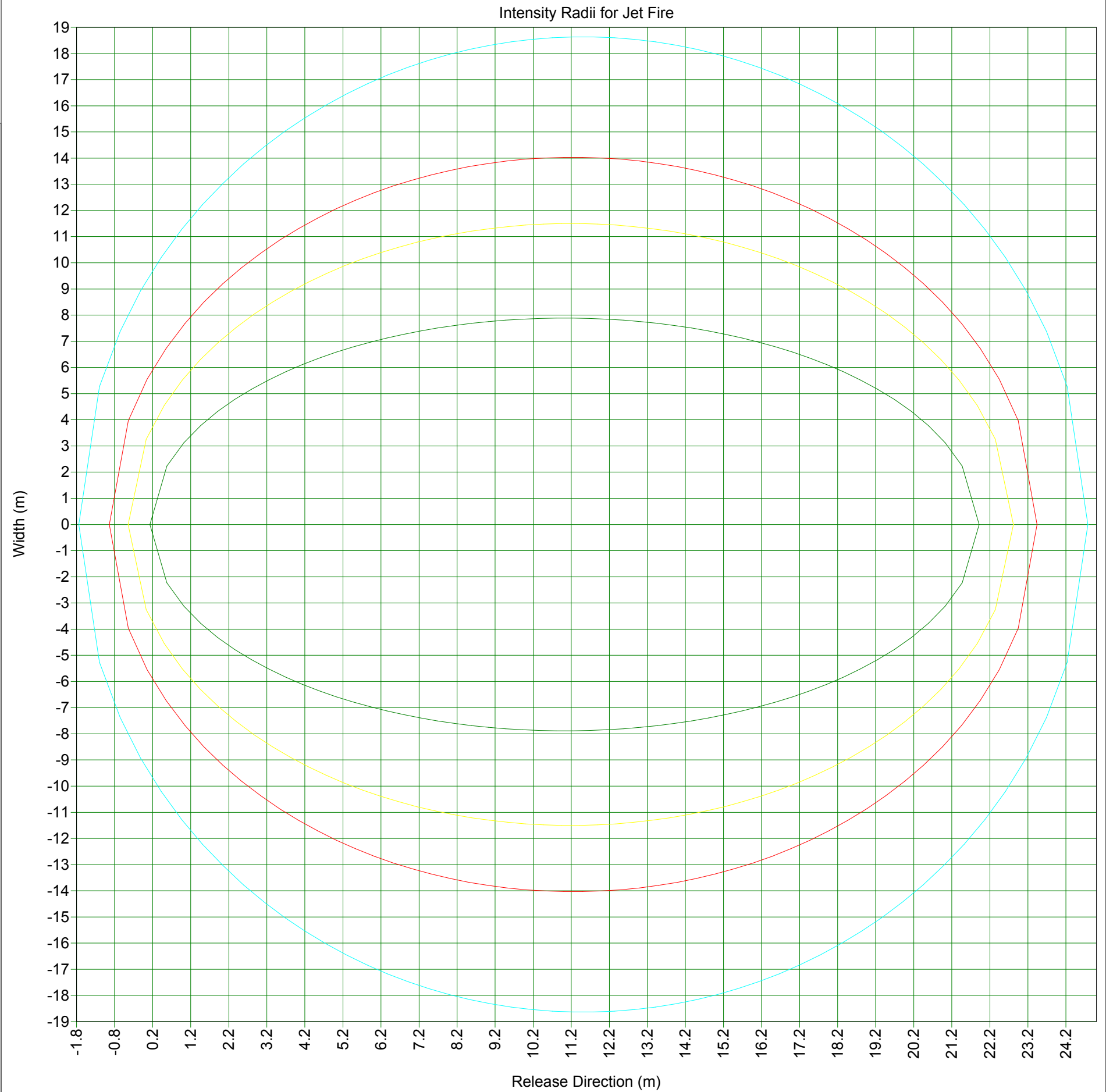
Phast 6.6



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		

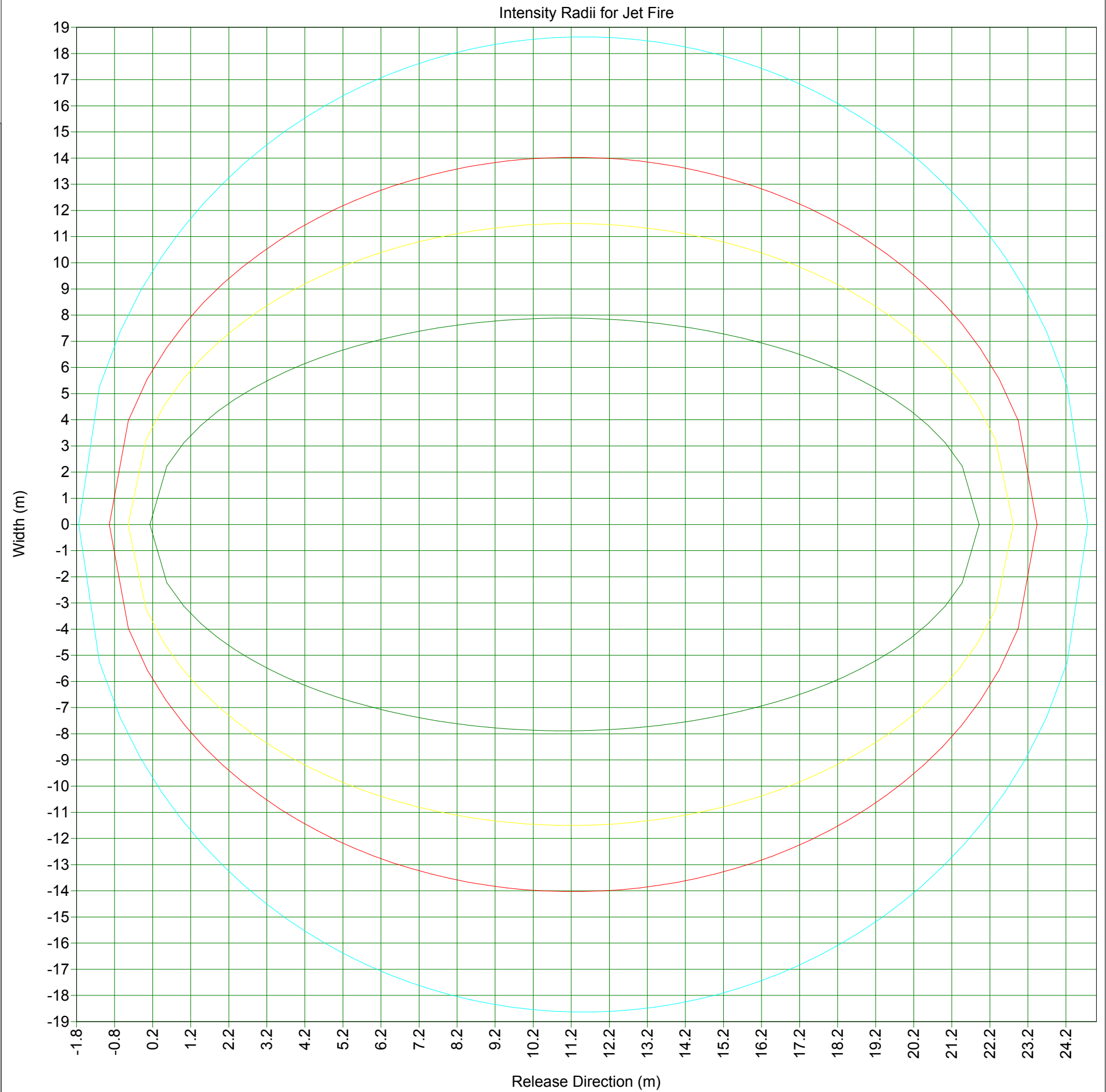
Study Folder: 70977-Fase
2-lp24
Audit No: 65745
Model: 10mm
Weather: Category 5/D
Material: METHANE

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



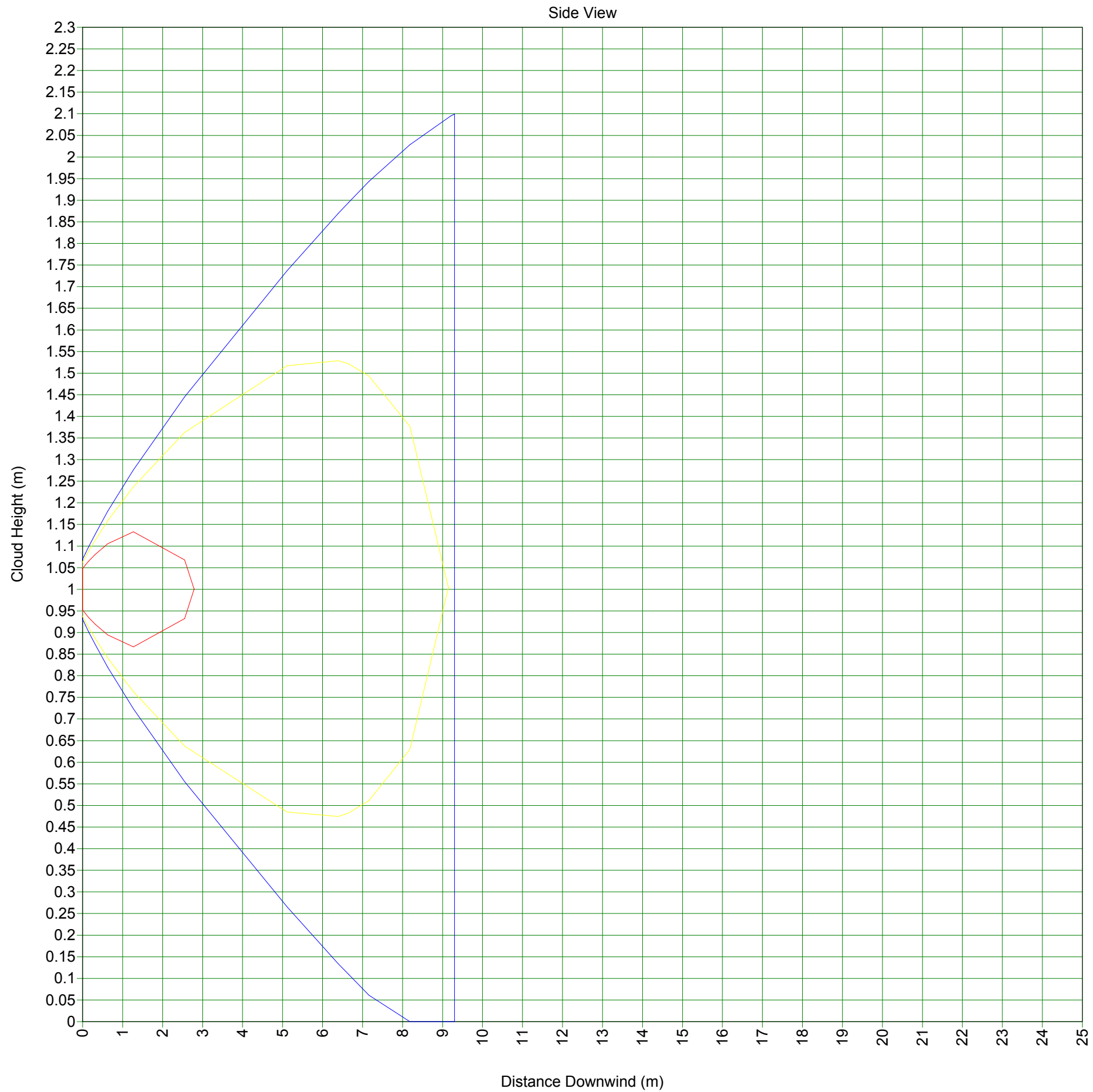
Study Folder: 70977-Fase
2-lp24
Audit No: 65745
Model: 10mm
Weather: Category 2/F
Material: METHANE

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



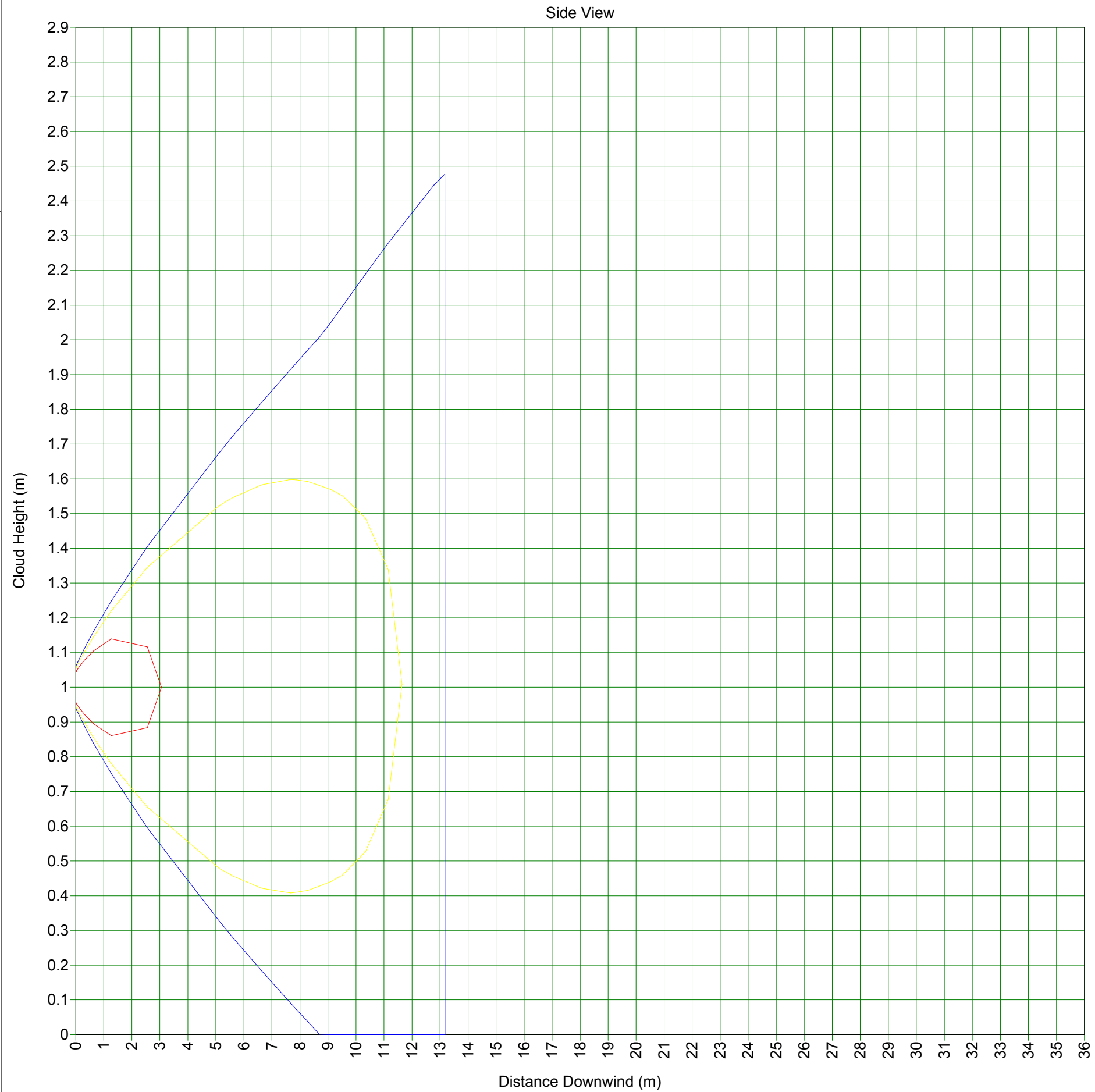
Study Folder: 70977-Fase
2-lp24
Audit No: 65745
Model: 10mm
Weather: Category 5/D
Material: METHANE
Averaging Time:
Flammable(18.75 s)
C/L Offset: 0 m
Concentration
Time: 0.3085 s

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



Study Folder: 70977-Fase
2-lp24
Audit No: 65745
Model: 10mm
Weather: Category 2/F
Material: METHANE
Averaging Time:
Flammable(18.75 s)
C/L Offset: 0 m
Concentration
Time: 0.6347 s

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



SUMMARY REPORT

Unique Audit Number: 65.745



Study Folder: 70977-Fase 2-IP24

Phast 6.6



70977-Fase 2-IP24



Air-Cooler

10mm

Base Case

CASE Name: Data

Path: \70977-Fase 2-IP24\Air-Cooler\10mm

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	154 bar
Temperature	45 degC
Mass Inventory	2500 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	2500 kg

SUMMARY REPORT

Unique Audit Number: 65.745



Study Folder: 70977-Fase 2-Ip24

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-Ip24\Air-Cooler\10mm

Discharge Data

User-Defined Quantities

Material	METHANE
Temperature	45,00 degC
Pressure	155,01 bar
Inventory	2.500,00 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
Final Temperature	-72,16 degC
Final Velocity	500,00 m/s
Droplet Diameter	0,00 um

Continuous Release Data:

Mass Flowrate	1.95700E+000 kg/s
Release Duration	1.277,47 s
Orifice Velocity	416,66 m/s
Exit Pressure	79,09 bar
Exit Temperature	-5,05 degC
Discharge Coefficient	0,86
Expanded Radius	0,04 m

SUMMARY REPORT

Unique Audit Number: 65.745



Study Folder: 70977-Fase 2-Ip24

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 -72,16 degC

Final Velocity 500,00 m/s

Droplet Diameter 0,00 um

Continuous Release Data:

Mass Flowrate 1.95700E+000 kg/s

Release Duration 1.277,47 s

Orifice Velocity 416,66 m/s

Exit Pressure 79,09 bar

Exit Temperature -5,05 degC

Discharge Coefficient 0,86

Expanded Radius 0,04 m

SUMMARY REPORT

Study Folder: 70977-Fase 2-IP24

Unique Audit Number: 65.745

Phast 6.6



Consequence Results

Distance to Concentration Results

Path: \70977-Fase 2-IP24\Air-Cooler\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		31.6769	18.5292
UFL (165000)	18.75	s		3.05859	2.79022
LFL (44000)	18.75	s		11.6417	9.1476
LFL Frac (22000)	18.75	s		35.1984	24.1899

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		1.00034	1.00023
LFL (44000)	18.75	s		1.00927	1.00429
LFL Frac (22000)	18.75	s		1.29209	1.04421

SUMMARY REPORT

Study Folder: 70977-Fase 2-IP24

Unique Audit Number: 65.745

Phast 6.6



Concentration At Distance Results

Path: \70977-Fase 2-IP24\Air-Cooler\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	17633.6	13339.2
250	m	1867.06	1091.35
500	m	929.383	297.52

Distance		Heights (m) for above concentrations	
		Category 2/F	Category 5/D
50	m	1.82213	1.25663
250	m	13.4606	3.28999
500	m	22.1023	4.19433

Distance		Conc.(ppm) at Core Avg. Time of 18.75 s	
		Category 2/F	Category 5/D
50	m	17633.6	13339.2
250	m	1867.06	1091.35
500	m	929.383	297.52

Distance		Heights (m) for above concentrations	
		Category 2/F	Category 5/D
50	m	1.82213	1.25663
250	m	13.4606	3.28999
500	m	22.1023	4.19433

Jet Fire Hazard

Path: \70977-Fase 2-IP24\Air-Cooler\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-IP24\Air-Cooler\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	21.916	21.916
Radiation Level	7	kW/m2	22.816	22.816
Radiation Level	5	kW/m2	23.4413	23.4413
Radiation Level	3	kW/m2	24.8146	24.8146

SUMMARY REPORT

Study Folder: 70977-Fase 2-Ip24

Unique Audit Number: 65.745

Phast 6.6



Radiation Effects: Jet Fire Distance

Path: \70977-Fase 2-Ip24\Air-Cooler\10mm

		Radiation Level (kW/m2)	
		Category 2/F	Category 5/D
Distance Of Interest 50	m	0.122411	0.122411
Distance Of Interest 250	m	0.00214336	0.00214336
Distance Of Interest 500	m	0.000446061	0.000446061

Flash Fire Envelope

Path: \70977-Fase 2-Ip24\Air-Cooler\10mm

All flammable results are reported at the cloud centreline height

			Distance (m)	
			Category 2/F	Category 5/D
Furthest Extent	22000	ppm	35.1984	24.1899
Furthest Extent	44000	ppm	11.6417	9.1476
			Heights (m) for above distances	
			Category 2/F	Category 5/D
Furthest Extent	22000	ppm	1.29209	1.04421
Furthest Extent	44000	ppm	1.00927	1.00429

SUMMARY REPORT

Study Folder: 70977-Fase 2-Ip24

Unique Audit Number: 65.745

Phast 6.6



Explosion Effects: Late Ignition

Path: \70977-Fase 2-Ip24\Air-Cooler\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	52.6341	39.4161
Overpressure	0.1379	bar	35.8605	25.0273
Overpressure	0.2068	bar	34.5347	23.89

			Supplementary Data at 0.02068 bar	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		0.297547	0.187826
Used Flammable Mass	kg		0.297547	0.187826
Overpressure Radius	m		22.6341	19.4161
Distance to:				
- Ignition Source	m		30	20
- Cloud Front/Centre	m		30	20
- Explosion Centre	m		30	20

			Supplementary Data at 0.1379 bar	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		0.297547	0.187826
Used Flammable Mass	kg		0.297547	0.187826
Overpressure Radius	m		5.86052	5.02732
Distance to:				
- Ignition Source	m		30	20
- Cloud Front/Centre	m		30	20
- Explosion Centre	m		30	20

			Supplementary Data at 0.2068 bar	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		0.297547	0.187826
Used Flammable Mass	kg		0.297547	0.187826
Overpressure Radius	m		4.53474	3.89003
Distance to:				
- Ignition Source	m		30	20
- Cloud Front/Centre	m		30	20
- Explosion Centre	m		30	20

			Overpressures (bar gauge) at Distances	
			Category 2/F	Category 5/D
Distance	50	m	0.0242104	0.0122293
Distance	250	m	0.00209113	0.00180749
Distance	500	m	0.00125166	0.00113251

			Supplementary Data at 50 m	
			Category 2/F	Category 5/D
Supplied Flammable Mass	kg		0.297547	0.187826

SUMMARY REPORT

Study Folder: 70977-Fase 2-Ip24

Unique Audit Number: 65.745

Phast 6.6



Used Flammable Mass	kg	0.297547	0.187826
Supplementary Data at 250 m			
		Category 2/F	Category 5/D
Supplied Flammable Mass	kg	0.297547	0.187826
Used Flammable Mass	kg	0.297547	0.187826
Supplementary Data at 500 m			
		Category 2/F	Category 5/D
Supplied Flammable Mass	kg	0.297547	0.187826
Used Flammable Mass	kg	0.297547	0.187826

Weather Conditions

Path: \70977-Fase 2-Ip24\Air-Cooler\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