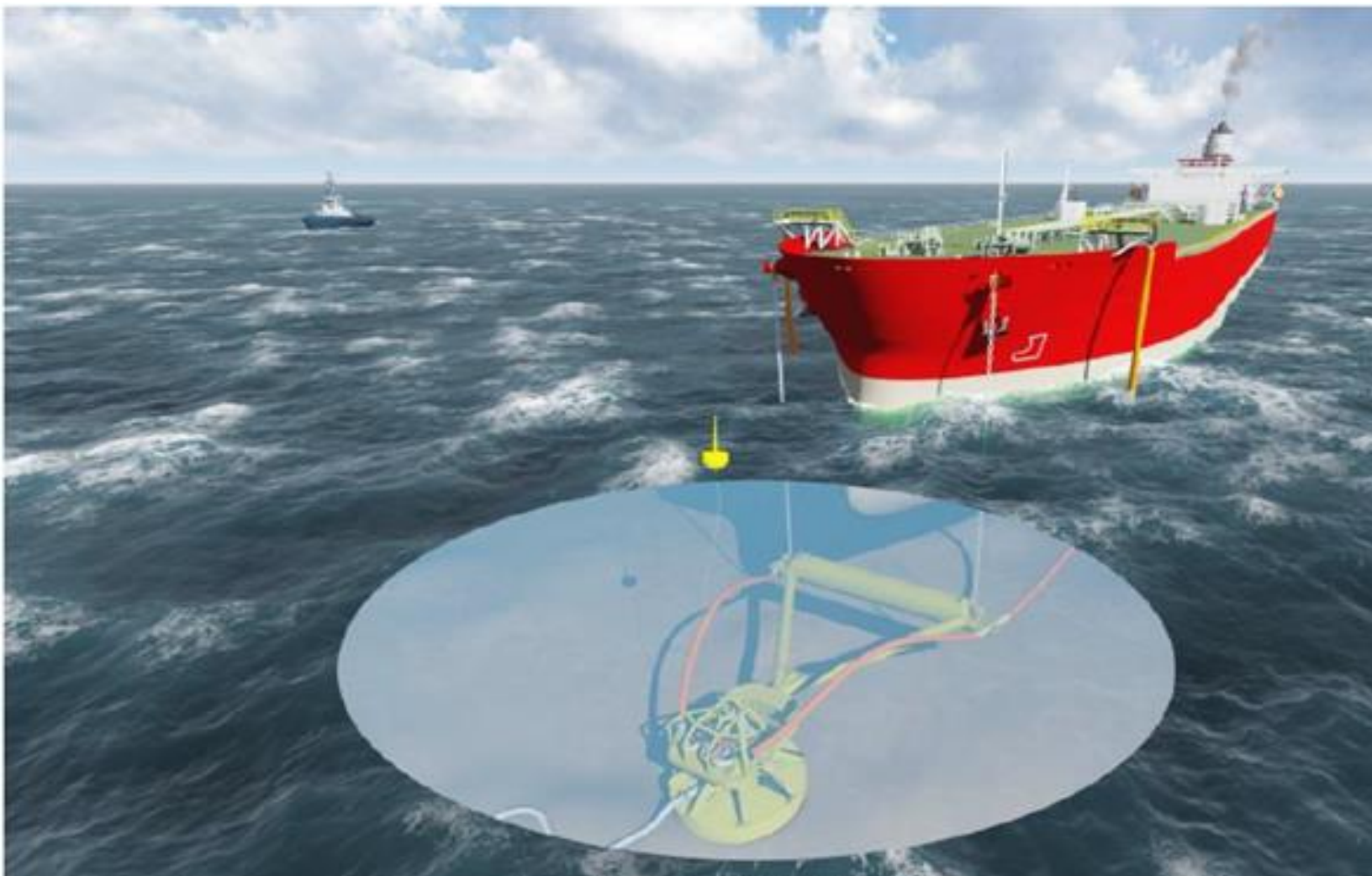


Estudo de Impacto Ambiental – EIA

Complexo Termelétrico Barra dos Coqueiros

Instalações *offshore* de gás natural, adutora e emissário submarino

Volume 7



Anexo 8-1

Estudo de Análise de Risco (EAR)



Usina Termoelétrica (UTE)

**Unidade de Regaseificação e Gasoduto
de Gás Natural**

Porto de Sergipe

Estudo de Análise de Riscos

Volume 2/2 - Anexo F – Modelagens Matemáticas



São Paulo

Junho – 2017

Anexo F - Modelagens Matemáticas

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7



Modelagem de Consequências - CELSE



Study

001.H07

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\001.H07

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Saturated Liquid (Equilibrium vapor/liquid)
Pressure Specification	Pressure not used
Temperature	-160 degC
Volume Inventory	4,55E4 m3

Scenario

Scenario Type	Catastrophic rupture
Phase to be Released	Liquid
Building Wake Effect	None

Location

Elevation	1 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
---------------------	------------------

Flammable

Explosion Method	TNT
Jet Fire Method	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1,912E7 kg
Use Burst Pressure	No - Use release pressure for fireball

Fireball Parameters

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

Toxic Parameters

[Indoor Calculations	Unselected]
----------------------	-------------

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

[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

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\001.H07

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Catastrophic rupture
Inventory 19.123.518,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 1,14 bar
- Temperature -160,00 degC
- Fluid State Saturated liquid

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate n/a kg/s
Release Duration n/a s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure n/a bar
- Temperature n/a degC
- Vena Contracta Velocity (exit velocity for pipe releases) n/a m/s
- Discharge Coefficient n/a

Final data (after atmospheric expansion):

- Temperature -161,48 degC
- Liquid Mass Fraction 0,99 fraction
- Droplet Diameter 614,21 um
- Expanded Radius n/a m
- Velocity 6,28 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Catastrophic rupture
Inventory 19.123.518,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 1,14 bar
- Temperature -160,00 degC
- Fluid State Saturated liquid

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	n/a kg/s
Release Duration	n/a s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	n/a bar
- Temperature	n/a degC
- Vena Contracta Velocity (exit velocity for pipe releases)	n/a m/s
- Discharge Coefficient	n/a
Final data (after atmospheric expansion):	
- Temperature	-161,48 degC
- Liquid Mass Fraction	0,99 fraction
- Droplet Diameter	614,21 um
- Expanded Radius	n/a m
- Velocity	6,28 m/s



Consequence Results

Pool Vaporization Results

Path: \Modelagem de Consequências - CELSE\Study\001.H07

N.B. Pool vaporization segments begin when the cloud has left the pool

		Dia	Noite
Liquid Rainout	fraction	0,913737	0,920007
Initial Vapor Cloud	kg	1,64965e+006	1,52974e+006
Time Pool Left Behind	s	126,722	141,317
Cloud Segment 1			
Cloud Segment Duration	s	121,551	124,881
Pool Vaporization Rate	kg/s	13621,7	13077,9
Cloud Segment 2			
Cloud Segment Duration	s	58,68	60,0794
Pool Vaporization Rate	kg/s	28116,1	27288,6
Cloud Segment 3			
Cloud Segment Duration	s	333,925	339,45
Pool Vaporization Rate	kg/s	34988,5	33780,9
Cloud Segment 4			
Cloud Segment Duration	s	85,8444	75,59
Pool Vaporization Rate	kg/s	17138,8	20084,1
Maximum Pool Radius	m	610,297	621,854

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\001.H07

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Dia	Noite
UFL (165000)	18,75	s	523,961	597,114
LFL (44000)	18,75	s	1530,64	2218,39
LFL Frac (44000)	18,75	s	1530,64	2218,39
Concentration(ppm)	Averaging Time		Dia	Noite
UFL (165000)	18,75	s	1	1
LFL (44000)	18,75	s	1	1
LFL Frac (44000)	18,75	s	1	1

Late Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\001.H07

	Dia	Noite
Late Pool Fire Status	Hazard	Hazard

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Radiation Effects: Late Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\001.H07

			Dia	Noite
Radiation Level	9,85	kW/m2	2089,54	2121,74
Radiation Level	19,45	kW/m2	1625,81	1649,24
Radiation Level	35	kW/m2	1268	1285,27

Radiation Effects: Late Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\001.H07

Dia
Noite
Radiation Level (kW/m2)

Fireball Hazard

Path: \Modelagem de Consequências - CELSE\Study\001.H07

	Dia	Noite
Fireball Flame Status	Hazard	Hazard

Radiation Effects: Fireball Ellipse

Path: \Modelagem de Consequências - CELSE\Study\001.H07

			Dia	Noite
Radiation Level	5	kW/m2	913,871	913,981
Radiation Level	9,85	kW/m2	594,468	594,549
Radiation Level	19,45	kW/m2	299,317	299,393

Radiation Effects: Fireball Distance

Path: \Modelagem de Consequências - CELSE\Study\001.H07

Dia
Noite
Radiation Level (kW/m2)



Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\001.H07

All flammable results are reported at the flammable effect height 1 m

			Distance (m)	
			Dia	Noite
Furthest Extent	44000	ppm	1530,64	2218,39
Furthest Extent	44000	ppm	1530,64	2218,39
			Heights (m) for above distances	
			Dia	Noite
Furthest Extent	44000	ppm	1	1
Furthest Extent	44000	ppm	1	1

Explosion Effects: Early Explosion

Path: \Modelagem de Consequências - CELSE\Study\001.H07

Early Explosions are assumed to be centered at the release location
Explosion Model Used : TNT

			Dia	Noite
Supplied Flammable Mass		kg	1,91235e+007	1,91235e+007
			Distance (m) at Overpressure Levels	
			Dia	Noite
Overpressure	0,069	bar	812,137	812,137
Overpressure	0,1	bar	631,882	631,882
Overpressure	0,3	bar	315,521	315,521
			Used Mass (kg) at Overpressure Levels	
			Dia	Noite
Overpressure	0,069	bar	198524	198524
Overpressure	0,1	bar	198524	198524
Overpressure	0,3	bar	198524	198524



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\001.H07

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	2030,68	2216,53
Overpressure	0,1	bar	1726,86	1896,74
Overpressure	0,3	bar	1205,23	1335,48
			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass	kg		981856	1,10856e+006
Used Flammable Mass	kg		981856	1,10856e+006
Overpressure Radius	m		1383,7	1440,83
Distance to:				
- Ignition Source	m		970	1470
- Cloud Front/Centre	m		646,987	775,707
- Explosion Centre	m		646,987	775,707
			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass	kg		928837	1,10856e+006
Used Flammable Mass	kg		928837	1,10856e+006
Overpressure Radius	m		1056,84	1121,03
Distance to:				
- Ignition Source	m		1010	1470
- Cloud Front/Centre	m		670,011	775,707
- Explosion Centre	m		670,011	775,707
			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass	kg		888152	1,10856e+006
Used Flammable Mass	kg		888152	1,10856e+006
Overpressure Radius	m		519,899	559,771
Distance to:				
- Ignition Source	m		1040	1470
- Cloud Front/Centre	m		685,328	775,707
- Explosion Centre	m		685,328	775,707

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\001.H07

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

002. H07 Fireball 1%

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\002. H07 Fireball 1%

User-Defined Data

Material

Material Identifier METHANE

Bund

Status of Bund No bund present

Fireball

Released Mass 2,275E7 kg
Vapour Fraction (mass) 1 fraction
Use Shape Correlation Use Correlation
Supply Flame Emissive Power Use emissive power correlation
Supply Burst Pressure - gauge Calculate the fireball pressure

Fireball Parameters

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

Radiation Ellipse

Inclination Given No
Radiation Ellipse Option Lethality Level
Radiation Ellipse: Lethality Level 1 %

Geometry

Shape Point
Dimension 2D
System Absolute
East(1) 733 m
North(1) 601 m



Consequence Results

Fireball Hazard

Path: \Modelagem de Consequências - CELSE\Study\002. H07 Fireball 1%

		Dia	Noite
Fireball Flame Status		Hazard	Hazard

Radiation Effects: Fireball Ellipse

Path: \Modelagem de Consequências - CELSE\Study\002. H07 Fireball 1%

				Distance (m)
			Dia	Noite
Radiation Level	9,84715	kW/m2	2524,67	2525,15

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\002. H07 Fireball 1%

			Dia	Noite
Wind Speed		m/s	4,9	4,6
Pasquill Stability			B/C	D
Surface Roughness Length		mm	951	951
Surface Roughness Parameter			0,170008	0,170008
Atmospheric Temperature		degC	27,2	26,3
Surface Temperature		degC	32,2	26,3
Relative Humidity		fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

003. H07 Fireball 50%

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\003. H07 Fireball 50%

User-Defined Data

Material

Material Identifier METHANE

Bund

Status of Bund No bund present

Fireball

Released Mass 2,275E4 kg
Vapour Fraction (mass) 1 fraction
Use Shape Correlation Use Correlation
Supply Flame Emissive Power Use emissive power correlation
Supply Burst Pressure - gauge Calculate the fireball pressure

Fireball Parameters

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

Radiation Ellipse

Inclination Given No
Radiation Ellipse Option Lethality Level
Radiation Ellipse: Lethality Level 50 %

Geometry

Shape Point
Dimension 2D
System Absolute
East(1) 733 m
North(1) 601 m



Consequence Results

Fireball Hazard

Path: \Modelagem de Consequências - CELSE\Study\003. H07 Fireball 50%

		Dia	Noite
Fireball Flame Status		Hazard	Hazard

Radiation Effects: Fireball Ellipse

Path: \Modelagem de Consequências - CELSE\Study\003. H07 Fireball 50%

				Distance (m)
			Dia	Noite
Radiation Level	29,3521	kW/m2	175,159	175,178

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\003. H07 Fireball 50%

			Dia	Noite
Wind Speed		m/s	4,9	4,6
Pasquill Stability			B/C	D
Surface Roughness Length		mm	951	951
Surface Roughness Parameter			0,170008	0,170008
Atmospheric Temperature		degC	27,2	26,3
Surface Temperature		degC	32,2	26,3
Relative Humidity		fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

004. H07 Fireball 35 kw/m2

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\004. H07 Fireball 35 kw/m2

User-Defined Data

Material

Material Identifier METHANE

Bund

Status of Bund No bund present

Fireball

Released Mass 2,275E4 kg
Vapour Fraction (mass) 1 fraction
Use Shape Correlation Use Correlation
Supply Flame Emissive Power Use emissive power correlation
Supply Burst Pressure - gauge Calculate the fireball pressure

Fireball Parameters

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

Radiation Ellipse

Inclination Given No
Radiation Ellipse Option Incident Radiation
Radiation Ellipse: Incident Radiation 35 kW/m2

Geometry

Shape Point
Dimension 2D
System Absolute
East(1) 733 m
North(1) 601 m



Consequence Results

Fireball Hazard

Path: \Modelagem de Consequências - CELSE\Study\004. H07 Fireball 35 kw/m2

		Dia	Noite
Fireball Flame Status		Hazard	Hazard

Radiation Effects: Fireball Ellipse

Path: \Modelagem de Consequências - CELSE\Study\004. H07 Fireball 35 kw/m2

				Distance (m)
			Dia	Noite
Radiation Level	35	kW/m2	148,36	148,378

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\004. H07 Fireball 35 kw/m2

			Dia	Noite
Wind Speed		m/s	4,9	4,6
Pasquill Stability			B/C	D
Surface Roughness Length		mm	951	951
Surface Roughness Parameter			0,170008	0,170008
Atmospheric Temperature		degC	27,2	26,3
Surface Temperature		degC	32,2	26,3
Relative Humidity		fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

005.H08

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\005.H08

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Padded Liquid
Pressure Specification	Pressure specified
Storage Pressure - gauge	0,25 bar
Temperature	-160 degC
Volume Inventory	4,25E4 m3

Scenario

Scenario Type	Catastrophic rupture
Phase to be Released	Liquid
Building Wake Effect	None

Location

Elevation	1 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
---------------------	------------------

Flammable

Explosion Method	TNT
Jet Fire Method	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1,786E7 kg
Use Burst Pressure	No - Use release pressure for fireball

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]

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

[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

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\005.H08

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Catastrophic rupture
Inventory 17.862.626,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 1,26 bar
- Temperature -160,00 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate n/a kg/s
Release Duration n/a s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure n/a bar
- Temperature n/a degC
- Vena Contracta Velocity (exit velocity for pipe releases) n/a m/s
- Discharge Coefficient n/a

Final data (after atmospheric expansion):

- Temperature -161,48 degC
- Liquid Mass Fraction 0,99 fraction
- Droplet Diameter 514,27 um
- Expanded Radius n/a m
- Velocity 6,27 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Catastrophic rupture
Inventory 17.862.626,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 1,26 bar
- Temperature -160,00 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	n/a kg/s
Release Duration	n/a s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	n/a bar
- Temperature	n/a degC
- Vena Contracta Velocity (exit velocity for pipe releases)	n/a m/s
- Discharge Coefficient	n/a
Final data (after atmospheric expansion):	
- Temperature	-161,48 degC
- Liquid Mass Fraction	0,99 fraction
- Droplet Diameter	514,27 um
- Expanded Radius	n/a m
- Velocity	6,27 m/s



Consequence Results

Pool Vaporization Results

Path: \Modelagem de Consequências - CELSE\Study\005.H08

N.B. Pool vaporization segments begin when the cloud has left the pool

		Dia	Noite
Liquid Rainout	fraction	0,91133	0,918204
Initial Vapor Cloud	kg	1,58387e+006	1,46108e+006
Time Pool Left Behind	s	124,534	139,11
Cloud Segment 1			
Cloud Segment Duration	s	118,81	122,656
Pool Vaporization Rate	kg/s	13027,7	12552,7
Cloud Segment 2			
Cloud Segment Duration	s	58,08	58,92
Pool Vaporization Rate	kg/s	26821,1	26069,4
Cloud Segment 3			
Cloud Segment Duration	s	327,112	335,987
Pool Vaporization Rate	kg/s	33313,5	32173,2
Cloud Segment 4			
Cloud Segment Duration	s	95,9975	82,4375
Pool Vaporization Rate	kg/s	14921,7	16953,3
Maximum Pool Radius	m	592,316	603,702

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\005.H08

The height for user defined concentrations is the user defined height 1 m

All toxic results are reported at the toxic effect height 0 m

All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Dia	Noite
UFL (165000)	18,75	s	515,695	582,661
LFL (44000)	18,75	s	1508,48	2188,77
LFL Frac (44000)	18,75	s	1508,48	2188,77
Concentration(ppm)	Averaging Time		Dia	Noite
UFL (165000)	18,75	s	1	1
LFL (44000)	18,75	s	1	1
LFL Frac (44000)	18,75	s	1	1

Late Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\005.H08

	Dia	Noite
Late Pool Fire Status	Hazard	Hazard



Radiation Effects: Late Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\005.H08

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	2041,77	2073,68
Radiation Level	19,45	kW/m2	1588,21	1611,39
Radiation Level	35	kW/m2	1238,3	1255,35

Radiation Effects: Late Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\005.H08

	Radiation Level (kW/m2)	
	Dia	Noite

Fireball Hazard

Path: \Modelagem de Consequências - CELSE\Study\005.H08

	Dia	Noite
Fireball Flame Status	Hazard	Hazard

Radiation Effects: Fireball Ellipse

Path: \Modelagem de Consequências - CELSE\Study\005.H08

			Distance (m)	
			Dia	Noite
Radiation Level	5	kW/m2	908,762	908,87
Radiation Level	9,85	kW/m2	593,97	594,049
Radiation Level	19,45	kW/m2	306,253	306,325

Radiation Effects: Fireball Distance

Path: \Modelagem de Consequências - CELSE\Study\005.H08

	Radiation Level (kW/m2)	
	Dia	Noite



Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\005.H08

All flammable results are reported at the flammable effect height 1 m

			Distance (m)	
			Dia	Noite
Furthest Extent	44000	ppm	1508,48	2188,77
Furthest Extent	44000	ppm	1508,48	2188,77
			Heights (m) for above distances	
			Dia	Noite
Furthest Extent	44000	ppm	1	1
Furthest Extent	44000	ppm	1	1

Explosion Effects: Early Explosion

Path: \Modelagem de Consequências - CELSE\Study\005.H08

Early Explosions are assumed to be centered at the release location
Explosion Model Used : TNT

			Dia	Noite
Supplied Flammable Mass		kg	1,78626e+007	1,78626e+007
			Distance (m) at Overpressure Levels	
			Dia	Noite
Overpressure	0,069	bar	793,254	793,254
Overpressure	0,1	bar	617,19	617,19
Overpressure	0,3	bar	308,185	308,185
			Used Mass (kg) at Overpressure Levels	
			Dia	Noite
Overpressure	0,069	bar	184996	184996
Overpressure	0,1	bar	184996	184996
Overpressure	0,3	bar	184996	184996



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\005.H08

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	1995,35	2176,15
Overpressure	0,1	bar	1696,84	1862
Overpressure	0,3	bar	1182,44	1310,66

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	925238	1,05083e+006
Used Flammable Mass		kg	925238	1,05083e+006
Overpressure Radius		m	1356,57	1415,37
Distance to:				
- Ignition Source		m	960	1440
- Cloud Front/Centre		m	638,783	760,779
- Explosion Centre		m	638,783	760,779

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	873731	1,05083e+006
Used Flammable Mass		kg	873731	1,05083e+006
Overpressure Radius		m	1035,52	1101,22
Distance to:				
- Ignition Source		m	1000	1440
- Cloud Front/Centre		m	661,327	760,779
- Explosion Centre		m	661,327	760,779

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	847401	1,05083e+006
Used Flammable Mass		kg	847401	1,05083e+006
Overpressure Radius		m	511,823	549,879
Distance to:				
- Ignition Source		m	1020	1440
- Cloud Front/Centre		m	670,622	760,779
- Explosion Centre		m	670,622	760,779

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\005.H08

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

006. H08 Fireball 1%

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\006. H08 Fireball 1%

User-Defined Data

Material

Material Identifier METHANE

Bund

Status of Bund No bund present

Fireball

Released Mass 2,125E4 kg
Vapour Fraction (mass) 1 fraction
Use Shape Correlation Use Correlation
Supply Flame Emissive Power Use emissive power correlation
Supply Burst Pressure - gauge Calculate the fireball pressure

Fireball Parameters

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

Radiation Ellipse

Inclination Given No
Radiation Ellipse Option Lethality Level
Radiation Ellipse: Lethality Level 1 %

Geometry

Shape Point
Dimension 2D
System Absolute
East(1) 733 m
North(1) 601 m



Consequence Results

Fireball Hazard

Path: \Modelagem de Consequências - CELSE\Study\006. H08 Fireball 1%

		Dia	Noite
Fireball Flame Status		Hazard	Hazard

Radiation Effects: Fireball Ellipse

Path: \Modelagem de Consequências - CELSE\Study\006. H08 Fireball 1%

				Distance (m)
			Dia	Noite
Radiation Level	15,0461	kW/m2	276,794	276,818

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\006. H08 Fireball 1%

			Dia	Noite
Wind Speed		m/s	4,9	4,6
Pasquill Stability			B/C	D
Surface Roughness Length		mm	951	951
Surface Roughness Parameter			0,170008	0,170008
Atmospheric Temperature		degC	27,2	26,3
Surface Temperature		degC	32,2	26,3
Relative Humidity		fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

007. H08 Fireball 50%

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\007. H08 Fireball 50%

User-Defined Data

Material

Material Identifier METHANE

Bund

Status of Bund No bund present

Fireball

Released Mass 2,125E4 kg
Vapour Fraction (mass) 1 fraction
Use Shape Correlation Use Correlation
Supply Flame Emissive Power Use emissive power correlation
Supply Burst Pressure - gauge Calculate the fireball pressure

Fireball Parameters

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

Radiation Ellipse

Inclination Given No
Radiation Ellipse Option Lethality Level
Radiation Ellipse: Lethality Level 50 %

Geometry

Shape Point
Dimension 2D
System Absolute
East(1) 733 m
North(1) 601 m

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Consequence Results

Fireball Hazard

Path: \Modelagem de Consequências - CELSE\Study\007. H08 Fireball 50%

	Dia	Noite
Fireball Flame Status	Hazard	Hazard

Radiation Effects: Fireball Ellipse

Path: \Modelagem de Consequências - CELSE\Study\007. H08 Fireball 50%

			Dia	Noite
				Distance (m)
Radiation Level	29,7451	kW/m2	169,844	169,862

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\007. H08 Fireball 50%

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

008. H08 Fireball 35 kw/m2

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\008. H08 Fireball 35 kw/m2

User-Defined Data

Material

Material Identifier METHANE

Bund

Status of Bund No bund present

Fireball

Released Mass 2,125E4 kg
Vapour Fraction (mass) 1 fraction
Use Shape Correlation Use Correlation
Supply Flame Emissive Power Use emissive power correlation
Supply Burst Pressure - gauge Calculate the fireball pressure

Fireball Parameters

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

Radiation Ellipse

Inclination Given No
Radiation Ellipse Option Incident Radiation
Radiation Ellipse: Incident Radiation 35 kW/m2

Geometry

Shape Point
Dimension 2D
System Absolute
East(1) 733 m
North(1) 601 m



Consequence Results

Fireball Hazard

Path: \Modelagem de Consequências - CELSE\Study\008. H08 Fireball 35 kw/m2

		Dia	Noite
Fireball Flame Status		Hazard	Hazard

Radiation Effects: Fireball Ellipse

Path: \Modelagem de Consequências - CELSE\Study\008. H08 Fireball 35 kw/m2

				Distance (m)
			Dia	Noite
Radiation Level	35	kW/m2	145,606	145,624

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\008. H08 Fireball 35 kw/m2

			Dia	Noite
Wind Speed		m/s	4,9	4,6
Pasquill Stability			B/C	D
Surface Roughness Length		mm	951	951
Surface Roughness Parameter			0,170008	0,170008
Atmospheric Temperature		degC	27,2	26,3
Surface Temperature		degC	32,2	26,3
Relative Humidity		fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

009.H09

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\009.H09

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Padded Liquid
Pressure Specification	Pressure specified
Storage Pressure - gauge	4 bar
Temperature	-160 degC
Volume Inventory	4,55E4 m3

Scenario

Scenario Type	Line rupture
Phase to be Released	Liquid
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Tank Head	1 m
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	254 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1,912E7 kg

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

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

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\009.H09

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 19.123.518,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 5,01 bar
- Temperature -160,00 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 5.61470E+002 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 1,17 bar
- Temperature -159,86 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 26,38 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -161,48 degC
- Liquid Mass Fraction 0,99 fraction
- Droplet Diameter 328,86 um
- Expanded Radius 0,23 m
- Velocity 28,62 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 19.123.518,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 5,01 bar
- Temperature -160,00 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	5.61470E+002 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	1,17 bar
- Temperature	-159,86 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	26,38 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-161,48 degC
- Liquid Mass Fraction	0,99 fraction
- Droplet Diameter	328,86 um
- Expanded Radius	0,23 m
- Velocity	28,62 m/s



Consequence Results

Pool Vaporization Results

Path: \Modelagem de Consequências - CELSE\Study\009.H09

			Dia	Noite
		Release Segment 1		
Release Duration	s		600	600
Liquid Rainout	fraction		0,817232	0,822765
		Release Segment 1 Cloud Segment 1		
Cloud Segment Duration	s		90,7256	92,16
Pool Vaporization Rate	kg/s		267,922	263,902
Total Vapor Flowrate	kg/s		370,541	363,414
		Release Segment 1 Cloud Segment 2		
Cloud Segment Duration	s		509,274	507,84
Pool Vaporization Rate	kg/s		429,449	430,064
Total Vapor Flowrate	kg/s		532,068	529,576
Maximum Pool Radius	m		69,1839	71,4529

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\009.H09

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Dia	Noite	Distance (m)
UFL (165000)	18,75	s	102,948	108,339	
LFL (44000)	18,75	s	277,376	324,555	
LFL Frac (44000)	18,75	s	277,376	324,555	
Concentration(ppm)	Averaging Time		Dia	Noite	Heights (m) for above distances
UFL (165000)	18,75	s	1	1	
LFL (44000)	18,75	s	1	1	
LFL Frac (44000)	18,75	s	1	1	

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\009.H09

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Truncated	Truncated
Flame Direction	Horizontal	Horizontal



Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\009.H09

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

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	297,859	296,704
Radiation Level	19,46	kW/m2	261,298	260,495
Radiation Level	35	kW/m2	236,089	235,44

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\009.H09

		Radiation Level (kW/m2)
		Noite
	Dia	

Early Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\009.H09

		Dia	Noite
Early Pool Fire Status		Hazard	Hazard

Radiation Effects: Early Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\009.H09

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	226,054	225,542
Radiation Level	19,45	kW/m2	179,221	178,629
Radiation Level	35	kW/m2	143,128	141,967

Radiation Effects: Early Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\009.H09

		Radiation Level (kW/m2)
		Noite
	Dia	

Late Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\009.H09

		Dia	Noite
Late Pool Fire Status		Hazard	Hazard

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Radiation Effects: Late Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\009.H09

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	392,676	401,181
Radiation Level	19,45	kW/m2	307,527	312,76
Radiation Level	35	kW/m2	240,917	243,738

Radiation Effects: Late Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\009.H09

	Radiation Level (kW/m2)	
	Dia	Noite

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\009.H09

All flammable results are reported at the flammable effect height 1 m

			Distance (m)	
			Dia	Noite
Furthest Extent	44000	ppm	277,376	324,555
Furthest Extent	44000	ppm	277,376	324,555

			Heights (m) for above distances	
			Dia	Noite
Furthest Extent	44000	ppm	1	1
Furthest Extent	44000	ppm	1	1

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\009.H09

Explosion Model Used : TNT

Explosion Location Criterion: Cloud Center

All distances are measured from the Source

All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	396,199	441,294
Overpressure	0,1	bar	338,225	378,86
Overpressure	0,3	bar	236,477	269,284

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	6604,48	8249,07
Used Flammable Mass		kg	6604,48	8249,07
Overpressure Radius		m	261,199	281,294
Distance to:				
- Ignition Source		m	270	320
- Cloud Front/Centre		m	270	320
- Explosion Centre		m	135	160

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	6604,48	8249,07
Used Flammable Mass		kg	6604,48	8249,07
Overpressure Radius		m	203,225	218,86
Distance to:				
- Ignition Source		m	270	320
- Cloud Front/Centre		m	270	320
- Explosion Centre		m	135	160

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	6604,48	8249,07
Used Flammable Mass		kg	6604,48	8249,07
Overpressure Radius		m	101,477	109,284
Distance to:				
- Ignition Source		m	270	320
- Cloud Front/Centre		m	270	320
- Explosion Centre		m	135	160

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\009.H09

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

010.H10

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\010.H10

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Padded Liquid
Pressure Specification	Pressure specified
Storage Pressure - gauge	4 bar
Temperature	-160 degC
Volume Inventory	4,55E4 m3

Scenario

Scenario Type	Line rupture
Phase to be Released	Liquid
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Tank Head	1 m
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	25,4 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1,912E7 kg

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

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

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \\Modelagem de Consequências - CELSE\Study\010.H10

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 19.123.518,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 5,01 bar
- Temperature -160,00 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 5.61470E+000 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 1,17 bar
- Temperature -159,86 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 26,38 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -161,48 degC
- Liquid Mass Fraction 0,99 fraction
- Droplet Diameter 328,87 um
- Expanded Radius 0,02 m
- Velocity 28,62 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 19.123.518,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 5,01 bar
- Temperature -160,00 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	5.61470E+000 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	1,17 bar
- Temperature	-159,86 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	26,38 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-161,48 degC
- Liquid Mass Fraction	0,99 fraction
- Droplet Diameter	328,87 um
- Expanded Radius	0,02 m
- Velocity	28,62 m/s



Consequence Results

Pool Vaporization Results

Path: \Modelagem de Consequências - CELSE\Study\010.H10

			Dia	Noite
		Release Segment 1		
Release Duration	s		600	600
Liquid Rainout	fraction		0,0444499	0,105119
		Release Segment 1 Cloud Segment 1		
Cloud Segment Duration	s		65,5513	71,5888
Pool Vaporization Rate	kg/s		0,205408	0,479297
Total Vapor Flowrate	kg/s		5,57054	5,50379
		Release Segment 1 Cloud Segment 2		
Cloud Segment Duration	s		534,449	528,411
Pool Vaporization Rate	kg/s		0,246204	0,581462
Total Vapor Flowrate	kg/s		5,61133	5,60595
Maximum Pool Radius	m		0,851774	1,38455

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\010.H10

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Dia	Noite	Distance (m)
UFL (165000)	18,75	s	10,3007		10,3105
LFL (44000)	18,75	s	38,9856		44,4784
LFL Frac (44000)	18,75	s	38,9856		44,4784
Concentration(ppm)	Averaging Time		Dia	Noite	Heights (m) for above distances
UFL (165000)	18,75	s	1		1
LFL (44000)	18,75	s	1		1
LFL Frac (44000)	18,75	s	1		1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\010.H10

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Truncated	Truncated
Flame Direction	Horizontal	Horizontal



Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\010.H10

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

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	51,6917	52,2118
Radiation Level	19,46	kW/m2	45,723	46,2
Radiation Level	35	kW/m2	41,3594	41,7795

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\010.H10

		Radiation Level (kW/m2)
		Noite
	Dia	

Early Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\010.H10

		Dia	Noite
Early Pool Fire Status		Hazard	Hazard

Radiation Effects: Early Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\010.H10

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	12,6144	15,331
Radiation Level	19,45	kW/m2	12,4753	14,2525
Radiation Level	35	kW/m2	12,4753	12,5019

Radiation Effects: Early Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\010.H10

		Radiation Level (kW/m2)
		Noite
	Dia	

Late Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\010.H10

		Dia	Noite
Late Pool Fire Status		Hazard	Hazard

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Radiation Effects: Late Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\010.H10

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	13,334	17,1084
Radiation Level	19,45	kW/m2	12,7668	15,6338
Radiation Level	35	kW/m2	12,5363	13,3698

Radiation Effects: Late Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\010.H10

Dia
Noite
Radiation Level (kW/m2)

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\010.H10

All flammable results are reported at the flammable effect height 1 m

			Distance (m)	
			Dia	Noite
Furthest Extent	44000	ppm	38,9856	44,4784
Furthest Extent	44000	ppm	38,9856	44,4784

			Heights (m) for above distances	
			Dia	Noite
Furthest Extent	44000	ppm	1	1
Furthest Extent	44000	ppm	1	1



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\010.H10

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	51,8216	62,8861
Overpressure	0,1	bar	43,649	53,3674
Overpressure	0,3	bar	29,3054	36,6615

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	18,5026	29,2331
Used Flammable Mass		kg	18,5026	29,2331
Overpressure Radius		m	36,8216	42,8861
Distance to:				
- Ignition Source		m	30	40
- Cloud Front/Centre		m	30	40
- Explosion Centre		m	15	20

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	18,5026	29,2331
Used Flammable Mass		kg	18,5026	29,2331
Overpressure Radius		m	28,649	33,3674
Distance to:				
- Ignition Source		m	30	40
- Cloud Front/Centre		m	30	40
- Explosion Centre		m	15	20

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	18,5026	29,2331
Used Flammable Mass		kg	18,5026	29,2331
Overpressure Radius		m	14,3054	16,6615
Distance to:				
- Ignition Source		m	30	40
- Cloud Front/Centre		m	30	40
- Explosion Centre		m	15	20

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\010.H10

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

011.H11

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\011.H11

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Padded Liquid
Pressure Specification	Pressure specified
Storage Pressure - gauge	0,25 bar
Temperature	-160 degC
Volume Inventory	4,25E4 m3

Scenario

Scenario Type	Line rupture
Phase to be Released	Liquid
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Tank Head	1 m
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	350 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1,786E7 kg

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

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

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\011.H11

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 17.862.626,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 1,26 bar
- Temperature -160,00 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 2.86187E+002 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 1,15 bar
- Temperature -159,99 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 7,08 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -161,48 degC
- Liquid Mass Fraction 0,99 fraction
- Droplet Diameter 533,60 um
- Expanded Radius 0,24 m
- Velocity 12,38 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 17.862.626,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 1,26 bar
- Temperature -160,00 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	2.86187E+002 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	1,15 bar
- Temperature	-159,99 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	7,08 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-161,48 degC
- Liquid Mass Fraction	0,99 fraction
- Droplet Diameter	533,60 um
- Expanded Radius	0,24 m
- Velocity	12,38 m/s



Consequence Results

Pool Vaporization Results

Path: \Modelagem de Consequências - CELSE\Study\011.H11

			Dia	Noite
		Release Segment 1		
Release Duration	s		600	600
Liquid Rainout	fraction		0,903936	0,910865
		Release Segment 1 Cloud Segment 1		
Cloud Segment Duration	s		83,7225	84,64
Pool Vaporization Rate	kg/s		165,637	163,449
Total Vapor Flowrate	kg/s		193,129	188,958
		Release Segment 1 Cloud Segment 2		
Cloud Segment Duration	s		516,277	515,36
Pool Vaporization Rate	kg/s		239,616	240,121
Total Vapor Flowrate	kg/s		267,108	265,63
Maximum Pool Radius	m		51,1324	52,8181

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\011.H11

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Dia	Noite	Distance (m)
UFL (165000)	18,75	s	56,2586	76,6382	
LFL (44000)	18,75	s	146,16	248,189	
LFL Frac (44000)	18,75	s	146,16	248,189	
Concentration(ppm)	Averaging Time		Dia	Noite	Heights (m) for above distances
UFL (165000)	18,75	s	1	1	
LFL (44000)	18,75	s	1	1	
LFL Frac (44000)	18,75	s	1	1	

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\011.H11

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Truncated	Truncated
Flame Direction	Horizontal	Horizontal



Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\011.H11

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

Radiation Level			Distance (m)	
			Dia	Noite
9,85	kW/m2		172,476	168,639
19,46	kW/m2		152,612	149,317
35	kW/m2		138,821	135,818

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\011.H11

	Radiation Level (kW/m2)	
	Dia	Noite

Early Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\011.H11

	Dia	Noite
Early Pool Fire Status	Hazard	Hazard

Radiation Effects: Early Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\011.H11

Radiation Level			Distance (m)	
			Dia	Noite
9,85	kW/m2		172,575	172,177
19,45	kW/m2		135,105	134,637
35	kW/m2		106,492	105,533

Radiation Effects: Early Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\011.H11

	Radiation Level (kW/m2)	
	Dia	Noite

Late Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\011.H11

	Dia	Noite
Late Pool Fire Status	Hazard	Hazard

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Radiation Effects: Late Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\011.H11

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	302,025	308,411
Radiation Level	19,45	kW/m2	235,096	239,225
Radiation Level	35	kW/m2	182,744	184,904

Radiation Effects: Late Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\011.H11

Dia
Noite
Radiation Level (kW/m2)

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\011.H11

All flammable results are reported at the flammable effect height 1 m

			Distance (m)	
			Dia	Noite
Furthest Extent	44000	ppm	146,16	248,189
Furthest Extent	44000	ppm	146,16	248,189

			Heights (m) for above distances	
			Dia	Noite
Furthest Extent	44000	ppm	1	1
Furthest Extent	44000	ppm	1	1



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\011.H11

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	250,963	347,685
Overpressure	0,1	bar	210,798	297,15
Overpressure	0,3	bar	140,305	208,457

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	2196,31	4374,52
Used Flammable Mass		kg	2196,31	4374,52
Overpressure Radius		m	180,963	227,685
Distance to:				
- Ignition Source		m	140	240
- Cloud Front/Centre		m	140	240
- Explosion Centre		m	70	120

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	2196,31	4374,52
Used Flammable Mass		kg	2196,31	4374,52
Overpressure Radius		m	140,798	177,15
Distance to:				
- Ignition Source		m	140	240
- Cloud Front/Centre		m	140	240
- Explosion Centre		m	70	120

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	2196,31	4374,52
Used Flammable Mass		kg	2196,31	4374,52
Overpressure Radius		m	70,3052	88,4573
Distance to:				
- Ignition Source		m	140	240
- Cloud Front/Centre		m	140	240
- Explosion Centre		m	70	120

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\011.H11

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

012.H12

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\012.H12

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Padded Liquid
Pressure Specification	Pressure specified
Storage Pressure - gauge	0,25 bar
Temperature	-160 degC
Volume Inventory	4,25E4 m3

Scenario

Scenario Type	Line rupture
Phase to be Released	Liquid
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Tank Head	1 m
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	35 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1,786E7 kg

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

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

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\012.H12

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 17.862.626,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 1,26 bar
- Temperature -160,00 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 2.86187E+000 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 1,14 bar
- Temperature -159,99 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 7,08 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -161,48 degC
- Liquid Mass Fraction 0,99 fraction
- Droplet Diameter 534,34 um
- Expanded Radius 0,02 m
- Velocity 12,33 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 17.862.626,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 1,26 bar
- Temperature -160,00 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	2.86187E+000 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	1,14 bar
- Temperature	-159,99 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	7,08 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-161,48 degC
- Liquid Mass Fraction	0,99 fraction
- Droplet Diameter	534,34 um
- Expanded Radius	0,02 m
- Velocity	12,33 m/s



Consequence Results

Pool Vaporization Results

Path: \Modelagem de Consequências - CELSE\Study\012.H12

			Dia	Noite
		Release Segment 1		
Release Duration	s		600	600
Liquid Rainout	fraction		0,459862	0,511508
		Release Segment 1 Cloud Segment 1		
Cloud Segment Duration	s		75,2205	77,0053
Pool Vaporization Rate	kg/s		1,00888	1,10585
Total Vapor Flowrate	kg/s		2,55469	2,50385
		Release Segment 1 Cloud Segment 2		
Cloud Segment Duration	s		524,78	522,995
Pool Vaporization Rate	kg/s		1,29773	1,43933
Total Vapor Flowrate	kg/s		2,84354	2,83733
Maximum Pool Radius	m		2,21928	2,47138

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\012.H12

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Dia	Noite	Distance (m)
UFL (165000)	18,75	s	4,92174	4,14254	
LFL (44000)	18,75	s	26,406	34,7247	
LFL Frac (44000)	18,75	s	26,406	34,7247	
Concentration(ppm)	Averaging Time		Dia	Noite	Heights (m) for above distances
UFL (165000)	18,75	s	1	1	
LFL (44000)	18,75	s	1	1	
LFL Frac (44000)	18,75	s	1	1	

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\012.H12

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Truncated	Truncated
Flame Direction	Horizontal	Horizontal



Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\012.H12

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

Radiation Level			Distance (m)	
			Dia	Noite
9,85	kW/m2		39,9446	40,3643
19,46	kW/m2		35,6189	35,9972
35	kW/m2		32,4218	32,7317

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\012.H12

	Radiation Level (kW/m2)
Dia	Noite

Early Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\012.H12

	Dia	Noite
Early Pool Fire Status	Hazard	Hazard

Radiation Effects: Early Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\012.H12

Radiation Level			Distance (m)	
			Dia	Noite
9,85	kW/m2		15,5622	16,2668
19,45	kW/m2		13,4741	13,9953
35	kW/m2		10,6867	11,0083

Radiation Effects: Early Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\012.H12

	Radiation Level (kW/m2)
Dia	Noite

Late Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\012.H12

	Dia	Noite
Late Pool Fire Status	Hazard	Hazard

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Radiation Effects: Late Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\012.H12

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	19,8183	21,9251
Radiation Level	19,45	kW/m2	16,7802	18,3786
Radiation Level	35	kW/m2	13,1662	14,3315

Radiation Effects: Late Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\012.H12

Dia
Noite
Radiation Level (kW/m2)

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\012.H12

All flammable results are reported at the flammable effect height 1 m

			Distance (m)	
			Dia	Noite
Furthest Extent	44000	ppm	26,406	34,7247
Furthest Extent	44000	ppm	26,406	34,7247

			Heights (m) for above distances	
			Dia	Noite
Furthest Extent	44000	ppm	1	1
Furthest Extent	44000	ppm	1	1



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\012.H12

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	36,4127	46,5313
Overpressure	0,1	bar	30,5503	39,5329
Overpressure	0,3	bar	20,2615	27,2501

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	6,82909	11,6186
Used Flammable Mass		kg	6,82909	11,6186
Overpressure Radius		m	26,4127	31,5313
Distance to:				
- Ignition Source		m	20	30
- Cloud Front/Centre		m	20	30
- Explosion Centre		m	10	15

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	6,82909	11,6186
Used Flammable Mass		kg	6,82909	11,6186
Overpressure Radius		m	20,5503	24,5329
Distance to:				
- Ignition Source		m	20	30
- Cloud Front/Centre		m	20	30
- Explosion Centre		m	10	15

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	6,82909	11,6186
Used Flammable Mass		kg	6,82909	11,6186
Overpressure Radius		m	10,2615	12,2501
Distance to:				
- Ignition Source		m	20	30
- Cloud Front/Centre		m	20	30
- Explosion Centre		m	10	15

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\012.H12

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

013.H13

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\013.H13

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Padded Liquid
Pressure Specification	Pressure specified
Storage Pressure - gauge	4,5 bar
Temperature	-160 degC
Volume Inventory	4,25E4 m3

Scenario

Scenario Type	Line rupture
Phase to be Released	Liquid
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Tank Head	0 m
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	350 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1,786E7 kg

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

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

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\013.H13

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 17.862.626,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 5,51 bar
- Temperature -160,00 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 1.12498E+003 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 1,16 bar
- Temperature -159,85 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 27,84 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -161,48 degC
- Liquid Mass Fraction 0,99 fraction
- Droplet Diameter 321,06 um
- Expanded Radius 0,32 m
- Velocity 29,92 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 17.862.626,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 5,51 bar
- Temperature -160,00 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	1.12498E+003 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	1,16 bar
- Temperature	-159,85 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	27,84 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-161,48 degC
- Liquid Mass Fraction	0,99 fraction
- Droplet Diameter	321,06 um
- Expanded Radius	0,32 m
- Velocity	29,92 m/s



Consequence Results

Pool Vaporization Results

Path: \Modelagem de Consequências - CELSE\Study\013.H13

			Dia	Noite
		Release Segment 1		
Release Duration	s		600	600
Liquid Rainout	fraction		0,847494	0,850336
		Release Segment 1 Cloud Segment 1		
Cloud Segment Duration	s		103,531	105,063
Pool Vaporization Rate	kg/s		488,89	478,866
Total Vapor Flowrate	kg/s		660,456	647,235
		Release Segment 1 Cloud Segment 2		
Cloud Segment Duration	s		496,469	494,938
Pool Vaporization Rate	kg/s		911,495	910,041
Total Vapor Flowrate	kg/s		1083,06	1078,41
Maximum Pool Radius	m		101,069	104,2

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\013.H13

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)		Averaging Time			Distance (m)	
					Dia	Noite
UFL (165000)	18,75	s			125,62	132,59
LFL (44000)	18,75	s			345,137	408,938
LFL Frac (44000)	18,75	s			345,137	408,938
Concentration(ppm)		Averaging Time			Heights (m) for above distances	
					Dia	Noite
UFL (165000)	18,75	s			1	1
LFL (44000)	18,75	s			1	1
LFL Frac (44000)	18,75	s			1	1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\013.H13

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Truncated	Truncated
Flame Direction	Horizontal	Horizontal



Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\013.H13

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

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	371,78	372,24
Radiation Level	19,46	kW/m2	325,75	326,416
Radiation Level	35	kW/m2	294,129	294,845

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\013.H13

		Radiation Level (kW/m2)
		Noite
	Dia	

Early Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\013.H13

		Dia	Noite
Early Pool Fire Status		Hazard	Hazard

Radiation Effects: Early Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\013.H13

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	297,169	296,266
Radiation Level	19,45	kW/m2	235,059	233,953
Radiation Level	35	kW/m2	186,628	184,898

Radiation Effects: Early Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\013.H13

		Radiation Level (kW/m2)
		Noite
	Dia	

Late Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\013.H13

		Dia	Noite
Late Pool Fire Status		Hazard	Hazard

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Radiation Effects: Late Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\013.H13

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	525,081	535,623
Radiation Level	19,45	kW/m2	409,474	415,933
Radiation Level	35	kW/m2	319,581	323,058

Radiation Effects: Late Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\013.H13

Dia
Noite
Radiation Level (kW/m2)

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\013.H13

All flammable results are reported at the flammable effect height 1 m

			Distance (m)	
			Dia	Noite
Furthest Extent	44000	ppm	345,137	408,938
Furthest Extent	44000	ppm	345,137	408,938

			Heights (m) for above distances	
			Dia	Noite
Furthest Extent	44000	ppm	1	1
Furthest Extent	44000	ppm	1	1



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\013.H13

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	503,182	558,346
Overpressure	0,1	bar	429,232	478,811
Overpressure	0,3	bar	299,443	339,22

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	13707,9	17054,3
Used Flammable Mass		kg	13707,9	17054,3
Overpressure Radius		m	333,182	358,346
Distance to:				
- Ignition Source		m	340	400
- Cloud Front/Centre		m	340	400
- Explosion Centre		m	170	200

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	13707,9	17054,3
Used Flammable Mass		kg	13707,9	17054,3
Overpressure Radius		m	259,232	278,811
Distance to:				
- Ignition Source		m	340	400
- Cloud Front/Centre		m	340	400
- Explosion Centre		m	170	200

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	13707,9	17054,3
Used Flammable Mass		kg	13707,9	17054,3
Overpressure Radius		m	129,443	139,22
Distance to:				
- Ignition Source		m	340	400
- Cloud Front/Centre		m	340	400
- Explosion Centre		m	170	200

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\013.H13

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

014.H14

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\014.H14

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Padded Liquid
Pressure Specification	Pressure specified
Storage Pressure - gauge	4,5 bar
Temperature	-160 degC
Volume Inventory	4,25E4 m3

Scenario

Scenario Type	Line rupture
Phase to be Released	Liquid
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Tank Head	0 m
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	35 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1,786E7 kg

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

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

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\014.H14

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 17.862.626,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 5,51 bar
- Temperature -160,00 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 1.12498E+001 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 1,16 bar
- Temperature -159,85 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 27,84 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -161,48 degC
- Liquid Mass Fraction 0,99 fraction
- Droplet Diameter 321,06 um
- Expanded Radius 0,03 m
- Velocity 29,92 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 17.862.626,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 5,51 bar
- Temperature -160,00 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	1.12498E+001 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	1,16 bar
- Temperature	-159,85 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	27,84 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-161,48 degC
- Liquid Mass Fraction	0,99 fraction
- Droplet Diameter	321,06 um
- Expanded Radius	0,03 m
- Velocity	29,92 m/s



Consequence Results

Pool Vaporization Results

Path: \Modelagem de Consequências - CELSE\Study\014.H14

			Dia	Noite
		Release Segment 1		
Release Duration	s		600	600
Liquid Rainout	fraction		0,145572	0,206446
		Release Segment 1 Cloud Segment 1		
Cloud Segment Duration	s		76,0509	77,2209
Pool Vaporization Rate	kg/s		1,2412	1,71124
Total Vapor Flowrate	kg/s		10,8534	10,6386
		Release Segment 1 Cloud Segment 2		
Cloud Segment Duration	s		523,949	522,779
Pool Vaporization Rate	kg/s		1,61006	2,25909
Total Vapor Flowrate	kg/s		11,2222	11,1864
Maximum Pool Radius	m		2,59608	3,47786

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\014.H14

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)		Averaging Time			Distance (m)	
					Dia	Noite
UFL (165000)	18,75	s			15,7017	23,3605
LFL (44000)	18,75	s			55,5055	65,847
LFL Frac (44000)	18,75	s			55,5055	65,847
Concentration(ppm)		Averaging Time			Heights (m) for above distances	
					Dia	Noite
UFL (165000)	18,75	s			1	1
LFL (44000)	18,75	s			1	1
LFL Frac (44000)	18,75	s			1	1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\014.H14

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Truncated	Truncated
Flame Direction	Horizontal	Horizontal



Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\014.H14

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

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	69,9912	70,688
Radiation Level	19,46	kW/m2	61,8135	62,4637
Radiation Level	35	kW/m2	55,9248	56,5045

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\014.H14

	Radiation Level (kW/m2)	
	Dia	Noite

Early Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\014.H14

	Dia	Noite
Early Pool Fire Status	Hazard	Hazard

Radiation Effects: Early Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\014.H14

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	23,1587	26,1922
Radiation Level	19,45	kW/m2	20,6964	23,0078
Radiation Level	35	kW/m2	17,4996	19,2407

Radiation Effects: Early Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\014.H14

	Radiation Level (kW/m2)	
	Dia	Noite

Late Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\014.H14

	Dia	Noite
Late Pool Fire Status	Hazard	Hazard

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Radiation Effects: Late Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\014.H14

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	29,0681	36,807
Radiation Level	19,45	kW/m2	25,2767	31,2007
Radiation Level	35	kW/m2	21,1451	26,0234

Radiation Effects: Late Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\014.H14

Dia
Radiation Level (kW/m2)
Noite

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\014.H14

All flammable results are reported at the flammable effect height 1 m

			Distance (m)	
			Dia	Noite
Furthest Extent	44000	ppm	55,5055	65,847
Furthest Extent	44000	ppm	55,5055	65,847

			Heights (m) for above distances	
			Dia	Noite
Furthest Extent	44000	ppm	1	1
Furthest Extent	44000	ppm	1	1



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\014.H14

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	78,3053	89,7189
Overpressure	0,1	bar	66,4741	76,4642
Overpressure	0,3	bar	45,7095	53,2012

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	56,1356	78,9334
Used Flammable Mass		kg	56,1356	78,9334
Overpressure Radius		m	53,3053	59,7189
Distance to:				
- Ignition Source		m	50	60
- Cloud Front/Centre		m	50	60
- Explosion Centre		m	25	30

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	56,1356	78,9334
Used Flammable Mass		kg	56,1356	78,9334
Overpressure Radius		m	41,4741	46,4642
Distance to:				
- Ignition Source		m	50	60
- Cloud Front/Centre		m	50	60
- Explosion Centre		m	25	30

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	56,1356	78,9334
Used Flammable Mass		kg	56,1356	78,9334
Overpressure Radius		m	20,7095	23,2012
Distance to:				
- Ignition Source		m	50	60
- Cloud Front/Centre		m	50	60
- Explosion Centre		m	25	30

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\014.H14

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

015.H15

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\015.H15

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Padded Liquid
Pressure Specification	Pressure specified
Storage Pressure - gauge	4,5 bar
Temperature	-153,4 degC
Volume Inventory	4,25E4 m3

Scenario

Scenario Type	Line rupture
Phase to be Released	Liquid
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Tank Head	1 m
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	400 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1,743E7 kg

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

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

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\015.H15

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 17.434.422,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 5,51 bar
- Temperature -153,40 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 1.46073E+003 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 1,90 bar
- Temperature -153,29 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 28,35 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -161,48 degC
- Liquid Mass Fraction 0,94 fraction
- Droplet Diameter 279,69 um
- Expanded Radius 0,52 m
- Velocity 56,51 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 17.434.422,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 5,51 bar
- Temperature -153,40 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	1.46073E+003 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	1,90 bar
- Temperature	-153,29 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	28,35 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-161,48 degC
- Liquid Mass Fraction	0,94 fraction
- Droplet Diameter	279,69 um
- Expanded Radius	0,52 m
- Velocity	56,51 m/s



Consequence Results

Pool Vaporization Results

Path: \Modelagem de Consequências - CELSE\Study\015.H15

			Dia	Noite
		Release Segment 1		
Release Duration	s		600	600
Liquid Rainout	fraction		0,661145	0,661868
		Release Segment 1 Cloud Segment 1		
Cloud Segment Duration	s		104,04	105,576
Pool Vaporization Rate	kg/s		492,916	481,864
Total Vapor Flowrate	kg/s		987,892	975,782
		Release Segment 1 Cloud Segment 2		
Cloud Segment Duration	s		495,96	494,424
Pool Vaporization Rate	kg/s		923,696	920,076
Total Vapor Flowrate	kg/s		1418,67	1413,99
Maximum Pool Radius	m		101,904	104,95

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\015.H15

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)		Averaging Time			Distance (m)	
					Dia	Noite
UFL (165000)	18,75	s			203,624	226,316
LFL (44000)	18,75	s			460,6	587,669
LFL Frac (44000)	18,75	s			460,6	587,669
Concentration(ppm)		Averaging Time			Heights (m) for above distances	
					Dia	Noite
UFL (165000)	18,75	s			1	1
LFL (44000)	18,75	s			1	1
LFL Frac (44000)	18,75	s			1	1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\015.H15

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Truncated	Truncated
Flame Direction	Horizontal	Horizontal



Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\015.H15

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

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	568,19	573,111
Radiation Level	19,46	kW/m2	496,283	501,152
Radiation Level	35	kW/m2	447,428	452,192

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\015.H15

	Radiation Level (kW/m2)	
	Dia	Noite

Early Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\015.H15

	Dia	Noite
Early Pool Fire Status	Hazard	Hazard

Radiation Effects: Early Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\015.H15

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	316,419	315,233
Radiation Level	19,45	kW/m2	254,001	252,649
Radiation Level	35	kW/m2	205,321	203,386

Radiation Effects: Early Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\015.H15

	Radiation Level (kW/m2)	
	Dia	Noite

Late Pool Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\015.H15

	Dia	Noite
Late Pool Fire Status	Hazard	Hazard

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Radiation Effects: Late Pool Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\015.H15

			Distance (m)	
			Dia	Noite
Radiation Level	9,85	kW/m2	546,203	556,323
Radiation Level	19,45	kW/m2	429,83	435,949
Radiation Level	35	kW/m2	339,354	342,55

Radiation Effects: Late Pool Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\015.H15

Dia
Noite
Radiation Level (kW/m2)

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\015.H15

All flammable results are reported at the flammable effect height 1 m

			Distance (m)	
			Dia	Noite
Furthest Extent	44000	ppm	460,6	587,669
Furthest Extent	44000	ppm	460,6	587,669

			Heights (m) for above distances	
			Dia	Noite
Furthest Extent	44000	ppm	1	1
Furthest Extent	44000	ppm	1	1



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\015.H15

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	689,059	749,277
Overpressure	0,1	bar	587,17	647,339
Overpressure	0,3	bar	408,348	468,432

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	35853,5	35904,5
Used Flammable Mass		kg	35853,5	35904,5
Overpressure Radius		m	459,059	459,277
Distance to:				
- Ignition Source		m	460	580
- Cloud Front/Centre		m	460	580
- Explosion Centre		m	230	290

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	35853,5	35904,5
Used Flammable Mass		kg	35853,5	35904,5
Overpressure Radius		m	357,17	357,339
Distance to:				
- Ignition Source		m	460	580
- Cloud Front/Centre		m	460	580
- Explosion Centre		m	230	290

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	35853,5	35904,5
Used Flammable Mass		kg	35853,5	35904,5
Overpressure Radius		m	178,348	178,432
Distance to:				
- Ignition Source		m	460	580
- Cloud Front/Centre		m	460	580
- Explosion Centre		m	230	290

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\015.H15

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

016.H16

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\016.H16

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Padded Liquid
Pressure Specification	Pressure specified
Storage Pressure - gauge	4,5 bar
Temperature	-153,4 degC
Volume Inventory	4,25E4 m3

Scenario

Scenario Type	Line rupture
Phase to be Released	Liquid
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Tank Head	1 m
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	40 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1,743E7 kg

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

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

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\016.H16

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 17.434.422,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 5,51 bar
- Temperature -153,40 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 1.46073E+001 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 1,90 bar
- Temperature -153,29 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 28,35 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -161,48 degC
- Liquid Mass Fraction 0,94 fraction
- Droplet Diameter 279,69 um
- Expanded Radius 0,05 m
- Velocity 56,51 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 17.434.422,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 5,51 bar
- Temperature -153,40 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	1.46073E+001 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	1,90 bar
- Temperature	-153,29 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	28,35 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-161,48 degC
- Liquid Mass Fraction	0,94 fraction
- Droplet Diameter	279,69 um
- Expanded Radius	0,05 m
- Velocity	56,51 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\016.H16

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Distance (m)	
			Dia	Noite
UFL (165000)	18,75	s	21,3394	22,7694
LFL (44000)	18,75	s	65,8744	73,1716
LFL Frac (44000)	18,75	s	65,8744	73,1716

Concentration(ppm)	Averaging Time		Heights (m) for above distances	
			Dia	Noite
UFL (165000)	18,75	s	1	1
LFL (44000)	18,75	s	1	1
LFL Frac (44000)	18,75	s	1	1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\016.H16

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Truncated	Truncated
Flame Direction	Horizontal	Horizontal

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\016.H16

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

Radiation Level			Distance (m)	
			Dia	Noite
9,85	kW/m2		75,4529	76,1547
19,46	kW/m2		66,5151	67,2082
35	kW/m2		60,202	60,8588

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\016.H16

	Dia	Radiation Level (kW/m2)
		Noite

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\016.H16

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm	65,8744	73,1716	
Furthest Extent	44000	ppm	65,8744	73,1716	
				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm	1	1	
Furthest Extent	44000	ppm	1	1	



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\016.H16

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	89,8194	101,763
Overpressure	0,1	bar	76,5424	86,9447
Overpressure	0,3	bar	53,2403	60,9378

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	79,3328	110,288
Used Flammable Mass		kg	79,3328	110,288
Overpressure Radius		m	59,8194	66,7628
Distance to:				
- Ignition Source		m	60	70
- Cloud Front/Centre		m	60	70
- Explosion Centre		m	30	35

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	79,3328	110,288
Used Flammable Mass		kg	79,3328	110,288
Overpressure Radius		m	46,5424	51,9447
Distance to:				
- Ignition Source		m	60	70
- Cloud Front/Centre		m	60	70
- Explosion Centre		m	30	35

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	79,3328	110,288
Used Flammable Mass		kg	79,3328	110,288
Overpressure Radius		m	23,2403	25,9378
Distance to:				
- Ignition Source		m	60	70
- Cloud Front/Centre		m	60	70
- Explosion Centre		m	30	35

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\016.H16

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

017.H17

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\017.H17

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Padded Liquid
Pressure Specification	Pressure specified
Storage Pressure - gauge	109 bar
Temperature	-145,8 degC
Volume Inventory	4,25E4 m3

Scenario

Scenario Type	Line rupture
Phase to be Released	Liquid
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Tank Head	0 m
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	200 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1,692E7 kg

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

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

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\017.H17

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 16.918.774,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 110,01 bar
- Temperature -145,80 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 1.76769E+003 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 3,80 bar
- Temperature -142,82 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 143,12 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -161,48 degC
- Liquid Mass Fraction 0,88 fraction
- Droplet Diameter 71,18 um
- Expanded Radius 0,47 m
- Velocity 179,42 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 16.918.774,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 110,01 bar
- Temperature -145,80 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	1.76769E+003 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	3,80 bar
- Temperature	-142,82 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	143,12 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-161,48 degC
- Liquid Mass Fraction	0,88 fraction
- Droplet Diameter	71,18 um
- Expanded Radius	0,47 m
- Velocity	179,42 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\017.H17

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Distance (m)	
			Dia	Noite
UFL (165000)	18,75	s	364,544	398,37
LFL (44000)	18,75	s	700,967	815,619
LFL Frac (44000)	18,75	s	700,967	815,619

Concentration(ppm)	Averaging Time		Heights (m) for above distances	
			Dia	Noite
UFL (165000)	18,75	s	1	1
LFL (44000)	18,75	s	1	1
LFL Frac (44000)	18,75	s	1	1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\017.H17

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Truncated	Truncated
Flame Direction	Horizontal	Horizontal

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\017.H17

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

Radiation Level			Distance (m)	
			Dia	Noite
9,85	kW/m2		551,269	555,548
19,46	kW/m2		484,442	488,924
35	kW/m2		439,719	444,31

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\017.H17

	Dia	Radiation Level (kW/m2)
		Noite

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\017.H17

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm		700,967	815,619
Furthest Extent	44000	ppm		700,967	815,619
				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm		1	1
Furthest Extent	44000	ppm		1	1



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\017.H17

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	915,311	1034,03
Overpressure	0,1	bar	789,839	894,418
Overpressure	0,3	bar	569,627	649,383

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	66955,7	92245,6
Used Flammable Mass		kg	66955,7	92245,6
Overpressure Radius		m	565,311	629,033
Distance to:				
- Ignition Source		m	700	810
- Cloud Front/Centre		m	700	810
- Explosion Centre		m	350	405

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	66955,7	92245,6
Used Flammable Mass		kg	66955,7	92245,6
Overpressure Radius		m	439,839	489,418
Distance to:				
- Ignition Source		m	700	810
- Cloud Front/Centre		m	700	810
- Explosion Centre		m	350	405

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	66955,7	92245,6
Used Flammable Mass		kg	66955,7	92245,6
Overpressure Radius		m	219,627	244,383
Distance to:				
- Ignition Source		m	700	810
- Cloud Front/Centre		m	700	810
- Explosion Centre		m	350	405

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\017.H17

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

018.H18

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\018.H18

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Padded Liquid
Pressure Specification	Pressure specified
Storage Pressure - gauge	109 bar
Temperature	-145,8 degC
Volume Inventory	4,25E4 m3

Scenario

Scenario Type	Line rupture
Phase to be Released	Liquid
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Tank Head	0 m
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	20 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1,692E7 kg

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

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

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\018.H18

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 16.918.774,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 110,01 bar
- Temperature -145,80 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 1.67807E+001 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 3,84 bar
- Temperature -142,81 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 135,87 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -161,48 degC
- Liquid Mass Fraction 0,88 fraction
- Droplet Diameter 71,15 um
- Expanded Radius 0,05 m
- Velocity 173,76 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 16.918.774,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 110,01 bar
- Temperature -145,80 degC
- Fluid State Non-saturated liquid

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	1.67807E+001 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	3,84 bar
- Temperature	-142,81 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	135,87 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-161,48 degC
- Liquid Mass Fraction	0,88 fraction
- Droplet Diameter	71,15 um
- Expanded Radius	0,05 m
- Velocity	173,76 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\018.H18

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Distance (m)	
			Dia	Noite
UFL (165000)	18,75	s	16,1438	16,9752
LFL (44000)	18,75	s	79,0453	87,0495
LFL Frac (44000)	18,75	s	79,0453	87,0495

Concentration(ppm)	Averaging Time		Heights (m) for above distances	
			Dia	Noite
UFL (165000)	18,75	s	1	1
LFL (44000)	18,75	s	1	1
LFL Frac (44000)	18,75	s	1	1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\018.H18

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Truncated	Truncated
Flame Direction	Horizontal	Horizontal

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\018.H18

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

Radiation Level			Distance (m)	
			Dia	Noite
9,85	kW/m2		70,3989	71,005
19,46	kW/m2		62,4462	63,0756
35	kW/m2		57,0205	57,6543

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\018.H18

	Dia	Radiation Level (kW/m2)
		Noite

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\018.H18

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm		79,0453	87,0495
Furthest Extent	44000	ppm		79,0453	87,0495
				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm		1	1
Furthest Extent	44000	ppm		1	1



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\018.H18

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	90,1535	99,3665
Overpressure	0,1	bar	77,9121	86,19
Overpressure	0,3	bar	56,4274	63,0643

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	62,1796	77,5442
Used Flammable Mass		kg	62,1796	77,5442
Overpressure Radius		m	55,1536	59,3665
Distance to:				
- Ignition Source		m	70	80
- Cloud Front/Centre		m	70	80
- Explosion Centre		m	34,9999	40

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	62,1796	77,5442
Used Flammable Mass		kg	62,1796	77,5442
Overpressure Radius		m	42,9122	46,19
Distance to:				
- Ignition Source		m	70	80
- Cloud Front/Centre		m	70	80
- Explosion Centre		m	34,9999	40

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	62,1796	77,5442
Used Flammable Mass		kg	62,1796	77,5442
Overpressure Radius		m	21,4276	23,0643
Distance to:				
- Ignition Source		m	70	80
- Cloud Front/Centre		m	70	80
- Explosion Centre		m	34,9999	40

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\018.H18

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

019.H19

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\019.H19

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	105 bar
Temperature	5 degC
Volume Inventory	4,25E4 m3

Scenario

Scenario Type	Line rupture
Phase to be Released	Vapor
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	400 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	3,854E6 kg

Fireball Parameters

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

[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

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\019.H19

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 3.853.965,75 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 2.37871E+003 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 63,06 bar
- Temperature -22,15 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 313,02 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -103,81 degC
- Liquid Mass Fraction 0,00 fraction
- Droplet Diameter 0,00 um
- Expanded Radius 1,14 m
- Velocity 500,00 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 3.853.965,75 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	2.37871E+003 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	63,06 bar
- Temperature	-22,15 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	313,02 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-103,81 degC
- Liquid Mass Fraction	0,00 fraction
- Droplet Diameter	0,00 um
- Expanded Radius	1,14 m
- Velocity	500,00 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\019.H19

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Distance (m)	
			Dia	Noite
UFL (165000)	18,75	s	202,474	204,729
LFL (44000)	18,75	s	393,826	419,976
LFL Frac (44000)	18,75	s	393,826	419,976

Concentration(ppm)	Averaging Time		Heights (m) for above distances	
			Dia	Noite
UFL (165000)	18,75	s	1	1
LFL (44000)	18,75	s	1	1
LFL Frac (44000)	18,75	s	1	1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\019.H19

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Truncated	Truncated
Flame Direction	Horizontal	Horizontal

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\019.H19

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

Radiation Level			Distance (m)	
			Dia	Noite
9,85	kW/m2		537,133	535,721
19,46	kW/m2		444,045	441,465
35	kW/m2		382,743	382,748

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\019.H19

	Dia	Radiation Level (kW/m2)
		Noite

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\019.H19

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm		393,826	419,976
Furthest Extent	44000	ppm		393,826	419,976
				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm		1	1
Furthest Extent	44000	ppm		1	1



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\019.H19

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	601,839	615,995
Overpressure	0,1	bar	511,128	524,373
Overpressure	0,3	bar	351,925	363,568

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	25300,3	26071
Used Flammable Mass		kg	25300,3	26071
Overpressure Radius		m	408,695	412,804
Distance to:				
- Ignition Source		m	390	410
- Cloud Front/Centre		m	390	410
- Explosion Centre		m	193,144	203,191

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	25300,3	26071
Used Flammable Mass		kg	25300,3	26071
Overpressure Radius		m	317,985	321,181
Distance to:				
- Ignition Source		m	390	410
- Cloud Front/Centre		m	390	410
- Explosion Centre		m	193,144	203,191

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	25300,3	26071
Used Flammable Mass		kg	25300,3	26071
Overpressure Radius		m	158,781	160,377
Distance to:				
- Ignition Source		m	390	410
- Cloud Front/Centre		m	390	410
- Explosion Centre		m	193,144	203,191

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\019.H19

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

020.H20

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\020.H20

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	105 bar
Temperature	5 degC
Volume Inventory	4,25E4 m3

Scenario

Scenario Type	Line rupture
Phase to be Released	Vapor
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	40 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	3,854E6 kg

Fireball Parameters

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

[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

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\020.H20

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 3.853.965,75 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 2.37871E+001 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 52,67 bar
- Temperature -33,14 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 357,36 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -103,81 degC
- Liquid Mass Fraction 0,00 fraction
- Droplet Diameter 0,00 um
- Expanded Radius 0,11 m
- Velocity 500,00 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 3.853.965,75 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	2.37871E+001 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	52,67 bar
- Temperature	-33,14 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	357,36 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-103,81 degC
- Liquid Mass Fraction	0,00 fraction
- Droplet Diameter	0,00 um
- Expanded Radius	0,11 m
- Velocity	500,00 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\020.H20

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Distance (m)	
			Dia	Noite
UFL (165000)	18,75	s	9,2019	9,54662
LFL (44000)	18,75	s	71,5753	70,7859
LFL Frac (44000)	18,75	s	71,5753	70,7859

Concentration(ppm)	Averaging Time		Heights (m) for above distances	
			Dia	Noite
UFL (165000)	18,75	s	1	1
LFL (44000)	18,75	s	1	1
LFL Frac (44000)	18,75	s	1	1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\020.H20

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Truncated	Truncated
Flame Direction	Horizontal	Horizontal

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\020.H20

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

Radiation Level			Distance (m)	
			Dia	Noite
9,85	kW/m2		70,6134	70,3748
19,46	kW/m2		62,4755	62,1031
35	kW/m2		56,1059	55,5511

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\020.H20

	Dia	Radiation Level (kW/m2)
		Noite

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\020.H20

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm		71,5753	70,7859
Furthest Extent	44000	ppm		71,5753	70,7859
				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm		1	1
Furthest Extent	44000	ppm		1	1

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\020.H20

Explosion Model Used : TNT

Explosion Location Criterion: Cloud Center

All distances are measured from the Source

All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	79,5245	80,3242
Overpressure	0,1	bar	69,642	70,2637
Overpressure	0,3	bar	52,2975	52,6068

Supplementary Data at 0,069 bar

			Dia	Noite
Supplied Flammable Mass		kg	32,7153	34,515
Used Flammable Mass		kg	32,7153	34,515
Overpressure Radius		m	44,5255	45,3274
Distance to:				
- Ignition Source		m	70	70
- Cloud Front/Centre		m	70	70
- Explosion Centre		m	34,999	34,9968

Supplementary Data at 0,1 bar

			Dia	Noite
Supplied Flammable Mass		kg	32,7153	34,515
Used Flammable Mass		kg	32,7153	34,515
Overpressure Radius		m	34,643	35,2669
Distance to:				
- Ignition Source		m	70	70
- Cloud Front/Centre		m	70	70
- Explosion Centre		m	34,999	34,9968

Supplementary Data at 0,3 bar

			Dia	Noite
Supplied Flammable Mass		kg	32,7153	34,515
Used Flammable Mass		kg	32,7153	34,515
Overpressure Radius		m	17,2984	17,61
Distance to:				
- Ignition Source		m	70	70
- Cloud Front/Centre		m	70	70
- Explosion Centre		m	34,999	34,9968

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\020.H20

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

021.H21 - jato vertical

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\021.H21 - jato vertical

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	105 bar
Temperature	5 degC

Scenario

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

Pipe

Internal Diameter	457,2 mm
Line length	8000 m
Distance To Break	7000 m
Relative Aperture	1 fraction
Pumped Inflow	174,4 kg/s
Use Ambient Temperature	Do not use ambient temperature

Vessel/Tank

Duration of Interest	600 s
Time for Time-Varying Release	30 s
Method Used for Time Varying Releases	Given time

Location

Elevation	0 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	Vertical

Flammable

Explosion Method	TNT
Jet Fire Method	Cone Model

Dispersion

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

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)	733 m
North(1)	601 m

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\021.H21 - jato vertical

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Long Pipeline
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 6.17478E+002 kg/s
Release Duration 301,53 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure n/a bar
- Temperature n/a degC
- Vena Contracta Velocity (exit velocity for pipe releases) n/a m/s
- Discharge Coefficient n/a

Final data (after atmospheric expansion):

- Temperature -27,65 degC
- Liquid Mass Fraction 0,00 fraction
- Droplet Diameter 0,00 um
- Expanded Radius n/a m
- Velocity 488,65 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Long Pipeline
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	6.17478E+002 kg/s
Release Duration	301,53 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	n/a bar
- Temperature	n/a degC
- Vena Contracta Velocity (exit velocity for pipe releases)	n/a m/s
- Discharge Coefficient	n/a
Final data (after atmospheric expansion):	
- Temperature	-27,65 degC
- Liquid Mass Fraction	0,00 fraction
- Droplet Diameter	0,00 um
- Expanded Radius	n/a m
- Velocity	488,65 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\021.H21 - jato vertical

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Distance (m)	
			Dia	Noite
UFL (165000)	18,75	s	1,09918	1,08902
LFL (44000)	18,75	s	1,47906	1,4535
LFL Frac (44000)	18,75	s	1,47906	1,4535

Concentration(ppm)	Averaging Time		Heights (m) for above distances	
			Dia	Noite
UFL (165000)	18,75	s	1	1
LFL (44000)	18,75	s	1	1
LFL Frac (44000)	18,75	s	1	1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\021.H21 - jato vertical

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Hazard	Hazard
Flame Direction	Vertical	Vertical

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\021.H21 - jato vertical

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

Radiation Level			Distance (m)	
			Dia	Noite
9,85	kW/m2		139,82	136,832
19,46	kW/m2		66,8638	64,2262
35	kW/m2		Not Reached	Not Reached

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\021.H21 - jato vertical

	Radiation Level (kW/m2)
Dia	Noite

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\021.H21 - jato vertical

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm	1,47906	1,4535	
Furthest Extent	44000	ppm	1,47906	1,4535	

				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm	1	1	
Furthest Extent	44000	ppm	1	1	

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\021.H21 - jato vertical

			Dia	Noite
Wind Speed	m/s		4,9	4,6
Pasquill Stability			B/C	D
Surface Roughness Length	mm		951	951
Surface Roughness Parameter			0,170008	0,170008
Atmospheric Temperature	degC		27,2	26,3
Surface Temperature	degC		32,2	26,3
Relative Humidity	fraction		0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

022.H21 - jato 45°

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\022.H21 - jato 45°

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	105 bar
Temperature	5 degC

Scenario

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

Pipe

Internal Diameter	457,2 mm
Line length	8000 m
Distance To Break	7000 m
Relative Aperture	1 fraction
Pumped Inflow	174,4 kg/s
Use Ambient Temperature	Do not use ambient temperature

Vessel/Tank

Duration of Interest	600 s
Time for Time-Varying Release	30 s
Method Used for Time Varying Releases	Given time

Location

Elevation	0 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 Angle	45 deg
Outdoor Release Direction	Angled from Horizontal

Flammable

Explosion Method	TNT
Jet Fire Method	Cone Model

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

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) 733 m
North(1) 601 m

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \\Modelagem de Consequências - CELSE\Study\022.H21 - jato 45°

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Long Pipeline
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 6.17478E+002 kg/s
Release Duration 301,53 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure n/a bar
- Temperature n/a degC
- Vena Contracta Velocity (exit velocity for pipe releases) n/a m/s
- Discharge Coefficient n/a

Final data (after atmospheric expansion):

- Temperature -27,65 degC
- Liquid Mass Fraction 0,00 fraction
- Droplet Diameter 0,00 um
- Expanded Radius n/a m
- Velocity 488,65 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Long Pipeline
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	6.17478E+002 kg/s
Release Duration	301,53 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	n/a bar
- Temperature	n/a degC
- Vena Contracta Velocity (exit velocity for pipe releases)	n/a m/s
- Discharge Coefficient	n/a
Final data (after atmospheric expansion):	
- Temperature	-27,65 degC
- Liquid Mass Fraction	0,00 fraction
- Droplet Diameter	0,00 um
- Expanded Radius	n/a m
- Velocity	488,65 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\022.H21 - jato 45°

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time			Distance (m)	
				Dia	Noite
UFL (165000)	18,75	s		2,73721	2,72024
LFL (44000)	18,75	s		3,55348	3,50138
LFL Frac (44000)	18,75	s		3,55348	3,50138

Concentration(ppm)	Averaging Time			Heights (m) for above distances	
				Dia	Noite
UFL (165000)	18,75	s		1	1
LFL (44000)	18,75	s		1	1
LFL Frac (44000)	18,75	s		1	1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\022.H21 - jato 45°

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Hazard	Hazard
Flame Direction	Angled	Angled

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\022.H21 - jato 45°

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

				Distance (m)	
				Dia	Noite
Radiation Level	9,85	kW/m2		214,401	215,217
Radiation Level	19,46	kW/m2		158,242	157,4
Radiation Level	35	kW/m2		76,9227	70,8902

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\022.H21 - jato 45°

	Dia	Radiation Level (kW/m2)
		Noite

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\022.H21 - jato 45°

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm	3,55348	3,50138	
Furthest Extent	44000	ppm	3,55348	3,50138	
				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm	1	1	
Furthest Extent	44000	ppm	1	1	

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\022.H21 - jato 45°

			Dia	Noite
Wind Speed	m/s		4,9	4,6
Pasquill Stability			B/C	D
Surface Roughness Length	mm		951	951
Surface Roughness Parameter			0,170008	0,170008
Atmospheric Temperature	degC		27,2	26,3
Surface Temperature	degC		32,2	26,3
Relative Humidity	fraction		0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

023. H21 Fireball 1%

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\023. H21 Fireball 1%

User-Defined Data

Material

Material Identifier METHANE

Bund

Status of Bund No bund present

Fireball

Released Mass 2,4E4 kg
Vapour Fraction (mass) 1 fraction
Use Shape Correlation Use Correlation
Supply Flame Emissive Power Use emissive power correlation
Supply Burst Pressure - gauge Calculate the fireball pressure

Fireball Parameters

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

Radiation Ellipse

Inclination Given No
Radiation Ellipse Option Lethality Level
Radiation Ellipse: Lethality Level 1 %

Geometry

Shape Point
Dimension 2D
System Absolute
East(1) 733 m
North(1) 601 m



Consequence Results

Fireball Hazard

Path: \Modelagem de Consequências - CELSE\Study\023. H21 Fireball 1%

		Dia	Noite
Fireball Flame Status		Hazard	Hazard

Radiation Effects: Fireball Ellipse

Path: \Modelagem de Consequências - CELSE\Study\023. H21 Fireball 1%

				Distance (m)
			Dia	Noite
Radiation Level	14,6932	kW/m2	290,998	291,023

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\023. H21 Fireball 1%

			Dia	Noite
Wind Speed		m/s	4,9	4,6
Pasquill Stability			B/C	D
Surface Roughness Length		mm	951	951
Surface Roughness Parameter			0,170008	0,170008
Atmospheric Temperature		degC	27,2	26,3
Surface Temperature		degC	32,2	26,3
Relative Humidity		fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

024. H21 Fireball 50%

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\024. H21 Fireball 50%

User-Defined Data

Material

Material Identifier METHANE

Bund

Status of Bund No bund present

Fireball

Released Mass 2,4E4 kg
Vapour Fraction (mass) 1 fraction
Use Shape Correlation Use Correlation
Supply Flame Emissive Power Use emissive power correlation
Supply Burst Pressure - gauge Calculate the fireball pressure

Fireball Parameters

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

Radiation Ellipse

Inclination Given No
Radiation Ellipse Option Lethality Level
Radiation Ellipse: Lethality Level 50 %

Geometry

Shape Point
Dimension 2D
System Absolute
East(1) 733 m
North(1) 601 m



Consequence Results

Fireball Hazard

Path: \Modelagem de Consequências - CELSE\Study\024. H21 Fireball 50%

		Dia	Noite
Fireball Flame Status		Hazard	Hazard

Radiation Effects: Fireball Ellipse

Path: \Modelagem de Consequências - CELSE\Study\024. H21 Fireball 50%

				Distance (m)
			Dia	Noite
Radiation Level	29,0475	kW/m2	179,432	179,451

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\024. H21 Fireball 50%

			Dia	Noite
Wind Speed		m/s	4,9	4,6
Pasquill Stability			B/C	D
Surface Roughness Length		mm	951	951
Surface Roughness Parameter			0,170008	0,170008
Atmospheric Temperature		degC	27,2	26,3
Surface Temperature		degC	32,2	26,3
Relative Humidity		fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

025. H21 Fireball 35 kw/m2

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\025. H21 Fireball 35 kw/m2

User-Defined Data

Material

Material Identifier METHANE

Bund

Status of Bund No bund present

Fireball

Released Mass 2,4E4 kg
Vapour Fraction (mass) 1 fraction
Use Shape Correlation Use Correlation
Supply Flame Emissive Power Use emissive power correlation
Supply Burst Pressure - gauge Calculate the fireball pressure

Fireball Parameters

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

Radiation Ellipse

Inclination Given No
Radiation Ellipse Option Incident Radiation
Radiation Ellipse: Incident Radiation 35 kW/m2

Geometry

Shape Point
Dimension 2D
System Absolute
East(1) 733 m
North(1) 601 m



Consequence Results

Fireball Hazard

Path: \Modelagem de Consequências - CELSE\Study\025. H21 Fireball 35 kw/m2

		Dia	Noite
Fireball Flame Status		Hazard	Hazard

Radiation Effects: Fireball Ellipse

Path: \Modelagem de Consequências - CELSE\Study\025. H21 Fireball 35 kw/m2

				Distance (m)
			Dia	Noite
Radiation Level	35	kW/m2	150,553	150,571

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\025. H21 Fireball 35 kw/m2

			Dia	Noite
Wind Speed		m/s	4,9	4,6
Pasquill Stability			B/C	D
Surface Roughness Length		mm	951	951
Surface Roughness Parameter			0,170008	0,170008
Atmospheric Temperature		degC	27,2	26,3
Surface Temperature		degC	32,2	26,3
Relative Humidity		fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

026.H22 - jato vertical

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\026.H22 - jato vertical

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	105 bar
Temperature	5 degC

Scenario

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

Pipe

Internal Diameter	457,2 mm
Line length	8000 m
Distance To Break	7000 m
Relative Aperture	0,2 fraction
Pumped Inflow	58,1 kg/s
Use Ambient Temperature	Do not use ambient temperature

Vessel/Tank

Duration of Interest	600 s
Time for Time-Varying Release	30 s
Method Used for Time Varying Releases	Given time

Location

Elevation	0 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	Vertical

Flammable

Explosion Method	TNT
Jet Fire Method	Cone Model

Dispersion

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

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)	733 m
North(1)	601 m

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\026.H22 - jato vertical

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Long Pipeline
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 6.57031E+002 kg/s
Release Duration 211,27 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure n/a bar
- Temperature n/a degC
- Vena Contracta Velocity (exit velocity for pipe releases) n/a m/s
- Discharge Coefficient n/a

Final data (after atmospheric expansion):

- Temperature -54,98 degC
- Liquid Mass Fraction 0,00 fraction
- Droplet Diameter 0,00 um
- Expanded Radius n/a m
- Velocity 500,00 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Long Pipeline
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	6.57031E+002 kg/s
Release Duration	211,27 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	n/a bar
- Temperature	n/a degC
- Vena Contracta Velocity (exit velocity for pipe releases)	n/a m/s
- Discharge Coefficient	n/a
Final data (after atmospheric expansion):	
- Temperature	-54,98 degC
- Liquid Mass Fraction	0,00 fraction
- Droplet Diameter	0,00 um
- Expanded Radius	n/a m
- Velocity	500,00 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\026.H22 - jato vertical

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time	Distance (m)	
		Dia	Noite
UFL (165000)	18,75 s	1,05641	1,04692
LFL (44000)	18,75 s	1,41961	1,39593
LFL Frac (44000)	18,75 s	1,41961	1,39593

Concentration(ppm)	Averaging Time	Heights (m) for above distances	
		Dia	Noite
UFL (165000)	18,75 s	1	1
LFL (44000)	18,75 s	1	1
LFL Frac (44000)	18,75 s	1	1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\026.H22 - jato vertical

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Hazard	Hazard
Flame Direction	Vertical	Vertical

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\026.H22 - jato vertical

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

Radiation Level	kW/m2	Distance (m)	
		Dia	Noite
9,85	kW/m2	142,848	139,836
19,46	kW/m2	68,4408	65,7437
35	kW/m2	Not Reached	Not Reached

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\026.H22 - jato vertical

	Radiation Level (kW/m2)
Dia	Noite

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\026.H22 - jato vertical

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm	1,41961	1,39593	
Furthest Extent	44000	ppm	1,41961	1,39593	
				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm	1	1	
Furthest Extent	44000	ppm	1	1	

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\026.H22 - jato vertical

			Dia	Noite
Wind Speed	m/s		4,9	4,6
Pasquill Stability			B/C	D
Surface Roughness Length	mm		951	951
Surface Roughness Parameter			0,170008	0,170008
Atmospheric Temperature	degC		27,2	26,3
Surface Temperature	degC		32,2	26,3
Relative Humidity	fraction		0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

027.H22 - jato 45°

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\027.H22 - jato 45°

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	105 bar
Temperature	5 degC

Scenario

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

Pipe

Internal Diameter	457,2 mm
Line length	8000 m
Distance To Break	7000 m
Relative Aperture	0,2 fraction
Pumped Inflow	58,1 kg/s
Use Ambient Temperature	Do not use ambient temperature

Vessel/Tank

Duration of Interest	600 s
Time for Time-Varying Release	30 s
Method Used for Time Varying Releases	Given time

Location

Elevation	0 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 Angle	45 deg
Outdoor Release Direction	Angled from Horizontal

Flammable

Explosion Method	TNT
Jet Fire Method	Cone Model

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

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) 733 m
North(1) 601 m

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\027.H22 - jato 45°

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Long Pipeline
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 6.57031E+002 kg/s
Release Duration 211,27 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure n/a bar
- Temperature n/a degC
- Vena Contracta Velocity (exit velocity for pipe releases) n/a m/s
- Discharge Coefficient n/a

Final data (after atmospheric expansion):

- Temperature -54,98 degC
- Liquid Mass Fraction 0,00 fraction
- Droplet Diameter 0,00 um
- Expanded Radius n/a m
- Velocity 500,00 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Long Pipeline
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	6.57031E+002 kg/s
Release Duration	211,27 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	n/a bar
- Temperature	n/a degC
- Vena Contracta Velocity (exit velocity for pipe releases)	n/a m/s
- Discharge Coefficient	n/a
Final data (after atmospheric expansion):	
- Temperature	-54,98 degC
- Liquid Mass Fraction	0,00 fraction
- Droplet Diameter	0,00 um
- Expanded Radius	n/a m
- Velocity	500,00 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\027.H22 - jato 45°

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time			Distance (m)	
				Dia	Noite
UFL (165000)	18,75	s		2,68033	2,66301
LFL (44000)	18,75	s		3,4705	3,4155
LFL Frac (44000)	18,75	s		3,4705	3,4155

Concentration(ppm)	Averaging Time			Heights (m) for above distances	
				Dia	Noite
UFL (165000)	18,75	s		1	1
LFL (44000)	18,75	s		1	1
LFL Frac (44000)	18,75	s		1	1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\027.H22 - jato 45°

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Hazard	Hazard
Flame Direction	Angled	Angled

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\027.H22 - jato 45°

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

				Distance (m)	
				Dia	Noite
Radiation Level	9,85	kW/m2		219,661	220,475
Radiation Level	19,46	kW/m2		162,246	161,335
Radiation Level	35	kW/m2		79,1559	72,8447

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\027.H22 - jato 45°

	Dia	Radiation Level (kW/m2)
		Noite

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\027.H22 - jato 45°

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm	3,4705	3,4705	3,4155
Furthest Extent	44000	ppm	3,4705	3,4705	3,4155

				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm	1	1	1
Furthest Extent	44000	ppm	1	1	1

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\027.H22 - jato 45°

			Dia	Noite
Wind Speed	m/s		4,9	4,6
Pasquill Stability			B/C	D
Surface Roughness Length	mm		951	951
Surface Roughness Parameter			0,170008	0,170008
Atmospheric Temperature	degC		27,2	26,3
Surface Temperature	degC		32,2	26,3
Relative Humidity	fraction		0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

028.H23 - jato vertical

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\028.H23 - jato vertical

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	105 bar
Temperature	5 degC
Mass Inventory	1E7 kg

Scenario

Scenario Type	Leak
Phase to be Released	Vapor
Hole Diameter	22,86 mm
Building Wake Effect	None

Location

Elevation	0 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	Vertical

Flammable

Explosion Method	TNT
Jet Fire Method	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1E7 kg

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]

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

[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)	733 m
North(1)	601 m

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \\Modelagem de Consequências - CELSE\Study\028.H23 - jato vertical

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Leak
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 7.76914E+000 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 54,98 bar
- Temperature -39,90 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 369,11 m/s
- Discharge Coefficient 0,86

Final data (after atmospheric expansion):

- Temperature -114,18 degC
- Liquid Mass Fraction 0,00 fraction
- Droplet Diameter 0,00 um
- Expanded Radius 0,06 m
- Velocity 500,00 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Leak
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	7.76914E+000 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	54,98 bar
- Temperature	-39,90 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	369,11 m/s
- Discharge Coefficient	0,86
Final data (after atmospheric expansion):	
- Temperature	-114,18 degC
- Liquid Mass Fraction	0,00 fraction
- Droplet Diameter	0,00 um
- Expanded Radius	0,06 m
- Velocity	500,00 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\028.H23 - jato vertical

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time			Dia	Noite	Distance (m)
UFL (165000)	18,75	s		6,00569		7,71409
LFL (44000)	18,75	s		8,04863		10,2972
LFL Frac (44000)	18,75	s		8,04863		10,2972

Concentration(ppm)	Averaging Time			Dia	Noite	Heights (m) for above distances
UFL (165000)	18,75	s		1		1
LFL (44000)	18,75	s		1		1
LFL Frac (44000)	18,75	s		1		1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\028.H23 - jato vertical

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Hazard	Hazard
Flame Direction	Vertical	Vertical

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\028.H23 - jato vertical

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

			Dia	Noite	Distance (m)
Radiation Level	9,85	kW/m2	17,7351		17,15
Radiation Level	19,46	kW/m2	5,79138		5,39632
Radiation Level	35	kW/m2	Not Reached		Not Reached

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\028.H23 - jato vertical

	Dia	Noite
Radiation Level (kW/m2)		

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\028.H23 - jato vertical

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm	8,04863	10,2972	
Furthest Extent	44000	ppm	8,04863	10,2972	
				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm	1	1	
Furthest Extent	44000	ppm	1	1	



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\028.H23 - jato vertical

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level
			Noite
Overpressure	0,069	bar	No Hazard
Overpressure	0,1	bar	No Hazard
Overpressure	0,3	bar	No Hazard
			Supplementary Data at 0,069 bar
			Noite
Supplied Flammable Mass		kg	No Hazard
Used Flammable Mass		kg	No Hazard
Overpressure Radius		m	0
Distance to:			
- Ignition Source		m	No Hazard
- Cloud Front/Centre		m	No Hazard
- Explosion Centre		m	0
			Supplementary Data at 0,1 bar
			Noite
Supplied Flammable Mass		kg	No Hazard
Used Flammable Mass		kg	No Hazard
Overpressure Radius		m	0
Distance to:			
- Ignition Source		m	No Hazard
- Cloud Front/Centre		m	No Hazard
- Explosion Centre		m	0
			Supplementary Data at 0,3 bar
			Noite
Supplied Flammable Mass		kg	No Hazard
Used Flammable Mass		kg	No Hazard
Overpressure Radius		m	0
Distance to:			
- Ignition Source		m	No Hazard
- Cloud Front/Centre		m	No Hazard
- Explosion Centre		m	0

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\028.H23 - jato vertical

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

029.H23 - jato 45°

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\029.H23 - jato 45°

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	105 bar
Temperature	5 degC
Mass Inventory	1E7 kg

Scenario

Scenario Type	Leak
Phase to be Released	Vapor
Hole Diameter	22,86 mm
Building Wake Effect	None

Location

Elevation	0 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 Angle	45 deg
Outdoor Release Direction	Angled from Horizontal

Flammable

Explosion Method	TNT
Jet Fire Method	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1E7 kg

Fireball Parameters

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

Toxic Parameters

[Indoor Calculations	Unselected]
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SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

[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)	733 m
North(1)	601 m

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\029.H23 - jato 45°

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Leak
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 7.76914E+000 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 54,98 bar
- Temperature -39,90 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 369,11 m/s
- Discharge Coefficient 0,86

Final data (after atmospheric expansion):

- Temperature -114,18 degC
- Liquid Mass Fraction 0,00 fraction
- Droplet Diameter 0,00 um
- Expanded Radius 0,06 m
- Velocity 500,00 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Leak
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 106,01 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	7.76914E+000 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	54,98 bar
- Temperature	-39,90 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	369,11 m/s
- Discharge Coefficient	0,86
Final data (after atmospheric expansion):	
- Temperature	-114,18 degC
- Liquid Mass Fraction	0,00 fraction
- Droplet Diameter	0,00 um
- Expanded Radius	0,06 m
- Velocity	500,00 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\029.H23 - jato 45°

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Dia	Noite	Distance (m)
UFL (165000)	18,75	s	1,29501	1,28985	1,28985
LFL (44000)	18,75	s	1,51897	1,50825	1,50825
LFL Frac (44000)	18,75	s	1,51897	1,50825	1,50825

Concentration(ppm)	Averaging Time		Dia	Noite	Heights (m) for above distances
UFL (165000)	18,75	s	1	1	1
LFL (44000)	18,75	s	1	1	1
LFL Frac (44000)	18,75	s	1	1	1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\029.H23 - jato 45°

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Hazard	Hazard
Flame Direction	Angled	Angled

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\029.H23 - jato 45°

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

			Dia	Noite	Distance (m)
Radiation Level	9,85	kW/m2	29,3974	29,4679	29,4679
Radiation Level	19,46	kW/m2	21,6439	21,221	21,221
Radiation Level	35	kW/m2	Not Reached	Not Reached	Not Reached

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\029.H23 - jato 45°

	Dia	Noite
Radiation Level (kW/m2)		

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\029.H23 - jato 45°

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm	1,51897	1,50825	
Furthest Extent	44000	ppm	1,51897	1,50825	
				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm	1	1	
Furthest Extent	44000	ppm	1	1	

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\029.H23 - jato 45°

			Dia	Noite
Wind Speed	m/s		4,9	4,6
Pasquill Stability			B/C	D
Surface Roughness Length	mm		951	951
Surface Roughness Parameter			0,170008	0,170008
Atmospheric Temperature	degC		27,2	26,3
Surface Temperature	degC		32,2	26,3
Relative Humidity	fraction		0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

030.H24

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\030.H24

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	51 bar
Temperature	10 degC
Mass Inventory	1E7 kg

Scenario

Scenario Type	Line rupture
Phase to be Released	Vapor
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	350 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1E7 kg

Fireball Parameters

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

[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) 733 m
North(1) 601 m

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\030.H24

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 52,01 bar
- Temperature 10,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 8.13329E+002 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 32,05 bar
- Temperature -11,88 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 325,70 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -65,48 degC
- Liquid Mass Fraction 0,00 fraction
- Droplet Diameter 0,00 um
- Expanded Radius 0,74 m
- Velocity 500,00 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 52,01 bar
- Temperature 10,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	8.13329E+002 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	32,05 bar
- Temperature	-11,88 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	325,70 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-65,48 degC
- Liquid Mass Fraction	0,00 fraction
- Droplet Diameter	0,00 um
- Expanded Radius	0,74 m
- Velocity	500,00 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\030.H24

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Dia	Noite	Distance (m)
UFL (165000)	18,75	s	109,195	108,655	
LFL (44000)	18,75	s	239,354	255,268	
LFL Frac (44000)	18,75	s	239,354	255,268	

Concentration(ppm)	Averaging Time		Dia	Noite	Heights (m) for above distances
UFL (165000)	18,75	s	1	1	
LFL (44000)	18,75	s	1	1	
LFL Frac (44000)	18,75	s	1	1	

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\030.H24

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Truncated	Truncated
Flame Direction	Horizontal	Horizontal

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\030.H24

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

			Dia	Noite	Distance (m)
Radiation Level	9,85	kW/m2	328,215	327,739	
Radiation Level	19,46	kW/m2	273,844	272,57	
Radiation Level	35	kW/m2	233,724	233,531	

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\030.H24

	Dia	Radiation Level (kW/m2)	Noite

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\030.H24

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm		239,354	255,268
Furthest Extent	44000	ppm		239,354	255,268
				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm		1	1
Furthest Extent	44000	ppm		1	1



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\030.H24

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	358,964	376,337
Overpressure	0,1	bar	304,59	320,308
Overpressure	0,3	bar	209,16	221,974

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	5449,1	5961,83
Used Flammable Mass		kg	5449,1	5961,83
Overpressure Radius		m	244,981	252,436
Distance to:				
- Ignition Source		m	230	250
- Cloud Front/Centre		m	230	250
- Explosion Centre		m	113,983	123,901

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	5449,1	5961,83
Used Flammable Mass		kg	5449,1	5961,83
Overpressure Radius		m	190,607	196,407
Distance to:				
- Ignition Source		m	230	250
- Cloud Front/Centre		m	230	250
- Explosion Centre		m	113,983	123,901

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	5449,1	5961,83
Used Flammable Mass		kg	5449,1	5961,83
Overpressure Radius		m	95,1769	98,0731
Distance to:				
- Ignition Source		m	230	250
- Cloud Front/Centre		m	230	250
- Explosion Centre		m	113,983	123,901

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\030.H24

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

031.H25

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\031.H25

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	51 bar
Temperature	10 degC
Mass Inventory	1E7 kg

Scenario

Scenario Type	Line rupture
Phase to be Released	Vapor
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	35 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1E7 kg

Fireball Parameters

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

[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) 733 m
North(1) 601 m

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\031.H25

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 52,01 bar
- Temperature 10,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 8.13329E+000 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 26,02 bar
- Temperature -23,94 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 383,88 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -65,48 degC
- Liquid Mass Fraction 0,00 fraction
- Droplet Diameter 0,00 um
- Expanded Radius 0,07 m
- Velocity 500,00 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 52,01 bar
- Temperature 10,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	8.13329E+000 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	26,02 bar
- Temperature	-23,94 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	383,88 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-65,48 degC
- Liquid Mass Fraction	0,00 fraction
- Droplet Diameter	0,00 um
- Expanded Radius	0,07 m
- Velocity	500,00 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\031.H25

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Distance (m)	
			Dia	Noite
UFL (165000)	18,75	s	5,23604	5,39997
LFL (44000)	18,75	s	27,0756	28,7419
LFL Frac (44000)	18,75	s	27,0756	28,7419

Concentration(ppm)	Averaging Time		Heights (m) for above distances	
			Dia	Noite
UFL (165000)	18,75	s	1	1
LFL (44000)	18,75	s	1	1
LFL Frac (44000)	18,75	s	1	1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\031.H25

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Truncated	Truncated
Flame Direction	Horizontal	Horizontal

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\031.H25

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

Radiation Level			Distance (m)	
			Dia	Noite
9,85	kW/m2		43,0335	42,876
19,46	kW/m2		38,6476	38,4223
35	kW/m2		35,1494	34,8359

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\031.H25

	Dia	Radiation Level (kW/m2)
		Noite

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\031.H25

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm		27,0756	28,7419
Furthest Extent	44000	ppm		27,0756	28,7419
				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm		1	1
Furthest Extent	44000	ppm		1	1



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\031.H25

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	29,249	29,5794
Overpressure	0,1	bar	24,9766	25,2337
Overpressure	0,3	bar	17,4783	17,6067

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	2,64332	2,78182
Used Flammable Mass		kg	2,64332	2,78182
Overpressure Radius		m	19,249	19,5795
Distance to:				
- Ignition Source		m	20	20
- Cloud Front/Centre		m	20	20
- Explosion Centre		m	9,99995	9,99994

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	2,64332	2,78182
Used Flammable Mass		kg	2,64332	2,78182
Overpressure Radius		m	14,9766	15,2338
Distance to:				
- Ignition Source		m	20	20
- Cloud Front/Centre		m	20	20
- Explosion Centre		m	9,99995	9,99994

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	2,64332	2,78182
Used Flammable Mass		kg	2,64332	2,78182
Overpressure Radius		m	7,47837	7,60676
Distance to:				
- Ignition Source		m	20	20
- Cloud Front/Centre		m	20	20
- Explosion Centre		m	9,99995	9,99994

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\031.H25

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

032.H26

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\032.H26

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	40 bar
Temperature	227 degC
Mass Inventory	1E7 kg

Scenario

Scenario Type	Line rupture
Phase to be Released	Vapor
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	300 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1E7 kg

Fireball Parameters

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

[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) 733 m
North(1) 601 m

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\032.H26

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 41,01 bar
- Temperature 227,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 3.27281E+002 kg/s
Release Duration 600,00 s
Orifice or pipe exit data (before atmospheric expansion):
- Pressure 26,27 bar
- Temperature 207,15 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 439,20 m/s
- Discharge Coefficient 1,00
Final data (after atmospheric expansion):
- Temperature 193,64 degC
- Liquid Mass Fraction 0,00 fraction
- Droplet Diameter 0,00 um
- Expanded Radius 0,71 m
- Velocity 500,00 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 41,01 bar
- Temperature 227,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	3.27281E+002 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	26,27 bar
- Temperature	207,15 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	439,20 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	193,64 degC
- Liquid Mass Fraction	0,00 fraction
- Droplet Diameter	0,00 um
- Expanded Radius	0,71 m
- Velocity	500,00 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\032.H26

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Dia	Noite	Distance (m)
UFL (165000)	18,75	s	49,3782	50,6437	
LFL (44000)	18,75	s	93,453	97,1997	
LFL Frac (44000)	18,75	s	93,453	97,1997	

Concentration(ppm)	Averaging Time		Dia	Noite	Heights (m) for above distances
UFL (165000)	18,75	s	1	1	
LFL (44000)	18,75	s	1	1	
LFL Frac (44000)	18,75	s	1	1	

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\032.H26

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Truncated	Truncated
Flame Direction	Horizontal	Horizontal

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\032.H26

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

			Dia	Noite	Distance (m)
Radiation Level	9,85	kW/m2	218,079	217,806	
Radiation Level	19,46	kW/m2	184,002	183,164	
Radiation Level	35	kW/m2	157,796	156,129	

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\032.H26

	Dia	Radiation Level (kW/m2)	Noite
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SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\032.H26

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm		93,453	97,1997
Furthest Extent	44000	ppm		93,453	97,1997
				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm		1	1
Furthest Extent	44000	ppm		1	1



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\032.H26

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	166,172	165,156
Overpressure	0,1	bar	138,976	138,243
Overpressure	0,3	bar	91,2464	91,0083

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	681,763	660,77
Used Flammable Mass		kg	681,763	660,77
Overpressure Radius		m	122,528	121,257
Distance to:				
- Ignition Source		m	90	90
- Cloud Front/Centre		m	90	90
- Explosion Centre		m	43,6434	43,899

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	681,763	660,77
Used Flammable Mass		kg	681,763	660,77
Overpressure Radius		m	95,3328	94,3441
Distance to:				
- Ignition Source		m	90	90
- Cloud Front/Centre		m	90	90
- Explosion Centre		m	43,6434	43,899

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	681,763	660,77
Used Flammable Mass		kg	681,763	660,77
Overpressure Radius		m	47,603	47,1093
Distance to:				
- Ignition Source		m	90	90
- Cloud Front/Centre		m	90	90
- Explosion Centre		m	43,6434	43,899

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\032.H26

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

033.H27

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\033.H27

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	40 bar
Temperature	227 degC
Mass Inventory	1E7 kg

Scenario

Scenario Type	Line rupture
Phase to be Released	Vapor
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	30 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1E7 kg

Fireball Parameters

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

[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) 733 m
North(1) 601 m

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\033.H27

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 41,01 bar
- Temperature 227,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 3.27281E+000 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 20,73 bar
- Temperature 189,88 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 535,69 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature 193,64 degC
- Liquid Mass Fraction 0,00 fraction
- Droplet Diameter 0,00 um
- Expanded Radius 0,07 m
- Velocity 500,00 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 41,01 bar
- Temperature 227,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	3.27281E+000 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	20,73 bar
- Temperature	189,88 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	535,69 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	193,64 degC
- Liquid Mass Fraction	0,00 fraction
- Droplet Diameter	0,00 um
- Expanded Radius	0,07 m
- Velocity	500,00 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\033.H27

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time			Dia	Noite
UFL (165000)	18,75	s		2,88696	2,97125
LFL (44000)	18,75	s		11,67	12,6095
LFL Frac (44000)	18,75	s		11,67	12,6095

Concentration(ppm)	Averaging Time			Dia	Noite	Heights (m) for above distances
UFL (165000)	18,75	s		1	1	
LFL (44000)	18,75	s		1	1	
LFL Frac (44000)	18,75	s		1	1	

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\033.H27

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Hazard	Hazard
Flame Direction	Horizontal	Horizontal

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\033.H27

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

				Dia	Noite
Radiation Level	9,85	kW/m2		27,4932	27,3973
Radiation Level	19,46	kW/m2		24,9956	24,8607
Radiation Level	35	kW/m2		22,7831	22,5408

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\033.H27

	Dia	Radiation Level (kW/m2)
		Noite

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\033.H27

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm	11,67	12,6095	
Furthest Extent	44000	ppm	11,67	12,6095	
				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm	1	1	
Furthest Extent	44000	ppm	1	1	



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\033.H27

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	15,3391	15,5882
Overpressure	0,1	bar	13,0442	13,238
Overpressure	0,3	bar	9,01664	9,11341

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	0,409639	0,439967
Used Flammable Mass		kg	0,409639	0,439967
Overpressure Radius		m	10,3393	10,5884
Distance to:				
- Ignition Source		m	10	10
- Cloud Front/Centre		m	10	10
- Explosion Centre		m	4,99974	4,99974

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	0,409639	0,439967
Used Flammable Mass		kg	0,409639	0,439967
Overpressure Radius		m	8,04448	8,2383
Distance to:				
- Ignition Source		m	10	10
- Cloud Front/Centre		m	10	10
- Explosion Centre		m	4,99974	4,99974

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	0,409639	0,439967
Used Flammable Mass		kg	0,409639	0,439967
Overpressure Radius		m	4,01689	4,11367
Distance to:				
- Ignition Source		m	10	10
- Cloud Front/Centre		m	10	10
- Explosion Centre		m	4,99974	4,99974

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\033.H27

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

034.H28

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\034.H28

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	1,15 bar
Temperature	5 degC
Mass Inventory	1E7 kg

Scenario

Scenario Type	Line rupture
Phase to be Released	Vapor
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	100 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1E7 kg

Fireball Parameters

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

[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) 733 m
North(1) 601 m

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\034.H28

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 2,16 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 2.31723E+000 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 1,11 bar
- Temperature -15,56 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 353,68 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -21,27 degC
- Liquid Mass Fraction 0,00 fraction
- Droplet Diameter 0,00 um
- Expanded Radius 0,05 m
- Velocity 386,50 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 2,16 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	2.31723E+000 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	1,11 bar
- Temperature	-15,56 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	353,68 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-21,27 degC
- Liquid Mass Fraction	0,00 fraction
- Droplet Diameter	0,00 um
- Expanded Radius	0,05 m
- Velocity	386,50 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\034.H28

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Dia	Noite	Distance (m)
UFL (165000)	18,75	s	3,08313		3,17653
LFL (44000)	18,75	s	10,6275		11,6817
LFL Frac (44000)	18,75	s	10,6275		11,6817

Concentration(ppm)	Averaging Time		Dia	Noite	Heights (m) for above distances
UFL (165000)	18,75	s	1		1
LFL (44000)	18,75	s	1		1
LFL Frac (44000)	18,75	s	1		1

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\034.H28

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Hazard	Hazard
Flame Direction	Horizontal	Horizontal

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\034.H28

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

			Dia	Noite	Distance (m)
Radiation Level	9,85	kW/m2	25,0891		24,9457
Radiation Level	19,46	kW/m2	22,8562		22,654
Radiation Level	35	kW/m2	20,6798		20,4741

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\034.H28

	Dia	Radiation Level (kW/m2)
		Noite

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\034.H28

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm		10,6275	11,6817
Furthest Extent	44000	ppm		10,6275	11,6817
				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm		1	1
Furthest Extent	44000	ppm		1	1



Explosion Effects: Late Ignition

Path: \Modelagem de Consequências - CELSE\Study\034.H28

Explosion Model Used : TNT
 Explosion Location Criterion: Cloud Center
 All distances are measured from the Source
 All flammable results are reported at the flammable effect height 1 m

			Maximum Distance (m) at Overpressure Level	
			Dia	Noite
Overpressure	0,069	bar	14,5937	14,9448
Overpressure	0,1	bar	12,4644	12,7376
Overpressure	0,3	bar	8,72722	8,86362

			Supplementary Data at 0,069 bar	
			Dia	Noite
Supplied Flammable Mass		kg	0,32726	0,364522
Used Flammable Mass		kg	0,32726	0,364522
Overpressure Radius		m	9,59377	9,94487
Distance to:				
- Ignition Source		m	10	10
- Cloud Front/Centre		m	10	10
- Explosion Centre		m	4,99997	4,99997

			Supplementary Data at 0,1 bar	
			Dia	Noite
Supplied Flammable Mass		kg	0,32726	0,364522
Used Flammable Mass		kg	0,32726	0,364522
Overpressure Radius		m	7,46441	7,73759
Distance to:				
- Ignition Source		m	10	10
- Cloud Front/Centre		m	10	10
- Explosion Centre		m	4,99997	4,99997

			Supplementary Data at 0,3 bar	
			Dia	Noite
Supplied Flammable Mass		kg	0,32726	0,364522
Used Flammable Mass		kg	0,32726	0,364522
Overpressure Radius		m	3,72724	3,86365
Distance to:				
- Ignition Source		m	10	10
- Cloud Front/Centre		m	10	10
- Explosion Centre		m	4,99997	4,99997

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\034.H28

		Dia	Noite
Wind Speed	m/s	4,9	4,6
Pasquill Stability		B/C	D
Surface Roughness Length	mm	951	951
Surface Roughness Parameter		0,170008	0,170008
Atmospheric Temperature	degC	27,2	26,3
Surface Temperature	degC	32,2	26,3
Relative Humidity	fraction	0,724	0,76

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

035.H29

Base Case

CASE Name: Data

Path: \Modelagem de Consequências - CELSE\Study\035.H29

User-Defined Data

Material

Material Identifier	METHANE
Type of Vessel	Pressurized Gas
Pressure Specification	Pressure specified
Storage Pressure - gauge	1,15 bar
Temperature	5 degC
Mass Inventory	1E7 kg

Scenario

Scenario Type	Line rupture
Phase to be Released	Vapor
Building Wake Effect	None
Specify Pump Head	No pump head supplied
Number of Excess Flow Valves	0
Number of Non-Return Valves	0
Number of Shut-Off Valves	0

Pipe

Internal Diameter	10 mm
Line length	1 m

Location

Elevation	1 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	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	1E7 kg

Fireball Parameters

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

[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) 733 m
North(1) 601 m

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Path: \Modelagem de Consequências - CELSE\Study\035.H29

DISCHARGE DATA for Weather: Study\Dia

Wind Speed: 4,90 m/s
Wind Speed at Height (Calculated) 3,03 m/s
Pasquill Stability: B/C

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 2,16 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

Mass Flow of Air (Vent from Vapor Space only) n/a
Mass Flowrate 1.79405E-002 kg/s
Release Duration 600,00 s

Orifice or pipe exit data (before atmospheric expansion):

- Pressure 1,01 bar
- Temperature -11,69 degC
- Vena Contracta Velocity (exit velocity for pipe releases) 304,63 m/s
- Discharge Coefficient 1,00

Final data (after atmospheric expansion):

- Temperature -11,69 degC
- Liquid Mass Fraction 0,00 fraction
- Droplet Diameter 0,00 um
- Expanded Radius 0,00 m
- Velocity 304,63 m/s

DISCHARGE DATA for Weather: Study\Noite

Wind Speed: 4,60 m/s
Wind Speed at Height (Calculated) 2,40 m/s
Pasquill Stability: D

USER-DEFINED QUANTITIES

Material METHANE
Scenario Line rupture
Inventory 10.000.000,00 kg
Fixed Duration n/a s

Stagnation data (data at upstream end for long pipe):

- Pressure 2,16 bar
- Temperature 5,00 degC
- Fluid State Pressurized gas

CALCULATED QUANTITIES

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Mass Flow of Air (Vent from Vapor Space only)	n/a
Mass Flowrate	1.79405E-002 kg/s
Release Duration	600,00 s
Orifice or pipe exit data (before atmospheric expansion):	
- Pressure	1,01 bar
- Temperature	-11,69 degC
- Vena Contracta Velocity (exit velocity for pipe releases)	304,63 m/s
- Discharge Coefficient	1,00
Final data (after atmospheric expansion):	
- Temperature	-11,69 degC
- Liquid Mass Fraction	0,00 fraction
- Droplet Diameter	0,00 um
- Expanded Radius	0,00 m
- Velocity	304,63 m/s



Consequence Results

Distance to Concentration Results

Path: \Modelagem de Consequências - CELSE\Study\035.H29

The height for user defined concentrations is the user defined height 1 m
 All toxic results are reported at the toxic effect height 0 m
 All flammable results are reported at the flammable effect height 1 m

Concentration(ppm)	Averaging Time		Dia	Noite	Distance (m)
UFL (165000)	18,75	s	0,332691	0,33852	
LFL (44000)	18,75	s	1,10123	1,1714	
LFL Frac (44000)	18,75	s	1,10123	1,1714	

Concentration(ppm)	Averaging Time		Dia	Noite	Heights (m) for above distances
UFL (165000)	18,75	s	1	1	
LFL (44000)	18,75	s	1	1	
LFL Frac (44000)	18,75	s	1	1	

Jet Fire Hazard

Path: \Modelagem de Consequências - CELSE\Study\035.H29

Jet fire method used: Cone model - DNV recommended

	Dia	Noite
Jet Fire Status	Hazard	Hazard
Flame Direction	Horizontal	Horizontal

Radiation Effects: Jet Fire Ellipse

Path: \Modelagem de Consequências - CELSE\Study\035.H29

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

			Dia	Noite	Distance (m)
Radiation Level	9,85	kW/m2	1,79415	1,85735	
Radiation Level	19,46	kW/m2	Not Reached	Not Reached	
Radiation Level	35	kW/m2	Not Reached	Not Reached	

Radiation Effects: Jet Fire Distance

Path: \Modelagem de Consequências - CELSE\Study\035.H29

	Dia	Radiation Level (kW/m2)
		Noite

SUMMARY REPORT

Unique Audit Number: 21.724.647



Study Folder: Modelagem de Consequências - CELSE

Phast 6.7

Flash Fire Envelope

Path: \Modelagem de Consequências - CELSE\Study\035.H29

All flammable results are reported at the flammable effect height 1 m

				Distance (m)	
				Dia	Noite
Furthest Extent	44000	ppm	1,10123	1,1714	
Furthest Extent	44000	ppm	1,10123	1,1714	

				Heights (m) for above distances	
				Dia	Noite
Furthest Extent	44000	ppm	1	1	
Furthest Extent	44000	ppm	1	1	

Weather Conditions

Path: \Modelagem de Consequências - CELSE\Study\035.H29

			Dia	Noite
Wind Speed	m/s		4,9	4,6
Pasquill Stability			B/C	D
Surface Roughness Length	mm		951	951
Surface Roughness Parameter			0,170008	0,170008
Atmospheric Temperature	degC		27,2	26,3
Surface Temperature	degC		32,2	26,3
Relative Humidity	fraction		0,724	0,76