

ANEXO XXIV
ANÁLISE RISCO

ANEXO XXIV-A
FG-079-515-50-0027-01-J
ÁREAS RELACIONADAS AOS CENÁRIOS ACIDENTAIS DE
SEVERIDADE SÉRIA OU CRÍTICA

ANEXO XXIV-B
RELATÓRIOS DA MODELAGEM MATEMÁTICA DO CÁLCULO DO ALCANCE
DOS EFEITOS FÍSICOS COM O EMPREGO DO PROGRAMA PHAST

SUMMARY REPORT

Unique Audit Number: 42.564



Study Folder: Projeto Ferro Carajas S11D

Phast 6.54



Projeto Ferro Carajas S11D



Cenário accidental

1

Cenário 1 - Ruptura catastrófica de tanque

Base Case

CASE Name: Data

Path: \Projeto Ferro Carajas S11D\Cenário accidental\1

User-Defined Data

Material

Material Identifier	N-OCTANE
Type of Vessel	Unpressurized (at atmospheric pressure)
Pressure Specification	Pressure not used
Discharge Temperature	25 degC
Volume Inventory of material to discharge	700 m3

Scenario

Type of Event	Catastrophic rupture
Phase	Liquid
Building Wake Option	None
Tank Head	0 m

Location

[Release 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
[Surface type	Concrete]
[Height	0 m]
[Modelling of bund failure	Bund cannot fail]

Indoor/Outdoor

Location of release	Open air release
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Flammable

Method to use for explosions	TNT
Jet Fire Method	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	4,894E5 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

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[Indoor calculations	Unselected]
[Ventilation specification	Case Specified]
[Building exchange rate	4 /hr]
[Tail time	1800 s]
[Method of setting time	Use a fixed averaging time]
[Cut-off fraction of toxic load	0,05 fraction]
[Cut-off concentration	0 fraction]

Geometry

Geometry shape	Point
Coordinates	Absolute
East(1)	0 m
North(1)	0 m

Path: \Projeto Ferro Carajas S11D\Cenário acidental\1

Discharge Data

User-Defined Quantities

Material	N-OCTANE
Temperature	25,00 degC
Pressure	1,01 bar
Inventory	489.438,53 kg
Scenario	Catastrophic rupture
Fixed Duration	n/a s

Calculated Quantities

Weather: Cenário acidental\Tempo

Mass Flow of Air (Vent from Vapor Space Only) n/a

Average Values for Segment Number 1

Liquid Fraction	1,00 fraction
Final Temperature	25,00 degC
Final Velocity	0,00 m/s
Droplet Diameter	10.000,00 um
Continuous Release Data:	
Mass Flowrate	n/a kg/s
Release Duration	n/a s
Orifice Velocity	n/a m/s
Exit Pressure	n/a bar
Exit Temperature	n/a degC
Discharge Coefficient	n/a
Expanded Radius	n/a m



Consequence Results

Pool Vaporization Results

Path: \Projeto Ferro Carajas S11D\Cenário acidental\1

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

		Tempo
Liquid Rainout	fraction	0,999999
Initial Vapor Cloud	kg	0,325187
Time Pool Left Behind	s	134,78
Cloud Segment 1		
Cloud Segment Duration	s	212,431
Pool Vaporization Rate	kg/s	21,3839
Cloud Segment 2		
Cloud Segment Duration	s	89,46
Pool Vaporization Rate	kg/s	50,8577
Cloud Segment 3		
Cloud Segment Duration	s	70,5994
Pool Vaporization Rate	kg/s	64,1609
Cloud Segment 4		
Cloud Segment Duration	s	335,07
Pool Vaporization Rate	kg/s	80,8987
Cloud Segment 5		
Cloud Segment Duration	s	2892,44
Pool Vaporization Rate	kg/s	69,9695
Maximum Pool Radius	m	207,306

Distance to Concentration Results

Path: \Projeto Ferro Carajas S11D\Cenário acidental\1

The height for user defined concentrations is the user defined height 0 m

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

All flammable results are reported at the cloud centreline height

Concentration(ppm)	Averaging Time		Tempo	Distance (m)
UFL (65000)	18,75	s	22,7877	
LFL (8000)	18,75	s	76,253	
LFL Frac (4000)	18,75	s	110,193	
Concentration(ppm)	Averaging Time		Tempo	Heights (m) for above distances
UFL (65000)	18,75	s	0	
LFL (8000)	18,75	s	0	
LFL Frac (4000)	18,75	s	0	

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Late Pool Fire Hazard

Path: \Projeto Ferro Carajas S11D\Cenário acidental\1

Late Pool Fire Status	Tempo Hazard
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Radiation Effects: Late Pool Fire Ellipse

Path: \Projeto Ferro Carajas S11D\Cenário acidental\1

			Tempo	Distance (m)
Radiation Level	7,3	kW/m2	249,251	
Radiation Level	14,4	kW/m2	208,582	
Radiation Level	37,5	kW/m2	Not Reached	

Radiation Effects: Late Pool Fire Distance

Path: \Projeto Ferro Carajas S11D\Cenário acidental\1

Tempo	Radiation Level (kW/m2)
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Fireball Hazard

Path: \Projeto Ferro Carajas S11D\Cenário acidental\1

Fireball Flame Status	Tempo No Hazard
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Flash Fire Envelope

Path: \Projeto Ferro Carajas S11D\Cenário acidental\1

All flammable results are reported at the cloud centreline height

			Tempo	Distance (m)
Furthest Extent	4000	ppm	110,193	
Furthest Extent	8000	ppm	76,253	

			Tempo	Heights (m) for above distances
Furthest Extent	4000	ppm	0	
Furthest Extent	8000	ppm	0	

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Explosion Effects: Early Explosion

Path: \Projeto Ferro Carajas S11D\Cenário acidental\1

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

Supplied Flammable Mass		kg	Tempo	489439
			Distance (m) at Overpressure Levels	
			Tempo	
Overpressure	0,1	bar	No Hazard	
Overpressure	0,3	bar	No Hazard	
Overpressure	0,2068	bar	No Hazard	
			Used Mass (kg) at Overpressure Levels	
			Tempo	
Overpressure	0,1	bar	0	
Overpressure	0,3	bar	0	
Overpressure	0,2068	bar	0	

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Explosion Effects: Late Ignition

Path: \Projeto Ferro Carajas S11D\Cenário acidental\1

Explosion Model Used : TNT

Explosion Location Criterion: Cloud Front (LFL Fraction)

All distances are measured from the Source

All flammable results are reported at the cloud centreline height

			Maximum Distance (m) at Overpressure Level
			Tempo
Overpressure	0,1	bar	152,392
Overpressure	0,3	bar	121,155
Overpressure	0,2068	bar	129,126
			Supplementary Data at 0,1 bar
			Tempo
Supplied Flammable Mass		kg	215,255
Used Flammable Mass		kg	215,255
Overpressure Radius		m	62,3925
Distance to:			
- Ignition Source		m	90
- Cloud Front/Centre		m	36,0201
- Explosion Centre		m	90
			Supplementary Data at 0,3 bar
			Tempo
Supplied Flammable Mass		kg	215,255
Used Flammable Mass		kg	215,255
Overpressure Radius		m	31,1548
Distance to:			
- Ignition Source		m	90
- Cloud Front/Centre		m	36,0201
- Explosion Centre		m	90
			Supplementary Data at 0,2068 bar
			Tempo
Supplied Flammable Mass		kg	215,255
Used Flammable Mass		kg	215,255
Overpressure Radius		m	39,1262
Distance to:			
- Ignition Source		m	90
- Cloud Front/Centre		m	36,0201
- Explosion Centre		m	90

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Weather Conditions

Path: \Projeto Ferro Carajas S11D\Cenário acidental\1

		Tempo
Wind Speed	m/s	2
Pasquill Stability		D
Surface Roughness Length	mm	1000
Surface Roughness Parameter		0,173718
Atmospheric Temperature	degC	25
Surface Temperature	degC	32
Relative Humidity	fraction	0,78

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Projeto Ferro Carajas S11D



Cenário acidental

2

Cenário 2 - Furo em tanque

Base Case

CASE Name: Data

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

User-Defined Data

Material

Material Identifier	N-OCTANE
Type of Vessel	Unpressurized (at atmospheric pressure)
Pressure Specification	Pressure not used
Discharge Temperature	25 degC
Volume Inventory of material to discharge	700 m3

Scenario

Type of Event	Leak
Phase	Liquid
HoleDiameter	25,4 mm
Building Wake Option	None
Tank Head	10 m

Location

[Release 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
[Surface type	Concrete]
[Height	0 m]
[Modelling of bund failure	Bund cannot fail]

Indoor/Outdoor

Location of release	Open air release
Outdoor Release Direction	Horizontal

Flammable

Method to use for explosions	TNT
Jet Fire Method	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	4,894E5 kg

Fireball Parameters

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

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Toxic Parameters

[Indoor calculations	Unselected]
[Ventilation specification	Case Specified]
[Building exchange rate	4 /hr]
[Tail time	1800 s]
[Method of setting time	Use a fixed averaging time]
[Cut-off fraction of toxic load	0,05 fraction]
[Cut-off concentration	0 fraction]

Geometry

Geometry shape	Point
Coordinates	Absolute
East(1)	0 m
North(1)	0 m

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

Discharge Data

User-Defined Quantities

Material	N-OCTANE
Temperature	25,00 degC
Pressure	1,01 bar
Inventory	489.438,53 kg
Scenario	Leak
Fixed Duration	n/a s

Calculated Quantities

Weather: Cenário acidental\Tempo

Mass Flow of Air (Vent from Vapor Space Only) n/a

Average Values for Segment Number 1

Liquid Fraction	1,00 fraction
FinalTemperature	24,99 degC
Final Velocity	15,12 m/s
Droplet Diameter	496,41 um

Continuous Release Data:

Mass Flowrate	3.21378E+000 kg/s
Release Duration	3.600,00 s
Orifice Velocity	15,12 m/s
Exit Pressure	1,01 bar
Exit Temperature	24,99 degC
Discharge Coefficient	0,60
Expanded Radius	0,01 m



Consequence Results

Pool Vaporization Results

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

		Tempo
Release Segment 1		
Release Duration	s	3600
Liquid Rainout	fraction	0,961623
Release Segment 1 Cloud Segment 1		
Cloud Segment Duration	s	1054,63
Pool Vaporization Rate	kg/s	0,31866
Total Vapor Flowrate	kg/s	0,441994
Release Segment 1 Cloud Segment 2		
Cloud Segment Duration	s	456,64
Pool Vaporization Rate	kg/s	0,736438
Total Vapor Flowrate	kg/s	0,859772
Release Segment 1 Cloud Segment 3		
Cloud Segment Duration	s	359,297
Pool Vaporization Rate	kg/s	0,934442
Total Vapor Flowrate	kg/s	1,05778
Release Segment 1 Cloud Segment 4		
Cloud Segment Duration	s	310,328
Pool Vaporization Rate	kg/s	1,08449
Total Vapor Flowrate	kg/s	1,20783
Release Segment 1 Cloud Segment 5		
Cloud Segment Duration	s	536,126
Pool Vaporization Rate	kg/s	1,25823
Total Vapor Flowrate	kg/s	1,38156
Release Segment 1 Cloud Segment 6		
Cloud Segment Duration	s	882,984
Pool Vaporization Rate	kg/s	1,51444
Total Vapor Flowrate	kg/s	1,63777
Maximum Pool Radius	m	26,7266



Distance to Concentration Results

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

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

Concentration(ppm)	Averaging Time			Tempo	Distance (m)
UFL (65000)	18,75		s	6,37389	
LFL (8000)	18,75		s	29,5803	
LFL Frac (4000)	18,75		s	39,5362	
Concentration(ppm)	Averaging Time			Tempo	Heights (m) for above distances
UFL (65000)	18,75		s	0,171388	
LFL (8000)	18,75		s	0	
LFL Frac (4000)	18,75		s	0	

Jet Fire Hazard

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

Jet fire method used: DNV recommended

Jet Fire Status	Tempo
Flame Direction	Truncated
	Horizontal

Radiation Effects: Jet Fire Ellipse

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

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

Radiation Level	Tempo	Distance (m)
5 kW/m2	18,6749	
7,3 kW/m2	17,1477	
14,4 kW/m2	14,9287	
28,4 kW/m2	13,1779	

Radiation Effects: Jet Fire Distance

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

Radiation Level (kW/m2)

Tempo

Early Pool Fire Hazard

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

Early Pool Fire Status	Tempo
	Hazard

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Radiation Effects: Early Pool Fire Ellipse

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

			Tempo	Distance (m)
Radiation Level	7,3	kW/m2	25,491	
Radiation Level	14,4	kW/m2	18,9092	
Radiation Level	37,5	kW/m2	10,0564	

Radiation Effects: Early Pool Fire Distance

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

Tempo
Radiation Level (kW/m2)

Late Pool Fire Hazard

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

Late Pool Fire Status
Tempo
Hazard

Radiation Effects: Late Pool Fire Ellipse

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

			Tempo	Distance (m)
Radiation Level	7,3	kW/m2	47,6219	
Radiation Level	14,4	kW/m2	32,7825	
Radiation Level	37,5	kW/m2	Not Reached	

Radiation Effects: Late Pool Fire Distance

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

Tempo
Radiation Level (kW/m2)

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Study Folder: Projeto Ferro Carajas S11D

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Flash Fire Envelope

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

All flammable results are reported at the cloud centreline height

				Distance (m)
			Tempo	
Furthest Extent	4000	ppm	39,5362	
Furthest Extent	8000	ppm	29,5803	
				Heights (m) for above distances
			Tempo	
Furthest Extent	4000	ppm	0	
Furthest Extent	8000	ppm	0	

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Explosion Effects: Late Ignition

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

Explosion Model Used : TNT

Explosion Location Criterion: Cloud Front (LFL Fraction)

All distances are measured from the Source

All flammable results are reported at the cloud centreline height

			Maximum Distance (m) at Overpressure Level
			Tempo
Overpressure	0,1	bar	47,1484
Overpressure	0,3	bar	38,5628
Overpressure	0,2068	bar	40,7537
			Supplementary Data at 0,1 bar
			Tempo
Supplied Flammable Mass		kg	4,46916
Used Flammable Mass		kg	4,46916
Overpressure Radius		m	17,1484
Distance to:			
- Ignition Source		m	30
- Cloud Front/Centre		m	30
- Explosion Centre		m	30
			Supplementary Data at 0,3 bar
			Tempo
Supplied Flammable Mass		kg	4,46916
Used Flammable Mass		kg	4,46916
Overpressure Radius		m	8,56279
Distance to:			
- Ignition Source		m	30
- Cloud Front/Centre		m	30
- Explosion Centre		m	30
			Supplementary Data at 0,2068 bar
			Tempo
Supplied Flammable Mass		kg	4,46916
Used Flammable Mass		kg	4,46916
Overpressure Radius		m	10,7537
Distance to:			
- Ignition Source		m	30
- Cloud Front/Centre		m	30
- Explosion Centre		m	30

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Study Folder: Projeto Ferro Carajas S11D

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Weather Conditions

Path: \Projeto Ferro Carajas S11D\Cenário acidental\2

		Tempo
Wind Speed	m/s	2
Pasquill Stability		D
Surface Roughness Length	mm	1000
Surface Roughness Parameter		0,173718
Atmospheric Temperature	degC	25
Surface Temperature	degC	32
Relative Humidity	fraction	0,78

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Projeto Ferro Carajas S11D



Cenário acidental

3

Cenário 3 - Ruptura de tubulação

Base Case

CASE Name: Data

Path: \Projeto Ferro Carajas S11D\Cenário acidental\3

User-Defined Data

Material

Material Identifier	N-OCTANE
Type of Vessel	Padded Liquid
Pressure Specification	Pressure specified
Discharge Pressure - gauge	2 bar
Discharge Temperature	25 degC
Volume Inventory of material to discharge	700 m3

Scenario

Type of Event	Leak
Phase	Liquid
HoleDiameter	25,4 mm
Building Wake Option	None
Tank Head	0 m

Location

[Release 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
[Surface type	Concrete]
[Height	0 m]
[Modelling of bund failure	Bund cannot fail]

Indoor/Outdoor

Location of release	Open air release
Outdoor Release Direction	Horizontal

Flammable

Method to use for explosions	TNT
Jet Fire Method	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	4,894E5 kg

Fireball Parameters

[Mass modification factor	3]
[Calculation method for fireball	DNV Recommended]

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[TNO model flame temperature 1727 degC]

Toxic Parameters

[Indoor calculations	Unselected]
[Ventilation specification	Case Specified]
[Building exchange rate	4 /hr]
[Tail time	1800 s]
[Method of setting time	Use a fixed averaging time]
[Cut-off fraction of toxic load	0,05 fraction]
[Cut-off concentration	0 fraction]

Geometry

Geometry shape	Point
Coordinates	Absolute
East(1)	0 m
North(1)	0 m

Path: \Projeto Ferro Carajas S11D\Cenário acidental\3

Discharge Data

User-Defined Quantities

Material	N-OCTANE
Temperature	25,00 degC
Pressure	3,01 bar
Inventory	489.438,53 kg
Scenario	Leak
Fixed Duration	n/a s

Calculated Quantities

Weather: Cenário acidental\Tempo

Mass Flow of Air (Vent from Vapor Space Only) n/a

Average Values for Segment Number 1

Liquid Fraction	1,00 fraction
FinalTemperature	24,96 degC
Final Velocity	25,82 m/s
Droplet Diameter	337,90 um
Continuous Release Data:	
Mass Flowrate	5.48846E+000 kg/s
Release Duration	3.600,00 s
Orifice Velocity	25,82 m/s
Exit Pressure	1,01 bar
Exit Temperature	24,96 degC
Discharge Coefficient	0,60
Expanded Radius	0,01 m



Consequence Results

Pool Vaporization Results

Path: \Projeto Ferro Carajas S11D\Cenário acidental\3

		Tempo
Release Segment 1		
Release Duration	s	3600
Liquid Rainout	fraction	0,934364
Release Segment 1 Cloud Segment 1		
Cloud Segment Duration	s	1064,39
Pool Vaporization Rate	kg/s	0,515197
Total Vapor Flowrate	kg/s	0,875439
Release Segment 1 Cloud Segment 2		
Cloud Segment Duration	s	458,56
Pool Vaporization Rate	kg/s	1,20113
Total Vapor Flowrate	kg/s	1,56137
Release Segment 1 Cloud Segment 3		
Cloud Segment Duration	s	360,609
Pool Vaporization Rate	kg/s	1,52829
Total Vapor Flowrate	kg/s	1,88854
Release Segment 1 Cloud Segment 4		
Cloud Segment Duration	s	309,021
Pool Vaporization Rate	kg/s	1,77663
Total Vapor Flowrate	kg/s	2,13688
Release Segment 1 Cloud Segment 5		
Cloud Segment Duration	s	532,259
Pool Vaporization Rate	kg/s	2,0648
Total Vapor Flowrate	kg/s	2,42504
Release Segment 1 Cloud Segment 6		
Cloud Segment Duration	s	679,883
Pool Vaporization Rate	kg/s	2,43996
Total Vapor Flowrate	kg/s	2,8002
Release Segment 1 Cloud Segment 7		
Cloud Segment Duration	s	195,277
Pool Vaporization Rate	kg/s	2,68607
Total Vapor Flowrate	kg/s	3,04631
Maximum Pool Radius	m	34,5516

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Distance to Concentration Results

Path: \Projeto Ferro Carajas S11D\Cenário acidental\3

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

Concentration(ppm)	Averaging Time		Tempo	Distance (m)
UFL (65000)	18,75	s	7,8056	
LFL (8000)	18,75	s	30,8611	
LFL Frac (4000)	18,75	s	44,9015	

Concentration(ppm)	Averaging Time		Tempo	Heights (m) for above distances
UFL (65000)	18,75	s	0,442988	
LFL (8000)	18,75	s	0	
LFL Frac (4000)	18,75	s	0	

Jet Fire Hazard

Path: \Projeto Ferro Carajas S11D\Cenário acidental\3

Jet fire method used: DNV recommended

Jet Fire Status	Tempo
Flame Direction	Truncated
	Horizontal

Radiation Effects: Jet Fire Ellipse

Path: \Projeto Ferro Carajas S11D\Cenário acidental\3

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

			Tempo	Distance (m)
Radiation Level	5	kW/m2	29,5375	
Radiation Level	7,3	kW/m2	27,0524	
Radiation Level	14,4	kW/m2	23,4812	
Radiation Level	28,4	kW/m2	20,7299	

Radiation Effects: Jet Fire Distance

Path: \Projeto Ferro Carajas S11D\Cenário acidental\3

Tempo
Radiation Level (kW/m2)

Early Pool Fire Hazard

Path: \Projeto Ferro Carajas S11D\Cenário acidental\3

Early Pool Fire Status	Tempo
	Hazard

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Radiation Effects: Early Pool Fire Ellipse

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			Tempo	Distance (m)
Radiation Level	7,3	kW/m2	30,8156	
Radiation Level	14,4	kW/m2	22,4469	
Radiation Level	37,5	kW/m2	13,484	

Radiation Effects: Early Pool Fire Distance

Path: \Projeto Ferro Carajas S11D\Cenário acidental\3

Tempo
Radiation Level (kW/m2)

Late Pool Fire Hazard

Path: \Projeto Ferro Carajas S11D\Cenário acidental\3

Late Pool Fire Status
Tempo
Hazard

Radiation Effects: Late Pool Fire Ellipse

Path: \Projeto Ferro Carajas S11D\Cenário acidental\3

			Tempo	Distance (m)
Radiation Level	7,3	kW/m2	60,4665	
Radiation Level	14,4	kW/m2	43,4493	
Radiation Level	37,5	kW/m2	Not Reached	

Radiation Effects: Late Pool Fire Distance

Path: \Projeto Ferro Carajas S11D\Cenário acidental\3

Tempo
Radiation Level (kW/m2)

SUMMARY REPORT

Unique Audit Number: 42.564



Study Folder: Projeto Ferro Carajas S11D

Phast 6.54

Flash Fire Envelope

Path: \Projeto Ferro Carajas S11D\Cenário acidental\3

All flammable results are reported at the cloud centreline height

				Distance (m)
				Tempo
Furthest Extent	4000	ppm		44,9015
Furthest Extent	8000	ppm		30,8611
				Heights (m) for above distances
				Tempo
Furthest Extent	4000	ppm		0
Furthest Extent	8000	ppm		0

SUMMARY REPORT

Unique Audit Number: 42.564



Study Folder: Projeto Ferro Carajas S11D

Phast 6.54

Explosion Effects: Late Ignition

Path: \Projeto Ferro Carajas S11D\Cenário acidental\3

Explosion Model Used : TNT

Explosion Location Criterion: Cloud Front (LFL Fraction)

All distances are measured from the Source

All flammable results are reported at the cloud centreline height

			Maximum Distance (m) at Overpressure Level
			Tempo
Overpressure	0,1	bar	58,9732
Overpressure	0,3	bar	49,474
Overpressure	0,2068	bar	51,8981

			Supplementary Data at 0,1 bar
			Tempo
Supplied Flammable Mass		kg	6,05313
Used Flammable Mass		kg	6,05313
Overpressure Radius		m	18,9732
Distance to:			
- Ignition Source		m	40
- Cloud Front/Centre		m	40
- Explosion Centre		m	40

			Supplementary Data at 0,3 bar
			Tempo
Supplied Flammable Mass		kg	6,05313
Used Flammable Mass		kg	6,05313
Overpressure Radius		m	9,474
Distance to:			
- Ignition Source		m	40
- Cloud Front/Centre		m	40
- Explosion Centre		m	40

			Supplementary Data at 0,2068 bar
			Tempo
Supplied Flammable Mass		kg	6,05313
Used Flammable Mass		kg	6,05313
Overpressure Radius		m	11,8981
Distance to:			
- Ignition Source		m	40
- Cloud Front/Centre		m	40
- Explosion Centre		m	40

SUMMARY REPORT

Unique Audit Number: 42.564



Study Folder: Projeto Ferro Carajas S11D

Phast 6.54

Weather Conditions

Path: \Projeto Ferro Carajas S11D\Cenário acidental\3

		Tempo
Wind Speed	m/s	2
Pasquill Stability		D
Surface Roughness Length	mm	1000
Surface Roughness Parameter		0,173718
Atmospheric Temperature	degC	25
Surface Temperature	degC	32
Relative Humidity	fraction	0,78

SUMMARY REPORT

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Study Folder: Projeto Ferro Carajas S11D

Phast 6.54



Projeto Ferro Carajas S11D



Cenário acidental

4

Cenário 4 - Furo em tubulação

Base Case

CASE Name: Data

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

User-Defined Data

Material

Material Identifier	N-OCTANE
Type of Vessel	Padded Liquid
Pressure Specification	Pressure specified
Discharge Pressure - gauge	2 bar
Discharge Temperature	25 degC
Volume Inventory of material to discharge	700 m3

Scenario

Type of Event	Leak
Phase	Liquid
HoleDiameter	6,35 mm
Building Wake Option	None
Tank Head	0 m

Location

[Release 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
[Surface type	Concrete]
[Height	0 m]
[Modelling of bund failure	Bund cannot fail]

Indoor/Outdoor

Location of release	Open air release
Outdoor Release Direction	Horizontal

Flammable

Method to use for explosions	TNT
Jet Fire Method	Cone Model

Dispersion

Late Ignition Location	No ignition location
Mass Inventory of material to Disperse	4,894E5 kg

Fireball Parameters

[Mass modification factor	3]
[Calculation method for fireball	DNV Recommended]

SUMMARY REPORT

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Study Folder: Projeto Ferro Carajas S11D

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[TNO model flame temperature 1727 degC]

Toxic Parameters

[Indoor calculations	Unselected]
[Ventilation specification	Case Specified]
[Building exchange rate	4 /hr]
[Tail time	1800 s]
[Method of setting time	Use a fixed averaging time]
[Cut-off fraction of toxic load	0,05 fraction]
[Cut-off concentration	0 fraction]

Geometry

Geometry shape	Point
Coordinates	Absolute
East(1)	0 m
North(1)	0 m

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

Discharge Data

User-Defined Quantities

Material	N-OCTANE
Temperature	25,00 degC
Pressure	3,01 bar
Inventory	489.438,53 kg
Scenario	Leak
Fixed Duration	n/a s

Calculated Quantities

Weather: Cenário acidental\Tempo

Mass Flow of Air (Vent from Vapor Space Only) n/a

Average Values for Segment Number 1

Liquid Fraction	1,00 fraction
FinalTemperature	24,96 degC
Final Velocity	25,82 m/s
Droplet Diameter	337,90 um
Continuous Release Data:	
Mass Flowrate	3.43029E-001 kg/s
Release Duration	3.600,00 s
Orifice Velocity	25,82 m/s
Exit Pressure	1,01 bar
Exit Temperature	24,96 degC
Discharge Coefficient	0,60
Expanded Radius	0,00 m

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Consequence Results

Pool Vaporization Results

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

		Tempo
	Release Segment 1	
Release Duration	s	3600
Liquid Rainout	fraction	0,88543
	Release Segment 1 Cloud Segment 1	
Cloud Segment Duration	s	1035,23
Pool Vaporization Rate	kg/s	0,034032
Total Vapor Flowrate	kg/s	0,0733327
	Release Segment 1 Cloud Segment 2	
Cloud Segment Duration	s	454,729
Pool Vaporization Rate	kg/s	0,0774981
Total Vapor Flowrate	kg/s	0,116799
	Release Segment 1 Cloud Segment 3	
Cloud Segment Duration	s	361,191
Pool Vaporization Rate	kg/s	0,0977919
Total Vapor Flowrate	kg/s	0,137093
	Release Segment 1 Cloud Segment 4	
Cloud Segment Duration	s	313,425
Pool Vaporization Rate	kg/s	0,113107
Total Vapor Flowrate	kg/s	0,152408
	Release Segment 1 Cloud Segment 5	
Cloud Segment Duration	s	539,424
Pool Vaporization Rate	kg/s	0,130702
Total Vapor Flowrate	kg/s	0,170002
	Release Segment 1 Cloud Segment 6	
Cloud Segment Duration	s	896
Pool Vaporization Rate	kg/s	0,156581
Total Vapor Flowrate	kg/s	0,195882
Maximum Pool Radius	m	8,25119



Distance to Concentration Results

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

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

Concentration(ppm)	Averaging Time			Tempo	Distance (m)
UFL (65000)	18,75		s	2,64948	
LFL (8000)	18,75		s	6,18056	
LFL Frac (4000)	18,75		s	13,7079	
Concentration(ppm)	Averaging Time			Tempo	Heights (m) for above distances
UFL (65000)	18,75		s	0,917072	
LFL (8000)	18,75		s	0,434195	
LFL Frac (4000)	18,75		s	0	

Jet Fire Hazard

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

Jet fire method used: DNV recommended

Jet Fire Status	Tempo
Flame Direction	Truncated
	Horizontal

Radiation Effects: Jet Fire Ellipse

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

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

Radiation Level	Tempo	Distance (m)
5 kW/m2	10,7409	
7,3 kW/m2	9,83001	
14,4 kW/m2	8,48954	
28,4 kW/m2	7,41075	

Radiation Effects: Jet Fire Distance

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

Radiation Level (kW/m2)

Tempo

Early Pool Fire Hazard

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

Early Pool Fire Status	Tempo Hazard

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Study Folder: Projeto Ferro Carajas S11D

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Radiation Effects: Early Pool Fire Ellipse

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

			Tempo	Distance (m)
Radiation Level	7,3	kW/m2	14,6038	
Radiation Level	14,4	kW/m2	12,0892	
Radiation Level	37,5	kW/m2	7,7945	

Radiation Effects: Early Pool Fire Distance

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

Tempo
Radiation Level (kW/m2)

Late Pool Fire Hazard

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

Late Pool Fire Status
Tempo
Hazard

Radiation Effects: Late Pool Fire Ellipse

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

			Tempo	Distance (m)
Radiation Level	7,3	kW/m2	31,8985	
Radiation Level	14,4	kW/m2	19,0693	
Radiation Level	37,5	kW/m2	Not Reached	

Radiation Effects: Late Pool Fire Distance

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

Tempo
Radiation Level (kW/m2)

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Study Folder: Projeto Ferro Carajas S11D

Phast 6.54

Flash Fire Envelope

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

All flammable results are reported at the cloud centreline height

				Distance (m)
				Tempo
Furthest Extent	4000	ppm		13,7079
Furthest Extent	8000	ppm		6,18056
				Heights (m) for above distances
				Tempo
Furthest Extent	4000	ppm		0
Furthest Extent	8000	ppm		0,434195

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Study Folder: Projeto Ferro Carajas S11D

Phast 6.54

Explosion Effects: Late Ignition

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

Explosion Model Used : TNT

Explosion Location Criterion: Cloud Front (LFL Fraction)

All distances are measured from the Source

All flammable results are reported at the cloud centreline height

			Maximum Distance (m) at Overpressure Level
			Tempo
Overpressure	0,1	bar	13,2897
Overpressure	0,3	bar	11,6427
Overpressure	0,2068	bar	12,063

Supplementary Data at 0,1 bar

Tempo

Supplied Flammable Mass	kg	0,0315524
Used Flammable Mass	kg	0,0315524
Overpressure Radius	m	3,28972
Distance to:		
- Ignition Source	m	10
- Cloud Front/Centre	m	10
- Explosion Centre	m	10

Supplementary Data at 0,3 bar

Tempo

Supplied Flammable Mass	kg	0,0315524
Used Flammable Mass	kg	0,0315524
Overpressure Radius	m	1,64267
Distance to:		
- Ignition Source	m	10
- Cloud Front/Centre	m	10
- Explosion Centre	m	10

Supplementary Data at 0,2068 bar

Tempo

Supplied Flammable Mass	kg	0,0315524
Used Flammable Mass	kg	0,0315524
Overpressure Radius	m	2,06298
Distance to:		
- Ignition Source	m	10
- Cloud Front/Centre	m	10
- Explosion Centre	m	10

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Study Folder: Projeto Ferro Carajas S11D

Phast 6.54

Weather Conditions

Path: \Projeto Ferro Carajas S11D\Cenário acidental\4

		Tempo
Wind Speed	m/s	2
Pasquill Stability		D
Surface Roughness Length	mm	1000
Surface Roughness Parameter		0,173718
Atmospheric Temperature	degC	25
Surface Temperature	degC	32
Relative Humidity	fraction	0,78

ANEXO XXIV-C

**FG-079-515-5020-0040-00-J - ALCANCE DOS EFEITOS FÍSICOS RELATIVOS
AOS CENÁRIOS ACIDENTAIS MODELADOS**

**(Alcance dos Níveis de radiação Térmica – Incêndio em Poça, Alcance do Limite
Inferior de Inflamabilidade – Incêndio em Nuvem, Alcance dos Níveis de Sobrepressão –
Explosão não confinada)**