Semi-quantitative risk analysis of a possible accident scenario at a gasoline storage facility

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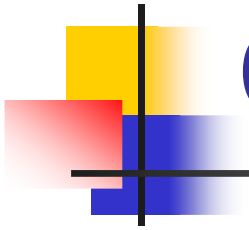

Outline

- About gasoline
- Consequence-based risk analysis
- Accident scenarios
- Results and discussions
- Conclusions

Gasoline

- Petro ture
- Consi rbons
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http://www.zmescience.com/wp-content/uploads/2008/04/gasoline.jpg

Gasoline

- High volatility
- Burns in the vapor phase
- Easily ignites

Therefore precautions must be taken during transportation and storage.

Consequence based risk analysis

- Starts with the identification of the major consequences
- Analyzes potential accident scenarios
- Analyzes the effects of the accidents upon the environment, human factor and structures
- Searches for combinations of hazard and vulnerability that could result in the most serious consequences

Accident scenarios

Potential accidents and their consequences during:

- gasoline transportation
- tank loading
- tank unloading
- maintenance operations

Accident scenarios

We have identified 3 major accident types:

- BLEVE (Boiling Liquid Expanding Vapor Explosion)
- Pool Fire
- Vessel rupture from internal pressure burst

BLEVE scenario

- external fire near the tank
- gasoline is heated until the vapor pressure increases and the tank ruptures
- Gasoline:
  - Small percent will burn in a fireball
  - Large quantity will burn on the ground as a pool-fire

Pool-fire scenario

Causes:

- a leakage is present in the pipeline

or

- external shock

  The content is released forming a pool in the drainage area.

In case of ignition a pool-fire will occur.

Vessel rupture scenario

Causes:

- external fire,
- filling level is lower, than in the case of BLEVE

(pressure effect is much more significant)

Results and discussions

Software used:

- PHA Pro 7 for Preliminary Hazard Analysis
- TNO Effects 7 for simulation of effects and consequences

Results and discussions

Preliminary Hazard Analysis

Process: 1. Operation
Node: 1. Tank
Type: Tank
Design Conditions/Parameters: storage at ambient pressure and temperature
Equipment ID:
Drawings:

Hazards	Causes	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
			S	L	RR			
1. BLEVE(Boiling Liquid Expanding Vapor Explosion)	1. Adjacent tank fires	1. Heat radiation from fireball - burns	2	2	4	1. Adequate spacing		
2. Blast forces	1. Overpressure (above line design specification)	1. Ambient overpresure - ear and lung damage	2	1	2	1. Pressure indication		

Process: 2. Loading
Node: 1. Tank
Type: Tank
Design Conditions/Parameters: storage at ambient pressure and temperature
Equipment ID:
Drawings:

Hazards	Causes	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
			S	L	RR			
1. BLEVE(Boiling Liquid Expanding Vapor Explosion)	1. Adjacent tank fires	1. Heat radiation from fireball - burns	2	2	4	1. Adequate spacing		
2. Pool fire	1. Leakage through vents & drains	1. Heat radiation from pool fire	2	3	6	1. Inspection procedures		
3. Blast forces	1. Overpressure (above line design specification)	1. Ambient overpresure - ear and lung damage	2	1	2	1. Pressure indication		

Process: 3. Unloading
Node: 1. Tank
Type: Tank
Design Conditions/Parameters: storage at ambient pressure and temperature
Equipment ID: 1
Drawings:

Hazards	Causes	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
			S	L	RR			
1. BLEVE(Boiling Liquid Expanding Vapor Explosion)	1. Adjacent tank fires	1. Heat radiation from fireball - burns	2	2	4	1. Adequate spacing		
2. Pool fire	1. Leakage through vents & drains	1. Heat radiation from pool fire	2	3	6	1. Inspection procedures		
3. Blast forces	1. Overpressure (above line design specification)	1. Ambient overpresure - ear and lung damage	2	1	2	1. Pressure indication		

Process: 4. Maintenance
Node: 1. Tank
Type: Horizontal cylinder
Design Conditions/Parameters: storage at ambient pressure and temperature
Equipment ID: 1
Drawings:

Hazards	Causes	Consequences	Risk Matrix			Safeguards	Recommendations	Responsibility
			S	L	RR			
1. Pool fire	1. Leakage through vents & drains	1. Heat radiation from pool fire	2	3	6	1. Inspection procedures		
2. Blast forces	1. Overpressure (above line design specification)	1. Ambient overpresure - ear and lung damage	2	1	2	1. Pressure indication		

Results and discussions

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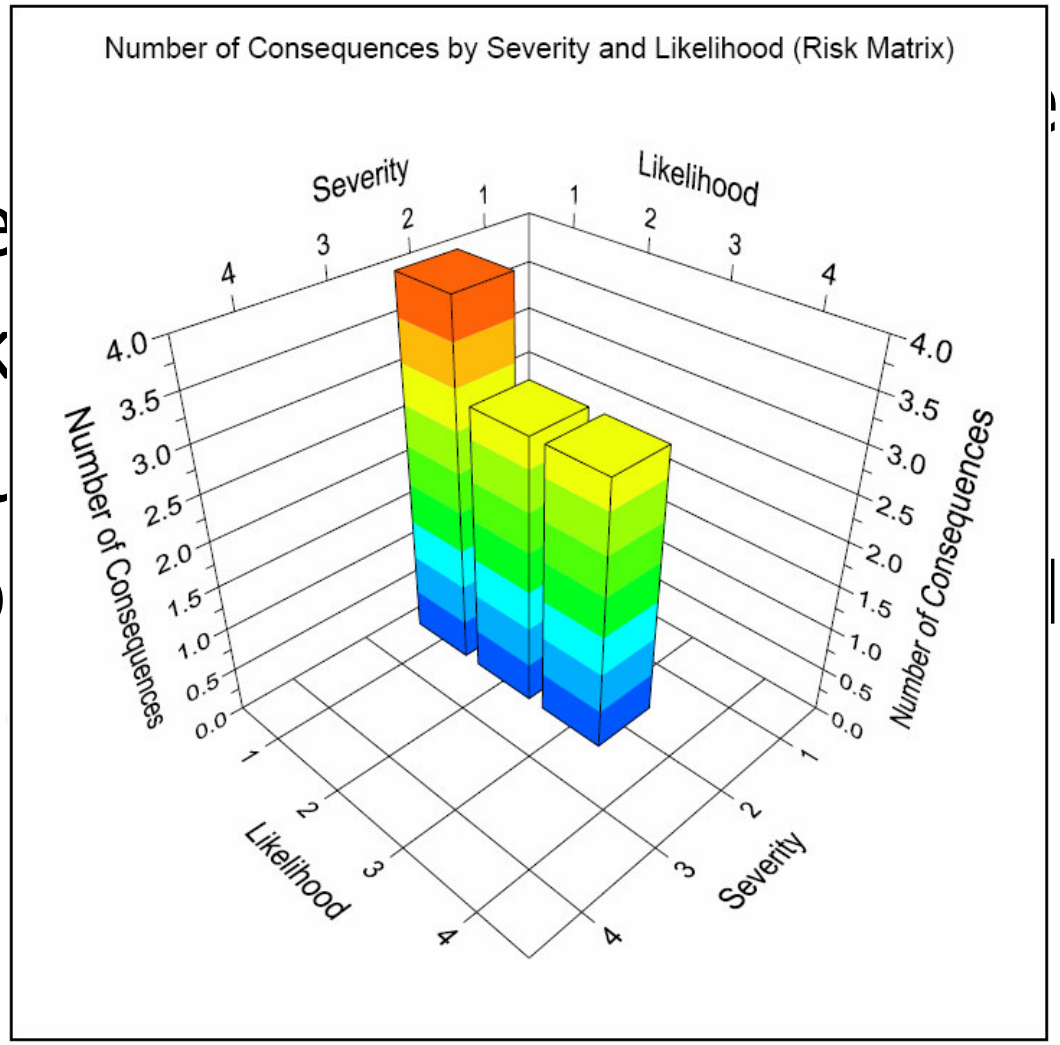

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Simulation of the accident scenarios

- Worst case scenario simulation
- Input data:
  - length = 6 m, diameter = 2,48 m, V = 29 m3, with 17000 kg gasoline at 80% filling degree.
  - The atmospheric parameters are the followings: wind speed = 2 m/s, measured at 10 m, ambient temperature = 25 oC, relative humidity = 70%.

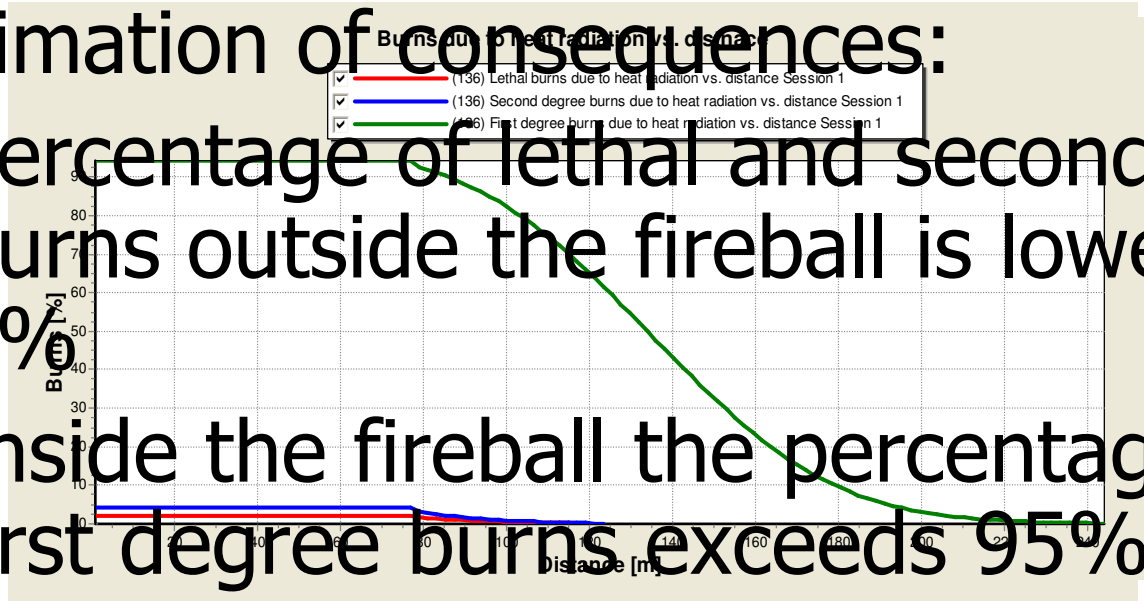
Simulation of the accident scenarios

BLEVE scenario:

- fireball of the BLEVE has a diameter of 76.81 m
- duration of the fire ball is 10.74 s.

Estimation of consequences:

- percentage of lethal and second degree burns outside the fireball is lower than 5%
- Inside the fireball the percentage of first degree burns exceeds 95%



Simulation of the accident scenarios

Pool fire scenario

- circular pool fire with 398 m2
- Heat radiation:

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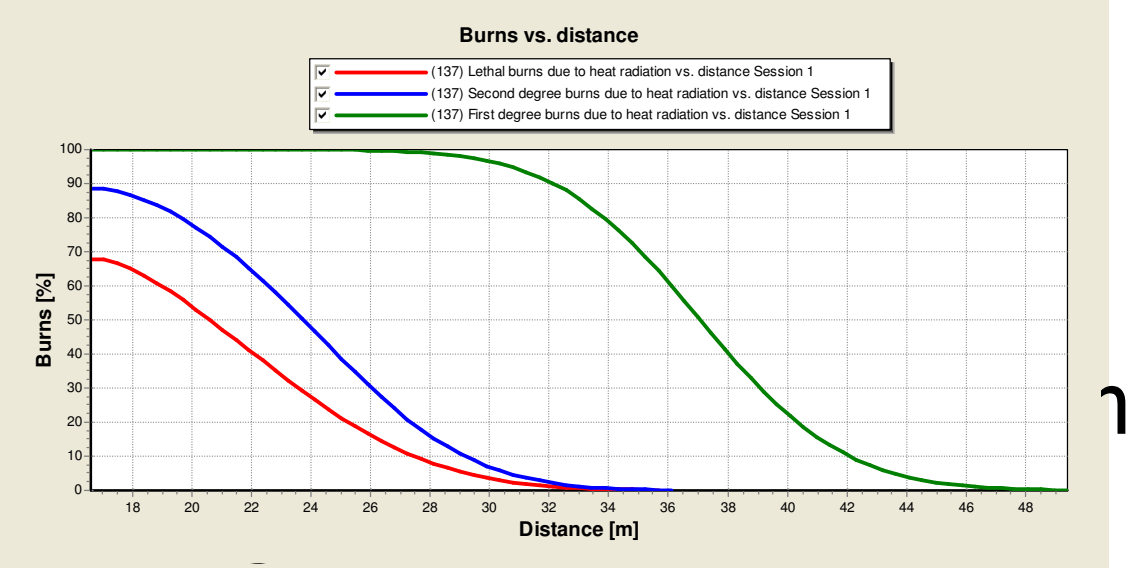
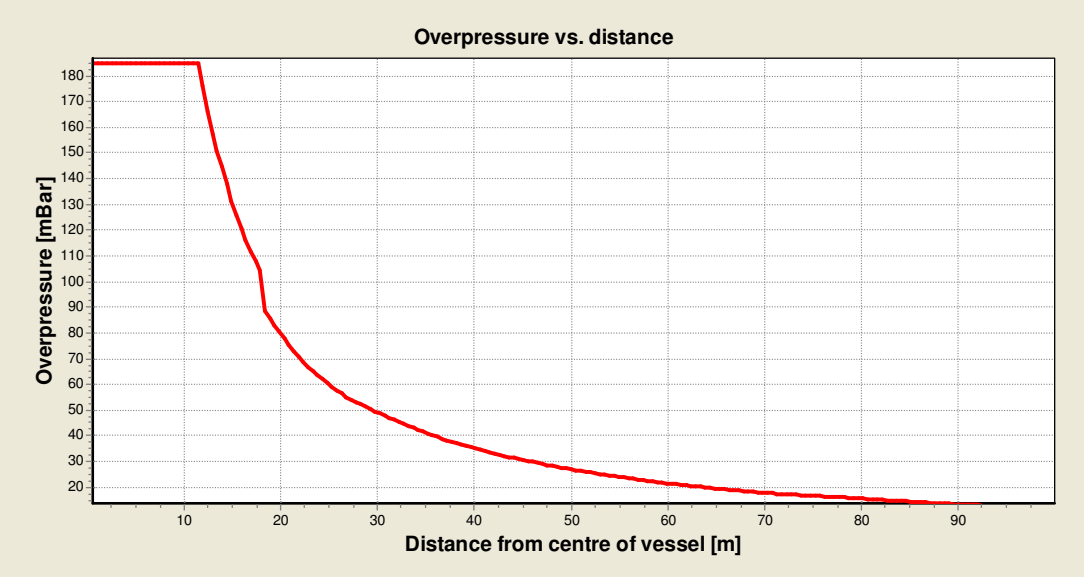


Simulation of the accident scenarios

Rupture of vessel

- 10%
- bur
- The during the



Simulation of the accident scenarios

Rupture of vessel

- maximum overpressure does not reach the 300 mBar lethal overpressure threshold
- the distance for irreversible effects on humans is 22 m

Conclusions

- The results obtained from the qualitative (PHA) and quantitative (Effects) analysis shows that the highest risk is present in the case of a pool fire scenario, but the risk category is only moderate
- In all cases the consequences can be considered moderate, and the probabilities are low
- The probability of BLEVE and Vessel Rupture scenarios can be mitigated if proper safety measures are taken

Conclusions

- The pool fire scenario is possible in case of an external mechanical impact, such as road tanker accident, with the crack of the vessel and release of the gasoline
- The Internal Emergency Plan of the storage facility should consider the simulation results for the development of the right rescue strategy in case of an accident
- The obtained results are also helpful in the Land use planning for the calculation of the safety zones.