Methods of technical risk assessment in a regional context

Transportation of dangerous goods (TDG)

International research

Swiss legislation
  • Transportation of dangerous goods
  • Guidelines of the StFV

CARGO approach
  • Basic concept
  • ’Hot Spots’
  • Computer tools - Results
Example: The Zurich-Affoltern Fire, March 8, 1994

SBB Cargo Train with 20 tank wagons carrying 80000 litres of benzin derailed due to a defected wheel bearing. From a derailed wagon, benzin flowed out through a leakage, ignited and caught fire. During the drainage of the tracks, big amounts of benzin entered the nearby canalization system. Explosive mixture of benzin vapors and air was developed and exploded at different locations up to a radius of 7 km, causing damages to hundred meters of the canalization's pipes. A nearby rainwater purification basin was also destroyed. Water and ground contamination due to the benzin and the polluted fire water used during the fire fighting. Three houses burned down, three persons injured and damages of several million CHF.
What is the specific problem with TDG?

- Moving, changing environment incl. population at risk
- Large variety of substances; amounts vary stochastically (cargo ship - delivery van)
- Accumulations possible (shunting yards, oil depots)
- Cascading effects more probable (railway/road nearby chemical facilities)
- Risk-influencing factors (actual time table, speed control)
- General safety requirement and emergency measures
International research topics

- Routing lorries/trains transporting dangerous goods; trade-off between shortest/fastest route and risk issues [1]; minimisation of the total risk of hazmat shipments [2]
- Assessing risks in transportation networks; calculation of societal risk due to potential accident scenarios [3], [4]
- Reduction of intervention times based on graph theory [5]; design and location of specialised emergency response teams [6]
- Multiple use of space: individual risk and group risk in buildings constructed above roads and railways [7]
Transportation of dangerous goods: Regulations

International transportation regulation
- Reglement concernant le transport international ferroviaire de marchandises dangereuses (RID)
- Accord européen relatif au transport international des marchandises dangereuses par route (ADR)

Risk regulation in Switzerland
- Major accidents ordinance (StFV)
- Ordinance on the transport of dangerous goods by rail (RSD)
- Ordinance on the transport of dangerous goods by road (SDR)
SDR/ADR – Substance groups

Class 1 Explosives*
Class 2 Gases (flammable, non-flammable and poisonous)
Class 3 Flammable liquids
Class 4 Flammable solids
Class 5 Oxidizing agents and organic peroxides (liquid or solid)
Class 6 Toxic and infectious substances
Class 7 Radioactive substances*
Class 8 Corrosive substances
Class 9 Miscellaneous dangerous substances

* Not subject to the StFV
Guidelines of the StFV

Handbook III of the Major Accidents Ordinance
Guidelines for Transportation Routes [8]:

Railways and roads must be divided into segments with homogeneous characteristics

- Building structure
- Technical equipment
- Surroundings
- Security measures …

Description of the segment characteristics

- Drainage system
- Type of road
- Additional installations (e.g. petrol station, picnic area)
- Railway stations
- Number of tracks …
Guidelines of the StFV

Description of the surroundings
- Population density
- Ground water
- Surface water
- Special objects (e.g. shopping centre, camping ground, dangerous industrial facilities, etc.) …

Estimation of undesired event frequency

Accident scenarios
- Fire
- Explosion
- Toxic gas release
- Release of water endangering substances
- Release of mineral oil products
Road – Release frequency calculation

\[ H_S = DTV \cdot 365 \cdot ASV \cdot UR \cdot AGS \cdot ASK \cdot ARS \cdot RFZ \cdot ASS \]

**H\(_S\):** Frequency of a representative release scenario which causes heavy damage [km\(^{-1}\) a\(^{-1}\)]

**DTV:** Daily mean traffic is calculated to yearly traffic [vehicles/a]

**ASV:** Share of heavy vehicle traffic on the DTV [-]

**UR:** Accident rate [vehicle\(^{-1}\) km\(^{-1}\)]

**AGS:** Share of dangerous goods transports on the heavy vehicle traffic [-]

**ASK:** Share of the decisive SDR-classes on the representative accident scenario [-]

**ARS:** Share of the relevant substances on the decisive SDR-classes for the representative accident scenario [-]

**RFZ:** Rate for relevant releases and (in case of fire and explosion) a following ignition [-]

**ASS:** Number of representative accident scenarios which cause heavy damage [-]
More advanced methods: Frequency of harm to the population
Basic concept

Loss of containment frequency
• Frequencies of transportations
• Basic event probabilities
• Human behaviour
• Segment parameters / characteristics

Consequence calculations
• Substance characteristics
• Amount transported
Basic concept

Loss of containment frequency
- Frequencies of transportations
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Consequence calculations
- Substance characteristics
- Amount transported
- Impact scenarios
Hot Spots

The concept of Hot Spots:

“A hot spot is defined by the existence of at least one infrastructural sensitive object in the vicinity of the actual location, and/or by the fact that the location has a high population density irrespective of the existence of an object.” [3]
Implementation of the models and the concepts into the software tool CARGO.

- Societal risk along transportation routes
- Detection of "Hot Spots"
- Generation of a "Risk profile"
CARGO – Hot spots regarding societal risks
CARGO – Societal risk profile
References


