

QRA in the Netherlands

RID working group
Standardized Risk Analysis
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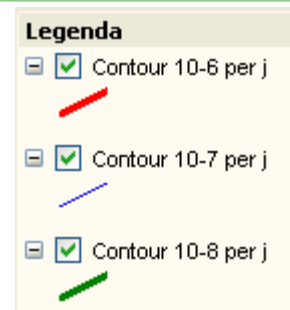
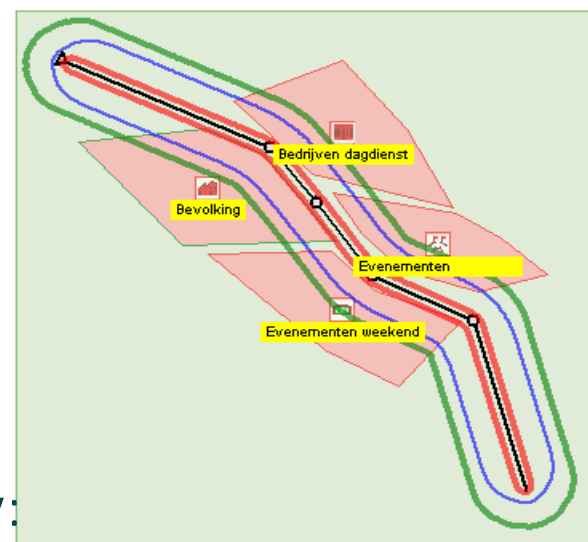
- ▶ Risk criteria
- ▶ General approach
- ▶ Available models and software
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- ▶ Scenarios, event trees, failure frequencies, consequences
- ▶ Overview of the software



Risk criteria: individual risk

Individual risk (location specific risk)

- ▶ Probability per year that a person who stays permanently and unprotected on a place along the route dies due to a transport accident with dangerous substances
- ▶ Connect points with the same probability: risk contour
- ▶ 10^{-6} location specific risk contour
 - ▶ Limit value for vulnerable objects for new situations
 - ▶ Guide value for limited/not vulnerable objects



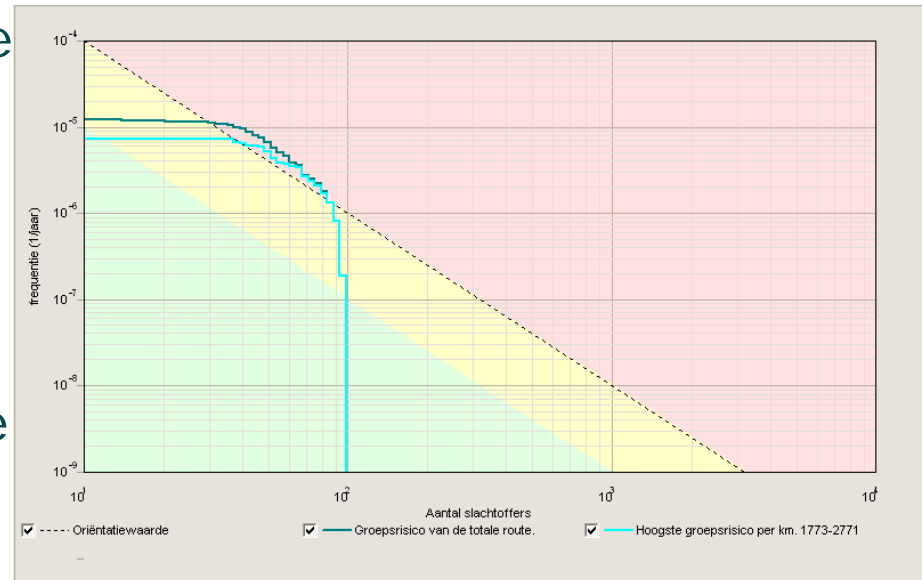
Risk criteria: societal risk

- ▶ Probability per year per km-transport route that a group of 10 persons or more dies due to a transport accident with dangerous substances on the transport route



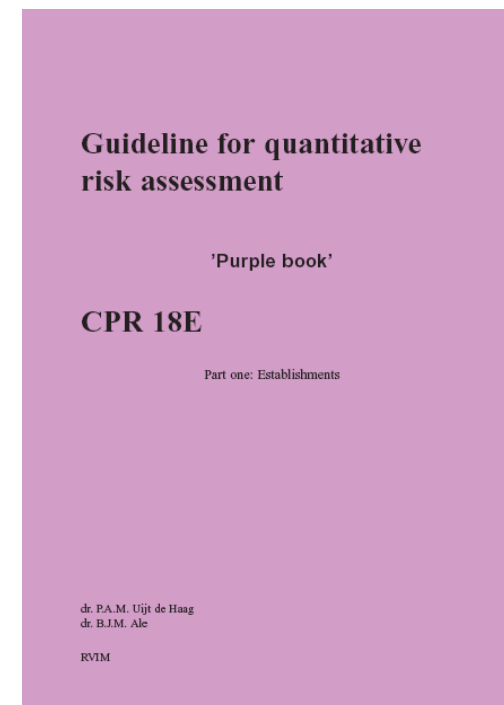
Societal risk: guide value

- ▶ When risk has increased or has exceeded the guide value the competent authorities have to give a motivation on the acceptability of the risk
- ▶ Investigate if risk reducing measures can be taken (ALARA)
- ▶ Elaborate possibilities for self-rescue and emergency response

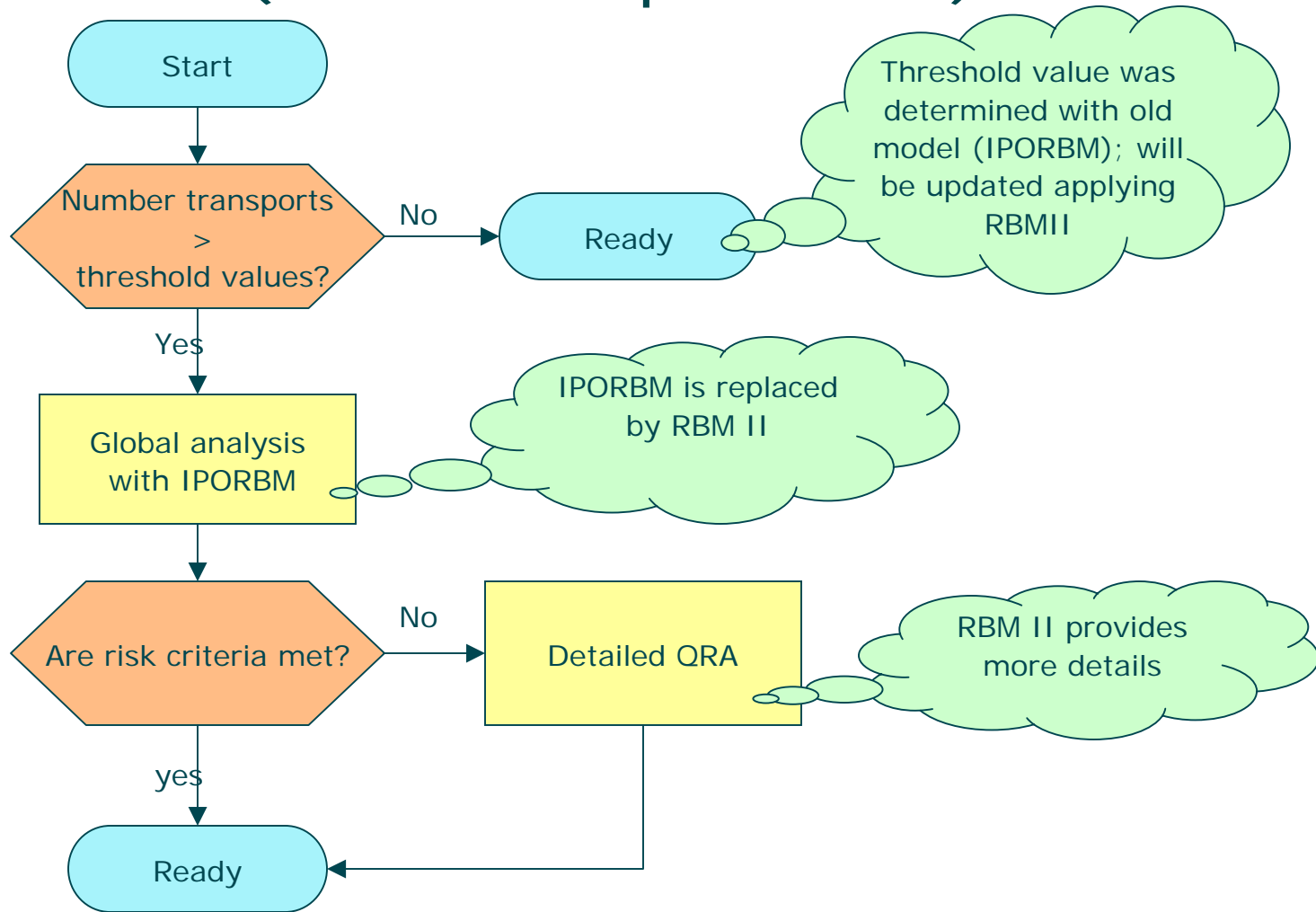


Standardized approach

- ▶ Guidelines for QRA described in Purple Book (1999): Publication series on dangerous substances (PGS 3), Guideline for quantitative risk analysis
 - ▶ Establishments and transport
- ▶ Updated version in progress,
 - ▶ Calculation protocol Railway (2005)
 - ▶ Protocol Sea- and inland waterways (2005)
- ▶ Free software made available by ministry of Transport:
 - ▶ First version IPORBM 1997
 - ▶ New, extended version RBMII (2005), recently updated



General and standardized approach (PGS3, Purple Book)



Threshold values rail transport

Individual risk contour 10^{-6} contour can occur with quantities larger than:

	High speed	Low speed
Number of flammable liquids (C3, tank cars/year)	3000	No 10^{-6} contour
Total number of dangerous subst. (tank cars/year)	7000	No 10^{-6} contour

Exceeding of guide value societal risk:

- Dominated by transport of LPG
- Depends on intensity of population along route
- Example:
 - Population density of 100 persons per hectare on one side of the route, and 1600 tank cars at high speed leads to exceeding of guide value



Standardized software: RBM II

- ▶ Used for calculation of IR and SR: to check if there is a conflict between transport activities and urban development
 - ▶ Module road traffic
 - ▶ Module railway traffic
 - ▶ Module inland waterways
- ▶ Only a limited set of input data is necessary
- ▶ Most transport QRA in the Netherlands are performed with RBMII (> 80%?)
- ▶ 624 registered users



Applicability of RBMII

- ▶ Suitable for standard situations, on-going traffic, open air situations, flat land
- ▶ Representative for most special situations such as lower or higher situated tracks, tracks with windscreens, crossings.
- ▶ Not to be used for private sidings and shunting yards
- ▶ Not suitable for waterways with more than 10% sea ships
- ▶ More detailed analysis necessary for tunnels and complex railway situations



The standard risk analysis

- ▶ Calculation of individual risk and societal risk
- ▶ Determine probabilities and consequences of accidents with dangerous substances
 - ▶ Flammable liquids
 - ▶ Toxic liquids
 - ▶ Flammable (liquefied) gasses
 - ▶ Toxic (liquefied) gasses



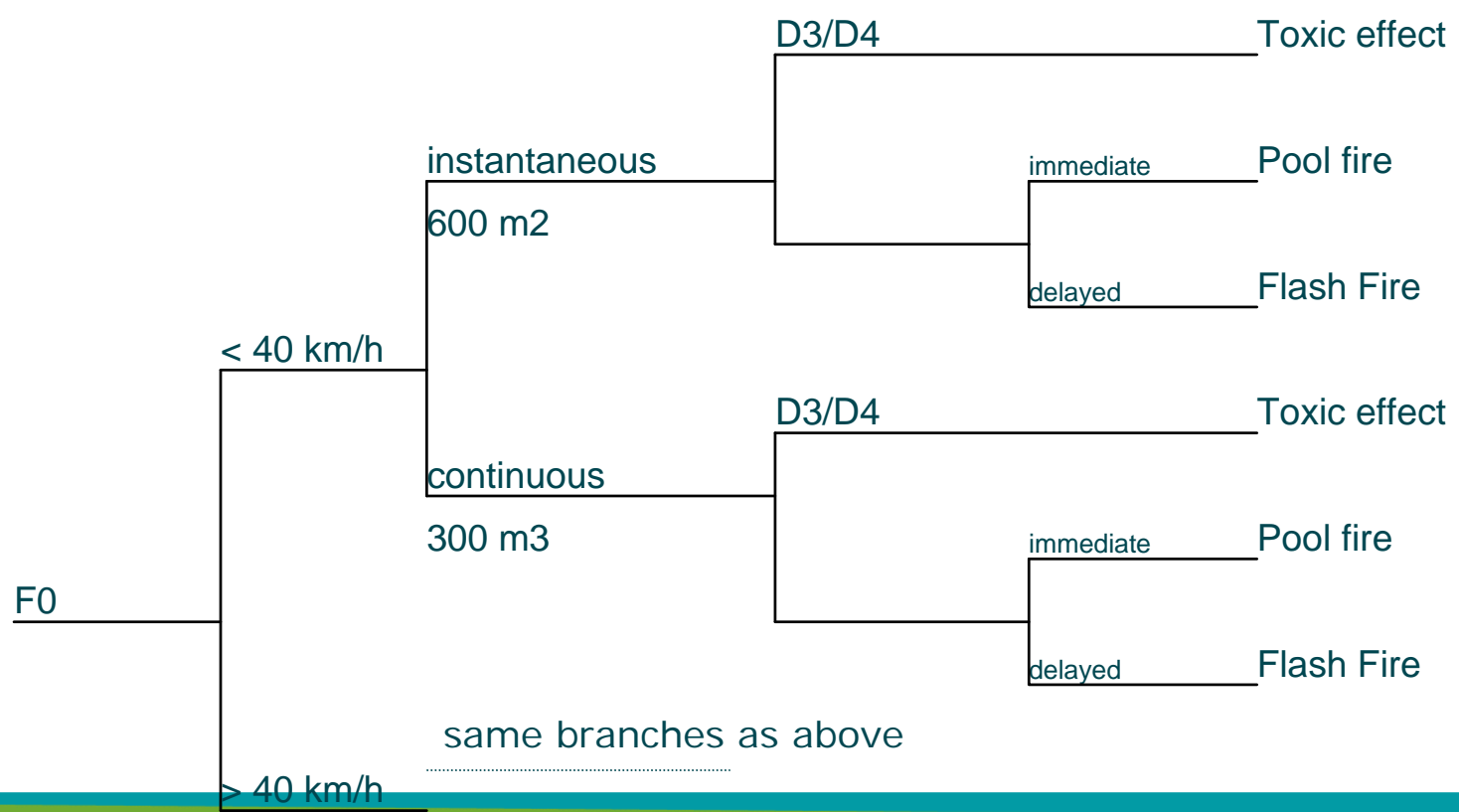
Substances categories

Category	Rail	Road/waterway	Repr. subs. RBMII
Flam. Liquid	C3	LF1	Heptane
		LF2	Pentane
Tox. liquid	D3	LT1	Acrylonitril
		LT2	
		LT3	Acroleine
Flam. gas	A	GF1	Etheenoxide
		GF2	n-Butane
		GF3	Propane
		GF4	
Tox. gas	B2	GT2	Methylmercaptane
		GT3	Ammonia
		GT4	Chlorine
	B3	GT5	Chlorine

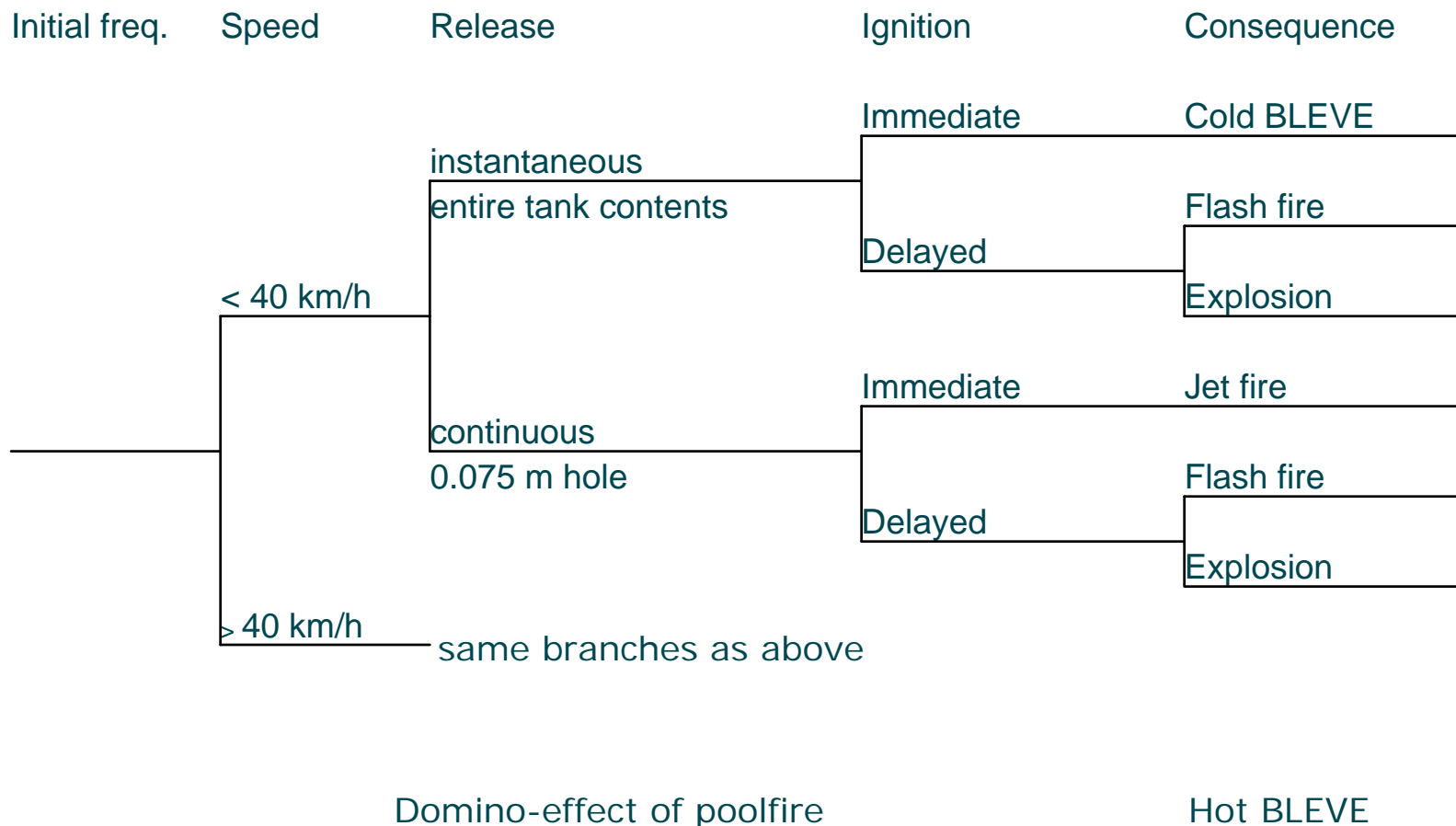


Scenarios: liquids

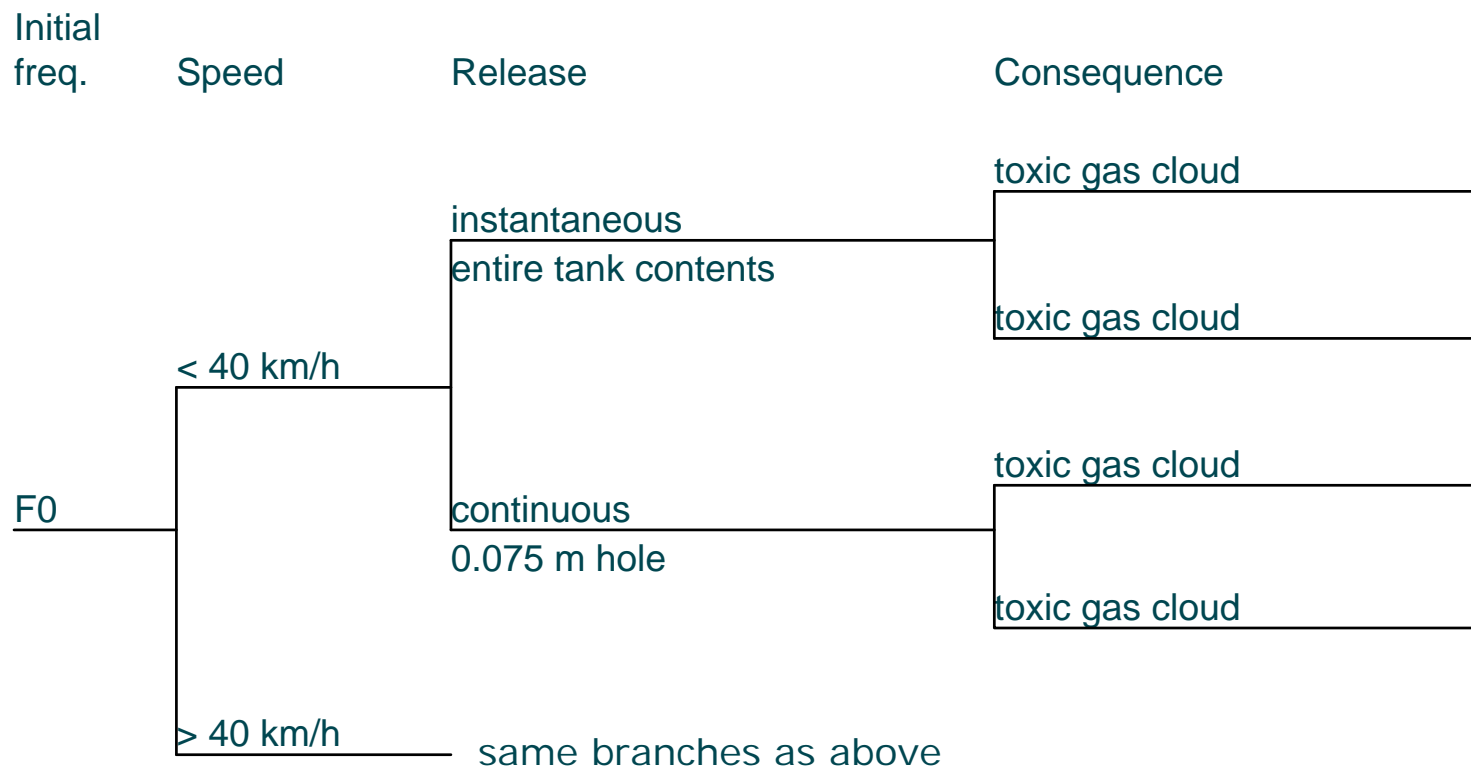
Initial freq. Speed Release Substance Ignition Consequence



Scenarios: flammable gasses



Toxic gas



Failure frequencies (rail)

- ▶ Initial failure frequency
 - ▶ High speed track: $2.77 \cdot 10^{-8}$ per wagon per kilometre
 - ▶ Low speed track: $1.36 \cdot 10^{-8}$ per wagon per kilometre

 - ▶ $0.8 \cdot 10^{-8}$ per wagon per kilometre for each level crossing
 - ▶ $3.3 \cdot 10^{-8}$ per wagon per kilometre for a kilometre track with set of points

- ▶ Failure frequencies based on Dutch accident data period 1981-1992
- ▶ Update with new data will be performed this year



Failure frequencies (2) (rail)

- ▶ Based on accident data (13 damaged railway tankers)
- ▶ Probability of outflow:

Category	Speed < 40 km/h	Speed > 40 km/h
Flam. Liquid	0.079	0.56
Toxic. Liquid	0.0079	0.056
Flam. Gas	0.00079	0.0028
Toxic. gas	0.00079	0.0028

- ▶ Ratio instantaneous and continuous release: 0.4 : 0.6
- ▶ Probability ignition flammable liquid: 0.25
- ▶ Ignition flammable gas, inst. release: immediate: 0.8
Ignition flammable gas, cont. release: immediate: 0.5
- ▶ Flam. Gas, flash fire vs. explosion: 0.6 vs. 0.4



Basic assumptions consequence modelling

- ▶ Flammable and toxic liquids: pool size is fixed
- ▶ Inventory pressurized tanks
 - ▶ Flammable gasses: 48 tonnes
 - ▶ Toxic gasses; 50 tonnes
- ▶ Prescribed models for dispersion, exposure damage same as used for installations, prescribed in
 - ▶ Purple Book (PGS3),
 - ▶ Yellow Book (PGs2),
 - ▶ Green Book (PGS1)
- ▶ Use of meteorological data:
 - ▶ 6 weather classes,
 - ▶ 12 wind directions,
 - ▶ data available from 18 weather stations

Guideline for quantitative
risk assessment

'Purple book'

CPR 18E

Methods for the calculation of
physical effects

— due to releases of hazardous materials (liquids and gases) —

'Yellow Book'

VROM

Publicatierreeks Gevaarlijke Stoffen 1
Methoden voor het bepalen van
mogelijke schade
Aan mensen en goederen door het vrijkomen
van gevaarlijke stoffen

Ministerie van VROM →
staat voor ruimte, wonen,
milieu en rijksgebouwen.
Beleid maken, uitvoeren
en handhaven.
Nederland is klein.
Denk groot.



Consequences, some results

- ▶ Flammable liquids:
 - ▶ Pool fire: *consequence. distances 10-30 metres*
- ▶ Flammable gasses:
 - ▶ Continuous release, immediate ignition: jet fire: *ca. 80x 30 m*
 - ▶ Instantaneous release, immediate ignition : BLEVE: *100% let in radius van ca. 150 meter*
 - ▶ Instantaneous or continuous release, delayed ignition: Flash fire or explosion *size gas cloud ca. 145 bij 45 m.*
- ▶ Toxic liquids:
 - ▶ Pool evaporation, exposure to toxic gasses: *1% lethality at several hundreds metres depending on substance, weather conditions*
- ▶ Toxic gasses (ammonia, chlorine):
 - ▶ exposure to toxic gasses: *1% lethality at several kilometres depending on substance, weather conditions*



Calculation of risks

- ▶ Risks are calculated by placing accident points along the route:
 - ▶ Individual risk every 10 metre (railway, road)
 - ▶ Societal risk every 25 metre (railway, road)
- ▶ Check for each location and each scenario which areas are affected and cumulate results:
 - ▶ Lethality rate per location: individual risk contours
 - ▶ Number of casualties per scenario: FN-curves, for transport calculates per km transport route



An overview of the standardized software RBMII

- ▶ Input of data:
 - ▶ Type of transport
 - ▶ Project data
 - ▶ Weather data
 - ▶ Data on the route
 - ▶ Transported substances:
 - ▶ Category, amount
 - ▶ Length, type, etc.
 - ▶ Build environment
- ▶ Calculation
- ▶ Analyse results
 - ▶ FN-curve
 - ▶ Individual risk
 - ▶ Reports

