

**Acceptable, tolerable,
non-tolerable
risks at the workplace**

**History of the German
traffic light model**

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GUS/TD – Hazardous Material Management

- ➔ Risks of every day life
- ➔ Assessment of the risks of carcinogenic substances for all inhabitants of industrial societies
- ➔ Recommendation of the German Radiation Safety Commission
- ➔ Comparison of the lethal risks of different industrial and professional areas
- ➔ Comparison of different risks of chemicals in everyday life

Risk Perception

Risk of a fatal lightning strike

1 : 1,600,000

Risk of dying from shark attack

1 : 70,000,000

Risk in USA of dying as a consequence of a hurricane

1 : 7,000,000

1 : 60,000

Risk of dying by a snakebite

1 : 56,000

Risk for a pregnant woman, dying during childbearing

1 : 300,000

Risk of dying in hospital from an infectious disease:

→ 1,000 time higher than from lightning strike!

**Optimum hygiene situation could prevent
30% infections in hospitals!**

Prof. Daschner, Uni-Klinikum Freiburg („German Hygiene pope“)

Most effective measures in hospitals:

→ hand washing; disinfection!

Cause of death

Reason	annual risk	risk per lifetime (80 a)
Smoking	1 : 500	1 : 6
Cancer	1 : 600	1 : 7
Heart disease	1 : 400	1 : 5
Suicide	1 : 8,000	1 : 95
Paragliding	1 : 555	1 : 7
Plane crash	1 : 1,500	1 : 19

Traffic death in Germany, 2008

Total number: 4,477

Distribution per means of transportation (driver + passenger):

Car	2368	53 %
Truck	200	4.5%
Bus	10	0.2 %
Motor-bike	656	14.7 %
Moped	110	2.5 %
Bicycle	456	10.2 %
Pedestrian	653	14.6 %

Automobile accident actuated by car defect: < 1 %

Risk from X-ray examination

Kind of examination	Risiko
Hand	1 : 10 Millionen
Elbow, knee	1 : 1 Million
Lung, cervical spine, skull	1 : 100,000
Thoracic spine, hip, mammography	1 : 40,000
Lumbar spine, abdomen, CT- head	1 : 10,000
Stomach and small intestine (radiography), CT-spine	1 : 2,000
Large intestine and artery (radiography), CT-thorax	1 : 1,000

Additional mortality risk by one time X-ray examination

Source: Prof. Jung, Uni Hamburg

Risk of Asbestos

Asbestos, 1,000 F/m³ during whole school time: 1 : 1,000,000

Lethal risk of children as pedestrians



1 : 3,000

Asbestos decontamination: longer way to school (10 ms): 1 : 100,000

Different Exposure Situations

General Population:

(Pt)



Exposure duration, in total:	70 a
Annual Exposure :	52 w
Weekly Exposure :	7 d
Daily Exposure :	24 h
Exposure group:	everybody including hypersensitive persons

Workplace situation:

(Wt)



Exposure :	40 a
Annual Exposure :	44 w
Weekly Exposure :	5 d
Daily Exposure :	8 h
Exposure group :	healthy worker

Starting point of our Discussion

Report of the Federal Environmental Agencies in 1992:

→ Risk from the 7 most important environmental carcinogens, in total:

Urban population : **1 : 1,000/Pt**

Rural population: **1 : 5,000/Pt**



The risks for the urban population was assessed as being too high.

Goal: adaptation to situation of the rural population

Intermediate step:

Urban population : **1 : 2,500/Pt**



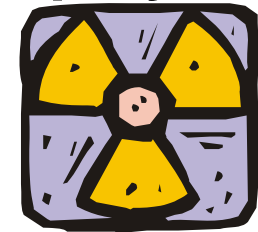
Accepted maximum annual radiation dose for employees:

⇒ 20 mS/a

Accepted maximum lifetime radiation dose for employers:

⇒ 400 mS

⇒ additional risk cancer : **2 : 100/Wt**



Natural Radiation Exposure

→ radiation dose: 1 mS/a

additional risk cancer: **4 : 1,000/Pt**



Lethal risks in different branches of economy

Forestry **2.5 : 1,000 /Wt**

Agriculture **3 : 1,000 /Wt**

Construction **2 : 1,000 /Wt**

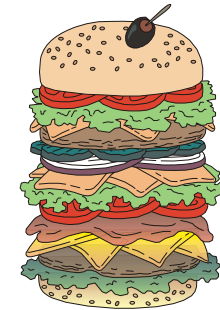
Mining **3 : 1,000 /Wt**

Retail **4 : 10,000 /Wt**

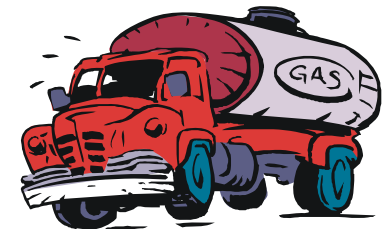
Common substances risks of every day life

Arsenic in drinking water (10 $\mu\text{g/l}$) **5 : 10,000/Pt**

Dioxin in food (2 pg Teq/kg) **3 : 10,000/Pt**



Diesel engine emissions (5 ng BaP/ m^3) **2 : 10,000/Pt**



Cadmium in environmental dust **2 : 100,000/Pt**

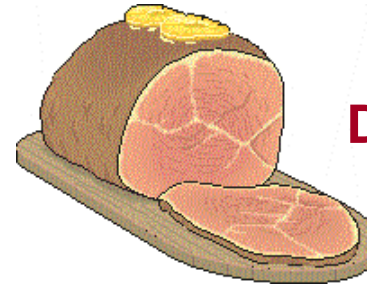
Natural carcinogens in food

bacon (100 g)

0,3 μg

calamaris

7,9 μg



Dimethyl-nitrosamine

cauliflower

12 – 66 ppm

Brussel sprouts

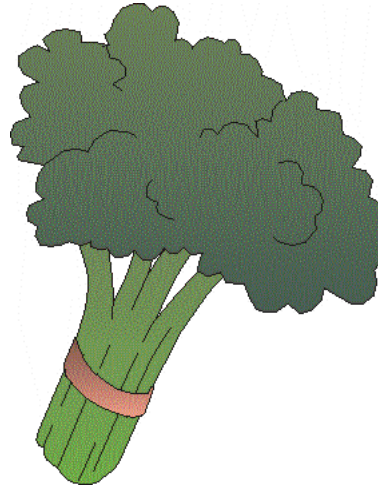
110 – 1,560 ppm

mustard

16,000 – 72,000 ppm

horseradish

4,500 ppm



Allyl isothiocyanate

Thresholds for Carcinogens and Mutagens

Are there currently no health-based thresholds for every carcinogens and mutagens?

Is this statement true for **all** carcinogens and mutagens?

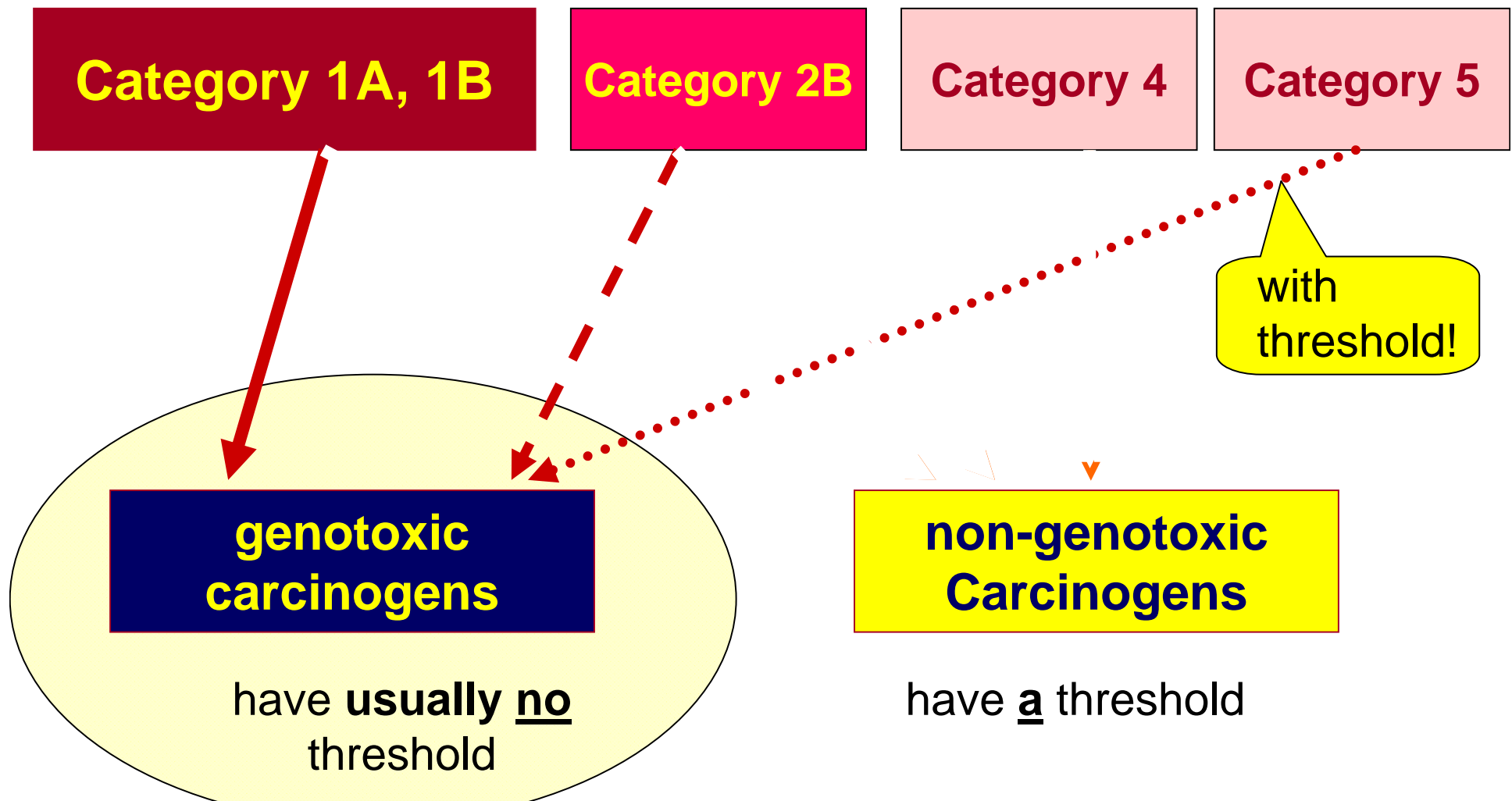
→ **non-genotoxic** (and non DNA-reactive) **carcinogens** have thresholds as a basic principle and a health-based OEL can be established!

⇒ carcinogens of category 4 German MAK-List, **SCOEL Group D**

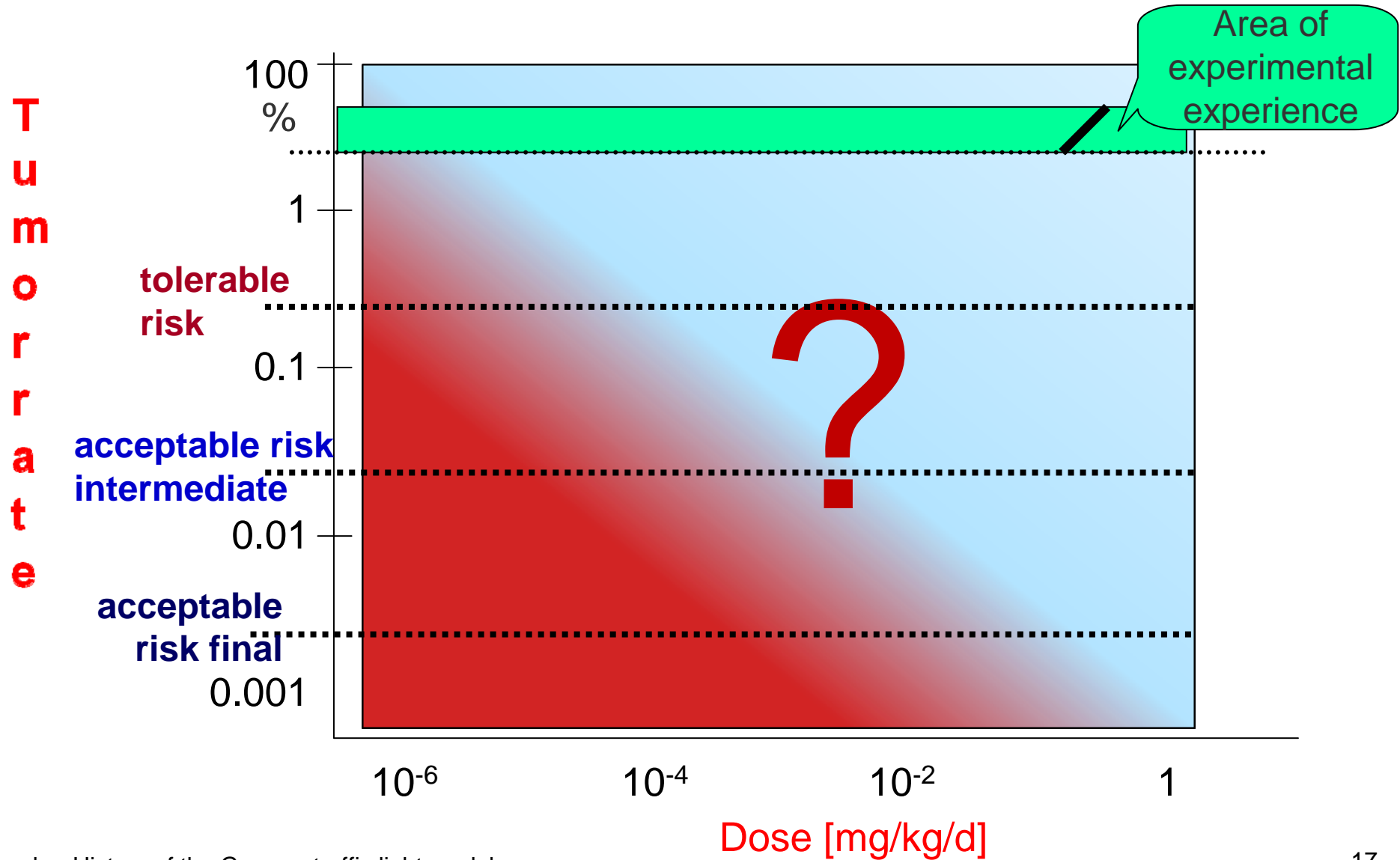
→ **genotoxic carcinogens** can also have a threshold
⇒ category 5 of German MAK-List, **SCOEL Group C**

Different kind of Carcinogens

A Carcinogen Cat. 1A, 1B or 2 can be quite different!



Risk extrapolation from high to low exposure



**Accepted risks in different countries, e.g. NL (DECOS),
USA (EPA)**

1 : 1,000,000 Pt

**Calculated for the workplace situations, based
on the same exposure dose:**

4 : 100,000 Wt

Risk Thresholds in Germany

Tolerable Risk: 4 : 1,000 Wt

Tolerable Risk:

Threshold, above which employees should not be exposed

Acceptable Risk (intermediate, until 2018: 4 : 10,000 Wt)

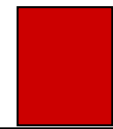
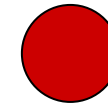
from 2019: 4 : 100,000 Wt

Acceptable risk:

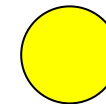
Risk at the workplace without any additional safety measures required by the agencies

Division into 3 risk areas:

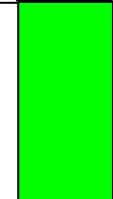
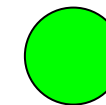
High risk: above tolerable limit



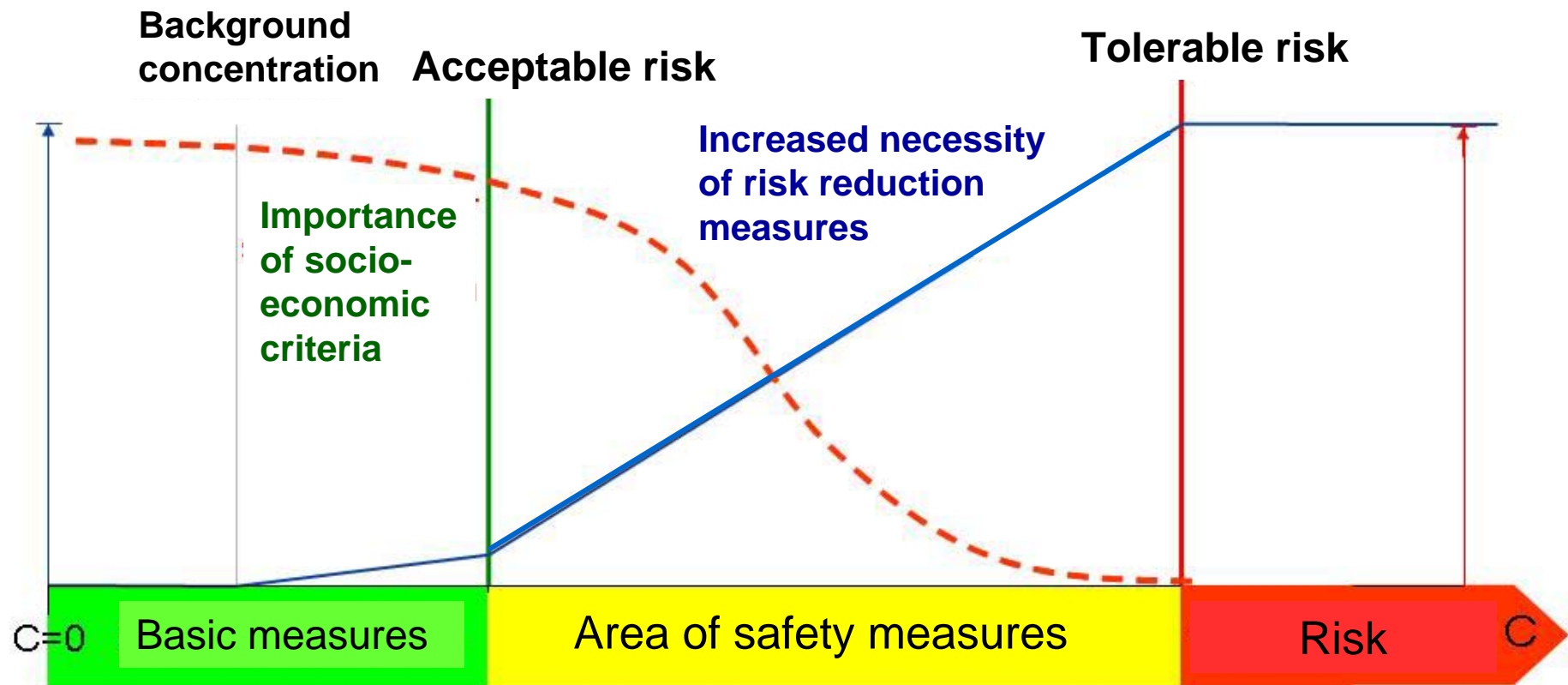
Medium risk: between acceptable and tolerable limit



Low risk: below acceptable limit



Priorisation of the different measure options in dependence of the risk



Consideration: state of technology

Procedure is needed, if state of the technology is

→ below tolerable concentration

or even

→ below acceptable concentration

General principle:

→ prohibition of degradation

→ former German TRK-values are not allowed to exceed

Tolerable and acceptable **risk**:

- ⇒ substance independent risks, which express a statistical risk of a cancer disease

Tolerable **concentration**:

- ⇒ **concentration** in the air at the workplaces of a specific substance, which correlate with the tolerable risk

Acceptable **concentration**:

- ⇒ **concentration** in the air at the workplaces of a specific substance, which correlate with the acceptable risk

Acceptable and tolerable concentration:

⇒ defined as TWA (time-weighted-average) for 8 h shift

Peak exposure:

⇒ Short time exposure limits (STEL) are established additionally, if needed

Different assessment duration:

⇒ For particles without acute (to chronic) health effects:
➔ assessment duration > shift are in discussion

Consideration of background concentration (ubiquitary):

- ⇒ procedure, if background concentration is above acceptable concentration
 - ↳ nitrosamines

Analytical limitations:

- ⇒ procedure, if detection limit is above acceptable concentration and can not be reached with reasonable effort
 - ↳ fibres, nitrosamines

Endogenous carcinogen:

- ⇒ Consideration of endogenous produced carcinogens
 - ↳ ethylenoxide

Risks at the workplace

Assessment of risks at the workplaces

- a task for real experts -

Thank you very much for your attention!



Bender: History of the German traffic light model

