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Acceptable risk from ammunition storage

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Acceptable risk from ammunition storage
Background of current Norwegian criteria

Svein Rollvik (1983):

- Method for establishing criteria for acceptable societal risk and individual risk for third parties
- Estimation of the probability of event

Hans Øiom (1993):

- Further development of criteria for group risk for all parties and individual risk for involved persons

Acceptable risk from ammunition storage
Background of proposed new Norwegian criteria

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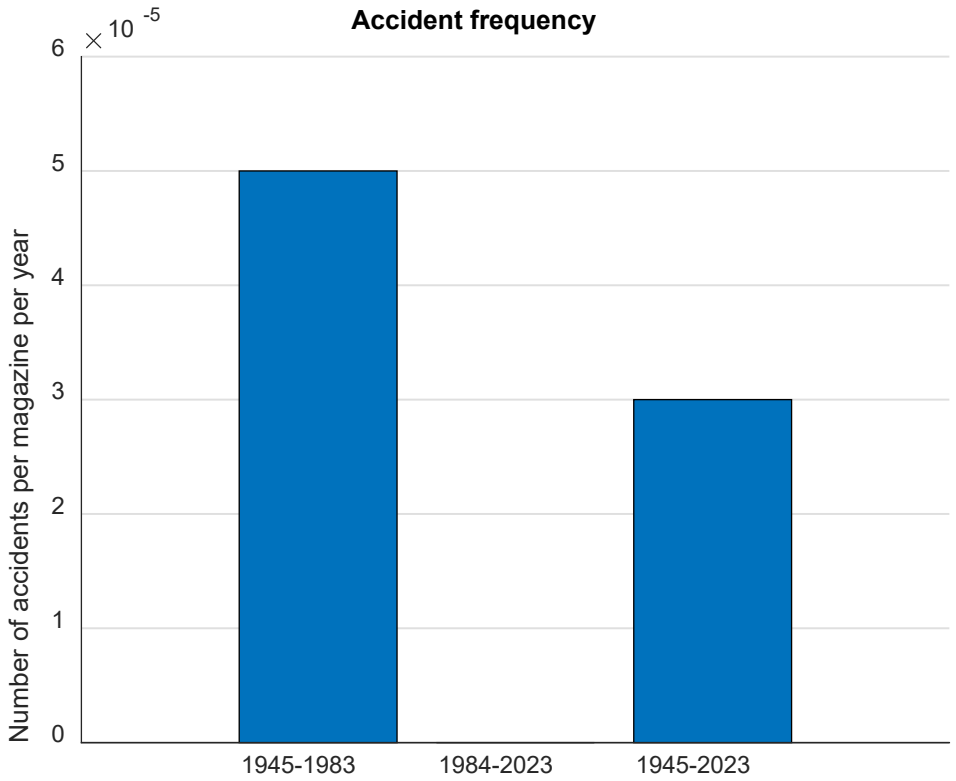
2025

- Updated statistics and methods

Probability of event (P_E)

Estimated by the frequency of accidents in Norway:



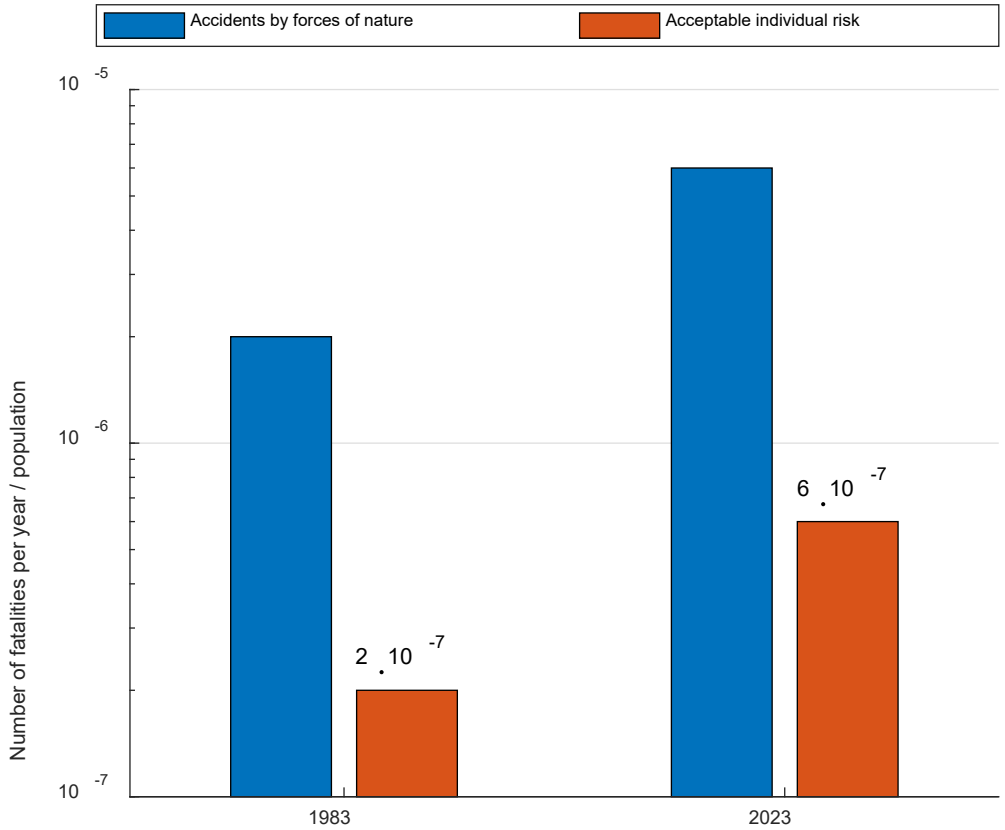
	1983	2023
Estimated P_E	$5.0 \cdot 10^{-5}$	$3.0 \cdot 10^{-5}$

Acceptable individual risk to third parties

- Acceptable individual risk, R_i:

  < 1/10 of the risk from exposure to forces of nature

- Higher risk from forces of nature in 2023 than in 1983



Acceptable individual risk to first parties

Current criterion

- Frequency of work accidents (1990-1991):

  $4.3 \cdot 10^{-5}$ fatalities per worker per year
- Acceptable individual risk: $4 \cdot 10^{-5}$

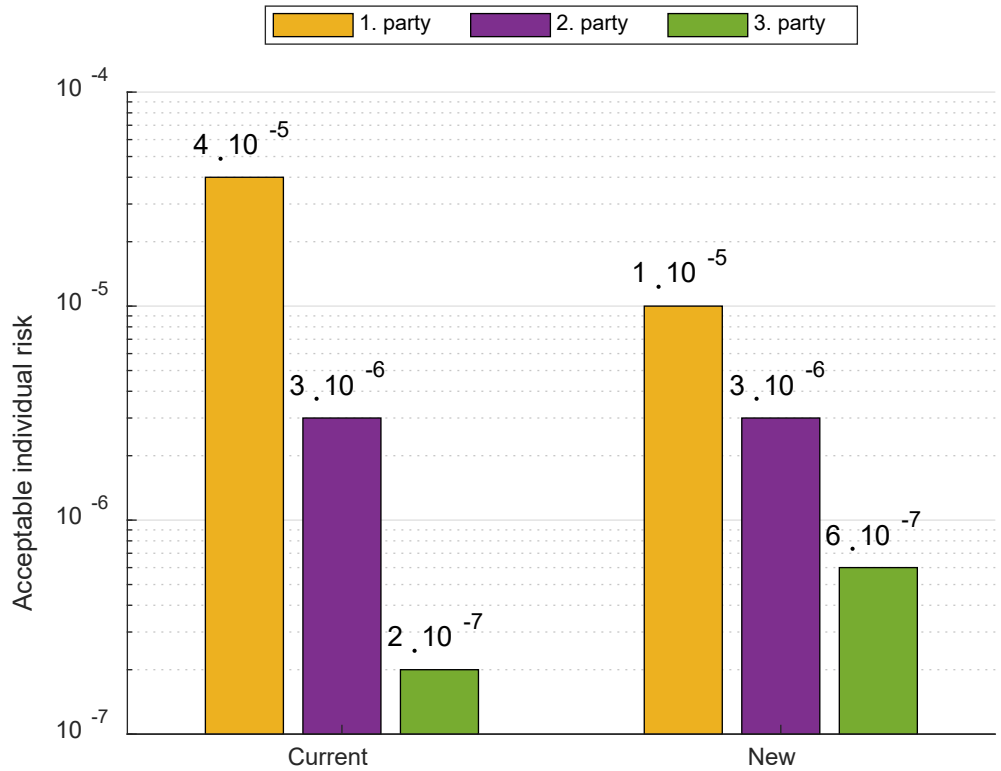
New criterion

- Frequency of work accidents (2019-2023):

  $1.3 \cdot 10^{-5}$ fatalities per worker per year
- Acceptable individual risk: $1 \cdot 10^{-5}$

Acceptable individual risk to second parties

Current and proposed new criterion for
2. party: $3 \cdot 10^{-6}$



Acceptable societal risk

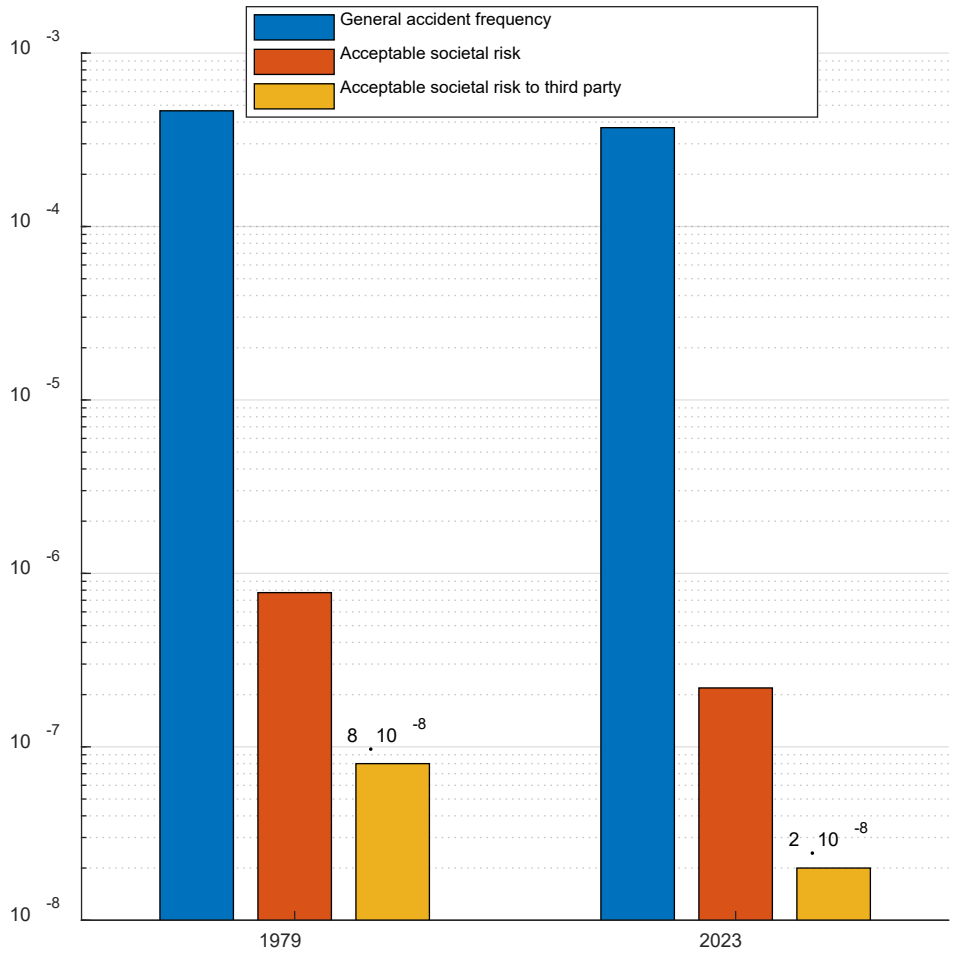
Acceptable societal risk to all persons =

$$\text{General societal risk} \cdot \frac{\text{Costs of ammunition storage}}{\text{Gross domestic product (GDP)}}$$

Assumption: Accidents at ammunition storage facilities mainly affect third parties.

Acceptable societal risk to third parties, R_s =

0.1 · Acceptable societal risk to all parties



Acceptable group risk to third parties

Group risk = risk from one PES

Average group risk:

$$R_g = R_s \frac{N}{n_m}$$

N = number of Norwegians
n_m = number of stores

Group risk corresponds to a consequence:

$$R_g = P_E \cdot C_E$$

C_E = consequence = expected number of fatalities

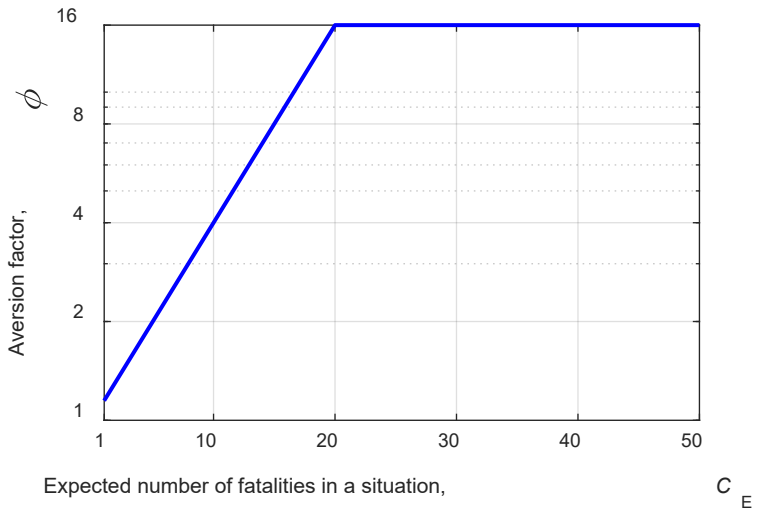
	Current	New
Acceptable group risk to third parties	$1 \cdot 10^{-4}$	$7 \cdot 10^{-5}$

Perceived group risk

Acceptable group risk applies to the perceived group risk:

$$R_{\text{g, perceived}} = P_{\text{E}} \cdot \phi \cdot C_{\text{E}}$$

$$\phi = \phi(C_{\text{E}}) = \text{aversion factor}$$



Acceptable group risk to involved persons

Current criteria

- Acceptable $C_E = 5$ as in the Norwegian explosives industry
- Acceptable $R_g = P_E \cdot C_E = 2.5 \cdot 10^{-4}$
- Criterion for all parties: $3 \cdot 10^{-4}$
- Criterion for 2. and 3. party: $2 \cdot 10^{-4}$

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New criteria

- Explosives industry: $P_E = 0.001$

  Acceptable $C_E = 5, \ \phi = 2$

  $R_g = P_E \cdot \phi \cdot C_E = 0.01$
- Acceptable group risk for 1. party: 0.01
- 2. party: $R_g = R_{g,\ 1.\ party} \cdot \dfrac{R_{i,\ 2.\ party}}{R_{i,\ 1.\ party}}$

  $= 3 \cdot 10^{-3}$

Criteria for acceptable group risk

Current		New	
All parties	$3 \cdot 10^{-4}$	1. party	0.01
2. and 3. party	$2 \cdot 10^{-4}$	2. party	$3 \cdot 10^{-3}$
3. party	$1 \cdot 10^{-4}$	3. party	$7 \cdot 10^{-5}$

Comparison with other nations

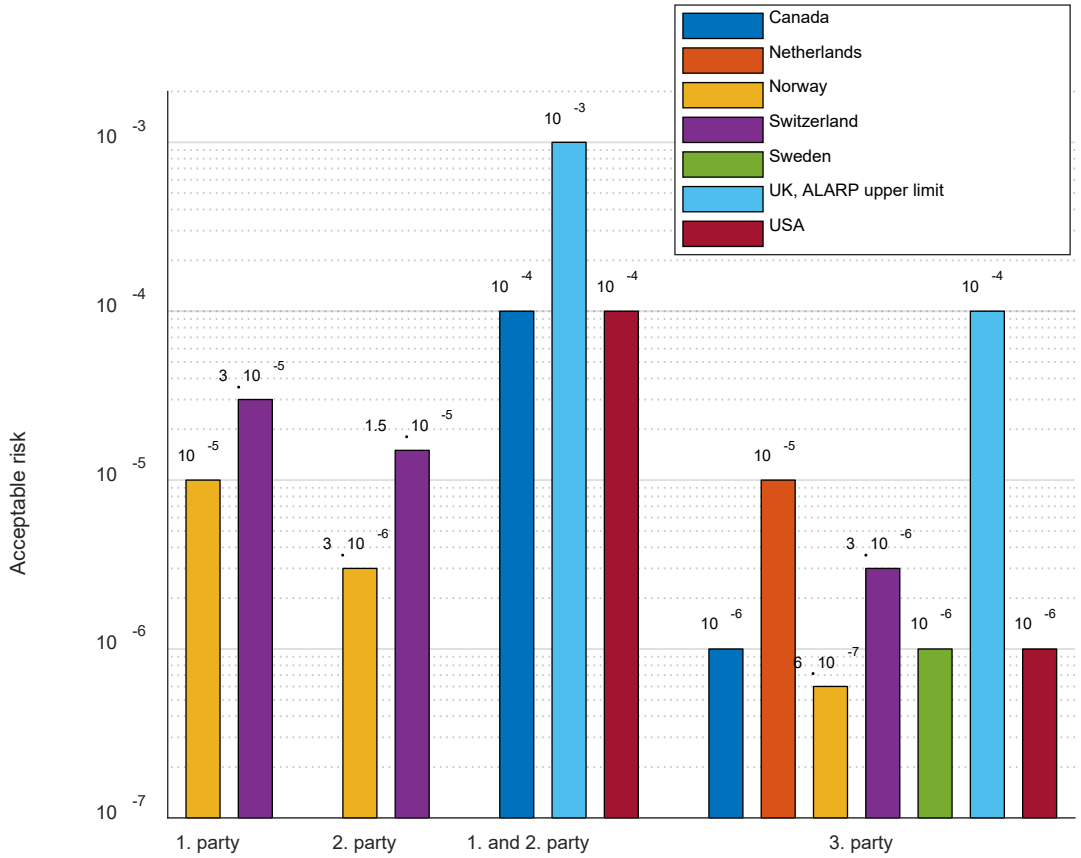
	Individual risk			Group risk		
	1. party	2. party	3. party	1. party	2. party	3. party
Canada	10^{-4}		10^{-6}	$10^{-3‡}$		$10^{-5‡}$
Netherlands			10^{-5*}			
Norway	10^{-5}	$3 \cdot 10^{-6}$	$6 \cdot 10^{-7}$	10^{-2}	$3 \cdot 10^{-3}$	$7 \cdot 10^{-5}$
Switzerland	$3 \cdot 10^{-5}$	$1.5 \cdot 10^{-5}$	$3 \cdot 10^{-6}$	Criteria for marginal cost per life saved		
Sweden			10^{-6}			10^{-4}
UK	$10^{-3†}$		$10^{-4†}$			
USA	10^{-4}		10^{-6}	10^{-3}		10^{-5}

Values from AASTP-4

* Continuous presence of one unprotected person
† ALARP, upper limit
‡ ALARP, lower limit

Comparison with other nations

Individual risk



Group risk