

# Implementation of BSS in Germany (Emergency preparedness and response)

Johannes Kuhlen (BMUB)  
Wolfram Rother (BMUB)  
Matthias Zähringer (BfS)  
Florian Gering (BfS)



## Current emergency management system in Germany

- **Disaster management acts** of the federal states
- **Precautionary Radiological Protection Act (StrVG)**
- **Recommendations** of the Commission on Radiological Protection
- **§§ 51 – 53, 59 Radiation Protection Ordinance**
- **Acts of the federal ministries** (z.B. LFGB, Produktsicherheits-, Gefahrgutrecht, Internationale Gesundheitsvorschriften, KrWG)



## Further development of the legal framework

- No distinction between **disaster management actions** and **precautionary radiological protection actions** (as it is currently being done)
- **StrISchG: Radiation Protection Act**  
**Specific radiation protection standards for implementation of**
  - Acts of the federal ministries
  - Disaster management acts of the federal states
  - Other legal regulations of the federal states
- **Ordinances and emergency response plans** specify generic intervention requirements of other acts



## Protection of the public

**Aim: Avoid major deterministic effects and reduce and limit the risk of stochastic effects**



**Reference level of the residual dose (in the first year): 100 mSv**  
**(Typical behaviour of representative persons and effect of protective actions considered)**

2014



**Generic intervention criteria for protective actions**  
**(No effect of staying indoors nor effect of protective actions considered)**

2014



**Operational intervention levels**  
**(German catalogue of countermeasures)**

2010



## Generic intervention criteria

Measure	Intervention reference levels		
	Organ dose (thyroid gland)	Effective dose	Integration times and exposure pathways
Sheltering		10 mSv	External exposure and committed effective dose due to inhaled radionuclides as a result of permanently staying outdoors for a period of 7 days
Iodine thyroid blocking	50 mSv Children and young people up to the age of 18 and pregnant women 250 mSv People aged 18 to 45		Committed equivalent dose due to inhaled radioactive iodine as a result of permanently staying outdoors for a period of 7 days
Evacuation		100 mSv	External exposure and committed effective dose due to inhaled radionuclides as a result of permanently staying outdoors for a period of 7 days

## Comparison of operational intervention levels

	Nordic Flagbook	NERDA	IAEA	Japan
Protection of food production	1 µSv/h	-	-	
Temporary banning of foodstuffs	10 µSv/h	-	1 µSv/h (non-essential food)	(food contamination OILs)
Partial sheltering	10 µSv/h	-	-	
ITB children/pregnant women	10 µSv/h	-	-	
Sheltering	100 µSv/h	100 µSv/h	-	
ITB	100 µSv/h	100 µSv/h	-	
Relocation		-	100 µSv/h (≤ 10 days) 25 µSv/h (> 10 days)	20 µSv/h
Access control	100 µSv/h	-	-	
Evacuation	-	1 000 µSv/h	1 000 µSv/h	500 µSv/h
Emergency workers	10 µSv/h 100 µSv/h 1 000 µSv/h 10 000 µSv/h	-	-	

## Consistency of reference level for residual dose with generic intervention criteria

- Assessment of residual dose over 1 year with consideration of:
  - Normal behaviour of representative persons
  - Effect of protective actions  
(taken according to generic intervention criteria)
  - Additional effect of 3 relocation options
- Comparison of the maximum residual dose against **reference level of 100 mSv**
- Evaluation based on about 100 typical weather scenarios + new reference source term for nuclear emergency planning (FKA)

⇒ **RL is consistent with GC** when considering relocation as additional long-term option



## Events and scenarios

0. Unclear situation
1. NPP accident in Germany
2. NPP accident in neighbouring countries (close to the border)
3. NPP accident within Europe
4. NPP accident outside Europe
5. Accident in a nuclear facility (e.g. research reactor)
6. Terroristic attack (e.g. dirty bomb)
7. Transport accident (involving radioactive material)
8. Radiological emergency situations
9. Satellite crash (involving radioactive material)



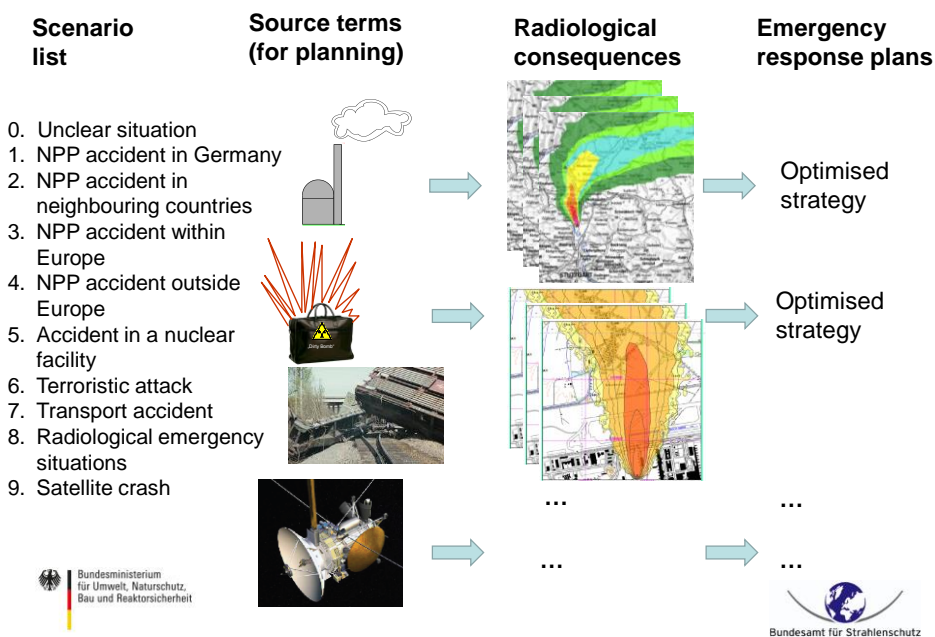
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➔ **Develop optimised protection strategies for each scenario (which include reference levels, generic intervention criteria, OILs, EALs – not yet existing in Germany, etc.)**



## Development of response plans and optimised strategies



## Emergency management system and emergency response plans

Plans to be included:

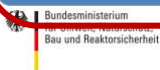
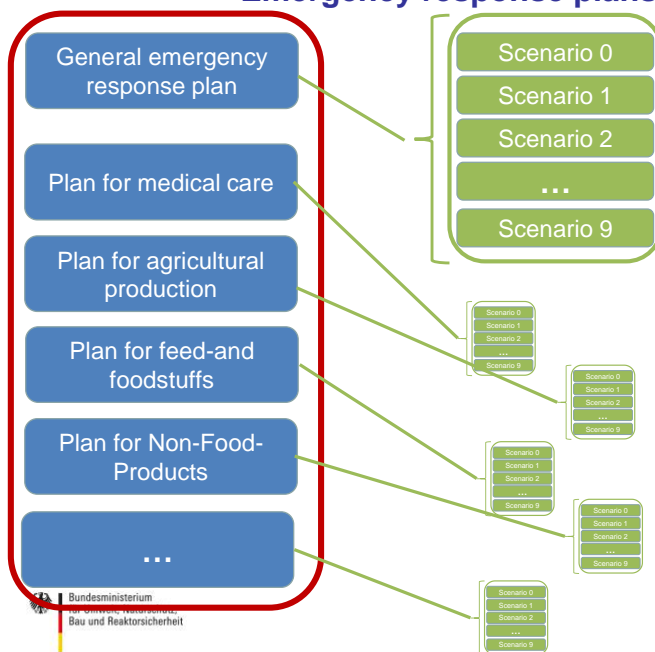
- **General emergency response plan**  
(Responsibilities and duties, optimised protection strategies, requirements for review and revision)

**Additional emergency response plans for:**

- Medical care
- Agricultural production
- Feed- and foodstuffs
- Non-Food-Products
- Waste handling
- Contaminated soils and water bodies
- Vehicles and transport of persons and goods
- Protection of critical infrastructure



### Emergency response plans

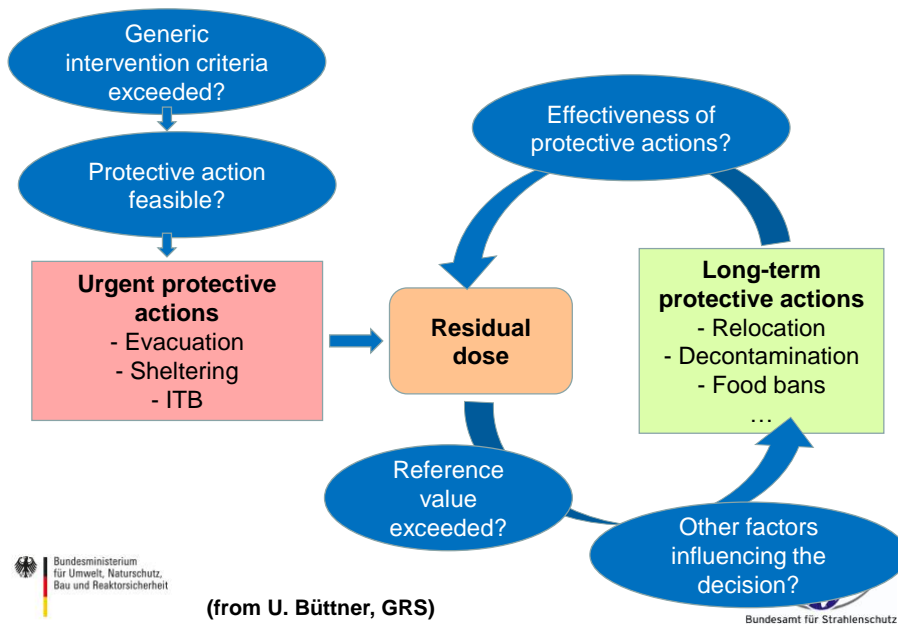


## Components of optimised protection strategies

- Goals and reference levels
- Protective actions and decision criteria
- Assessment, evaluation and decision making
- Protection of the emergency workers
- Review, revision and optimisation
- Arrangements for the transition from an emergency exposure situation to an existing exposure situation



## Optimised protection strategies



**A. Elements to be included in an emergency management system**

1. Assessment of potential emergency exposure situations and associated public and emergency occupational exposures;
2. Clear allocation of the responsibilities of persons and organisations having a role in preparedness and response arrangements;
3. Establishment of emergency response plans at appropriate levels and related to a specific facility or human activity;
4. Reliable communications and efficient and effective arrangements for cooperation and coordination at the installation and at appropriate national and international levels;
5. Health protection of emergency workers;
6. Arrangements for the provision of prior information and training for emergency workers and all other persons with duties or responsibilities in emergency response, including regular exercises;
7. Arrangements for individual monitoring or assessment of individual doses of emergency workers and the recording of doses;
8. Public information arrangements;
9. Involvement of stakeholders;
10. Transition from an emergency exposure situation to an existing exposure situation including recovery and remediation.

**B. Elements to be included in an emergency response plan**

For emergency response:

1. Promptly implementing protective measures, if possible, before any exposure occurs;
2. Assessing the effectiveness of strategies and implemented actions and adjusting them as appropriate to the prevailing situation;
3. Comparing the doses against the applicable reference level, focusing on those groups whose doses exceed the reference level;
4. Implementing further protection strategies, as necessary, based on prevailing conditions and available information.



**End**



## **Open questions**

- 1. „Standard“ procedure how to derive RL(s)?**
- 2. „Standard“ procedure how to derive GC and OILs from RL(s)?**
- 3. Different RL for different scenarios -> confusion?**
- 4. How to „optimise“ RL during the response (procedure)?**
- 5. Can there be different RL's for different areas in parallel?**
- 6. How to decide about the transition to an existing exposure situation?**
- 7. ...**



## Basic Radiological Principles for Decisions on Measures for the Protection of the Population against Incidents involving Releases of Radionuclides

Recommendation by the German Commission on Radiological Protection

- Includes **Reference Level** and **Generic intervention criteria**
- Describes health effects of radiation exposure, measures to protect the population, radiation protection for emergency workers
- Considers ICRP 103, UNSCEAR report 2006, IAEA- and EU-Basic safety standards (draft), experiences from the Fukushima accident
- Revised between 2009 – 2013, published in 2014



### Operational intervention levels („German catalogue of countermeasures“)

GDR	Protective action	Time period	Generic dose criteria
30 – 300 $\mu\text{Sv/h}$	Sheltering	0 – 7 days	10 mSv over 7 days (external exposure from radionuclides deposited on the ground)
300 – 3000 $\mu\text{Sv/h}$	Evacuation	0 – 7 days	100 mSv over 7 days (external exposure from radionuclides deposited on the ground)
18 – 120 $\mu\text{Sv/h}$	Temporary relocation	0 – 30 days	30 mSv over 30 days (external exposure from radionuclides deposited on the ground)
8 – 120 $\mu\text{Sv/h}$	Permanent relocation	0 – 365 days	100 mSv over 1 year (external exposure from radionuclides deposited on the ground)



...



## Revised OILs as proposed in the German NERDA concept

### OILs during a release

Measure	Evacuation	Sheltering + iodine tablets
OIL	1000 $\mu\text{Sv/h}$	100 $\mu\text{Sv/h}$

### OILs after end of release

Measure	Evacuation
OIL	1000 $\mu\text{Sv/h}$



## Assumptions for dose reduction due to normal behaviour and protective actions

### Reduction factor for external exposure and inhalation

- For **evacuation** = 0
- For **relocation** = 0
- For **sheltering** = 0.33
- (Ingestion not considered).

### Additional reduction factor for exposure due to inhalation of iodine isotopes

For **iodine thyroid blocking** = 0,1

### Reduction factor for external exposure

for normal behaviour = 0.55

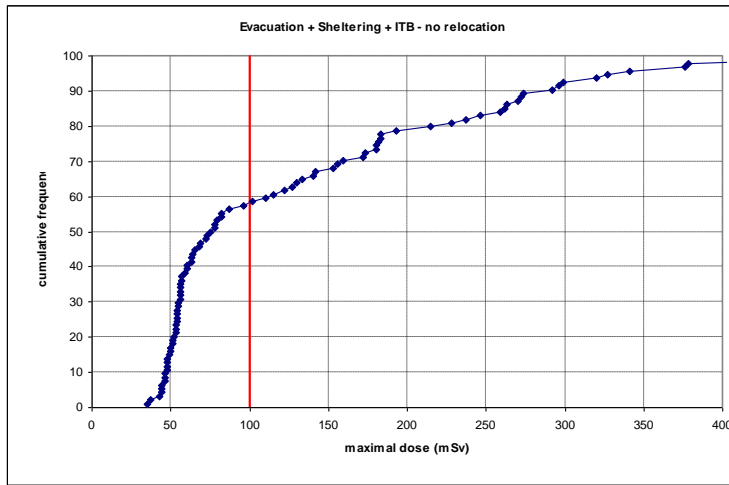
(Assumptions:

staying outdoors 8 h per day,

staying indoors 16 h per day, reduction factor indoors = 0.33)



## Cumulative frequency of the maximum residual dose: Evacuation + Sheltering + ITB, no relocation

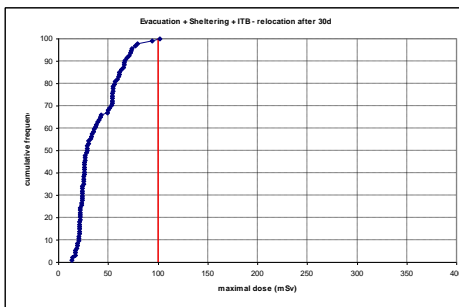


The residual dose over 1 year is:  
**a) in about 40% of all cases higher than 100 mSv**  
**b) in more than 80% of all cases higher than 50 mSv**



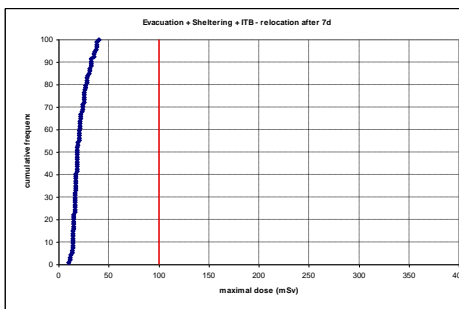
Bundesamt für Strahlenschutz

## Cumulative frequency of the maximum residual dose: Evacuation + Sheltering + ITB, different relocation options



### Relocation after 30 days

The residual dose over 1 year is:  
**a) always below 100 mSv**  
**b) in about 1/3 of all cases higher than 50 mSv**



### Relocation after 7 days

The residual dose over 1 year is:  
**a) is always below 50 mSv**



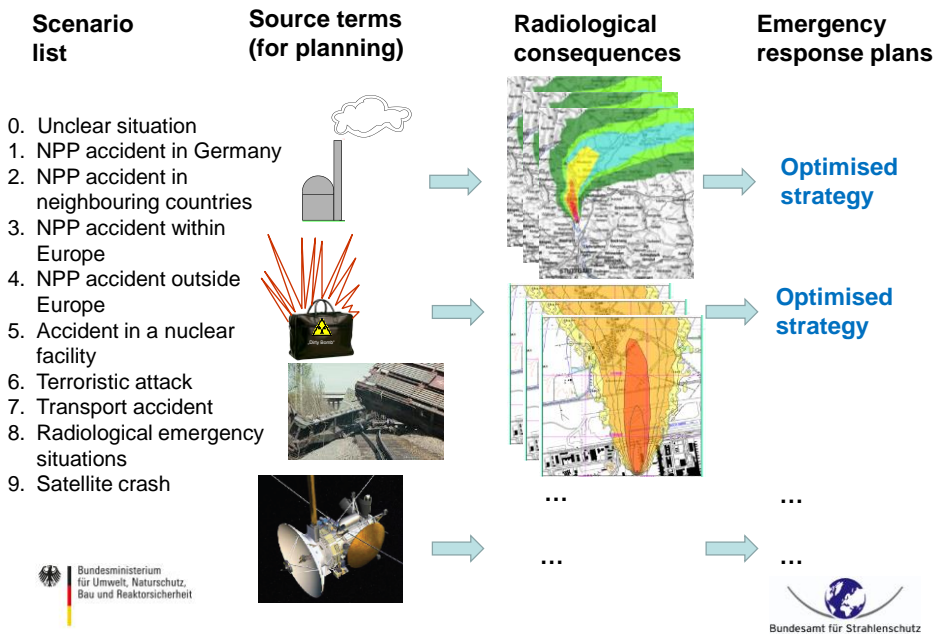
Bundesamt für Strahlenschutz

# German thoughts on Optimisation

Johannes Kuhlen (BMUB)  
 Wolfram Rother (BMUB)  
 Matthias Zähringer (BfS)  
 Florian Gering (BfS)



## Development of optimised protection strategies



## Components of optimised protection strategies

### Goals and reference levels:

1. Reference level for public exposure (scenario-specific?).
2. Reference levels for emergency occupational exposure.
3. Non-radiological goals of the optimisation, evaluation principles (limitation and reduction of disadvantages and harm of protective actions)

### Protective actions and decision criteria:

4. Description of the protective actions.
5. Predefined generic criteria for particular protective measures, which are consistent with the reference level.
6. Operational criteria such as observables and indicators of on-scene conditions for particular protective measures, which are consistent with the reference level.
7. Procedures for review/revision of the criteria.



## Components of optimised protection strategies

### Assessment, evaluation and decision making:

9. Approach for assessment of the radiological situation.
10. Approach for evaluating whether protective actions should be recommended.
11. Recommendations for the monitoring strategy.

### Protection of the emergency workers:

12. Mission planning considering radiation protection aspects.
13. RP expert advice and guidance.
14. Personal protective equipment.
15. Dosimetric surveillance.
16. Medical surveillance and follow-up.



## Components of optimised protection strategies

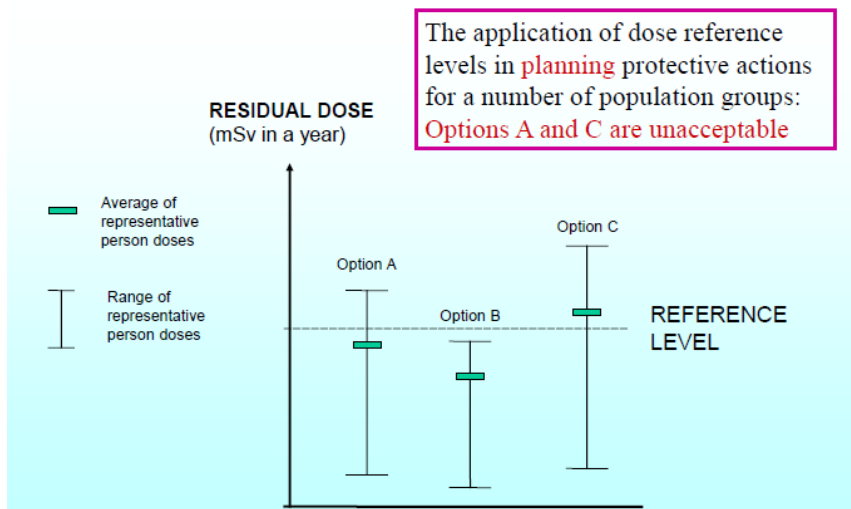
### Review, revision and optimisation:

17. Arrangements to revise RL, GC and OILs as appropriate during an emergency exposure situation
18. Arrangements for comparing the doses against the applicable reference level.
19. Arrangements for assessing the effectiveness of strategies and implemented actions and adjusting them as appropriate.
20. Arrangements for implementing further protection strategies, as necessary.

### Arrangements for the transition from an emergency exposure situation to an existing exposure situation



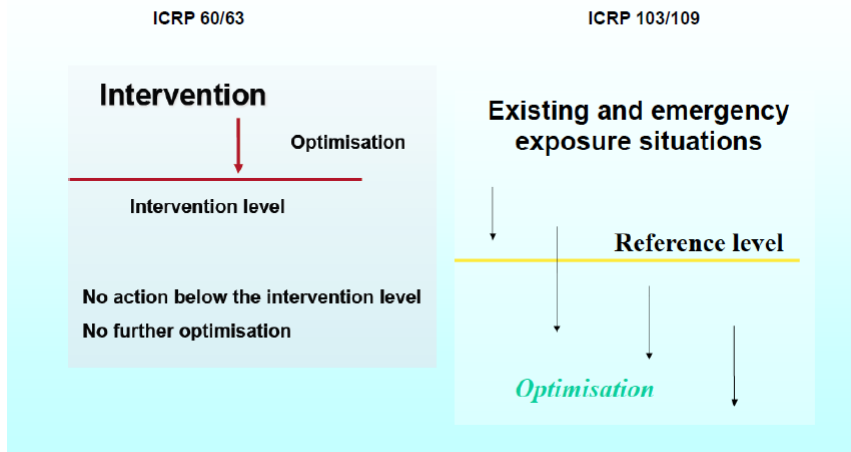
## Reference levels in planning



(Wolfgang Weiss, „Application of ICRP recommendations 103/109“, 2015)



## The ROLE of OPTIMISATION



## IMPORTANT ASPECTS in DEVELOPING PROTECTION STRATEGIES (PREPAREDNESS)

(ICRP 103/109)

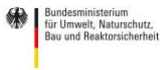
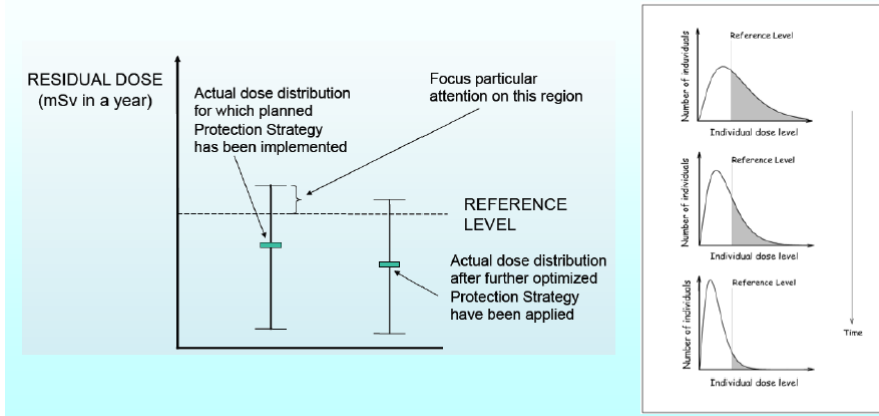
Identification of the **dominant exposure pathways**, the relevant exposure **times**, and the **potential effectiveness** of protective measures.

Preparation of **plans** for all types of possible emergency exposure situation based on a **graded approach**.

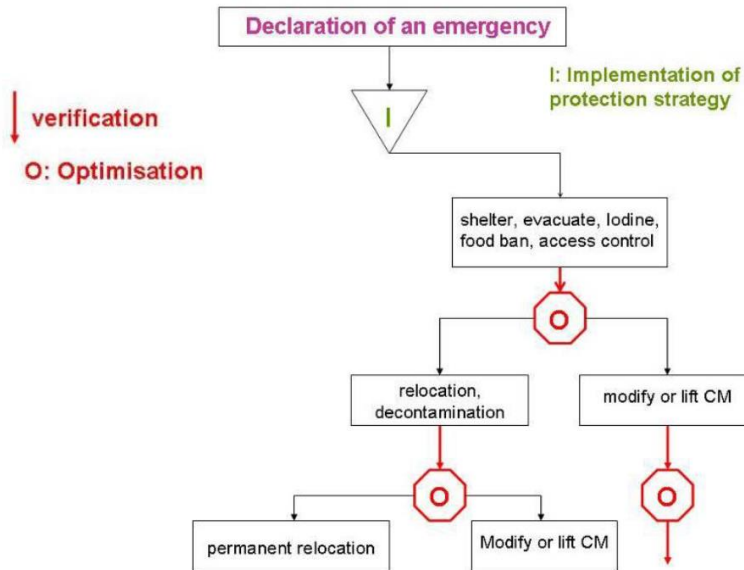
Development of the protection strategy in consultation with all those potentially exposed or affected (**stakeholder involvement**).



## OPTIMISATION during RESPONSE



(Wolfgang Weiss, „Application of ICRP recommendations 103/109“, 2015)



(Wolfgang Weiss, „Application of ICRP recommendations 103/109“, 2015)



# German thoughts on Emergency Management System

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## Emergency response

Implementing appropriate **protective actions**

- in accordance with the optimised protection strategy
- within the framework of the emergency response plan
- under consideration of the prevailing situation
- with immediate coordination within all responsible authorities and organisations

Common **assessment and evaluation** of the radiological situation

**Decision about protective actions:** disaster response authorities and other specialized authorities

Assessment of individual exposures and the effectiveness of protective actions -> **dose reconstruction**



# Source term used for NPP emergency planning

