International Safety Standards: Protection of Public and Environment

International Symposium on Decontamination
– Towards the Recovery of the Environment –
16 – 17 October 2011
Fukushima City

Volodymyr Berkovskyy
Waste and Environment Safety Section, IAEA

IAEA
International Atomic Energy Agency

Foreword

- The first use of X rays was in medical diagnosis, within six months of their discovery in 1895
- A benefit from the use of radiation was established very early on, but equally the potential risks of radiation became apparent much later
- The IAEA was created in 1957 in response to the deep fears and expectations resulting from the discovery of nuclear energy

IAEA & UN

United Nations System (1945)

192 Member States

- **Trusteeship Council (before 1994)**
- **Security Council**
- **General Assembly**
  - **Main Committees**
    - **UNSCEAR (1955)**
  - **UNDP**
  - **UNEP**
  - Other UN Programmes and Funds
- **Economic and Social Council**
  - UN Specialized Agencies:
    FAO (1945)
    UNESCO (1945)
    ILO (1946)
    ICAO (1947)
    IMO (1948)
    WHO (1948)
    WMO (1951)
    World Bank Group (1956):
    IBRD, IFC, IDA, MIGA, ICSID

    UNIDO (1966)
    others
- **International Court of Justice**
- **Secretariat**
  - **UNEP secretariat**
    - **UNSCEAR Secretariat**

IAEA (1957)
independent international organization related to the UN system
151 Member States

In terms of its Statute, the IAEA is authorized…

- **to establish… standards of safety for protection of health and minimization of danger to life and property… and**
- **to provide for the application of these standards…**

Other independent international organization related to the UN system:
WTO - World Trade Organization
ICC - International Criminal Court
ISA - International Seabed Authority
ITLOS - International Tribunal for the Law of the Sea
Standby High-Readiness Brigade - The UN's standing military force
UNSOG - Special Operations Group

IAEA

International IAEA Mission on Remediation of Areas Off-site Fukushima Daiichi NPP

- **Following a request by the Government of Japan, the mission, comprising 12 international and IAEA experts from several countries, visited Japan between 7 and 15 October 2011**
  - **The mission was conducted under the leadership of Mr. Juan Carlos Lentijo, General Director for Radiation Protection at Spain's nuclear regulatory authority**
- **The team visited the Fukushima Prefecture and conducted meetings in Tokyo with Japanese officials to:**
  - **Provide assistance to Japan in its plans to manage remediation efforts;**
  - **Review the country's remediation strategies, plans and work; and**
  - **Share its findings with the international community.**
- **Follow-Up to the International Fact Finding Expert Mission, 24 May - 2 June 2011**

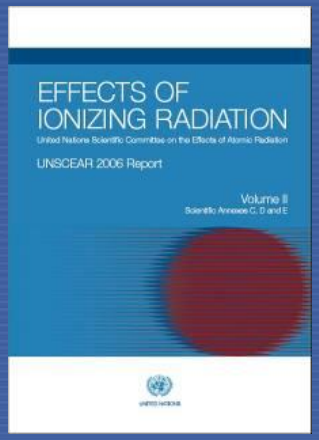
IAEA

Contents

- Scope and scientific basis of the IAEA International Safety Standards
- Remediation: protection of people and environment in existing exposure situations
  - Protection strategy: principle and requirements
  - Reference levels and optimisation
  - Reference person
  - Pathways of exposure
  - Radiocaesium in the environment and human body

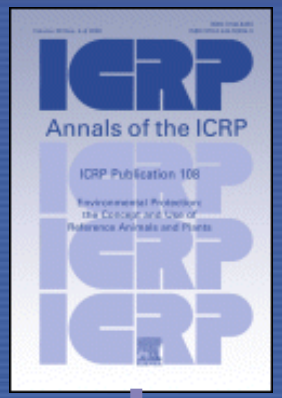
IAEA

BASIS OF INTERNATIONAL SAFETY STANDARDS



UNSCEAR
- Scientific basis

effects
risks

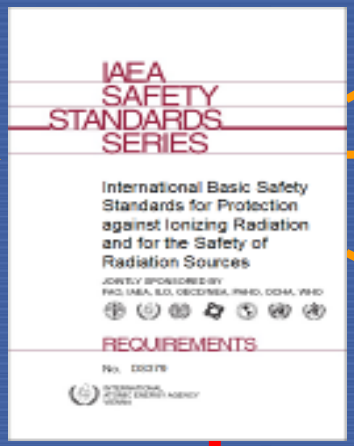


ICRP
- Scientific basis of the radiation protection
- Reference models
- Dose coefficients

recommendations

IAEA

levels
trends



ILO convention 115: occupational radiation protection

FAO/WHO
Codex Alimentarius Commission (food contamination guides)

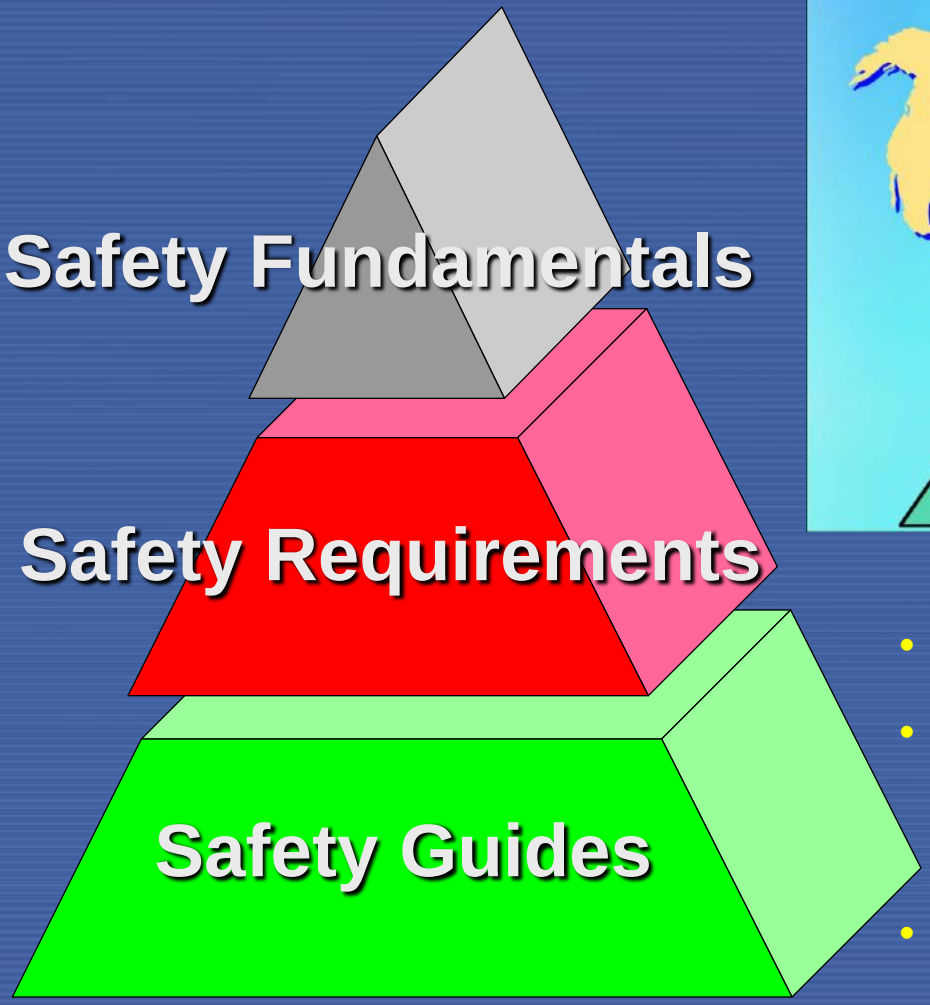
UN transport regulations
for radioactive material

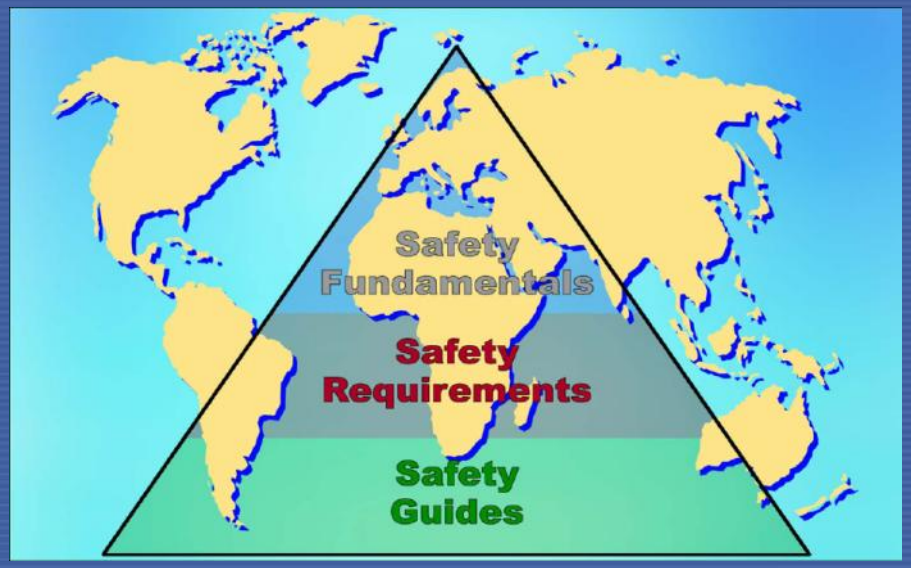
Participation by WHO, ILO, FAO etc.
-Safety standards
-Protection programmes

Implemented by IAEA Member States

IAEA

International Safety Standards



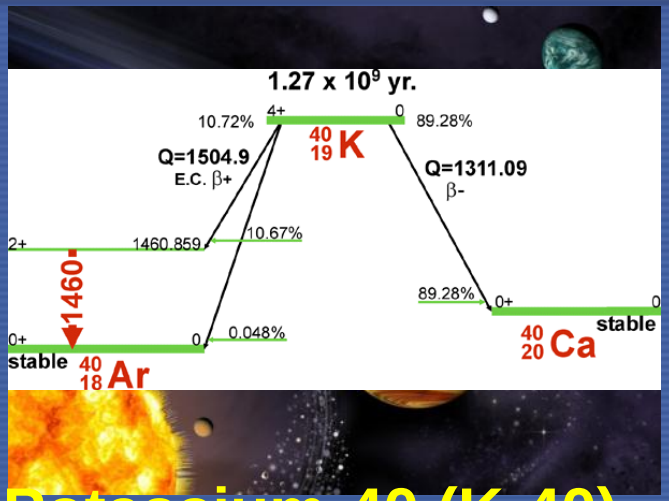


- Global Reference Point
- Reflects a broad international consensus on what constitutes a high level of safety
- Based on the accumulated experience of the IAEA Member States (e.g. in remediation of the environment)

IAEA

Radioactivity and ionizing radiation are integral features of our universe

- Radioactivity and ionizing radiation are natural phenomena that have existed every since the beginning of our universe
- During millions of years the human is surrounded by the natural radionuclides
- Our bodies are exposed to the natural ionising radiations and contain natural radionuclides
- The global average effective dose from natural sources ~2.4 mSv/a
- Some national averages exceed 10 mSv/a
- Individual doses from natural sources may exceed 100 mSv/a in some regions



Potassium-40 (K-40)

- A part of the natural potassium, content in the human body is controlled metabolically
- About 4000 radioactive decays of K-40 occur each second in our bodies
- 4000 Bq in a body
- ~0.17 mSv per year

IAEA

Exclusion from the scope of Standards

- IAEA International Safety Standards are applicable to all situations involving radiation exposure that is amenable to control
- Exposures deemed to be unamenable to control are excluded from the scope of Standards
- It is not feasible to control K-40 in the body or cosmic radiation at the surface of the Earth

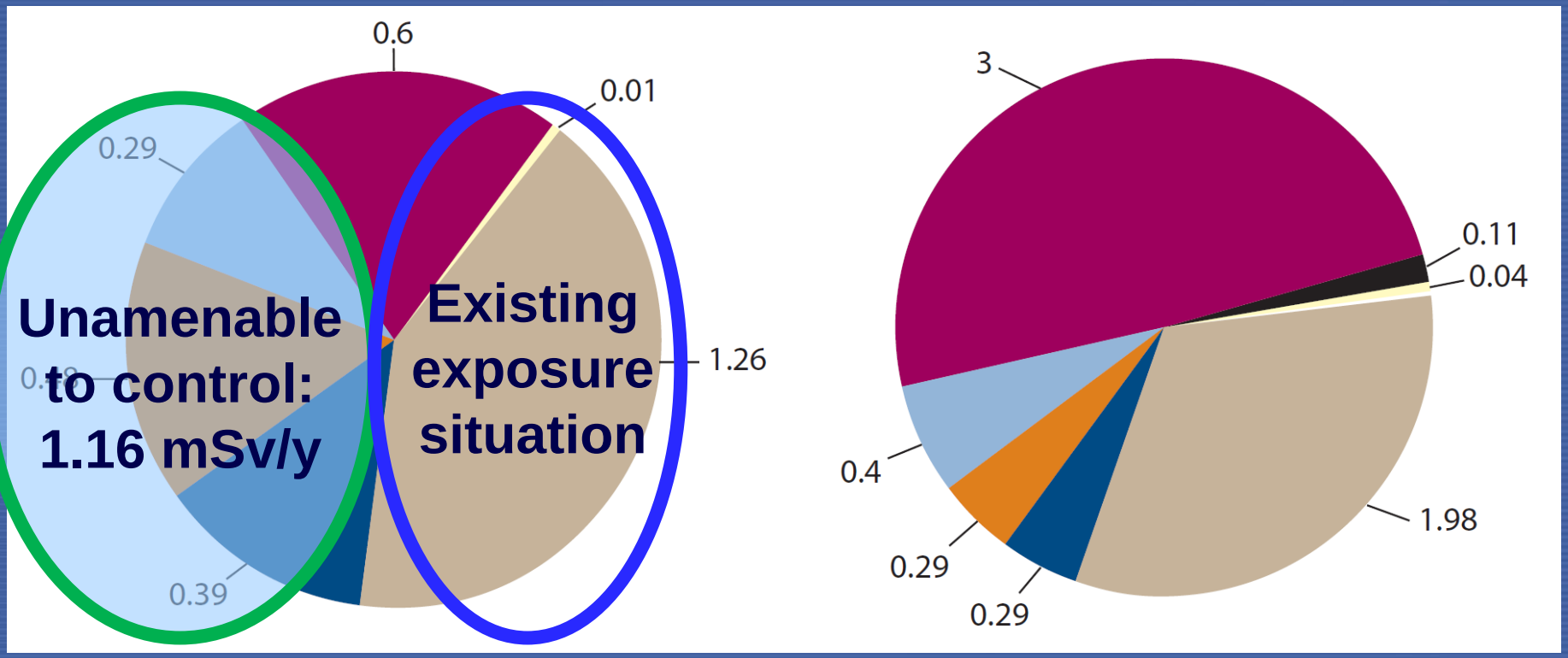
IAEA

Types of exposure situations

- **Planned exposure situations**
  - From planned operation of a nuclear facility, includes medical exposure (diagnostics and treatment)
- **Emergency exposure situations**
- **Existing exposure situations**
  - Natural exposure (see details in Standards)
  - Residual radioactive materials from past activities
  - **Post-emergency contamination**

IAEA

Doses to members of the public, mSv/y



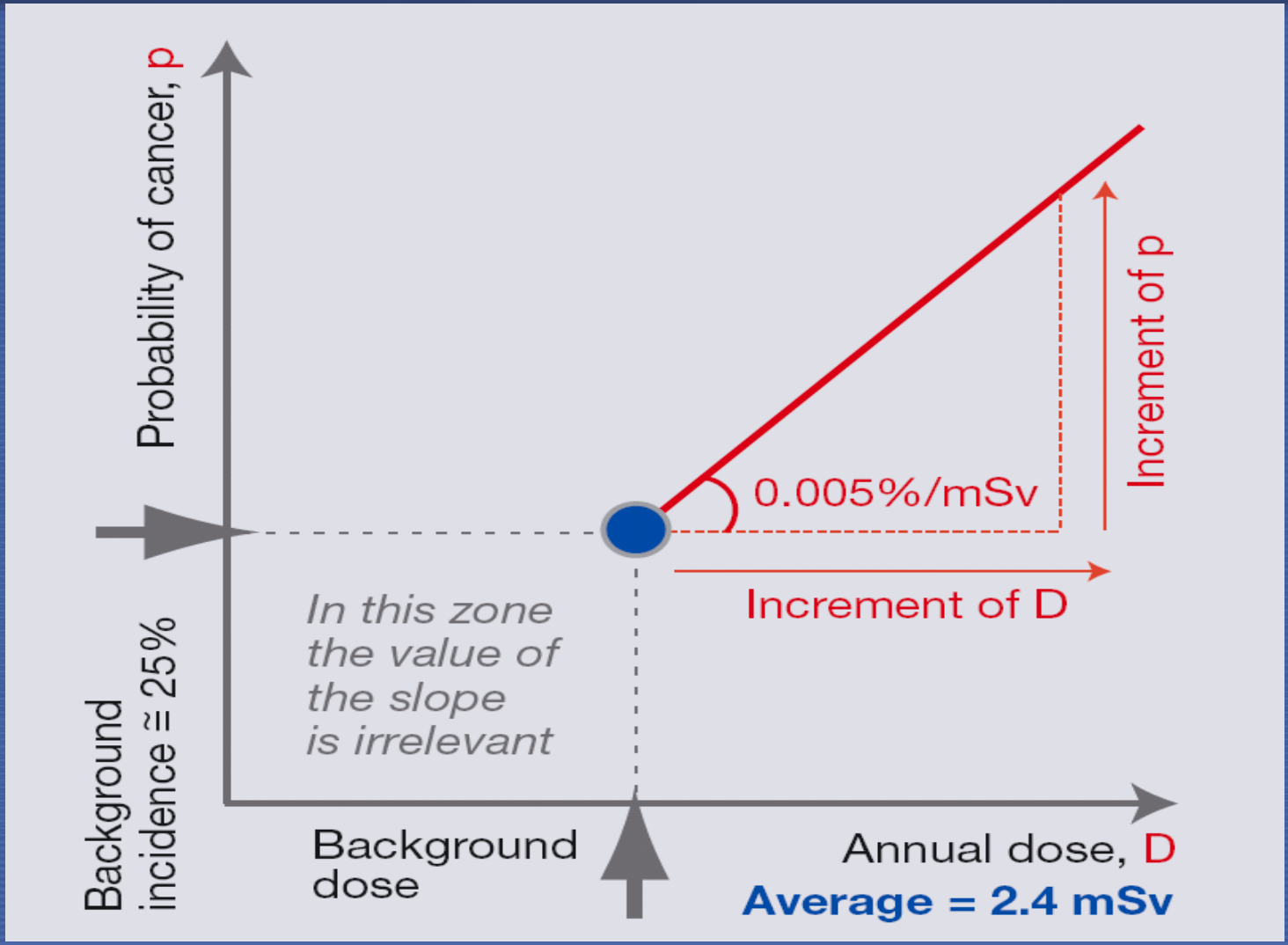
Global average: 3 mSv/a

USA average: 6 mSv/a

IAEA

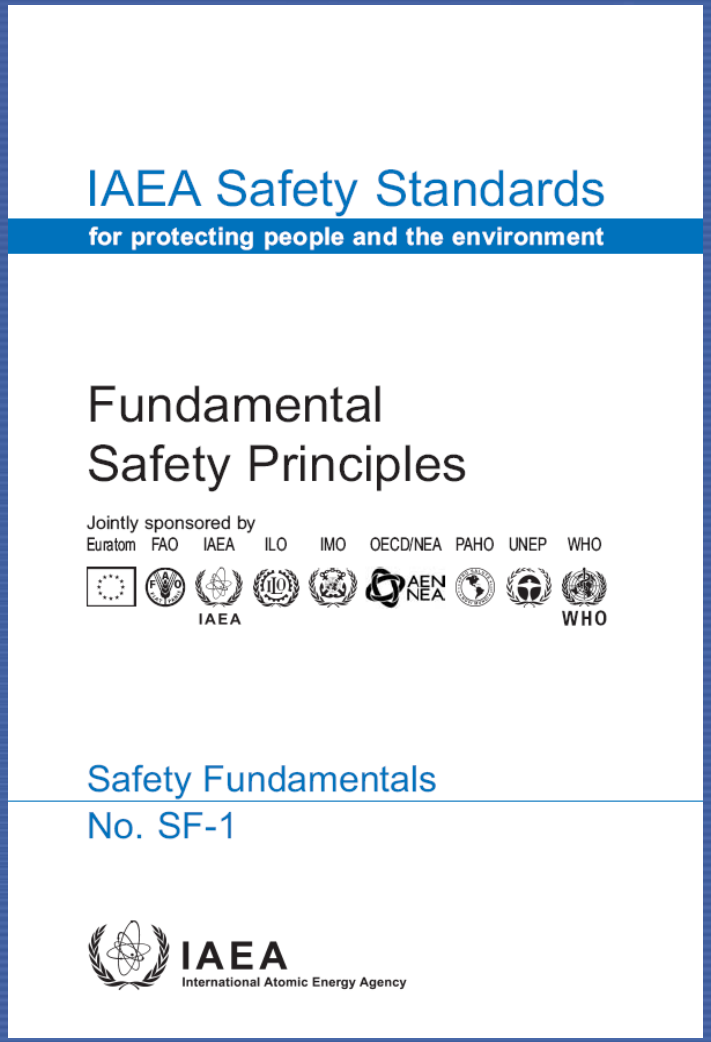
Source: UNSCEAR-2008

Linear non-threshold concept



SF-1: Fundamental safety objective

- Regarding protection of the public and the environment, the SF-1 states that “The fundamental safety objective is to protect people and the environment from harmful effects of ionizing radiation” and elaborates this statement in 10 fundamental safety principles



SF-1: Safety Principles 1-3

- **Principle 1: Responsibility for safety**

  The prime responsibility for safety must rest with the person or organization responsible for facilities and activities that give rise to radiation risks.

- **Principle 2: Role of government**

  An effective legal and governmental framework for safety, including an independent regulatory body, must be established and sustained.

- **Principle 3: Leadership and management for safety**

  Effective leadership and management for safety must be established and sustained in organizations concerned with, and facilities and activities that give rise to, radiation risks.

SF-1: Safety Principles 4-7

- **Principle 4: <u>Justification</u> of facilities and activities**
  Facilities and activities that give rise to radiation risks must yield an overall benefit.

- **Principle 5: <u>Optimization</u> of protection**
  Protection must be optimized to provide the highest level of safety that can reasonably be achieved.

- **Principle 6: <u>Limitation</u> of risks to individuals**
  Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm.

- **Principle 7: <u>Protection of present and future generations</u>**
  People and the environment, present and future, must be protected against radiation risks

IAEA

SF-1: Safety Principles 8-10

- **Principle 8: Prevention of accidents**

  All practical efforts must be made to prevent and mitigate nuclear or radiation accidents.

- **Principle 9: Emergency preparedness and response**

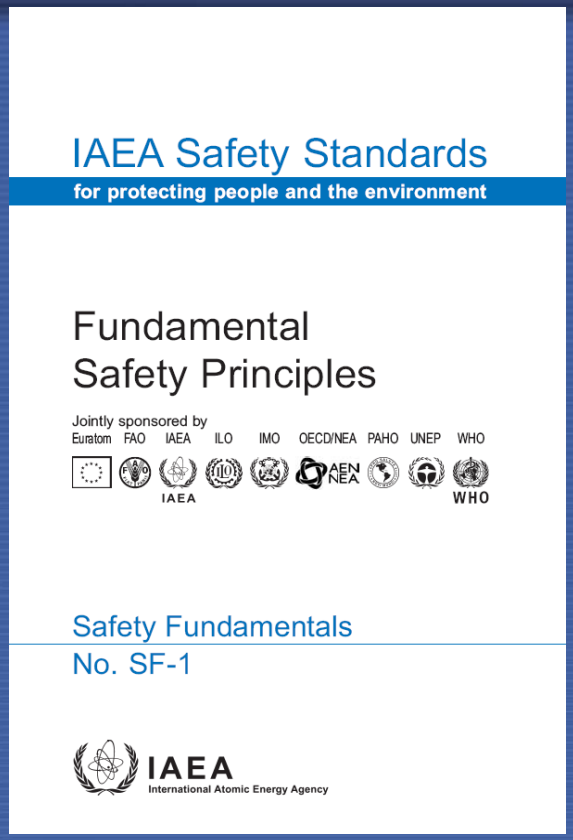
  Arrangements must be made for emergency preparedness and response for nuclear or radiation incidents.

- **Principle 10: <u>Protective actions to reduce existing or unregulated radiation risks</u>**

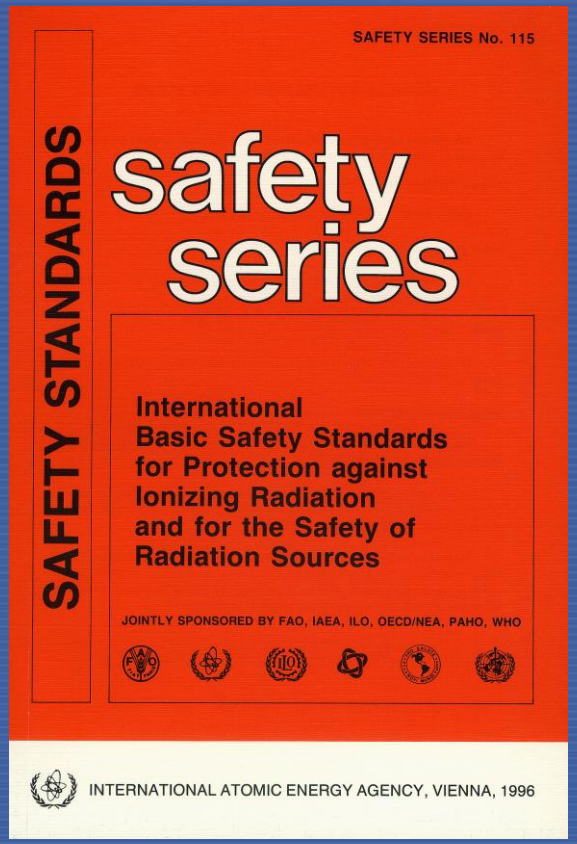
  Protective actions to reduce existing or unregulated radiation risks must be justified and optimized.

IAEA

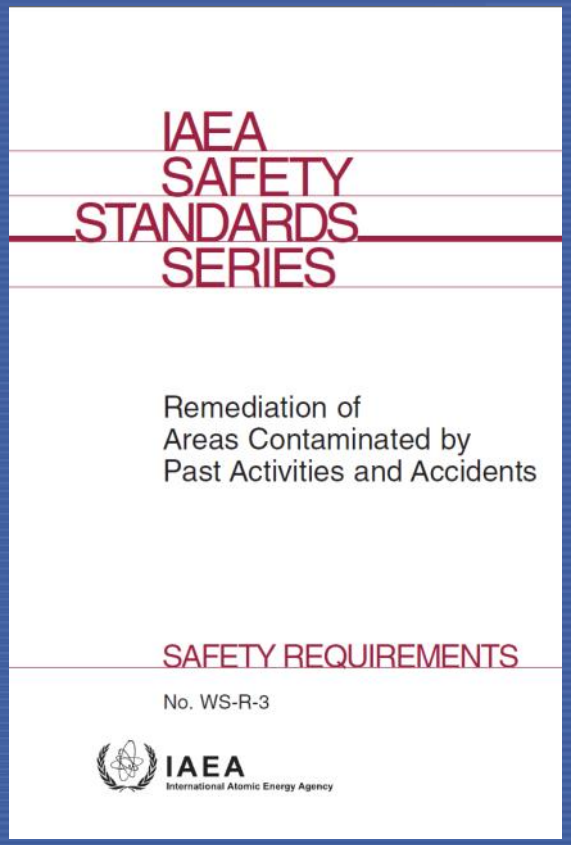
International Safety Standards



2006



BSS-1996



2003

NEW BSS-2011

IAEA

BSS-2011: New International Basic Safety Standards

- A month ago the IAEA Board of Governors approved the new International Basic Safety Standards laying down the basic requirements on radiation protection and safety

EXISTING EXPOSURE SITUATIONS

- The requirements on the protection of people and environment in post-accidental conditions and on remediation have been updated and expanded

- These Standards were developed by the IAEA in cooperation with the European Commission, the Food and Agriculture Organization of the United Nations, the International Labour Organization, the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development, the Pan American Health Organization, the United Nations Environment Programme and the World Health Organization.

IAEA

Optimization of protection

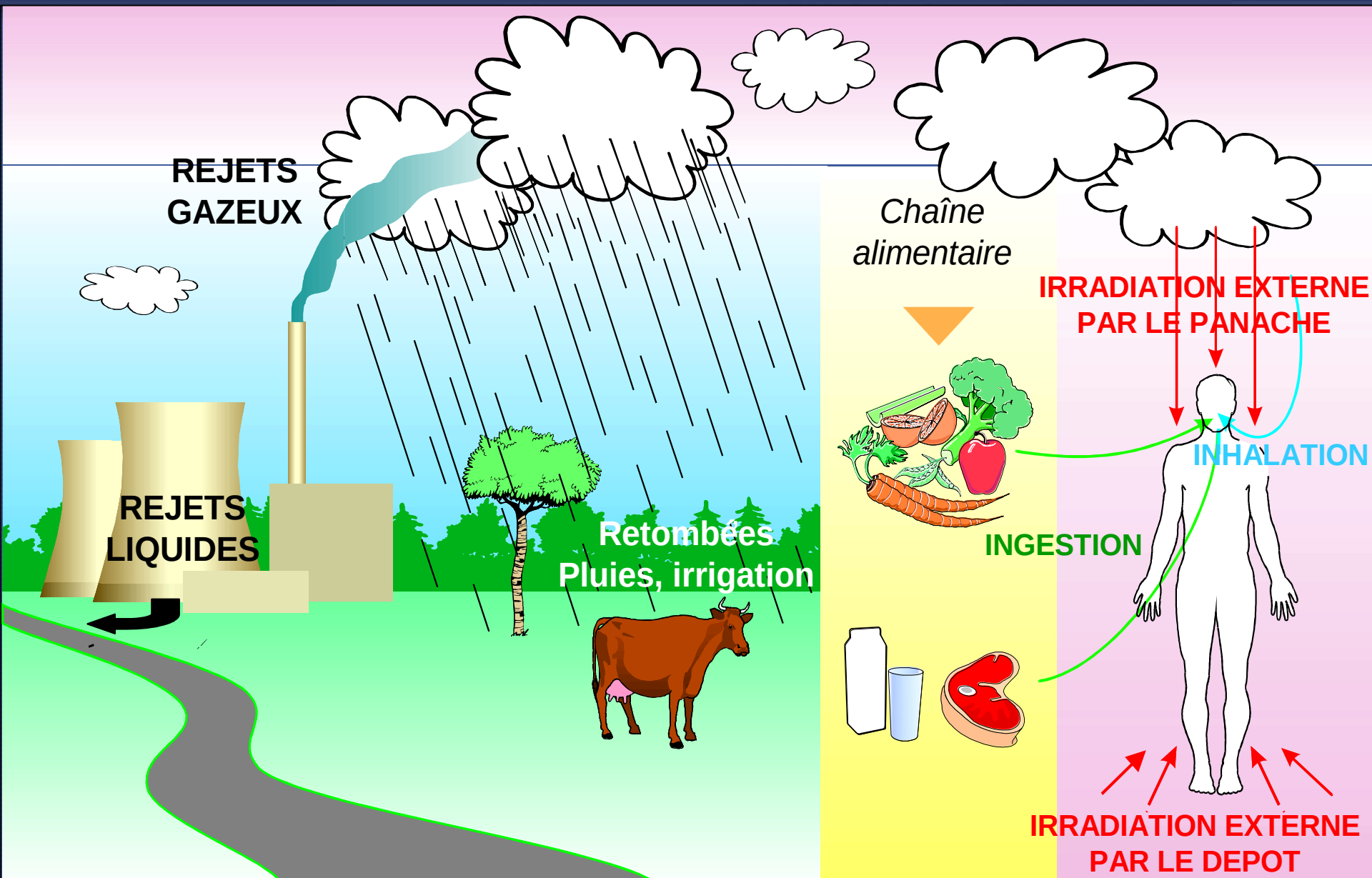
- **The optimization of protection requires judgements to be made about the relative significance of various factors, including:**
  - **the number of people (workers and the public) who may be exposed to radiation;**
  - **the likelihood of their incurring exposures;**
  - **the magnitude and distribution of radiation doses received;**
  - **radiation risks arising from foreseeable events; and**
  - **economic, social and environmental factors.**

- **The optimization of protection also means using good practices and common sense to avoid radiation risks as far as is practical in day to day activities.**

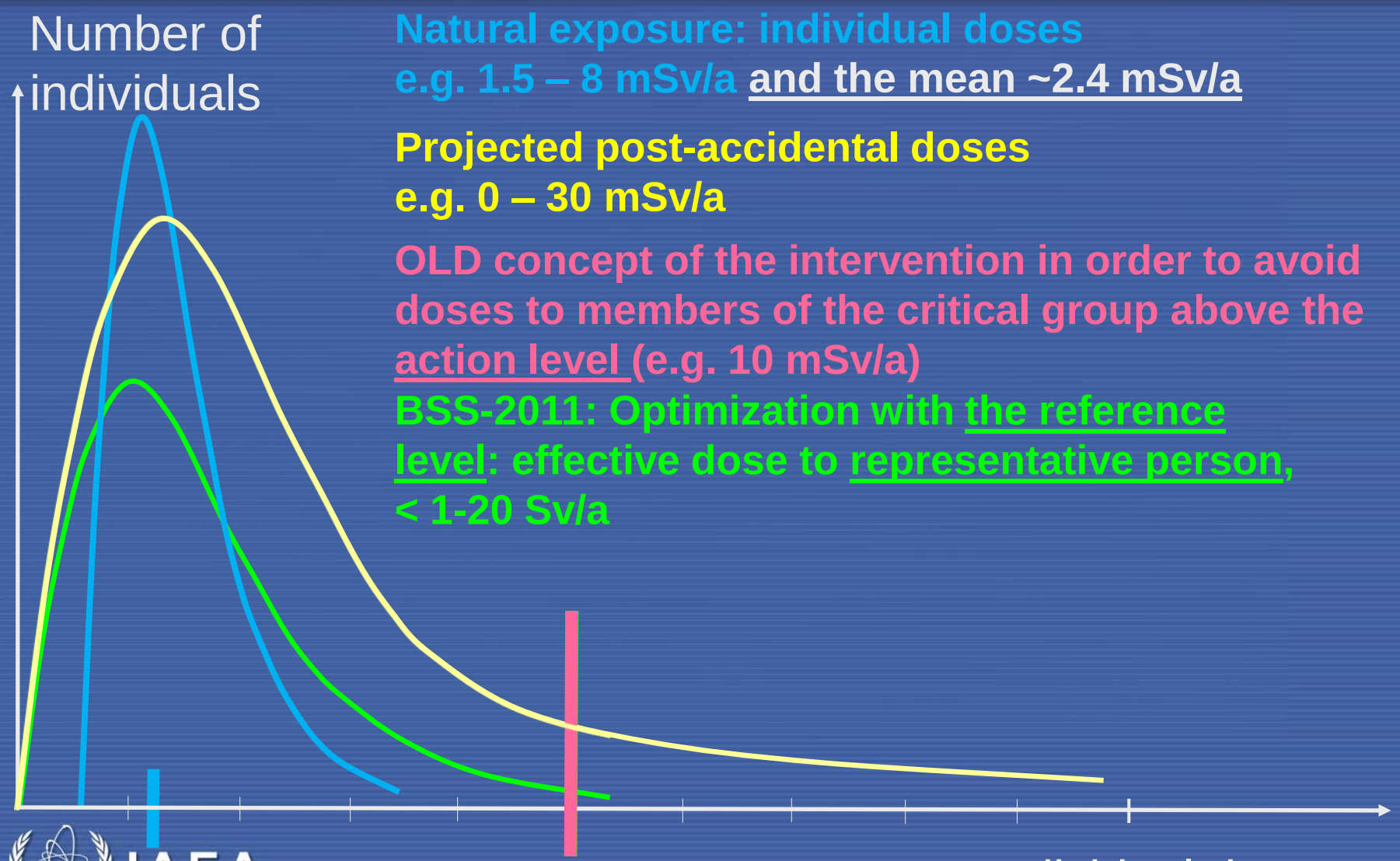
IAEA

REPRESENTATIVE PERSON: the most exposed individual

ICRP Reference Person + Habit data (95% percentile of behaviour)+Environment



Optimization of protection and safety in the protection strategy



Natural exposure: individual doses e.g. 1.5 – 8 mSv/a and the mean ~2.4 mSv/a

Projected post-accidental doses e.g. 0 – 30 mSv/a

OLD concept of the intervention in order to avoid doses to members of the critical group above the action level (e.g. 10 mSv/a)

BSS-2011: Optimization with the reference level: effective dose to representative person, < 1-20 Sv/a

IAEA

BSS-2011, Req.47: Responsibilities of the government

- Shall ensure that RESPONSIBILITIES for protection and safety are assigned… and appropriate REFERENCE LEVELS are established
- Shall specify the general PRINCIPLES UNDERLYING THE PROTECTION STRATEGIES developed to reduce exposure
- Shall assign RESPONSIBILITIES FOR THE ESTABLISHMENT AND IMPLEMENTATION OF PROTECTION STRATEGIES to the regulatory body and to other relevant authorities
- Shall provide for the INVOLVEMENT OF INTERESTED PARTIES in decisions regarding the development and implementation of protection strategies

IAEA

BSS-2011, Req.47: The regulatory body or other relevant authority

- **Shall implement the PROTECTION STRATEGY, including:**
  - **Evaluation of the available remedial actions and protective actions for achieving the objectives, and for evaluation of the efficiency of the actions planned and implemented**
  - **Ensuring that information is available to individuals subject to exposure on potential health risks and on the means available for reducing their exposures and the associated risks**

IAEA

BSS-2011: Protection strategies in existing exposure situations

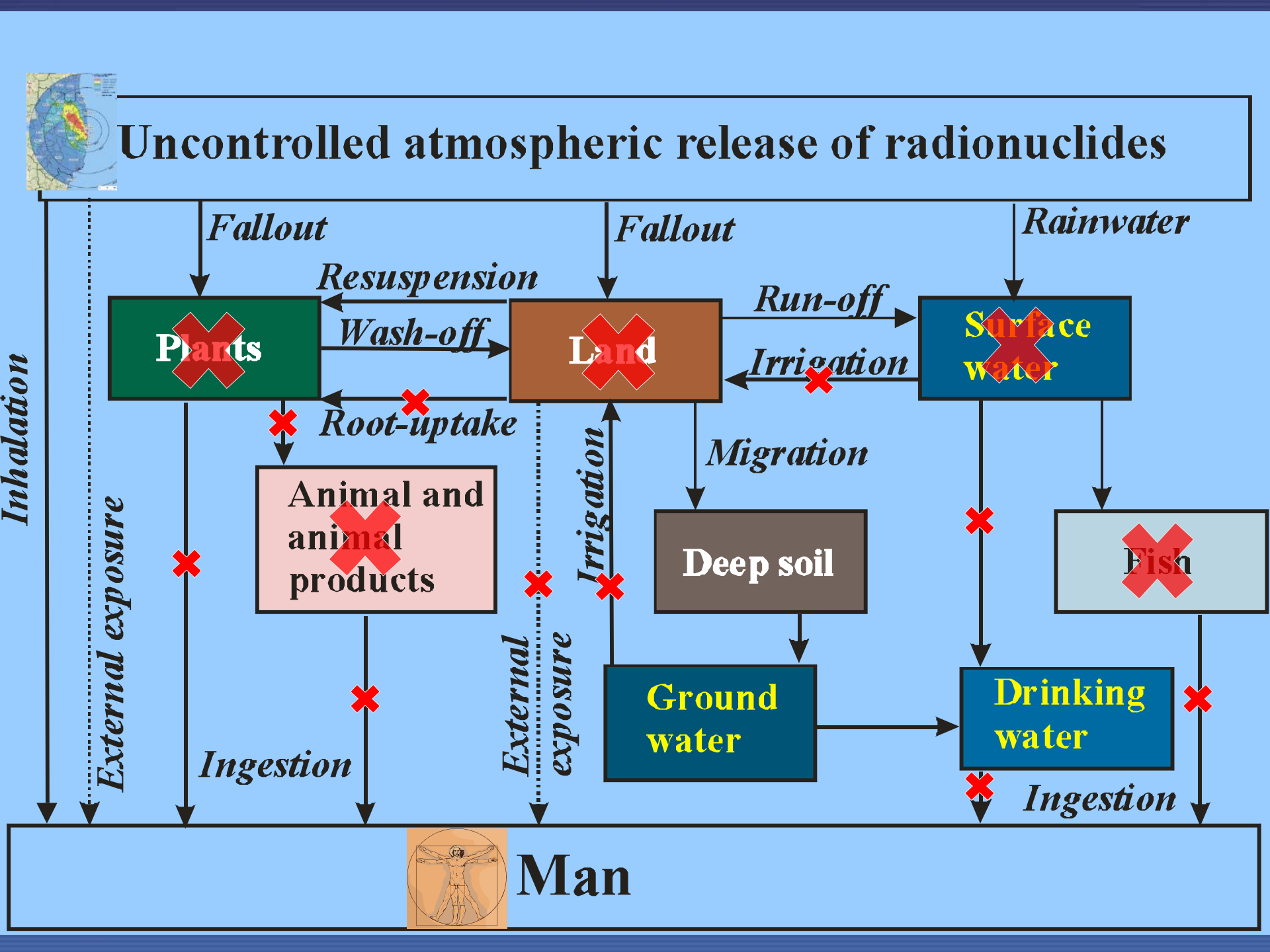
GENERAL PUBLIC

- **Req.48: Justification and optimization**
  - **Reference levels: annual effective dose to the representative person shall typically be in the range 1-20 mSv**
  - **Dose limits are not applicable!**
- **Req.49: Responsibilities for remediation**
  - **Remediation programmes and safety assessments, post-remediation control measures**
  - **Strategy for radioactive waste management**
- **Req.51: Commodities: food, feed and drinking water: reference level – 1 mSv/y to rep. person**

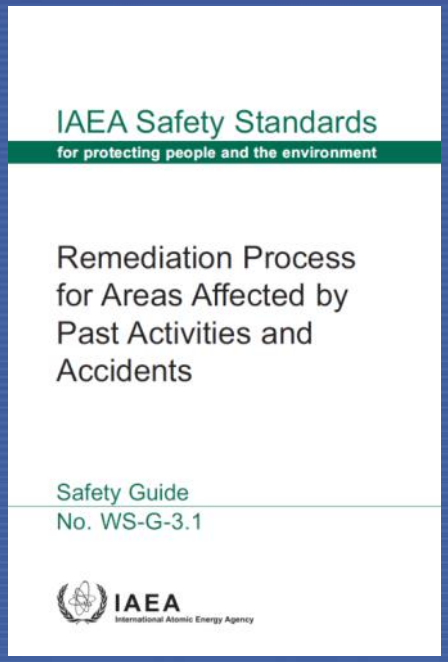
WORKERS

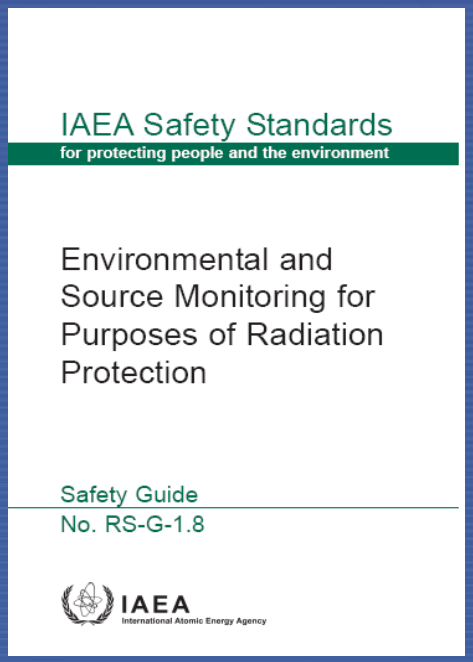
- **Req.52: Exposure of workers undertaking remedial actions shall be controlled in accordance with the requirements for occupational exposure in planned exposure situations**
  - **Justification**
  - **Dose limits: effective dose to a Reference Worker 20 mSv/y + limits for equivalent doses**
  - **Constraints**
  - **Constrained optimization of the protection and safety**
  - **individual monitoring of exposure**

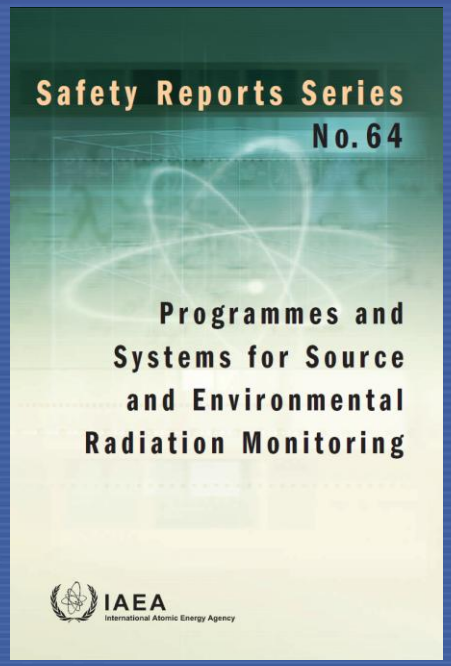
IAEA

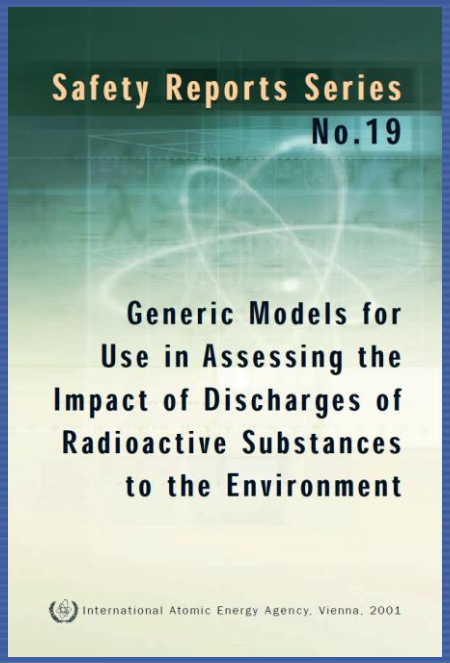

Uncontrolled atmospheric release of radionuclides
Fallout
Fallout
Rainwater
Resuspension
Run-off
Wash-off
Irrigation
Root-uptake
Migration
Inhalation
External exposure
Irrigation
External exposure
Ingestion
Ingestion
Plants
Land
Surface water
Animal and animal products
Deep soil
Fish
Ground water
Drinking water
Man

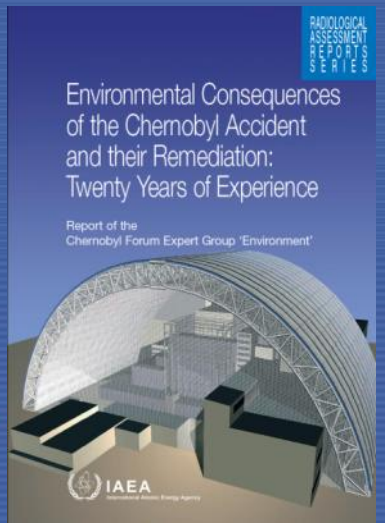
IAEA Safety Standards and Supporting Publications
Remediation: protection of public and environment

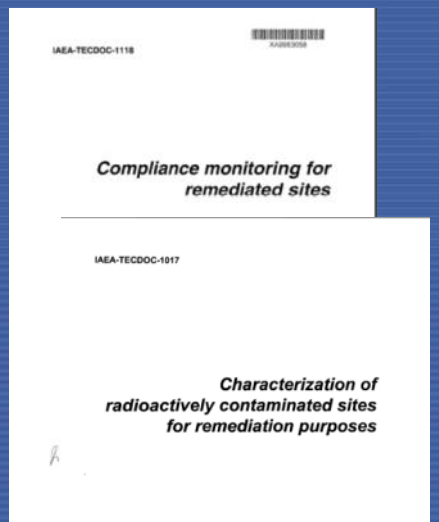


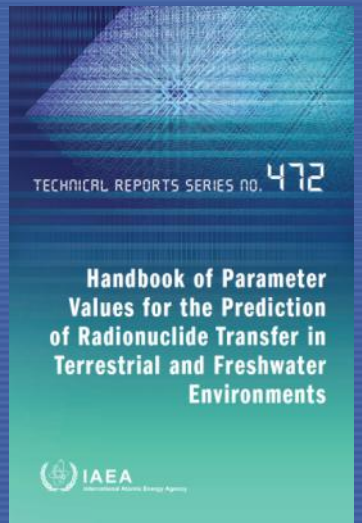


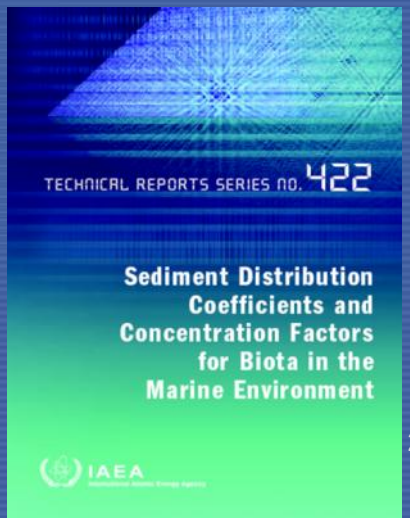






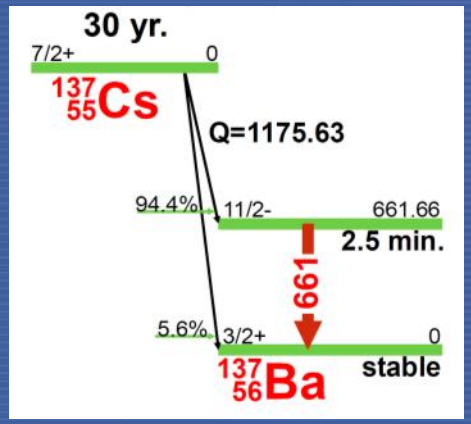


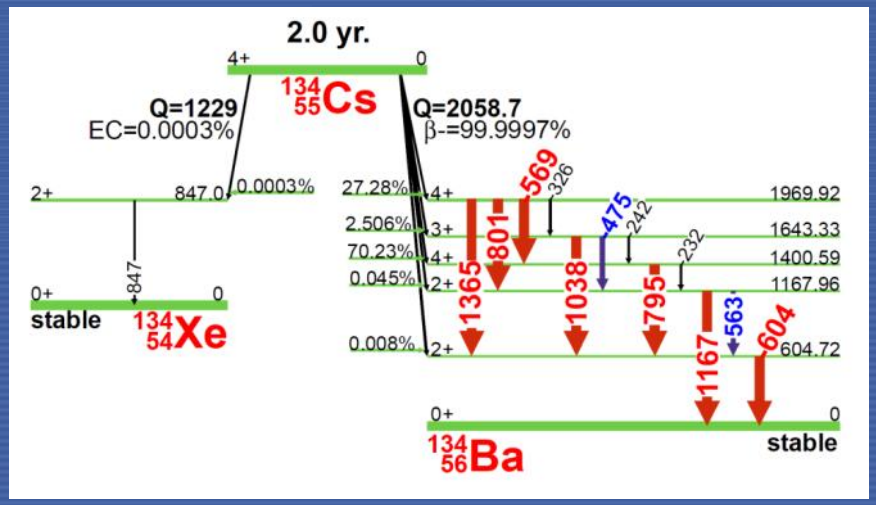




Caesium

- Alkaline metal
- Potassium is a chemical analogue/competitor
- One naturally occurring stable isotope, Cs-133
- Physical half-life:
  - Cs-137: 30 years
  - Cs-134: 2 years





Caesium in soil and plants

SOIL

- Cs-133 (stable) 0.3-25 mg/kg
- Ability for non-exchangeable fixation by the soil
- High biological mobility

ACCUMULATION IN PLANTS

- Depends on soil properties
- Decrease with increasing cation exchangeable capacity and clay fraction

IAEA

Caesium in human body

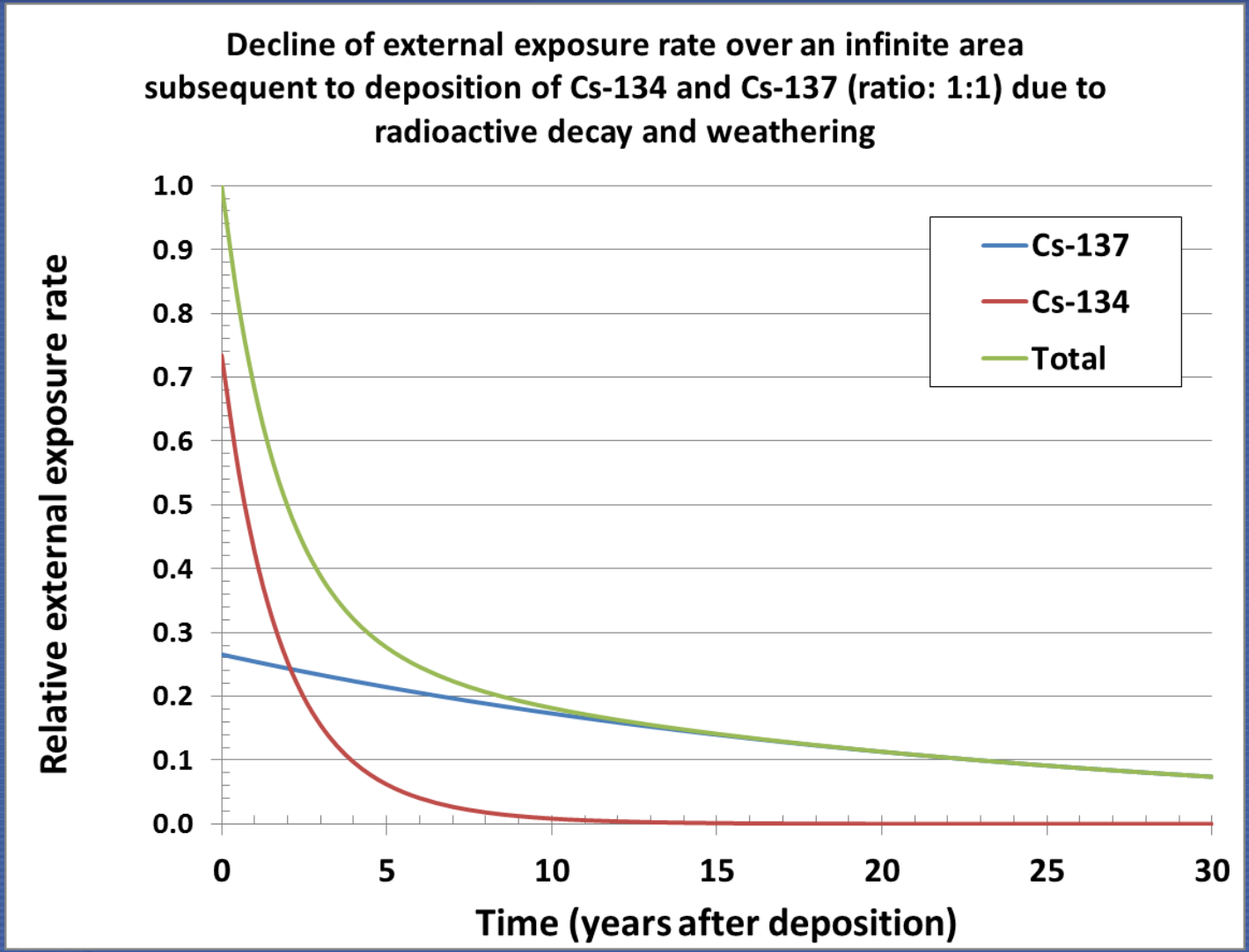
- Uniform distribution in whole body
- Biological half-life in human body (adult): 50-200 days

Dose coefficients: effective dose

reference adult member of the public

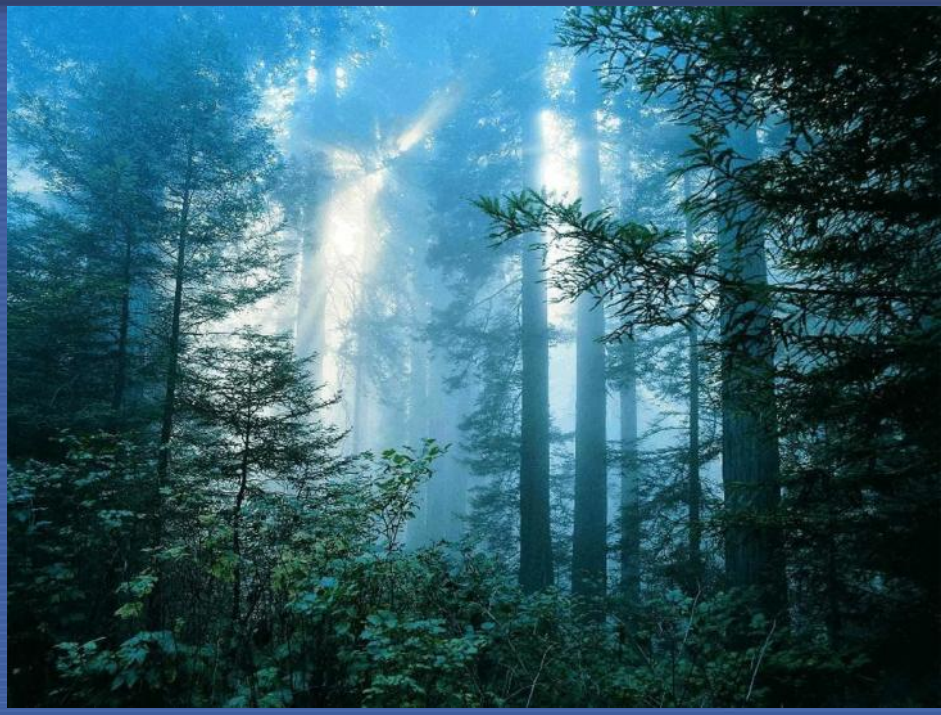
	Cs-134	Cs-137 (+Ba-137m)
External exposure from surface deposition, Sv/a per Bq/m^2 from IAEA SRS-19 (2000)/FGR-12(1993)	4.9 E-8	1.8 E-8
Internal exposure, from radionuclide intake, Sv per Bq intake from IAEA BSS-2011		
Ingestion	1.9 E-8	1.3 E-8
Inhalation, Type F AMAD = 5 micrometers	6.6 E-9	4.6 E-9

External exposure in time



IAEA

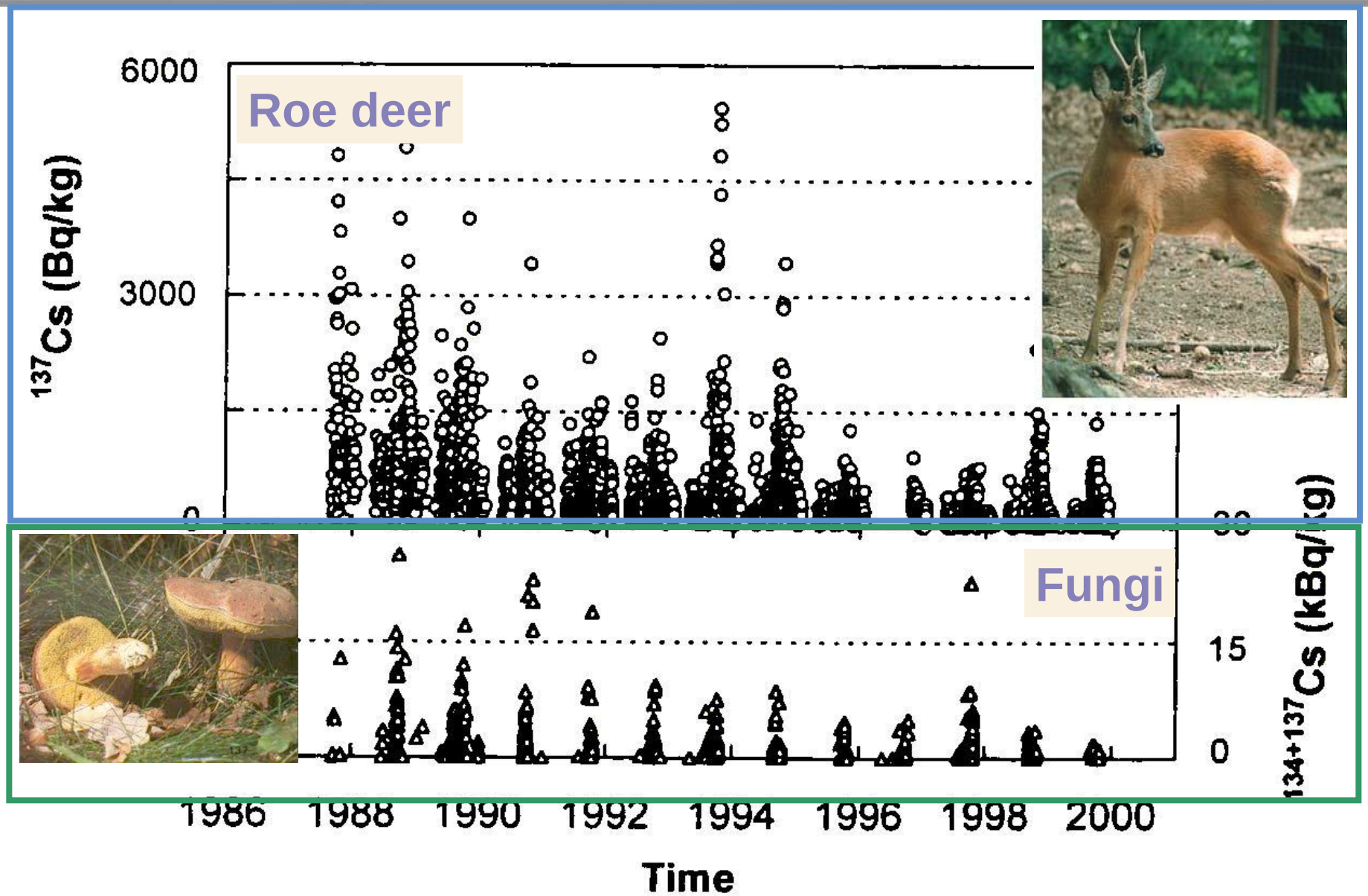
Chernobyl: transfer of Cs-137 in forest



- Strong activities are still observed in forest products
- Berries, mushrooms, games
- This is mainly due to high uptake of Cs-137 by forest products
- Also large activities are observed in soils and especially in litter

IAEA

Chernobyl: contamination of roe deer and fungi



A return to normal life

- A return to normal life is a realistic prospect for the people from the affected regions

- To achieve this aim, what these areas now need most are:
  - Intensive efforts on the remediation of contaminated villages and agricultural land
  - Comprehensive public information on the available cost-effective remedial options and safe methods to undertake the remediation
  - Collaboration and trust between people, scientists and decision makers
  - Long-term programmes on the sustainable development of local communities
  - Restoration of infrastructure, creation of new businesses and jobs

IAEA

International Safety Standards: the product of the international consensus