# Regulatory challenges relevant to decommissioning and remediation

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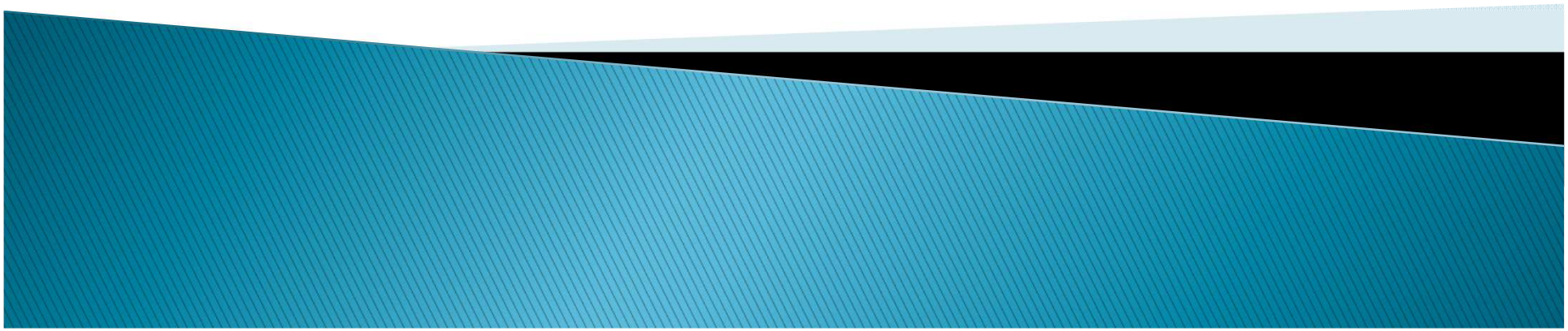
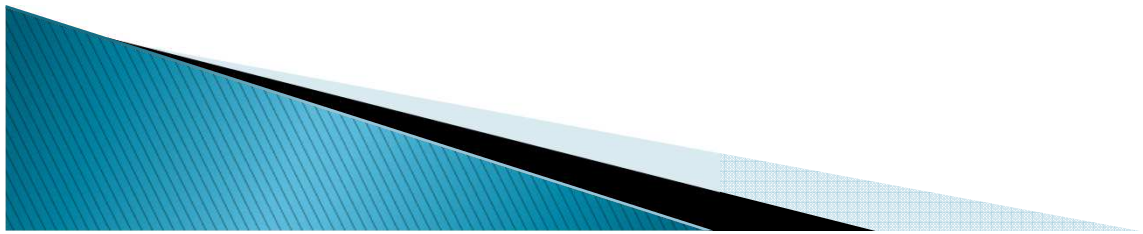


# International safety regime

- Joint Convention on Safety of SFM and on Safety of RWM (Article 26)
- Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards – Interim Edition General Safety Requirements Part 3
- Decommissioning of Facilities Using Radioactive Material (Safety Requirements)
- Safety Assessment for the Decommissioning of Facilities Using Radioactive Material (Safety Guide)
- Release of Sites from Regulatory Control on Termination of Practices (Safety Guide)
- Remediation Process for Areas Affected by Past Activities and Accidents (Safety Guide)

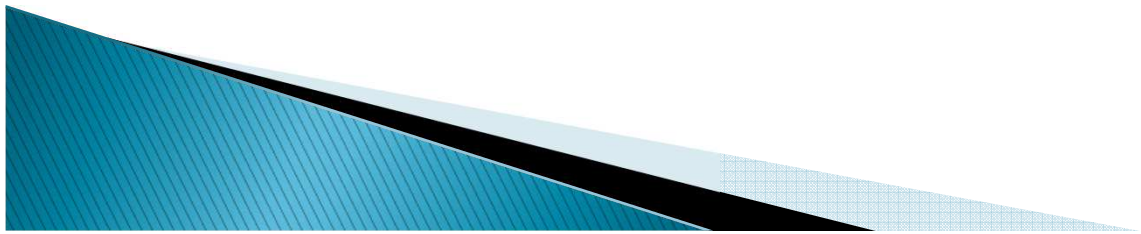


# DECOMMISSIONING

- Administrative and technical actions taken to allow the removal of some or all of the *regulatory controls* from a *facility*
  - Except for a *repository* or for certain *nuclear facilities* used for the *disposal* of residues from the mining and processing of *radioactive material*, which are 'closed' and not 'decommissioned'
- Decommissioning actions are taken at the end of the operating lifetime of a facility to retire it from service with due regard for the health and safety of workers and members of the public and the protection of the environment
- Should be anticipated at the design stage
- Decommissioning plan is the a prerequisite of the authorization of a new facility
- Usually considered within the planned exposure situation

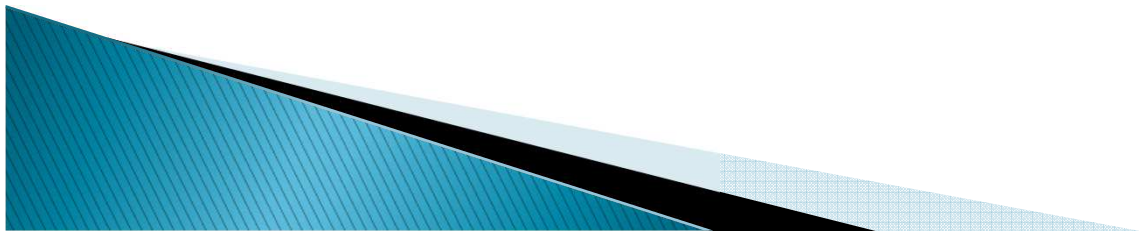
# Decommissioning experience

- Nuclear power plants
- Nuclear fuel cycle facilities
- Nuclear research reactors
- Other small facilities
- Projects completed, including nuclear facilities dismantled to green field conditions
- Projects ongoing, including deferred dismantling



# Why are we still talking about regulatory challenges?

- Decommissioning for nuclear and radiological facilities in many cases is not yet a full-scale industrial process with standardized procedures – so case by case approach is still needed
- Even to-be-routine decommissioning poses regulatory challenges
- All challenges concerning decommissioning are transforming into regulatory challenges
- Nuclear legacy and post-accidental decommissioning – almost each case is unique

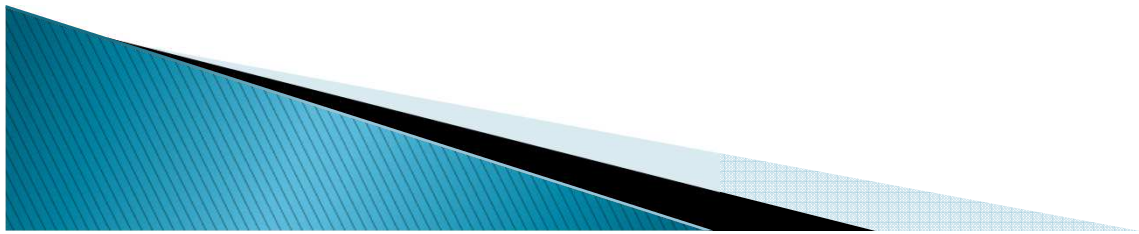


# Role of Nuclear Safety Regulator

- Planned decommissioning, including pre-scheduled one – in addition to basic regulatory responsibilities (establishing regulations, licensing and safety evaluation, inspection and enforcement) – duties concerning strategy choice, control and advisory functions in respect of availability of resources, information preservation and introduction of stewardship
- Other cases of decommissioning are depending on particular case and varying from country to country

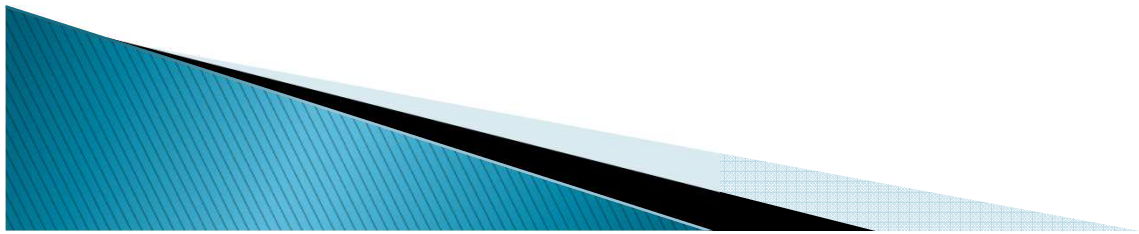
# Financial assurance for decommissioning

- Ideally – funds are to be collected from economical revenues during facility operation
- Reality – prescheduled termination of operation, post-accidental activities costs, underestimation of decommissioning costs, improper management of funds…
- What is the role and duty of regulator? – no simple and universal answer…
- What if regulatory requirements result in cost increase? – and how to get best results within resources available? – challenging reality…



# Long term preservation of information

- Relevant even to green field end state
- Regulatory requirements and how to fulfill them
- Availability of historical data
- Progress in data preservation technologies and cost of following the progress
- Responsibility for data preservation and retrieval
- Stewardship concept and viability



# Decommissioning – routine

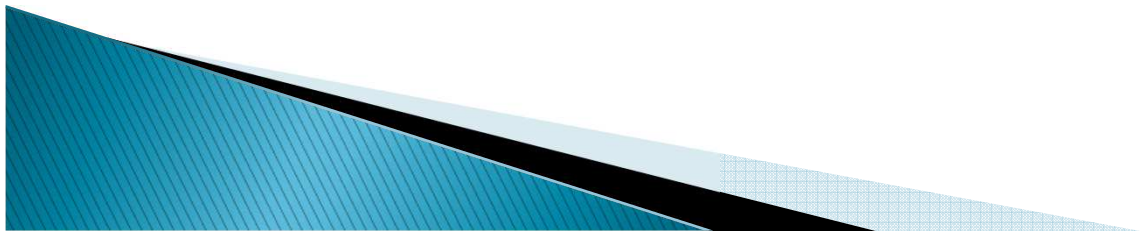
- Smooth decommissioning is decommissioning prepared well in advance
- Selection of decommissioning strategy and selection of acceptable end-state
- Site characterization and information management value
- Multi-unit case – decommissioning activities should be adopted to prevent inadvertent impact on safety of operating units
- Two transition phases that requires particular attention:
  - From operation to decommissioning
  - From dismantling to another state (authorized reuse, unrestricted release, whatever)
- "no hurry" challenge – how to respond?

# Decommissioning – prescheduled

- Different reasons (pure safety, technology obsolense,  economy, pure policy, mixed) – common challenges (lack of funding, infrastructure, preparations, bad attitude of operating staff, unavailability of organizational arrangements)
- Disembarking countries – specific challenges (preservation of qualified man-power, funding of research and technological development, motivation for future generations)
- Regulator's role – not just follow the books – think ahead, be proactive, advice government

# Decommissioning – post-accidental

- Lessons learnt from Chernobyl NPP decommissioning:
  - Accidental contamination: non-standard pattern, higher doses – difficulties in site characterization
  - Excessive amounts of post-accidental waste
  - Lack of technical solutions for some issues (fuel-containing masses, chemical contaminants, alpha-emitters in liquid waste etc.)
  - Unavailability of basic prerequisites (funds, programs, infrastructure, knowledge)
  - Nothing goes as expected
  - End state and way to get it – still not clear
- Fukushima-1 NPP: lessons to be learnt

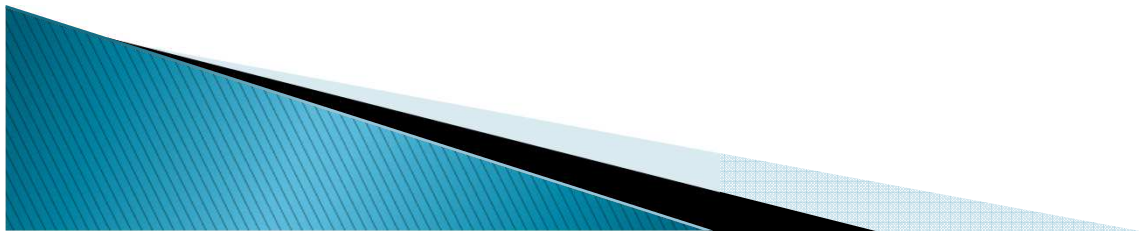


# REMEDIATION

- Any measures that may be carried out to reduce the *radiation exposure* due to existing *contamination* of land areas through actions applied to the *contamination* itself (the *source*) or to the *exposure pathways* to humans.
- It usually required as a result of an accident or non-regulated or inadequately regulated practice, may also be needed after non-nuclear activities, such as mining
- Inadequate regulation ≅ accident!

# Remediation challenges

- On-site remediation
- Environmental remediation
- Existing exposure situation – a solution to be find – and regulator is to contribute to it
- Regulatory challenges:
  - Complete removal of the *contamination* is not always implied
  - The end-points should be defined and communicated to the interested parties, including public



# “Contamination”

- *Radioactive substances* on surfaces, or within solids, liquids or gases (including the human body), where its presence is unintended or undesirable, or the process giving rise to its presence in such places [BSS-2012].
  - *Contamination* does not include residual *radioactive material* remaining at a site after the completion of *decommissioning*.
  - The term *contamination* may have a connotation that is not intended. The term *contamination* refers only to the presence of *radioactivity*, and gives no indication of the magnitude of the hazard involved.

# Uncontrolled atmospheric release of radionuclides

*Fallout*

*Fallout*

*Rainwater*

*Resuspension*

*Wash-off*

*Run-off*

*Irrigation*

Plants

Land

Surface water

*Root-uptake*

*Migration*

*Inhalation*

*External exposure*

Animal and animal products

*Irrigation*

Deep soil

Fish

*Ingestion*

*External exposure*

Ground water

Drinking water

*Ingestion*

Man

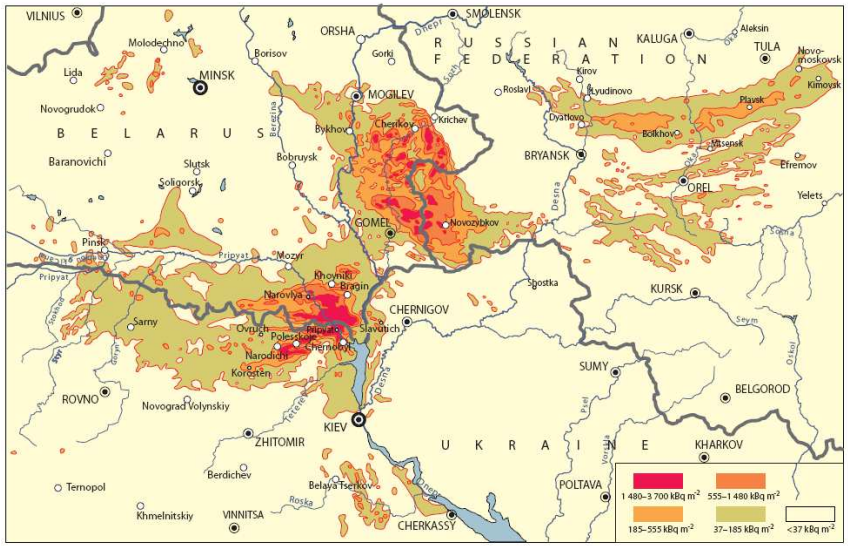
# Remediation – general remarks

- Remediation is out of scope of the regulatory framework in many countries
- Case by case basis
- Many different actors – not always clear roles
- Socioeconomic factors and public perception
- Site characterization and prioritization of remediation activities
- By-products below regulatory limits – decontamination waste? contaminated materials?
- Institutional control following site clearance

# Remediation off-site – major accident case (1/2)

- Accidents with large-scale environmental contamination – nobody is really prepared for extensive remediation activities
- Early post-accident protective actions are crucial for the success of remediation activities
- The government and the regulatory body or other relevant authority shall ensure that remedial actions and protective actions are justified and that the protection and safety is optimized [BSS-2012]

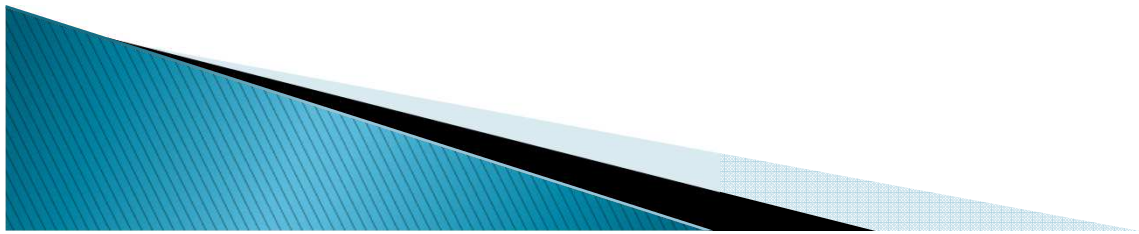
# Remediation off-site – major accident case (2/2)




- After Chernobyl accident a wide range of urgent immediate and long-term protective measures (counter-measures) was applied
- The world community recognized that the application of counter-measures/remediation after the Chernobyl accident had made possible to reduce the public exposure doses significantly
- The Chernobyl experience became the basis for the international standards

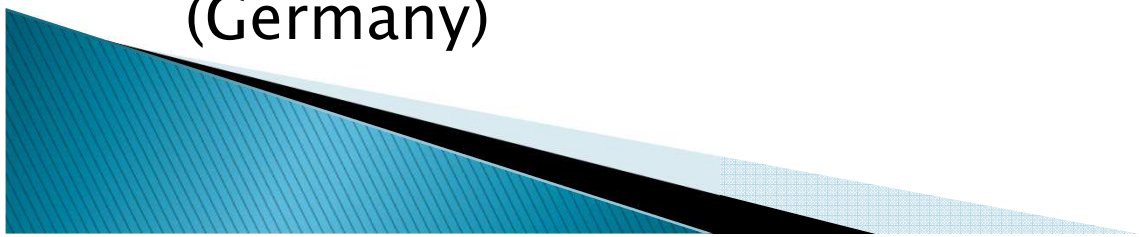
# Remediation – non-licensed sites

- Radioactive contamination as a result of activities not related with nuclear energy use – usually exploration and processing of mineral deposits
- A facility or activity itself was out of regulatory control, so no dedicated staff or radiological safety arrangements in place
- No dedicated funding or waste infrastructure available
- Poorly documented site operational history
- Deterioration of engineering structures
- An example of the “success story” – Santo Amaro mineral sand mill decommissioning (Brazil)



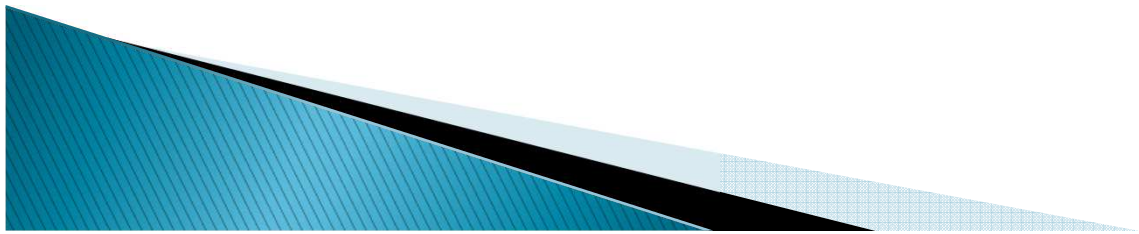
# Remediation – nuclear legacy case

- Sites and areas contaminated by past activities – existing exposure
  - Past uranium mining and milling activities
  - Former nuclear tests and other military activities
  - Historical contamination due to accidents or unknown origin
- Governmental responsibility for funding and implementation of remediation programs – regulator requested to contribute
- Major issues:
  - Site characterization
  - Development of tailored strategy
  - Management and control of implementation
  - Socioeconomic considerations
- An example of the “success story”– Wismut Project (Germany)



# Remediation – mixed contamination case

- In many countries – separate regulatory regimes to deal with radioactive and non-radioactive contamination – to deal separately? to cooperate? who would be leading?
- Integrated safety and risk assessments, operational safety considerations and clean-up targets – optimization of acceptable residual levels and identification of scenarios for future site use
- Decontamination waste – availability of disposal routes for wastes with mixed contaminants? – tailored solutions may be needed – Regulator expected to contribute to finding the solution



# Regulatory response on challenges posed by decommissioning and remediation

- We must continue to carry out our regulatory duty to ensure safety, but that we must do it in such a way that ensuring the achievement of the final goal of making our nuclear sites or contaminated areas safer for future generations, thus saving them from facing the problems we have to solve today
- Proper cooperation with other authorities involved, including local ones, could be crucial
- Regulatory transparency and good public relations could help to ensure regulatory effectiveness
- Looking ahead and preventing troubles

# Issues to be put/kept on international agenda

- Identification and promotion of decommissioning good practices for different scenarios
- Support to disembarking countries, particularly in competence preservation and development
- Learning from different remediation cases, identification of common challenges, development of model response
- IDN, ENVIRONET, etc

Thank you for your attention!