

# **The Waste Management Strategy and the Licensing Process Prior to and After a Nuclear Accident**

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# Table of Contents

- **Introduction**
- **Normal situation**
- **Emergency situation**
  - **Preparing the unexpected**
  - **Legal aspects and responsibilities**
  - **Technical issues**
- **Off-site: Environmental remediation**
- **On-site: Management of residues**
- **Post-accident activities**
- **Conclusions**

# Normal Situation

- **Nuclear facility, e.g., nuclear power plant**
  - **Implementation of a system of legal regulations**
  - **High levels of safety, safe operation predominantly required**
  - **Licensing process well established**
  - **Clear allocation of responsibilities**
  - **Supervision by competent authority**
- **Well-established radioactive waste management system**
  - **Handling, treatment, and processing of operational, decommissioning and dismantling waste**
  - **Engineered storage**
  - **Disposal in near-surface and / or geological repositories**

# Emergency Situation

- **Nuclear accident and its consequences (i.e., emergency situation) totally different from the normal situation**
- **Unexpected event (beyond design) including many uncertainties and unforeseen issues**
- **Essential features:**
  - **Destruction (at least of parts) of the nuclear facility**
  - **Release of radionuclides, high radiation exposures**
  - **Contamination of large areas of land (mainly off-site)**
  - **Arisings of huge amounts of radioactive residues, i.e., radioactive waste and contaminated material (mainly on-site)**
  - **Urgent measures for clean-up activities in severe radiation fields**

# Preparing the Unexpected (1)

- **Precautionary measures to be developed the rationale of which is to give guidance on the complex issues during and after a nuclear accident**
- **Primary objectives: reduction of radiological exposure and impact and mitigation of accident consequences**
- **Planning and implementation of such measures only meaningful and advisable**
  - **well in advance of any future nuclear accident**
  - **during normal situation offering time and room for development including all parties involved**

# Preparing the Unexpected (2)

- **Precautionary measures to be focused on the prioritization of activities**
- **Initial phase of a nuclear accident**
  - **Main activities aiming at mitigation of accident consequences, less activities on waste management**
  - **Clear ideas on “What should NOT be done“ needed in order to avoid irresistible impacts on long-term safety of waste management**
- **Phase subsequent to the actual accident**
  - **Activities on waste management more and more important**

# Preparing the Unexpected (3)

- **Gradually increasing consideration of “What should be done“ in order to support effective implementation of waste management activities taking into account the interdependencies between each waste management step**
- **Development of a waste management strategy, including “What should NOT be done“ and “What should be done“ issues, inevitable for enabling and / or providing**
  - **Guidance for effective waste-related emergency response**
  - **Perspectives for reasonable clean-up measures**
  - **Advice for decision making**

# Legal Aspects and Responsibilities (1)

- **Regulating the unexpected impossible due to**
  - **Not known type and nature of a nuclear accident and its consequences**
  - **Implication of uncertainties and unforeseen issues during and after such an accident**
- **Regulatory challenge to be faced for addressing an emergency situation from a legal point of view**
  - **Examination of existing internationally agreed-upon recommendations and national legal regulations and identification of issues for further developments**
  - **Updating the international and national safety regime for decommissioning and remediation after a nuclear accident**
  - **Examination and weighing up legal possibilities for the acceleration of licensing processes (or at least parts of it) and, if feasible, adaption of such processes**

# Legal Aspects and Responsibilities (2)

- **In either case preparation for any future nuclear accident should definitively comprise**
  - **Clear allocation of the roles and responsibilities of competent authorities, operators of nuclear facilities, further institutions involved and experts in an emergency situation**
  - **Identification of a “leading organization“ (if applicable)**
- **Allocation of responsibilities and availability of short-term licensing processes of utmost importance for immediately launching appropriate decommissioning and remediation activities in an emergency situation**

# Technical Issues (1)

- **Development of a waste management strategy for application in an emergency situation to be based on available experience and knowledge in a step-by-step procedure well in advance**
- **Analysis and suitable preparation of lessons in particular learnt from**
  - **Decontamination, decommissioning and dismantling of nuclear facilities**
  - **Safe enclosure of nuclear power plants**
  - **Environmental remediation, in particular large nuclear legacy sites and clean-up of uranium ore mining and processing sites**
  - **Emergency preparedness and response actions**
  - **Past nuclear accidents and emergency situations**

# Technical Issues (2)

- **Identification of waste management strategy-relevant issues**
- **In-depth discussion of and decision on technologies being worth to be developed from now on (including the initiation of R & D work, if required)**
- **In-depth discussion of and decision on procedures, measures and technologies to be prepared in advance**
- **Combining agreed-upon issues and preparation of such a strategy (off-site, on-site) in form of strategic recommendations**

# Off-site: Environmental Remediation

- **Essential elements of a waste management strategy focussed on off-site necessities**
- **Guidance on appropriate clean-up strategy and associated actions depending, i.a., on the release of radionuclide-specific inventories**
  - **Release of short-lived radionuclides such as Cs-137**
  - **Release of long-lived Plutonium and Uranium isotopes**
  - **Feasibility of clean-up due to the amount of contamination**
- **Recommendation on management options such as direct clean-up of bulk contaminated soil or its decay storage, e.g., in the case of contamination with short-lived radionuclides**

# **On-site: Management of Residues (1)**

- **Totally different types and amounts of radioactive residues to be dealt with as compared to remediation waste**
- **Essential elements of a waste management strategy focussed on on-site necessities:**
  - **Issues for immediate actions for reducing the radiological exposure and impact being of utmost importance with respect to the performance of stabilization work for the damaged or destroyed nuclear facility and the clean-up activities**
  - **Issues for effective handling and treatment of large volumes of solid and liquid radioactive waste as well as of contaminated material**

## **On-site: Management of Residues (2)**

- **Basic approach to radiological exposure and impact reduction: collection of radioactive residues and shipment to storage and / or disposal facilities**
- **Realization of the basic approach within the waste management strategy:**
  - **Specifically designed or tailored emergency storage and / or disposal facilities**
  - **Provisions on the siting of such facilities taking into account the off-site and on-site situation**
  - **Preparation of a set of minimum requirements on such emergency storage and / or disposal facilities for licensing processes and, if feasible, conduction of those processes well in advance**

# **On-site: Management of Residues (3)**

- **Challenges in the management of radioactive residues: development and provision of technical options for the removal, handling and treatment of**
  - **Damaged nuclear fuel elements and nuclear fuel debris**
  - **Solid and liquid radioactive waste (including destroyed components of big dimension)**
  - **Large amounts of contaminated material**
- **Most important and crucial issues:**
  - **Developing a waste management strategy for mixtures of damaged nuclear fuel and fuel debris, radioactive waste and contaminated rubble and material**

# **On-site: Management of Residues (4)**

- Recommendations on the proper handling, treatment and processing of radioactive residues within the accident phase and during the post-accident phase**
- Recommendations on the emplacement of residues in emergency storage and / or disposal facilities**
- Recommendations on proper record keeping and documentation of all residue-related measures taken**
- Avoidance of improper waste management steps in the emergency situation, i.e., avoidance of those measures and procedures which might cause difficulties with respect to the future (final) storage and disposal options (consideration of interdependencies)**

# Post-accident Measures

- **Evaluation of the measures taken for emergency storage and / or disposal of radioactive waste and contaminated material**
- **Decision and, as far as applicable, performance of possibly required recovery actions for radioactive waste and contaminated material for further treatment and processing to meet final storage and / or disposal requirements (even including considerations on reuse / recycling options and possibilities)**
- **Delivery of appropriately treated and processed radioactive residues to an engineered storage facility or a repository, respectively**

# Conclusion

- **A proper waste management strategy to be applied in an emergency situation offers targeted assistance and help in a complex situation as compared to a situation without clearly arranged provisions**
- **Targeted handling and treatment of solid and liquid radioactive waste and contaminated material represents the first management step and will definitively facilitate all following steps up to disposal**
- **Thus, such a strategy must clearly highlight issues on “What should NOT be done“ and “What should be done“**
- **A waste management strategy for application in an emergency situation should well in advance be prepared and implemented**