

**TRAINING WORKSHOP ON REVIEW OF REMEDIATION
PLANS AND ACTIVITIES FOR URANIUM MINING AND
MILLING SITES**

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CHAPTER 1. INTRODUCTION

Background

Many countries have legacy sites associated with the mining and processing of uranium ore (hereinafter referred to simply as legacy sites) that were created at a time when the regulatory supervision of operations was weak or absent and the real risks arising from those operations were not fully understood. Because of this lack of experience in some countries, even today, the relevant authority¹ may face difficulties in determining how to remediate these legacy sites, and regulatory supervision of the remediation process (and indeed of new uranium mining operations) may be lacking.

Because of the potential risks to human health and the environment there is a need for better management and remediation of many of these legacy sites, especially in countries where the general public, through lack of awareness, may try to access or be exposed to contaminated areas or contaminated materials. Guidance is needed to assist the relevant authority in reviewing the various options set out in remediation plans and eventually in approving the remediation approach deemed to be the most appropriate and sustainable for a particular site. These plans may relate to the remediation of legacy sites (which include abandoned sites and old sites at which operations have been suspended) and even some of the older sites at which operations are continuing. This guidance will help the relevant authority to understand the concepts associated with the planning and authorization of operations at new sites.

Some regional and national training courses partially relevant to remediation of legacy sites have been held on the past. In almost all cases, the lectures have been prepared without the benefit of a structured syllabus and without training plans to describe the objective and scope for each lecture. Thus, a need for better standardization of lecture materials has been identified.

Objective

The objective of this training course is to provide guidance for the relevant authorities on what they should expect to see contained within a remediation plan for legacy sites and how they should review and ultimately approve such plans. The training course may also be used for older facilities that are still operating, where decommissioning and remediation will be required in the future, and for legacy sites from the mining and processing of radioactive minerals other than uranium ore. Although targeted at the relevant authorities, the training materials will also be useful for facility operators and policy makers, as well as public interest groups. The training course was developed as part of Project B.2. Regulatory Review of Remediation Plans for Legacy Sites Associated with the Mining and Processing of Uranium Ore — this project is included under IAEA Project 3.4.1.3 on Decommissioning and Remediation Safety and is being conducted by the IAEA with supplementary funding from the European Union.

Scope

This training course is intended to address the review of remediation plans for legacy sites. Such sites are associated with exploration for uranium ore and its subsequent mining and processing, and vary from small scale exploratory boreholes and shallow pits to larger scale open pit or underground mining operations complete with processing facilities and large tailings management areas.

¹ The planning, implementation and control of the remediation process usually involves more than one national authority or State/Provincial authority, with one of them being designated as the lead authority. Depending on the type of remediation situation and the legal and institutional framework, the lead authority could be an authority such as the regulatory body for radiation protection and safety, a public health authority, an environmental protection authority, a radioactive waste management authority, a mining authority or a national scientific institution.

The primary focus of the lectures is directed at legacies from the mining and processing of uranium ore, the principles and approaches outlined in the report can generally be applied also to address legacies from the mining and processing of other radioactive minerals.

Structure

This Standard Syllabus is structured similarly to the syllabus for the *Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources* (2002). The descriptions for the individual module and specific training plans for each lecture and exercise were developed using the *Guidance for the elaboration of training material for the Post Graduate Educational Course and Practice Specific Specialized Courses in Radiation Protection and Safety of Radiation Sources* (IAEA unpublished working material, 2003). Using these guidelines, the syllabus is organized as follows: Chapter 2 includes an overview of the lectures in the module. Chapter 3 includes the detailed lecture plans for the lectures in the module; Chapter 4 presents a suggested schedule for the training course.

CHAPTER 2. OVERVIEW

This chapter provides an overview of each lecture to be included in the training course.

Lecture 1. Workshop Introduction and Overview

This introductory presentation is aimed at providing an overview of the week's workshop and an introduction to the importance of the workshop subject, namely "Review of Remediation Plans and Activities for Uranium mining and Milling Sites".

Lecture 2. Types of mining and milling sites

This presentation is aimed at describing the different types of mining and milling sites that exist in different countries around the world. They may be legacy sites, operational sites or sites which are being planned for future uranium exploitation. Some of the different challenges associated with these sites will be highlighted.

Lecture 3. Radiation and Radiation Protection

In designing, planning and carrying out a remediation project, one of the most important elements to consider is the protection of both people and the environment from the harmful effects of the ionizing radiation. For considering this in a proper way, it is necessary to have a basic knowledge of the nature and features of ionizing radiation and the main sources of radiation, the quantities used for measuring ionizing radiation with radiation protection purposes, as well as the basic radiation protection concepts.

Lecture 4. Exposure situations from the mining and milling lifecycle

The presentation gives an overview of different exposure situations that can take place during and as result of uranium mining and milling activities.

Lecture 5. Lifecycle and graded approach to regulation and safety

This lecture provides the basic information on the lifecycle of uranium mining and milling activities, in particular with respect to remediation of legacy sites. It also includes information on the implementation of a graded approach to regulation and safety of legacy sites. It is expected that the information provided in the lecture will assist in the participants' understanding of the objective of this project, i.e. to learn about Review of Remediation Plans and Activities for Uranium Mining and Milling Sites.

Lecture 6. Roles and Responsibilities

The regulator plays an important role in the process of identification, characterisation and remediation of legacy uranium sites. The regulatory process can be complicated in those cases where ownership of the legacy site cannot be assigned to a particular organisation. This presentation describes what are the roles and responsibilities of government, the regulatory agencies, and the operator.

Lecture 7. Interim Measures for Legacy Sites

The objective of this lecture is to provide an overview of the simple intervention techniques that can be used to reduce public exposure to ionizing radiation from uranium legacy sites.

Lecture 8. Overview of the environmental remediation process

This presentation covers three separate but interrelated subjects, namely; overview of the environmental remediation process, regulatory requirements and remediation objectives and criteria. An explanation is provided about the various drivers for environmental remediation and the different ways it can be approached.

Lecture 9. Site characterization

This presentation is aimed at explaining why site characterization data is required to underpin a remediation scheme. It will highlight that in many instances a large amount of data will already exist which will then be supplemented if necessary through the acquisition of new data.

Lecture 10. Stakeholder engagement and risk communication

This presentation will define what is meant by the term stakeholder and provide an explanation as to why stakeholder engagement is now so necessary, irrespective of the country a remediation project with a human health or environmental implication may be located in. Some of the mechanisms for engagement will be explored as will some of the mechanisms, which will increase the likelihood of success of any formulated stakeholder engagement programme.

Lecture 11. Environmental Impact Assessment, Dose and Risk Assessment

The purpose of this lecture is to provide an overview of the EIA and EIS process and requirements for remediation of legacy sites. Given the importance of the EIA and EIS in determining the future safety of the site and in mitigating future impacts the lecture provides significant detail in terms of the scope of the studies and the supporting documents. The lecture also deals with dose and risk assessment for workers and the public that are involved in remediation activities, as well as a description of remediation hazards.

Lecture 12. Management and Disposal of Wastes

This presentation provides the basic information on different waste materials that need to be managed, what factors to consider in waste disposal, key design criteria and the different options available for disposal. It is expected that the information provided in the lecture will assist in the participants' understanding of what is involved in choosing an alternative for waste disposal.

Lecture 13. Site Remediation Plan

This presentation provides the basic information on contents of a decommissioning plan, site characterization and the complexity of cleaning up a large site, importance of determining background concentrations to establish cleanup levels, elements of a cleanup strategy, and how physical and non-radiological hazards may present a greater risk to workers and the public than the radiological hazards.

Lecture 14. Geotechnical Engineering

This presentation provides the basic information on long-term care and surveillance of disposal cells and underground storage facilities containing radioactive waste. It is expected that the information provided in the lecture will assist in the participants' understanding of what is involved in critical design aspects of disposal cells to withstand seismic, erosion, and other forces.

Lecture 15. Unique considerations for exploratory drilling, ISL facilities and heap leach

This presentation provides the participants with a reminder of the remediation required for uranium exploration sites and also introduces the specific requirements for remediation of heap leach and in-situ leach operations.

Session 16: Protection of Water Resources

This lecture provides the basic information for the "Protection of Water Resources" when contemplating the development or decommissioning of uranium mine/mill. It is expected that the information provided in the lecture will assist in the participants' understanding of other lectures of the Module dealing with environmental protection

Lecture 17. Surface Water and Erosion Protection (Water Treatment, Sludge, Disposal of Other Waste)

This lecture provides the basic understanding of the factors that must be considered when evaluating and developing an adequate overall plan to protect surface waters and to provide adequate erosion

protection at uranium mines and mills. If properly planned and implemented, it can effectively provide protection through the entire lifecycle of the uranium mining and milling operation.

Lecture 18. Radiation Protection. Remediation and Abatement of Radiation Hazards

This lecture provides the basic information on the radiation protection aspects during remediation, in particular the abatement of hazards, caused by the remediation activities. It is expected that the information provided in the lecture will assist in the participants' understanding of the objective of this project, i.e. to learn about Review of Remediation Plans and Activities for Uranium Mining and Milling Sites.

Lecture 19. Monitoring during remediation and post-remediation monitoring and control

This lecture provides basic elements of design, logistics and implementation of environmental monitoring programs required to be carried out in support of remediation activities and post remediation stage of remediated territories or scenarios.

Lecture 20. Institutional Control and Surveillance

This presentation provides the basic information on long-term care and surveillance of disposal cells or underground storage facilities containing radioactive waste. It is expected that the information provided in the lecture will assist in the participants' understanding of what is involved in long term planning and inspections.

Lecture 21. Financial assurance for remediation activities

This lecture provides the basic understanding of the factors that must be considered when evaluating the adequacy of financial assurance to cover costs associated with the decontamination, decommissioning, and reclamation of sites, structures, and equipment used in conjunction with uranium mining and milling. It is expected that the information provided in the lecture will assist in the participants' understanding of other lectures of the Module dealing mining and milling of uranium ores.

Lecture 22. Regulatory Oversight of Remediation: Authorization and Inspection

This presentation describes how the regulatory body will authorize the remediation activities, and then follow that up with their inspection and verification process. This lecture will connect with the roles and responsibilities of the regulators, and their regulatory requirements as defined by the state/country laws.

Lecture 23. Regulatory checklist for reviewing remediation plans

This presentation is aimed at showing that the production of a regulatory checklist can provide a formal way of ensuring that each expected component of the remediation plan has been highlighted to an operator well in advance of the remediation work taking place. The checklist allows the regulator to map out and then confirm that all of the expected components are being undertaken and it allows the operator to incorporate all of these highlighted components into their project and communication plan. It should be recognized that the list, while comprehensive, needs to be project and country specific.

Lecture 24. Prevention of future legacy sites

This presentation is aimed at highlighting the importance of preventing future legacy sites. Many legacy sites exist today and are often extremely difficult to manage and remediate because the tailings and rock piles were not adequately engineered or remediated in the past with a long term vision in mind. Nowadays these site often have no owner, little funding and reside in countries which may not have a well-developed regulatory and statutory regime. The lecture highlights many of the approaches that can be taken throughout the mining lifecycle which should go some way to prevent a site eventually becoming a legacy site that future generations need to resolve.

Member State Reports by the Participants

The participants from each IAEA Member State would provide a short presentation to the workshop, as appropriate. The purpose of the reports is to inform all participants and experts of the conditions and issues in each Member State related to uranium legacy sites.

Course Exercises

The course exercises comprise materials provided to the participants as a class or group on which they must provide a solution. Each group then presents their solution for discussion by all participants and the experts.

There are three exercise sessions during the week:

- E-1: Conceptual Site Model,
- E-2: Regulatory checklist for the review of the remediation plans.

The course experts will facilitate the exercises and discussions.

Discussion and Question and Answer Sessions

There is a brief period for class discussions and question and answer sessions after each presentation. At the end of each day there will be a longer period available for discussion of the presentations.

CHAPTER 3. DETAILED LECTURE PLANS FOR THE LECTURES IN THE MODULE

Lecture 1: Workshop overview and introduction

Objectives:

This introductory presentation is aimed at providing an overview of the week's workshop and an introduction to the importance of the workshop subject, namely "Review of Remediation Plans and Activities for Uranium mining and Milling Sites".

The primary objective of the workshop is to assist regulators responsible for reviewing remediation plans at uranium mining and milling sites (legacy sites). However, the course should additionally assist the regulator, other government entities, and industry by providing information applicable to the development, operation, and remediation of potential new sites or sites that previously were uneconomical to operate, and which are being considered for re-development. The course attendees will gain an insight into how the week's activities will be structured as there will be a combination of lectures and team based exercises.

At the end of the lecture, the participants should:

- (a) Understand the relevance and importance of the workshop and whom it will benefit,
- (b) Understand the various workshop objectives, and
- (c) Ascertain which subjects the workshop will cover.

Lecture 2: Types of mining and milling sites

Objectives:

This presentation will describe the different types of mining and milling sites that exist around the world. These sites may be legacy sites, operational sites or sites that are in the planning stage for future uranium exploitation. Some of the different challenges associated with these sites will be highlighted.

At the end of the lecture, the participants should:

- (a) Gain an understanding about the different kinds of mining and milling sites around the world;
- (b) Understand that the type of uranium deposit will dictate the type of operation put into place to mine and process the uranium ore to produce uranium concentrate;
- (c) See that each type of mining and milling operation will have a different kind of infrastructure associated with it and will also have different potential implications to human health and the environment.

Lecture 3: Radiation and radiation protection

Objectives:

This presentation provides an overview of basic concepts related with ionizing radiation and radiation protection, which serve as a basis for understanding the safety elements to be taken into account when deciding on, planning and carrying out a remediation project, in particular for the case of uranium mining and milling sites remediation.

At the end of the lecture, the participants should:

- (a) Understand the basic concepts related with ionizing radiation: radioactive decay, ionization, main types of ionizing radiation, activity, half-life;
- (b) Be aware of the harmful effects of ionizing radiation on humans and biota;
- (c) Be familiar with the magnitudes used for quantifying the effects of ionizing radiation on humans;

- (d) Explain the basic elements to be considered when protecting people and the environment from ionizing radiation.

Lecture 4: Exposure situations from the mining and milling lifecycle

Objectives:

The presentation gives an overview of different exposure situations that can take place during and as result of uranium mining and milling activities.

At the end of the lecture, the participants should:

- (a) Refresh the general concept of exposure situations according to IAEA standards, enumerating and differentiating them;
- (b) Identify different exposure scenarios that can occur during and as result of uranium mining and milling activities and classify them according to the general classification of exposure situations;
- (c) Be aware of the main exposure pathways that can affect both workers and the public for each identified exposure scenario.

Lecture 5: Lifecycle and Graded Approach to Regulation and Safety

Objectives:

This lecture provides the basic information on the lifecycle of uranium mining and milling activities, in particular with respect to remediation of legacy sites. It also includes information on the implementation of a graded approach to regulation and safety of legacy sites. It is expected that the information provided in the lecture will assist in the participants' understanding of the objective of this project, i.e. to learn about Review of Remediation Plans and Activities for Uranium Mining and Milling Sites.

Upon completion of this lecture, the participants will:

- (a) Have an understanding of the lifecycle of uranium mining, in particular with respect to remediation activities at legacy sites;
- (b) Have an understanding of the importance of implementing a graded approach to regulation of legacy sites and the remediation activities;
- (c) Have an understanding of the safety issues during remediation and the graded approach of implementation of safety measures.

Lecture 6: Roles and Responsibilities

Objectives:

Lecture 6 describes the roles and responsibilities of government entities, including the relevant regulatory agencies; the operator (in the case of legacy sites, there is unlikely to be an operator), and any other parties to the remediation.

This lecture will discuss the roles and responsibilities of the regulators, and regulatory requirements as defined by the state/country laws.

- (a) What are the respective roles of these groups?
- (b) How do the government, the various regulatory agencies that may be involved, and the operator (or party conducting the remediation activities) fulfil their responsibilities?

Lecture 7: Interim Measures for Legacy Sites

Objectives

The objective of this lecture is to provide an overview of the simple intervention techniques that can be used to reduce public exposure to ionising radiation from uranium legacy sites.

Lecture Topics

The lecture covers the following topic areas:

- Introduction to Uranium Legacy Sites
- Definition of Remediation and Mitigation
- Overview of Risks to the Public Arising from Legacy Uranium Sites
- Potential Public Exposure Pathways to Radiation from Legacy Sites
- Simple Non-Physical Actions to Reduce Public Doses
- Physical Remediation Strategies for Contaminated Materials
- Covering and Containment of Radioactive Materials
- Methods of Sealing Open Mine Workings
- Methods of Moving Solid Materials
- Removing Contaminated Materials from the Legacy Site

Lecture 8: Overview of environmental remediation process

Objectives:

This presentation covers three separate but interrelated subjects, namely; overview of the environmental remediation process, regulatory requirements and remediation objectives and criteria. An explanation is provided about the importance of environmental remediation and the different ways it can be approached. The discussions on the regulatory requirements set out the importance of having a national policy and legal framework as well as the regulatory process itself. The importance of setting early and transparent remediation criteria and objectives are highlighted as important to finding a balance between the level of remediation and the next intended use of the site.

At the end of the lecture, the participants should:

- (a) Gain a good overview of the environmental remediation process;
- (b) Understand the regulatory requirements in relation to the remediation of uranium mining regions, and
- (a) Gain an understanding of the types of remediation objectives and criteria that need to be set and achieved in order to adequately protect human health and the environment.

Lecture 9: Site characterization

Objectives:

This presentation is aimed at explaining why site characterization data is required to underpin a remediation scheme. It will highlight that in many instances a large amount of data will already exist which will then be supplemented if necessary through the acquisition of new data. The use of a conceptual site model concept allows the potential sources, pathways and receptors to be identified in a manner that allows a suitable site characterization to be designed. Some of the approaches to site characterization will be explained as will the importance of eventually managing and visualizing all of the available data.

At the end of the lecture, the participants should:

- (a) Understand the relevance of the site characterization process;
- (b) Be able to construct a conceptual site model and clearly identify sources, pathways and receptors;
- (c) Understand the type of data that is required to underpin a remediation approach and design;
- (d) Gain an understanding of the areas within a site and the types of media that are likely to be contaminated;
- (e) Gain an overview of the various approaches to site characterization, and
- (f) Comprehend the importance of managing all available data sets.

Lecture 10: Stakeholder engagement and risk communication

Objectives:

This presentation will define what is meant by the term stakeholder and provide an explanation as to why stakeholder engagement is now so necessary, irrespective of the country a remediation project with a human health or environmental implication may be located in. Some of the mechanisms for engagement will be explored as will some of the mechanisms which will increase the likelihood of success of any formulated stakeholder engagement programme. An important point to note is that people are generally concerned more about radiation and radioactivity than contamination from other sources. This concern is often brought about as a consequence of a lack of knowledge and understanding of the subject area so allaying these concerns is important. In addition to allaying people's concerns it is important to talk about risk and how risk can be explained better and then communicated.

At the end of the lecture, the participants should:

- (a) Understand the importance and relevance of engaging with stakeholders;
- (b) Understand more about the concerns and aspirations of stakeholders;
- (c) Be able to identify key stakeholders;
- (d) Have learnt about the different approaches that can be taken to keep people informed about projects, and
- (e) Consider how terms like "risk" and "contamination" need to be better explained.

Lecture 11: Environmental Impact Assessment. Dose and Risk Assessment

Objectives:

The purpose of this lecture is to provide an overview of the EIA and EIS process and requirements for remediation of legacy sites. Given the importance of the EIA and EIS in determining the future safety of the site and in mitigating future impacts the lecture provides significant detail in terms of the scope of the studies and the supporting documents. The lecture also deals with dose and risk assessment for workers and the public that are involved in remediation activities, as well as a description of remediation hazards.

Upon completion of this lecture, the participants will:

- (a) Understand the role of EIA in the decision making process for remediation;
- (b) Be able to describe the contents of an EIA;
- (c) Be able to describe the exposure pathways to the public from the radiological and other contaminants in the legacy sites;
- (d) Have an understanding of the ways to assess the doses and risks associated with the remediation.

Lecture 12: Management and disposal of wastes

Objectives:

This presentation provides the basic information on different waste materials that need to be managed, what factors to consider in waste disposal, key design criteria and the different options available for disposal. It is expected that the information provided in the lecture will assist in the participants' understanding of what is involved in choosing an alternative for waste disposal.

Upon completion of this lecture, the participants will understand:

- a) The basic design principles for protecting human health and the environment
- b) Long-term solutions need to be found for waste with radionuclides
- c) Goal to permanently isolate wastes from people and the environment

- d) How to avoid creating more waste

Lecture 13: Site Remediation Plan

Objectives:

This presentation provides the basic information on contents of a remediation plan, site characterization, the complexity of cleaning up a large site, importance of determining background concentrations to establish cleanup levels, elements of a cleanup strategy, and how physical and non-radiological hazards may present a greater risk to workers and the public than the radiological hazards.

Upon completion of this lecture, the participants will understand:

- (a) Key elements of a remediation plan
- (b) Extent of site characterization and importance in determining background concentrations
- (c) Different remediation strategies and associated tasks
- (d) Examples of standards set by other countries
- (e) Non-radiological hazards

Lecture 14: Geotechnical Engineering

Objectives:

This presentation provides the basic information on long-term care and surveillance of disposal cells and underground storage facilities containing radioactive waste. It is expected that the information provided in the lecture will assist in the participants' understanding of what is involved in critical design aspects of disposal cells to withstand seismic, erosion, and other forces.

Upon completion of this lecture, the participants will:

- a) Understand the basic geotechnical principles of designing impoundments to store uranium mill tailings, waste rock, and other waste.
- b) Obtain general knowledge through field investigations and geotechnical information learned both in the field and in laboratory testing programs.

Lecture 15: Unique considerations for exploratory drilling, ISL facilities and heap leach

Objectives:

This presentation provides the participants with a reminder of the remediation required for uranium exploration sites and also introduces the specific requirements for remediation of heap leach and in-situ leach operations.

Upon completion of this lecture, the participants will:

- a) Be able to describe the remediation measures required for an exploration site,
- b) Be able to describe the specifics of remediation necessary for a uranium heap leach and in-situ leach operation,
- c) Be able to locate any required additional information, especially practical examples, in the references provided.

Lecture 16: Protection of Water Resources

Objectives:

This lecture provides the basic information on protection of water resources when contemplating the development or remediation of a uranium mine or mill. It is expected that the information provided in the lecture will assist in the course participants' understanding of other lectures dealing with environmental protection.

Upon completion of this lecture, the course participants will:

- a) Understand the concept of acid rock drainage (ARD) and the long term danger it poses to the environment, particularly water resources,
- b) Understand the importance of a robust liner and leach detection system as part of the mill tailings management system,
- c) Be familiar with some of the concepts in planning a future mine or mill to prevent these impacts to water quality,
- d) Be familiar with some of the techniques currently in use to remediate uranium mining and milling sites which were not designed at the outset to prevent contaminants from reaching the ground and surface waters, and
- e) Be aware of monitoring techniques necessary to detect and define the degree of environmental impact and respond accordingly.

Lecture 17: Overview of the surface water and erosion protection (water treatment, sludge, disposal of other waste)

Objectives:

This lecture provides the basic understanding of the factors that must be considered when evaluating and developing an adequate overall plan to protect surface waters and to provide adequate erosion protection at uranium mines and mills. If properly planned and implemented, it can effectively provide protection through the entire lifecycle of the uranium mining and milling operation. The radioactive waste from uranium mining and milling includes radionuclides with very long half-lives that will require careful consideration of the long-term site conditions and the reclamation options in order to provide reasonable assurance that the integrity of the containment design will function as required over such long time periods.

Upon completion of this lecture, the participants will be able to:

- (a) Understand the importance of ensuring the principles of uranium mine and mill waste management to incorporate with IAEA's fundamental safety standards.
- (b) Understand the health and environmental impacts associated with uranium mine and mill facilities and be able to describe various remediation options available to provide long-term protection of water resources and reclaimed areas.
- (c) Understand the complexities of a mine or mill site, the uniqueness of waste streams that can be encountered at individual sites, and be able to describe methods for identified and addressing potential impacts to water resources and final covers.
- (d) Understand the consequences from failing to manage impacts on water resources (surface and groundwater) in an acceptable manner, on both a local and a regional scale.
- (e) Understand the importance that detailed planning plays in the successful closeout of a tailings impoundment/pile, and the protection of the environment.
- (f) Have a comprehensive understanding of the hazards associated with mine and mill sites and be able to describe methods for controlling such hazards.
- (g) Be able to locate any required additional information in the references provided.

Lecture 18: Radiation Protection. Remediation and Abatement of Radiation Hazards

Objectives:

This lecture provides the basic information on the radiation protection aspects during remediation, in particular the abatement of hazards, caused by the remediation activities. It is expected that the information provided in the lecture will assist in the participants' understanding of the objective of this project, i.e. to learn about Review of Remediation Plans and Activities for Uranium Mining and Milling Sites.

Upon completion of this lecture, the participants will:

- (a) Understand the hazards that are related to the remedial activities;
- (b) Be able to describe the general contents of a health and safety plan;
- (c) Understand the implementation issues regarding a H&S plan;
- (d) Understand the protection measures during remediation.

Lecture 19: Monitoring during remediation and post-remediation monitoring and control

Objectives:

This lecture provides basic elements of design, logistics and implementation of environmental monitoring programs required to be carried out in support of remediation activities and post remediation stage of remediated territories or scenarios.

At the end of the lecture, the participants should be able to:

- (a) Enumerate the objectives of monitoring programs carried out during the remediation process;
- (b) Explain the main features of different types of monitoring programs to be implemented in the different stages of the remediation process, as well as their specific objectives;
- (c) Describe the basics of the data quality objectives (DQO) methodology for designing a monitoring program;
- (d) Enumerate the sampling alternatives that can be considered when designing a monitoring and describe them briefly;
- (e) Explain the method of classification of areas as a tool for aiding in the design of monitoring programs;
- (f) Describe the survey and techniques alternatives that can be implemented in monitoring remediation scenarios;
- (g) Describe the elements that should be present in any monitoring plan and monitoring report;
- (h) Explain the objectives of post remediation monitoring programs, their scope and main features.

Lecture 20: Institutional Control and Surveillance

Objectives:

This presentation provides the basic information on institutional control and surveillance of disposal cells or underground storage facilities containing radioactive waste. It is expected that the information provided in the lecture will assist in the participants' understanding of what is involved in long term planning and inspections.

Upon completion of this lecture, the participants will be able to:

- (a) Identify the goals of institutional control and surveillance;
- (b) Prepare the contents of a institutional control and surveillance plan;
- (c) Understand what is involved with a site inspection;
- (d) Know how to respond to repair situations and emergencies.

Lecture 21: Financial Plan for Remediation Activities

Objectives:

This lecture provides the basic understanding of the factors that must be considered when evaluating the adequacy of financial assurance to cover costs associated with the decontamination, decommissioning, and reclamation of sites, structures, and equipment used in conjunction with uranium mining and milling. It is expected that the information provided in the lecture will assist in the participants' understanding of other lectures of the Module dealing mining and milling of uranium ores.

Upon completion of this lecture, the participants will:

- (a) Be able to identify and prioritize the steps for developing a mine and mill remediation and financial plan.

- (b) Be able to describe the site-specific factors affecting the environmental impacts and the cost of decommissioning of a uranium mining and milling operation.
- (c) Be able to list facility decommissioning elements that must be covered by financial assurance.
- (d) Have an understanding of different reclamation methods and their costs.
- (e) Be able to strategically assess the priorities of remediation to optimize available financial resources.
- (f) Be able to locate any required additional information in the references provided.

Lecture 22: Regulatory Oversight of Remediation: Authorization and Inspection

Objectives:

This presentation describes how the regulatory body will authorize the remediation activities, and then follow that up with their inspection and verification process. This lecture will connect with the roles and responsibilities of the regulators, and their regulatory requirements as defined by the state/country laws.

At the end of the lecture, the participants should understand:

- (a) How their regulatory requirements have been addressed in their authorization or approvals for the remediation activities; and
- (b) How their regulatory inspections will verify if the safety requirements and conditions for authorization have been met, and what their inspector roles would involve.

Lecture 23: Regulatory checklist for reviewing remediation plans

Objectives:

This presentation is aimed at showing that the production of a regulatory checklist can provide a formal way of ensuring that each expected component of the remediation plan has been highlighted to an operator well in advance of the remediation work taking place. The checklist allows the regulator to map out and then confirm that all of the expected components are being undertaken and it allows the operator to incorporate all of these highlighted components into their project and communication plan. It should be recognised that the list, while comprehensive, needs to be project and country specific.

At the end of the lecture, the participants should:

- (a) Gain an understanding about what a regulatory checklist is and what it is comprised of;
- (b) Understand the importance of compiling and working to a formal regulatory checklist;
- (c) Recognize the importance of early communication between site operator and regulator, and
- (d) Understand how such a checklist not only assists the regulator to carry out its activities but also enables other parties to understand in advance regulatory expectations.

Lecture 24: Prevention of future legacy sites

Objectives:

This presentation is aimed at highlighting the importance of preventing future legacy sites. Many legacy sites exist today and are often extremely difficult to manage and remediate because the tailings and rock piles were not adequately engineered or remediated in the past with a long term vision in mind. Nowadays these sites often have no owner, little funding and reside in countries which may not have a well-developed regulatory and statutory regime. The lecture highlights many of the approaches that can be taken throughout the mining lifecycle, which should go some way to prevent a site eventually becoming a legacy site that future generations need to resolve.

At the end of the lecture, the participants should:

- (a) Understand why legacy sites exist and the importance of preventing future sites of this nature;
- (b) Learn that the main concern around legacy sites will revolve around contaminated groundwater, tailings and rock piles;

- (c) Learn about the concept of Lifecycle Management and why its implementation can help prevent future legacy situations, and
- (d) Gain an understanding of the different measures that can be taken during the mining lifecycle, which will help reduce the chances of future legacy sites being created.

4. EXAMPLE COURSE SCHEDULES

This final chapter presents suggested schedules for the one-week training workshop, in Table 1 on the following page.

The lecture and exercise durations have usually been set at certain number of minutes generally reflecting the number of slides and information to be presented but also having regard to the difficulty of the subject. It is expected that individual lectures will deviate from these preset durations so that some sessions may be shorter or longer than shown in the schedules, depending on the character of the course (National or Regional) and on the prior knowledge of subject matter by the participants. This, combined with the proposed discussion sessions and class exercises, should provide, over the course of a day, adequate time to cover all the material and to have fruitful discussions.

It is extremely important that the lecturers should aim to stimulate debate and discussion amongst the participants and the course includes discussion sessions and question-and-answer sessions for this purpose. The test questions that are listed at the end of each lecture description in this syllabus may form the basis of these sessions. Alternatively, lecturers may wish to develop their own sets of questions or allow discussions to take their own course.

The table on the following page is to be amended, dependent on the specific needs of the participants.

DRAFT AGENDA FOR A ONE WEEK TRAINING WORKSHOP

Project B.2 Review of Remediation Plans and Activities for Uranium Mining and Milling Sites

	Monday	Tuesday	Wednesday	Thursday	Friday
08.30-9.30	Opening statements (IAEA & MS representatives) House Keeping	Interim Measures for Legacy Sites (L-7)	Management and disposal of Waste (L-12)	Institutional control and surveillance (L-20)	Case studies to be reviewed by the participants in groups
	Round table introductions (everyone)				
	Workshop overview and introduction (L-1)				
9.30-10.30	Types of mining and milling sites (L-2)	Overview of the environmental remediation process. Regulatory requirements. Remediation objectives and criteria (L-8)	Site Remediation Plan (L-13)	Financial plan for remediation activities (L-21)	<i>Exam</i>
	Radiation and radiation protection (L-3)				
10.30-10.45	Break				
10.45-11.45	Exposure situations from the mining and milling lifecycle (L-4)	Site Characterization (including non-radiological) (L-9)	Geotechnical Engineering (L-14)	Regulatory oversight of remediation. Authorization and, inspection (L-22)	Presentation and discussion in plenary of the review results by groups
			Unique considerations for exploratory drilling, ISL facilities and heap leach (L-15)		
11.45-12.45	Lifecycle and graded approach to regulation and safety (L-5)	Stakeholder engagement and risk communication (L-10)	Protection of water resources (L-16)	Regulatory checklist for review of remediation plans (L-23)	Closure/critique of the workshop
12.45-14.00	Lunch break				
14.00-15.00	Roles and Responsibilities (L-6)	Exercise 1 CSM	Surface water and erosion protection (water treatment, sludge, disposal of other waste) (L-17)	Prevention of future legacy sites (L-24)	
15.00-16.00	Country presentations	Exercise 1 CSM	Radiation protection. Remediation and abatement of radiation hazards (L-18)	Exercise 2 Regulatory checklist for review of remediation plans	
16.00-16.15	Break				
16.15-17.15	Continuation If time permits, insert an exercise	Environmental Impact Assessment. Dose and Risk Assessment (L-11)	Monitoring during remediation and post-remediation monitoring and control (L-19)	Exercise 2 Regulatory checklist for review of remediation plans	

Additional comments:

- Presenters would preferably be experts with both regulatory and hands on field experience
- MS reports: IAEA would provide a template for the presentations
- Develop Excel spreadsheets for calculations and for pre- and post-course questionnaires
- Participants should bring laptops
- Exam course evaluation: A short multiple choice (20-30 questions) would be of use to focus the attention of the participants during the course.