Remediation of Land Contaminated by Radioactive Material Residues

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REMEDIATION OF LAND CONTAMINATED BY RADIOACTIVE MATERIAL RESIDUES

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PROCEEDINGS SERIES

REMEDIATION OF LAND CONTAMINATED BY RADIOACTIVE MATERIAL RESIDUES

SUMMARY OF AN INTERNATIONAL CONFERENCE ORGANIZED BY THE INTERNATIONAL ATOMIC ENERGY AGENCY, HOSTED BY THE GOVERNMENT OF KAZAKHSTAN AND HELD IN ASTANA, 18–22 MAY 2009

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2014

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Marketing and Sales Unit, Publishing Section
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PO Box 100
1400 Vienna, Austria
fax: +43 1 2600 29302
tel.: +43 1 2600 22417
email: sales.publications@iaea.org
http://www.iaea.org/books

Printed by the IAEA in Austria
August 2014
STI/PUB/1612

IAEA Library Cataloguing in Publication Data

Remediation of land contaminated by radioactive material residues : summary of an International Conference on the Remediation of Land Affected by Radioactive Residues organized by the International Atomic Energy Agency, hosted by the Government of Kazakhstan and held in Astana, 18-22 May 2009. — Vienna : International Atomic Energy Agency, 2014.
p. ; 24 cm. — (Proceedings series, ISSN 0074–1884)
STI/PUB/1612
ISBN 978–92–0–142310–8
Includes bibliographical references.

1. Uranium mines and mining — Environmental aspects — Congresses. 2. Radioactive substances — Environmental aspects. 3. In situ remediation — Congresses. I. International Atomic Energy Agency. II. Series: Proceedings series (International Atomic Energy Agency).

IAEAL 14–00895

FOREWORD

In past decades, when supplies of uranium were urgently needed for nuclear weapons production and for nuclear energy generation, the emphasis of the industry was on production, often at the expense of the environment from which the uranium ore was taken. The uranium mining activities of this era have left a legacy of tailings piles and polluted land and water courses in many countries of the world. The need to restore the contaminated areas is now recognized and remediation programmes are under way in many countries.

Some uranium mining took place in countries which had no other nuclear or radiation related practices and, as a result, have little or no expertise to manage remediation. Furthermore, these countries tend to have only modest resources and so finding funds to remediate uranium legacy sites is often difficult. These problems have been recognized by the international community and efforts to assist countries in resolving them have been made in recent years.

Against this background, the IAEA decided to organize an international conference on the Remediation of Land Contaminated by Radioactive Material Residues with the purpose of reviewing global progress in remediating areas contaminated by radioactive materials — with special emphasis on areas affected by former uranium mining and milling activities. The conference was held in Astana, Kazakhstan, from 11 to 22 May 2009.

This was the second conference organized by the IAEA on this subject. The first was held in 1999 in Arlington, Virginia, United States of America, and was entitled 'Restoration of Environments with Radioactive Residues'. The Arlington conference focused mainly on the cleanup of nuclear weapons test sites and areas affected by nuclear accidents. In contrast, the Astana conference concentrated on legacy sites from uranium mining and milling activities.

The Astana conference was organized in eight sessions: From Arlington to Astana — Lessons Learned; International Cooperation and Support in Environmental Remediation; Complying with Safety Criteria; Innovative Technologies and Environmental Remediation; Life Cycle Planning and Stakeholder Issues in Environmental Restoration; Case Studies (2 sessions); and Expediting and Enhancing Experience Exchange in Enviromental Remediation. This publication, which constitutes the record of the conference, includes the opening address, the summaries of the individual sessions and the conference president's summary. The invited papers are available on the CD-ROM in the back of this book.

The IAEA gratefully acknowledges the support and generous hospitality of the Government of Kazakhstan in hosting this conference. The IAEA officers responsible for this publication were R. Edge of the Division of Radiation, Transport and Waste Safety and H. Monken-Fernandes of the Division of Nuclear Fuel Cycle and Waste Technology.

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CONTENTS

CONFERENCE SUMMARY

This conference was concerned with the progress being made globally in the remediation of land areas contaminated by radioactive material residues. This was the second conference organized by the International Atomic Energy Agency on this subject. The first was held in 1999 in Arlington, Virginia, in the United States of America and was entitled 'Restoration of Environments with Radioactive Residues'. The Arlington conference was focused mainly on the cleanup of nuclear weapons test sites and areas affected by nuclear accidents. In contrast, the Astana conference was concentrated on legacy sites from uranium mining and milling activities.

Uranium mining legacy sites exist in many countries and result mainly from mining activities in the period 1950–1990 when uranium was being sought globally for nuclear weapons and for nuclear energy generation. Some of the countries affected are among the poorest of nations. The problems that these countries have in remediating their legacy sites stem mainly from the lack of available economic and human resources. The uranium mining site remediation issue has emerged strongly in recent years since the end of the Cold War. In response, the international organizations have begun to provide support to the countries concerned in addressing the problems, especially to the countries of Central Asia. It was mainly for this reason that the conference was held in Astana, the capital city of Kazakhstan.

The conference was designed to cover all relevant aspects related to environmental remediation including: regulatory and safety regimes, innovative and mature technologies, life cycle planning, technical experience exchange, and issues regarding interested parties and international cooperation and support. A series of case study presentations was organized to provide the participants with an overview of environmental remediation activities in different parts of the world. A special session addressed environmental remediation in Central Asian countries (Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan) where many legacy sites were created without proper consideration of the associated environmental impacts.

Unlike most other areas of radiation protection, there is not a global consensus on radiological principles and criteria for the remediation of areas affected by radioactive contamination. This was shown at the Arlington conference, where a wide variation in the radiological criteria being used as the basis for decisions on the cleanup of contaminated areas was demonstrated. Most of the concern at Arlington was with artificial radionuclides. In the context of the present conference, it is relevant to consider whether the criteria ought to be the same when the contamination is caused by naturally occurring radioactive material. Guidance on radiological criteria for remediation has been given by the

international organizations but it is by no means universally accepted, especially by persons living in the affected areas. Despite the fact that, in many situations, such as the areas affected by the Chernobyl release, the exposures to radiation are low, and are below the levels of acceptability recommended by national and international organizations, the population living in these areas remain unconvinced.

In some of the countries in which uranium has been mined, the regulatory infrastructure is weak and is not yet capable of ensuring that tailings remediation operations are conducted safely. Efforts are being made to correct this situation by the transfer of experience and expertise from industrialized countries. The progress of this work, which involves national and international organizations, was reported at the conference.

It is clear that many of the environmental problems that have resulted from the mining and milling of uranium could have been avoided with proper planning during the uranium extraction phase. Nowadays, life cycle planning is being emphasized as a strategy for avoiding the generation of future legacy sites. Life cycle planning means considering the potential environmental and other impacts at all stages in the life of a facility, for example design, construction, operation, closure and decommissioning, and planning to avoid them. A session focusing on this strategy was an important element of the conference.

A major aim of the conference organizers was to promote the transfer of remediation technology from countries which already have considerable experience in addressing the problem to countries which are relative newcomers to the subject. It was also intended to provide countries having similar problems with an opportunity to exchange information. Special sessions of case studies were included for this purpose. The aims of these information transfer sessions are similar to those of an IAEA networking initiative called ENVIRONET whose objectives are to provide coordinated support, to organize training and demonstration events, and to foster information exchange by establishing a forum for discussion in different areas. The final structure of ENVIRONET is still being developed but the programme was formally announced at the General Conference of the IAEA in October 2009.

Remediation activities often affect local populations by requiring them to change their habits and lifestyles or even to be relocated. For these reasons, the concerned public must be part of the decision making process and formal arrangements must be established to enable this to happen. In recognition of the importance of this topic, often termed ‘stakeholder involvement’, it was specifically addressed in one of the conference sessions.

The problems associated with the uranium mining legacy sites in the countries in Central Asia are well known and many international organizations are interested in providing assistance to the countries concerned. However, to date,

the coordination between them has been less than optimal and this conference led to an agreement among the participating international organizations that a mechanism to facilitate coordination is desirable. The organizations concerned include the European Commission, the International Science and Technology Center (ISTC), the European Bank for Research and Development (EBRD), the North Atlantic Treaty Organization (NATO), the Organization for Security and Cooperation in Europe (OSCE), the World Bank, the World Health Organization (WHO) and the IAEA. In this context, it was suggested that the mechanism used by the IAEA for coordinating international and bilateral cooperation in the northern Russian Federation (the Contact Expert Group (CEG)) could be used as a model for coordinating international cooperation in Central Asia.

In summary, the environmental contamination of land with radionuclides is a problem in many countries. The policies and regulatory strategies for managing the remediation of affected areas have not yet been globally harmonized although there is considerable international experience with remediation technology. Some of the concerned countries have insufficient resources and expertise to properly manage the remediation required to render the affected areas fit for human use and occupancy. Efforts in the future will therefore ideally be focused on unifying regulatory policies and strategies, promoting the transfer of knowledge and, where necessary, supporting countries in their efforts to remediate their land.

In the third session, the progress of the relevant international organizations in developing recommendations and guidance to ensure the safety of remediation was summarized and, in addition, the international operators' organization, the World Nuclear Association, presented its safety code of practice for industry. The development of regulatory frameworks in the Russian Federation and in the United States of America (USA) were described, as well as a Norwegian-led initiative to improve regulatory supervision in the countries of Central Asia. The discussion in this session led to a recognition of the need for coordination among regulatory authorities and it was suggested that an international forum for the regulatory supervision of legacy sites would ideally be created.

Different technologies for the remediation of sites were discussed in Session 4. It was shown that local conditions have to be well understood in order to design appropriate cover systems for uranium tailings piles. Bioremediation techniques are still at the developmental stage but it was demonstrated that this is a particularly attractive solution for situations where the groundwater reservoir is deep and difficult to access. 'Natural monitored attenuation' is an approach in which the attenuation of the migration of the contaminant by natural processes is utilized. In many cases, if a sufficiently good understanding of the location and movement of the contaminant plume can be obtained, no further remedial measures may be needed. This approach seems to be gaining support in the USA

from the cost perspective; it is an alternative to treating large volumes of water for long periods of time.

Electrical vitrification of contaminated soil to produce a solid matrix has been applied at various sites around the world. Its main advantage is that it creates a waste form that isolates the radionuclide or metal contaminants and prevents leaching by water. Because of this, it avoids the long term monitoring that other waste storage options require. Mathematical modelling is an essential tool for the design and performance assessment of remediation solutions. Most models use the K_d approach but since this approach does not really represent the processes taking place in the environment, it must be used with caution. Instead, it was recommended that reactive transport models be used whenever the necessary data can be obtained.

Along the same lines, the planning approach used by the US Department of Energy (DOE) to manage environmental remediation projects was presented. It was pointed out that the regulator must be involved in the overall management programme as well as interested parties.

In relation to the session (Session 6) devoted to the Central Asian countries (Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan) it was evident that these countries share common problems, such as similar histories and geographical locations for the tailings sites, a lack of funds to deal with remediation, a lack of local expertise and equipment and, as a result, inadequately characterized sites. Furthermore, the radiological conditions of people living near to the sites may not be known. Each country has particular conditions that have caused the situation to worsen. In some areas, precipitation has caused an increase in erosion, landslides have caused significant changes in previously stable storage sites and residues have been used as building material in homes and public buildings such as schools. If solutions are not implemented in a timely manner, the possibility exists that contamination from one country could cross national borders and cause contaminated areas in surrounding countries.

So far, only preliminary studies have been conducted at the Central Asian legacy sites. It was concluded that near term actions for all of these sites would ideally involve: measurement and assessment studies in order to gain an understanding of the radiological situation at each site; the identification of alternative water supplies if groundwater has been contaminated; the maintenance of institutional controls at the sites; routine monitoring to ensure controls are performing their intended functions; and finally, the enhancement of public awareness of the local situation.

It was stressed that decisions on intervention at these sites must be the result of a comprehensive risk assessment, and decision making based solely on the perceived risk must be resisted. It was noted in one study that risk assessment studies would ideally take account of *all* the risks present, not just those due to

radionuclides. It is often the case that other pollutants are present together with radionuclides; they are typically heavy metals and chemicals.

More case studies were discussed in Session 7. In some countries, environmental remediation works cannot be easily implemented by local technical workers, and international assistance is essential. However, working in different juridical, social and political environments has proved to be difficult. As a result, local capacity building is of utmost importance and this is an essential role to be played by the relevant international organizations.

The involvement of interested parties in the context of environmental remediation emerged as one of the most important themes discussed during the conference. Many presentations highlighted the importance of the effective involvement of interested parties in reaching solutions which satisfy all parties.

OPENING ADDRESS

H. Forsstroem
International Atomic Energy Agency

Your Excellency, Mr. Minister, Mr. Mayor, on behalf of all of us I would like to thank you very much for the warm welcome that we have received coming to Astana this week and for the excellent preparations for this international conference.

Ladies and gentlemen, dear colleagues, we have come to Astana to discuss the challenges involved in the remediation of lands affected by radioactive residues, which is an international problem. In the past, many industries, such as the uranium mining industry, were often developed without deep consideration of environmental issues in the overall planning and implementation of their operations.

Many of these industries operated in an environment that did not have appropriate or effective environmental laws and regulations. As a result, many contaminated sites have been created. Other nuclear activities, for example defence programmes and the Cold War legacy, as well as nuclear and radiological accidents, such as Chernobyl and Goiânia, also created important legacy sites.

Such sites can lead to undesired health effects for members of the public and harm to the environment. The objective of environmental remediation is to mitigate the radiation exposure from existing areas of contaminated land to reduce exposures now and in the future. The main goal is, if possible, to release the land for unrestricted use, which means total removal from regulatory control.

However, there are situations in which the removal from regulatory control cannot be practically achieved. In these cases, once the cause of unacceptable risks to humans and the environment is removed, restrictions on access and use of the area must be established and long term stewardship schemes put in place. It is important to remember that remediation can be done not only by removing the contamination itself but also through other actions that prevent the contamination from influencing human and non-human biota.

From the perspective of radiation safety, two main principles govern the decision making for any remediation programme. Firstly, justification: the implementation of the remediation programme shall produce more good than harm; and secondly optimization: working to ensure that the residual doses will be as low as reasonably achievable, social and economic factors taken into account. Therefore, when selecting an optimized remediation option, a wide variety of factors need to be considered.

The need to address radiological liabilities has been increasingly recognized since the end of the Cold War. However, in many Member States, remediation programmes have made little progress beyond the assessment or planning stages. One reason for this is that the costs of remediating contaminated sites can be very high and, in many cases, these costs cannot easily be met, even by the State. Just to give you an example of the costs involved on environmental remediation projects, in the USA more than $5 billion are spent per year on activities related to environmental remediation.

In many cases, remediation might require that resources have to be diverted from other priority actions in order to improve the environmental conditions of a particular site or region. It is thus critical to develop remediation projects together with all interested parties and, in particular, with the local communities.

Today, with increasing activity in uranium production, the challenge for the international community is to avoid new legacy sites being created. This can be achieved through the development of sustainable good practices and stewardship principles throughout the global uranium production industry. There is a need for active promotion of the concept of life cycle planning at the early stages. This is valid for all projects — be they remediation of legacy sites, establishment of new developments, such as uranium mines, or redevelopment of legacy sites for renewed production of radioactive minerals. In this context, the development of a widespread safety culture and the building of relevant safety infrastructures and competences are key factors.

The present situation in the Central Asian countries is an illustrative example. One of the reasons that this conference is taking place in Kazakhstan is to highlight the need to find a viable and effective architecture to address the remediation of the existing legacy sites, which have resulted from the inappropriate development of several uranium mining and milling operations. The mining enterprises that extracted uranium and rare earth elements for over 50 years in Central Asia have left behind very large amounts of industrial waste, including radioactive residues.

Recent initiatives by the International Atomic Energy Agency concerning the former uranium mining and production activities in Central Asia include cooperation and communication with other international organizations. We expect that improved coordination among affected countries and international organizations will result in a regional initiative to tackle the health and environmental consequences of these legacies.

Meanwhile, the IAEA provides comprehensive assistance at both national and regional levels, with the aim of upgrading institutional capabilities. So far, the main focus of this assistance has been on upgrading regulatory control and expanding environmental monitoring and laboratory analysis capabilities in full

compliance with the IAEA Safety Standards. In the future, the emphasis will shift to helping States to fully implement environmental remediation programmes.

Another very important case of environmental remediation is concerned with the Chernobyl accident that took place in 1986. It resulted in a very large release of radionuclides to the environment. The Chernobyl Forum, which was an initiative grouping together the three affected countries and eight United Nations organizations, completed its tasks in 2005 and issued consensus reports on the health, environmental, social and economic consequences of the Chernobyl accident. The Forum also provided directions for future actions and, in particular, for the remediation of contaminated territories, the decommissioning of the Chernobyl nuclear power plant and the management of radioactive waste resulting from these operations. As a follow-up, the IAEA is carrying out a regional programme of technical cooperation on the remediation of agricultural land and it is supporting Ukraine in decommissioning planning and radioactive waste management.

As we all know, there have been other activities that resulted in the contamination of extensive areas. The former nuclear weapons testing programmes radioactively contaminated large territories in many places. Here, in Kazakhstan, there are still 16 000 km^2 where public use is restricted. The IAEA has provided an independent assessment of the radiological situation at some of these former test sites and is prepared to continue to support its Member States in assessing present and future radiological threats and in planning the remediation of these sites.

The IAEA has thus been working worldwide to assist Member States with their efforts to come to grips with the important task of remediating radioactively contaminated sites. Numerous activities are ongoing, primarily national and regional technical cooperation projects. However, the IAEA is not alone in working to alleviate this situation. Other agencies and organizations have also been working on these same issues. In recent times, there has been a major effort directed at Central Asia to bring all the players together to work with the affected nations to better coordinate and complement the many aspects of the existing programmes. This will culminate in a series of meetings later this year with the objective of producing a framework document that will bring all the issues together in one place so that a common approach can be taken to obtain the necessary funding for the remediation of these sites.

Let us remember, however, that environmental remediation programmes are constrained not only by the lack of financial resources. Technical and non-technical factors including appropriate programme management, socioeconomic issues and changing regulatory regimes have also contributed to the slow pace at which cleanup projects are being implemented. A lesson which has been learned is that strong involvement at government level is essential.

From the regulatory perspective, legal instruments applicable to cleanup requirements for groundwater and soil are evolving. It is necessary to keep track of these changes as new regulations or improved international standards may affect the selection of cleanup strategies and techniques. Legal requirements will determine the standards and levels of compliance to be achieved. Such standards need to take into account updated scientific evidence. The policies and regulatory frameworks are essential to provide assurance to members of the public that they are being adequately protected. This will be discussed in Session 3 of the conference.

Technologies must continuously evolve to bring solutions to existing problems in a cost effective way and to achieve compliance with regulatory standards. Some of the best established technologies can be ineffective in meeting modern regulatory standards. A close follow-up of the performance of innovative technologies is thus essential. But it also ought to be noted that remediation implementers are sometimes reluctant to promote innovative technologies on a commercial scale, partly owing to the risk that innovative technologies may fail to perform as predicted. Session 4 will provide some good illustrations of this.

Every remediation project is composed of separate tasks which are prioritized to assist in planning and to optimize the use of resources. These tasks will vary significantly in size and scope. It may, from time to time, be efficient to catch the less costly 'low hanging fruits' first in order to bring immediate relief to the most important problems, without affecting the long term objectives. It is important to ensure in the planning that 'the best will not become the enemy of the good'.

For these and other reasons, the involvement of different stakeholders in the decision making process has become more and more relevant. Stakeholders may include local communities, non-governmental organizations with national, regional or international outreach, regulatory authorities and other relevant authorities. Failing to obtain the complete involvement of interested parties in environmental remediation programmes will usually result in unnecessary delays and higher costs in project implementation. Session 5 will touch upon these aspects.

The scope of environmental remediation has recently increased dramatically. A series of study cases will be presented during Sessions 6 and 7 and in the Poster Session to give an overview of various environmental remediation programmes in different countries, representing different regions of the world. It is not only uranium mining, weapons testing and nuclear scientific applications that have given us contaminated sites. Some radiological problems may have arisen as a consequence of non-nuclear activities, for example as a result of the so called NORM (naturally occurring radioactive material) industries.

What is the role of the IAEA in all this? The key role of the IAEA is to assist Member States with the planning, development, implementation, maintenance and continuous improvement of programmes and activities. The IAEA provides support in the form of guidance documentation, technical advice and training. The guidance may be found in IAEA publications including Safety Standards and Safety Reports, Technical Reports and Technical Documents. The technical advice and training is mainly provided through technical cooperation programmes or bilateral assistance agreements. By taking full advantage of these opportunities, a Member State will ideally be able to avoid creating new legacy sites as well as to achieve a significant decrease in the costs associated with extensive and long lasting environmental remediation programmes.

The IAEA recognizes, however, that new mechanisms and means of experience exchange and information transfer must be put in place. For this reason the IAEA is establishing networks in different areas such as decommissioning, waste disposal and, specifically related to the scope of this conference, environmental remediation (the ENVIRONET will be presented during Session 8).

This conference creates a good opportunity to discuss the relevant issues relating to the environmental remediation of radioactively contaminated sites. It follows on from the environmental remediation conference that took place 10 years ago in Arlington, USA, and will allow discussion of the achievements, the successes, the failures and the lessons learned, as well as the new challenges that have emerged since that time.

The conference will also provide a forum for discussions on: financing mechanisms and support for the international or multilateral organization of environmental remediation programmes; regulatory and safety issues; mature and innovative technologies; life cycle planning; and non-technical issues in environmental remediation.

As a result, it is expected that the conference will encourage and assist the establishment of different partnerships, reveal synergies that can help in the full implementation of environmental remediation projects and provide a forum for improved coordination among the international organizations that support environmental remediation programmes, especially in this region.

Finally, the conference will allow the IAEA to collect ideas for its programme and for the assistance it gives to its Member States.

I wish you all a fruitful and rewarding conference with good and intensive discussions both here and in the coffee breaks.

SUMMARY OF TOPICAL SESSION 1:

FROM ARLINGTON TO ASTANA — LESSONS LEARNED

Chairperson:
H. Forsstroem
IAEA

The first session covered a review of the 1999 Arlington conference, a review of international policies and strategies for remediation, a new United Nations initiative on Chernobyl and a summary of remediation activities in Kazakhstan.

Ten years ago, the IAEA organized a conference entitled 'Restoration of Environments with Radioactive Residues' in Arlington, USA. This Astana conference is seen as a follow-up; however, there are many differences between the two conferences. The Arlington conference focused on the cleanup of nuclear weapons test sites and areas affected by nuclear accidents while this conference is concentrating on uranium mining and milling sites.

Also, at the time of the Arlington conference, there was quite a controversy surrounding the subject of radiological criteria for remediation and so it was an important topic at that conference. The concept of intervention had been introduced in international recommendations — and criteria had been developed to go with it. However, many countries continued to use criteria developed for normal operations for guiding remediation activities. In the USA, where the conference was being held, there was a separate ongoing controversy because of the different approaches to radiological protection being used by the regulatory agencies.

An important element in the Arlington conference was the analysis of a number of test cases covering different remediation situations. The analysis showed that there was a wide variation in the radiological criteria being used as the basis for decisions on cleanup. The criteria values at the lower end of the range were judged to be due to the influence of social and political factors influencing decision making — that is, the low dose values that were being used were not cost effective. The analysis also raised the question of whether the same criterion ought to be used in all types of contamination situation, whether a contamination situation is due to an accident or whether it is the result of a poorly controlled practice.

Other questions raised were whether the same criteria ought to be used for human-made and naturally occurring radiation, how will the public ideally be involved in decision making, and ought criteria for the cleanup of radioactive

and chemical contamination be harmonized? These issues were addressed in Session 1 of this conference.

The second presentation in Session 1 was a review of International Policies and Strategies for the Remediation of Land Contaminated by Radioactive Material Residues. It set out the roles of the international organizations UNSCEAR, ICRP and IAEA as, respectively, providing the basic scientific knowledge, the radiological interpretation of that knowledge and the development of international standards. The presentation drew attention to the problems caused by the technical language used in this area. In particular, the term 'contamination' is often used in a misleading way; for example, in the context of Chernobyl affected areas, it is used to describe land which, on the basis of the associated risks, is fit for habitation.

The presentation was concluded by noting that the international recommendations and standards have not yet provided a simple answer to the question "Is it safe for me and my family to live here?"

Chernobyl continues to cast a shadow over many countries and, in spite of the many studies and international reviews that show radiation doses to persons living in affected areas to be low, many people continue to be adversely affected in the aftermath of the accident. Unexplained physical conditions, anxiety and mental problems are much more frequent in Chernobyl affected populations and it has been concluded that psychological and social effects now represent the main impact. A new United Nations action plan will seek to resolve the situation by promoting knowledge and understanding in those affected and to relieve their poverty. The third presentation described the plan, organized by UNDP, WHO, IAEA and UNICEF, which will seek to do this by 'building a bridge between science and people'.

Another presentation described the legacy of past nuclear activities in Kazakhstan; it included the numerous areas affected by the uranium mining and milling activities, several areas affected by nuclear weapons testing activities, the shutdown fast breeder reactor at Aktau and the many disused sealed sources used in military and civilian activities.

— In the last ten years, Government remediation programmes for the uranium mining and milling sites have been effective and most sites have been cleaned up.
— At the nuclear test sites, the underground testing wells and mines have been destroyed but more remains to be done before the sites can be fully opened to the public.
— The spent fuel has been removed from the fast breeder reactor and a plan has been developed for transporting the packaged fuel for storage at Baikal on the Semipalatinsk Test Site.

— Disused sealed sources have been collected from all over Kazakhstan and are also being stored at the Baikal waste storage site.

Kazakhstan has had help in its remediation work through its cooperation with other countries and with the international organizations.

SUMMARY OF TOPICAL SESSION 2:

INTERNATIONAL COOPERATION AND SUPPORT IN ENVIRONMENTAL REMEDIATION

Chairperson:
S. Vorobiev
Russian Federation

From the presentations in Session 2, it is clear that a wide range of international organizations are well positioned to undertake work in the remediation of lands affected by radioactive contamination in Central Asia:

— The Organization for Security and Co-operation in Europe (OSCE) with a mandate for facilitating broader environmental rights and security and heightened regional profiles;
— The European Commission, previously through its TACIS programme and now through its Instrument for Nuclear Safety and Cooperation (INSC);
— The European Bank for Reconstruction and Development (EBRD) through its range of funds dedicated to radioactive damage prevention and remediation;
— The International Scientific Technology Center (ISTC) with its wide network of scientists, radioactive contamination database and research and development expertise;
— The North Atlantic Treaty Organization (NATO) through its active measurement and assessment projects in this area;
— The IAEA as an ideal forum for cooperation with tools for establishing safety standards, knowledge transfer, technical and regulatory capacity building;
— The World Health Organization (WHO), whose mandate includes radiation health matters;
— The United Nations Development Programme (UNDP), whose regional office in Central Asia has already initiated cooperation between regional actors.

Several issues permeated the presentations of the representatives of all of these organizations and of the ensuing discussion:

— The need for better coordination between international organizations (although all organizations expressed their eagerness to engage with one another and provide expertise);
— The importance of ownership and commitment by the national host government in its approach to radioactive waste management;
— The necessity of regional, transboundary approaches guided by 'master plans', or 'road maps';
— The integration of regulatory aspects into international radiological assistance projects;
— The need to consider the problem of environmental remediation from a multifaceted perspective, including not only direct health effects, but also lasting economic, social and psychological consequences;
— The best ways of measuring success. Are concrete, scientific measurements and indicators the only method or could broader criteria of social contentment also play a role?
— The urgency of finally moving from talk, surveys and assessments to concrete actions;
— The ability of the aforementioned organizations to bring together interested stakeholders.

Considering the discussions of the panel of speakers, these points will ideally form the basis for any new approach for assessing the effectiveness of aid being rendered to countries, for improving the quality and relevance of the aid and for strengthening the coordination of the organizations involved in radioactive waste remediation.

One possible scenario for cooperation, which could guide the international approach to remediation in Central Asia, is the Contact Expert Group (CEG), a model for coordination developed by the IAEA and used with much success in relation to the environmental problems in the north-west Russian Federation. A CEG for Central Asia would bring together all interested states, international organizations, donor organizations, non-governmental organizations and independent experts for working level meetings and annual plenary sessions. The purpose of the CEG would be to:

(a) Stimulate cooperation, coordination and co-funding of remediation activities;
(b) Share information on past, ongoing and planned activities in order to maximize effectiveness and avoid redundancy;

(c) Exchange information on best practices and experiences to avoid repeating historical mistakes;
(d) Provide a stable platform with permanent membership for the elaboration of joint projects;
(e) Outline what specifically needs to be funded and what regional solutions are available.

A high level political conference designed to generate awareness, political will and technical expertise in order to increase funding to support land remediation projects in Central Asia is planned. It was suggested that this conference would provide a good forum for discussing the idea of a Central Asian CEG model in the context of land remediation.

SUMMARY OF TOPICAL SESSION 3:

COMPLYING WITH SAFETY CRITERIA

Chairperson:
A.J. Gonzalez
Argentina

This session was mainly concerned with existing international and national safety standards for environmental remediation.

In the first presentation, the ongoing process to update the International Basic Safety Standards (BSS) was described. Particular emphasis was given to the incorporation of the new standards on environmental remediation (i.e. IAEA Safety Standards No. WS-R-3 of 2003) within the new BSS and the adaptation of the BSS to the new recommendations of the International Commission on Radiological Protection (ICRP) (Publication 103). In the new BSS, the remediation of land affected by radioactive residues will be considered an 'existing' exposure situation, following the new ICRP classification of 'planned', 'emergency' and 'existing' exposure situations. However, it was pointed out in discussion that remediation may be considered at the planning stage of some operations such as mining; in this case, it would be treated as a 'planned' exposure situation. Moreover, it was also pointed out that although remediation is usually necessary after an emergency, such a need would normally materialize in the aftermath of the emergency and the situation therefore may be considered a de facto existing exposure situation.

The second presentation was concerned with the regulatory framework for environmental remediation in the Russian Federation. There are many situations requiring environmental remediation in the Russian Federation; they include areas affected by nuclear accidents, those due to poorly controlled practices and those that are a legacy of past military activities. At the present time, there are no comprehensive regulatory instruments for dealing with existing exposure situations in the Russian Federation but the revision of the relevant regulatory documents is taking account of recent and ongoing international developments, including the recommendations in ICRP Publication 103 and the requirements of the new BSS.

The standards used by the United States Environmental Protection Agency for environmental remediation were the subject of the third presentation. These are the CERCLA or 'Superfund' regulations and apply to abandoned sites at which activities such as uranium mining and milling, thorium gas mantle production and nuclear weapons production were previously carried out. The regulations are

very detailed with specific numerical criteria for application to environmental materials, surfaces and aquatic media. The criteria are based on the associated risk of cancer — unlike those in international recommendations and standards that are used by other US Federal Agencies which are based on weighted radiation dose criteria. Because the criteria are different, ad hoc agreements have been reached between the US agencies to cover situations where their jurisdictions overlap.

In the fourth presentation, the new guidance from the World Nuclear Association on principles for the decommissioning and remediation of uranium mining and milling facilities was presented. The guidance stresses the need for proper planning at the design stage to anticipate all of the issues which will arise — including the provision of sufficient financial resources for decommissioning and the arrangements for the long term management of waste.

In the fifth and final presentation, a plan to assist in the regulatory supervision of legacy sites in the Central Asian Republics proposed by the Norwegian Radiation Protection Authority (NRPA) was described. The extensive disused uranium mining and milling sites in these countries are in need of remediation. Based on the previous experience of the NRPA in the Russian Federation, the plan envisages assisting the countries by improving regulatory infrastructures and, in particular, providing training to the regulatory body in procedures and regulatory supervision. It was also suggested that IAEA might become involved, for example, by promoting forums of regulators to discuss common problems.

In the Panel Discussion, some of the questions related to criteria for remediation that remained unanswered at the Arlington conference were addressed, namely:

(a) Have consistent criteria been established that provide guidelines for the remediation of contaminated sites?
(b) Can a single criterion be applied to the remediation of all forms of contaminated site, be they nuclear test sites, areas resulting from accidents, the termination of practices, mining and milling activities or legacy discharges?
(c) Ought areas contaminated with human-made versus natural radioactive material to have different criteria? Can the same criteria be used for both?
(d) Will the public ideally be involved during the decision making process?
(e) How can it be ensured that overly conservative and unrealistic modelling is not being used which could lead to an overestimation of the risks?
(f) Have the cleanup levels and goals for sites that are contaminated with chemical and radioactive material been harmonized?
(g) How can the removal of material from one site to another versus stabilizing the material in place be justified?

The panel, composed of the presenters of the papers in this session, responded to the questions arising from the Arlington conference as described below.

In response to the question concerning the global unification of criteria for remediation, it was concluded that the international recommendations of the ICRP and the intergovernmental safety standards issued by the IAEA provide a framework within which optimized criteria can be developed taking into account country and site specific features.

The US EPA risk based approach differs from the radiation dose based approach recommended by the international organizations and used in most countries. In the context of the subject of the conference, it was noted that the risk based approach has the merit of allowing radiation risks to be compared on the same basis as risks from chemical hazards. However, it was observed that there are some problems with the approach and these have been discussed by the ICRP.

The aims of any approach used will ideally be the same, namely protecting people adequately from the health hazards attributable to radiation exposure. However, it is noted that a comprehensive approach that takes account of both radiation and other hazards in a coherent and consistent manner is currently missing in international guidance.

It was recognized that decisions on remediating areas contaminated with artificial radionuclides are usually different from those for areas affected by naturally occurring radionuclides even though the 'natural' doses to exposed persons might be the same and, in some cases, many times higher than the 'artificial' doses. The international system does not differentiate between the health hazards of natural and those of artificial radiation. A dichotomous approach for remediating artificially versus naturally contaminated land is therefore scientifically unjustifiable. Nevertheless, such separate approaches are used in practice, perhaps due to a perceived public reluctance to remediate areas in which enhanced radiation levels occur naturally.

The public will ideally be involved in decisions on remediation — but when, and to what extent, may vary. In some countries, the public is more empowered than in others and in those countries it will insist on having its views heard at all stages of the remediation process.

The time available did not allow the panel to address all of the questions arising from the Arlington conference.

SUMMARY OF TOPICAL SESSION 4:

INNOVATIVE TECHNOLOGIES AND ENVIRONMENTAL REMEDIATION

Chairperson:
V. Adams
United States of America

This session contained presentations concerned with technologies for use in environmental remediation with emphasis on some innovative approaches.

The first presentation provided an overview of the science and technology behind the application of cover systems in the remediation of contaminated sites. It was pointed out that no universal solution is available. Moreover, if remediation is not planned in the initial stages of an operation, the available options will decrease and costs will increase significantly. The involvement of stakeholders in the planning process is essential for a successful project. The main factor affecting the long term performance of dry covers is erosion and, because of that, it is critical to observe the potential interactions between vegetation, the cover material, the waste and the associated transport mechanisms (gas and water) in developing an appropriate cover design. This is an area where more guidance could usefully be provided by international organizations to Member States.

The use of bioremediation as a technique to remediate contaminated groundwater was reviewed in the second presentation. The remediation of groundwater contaminated by metals and radionuclides involves the conversion of the contaminants into more complex states, sorption, precipitation or valence state changes at multiple scales. For the successful application of bio-remediation, an integrated approach involving site characterization and monitoring (using hydrogeological, geochemical, geophysical and microbiological methods supported by mathematical modelling) is needed. It has been demonstrated that for the long term remediation of uranium contaminated sites, organic carbon will ideally be supplied naturally to offset continuous influxes of dissolved oxygen. This technique may be the only viable solution for deep and widely dispersed plumes of heavy metals and radionuclides which are otherwise inaccessible. It can be used for complex mixtures of contaminants provided that appropriate microorganisms are employed.

In the third presentation, the technique of monitored natural attenuation was described. The technique is gaining acceptance by regulatory bodies in the context of remediation of contaminated groundwater. It was highlighted

that the approach must not be seen as a 'do nothing option'. On the contrary, justification for the adoption of this strategy depends heavily on appropriate modelling of the fate and transport of pollutants in groundwater. It was pointed out that the forecasting and monitoring strategies need to be discussed with the relevant stakeholders to ensure that the predictions and their limitations are well understood. The strategy is gaining acceptance worldwide because the costs of treating water over long periods of time have been shown to be prohibitively high. The US EPA is making available guidance on the use of this approach.

The fourth presentation described innovative mathematical modelling approaches applied to environmental remediation. The presenter emphasized that the use of mathematical models based on K_d approaches can lead to very conservative estimates and, instead, reactive geochemical transport modelling will ideally be used wherever possible. Good interaction between proponents and regulators is a critical issue and mutual understanding about the overall simulation details must exist.

Vitrification, as a means of immobilizing and isolating contaminated soil zones, has been used at various locations in the world. The fifth presentation described the improvements that have taken place in the technique over the last 10–15 years. These improvements have been achieved through its application to various problems and from an increased understanding of the melting process. It was argued that the technique avoids many of the problems of other remediation approaches by providing an almost permanent solution that does not require active maintenance. Furthermore, the public is said to be convinced by the technique. The costs, while initially higher than other techniques, are said to become comparable or less over time because of the absence of the need for maintenance or storage. Mitigative approaches are now being applied to address the safety issues which were associated with use of the technique in the past, for example incidents involving steam explosions caused by groundwater heating.

The final presentation described the remediation of an actual uranium mining site in Hungary. Restoration of rock piles, ponds and heap leaching sites was necessary. The steps needed to reduce radiation levels on the site, roads, pipelines and in groundwater to acceptable values were described.

In all of the presentations, the importance of stakeholder involvement was emphasized. The confidence of stakeholders, including the affected public, must be obtained when applying the various techniques described in this session.

SUMMARY OF TOPICAL SESSION 5:

LIFE CYCLE PLANNING AND STAKEHOLDER ISSUES IN ENVIRONMENTAL RESTORATION

Chairperson:
M. Paul
Germany

This session dealt with two important topics in environmental remediation: life cycle planning and stakeholder issues. One general concern expressed in this session was that the upsurge in nuclear power plant building will lead to new demands for uranium and a 'new wave' of uranium exploration and extraction. It is vital that lessons be learnt from the past and that new legacy sites are not created.

A working group that involves experts from different disciplines has been established in France. Its purpose is to provide an appraisal of the residual environmental situation after the completion of remediation works at a former uranium production centre. The participation of international organizations in the activities of this group adds value to its outcome and reassures the public of the credibility of its findings and reports. Adaptations of this working methodology could be usefully considered in other countries in order to improve the process of stakeholder involvement in decision making on environmental remediation programmes. A negative aspect that was discussed during the presentation is that, in order to be effective, the work of this group has involved several meetings leading to an intense agenda.

An approach to quantitatively assess the environmental impacts of any industrial activity throughout its entire life cycle was described. This approach allows the identification of potential opportunities for improving operations so that there are reductions in material and energy consumption as well as reductions in discharges to the environment; it also integrates the idea of considering environmental remediation as part of the whole life cycle of the operation.

In another presentation dealing with life cycle management, it was stressed that to ensure a low environmental impact and to minimize possible remediation costs arising after operations cease, new uranium mine developments will ideally follow a 'whole-of-life mining cycle approach'. Through this approach, the need for post-operation remediation can be minimized by effective planning at the design and operational stages. In developed uranium producing countries, the appropriate involvement of stakeholders, such as neighbouring communities,

public representatives, independent scientists and non-governmental organizations (NGOs), is very much in the interest of the operators of uranium mines or implementers of remediation projects. Companies need to obtain the support of the public to receive — in addition to the regulatory licences and permits — a 'social licence' from the local community and district in which the project is being operated.

Environmental remediation was addressed from the point of view of project management — based on the experiences of the US Department of Energy (DOE), although the experience presented is useful for all environmental remediation programme implementers and managers. In the past, insufficient project management at DOE led to inefficiency and a waste of money. Nowadays, the DOE uses well established protocols for environmental remediation project management. The work done is accurately measured and accounted for so as to avoid unnecessary expenditures. It was emphasized that the participation and integration of regulators in project management is essential to guarantee the success of project implementation.

Environmental remediation was also assessed from the ethical point of view. One key element is that the people involved in presenting the different issues related to environmental remediation must use credible and accurate information and numbers. If the wrong figures are used it can promote confusion and distrust; this can ultimately turn the process against the interests of the population that are to be the beneficiaries of the environmental remediation project. This occurred after the Chernobyl accident where misinformation led to many undesirable decisions and unnecessary fear. It was suggested that ethical evaluation can aid in structuring decision making in environmental remediation.

A scheme to guide the implementation of environmental remediation projects called EURSSEM was presented. This will be released for free use on the Internet by the end of September 2009 and it is expected become an important tool to aid in the structuring of environmental remediation projects.

An assessment, by a team of international experts, of the radiological situation in the desert environment of Algeria, where nuclear weapons testing was conducted by the Government of France in the 1960s, was described. The tests were conducted above ground and in mountain caverns. Remediation of the affected areas was carried out after the testing period ended. The expert team was able to detect evidence of the testing but, when the habits of the sparse local population were taken into account, the assessed potential radiation doses were very small. A full report of the assessment is published in the IAEA's Radiological Assessment Reports Series.

The final presentation addressed the issues that can cause difficulties when international organizations like the IAEA give assistance to countries. A case study concerned the decommissioning of the Vinča nuclear research institute

facilities in Serbia. Constraints in the bidding process, problems with employing local workers and the difficulties that companies face when taking jobs outside Western Europe were some of the issues that had to be faced.

SUMMARY OF TOPICAL SESSION 6:

CASE STUDIES I: ENVIRONMENTAL REMEDIATION IN CENTRAL ASIAN COUNTRIES

Chairperson:
A. Kim
Kazakhstan

This session was concerned with the status of sites that have been contaminated with radioactive residues in the Central Asian countries of Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan.

The four countries in Central Asia have common problems concerning residues due to uranium mining and milling activities conducted mainly during the Cold War years. In addition, the territory of Kazakhstan has been affected by nuclear weapons testing on several locations.

It is recognized that environmental management took a back seat to operations while the uranium mining was most active and, as a result, there are large areas of territory affected by residues. The public is concerned in all of the countries about the potential impacts of the releases of radioactivity into the environment.

The presentations showed there to be a general lack of data concerning the characterization of the sites and a lack of experience and funding to perform remediation activities; these are some of the reasons why these problems are still unresolved.

Many areas have elevated radiation backgrounds caused by a variety of circumstances, for example, arising from the residues of the mining and processing of uranium ore but also from the mining and processing of other minerals, from oil and gas exploration, from nuclear weapons testing and due to naturally elevated concentrations of radionuclides in the soil. Some of these conditions have led to increases in the radon concentrations in the atmosphere in occupied areas and to groundwater which is used for drinking and agricultural purposes being contaminated with radionuclides and/or chemicals and metals.

Each country has its own particular conditions. In some areas, precipitation has caused the erosion of tailing piles; in others, landslides have caused significant changes in previously stable storage sites. In some areas, residues have been used as building material in homes and public buildings such as schools. Because of the physical geography of some of the Central Asian countries, contaminants

from one country can be transported by rapidly flowing rivers across national borders.

Generally, although large land areas have been affected by uranium mining activities, the associated radiological conditions are not sufficiently serious to justify intervention on the basis of international safety standards but, on the other hand, radiation exposures can often be reduced by simple expedients.

The radiological situation in these countries is currently being assessed — sometimes with the aid of the international organizations. However, insufficient attention is being given to the presence of chemicals and metals in the residues; in some cases these could represent the main hazard to humans. One presentation raised the issue of large airborne particles containing a mixture of radionuclides and metals — which have been detected at some sites, for example at the Semipalatinsk Nuclear Test Site. However, the hazards presented by these particles are difficult to assess.

The following short term actions, if implemented, would assist in mitigating some of the concerns at the uranium legacy sites:

— The performance of comprehensive environmental impact assessments for each site to include all potential contaminants (radiological and chemical);
— The identification of alternative water supplies if groundwater has been contaminated;
— The implementation and maintenance of institutional controls at the sites;
— The performance of routine monitoring to ensure the controls are performing their intended functions;
— The increase public awareness of the local situation and answer public concerns about safety issues.

While these near term actions are being implemented, longer term actions can be identified and planning can be started to find permanent solutions.

It was clear from the presentations that there are a number of international organizations providing support to the countries, but it was not clear if these support actions are fully coordinated. It is also recognized that there is not a technical network which allows an exchange of information among the countries and the coordination of activities.

SUMMARY OF TOPICAL SESSION 7:

CASE STUDIES II

Chairperson:
B. Salbu
NATO

From the presentations and the discussion in this session, a number of valuable lessons were learned. As a general lesson, it is clear that there is no substitute for competent regulators, operators and good science. This underscores the need for training, education and national capacity building in order to meet the challenges associated with contaminated sites.

Life cycle planning (or lack of it) was a recurring theme in many of the presentations in the session. Life cycle planning is needed in order to prevent significant problems from occurring in the latter stages of a uranium mining and milling operation. A robust regulatory system (i.e. one that requires an environmental impact assessment prior to the start of a mining operation) and good coordination between the regulatory body, the operators and the research community, are also very important. The regulatory body will ideally be independent of the operator. It was clearly demonstrated there is a strong need for stakeholder involvement throughout the whole period of a project.

The experience gained in the remediation of a uranium extraction plant in Mexico showed that if the organization that is performing the remediation is different from that responsible for long term care of the site, there needs to be good coordination between them to ensure a smooth transition of responsibilities. The study showed the need for adequate compliance verification of the remediation plan, for example, by the use of proper institutional controls.

One presentation discussed an innovative way to calculate radiation doses when background radiation makes the radiation caused by human activities difficult to measure. The presentation also emphasized the need to take due account of the habits of local potentially exposed population groups in dose assessments and provided an example of this in relation to Aboriginal Australians.

Radiation monitoring programmes and radiation dose assessments to workers involved in remediation activities at uranium mine sites and to the public were described in several presentations. The public perception of radiation risks was raised as an issue in at least one presentation and the need for improved approaches for risk communication was emphasized.

Experience in the implementation of remediation schemes in different countries has shown that:

— What may work in one part of the world may not work in another, for example, for cultural, climatic and physical geographic reasons.
— Having a site conceptual model is valuable for targeting limited resources towards the activities that will give the greatest risk reduction.
— Stakeholder involvement may be more challenging than the technical solutions.

Furthermore, it was noted that many of these legacy sites have common issues:

— Operations were terminated abruptly.
— There was improper or no management of waste and residues.
— No funding exists for post mining/milling activities.
— There was no stakeholder involvement due to the secret nature of the sites.

An important conclusion from the studies presented on the radiological impact of uranium mining and milling legacy sites is that, in almost every case, with a few localized exceptions, the radiation doses are low. This underscores the need to evaluate these legacy sites individually using a site specific, evidence based approach. Only in this way can the true risks to the public and the environment be properly evaluated and addressed.

SUMMARY OF TOPICAL SESSION 8:

EXPEDITING AND ENHANCING EXPERIENCE EXCHANGE IN ENVIRONMENTAL REMEDIATION

Chairperson:
D. Louvat
IAEA

In this short session the presentations covered an internationally sponsored review of uranium mining legacy sites in countries of Central Asia and the programmes of two international organizations in the field of environmental remediation. These presentations were followed by a final discussion.

The secrecy surrounding the sites in former times led to a lack of disclosure of information. Nowadays, more data are available, but the reliability of the information is an issue. Therefore, it is essential for measurements to be carried out to validate and complete the information. The quality and accuracy of dose assessments depend on the reliability of the data used in the models. Under the NATO RESCA project a number of field missions have been carried out involving measurement and radioactive dose assessment, among other activities. The overall conclusion is that, in general, radiation levels are not very high, except at very specific locations within some sites or when there is easy access to radioactive material that potentially could be misused. The dose assessments were, however, very preliminary since the radiological characterization of the sites has not been completed. Indoor radon generally makes the highest contribution to the dose. Drinking water makes a smaller contribution and other pathways make even smaller contributions.

A short summary of the goals of NATO in the field was presented and, in particular, the organization and objectives of the Science for Peace and Security Committee were described. The activities of the Committee are non-military and are for civil science cooperation. The main topics dealt with by the Committee are orientated towards defence against terrorism and other threats, including environmental security. The work is implemented in many cases in association with other international initiatives. Working groups and subgroups deal with a wide range of subjects connected to environmental hazards and human-made induced degradation of the world's natural resources, among other topics. In particular, two large projects related to the former nuclear test site at Semipalatinsk in Kazakhstan have been implemented.

In the final presentation, ENVIRONET, an IAEA initiative on a 'network of centres of excellence on environmental remediation' was described. The objectives of ENVIRONET are to provide coordinated support, to organize training and demonstration events, to foster information exchange and to establish a forum. ENVIRONET will cover a wide range of topics, for example site characterization and remediation, but its final structure is still being designed, including the roles and functions of the partners. The establishment of the network will be formally announced at the General Conference of the IAEA in October 2009.

The Chairperson started the discussion session by reminding the participants that there are several ongoing and planned international initiatives in relation to remediation of uranium legacy sites.

In the subsequent discussion, the ENVIRONET project was generally appreciated and well supported. Detailed questions as to its scope, content, mechanisms and resources for its support were raised.

While appreciating the ENVIRONET initiative, it was noted that a separate forum for regulators is needed. Most problems (no maintenance, lack of planning) have resulted from poor regulatory infrastructure and organization of the regulatory bodies. The establishment of a global network of regulators in this field is needed.

It was pointed out that the issue of site maintenance had not been properly addressed at the Conference. The IAEA has issued guidance on this but it needs to be strongly emphasized in projects, otherwise remediation actions will fail in the long term.

The Conference participants heard of a number of international initiatives related to the remediation of legacy sites in Central Asia. It is important that these are properly coordinated so as to avoid wasting resources in the countries concerned, in the international organizations and in their supporting Member States. The international organizations will ideally urgently address this potential problem.

SUMMARY AND CONCLUSIONS OF THE CONFERENCE

Report of the Conference President[1]

T. Zantikin
Conference President
Kazakhstan Atomic Energy Committee (KAEC)
Almaty, Kazakhstan

The need for the remediation of legacy sites resulting from nuclear weapons testing, nuclear accidents, poorly operated practices and abandoned facilities became evident after the end of the Cold War in 1989. Since then, the full extent of the global remediation problem has become clear and, in response, the IAEA organized several radiological assessments of major affected sites around the world. In 1999, the IAEA held an international conference on the Restoration of Environments with Radioactive Residues in Arlington, Virginia, USA. The Arlington conference was mainly focused on the remediation of areas affected by nuclear weapons testing and nuclear accidents and on the issue of radiological criteria to guide cleanup decisions. By 2009, the emphasis had moved to the remediation of uranium mining and milling legacy sites and the technology for use in site remediation. These are the main topics of this week's conference in Astana, Kazakhstan.

The conference has attracted participants from all over the world and presentations from many countries and organizations, but the emphasis of our discussions this week has been on the problems caused by uranium mining and milling legacy sites in the countries of Central Asia.

The conference addressed the important issue of international regulatory standards for remediation and noted the progress being made towards incorporating regulatory requirements and guidance for remediation into the revised International Basic Safety Standards on Radiation Protection (BSS). The revised BSS will include a radiological protection framework for remediation which allows criteria for remediation to be developed by a process of optimization, taking due account of national and local circumstances.

In the context of regulations, the Norwegian Radiation Protection Authority (NRPA) announced a plan during the conference to assist in the regulatory

[1] The views and recommendations expressed here are those of the President of the Conference and the participants, and do not necessarily represent those of the IAEA.

supervision of legacy sites in the Central Asian Republics. Based on its previous experience in the Russian Federation, in which it helped to improve the regulatory capabilities of the nuclear regulator, the NRPA proposes to assist the countries of the Central Asian Republics by improving regulatory infrastructures and, in particular, providing training to the regulatory body in procedures and regulatory supervision. It was also suggested that IAEA might wish to become involved, for example, by hosting meetings of the coordination forum.

Many of the old uranium mines were developed in an era in which efficiency of uranium production was the only concern — with no attention being given to the damage inflicted on the environment or to the residues left behind. The environmental consequences of the first phase of uranium mining and milling were therefore often significant and could have been avoided. This has prompted concern that the same mistakes might be repeated in the new wave of uranium mining. The conference supported the strategy of avoiding the creation of future legacy sites by proper planning (life cycle planning) and good operating practices and by promoting an environmental protection culture among the mining companies. It was also recognized that much could be achieved by establishing appropriate regulations and a strong regulatory body in the country in which the mining operations are conducted.

Many of the countries with legacy uranium mining sites share common problems, such as a lack of funds to deal with the problem, a lack of local expertise and equipment and, as a result, inadequately characterized sites. Furthermore, the radiological conditions of people living near to the sites may not be known.

In most of the major industrialized uranium producing countries of the world, the uranium mining sites have been successfully remediated. During the conference the experience obtained in attempting to transfer this experience to developing countries was shared with the participants. Some of the key points were:

— It is necessary to build capacity through training so that the local organizations become capable of managing and regulating their own remediation activities.
— In many countries, resources are limited and the remediation solutions which have been used in industrialized countries may not be ideally suited to the application; usually, simple rather than sophisticated solutions are to be preferred.
— It is necessary to involve local stakeholders and to be sensitive to their concerns; sometimes it may not be appropriate to apply the most effective technical solutions because of social considerations, such as, maintaining the wellbeing of local people and securing their employment.

— Precautions may need to be taken to ensure the long term viability of supplied equipment, for example, by providing spares and arrangements for maintaining and servicing it.

New and innovative technologies were discussed at the Conference and information was provided on such technologies for application to monitoring, assessing and restricting the movement of radionuclides in soil and groundwater.

The Conference gave strong support to ENVIRONET — a new initiative of the IAEA which has the aim of promoting mutual interests and the sharing of information in the area of environmental remediation.

Many presentations dealt with the characterization and radiological assessment of sites. In most of the cases considered, there are chemical (metals) hazards as well as those due to ionizing radiation and these must be taken into account in any assessment — too often only radiological hazards are considered.

A number of posters were displayed throughout the week describing studies additional to those presented in the oral sessions; they were mainly related to uranium mining and milling. All of the conference papers and posters will be useful and a help to persons wishing to learn from the experience of others.

The involvement in the Conference of many international organizations is a reflection of the importance being given to this problem. The World Bank, the United Nations Development Fund, the North Atlantic Treaty Organization, the World Health Organization, the European Bank for Reconstruction and Development, the Organization for Security and Cooperation in Europe, the European Commission and the IAEA have all been represented and almost all have made presentations. The aims of most of these organizations are similar in that they wish to provide assistance in the remediation of uranium mining and milling legacy sites in the countries of Central Asia. Most of them favour a regional approach and see the need for a well defined road map before proceeding with any project. They recognize the importance of developing regulatory capabilities in the countries and agree on the need to have well defined indicators of success. It is evident that they are already in contact with each other, but this Conference has shown more clearly that there is a need for increased coordination between them.

In this context the IAEA has a special role. It is the only one of the organizations with formal international responsibilities and specialized knowledge in the areas of radiation protection and radioactive waste management. For this reason, if a joint regional project were to be established, the IAEA would be the appropriate international organization to provide the technical safety justification for it on the basis of its safety standards.

The discussions at the conference have resulted in a number of initiatives and proposals being put forward for cooperative action at the regional level;

these are elaborated in the session summaries. It is now up to the international organizations to deliberate on these and to decide if and when to take action, taking into account the demands from other sectors.

I am sure that you have all benefited from the exchange of information which has been possible during this conference and that you have made many useful contacts. These are often the main benefits from such meetings.

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ISSN 0074–1884