SUMMARY OF THE 1999 INTERNATIONAL CONFERENCE ON THE RESTORATION OF ENVIRONMENTS WITH RADIOACTIVE RESIDUES

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Abstract

In November 2008, an international conference on the Restoration of Environments with Radioactive Residues was held in Arlington, Virginia, USA. This paper reviews the contents and outcomes of the Arlington conference and examines its relevance for the issues of today.

1. INTRODUCTION

In November 1999, the International Atomic Energy Agency organized an international conference on the Restoration of Environments with Radioactive Residues, in Arlington, Virginia, USA. The conference was co-sponsored by the US Department of Energy, the US Environmental Protection Agency and the US Nuclear Regulatory Commission. This was the first IAEA conference to address the subject of environmental remediation.

The format of the conference comprised five technical sessions, a panel discussion, a poster session and opening and closing sessions. Thirty-seven papers were presented orally in the technical sessions. The discussions that followed each paper together with the panel discussion were recorded and an edited version of them was included in the conference proceedings. Summaries of each of the five sessions were also included in the proceedings which were published by the IAEA [1]. In addition, over 120 contributed papers were published as a separate volume of the proceedings.

2. SESSION ONE — GLOBAL OVERVIEW

The first session provided a global overview of the environments contaminated with radionuclides requiring restoration and identified the major areas where environmental contamination has occurred. Presentations addressed the radioactive residues in China, the European Union, the Russian Federation and the USA. Other presentations addressed areas contaminated with naturally occurring radioactive material, residues from accidents that have occurred in the former Soviet Union and the general approach that the IAEA was taking to establish policies on environmental restoration.

The session clearly illustrated that radioactive residues exist at many sites around the world and result from events including accidents, nuclear weapons testing, decommissioning and inappropriate past practices. There are also many areas that are affected by elevated levels of naturally occurring radioactive materials. Three major issues were identified during the discussions:

- The need for harmonized criteria for guiding restoration efforts;
- The need for consistency in the treatment of natural versus human-made radioactive residues;
- The need for good communications with the public on decisions related to restoration.

3. SESSION TWO — RESTORATION PRINCIPLES AND CRITERIA

The papers in this session described current remediation approaches and cleanup criteria being used by different countries, i.e. France, Germany, the Russian Federation and the USA. The three concerned governmental agencies in the USA have slightly different approaches and criteria and these were discussed. The recommendations of the International Commission on Radiological Protection (ICRP) relevant to cleanup were also presented.

There was considerable discussion of the issues contained in this session. It was apparent that a unified view on the subject of radiological criteria and policies for aiding cleanup decisions did not exist. It was recognized that the concept of intervention is generally not recognized in national regulations. Proposals were discussed on how to build a framework that can deal with the remediation of residual contamination situations associated with both human-made and naturally occurring origins. The following major conclusions were identified during the discussions:

- The involvement of interested parties as part of the overall remediation process is of primary importance;
- Establishing derived (and measurable) criteria is necessary for the management of contamination situations as well as the protection of the environment;
- There is a serious potential for overestimating risks because of overly conservative and unrealistic modelling and this can prove to be very costly.

4. SESSION THREE — CASE STUDIES

In the third session, various case studies involving remediation efforts were presented. The session was divided into five sub-sessions, each dealing with a particular type of remediation problem. Each type of problem has unique issues and requires different approaches to its remediation. The sub-sessions were concerned with:

- Nuclear weapons test sites;
- Legacy of discharges;
- Legacy of accidents;
- Mining and milling activities;
- Residues from the termination of practices.

It was identified that choosing between alternative restoration options will ideally be based on weighing the potential reduction achieved in worker and public doses against the associated cost of the strategy. Site characterization approaches must include both a historical review and a contaminant assessment. It was stressed that a good understanding of the site is important when planning the characterization activities. The importance of interested party involvement as part of the restoration activities was underlined and it was recognized that this involvement is critical for project success. Since most sites are affected by both chemical and radiological contamination, the harmonization of cleanup levels and goals for these different contaminants is an important issue. It was also recognized that consideration has to be given to the possible uses of the site and, if necessary, the maintenance of institutional controls to limit use or access. Policies in this area still needed development at the time of the conference.

5. SESSION FOUR — CRITICAL ANALYSIS OF CASE STUDIES

A critical review of the case studies presented during Session Three had been conducted by a small group of experts. The radiological protection approach, the criteria used for remediation, the application of various non-radiological factors and the involvement of interested parties were all considered during this analysis.

It was determined that there were no uniform criteria in use for guiding restoration activities. The criteria being used ranged from 0.1 to 10 mSv/a. The cost–benefit justification for the lower levels was questionable and it was clear that the decisions on remediation were influenced by social, political and psychological factors, rather than by health or safety aspects. The importance of early planning and the involvement of interested parties in the decision making process were emphasized. The lack of public acceptance of even low levels of voluntary risk was a significant factor influencing the decision making process. It was recognized that the lack of disposal facilities for the high volumes of material that can be generated during the restoration process can be problematic.

6. SESSION FIVE — ROLE OF PUBLIC PARTICIPATION

This session was concerned with public involvement during the restoration process, from the initial planning and decision making through to the final disposition of the site. This issue was discussed during the other sessions, but this session focused on two programmes that were developed to foster public participation in the process. The first was the Superfund programme in the USA and the second was the European Commission ETHOS programme involving territories that were contaminated owing to the Chernobyl accident.

It was determined that the public must be brought into the decision making process at an early stage to ensure the success of the project. The level of information needed will vary depending on the level of interest of the individuals, and this may range from information summaries to documentation of the detailed studies and data. It is important that involved members of the public have the feeling that their input is important. It will ideally be recognized that individuals may have different concerns from those of the overall community and these concerns must be taken into account.

7. PANEL SESSION

The panel session was designed to bring together a wide range of interested parties to discuss their concerns about the restoration process. The panellists included a radiation protection expert, an individual from the local government of an area affected by nuclear tests (the Marshall Islands), a representative from a local environmental group, a representative from a public interest group and an environmental expert.

Not surprisingly, the concerns and the approach that will ideally be taken to restore a site can vary depending on the perspective of the individual or group providing comment. The radiation protection expert thought there were three main issues concerning site restoration: standards and limits, risk limitation with respect to natural versus human-made radiation and the role of the radiation protection community. The Marshall Island governmental representative was concerned with the people and his community; how the island would be restored, and how the people and community would be compensated. The environmental group representative was concerned with the local population being involved with the federal and local governments in a timely manner and in ensuring that all information is presented to allow an informed decision to be made. The environmental expert agreed that stakeholder involvement is important, but that it is not a substitute for governmental or official action. It was considered that for stakeholders, the process is often more important than the criteria. The public interest group representative considered that the intelligence of the general public is sometimes underestimated and that scientists sometimes tend to patronize the public. It was emphasized that respect must be shown to all interested parties.

8. SUMMARY

The closing session summarized the overall conference. The basic concepts of restoration were agreed and the need for consistent criteria was identified. The problem within the USA of the divergent opinion of governmental agencies on radiological criteria was identified and a plea was made for convergence. There was also a recognition that the concept of intervention was not fully endorsed by everyone and that this issue needs to be addressed to help avoid confusion in the future. At the beginning of the conference it was thought that there was a need for education of the public but by the end of the week it was determined that this was not the problem, and that what is needed is early public involvement in the remediation planning phase.

The following is a list of questions that was developed from the discussions on the major issues:

- Have consistent criteria been established that provide guidelines for the remediation of contaminated sites?
- 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?
- Ought areas contaminated with human-made versus those contaminated with natural radioactive material have different criteria from one another?
- Is the public being properly involved during the decision making process?
- How do we ensure that overly conservative and unrealistic modelling is not being used which could lead to the overestimation of risks?
- Have we harmonized the cleanup levels and goals for sites that are contaminated with chemical and radioactive material?
- How do we justify removing material from one site and moving it to another site verses stabilizing the material in place?
- It is appropriate to challenge this (Astana) conference to reflect on these questions and to ask "Have these questions, that were identified ten years ago, been addressed in the intervening time?"

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INTERNATIONAL POLICIES AND STRATEGIES FOR THE REMEDIATION OF LAND AFFECTED BY RADIOACTIVE RESIDUES

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Abstract

The paper addresses the international policies and strategies for the remediation of land affected by radioactive residues. The main aim of the paper is to describe the evolution and status of the international paradigms in this area while, at the same time, identifying some of the associated misunderstandings, mainly due to the terminology employed. The international radiation protection approaches for remediation are described. They derive from the recommendations of the International Commission on Radiological Protection. Prolonged exposure situations, which are typical in the case of contaminated land, are analysed in some detail. Finally, the international safety standards on remediation, which are being established under the aegis of the International Atomic Energy Agency, are explored. The paper suggests that the time is ripe for a simple and clear international agreement on the levels of land contamination with radioactive material that may be considered unambiguously safe.

1. INTRODUCTION

The so-termed remediation of territories experiencing contamination with radioactive residues has been one of the more elusive issues to tackle and regulate for the radiation protection community. Radiation protection experts have generally been unable to respond to a simple and straightforward question from anxious members of the general public: "Is it safe for me and my family to live here?" Experts have tried to explain that, while the territory was in fact contaminated, remediation had to be optimized, and depending on many factors (generally incomprehensible for the general public) they might, or might not, be able to remain there. Moreover, sometimes, experts have implicitly advised members of the public that it was ultimately their decision whether to leave or to remain in contaminated land or whether it ought to be remediated. The meanings of the terms contamination and remediation, in the context of radioactive material on land surfaces, are sometimes not clear to non-specialists and can create ambiguity in understanding.

The paper's main aim is to describe the evolution and status of the international paradigms and standards for the remediation of land affected by radioactive residues and also to discuss the misunderstandings caused by the terminology used. It also suggests further international actions to help countries to solve their problems in this area. The ideas in this paper are elaborated in greater depth elsewhere [1].

While many States have been challenged by the issue of remediating contaminated land, Kazakhstan has been particularly challenged because its territory suffered extensive contamination from the nuclear testing activities of the former Soviet Union. In May 1993, representatives of the Kazakhstan Government informed the International Atomic Energy Agency of their concern [2]. Subsequently, at the request of the Government of Kazakhstan, the IAEA undertook to carry out a study of the radiological situation at Semipalatinsk [3]. From 1949 to 1989, the former Soviet Union had conducted 456 nuclear explosions at the Semipalatinsk test site. Until 1963, the explosions were mainly carried out on the surface and in the atmosphere. After 1963, testing was conducted underground. The last nuclear explosion at the site was in 1989. Two Semipalatinsk areas, the so-called Ground Zero and Lake Balapan areas, were found to be heavily contaminated. Since the IAEA assessment, little aid has been provided by the international community to help Kazakhstan remediate this vast area of territory. The IAEA had clearly qualified its assessment as "preliminary in nature" and expressly indicated that "it does not constitute a comprehensive radiological survey of the site, which covers a very large surface area, but rather identifies the topics on which further study is needed in order to develop a full understanding of the radiological situation at the site" [3].

2. MISUNDERSTANDINGS

The term (radioactive) contamination is widely misunderstood and its misinterpretation has had significant effects in radiation protection strategies. Surprisingly, the term derives from a historical religious background as a descriptor of impurity. Contamination originates from the Latin 'contaminat-', 'contaminare', or 'make impure'. The obvious conclusion from this definition is that something that is contaminated is automatically unacceptable, regardless of the quantification of such contamination. The original intention of

radiation specialists was to denote the presence of radioactive materials, as expressed by the quantity (radio) activity, a denotation describing an amount or concentration of radionuclides in a given energy state at a given time. The intention was not of a connotation of impurity or dirtiness, nor even of the magnitude of the hazard involved. However, in the public mind, contamination became a quasi-synonym of dangerously undesirable radioactivity. In sum, while the term is commonly used by experts to quantify the presence and distribution of radioactive material in a given environment, it has become widely misinterpreted as a measure of radiation related dangerousness. Moreover, contamination strictly refers to radioactive substances on surfaces, or within solids, liquids or gases (including those in the human body), where their presence is unintended or undesirable, or to the process giving rise to their presence in such places. Unfortunately the term is used more informally (even by experts) to refer to the amount of (radio)activity on a surface, and it is misinterpreted and misunderstood as a dangerous level of (radio)activity.

The term (radioactive) remediation became closely associated with the misinterpretations of contamination, as the former is a consequence of the latter. The term may be used in a variety of contexts and, as a result, it can be badly misunderstood. In common parlance, it means providing a remedy, namely a pharmaceutical product, cure or treatment, for a medical condition. Not surprisingly, members of the public became extremely anxious when informed that the place where they are living was subject to remediation because of a radiation related contamination! Environmental radiation protection specialists, however, use remediation to mean the removal or reduction of radioactive substances from environmental media such as soil, groundwater, sediment or surface water. The ultimate purpose of remediation is protecting human health and the environment against potential detrimental effects from radiation exposure, rather than eliminating contamination completely.

The untranslatable and more informal English term ‘cleanup’ has been used as a synonym of remediation and this usage has added to the misunderstanding. The term implies making a place clean’, and is taken to mean making it absolutely free from dirt or harmful substances. The confusion arises because a decision to reduce a given level of radioactive contamination may be taken simply because the radioactivity is measurable and not because it is ‘dirty’ or ‘harmful’. Moreover, the term clean can also be tacitly equated to ‘morally pure’, which again has religious implications. This interpretation combined with the misinterpretations of the term contamination described previously may have played an important role in the misunderstanding. Members of the public may be further confused because regulations for the remediation of contamination are not established in terms of quantities expressing radioactivity levels in the contamination but rather in terms of radiation doses to be expected from the contamination. Increasing the confusion is the fact that these doses can be expressed as integrated doses (e.g. doses to be incurred over a lifetime) or as dose rates (e.g. annual doses).

It seems, therefore, that there is a strong connection between the misunderstandings of contamination and remediation and the quantities used to measure them. In simple terms, remediation ought to be expected if there is contamination and there will be contamination if, and only if, the levels of radioactivity per unit area are above values considered to be unsafe.

Despite the confusion described in this section of the paper, it is considered that the usage of the terms contamination, remediation, etc. is so entrenched in radiation protection practice that changes at this stage into more precise language may produce more harm than good.

3. SCENARIOS

Radioactive residues can originate from several causes, as follows:

(a) Occasionally, they may have been generated by the accumulation of radionuclides from normal discharges of radioactive effluents into the environment from planned and properly authorized human activities (so-called ‘practices’ in international jargon).

(b) They may also be radioactive remnants from the termination of a practice and the decommissioning of the installations used by it.

(c) Most commonly, radioactive residues are the result of unregulated human activities that have been carried out in the past, where the termination of the activity and the handling of the remaining residues would most probably not have been adequately considered when the activity was initiated (a simple example of this is the ancient practice of mining and milling operations of ores containing natural radioactive substances).

(d) Radioactive residues may also remain from past events that may have been unforeseeable at the time of occurrence, such as accidents releasing long lived radioactive materials to the environment.

(e) Finally, the largest part of the radioactive residues in the human habitat is a legacy from past military operations that were both foreseeable and avoidable.

It ought to be noted that the complexity of the situations that may arise from territorial contamination was not recognized early enough by the international community. The many assessments of the aftermath of the Chernobyl accident have shown the difficulties in dealing with this type of situation. However, it was not until

the year 2002 that the IAEA issued a report in which governments and international organization documented the severity of the problem [4].

4. THE ICRP RECOMMENDATIONS

At the root of the international approach for the remediation of contaminated land is the discipline of radiation protection. Radiation protection is not a science but a paradigm, namely a model for keeping people safe from the potential detriment that radiation exposure may cause. The International Commission on Radiological Protection (ICRP) provides international recommendations on radiation protection. The ICRP recommendations that are still used in current standards appeared as Publication 60 [5] in 1990. Recently, in 2007, new recommendations were issued as ICRP Publication 103 [6]. Virtually all international standards and national regulations addressing radiological protection are based on the ICRP recommendations contained in ICRP Publication 60. The relevant international standards are the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, or BSS [7]. Currently, a process is under way to revise the BSS, taking into account the new recommendations contained in ICRP Publication 103.

In the context of remediation, there is an important presentational difference between the ICRP Publications 60 and 103. The former is founded on a process based approach using concepts termed 'practices' and 'interventions' (a practice being defined as a human endeavour that can increase the overall exposure to radiation and an intervention being defined as human actions that decrease the overall exposure to radiation). Thus, remediation, in the language of ICRP Publication 60, is an archetypical intervention. Conversely, ICRP Publication 103 uses a situation based approach to characterize the possible circumstances where radiation exposure may occur. It considers that the term 'planned exposure situations' better characterizes its previous intentions for defining practices and, similarly, that 'emergency exposure situations' and 'existing exposure situations' better characterize interventions. The new characterization is defined as follows:

Thus, in ICRP 103 language, contaminated territories requiring remediation could be considered a case of existing exposure situations, which, however, could have originated from planned situations or from emergency situations or could be an existing situation proper.

Three fundamental principles provide the basis of the ICRP paradigm. They are termed justification, optimization and individual dose limitation, and are particularly relevant to situations of remediation and, importantly, they are based on solid ethical principles. Within the context of remediation, these fundamental principles can be formulated as justification of remediation, optimization of remedial actions and restriction of residual individual doses:

Justification of remediation: Any remediation will ideally be justified, namely: the alteration that remediation generates in the radiation exposure situation of the contaminated territory will ideally do more good than harm. This means that by reducing the existing exposure through remediation, the individual or societal benefit must offset the detriment that the remediation may cause.

Optimization of remedial actions: Remediation measures in a contaminated territory will ideally be optimized, namely: the level of protection to be achieved by the remediation ought tobe the best under the prevailing circumstances, maximizing the margin of benefit over harm. Optimization will ideally result in the likelihood of incurring exposures, the number of people exposed, and the magnitude of their individual doses being all kept as low as reasonably achievable, taking into account economic and societal factors.

Individual dose restrictions: In order to avoid severely inequitable outcomes of the optimization procedure, there will ideally be restrictions on the doses or risks to individuals remaining in the contaminated territory. Restrictions are applied to the doses to a nominal individual (or reference person). Protection options resulting in doses greater in magnitude than such restrictions will ideally be rejected at the planning stage. Importantly, these restrictions on doses are applied prospectively, as with optimization as a whole. If, following the implementation of an optimized protection strategy, it is subsequently shown that the value of the constraint or reference level is exceeded, the reasons will ideally be investigated, but this fact alone ought not necessarily to prompt regulatory action. The ICRP has traditionally recommended an individual-related annual dose limit of 1 mSv for planned exposures from regulated practices and has further recommended the use of source-related dose constraints and reference levels, which, in the context of remediation, can be described as follows: (i) a dose constraint is a prospective and source related restriction on the individual dose from a specific contamination source which provides a basic level of protection for the most highly exposed individuals from such a source, and serves as an upper bound on the dose in optimization of protection for that source; (ii) in contrast, if protection cannot be planned in advance for a situation, reference levels will ideally be used in deciding on intervention with protective measures. Reference levels will ideally represent the level of dose or risk above which it is judged to be inappropriate to plan to allow exposures to occur and below which optimization of protection will ideally be implemented. The chosen value for a reference level will depend upon the prevailing circumstances of the exposure under consideration. The ICRP now recommends that reference levels, set in

terms of individual dose, will ideally be used in conjunction with the implementation of the optimization process for exposures in existing exposure situations. The objective is to implement optimized protection strategies, or a progressive range of such strategies, which will reduce individual doses to below the reference level. However, exposures below the reference level will ideally not be ignored; these exposure circumstances ought also to be assessed to ascertain whether protection is optimized, or whether further protective measures are needed. An end point for the optimization process must not be fixed in advance and the optimized level of protection will depend on the situation. It is the responsibility of regulatory authorities to decide on the legal status of the reference level which is implemented to control a given situation. Retrospectively, when protective actions have been implemented, reference levels may also be used as benchmarks for assessing the effectiveness of the protection strategies. The use of reference levels in existing situation is illustrated by Fig. 1, which shows the evolution of the distribution of individual doses with time as a result of the optimization process.

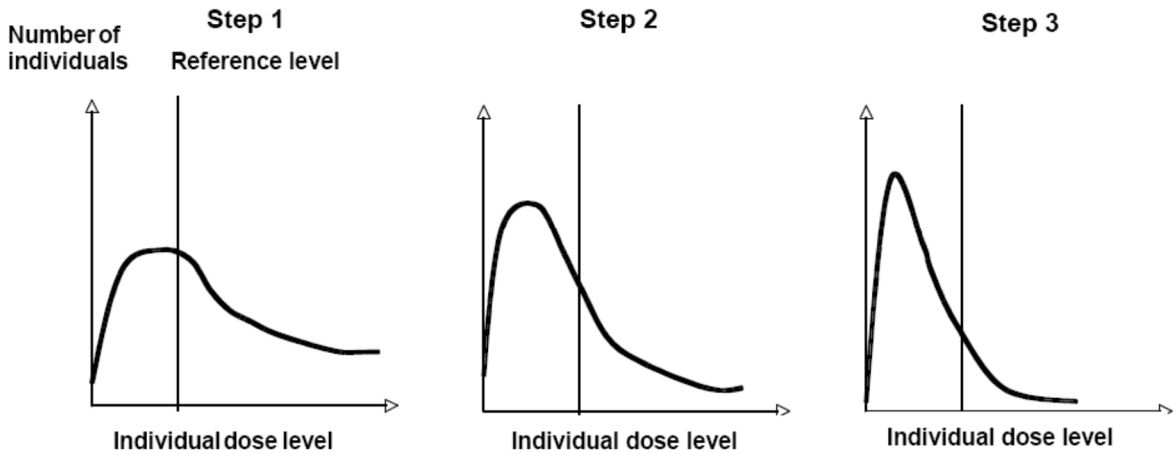

FIG. 1. The use of a reference levels in existing exposure situations and the evolution of the distribution of individual doses with time as a result of the optimization process.

According to the new ICRP recommendations, reference levels for existing exposure situations such as those candidates for remediation will ideally be set typically in the 1–20 mSv band of projected dose. The individuals concerned will ideally receive general information on the exposure situation and the means to reduce their doses. In situations where individual lifestyles are key drivers of the exposures, individual monitoring or assessment as well as education and training may be important requirements. Living in contaminated areas after a nuclear accident or a radiological event is a typical situation of that sort.

The current recommended values for protection criteria are compared in Table 1 with those provided by the previous recommendations in ICRP Publication 60 [5] and the derivative ICRP Publication 82 [8]. The comparison shows that the current recommendations are essentially the same as the previous recommendations encompassing the previous values but are wider in their scope of application.

TABLE 1. RECOMMENDED VALUES FOR PROTECTION CRITERIA

Intervention	Previous reference levels [8]	Current reference level [6]
Unlikely to be justifiable	< ≈ 10 mSv/a	Between 1 and 20 mSv/a according to the situation
May be justifiable	> ≈ 10 mSv/a	
Almost always justifiable	Towards 100 mSv/a	

Remediation usually includes considerations of environmental protection. The traditional position of the ICRP on environmental protection has evolved over time. Usually, the traditional environmental concern of radiation protection has been limited to the transfer of radionuclides through the human habitat primarily in relation to planned exposure situations (because this transference directly affects the protection of human beings). In ICRP Publication 60, the ICRP considered that the standards of environmental control needed to protect the general public would ensure that other species are not put at risk. Under this approach, if remediation

is not needed for humans it ought not to be needed for other species. While the ICRP continues to believe that this is likely to be the case, it also recognizes that interest in the protection of the environment has greatly increased in recent years in relation to all aspects of human activity. This has been accompanied by the development and application of various means of assessing and managing the many forms of human impact upon the environment. The growing need for advice and guidance on such matters in relation to radiological protection have, however, not arisen from any new or specific concerns about the effects of radiation on the environment. There seemed to be a lack of consistency at international level with respect to addressing such issues in relation to radioactivity. The ICRP is also aware of the needs of some national authorities to demonstrate, directly and explicitly, that not only humans but the overall environment is being protected and, therefore, it decided to develop a clearer framework to assess the relationships between exposure and dose, and between dose and effect, and the consequences of such effects, for non-human species, on a common scientific basis. This issue was first discussed in ICRP Publication 91 [9], and it was concluded that it was necessary to draw upon the lessons learned from the development of the systematic framework for the protection of human beings.

Another issue affecting international remediation policies is the necessary global agreement on situations that do not justify being remediated. The ICRP has long recognized that there may be exposure situations for which it will be obvious that remediation to reduce exposures is either not feasible or not warranted [10]. While many exposures from contaminated territories are controllable, a number of situations can be either uncontrollable or essentially unamenable to control (for example exposure to undisturbed levels of natural radioactivity). Exposure situations that are uncontrollable or unamenable to control are generally subject to exclusion from the scope of radiological protection measures. Other situations may be controllable but considered trivial by the authorities and not requiring control. Exposure situations for which control is not needed are subject to exemption. According to ICRP, the decision as to what components of existing exposure are either not amenable to control or do not need to be controlled requires a judgement by the regulatory authority that will depend on the controllability of the source or exposure and also on the prevailing economic, societal and cultural circumstances.

Moreover, it will ideally be emphasized that non-technical factors have an enormous influence on remediation policies. For this reason, the ICRP has always cautioned that its recommendations are based on objective assessments of the health risks associated with exposure levels and on radiological protection attributes of various exposure situations. However, members of the public (and sometimes their political representatives) may have personal and distinct views on radiation risks, for instance between those attributable to artificial sources of exposure in relation to those due to natural sources. Social and political attributes, generally unrelated to radiological protection, usually influence the final decision on remediation. Therefore, while the ICRP reports will ideally be seen as a provider of decision aiding recommendations, mainly based on scientific considerations on radiological protection, the outcome of the ICRP advice is expected to serve just as an input to a final (usually wider) decision making process, which may include other societal concerns and considerations and the participation of relevant stakeholders rather than of radiological protection specialists alone.

The ICRP is issuing new recommendations on the application of its recommendations to the protection of individuals living in long term contaminated territories after a nuclear accident or a radiation emergency. The new recommendations recognize that nuclear accidents and radiation emergencies are managed according to guidance covering short, medium and long term actions. The most recent guidance related to the management of the short and medium term actions is provided by recently approved ICRP recommendations on the Application of the Commission's Recommendations for the Protection of People in Emergency Exposure Situations. The post-accident rehabilitation situation covered by these recommendations corresponds to the long term actions that may be necessary to be implemented in the case of a nuclear accident or radiological event resulting in the long lasting contamination of large inhabited territories. The transition from an emergency exposure situation to an existing exposure is characterized by a change in management, from strategies mainly driven by urgency, with potentially high levels of exposures and predominantly central decisions, to more decentralized strategies aimed at improving living conditions and reducing exposures to as low as reasonably achievable given the circumstances. These strategies must take into account the long term dimension of the situation with the direct involvement of the exposed individuals in their own protection. The ICRP recommends in its new report that this transition will ideally be undertaken in a coordinated and fully transparent manner and agreed and understood by all the affected parties. The decision to allow people to live in contaminated territories marks the transition between emergency and the existing exposure situations and will be taken by the authorities. This will be the beginning of the post-accident rehabilitation phase and is where the new recommendations have their focus.

5. INTERNATIONAL STANDARDS

The International BSS [7] of 1996 are standards that govern general international requirements on radiation protection. The BSS, however, are basically silent on the remediation of contaminated territories. They only include generic requirements for intervention in what, at the time, were termed 'chronic' exposure situations. The BSS presumed that States will ideally determine the allocation of responsibilities among regulatory authorities, national and local intervening organizations and even registrants or licensees, for the management of interventions in chronic exposure situations. Under this proviso, the BSS require that generic or site specific remedial action plans for chronic exposure situations shall be prepared by intervening organizations, as appropriate. The plans shall specify remedial actions and action levels that are justified and optimized, taking into account: (a) individual and collective radiation exposures; (b) radiological and non-radiological risks; and (c) financial and social costs, benefits and the financial liability for remedial actions. They also require that action levels for intervention through remedial action shall be specified in terms of appropriate quantities, such as the annual average ambient dose equivalent rate or a suitable average activity concentration of radionuclides that exist at the time remedial action is being considered. However, the BSS failed to prescribe numerical action levels for remediation.

The many assessments of the Chernobyl accident [11–17] clearly demonstrate that the BSS had to be complemented with specific guidance. In the year 2000, the IAEA issued guidance on the restoration of environments affected by residues from radiological accidents, with approaches to decision making [18]. Areas needing remediation from technologically enhanced natural radiation were also discussed in various forums (see, for example, Refs [19–22]). After the accident in Goiânia, Brazil, the IAEA started to publish a review of major radiological abnormal situations around the world, many of them requiring remediation (see, for example, Refs [3, 23]). Last but not least, the IAEA started to tackle the controversial issue of decommissioning of nuclear installations and the remediation of sites [24, 25].

However, it was not until November 2003 [26] that the IAEA finally established safety requirements for the remediation of areas contaminated by past activities and accidents. The new requirements did not introduce any fundamental change in the remediation philosophy. The objectives of remediation were now formulated as: (a) to reduce the doses to individuals or groups of individuals being exposed; (b) to avert doses to individuals or groups of individuals that are likely to arise in the future; and (c) to prevent or reduce environmental impacts from the radionuclides present in the contaminated area. Reductions in the doses to individuals and environmental impacts were to be achieved by means of interventions aimed at: (a) removing the existing sources of contamination; (b) modifying the pathways of exposure; and/or (c) reducing the numbers of individuals or other receptors exposed to radiation from the source. In some cases, the restricted use of human habitats may be the outcome of the optimization process for remediation [27]. The requirements established a generic reference level for aiding decisions on remediation as an existing annual effective dose of 10 mSv from all environmental sources, including natural background radiation.

The IAEA also analysed the non-technical factors influencing decision making processes in environmental remediation [28]. It concluded that a range of non-technical factors will influence the choice of technologies to be employed in remediation and the strategy for their implementation, including: economy, employment and infrastructure; costs, funding and financing; regulatory and institutional aspects; stakeholder perception and participation; project implementation related risks; co-contamination issues; future land use; and stewardship issues.

6. OUTLOOK

It is clear that substantive international recommendations, policies, strategies and, ultimately, standards are available for the remediation of land affected by radioactive residues. What is missing, however, is a simple, clear, unambiguous and unmistakable international agreement on what is safe and what is unsafe in relation to land contamination with radioactive materials. Fundamentally, an international safety regime is also missing — one that governs the standardization of protection in the remediation of contaminated territories and also the appraisal of compliance. Conveniently, an agreement on remediation could be expressed in terms of a derived practical quantity rather than in terms of the fundamental dosimetric radiation protection quantities. For instance, it could be expressed as activity per unit area rather than as a dose. Expediently, the agreement could ignore distinctions among radionuclides, even if it became over-conservative for some of them, and just include three basic numbers, for alpha, beta and gamma emitters, with some caveats for hot particles.

The time is ripe for such an agreement. People dwelling in the so-called 'contaminated' lands continue to ask an elementary question: "Is it safe for me and my family to live on this land?" And we, the radiation protection community ought to provide a clear and unambiguous answer.

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ASSISTING THE RETURN TO NORMAL LIFE IN CHERNOBYL-AFFECTED REGIONS: THE INTERNATIONAL CHERNOBYL RESEARCH AND INFORMATION NETWORK (ICRIN)

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Abstract

This article describes the International Chernobyl Research and Information Network (ICRIN) project, a programme designed to meet the priority information needs of communities in areas of Belarus, the Russian Federation and Ukraine which were affected by the 1986 nuclear accident. Its aim is to empower Chernobyl affected communities through targeted delivery of the most recent scientific information on the accident's impacts, translated into practical advice, including recommendations on healthy lifestyles. Supported by a United Nations General Assembly resolution, the project is part of a broader effort by all United Nations agencies to help local communities return to normal life, under the United Nations Action Plan on Chernobyl to 2016.

1. INTRODUCTION

On 26 April 1986 and over the following days, one of the Chernobyl reactors released around 14×10^{18} Bq of radioactivity into the environment, mainly in the form of iodine (^{131}I), caesium (^{137}Cs) and strontium (^{90}Sr). Around 340 000 people were evacuated and millions have lived since then in territories classified as 'contaminated'.

Although in 1986 more than 200 000 km^2 of Europe was contaminated with radionuclides (at a level greater than 37 kBq/m^2 of ^{137}Cs), nowadays the radiation exposure has been reduced by a factor of several hundred through natural processes and countermeasures. Now, most of the contaminated land is safe for life and economic activities, but around 5 million people in Belarus, the Russian Federation and Ukraine still live in Chernobyl affected areas. Although in most places the Chernobyl exposure is comparable with the exposure due to natural radiation, in about 700 settlements annual individual doses exceed the value of 1 mSv (in addition to the dose due to natural background radiation) and protective measures could be required.

In recent years, a consensus has emerged among governments and United Nations agencies that a sustainable development approach is the way forward for the Chernobyl area. Local communities have not fully recovered from the enormous socioeconomic impact of the accident, produced by population resettlement, psychological trauma, unemployment, broken social ties, anxiety and fear. Investment remains scarce, infrastructure is often lacking or neglected and young people tend to leave the region to seek opportunities elsewhere. All these factors have been exacerbated by the upheaval that followed the break-up of the Soviet Union.

2. UNITED NATIONS CHERNOBYL FORUM

Between 2003 and 2006, the United Nations Chernobyl Forum brought together the governments of Belarus, the Russian Federation and Ukraine, eight United Nations agencies and the World Bank, with the objective of conducting a rigorous scientific investigation into the long term health, environmental and socioeconomic consequences of the accident. In a resolution A/RES/60/14, the United Nations General Assembly noted "with satisfaction assistance rendered by the International Atomic Energy Agency to Belarus, the Russian Federation and Ukraine on remediation of agricultural and urban environments, cost-effective agricultural countermeasures and the monitoring of human exposure in areas affected by the Chernobyl disaster". It also noted "the necessity of further measures to ensure the integration of the assessment by the Chernobyl Forum of the environmental, health and socioeconomic consequences of the Chernobyl nuclear accident into the International Chernobyl Research and Information Network process through dissemination of the findings of the Forum, including in the form of practical messages on healthy and productive lifestyles, to the populations affected by the accident in order to empower them to maximize social and economic recovery and sustainable development in all its aspects".

According to the findings and recommendations of the United Nations Chernobyl Forum [1, 2], lack of information is one of the biggest challenges for those residing in the Chernobyl affected territories. The solution to this situation is seen in improved information provision that will help dispel the misconceptions surrounding

Chernobyl, promote healthy lifestyles and encourage the restoration of community self-reliance by showing local residents that they themselves hold the key to their own recovery, whether in health, environment or employment creation.

The forum pinpointed the fact that many local people were traumatized not only by the accident but also by their rapid relocation. They remained anxious about their health, perceiving themselves as 'victims' rather than 'survivors'. Fear and uncertainty about the long term effects of radiation were having a detrimental effect on the health of many citizens, translating into elevated anxiety levels, chronic stress, unexplained physical symptoms and subjective poor health.

The Chernobyl Forum came to the conclusion that the lack of information about the long term effects of the accident was a major problem, and that knowledge and information were necessary in order to reassure the populations and to address psychological impacts and mental wellbeing. Other public health problems such as unhealthy lifestyles and socioeconomic deprivation also needed to be addressed. A concerted cross-sectoral approach was deemed to be necessary in order to assist the inhabitants to live a normal life and to overcome the dominating stigma of the Chernobyl accident.

3. UNITED NATIONS ACTION PLAN ON CHERNOBYL TO 2016

On 20 November 2007, the United Nations General Assembly voted a resolution demanding a new action plan for the third decade after the Chernobyl accident. The aim of this 'Decade of Recovery and Sustainable Development' is to ensure that, by 2016, the stigma in the area will be overcome and a full return to normal life will be achieved.

The resolution underlines the need to disseminate the findings of the Chernobyl Forum by providing accurate information on the impact of radiation in accessible language. The provision of information to affected populations will ideally include the promotion of healthy lifestyles and support for community based social and economic development, as well as the provision of evidence based policy advice to national authorities. The United Nations Action Plan on Chernobyl to 2016 is a practical framework [3] that builds on recognized IAEA mandates and competencies. It seeks to maximize the effects of limited resources, while avoiding the duplication of efforts. The International Chernobyl Research and Information Network (ICRIN) is one of the major joint United Nations activities foreseen under the United Nations Action Plan on Chernobyl to 2016.

ICRIN: A FOUR–AGENCY PROJECT BY UNDP, WHO, THE IAEA AND UNICEFICRIN is a $2.5 million programme designed to meet the priority information needs of communities in Belarus, the Russian Federation and Ukraine. Funded by the United Nations Human Security Trust Fund, the project is operated by the United Nations Development Programme (UNDP), the World Health Organization (WHO), the United Nations Children's Fund (UNICEF) and the IAEA.

This three year programme, which began in 2009, aims to translate scientific information on the consequences of the accident into sound practical advice for residents of the affected territories. Activities planned under ICRIN include: education and training for teachers, medical professionals, community leaders and the media; providing local residents with practical advice on health risks and healthy lifestyles; the creation of Internet equipped information centres in rural areas; and small scale community infrastructure projects aimed at improving living conditions and promoting self-reliance.

ICRIN objectives

- Deliver information in non-technical language and linked to day-to-day life;
- Adapt scientific knowledge to public needs;
- Build the capacity of local stakeholders;
- Invest in information technologies at the local level.

ICRIN main activities

- Match current scientific knowledge to local information needs and introduce efficient methods of dissemination;
- Set up a monitoring system with a focus on changes in human security levels, behavioural patterns and perceptions of the affected population;
- Develop practical information materials and 'user friendly' recommendations for residents of contaminated areas.

ICRIN expected outcomes

- Credible communication and communicators will help residents regain confidence and self-reliance.
- Local stakeholders and the general public will gain access to and become able to rely on up-to-date and scientifically accurate information.

- The stigma still associated with the affected territory will be overcome.
- Poverty reduction will be achieved.
- Support will be available for innovative solutions accepted or proposed by the communities.
- Healthy lifestyles will be promoted among all age groups.
- Success will be achieved in turning a generation of victims into a generation of proud survivors.

UNDP

The UNDP approach is based on the recommendations of the 2002 UNDP report [4], which outlines the shift from humanitarian to development assistance. In line with this change in strategy and at the request of the United Nations Secretary-General, UNDP has assumed responsibility for the United Nations wide coordination of Chernobyl issues since 2004. UNDP is also responsible for coordinating the ICRIN project.

Before ICRIN began, UNDP conducted surveys in Belarus, the Russian Federation and Ukraine, aimed at identifying specific information needs and at assessing public perception of the issue of radioactive contamination. Information needs in the three countries turned out to be very consistent. The top three answers to the question "What worries you the most?" were the health effects of radioactivity and low standards of living/poverty, followed by radioactivity in the environment.

Under the United Nations Action Plan, UNDP places particular emphasis on community development efforts. These include:

- Expanding community development efforts in Belarus through integrated projects that include: improving the income of small private farmers by helping them develop products that meet health and safety standards; supporting community decision making; advocating healthy lifestyles; improving access to primary health care services; and establishing school centres for radiological advice and training.
- Promoting the replication of the Bryansk local economic development centre in other Chernobyl affected oblasts of the Russian Federation.
- Expanding the Chernobyl Recovery and Development Programme (CRDP) in Ukraine, to bring practical infrastructure improvements, job creation and a message of self-reliance to affected communities.
- Supporting the creation of local economic development agencies in affected areas of Ukraine to stimulate small and medium sized businesses and improving the business and investment climate in the region.

UNDP's presence in local communities will help ensure that the message of reassurance that emerged from the United Nations Chernobyl Forum will reach local residents.

WHO

According to the WHO report on the health consequences of the Chernobyl accident [5], an important aspect of the ICRIN project is the mitigation of one of the largest consequences of the Chernobyl accident — psychological impact — by shifting the stigma away from the inhabitants of the Chernobyl area. It is also vital to address the fears about radiation, which are mostly caused by information gaps, and the development issues, as well as the other public health problems which are not specific to the Chernobyl area but that remain common throughout many former Soviet Union States. In these States, the top five causes of death are, according to the WHO Global Health Risks report: high blood pressure, tobacco use, high blood glucose, physical inactivity, being overweight and high cholesterol levels [6]. The situation is further aggravated by the lack of adequate resources in rural health care settings, which resulted from economic changes following the break-up of Soviet Union.

In view of these facts, the WHO contribution to ICRIN is focused on the following areas:

- Assisting the national authorities of the three most affected countries with technical guidance, consultation and advice on health care programmes and medical monitoring, particularly of high risk groups, through a series of educational and information activities, such as workshops, seminars and training programmes;
- Translating the health findings of the Chernobyl Forum into easy to understand messages and producing targeted education packages tailored for health workers, teachers and local decision makers;
- Achieving a broad dissemination of these messages, in a format accessible to local residents;
- Shaping the Chernobyl research agenda and promoting priority research in the area of the health consequences of the Chernobyl accident — drawing on the recommendations of the Chernobyl Forum.

IAEA

The IAEA was the driving force behind the United Nations Chernobyl Forum. The ICRIN project is a part of the IAEA contribution to the United Nations Action Plan on Chernobyl to 2016. Within the framework of ICRIN the IAEA could continue efforts towards the:

- Adaptation of the scientific information about environmental and radiological consequences of the Chernobyl accident to meet public needs;
- Promotion of a safety culture and the delivery of information in non-technical language, linked to daily life;
- Development of public information materials and resources about Chernobyl related issues.

In addition to its role in the ICRIN project, under the United Nations Action Plan it is suggested that the IAEA will focus on:

- Radiological support for the rehabilitation of areas affected by the Chernobyl accident and upgrading of national capabilities to control public exposure;
- Assistance in the remediation of affected areas using environmentally sound technologies;
- Assistance in improving safety at the Chernobyl nuclear plant, in the decommissioning of Units 1, 2 and 3 and in radioactive waste management;
- Support to Ukraine in fulfilling its Nuclear Safeguards Agreement obligations to report relevant nuclear material related to decommissioning and excavation at the Chernobyl site;
- Cooperation within the scope of the IAEA mandate with other organizations in the planning, design and implementation of projects and activities related to the broader issue of mitigating the health, environmental and socioeconomic consequences of the accident.

UNICEF

UNICEF has been actively participating in ICRIN development and design from the beginning. The ICRIN Scientific Board is a welcome arena in which UNICEF is glad to provide child-related contributions, expertise in the area of psychosocial wellbeing, as well as ideas about support to vulnerable families and micronutrient supplementation.

UNICEF's main contribution to ICRIN is 'Facts for Life Chernobyl' [7], an empowerment tool that helps people, in particular children, young people and women, to enjoy healthy and productive lives. This publication provides people living in affected areas with practical information on how to cope with the environmental, social and health problems that they face. Using 16 key messages, it provides facts on proper nutrition, early child development and iodized salt consumption for the prevention of iodine deficiency disorders. The publication also addresses cancer prevention and provides information on health care services.

'Facts for Life Chernobyl' was first launched in March 2008 in three languages in Ukraine, the Russian Federation and Belarus, using UNICEF regular resources. The ICRIN project will give a decisive boost to its dissemination, enabling media advocacy and training for health workers and teachers, in coordination with the other United Nations agencies.

Outside the ICRIN project, UNICEF will also invest in the promotion of universal salt iodization. This includes enhancing national capacities for monitoring iodized salt quality, establishing an efficient system for the prevention of iodine deficiency diseases, and helping to investigate and disseminate information on iodine nutrition and the iodine deficiency status of women and children.

4. CONCLUSION: A SINGLE VOICE ON CHERNOBYL

This article has shown that several United Nations agencies are active in Chernobyl recovery efforts. They are united under the principles of the United Nations Action Plan Chernobyl to 2016 and share the same resolve to support the territories affected by the accident in achieving a full return to normal life. The ICRIN project, with its emphasis on providing affected communities with the information they need to live normal, healthy lives, offers the four United Nations agencies involved an opportunity to demonstrate the benefits of joint United Nations action on a common theme. A first indication of how well this effort is succeeding will be found in the Secretary-General's report on Chernobyl to the United Nations General Assembly, due in the course of 2010.

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