THE EXISTING RUSSIAN FEDERATION REGULATORY FRAMEWORK ON ENVIRONMENTAL REMEDIATION

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Abstract

The paper addresses the public radiation exposures and medical consequences resulting from the territories of the Russian Federation contaminated with residual radioactive materials due to nuclear weapons tests and large scale accidents. A comparison is made between the current Russian system of environmental remediation regulation and the new international approaches of ICRP Publication 103.

1. INTRODUCTION

The nature and extent of radioactive contamination of territories in the Russian Federation is currently being assessed in relation to the regulations established on the basis of Russian legislation in the fields of sanitary and epidemiological supervision of the public, radiation safety and protection of the environment. The same regulations are used to define harm to human health and the environment.

According to current Russian Federation legislation, the Federal Medical-Biological Agency (FMBA) is responsible for medical and sanitary support as well as for state sanitary epidemiological supervision. It covers organizations in some industrial branches in which there are especially hazardous work conditions and the population of some Russian territories according to a list approved by the Government. This list includes all radiation hazardous facilities in the Russian Federation (more than 400 facilities). One of the FMBA's principal functions is the state regulatory supervision of safety in nuclear energy exploitation.

2. PROBLEMS IN THE NUCLEAR INDUSTRY AND LAND AFFECTED BY RADIOACTIVE MATERIAL RESIDUES IN THE RUSSIAN FEDERATION

Routine discharges from nuclear facilities do not contribute significantly to the exposure of the general public. In contrast, some historical radioactive releases which occurred in emergency situations (Techa River, 1949, Kyshtym, 1957, Chernobyl, 1986) resulted in radiation doses to population groups that significantly exceeded safe levels (see Table 1, which shows data from Ref. [1]).

Exposures of this magnitude can lead to adverse health effects such as radiation sickness and a long term increase in the incidence of cancer in the residents of the affected areas (Table 2, which shows data from Ref. [1]). The research institutions of the FMBA study the consequences of the contamination of Techa River, Southern Urals, due to both unauthorized radioactive discharges from the Production Asscoiation (PA) Mayak in the late 1940s and the accident at Mayak in 1957. These institutions are the Southern Urals Institute of Biophysics and the Urals Research Centre of Radiation Medicine.

TABLE 1. RADIATION DOSES FROM HUMAN-MADE RADIONUCLIDE RELEASES

Source	Time period	Significant nuclides	Mean dose (mSv)
Global fallout	1950–2020	^{137}Cs, ^{90}Sr, ^{131}I, ^{14}C, ^{3}H	1.1 mSv
Techa River	1949–2020	^{90}Sr, ^{89}Sr, ^{137}Cs, other	50–2000 mSv
Chernobyl	1986–2056	^{131}I, ^{134}Cs, ^{137}Cs, ^{90}Sr	Effective — up to 500 mSv Thyroid — up to 10^4 mGy

TABLE 2. OBSERVED HEALTH EFFECTS FROM ENVIRONMENTAL EXPOSURES

Source	Number of persons exposed	Observed health effect
Global fallout	Few billions	None observable against a very large background of cancer incidence
Techa River	28 thousand	100–1000 cases of chronic radiation sickness; leukaemia and solid cancer
Chernobyl	Few millions	2000 thyroid cancers in children by 2000; more are expected

Following some nuclear accidents, various radiobiological effects in non-human species, for example plants and animals, have also been observed. Thus, managing the mitigation of effects applies to the environment generally, as well as to humans.

In addition to the above mentioned challenges in the Russian nuclear industry, some additional problems affecting the land areas of the Russian Federation are to be considered: the inadequacy of the containment provided by some shallow radioactive waste storage facilities (and the absence of any reserve of storage facilities at some NPPs) and the consequences of military activities within the areas of nuclear submarine bases. (This latter activity has resulted in large amounts of the spent nuclear fuel and radioactive waste being accumulated at the sites of temporary storage in the north-west and far east of Russia.)

Radioactive contamination due to the presence of uranium tailing dumps is also a very important environmental issue for the Russian Federation. The residents of some Russian settlements are subjected to significant radiation exposure due to high concentrations of ^{222}Rn in dwellings. For example, an unsatisfactory situation in this respect exists at two areas under FMBA responsibility. These are Oktyabrsky village in the Chita region (Eastern Siberia, the Chinese border) and Lermontov city in the Stavropol Territory. Oktyabrsky village is situated in the neighbourhood of the largest Russian uranium complex facility. Radiation dose rates in the area of this village are typical for uranium containing areas. Levels exceeding the ^{222}Rn limit (200 Bq/m^3) have been found in 39% of dwellings. The FMBA submitted the findings of its examinations to Rosatom (the State Atomic Energy Corporation) and, at the end of 2007, the decision was made to re-settle the residents of this village. A similar problem in Lermontov city, which has about 1000 dwellings with high radon levels, has not yet been solved.

Thus, in the foreseeable future, the Russian Federation nuclear industry will have to solve many resource intensive environmental problems. For this purpose, the special Federal Target Programme Nuclear and Radiation Safety for 2008 and for the Period Till 2015 is currently in force in the Russian Federation. The FMBA is taking part in some activities within this programme.

3. CURRENT REGULATION OF ENVIRONMENTAL REMEDIATION IN THE RUSSIAN FEDERATION

National radiation protection standards of many states, including the Russian Federation, are based on documents of the International Commission on Radiological Protection (ICRP) and of the International Atomic Energy Agency:

- ICRP: Recommendations on Radiological Protection (Publication 103, 2008 [2]);
- IAEA: Basic Safety Standards, 1996 [3] (now under revision);
- Russian Federation: Radiation Safety Standards (NRB-99), 1999 (to be reviewed).

NRB-99 contains guidance (intervention criteria) with respect to previously radioactively contaminated areas. Optimized protective and remedial measures are recommended at annual doses within the range 1–20 mSv; at a dose >20 mSv, residence within the territory is forbidden. Quite good compliance with the recommendations of ICRP Publication 103 [2] is evident; nevertheless, the existing application of the lower boundary (1 mSv/a) for large scale situations (Chernobyl, Kyshtym, Techa) seems to be inappropriate. This can be explained by the Chernobyl Law adopted on the rise of democracy in the early 1990s and by the incorrect use of the public dose limit in the case of emergency and existing exposure situations.

4. REGULATORY TRENDS IN ENVIRONMENTAL REMEDIATION IN THE RUSSIAN FEDERATION

According to ICRP Publication 103 [2], environmental contamination can be considered an existing exposure situation, i.e. the exposure situation already exists when a decision has to be made on radiation protection. This kind of exposure situation includes prolonged exposure due to excess radiation background, after radiation accidents and following previous radiation substance handling (including nuclear weapon

manufacturing and tests, etc.). In many respects, the Chernobyl accident resulted in the generation of such exposure situations.

The previous ICRP publication on this subject, Publication 82 (1999) [4], and the IAEA documents (WS-R-3 [5], WS-G-3.1 [6]) recommended the following principal provisions with respect to remediation situations:

- Dose limits cannot be used.
- Criteria for human protection — justification and optimization of intervention.
- General criterion of non-intervention — non-exceedance of an annual effective dose to the public (due to all environmental sources (including background)) of 10 mSv. Intervention will ideally be implemented above this level.

ICRP Publication 103 [2] and a draft special ICRP Publication on remediation (2009) reject the previously mentioned 'intervention' concept and introduce the 'reference dose or risk level'. The reference level is a level above which radiation exposure is not permitted, so optimized protective measures are to be taken. The regulatory body will ideally establish the reference level for the specific or typical situation. In the case of existing exposure situations, the reference level of annual effective dose is suggested to be in the range of 1–20 mSv. Higher levels are proposed to be applied for larger scale situations.

In addition to the review of the Russian NRB-99, some special criteria for environmental remediation are to be developed. The special environmental programmes and Government directives serve as the legal basis for carrying out such developments:

- The Federal Law on The Special Environmental Remediation Programmes of Some Parts of the Territory under Radioactive Contamination, 2001;
- The Federal Law on The Transfer of Lands from One Category to Another, 2004;
- The Government Directive on Use of Lands under Radioactive or Chemical Contamination, Performance of Reclamation Operations there, and Establishment of Security Areas, 2004.

According to these laws, remedial measures must be anticipated at the stage of the remediation design development. The programme of site remediation must be developed for normal living activities of the population and land use. Information on the radiation situation must be provided in relation to the public living close to the facility in the affected zone.

International cooperation can play a significant role in regulatory aspects of environmental remediation because of the similarity of the problems existing in the states which have researched and developed nuclear technologies. The large scale international collaborative project with the participation of the Norwegian Radiation Protection Authority and the Federal Medical Biological Agency is an example of the application of up-to-date regulations to environmental remediation in the Russian Federation. This project deals with radiation safety regulation in the north-west of the Russian Federation, in particular, on the Kola Peninsula, where two ex-navy bases are located. At these bases, spent nuclear fuel and radioactive waste from nuclear submarines are stored. In the course of such cooperation, the FMBA's specialists together with their Norwegian colleagues have developed many regulatory documents based on the findings of scientific research. These documents include the remediation criteria and regulations relevant to the site of spent nuclear fuel and radioactive waste temporary storage, taking into account up-to-date ICRP approaches.

5. CONCLUSIONS

- Nuclear weapons tests, large scale radiological accidents, discharges of effluents from nuclear facilities and poor storage of solid radioactive waste have led to the appearance of human-made radionuclides in the biosphere as a whole and to excess radioactive contamination of some areas of the Russian Federation. Defence activities have been the largest contributor to this areal contamination.
- Levels of radiation exposure of environmental media, typical for the routine operation of the nuclear energy using facilities, are hundreds and thousands of times less than those which can affect the biota. However, radiation effects in environmental media have been found in limited areas within territories most contaminated after the accidents at Chernobyl accident in 1986 and at PA Mayak in 1957.
- In many respects, the ICRP and IAEA have developed the international radiation protection system for the existing (prolonged) public exposure situations under the influence of the Chernobyl experience.

– The current Russian radiation protection system is not arranged well enough in its documentation and differs from the international system, in particular, in the application of the dose limit for planned exposure situations (1 mSv/a) for situations of emergency and existing exposure.

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UNITED STATES POLICIES FOR CLEANUP AT RADIOACTIVELY CONTAMINATED SITES

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Abstract

The United States Environmental Protection Agency (EPA) Office of Superfund Remediation and Technology Innovation is responsible for implementing the long term (non-emergency) portion of a key law regulating cleanup: the Comprehensive Environmental Response, Compensation and Liability Act, CERCLA, nicknamed 'Superfund.' This paper provides a brief overview of the approach used by EPA to conduct Superfund cleanups at contaminated sites, including those that are contaminated with radionuclides, and to ensure protection of human health and the environment. The theme emphasized throughout the paper is that within the Superfund remediation framework, radioactive contamination is dealt with in a manner consistent with chemical contamination, except to account for the technical differences between radionuclides and chemicals. This consistency is important since at every radioactively contaminated site being addressed under Superfund's primary programme for long term cleanup (the National Priorities List), chemical contamination is also present.

1. INTRODUCTION

The United States (US) Environmental Protection Agency (EPA) Office of Superfund Remediation and Technology Innovation (OSRTI) is responsible for implementing the long term (non-emergency) portion of a key law regulating cleanup: the Comprehensive Environmental Response, Compensation and Liability Act, CERCLA, commonly known as 'Superfund.' The purpose of the Superfund programme is to protect human health and the environment over the long term from releases or potential releases of hazardous substances from abandoned or uncontrolled hazardous waste sites. The focus of this paper is on Superfund, including how radiation is addressed by the Superfund programme.

This paper provides a brief overview of the approach used by EPA to conduct Superfund cleanups at contaminated sites, including those that are contaminated with radionuclides, to ensure protection of human health and the environment. The paper addresses how it is determined if a site poses a risk to human health and the framework used to determine cleanup levels. The theme emphasized throughout the paper is that within the Superfund remediation framework, radioactive contamination is dealt with in a manner consistent with chemical contamination, except to account for the technical differences between radionuclides and chemicals. This consistency is important since at every radioactively contaminated site being addressed under Superfund's primary programme for long term cleanup (the National Priorities List (NPL)), chemical contamination is also present.

While every Superfund site is unique, and thus cleanups must be tailored to the specific needs of each site, there are two requirements that must be met at each site. Firstly, CERCLA requires that all remedial actions at Superfund sites must be protective of human health and the environment. Therefore, cleanup actions are developed with a strong preference for remedies that are highly reliable, provide long term protection and provide treatment of the principal threat by permanently and significantly reducing the volume, toxicity or mobility of the contamination. In addition, EPA believes that site cleanups will ideally protect groundwater that is a current or potential source of drinking water to drinking water standards whenever practicable. Secondly, CERCLA specifically requires Superfund actions to attain the standards and requirements found in other State and Federal environmental laws and regulations unless there is a specific basis for waiving that standard or requirement. This mandate is known as compliance with 'applicable or relevant and appropriate requirements' or ARARs.

2. REMEDY SELECTION

A comprehensive regulation known as the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) contains the guidelines and procedures for implementing the Superfund programme. The NCP sets forth nine criteria for selecting Superfund remedial actions. These evaluation criteria are the standards by which all remedial alternatives are assessed and are the basis of the remedy selection process. The criteria can be separated into three levels: threshold, balancing and modifying. The first two (of the nine) criteria are known as 'threshold' criteria. They are a reiteration of the CERCLA mandate that remedies must (a) at a minimum assure

protection of human health and the environment and (b) comply with (or waive) ARARs. They are the minimum requirements that each alternative must meet in order to be eligible for selection as a remedy.

After the threshold criteria are applied, EPA considers the other evaluation criteria. Five of the criteria are known as the 'balancing' criteria. These criteria involve assessing tradeoffs between alternatives so that the best option will be chosen, given site specific data and conditions. The criteria balance long term effectiveness and permanence, reduction of toxicity, mobility or volume, short term effectiveness, implementability and cost. The final two criteria are called 'modifying' criteria: new information or comments from the State or the community may modify the preferred remedial action alternative or cause another alternative to be considered.

3. RISK BASED CLEANUP LEVELS

Cleanup levels for radioactive contamination at CERCLA sites are generally expressed in terms of risk levels, rather than dose (millirem or millisieverts), as a unit of measure. CERCLA guidance recommends the use of slope factors based on the risk coefficients contained in Federal Guidance Report 13, which is based on International Commission on Radiological Protection (ICRP) publications 60 and 72.

Compliance with ARARs is often the determining factor in establishing cleanup levels at CERCLA sites. However, where ARARs are not available or are not sufficiently protective, EPA generally sets site specific remediation levels for: (a) carcinogens at a level that represents an upper bound lifetime cancer risk to an individual of between 10^{-4} to 10^{-6}; and for (b) non-carcinogens such that the cumulative risks from exposure will not result in adverse effects to human populations (including sensitive sub-populations) that may be exposed during a lifetime or part of a lifetime, incorporating an adequate margin of safety. The specified cleanup levels account for exposures from all potential pathways, and through all media (e.g. soil, groundwater, surface water, sediment, air, structures and biota).

The 10^{-4} to 10^{-6} cancer risk range can be interpreted to mean that a highly exposed individual may have a one in 10 000 to one in 1 000 000 increased chance of developing cancer because of exposure to a site related carcinogen. Once a decision has been made to take an action, EPA prefers cleanups that achieve the more protective end of the range (i.e. 10^{-6}). EPA uses 10^{-6} as a point of departure and establishes Preliminary Remediation Goals (PRGs) at 1×10^{-6}.

To assess the potential for cumulative non-carcinogenic effects posed by multiple contaminants, EPA has developed a hazard index (HI). The HI is derived by adding the non-cancer risks for site contaminants with the same target organ or mechanism of toxicity. When the HI exceeds 1.0, there may be concern for adverse health effects due to exposure to multiple contaminants. Radioisotopes of uranium are generally the only radionuclides for which EPA will evaluate the HI.

3.1. Preliminary remediation goals (PRGs)

PRGs are used for site 'screening' and as initial cleanup goals, if applicable. The PRG's role in site screening is to help identify areas, contaminants and conditions that do not require further federal attention at a particular site. PRGs not based on ARARs are risk based concentrations, derived from standardized equations combining exposure information assumptions with EPA toxicity data. PRGs based on cancer risk are established at 1×10^{-6}. PRGs are modified, as needed, based on site specific information.

3.2. Superfund risk and dose soil and water models

EPA has developed an electronic PRG calculator for radionuclides, known as the Rad PRG calculator. This electronic calculator presents risk based standardized exposure parameters and equations that will ideally be used for calculating radionuclide PRGs for residential, commercial/industrial and agricultural land use exposures, tap water and fish ingestion exposures. The calculator also presents PRGs to protect groundwater, which are determined by calculating the concentration of radioactively contaminated soil that does not result in leaching from soil to groundwater that would exceed MCLs or risk based concentrations. The Rad PRG calculator may be found at: http://epa-prgs.ornl.gov/radionuclides/.

To address ARARs that are expressed in terms of millirem per year, an approach similar to that taken for calculation of PRGs is used to calculate soil 'compliance concentrations' based upon various methods of dose calculation in another EPA tool, the 'Dose Compliance Concentrations', or DCC calculator. The DCC calculator equations are identical to those in the Rad PRG calculator, except that the target dose rate (ARAR based) is substituted for the target cancer risk (1×10^{-6}), the period of exposure is one year to indicate year of peak dose, and a dose conversion factor (DCF) is used in place of the slope factor. The DCC calculator may be found at http://epa-dccs.ornl.gov/.

3.3. Superfund decommissioning models

EPA has recently completed two risk assessment tools that are particularly relevant to decommissioning activities conducted under CERCLA authority. EPA developed the Preliminary Remediation Goals for Radionuclides in Buildings (BPRG) electronic calculator to help standardize the evaluation and cleanup of radioactively contaminated buildings at which risk is being assessed for occupancy. BPRGs are radionuclide concentrations in dust, air and building materials that correspond to a specified level of human cancer risk. The BPRG calculator may be found at: http://epa-bprg.ornl.gov/.

EPA developed the Preliminary Remediation Goals for Radionuclides in Outside Surface (SPRG) calculator to address hard outside surfaces such as building slabs, outside building walls, sidewalks and roads. SPRGs are radionuclide concentrations in dust and hard outside surface materials that correspond to a specified level of human cancer risk. The SPRG calculator may be found at: http://epa-sprg.ornl.gov/.

3.4. Superfund ecological risk model

EPA is also developing the Radionuclide Ecological Benchmark calculator. This calculator provides biota concentration guides (BCGs), also known as ecological screening benchmarks, for use in ecological risk assessments at CERCLA sites. The calculator develops ecological benchmarks for ionizing radiation based on cell death only.

4. COMPLIANCE WITH ENVIRONMENTAL LAWS

Compliance with (or waiver of) ARARs is a cornerstone of CERCLA. Because the diverse characteristics of Superfund sites preclude the development of prescribed ARARs, it is necessary to identify ARARs on a site by site basis. Some of the radiation standards most frequently used as ARARs at Superfund sites are the soil cleanup and indoor radon standards developed to address contamination at sites that are subject to the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA). When used as an ARAR at Superfund sites, the soil cleanup level for radium-226 and radium-228 combined, or thorium-230 and thorium-232 combined, is 5 picocuries per gram (pCi/g) (0.185 becquerels per gram (Bq/g)) above background, while the indoor radon level is 0.02 working levels inclusive of background. For a list of 'Likely Federal Radiation Applicable or Relevant and Appropriate Requirements (ARARs)', see Attachment A of EPA's guidance 'Establishment of Cleanup Levels for CERCLA sites with Radioactive Contamination' at:

http://www.epa.gov/superfund/health/contaminants/radiation/pdfs/radguide.pdf

One extremely important category of ARARs that ought to be noted are Maximum Contaminant Levels (MCLs) that are established under the US law for drinking water standards, called the Safe Drinking Water Act. EPA believes contaminated groundwater should be restored to beneficial use, whenever practicable. This means that sites where the contaminated groundwater is a potential or current source of drinking water will ideally be remediated to concentrations corresponding to drinking water standards (e.g. concentrations corresponding to MCLs or more stringent State drinking water standards). The Superfund programme requires MCLs be met within the aquifer, not at the tap.

The current MCLs for radionuclides are set at 4 mrem/a (0.04 mSv/a) to the whole body or an organ for the sum of the doses from beta and photon emitters, 15 pCi/L (0.555 Bq/L) for gross alpha and 5 pCi/L (0.185 Bq/L) combined for radium-228 and radium-226 and 30 mg/L of uranium. EPA has published concentration tables for each radionuclide that correspond to the 4 mrem/a MCL which may be found at:

http://www.epa.gov/safewater/radionuclides/pdfs/guide_radionuclides_table-betaphotonemitters.pdf.

5. SUMMARY

The CERCLA framework for addressing hazardous sites ensures that risks from radioactive contamination will be addressed in a manner consistent with risks from non-radioactive contamination, except to account for technical differences posed by radionuclides. For more information and copies of EPA guidance documents for addressing radioactively contaminated CERCLA sites, see the EPA's Superfund Radiation web page. For more information and copies of EPA guidance documents for developing cleanup levels for long term CERCLA sites, see EPA's Remedy Decisions webpage. These webpages may be found at:

http://www.epa.gov/superfund/health/contaminants/radiation/index.htm

http://www.epa.gov/superfund/policy/remedy/sfremedy/index.htm

Both of these webpages contain numerous Office of Solid Waste and Emergency Response (OSWER) Directives, which are EPA's official guidance for the Superfund programme and other material that is useful for cleaning up CERCLA sites.

PRINCIPLES OF URANIUM STEWARDSHIP: GUIDANCE FROM THE WORLD NUCLEAR ASSOCIATION

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Abstract

The World Nuclear Association (WNA) has established 'Principles of Uranium Stewardship' whose purpose is to ensure that uranium and its by-products are managed so as to combine safety, environmental responsibility, sound economics and social acceptability. The principles are equally relevant for operators, contractors, and regulators newly engaged in uranium mining and processing. This paper outlines the background to the principles and the essential features of the WNA principles document.

1. INTRODUCTION

The worldwide community of professionals engaged in uranium mining and processing recognizes that managing health and safety, waste and the environment is of paramount importance. This recognition — and the acceptance of commensurate responsibility — is fundamental to the vision of the World Nuclear Association (WNA), its values and measures of success.

Responsible management of uranium mining and processing projects will ideally be applied at all stages of planning and activities — from exploration through to development, construction and operations, and on to decommissioning. Today, the WNA is acting to ensure that all parties directly involved in uranium mining and processing — including operators, contractors, and regulators — strive to achieve the highest levels of excellence in these fields of management. The WNA is doing this by sustaining a strong safety culture based on a commitment to a framework of common, internationally shared principles.

These international principles build on — and are complementary to — the World Nuclear Association's 'Charter of Ethics' and its 'Principles of Uranium Stewardship'.

The WNA Charter of Ethics is founded on the belief "... that sustainability must be the guiding principle of global development — requiring worldwide policies that meet the needs and aspirations of the present generation without compromising the opportunity of future generations to fulfil their needs and aspirations".

The Waste Management and Decommissioning Working Groups (WM and DWG) of the WNA each currently consists of over forty radiation protection experts from various sectors of the nuclear industry and from around the world. This policy document was developed by a subgroup which consists of relevant uranium mining experts. The WNA Principles of Uranium Stewardship focus on the commodity on which nuclear energy is based. The principles embody best practice and ethical conduct for the entire global nuclear industry. The WNA programme of Uranium Stewardship is based on a commitment to ensure that uranium and its by-products are managed so as to combine safety, environmental responsibility, sound economics and social acceptability.

The WNA document sets out principles for the management of radiation, health and safety, waste and the environment and is applicable to sites throughout the world. In national and regional settings, where activities of the nuclear fuel cycle have reached advanced stages of development, these principles already serve to underpin Codes of Practice that govern uranium mining and processing. In any given setting, a Code of Practice is needed to guide practical implementation of these principles according to the regional, national or site- specific context.

The WNA has published these principles in the belief that they hold special relevance for emerging uranium producing countries that do not yet have fully developed regulations for the control of radiation, health and safety, waste and the environment associated with uranium mining and processing. Moreover, experience shows that close cooperation among these three parties is a key to the successful management of radiation, health and safety, waste and the environment.

While the independence of regulators is clearly essential to their function, the very existence of these regulatory agencies derives from governmental recognition that uranium mining can provide socially beneficial results. Thus, the ultimate purpose of such regulators is to enable mining and processing in compliance with acceptably high standards.

Of course, each principle affirmed in the WNA document will not apply to the same extent for each party. For example, general responsibility for installations and sites lies fundamentally with operators, who must accept overall responsibility for the performance of contractors. Ultimately, the precise allocation of responsibilities must be set at national and local levels.

Once national regulations are fully developed, they can be expected to embody the principles enunciated in WNA's document. During any transition period during which regulatory rules and regimes are not yet fully formed, the principles will ideally still be applied.

The WNA document holds the status of a policy and ethical declaration by the full WNA membership, which encompasses most of the wide range of enterprises that comprise the global nuclear industry — from uranium miners, to equipment suppliers, service providers and generators of electricity. In the category of uranium miners, the WNA membership includes all major uranium mining and processing companies as well as many midsize and junior companies.

The principles affirmed here are supported by key relevant international organizations, including the International Atomic Energy Agency. Indeed, these principles have been affirmed as an outgrowth of an IAEA cooperation project aimed at encouraging expanded exchanges between professionals from governments and industry. These principles are also supported by the global mining community through relevant international and national associations that cover uranium mining and processing.

2. PRINCIPLES

Principle 1: Adherence to sustainable development

Conduct all aspects of uranium mining and processing with full adherence to the principles of sustainable development as set forth by the International Council on Mining and Metals (ICMM). Apply these principles with an emphasis on excellence in professional skills, transparency in operations, accountability of management, and an overarching recognition of the congruency of good business and sound environmental practices.

Discussion:

In establishing its sustainable development principles, the ICMM adopted the landmark definition of that term advanced by the UN Brundtland Commission in 1983: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

To this the ICMM added: "In the mining and metals sector...investments should be financially profitable, technically appropriate, environmentally sound and socially responsible". In emphasizing the practical necessity of financial profitability, the ICMM underscored that economic profitability and sustainable development, far from being at odds, must be consistent in reinforcing goals. This congruency of purpose is reflected in the ICMM commitment to "seek continual improvement in performance and contribution to sustainable development so as to enhance shareholder values".

Principle 2: Health, safety and environmental protection

In all management practices, ensure adequate protection of employees, contractors, communities, the general public and the environment, as follows:

Mining safety — Ensure safe, well maintained site conditions for the protection of employees and the public from all conventional mining hazards, including those related to airborne contaminants, ground stability and structure, geological and hydrogeological conditions, storage and handling of explosives, mine flooding, mobile and stationary equipment, ingress and egress, and fire.

Radiation safety — Comply with the principles of justification, optimization and limitation, as follows:

Justification: Authorize the introduction of any new practice involving radiation exposure, or the introduction of a new source of radiation exposure within a practice, only if the practice can be justified as producing sufficient benefit to the exposed individuals or to society to offset any potential radiation harm.

Optimization and Limitation: Optimize radiation exposure to as low as reasonably achievable, taking into account all socioeconomic factors. Ensure compliance with the occupational and public dose limits laid down by the appropriate national and international regulatory and advisory bodies. In so doing, classify, according to risk, site personnel and work areas that are subject to radiation exposure. Plan and carefully monitor employee and contractor doses, radioactive discharges and emissions as well as resulting environmental concentrations and exposure rates. Estimate potential radiological impacts on the public and the environment.

Personal protective equipment — Ensure that employees and visitors are provided personal protective equipment (PPE) appropriate for the hazard being controlled and compliant with relevant standards or specifications to control exposure to safe levels. Ensure that relevant personnel remain properly trained in the use and maintenance of this equipment.

Ventilation — Ensure that workplaces are adequately ventilated and that airborne contaminants are minimized in workplaces. Pay particular attention to controlling radon and related radiation exposures in

uranium mines and processing facilities.

Water quality — Develop and implement site specific water management practices that meet defined water quality objectives for surface and groundwaters (focusing particular attention on potable water supplies). Subject water quality objectives to periodic review to ensure that people and the environment remain protected.

Environmental protection — Overall, avoid the pollution of water, soil and air. Optimize the use of natural resources and energy and minimize any impact from the site and its activities on people and the environment. In so doing, include considerations of sustainability, biodiversity and ecology in guarding against environmental impact.

Principle 3: Compliance

Support the establishment of a suitable legal framework and relevant infrastructure for the management and control of radiation, occupational and public health and safety, waste and the environment. Ensure that all activities are authorized by relevant authorities and conducted in full compliance with applicable conventions, laws, regulations and requirements, including, in particular, the Safety Standards of the IAEA. In recognition that effective interaction of operators (including contractors) and the appropriate regulatory authorities is essential to safety, ensure that operators and contractors are licensed, having met the requirement of relevant authorities.

Principle 4: Social responsibility

At all stages of uranium mining and processing, properly inform — and seek, gain and maintain support from — all potentially affected stakeholders, including employees, contractors, host communities and the general public. Establish an open dialogue with affected stakeholders, carefully consider their views, and provide feedback as to how their concerns are addressed.

Principle 5: Management of hazardous materials

Manage and dispose of all hazardous materials (radioactive or non-radioactive) — including products, residues, waste and contaminated materials — in a manner that is safe, secure and compliant with laws and regulations.

Act systematically to establish and implement controls to minimize risks from such waste and contaminated materials.

Take actions to maintain and treat sources of hazardous materials on-site wherever it is practicable to do so. Control and minimize any releases into the environment, using carefully planned strategies that involve pollution control technologies, robust environmental monitoring, and predictive modelling to ensure that people and the environment remain well protected. Rely, where possible, on proven, best available, industry scale technologies.

Focus particular attention on managing ore stockpiles and such potentially significant sources of contamination as waste rock, tailings and contaminated water or soils. With tailings, concentrate special effort on the design and construction of impoundments and dams and on the application of a recognized tailings management system for operations, monitoring, maintenance and closure planning. Use risk analysis and controls to account for the current and long term stability of waste repositories and containments. As an integral aspect of mining and processing, characterize the ore and waste rock. Consider the geochemistry and assess the risk of acid rock drainage (ARD); where ARD could occur, develop an ARD management plan which accounts for ARD producing ore, rejects materials and gangue, and provides for appropriate scheduling of mining, stockpile segregation, processing and contaminant containment. Use effective containment designs to ensure against long term liability from ARD producing rock. Use all opportunities to reduce the creation of hazardous waste and contaminated materials. To the extent practicable, recover, recycle and reuse such waste and materials, regarding waste disposal as a last resort option. At each site, control the release or removal of waste and contaminated materials; use a 'chain of custody' approach, where needed. Safely manage all off-site streams for hazardous materials and contaminated waste.

Principle 6: Quality management system

Employ a recognized quality management system — including the quality assurance steps of 'Plan, Do, Check and Act' (PDCA) — in administering the management of all activities pertinent to managing radiation, health and safety, waste and the environment.

Planning — At all development and operational stages, plan the management of radiation, health and safety, waste and the environment. With the constant goal of avoiding risk and optimizing the use of natural

resources and energy, update such plans regularly, and particularly in response to any significant change in activities or site conditions. Include, as a central element in such plans, steps for the control of emergencies and unplanned events. Ensure that plans are well documented and communicated.

Environmental impact assessment — In developing uranium mining or processing projects, prepare formal Environmental Impact Assessments (EIAs) that deal with all questions and concerns related to radiation, occupational and public health and safety, waste and the environment, as well as the socioeconomic impact. Submit the EIA as part of the public review process so as to provide response opportunities for stakeholders, especially the workforce and host communities. During the life of a project, prepare further EIAs if and as warranted by new circumstances.

Risk management — Apply risk assessment and management procedures. Identify, characterize and assess all risks that can impact on health, safety and environmental protection. Mitigate risks with controls using engineering, administration and other protective measures. Apply a hierarchy of risks and controls. Monitor risks and take timely action to offset the emergence of new risks. Regularly review performance to improve procedures, further reduce risk, detect weaknesses and trigger corrective measures.

Documentation — Document and report relevant data and maintain records in compliance with regulatory requirements. Place special emphasis on data required by the quality assurance management system.

Principle 7: Accidents and emergencies

Identify, characterize and assess the potential for incidents and accidents, and apply controls to minimize the likelihood of their occurrence. Develop, implement and periodically test emergency preparedness and response plans. Ensure the availability of mechanisms for reporting and investigating all incidents and accidents so as to identify the 'root cause' and facilitate corrective actions.

Principle 8: Transport of hazardous materials

Package and transport all hazardous materials (radioactive and non-radioactive), including products, residues, waste and contaminated materials, safely, securely, and in compliance with laws and regulations. For radioactive materials, adhere to IAEA Regulations for the Safe Transport of Radioactive Material, relevant IAEA Safety Guides, applicable international conventions and local legislation.

Principle 9: Systematic approach to training

In each area of risk, provide systematic training to all site personnel (employees and contractors) to ensure competence and qualification; include in such training the handling of non-routine responsibilities. Extend such training, where appropriate, to visitors and relevant persons in communities potentially affected by these risks. Regularly review and update this training.

Principle 10: Security of sealed radioactive sources and nuclear substances

Ensure the security of sealed radioactive sources and nuclear substances, using the 'chain of custody' approach where practicable. Comply with applicable laws, international conventions and treaties, and agreements entered into with stakeholders on the safety and security of such sources and substances.

Principle 11: Decommissioning and site closure

In designing any installation, plan for future site decommissioning, remediation, closure and land reuse as an integral and necessary part of original project development. In such design and in facility operations, seek to maximize the use of remedial actions concurrent with production. Ensure that the long term plan includes socioeconomic considerations, including the welfare of workers and host communities, and clear provisions for the accumulation of resources adequate to implement the plan. Periodically review and update the plan in the light of new circumstances and in consultation with affected stakeholders. In connection with the cessation of operations, establish a decommissioning organization to implement the plan and safely restore the site for reuse to the fullest extent practicable. Engage in no activities — or acts of omission — that could result in the abandonment of a site without plans and resources for full and effective decommissioning or that would pose a burden or threat to future generations.

ADAPTING INTERNATIONAL EXPERIENCE TO REGULATORY SUPERVISION OF LEGACY SITES IN THE CENTRAL ASIAN REPUBLICS

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Abstract

This paper outlines progress being made within the regulatory cooperation programme between the Norwegian Radiation Protection Authority and its sister organizations in the Russian Federation. Experience is drawn from work at nuclear technology legacy sites, such as the sites of temporary storage at Andreeva and Gremikha, and also on the remediation of uranium mining and milling facilities. The planned application of this experience to the enhancement of regulatory supervision in Kazakhstan, Tajikistan and the Kyrgyz Republic is described. Preliminary observations are made concerning how this work might feed into the development of international guidance.

1. INTRODUCTION

In the last decade, the global community has addressed the environmental legacy from the earlier development of nuclear technologies. In this, the general objectives have been to develop a responsible approach to environmental and human health protection and to help ensure that future developments do not create new problematic legacies. Radiation protection and nuclear safety are a significant part of legacy management, and strong independent regulatory supervision is, in turn, crucial to the delivery of safety and confidence in the whole process.

At the same time, a wide range of other issues contribute to decisions on how the legacies will ideally be managed. For example, radiation and radioactive material are not the only health protection issues at sites affected by radioactive residues; there are many other pernicious pollutants and physical safety factors to consider. Yet more broadly, decisions on legacy site management have often to be made in the recognition that there are limited financial and other resources. In addition, account has to be taken of many other social and cultural factors which operate on many different temporal and spatial scales. The overall system of norms and standards and the related regulatory process need to be strong and clear enough to provide a proper basis for environmental as well as health and safety management and flexible enough to allow an effective interface with the wider management issues so that balanced and proportionate decisions can be made.

2. EXPERIENCE OF REGULATORY SUPPORT IN THE RUSSIAN FEDERATION

The Norwegian Radiation Protection Authority (NRPA) is the radiation and nuclear safety regulatory authority in Norway. It falls naturally to NRPA to assist the Norwegian Ministry of Foreign Affairs in implementing the Norwegian Plan of Action on Improving Nuclear and Radiation Safety in the north-west Russian Federation. The initial plan of action focused on the safety of nuclear technology development and application and therefore included consideration of nuclear power plants.

A significant component of the plan of action is for the NRPA to provide support to its sister authorities in the Russian Federation. The situation is complex because of the technical and political history. However, over the years, a considerable degree of confidence and mutual trust has been built up among all the relevant organizations, allowing for real progress to be made in meeting protection objectives. This forms a strong basis for continued cooperation to mitigate radiation risks and the prevention of the development of new legacies.

The Norwegian Government has recognized the effectiveness of the programme and the plan of action was updated in 2008 and extended until at least 2012 with renewed focus on managing the nuclear legacy from the Cold War period and other operations carried out at the time of the Soviet Union.

2.1 Who is involved?

The two key regulatory authorities for civil protection in the Russian Federation are the Federal Environmental, Industrial and Nuclear Supervision Service of the Russian Federation (Rostechnadzor) and the Federal Medical-Biological Agency (FMBA). Rostechnadzor focuses on nuclear and radiation safety and the FMBA focuses on radiological protection. Both are supported by technical support organizations, notably the Science and Engineering Centre for Nuclear and Radiation Safety (SEC NRS) and the Burnasyan Federal Medical Biophysical Centre (FMBC). Many of the legacy issues originated from the military programme. It is therefore vital that the military authority be involved. In fact, the Directorate of State Supervision over Nuclear and Radiation Safety of the Ministry of Defence of the Russian Federation (DSS NRS) has agreed to take part in the cooperation programme.

Regulators and operators must rigorously and transparently retain their separate responsibilities and integrities. At the same time, an effective dialogue is necessary between them. Thus, the programme allows for and encourages FMBA, Rostechnadzor and DSS NRS to regularly hold information exchange meetings with other Russian Federation authorities, notably Rosatom. Experts from other national authorities and technical support organizations participate through the review of project proposals and the provision of technical output. They include the Institut de Radioprotection et de Sûreté Nucléaire, the Swedish Radiation Safety Authority, the US Environmental Protection Agency and the Environment Agency of England and Wales. International contacts are maintained with the Nordic Liaison Committee for Atomic Energy, the European Union, the World Health Organization and the International Atomic Energy Agency.

2.2 What are the objectives?

The objectives are:

(a) Efficient and effective regulatory supervision of nuclear legacy projects in order to protect western and Russian Federation investment in nuclear legacy management.

(b) Integrated coverage of nuclear and radiation safety, comprising:
- Worker and public safety;
- Environmental and human health protection and monitoring;
- Normal and accident conditions;
- Emergency preparedness and response;
- Addressing high risk issues arising from nuclear legacies, but, at the same time, addressing longer term management, site remediation and waste storage and disposal, so as not to prejudice safety in the future, thereby avoiding the creation of new legacies.

(c) Long term development of an enhanced safety culture.

(d) Development of a close working relationship with Russian authorities so that future challenges can be addressed effectively.

2.3. What has been achieved?

The projects have helped provide the regulatory authorities with the tools they need to carry out their responsibilities. They have resulted in:

(a) Updated Federal norms and regulations and regulatory guidance which take account of international requirements and recommendations, as well as other relevant national good practice;

(b) The development of effective and efficient regulatory procedures for licensing and compliance monitoring.

The work began with the review and comparison of environmental impact assessment in Norway, the Russian Federation and other European countries. Based on the developed understanding of the system and situation, the industrial projects in which NRPA cooperation has supported regulatory development and supervision have included:

(a) Decommissioning of the Lepse spent fuel storage vessel;

(b) Decommissioning of radiothermal generators (RTG);

(c) Rehabilitation of the sites of temporary storage (STS) at Andreeva and Gremikha;

(d) Development of waste acceptance criteria for storage of radioactive waste at Sayda Bay.

The work has proceeded as far as the promulgation of official regulatory norms and standards. Progress is reported in technical NRPA reports [1–3] which include English translations of relevant regulatory guidance. The integrated coverage of radiological risks, from the optimization of especially hazardous operations to standard setting for radioactive waste management, has been especially worthwhile and effective at the STSs.

The programme of work is also widely promulgated to a broader audience in conference papers (e.g. Refs [4, 5]), but also in a less technical context in NRPA information bulletins, for example on a joint exercise for emergency preparedness [6] and on RTG decommissioning safety in the IAEA Bulletin [7].

Finally, it ought not to be forgotten that the work is fundamentally based on science, and the programme has also resulted in the publication of peer reviewed journal articles, such as one on the basis for remediation criteria [8].

2.4. How has it been achieved?

The NRPA policy has been to start by addressing real regulatory problems that need to be solved in order for legacy management projects to proceed under relevant and effective supervision. Hard work, patience, tenacity and perseverance from all concerned has been necessary but the most important factor is effective communication, particularly through listening to the real needs of Russian colleagues and then responding robustly noting the limits on resources and other practical factors.

3. RELEVANCE AND APPLICATION IN THE CENTRAL ASIAN REPUBLICS

The details of situations for legacy management are different in each country, not only because of technical and geographical differences, but also because national regulatory frameworks are different, social and cultural attitudes are different and political choices on resource management can constrain options in different ways. However, the strategy approach adopted in the cooperation between the Russian authorities and the NRPA is planned to be followed with the authorities in Kazakhstan, Tajikistan and Kyrgyzstan, with broadly the same objectives.

4. NEXT STEPS

The next steps in cooperation with the Russian authorities involve enhancement of regulatory compliance monitoring as major industrial projects are implemented, for example under the Strategic Master Plan V2. It is also hoped to extend the work completed at SevRAO and other facilities in the north-west Russian Federation to other sites. This is already happening, for example, concerning the application of regulatory documents developed for the Lepse to the decommissioning [9] of other floating nuclear objects, and the application of hygienic standards for very low level waste management at STSs to other sites.

The initial phases of the work in Central Asia concern support in the development and application of national radioactive waste management strategies and preliminary threat assessments to determine regulatory priorities. The work will, as in the Russian Federation, be based on practical problems at real sites.

Little if any of this work could be done were it not for the goodwill and positive attitude to cooperation among the project participants. However, support from international and other national organizations has also been important. The proposed establishment of a new working group for coordinating activities in the Regulatory Supervision of Legacy Sites, under the auspices of the IAEA, is therefore much welcomed. The key to success will be to make international guidance as clear and precise as possible without prejudicing the regionally or locally optimum solution.

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