ROLE OF REGULATORY AUTHORITIES IN CROSS-CUTTING DIALOG ON RISK MANAGEMENT IN COMPLEX SITUATIONS

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Abstract

Achieving stakeholder recognition of the role of nuclear technologies in delivering United Nations sustainable development goals is significantly dependent upon building confidence in the safety of radioactive waste management, decommissioning, environmental protection and remediation. Achievement of such confidence is particularly difficult when linked to management and regulation of the legacy of nuclear technology development that took place during the cold war. The paper sets out the complex situations that can typically arise in decommissioning and legacy management and discusses specific experience arising from bilateral regulatory cooperation programs between the Norwegian Radiation and Nuclear Safety Authority and corresponding authorities in other countries. A range of important lessons is set out, based on practical experience in developing and applying national level and locally relevant requirements on nuclear and radiation safety. The need to address all the hazards present is highlighted, adopting a proportionate approach to risk management that leads to overall optimisation, not just in the context of radiation protection. Particular experience in Ukraine provides new perspectives on multiple risks during a war. Further international work would be valuable to determine how to achieve a reasonable balance between:

— the need for urgent action in order to avoid a major incident or accident in a critical situation, against
— avoiding creation of such an incident or accident by acting to quickly, before the situation is properly understood.

The value of sharing experience is noted and illustrated with examples, so as to better address continuing challenges. Given the multiple hazards and complex social and other factors, it is suggested that this will require effective cross-cutting dialogue among different parties that may hold widely different objectives and responsibilities. International engagement through a range of forums offers the best way forward.

1. COMPLEX SITUATIONS IN DECOMMISSIONING AND LEGACY MANAGEMENT

Achieving stakeholder recognition of the role of nuclear technologies in delivering United Nations sustainable development goals[1] is significantly dependent upon building confidence in the safety of radioactive waste management, decommissioning, environmental protection and remediation. The challenges of the nuclear legacy of the cold war period have long been recognised [1]. Even countries without nuclear energy and related programmes may face problems involving artificial or naturally occurring radioactive material. In order to build confidence in sustainable solutions, it has also been recognised for many years that all these situations should be managed in an open, transparent and coherent fashion [2].

As work has progressed to address these challenges it has become increasingly clear how complex the problems are. Common characteristics that contribute to this complexity typically include the following [3]:

— Each site presents unusual features; typically, a complex combination of radiological, chemical and physical hazards, along with other operational challenges.
— This mixture of hazards and related site characteristics that influence their management are, initially, broadly unknown. For example, appropriate and adequate records may have been lost or were never kept; former site operators with knowledge of the site are unavailable, or site ownership has changed hands several times and responsibilities for the site, including their regulation, are unclear.
— The regulatory circumstances are complex because the facilities and sites were not designed and operated in line with up-to-date standards; a modern regulatory framework may not have been designed with this in mind, having a focus on how things should be rather than how they are.

[1] See https://iaea.org/about/overview/sustainable-development-goals

It is also increasingly recognised as important not to deal separately with operations and decommissioning. An integrated approach is needed for transition from operational to decommissioning status that also addresses waste management comprehensively: dismantling activities; site remediation; waste treatment; waste transport; interim storage, and final disposal all involve very strong strategic, technical and stakeholder linkages [3-5]. Based on a wide range of case studies and not hypothetical discussion, these same references highlight that flexibility and adaptability in the application of regulation is needed if delays in the elimination of major hazards are to be avoided.

2. DSA EXPERIENCE IN BILATERAL REGULATORY COOPERATION

The Norwegian government has maintained a Plan of Action on Nuclear Safety and Security for over 25 years. The need for such a Plan grew from extensive nuclear activities during the Cold War, both civil and military, that led eventually to significant amounts of radioactive waste and nuclear material being stored in unsafe conditions in northwest Russia. This represented a range of risks to Norway and neighbouring countries, as well as to Russia itself. Those risks concerned human health, the environment and other important social interests. Multi-national efforts to reduce those risks were inaugurated.

A significant feature of Norway's contribution to those efforts was to support bilateral regulatory cooperation with appropriate authorities in Russia. The basic intention was that any internationally supported projects to reduce radiation risks should be carried out in line with modern international standards and under the supervision of an appropriately robust, independent and up to date national regulatory framework. Any other approach could have been seen as reckless. The regulatory support program was implemented via the Norwegian Radiation Protection Authority, now the Norwegian Radiation and Nuclear Safety Authority (DSA). The Plan of Action and the strategy to implement it have both evolved over several decades to reflect changes in circumstances, including significant progress with risk reduction at the most hazardous sites and facilities, notably decommissioning of the Lepse [6][2] and the management of spent fuel and radioactive waste at the Andreeva Bay site of temporary storage [7]. It was also necessary to take into account on-going developments in international standards [8] and their regulatory application [9], as well as a wide range of technological and scientific advances.

Following the progress in the Russian Federation, in 2008, the bilateral regulatory cooperation program was extended to include countries in central Asia, aimed at assisting the regulatory authorities in Kazakhstan, Kyrgyzstan and Tajikistan, later extended to include Uzbekistan. There were several advantages in working collaboratively across these countries, linked by geographical, technical, cultural and political commonalities.

The regulatory authorities that DSA work in cooperation with include:

- the Kazakhstan Atomic Energy Committee, now called the Committee for Atomic Energy Supervision and Control,
- the State Agency on Environment Protection and Forestry under the Government of the Kyrgyz Republic, now called the Ministry of Mineral Resources,
- the Nuclear and Radiation Safety Agency of Tajikistan, now called the Chemical Biological Radiological Nuclear Safety and Security Agency, and
- the State Inspectorate on Supervision of Geological Study of Depths, Safety in Industry, Mining and Public Sector under the Cabinet of Ministers of the Republic of Uzbekistan.

An important feature of the work programme, based on earlier cooperation experience, has been the completion of so-called regulatory threat assessments (RTA), carried out to identify the main issues and priorities for regulatory development. Specific projects addressing specific challenges of practical interest are then developed and implemented within the cooperation program.

By conducting an RTA every few years, it has been possible to redirect the cooperation activities to take account of on-going progress and wider changes in circumstances. The most recent RTA and the road map developed to address the continuing threats in each topical area (see Fig. 1) was documented in reference [10].

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[2] See also https://www.neimagazine.com/news/newsfinal-used-fuel-removed-from-lepse-8822807

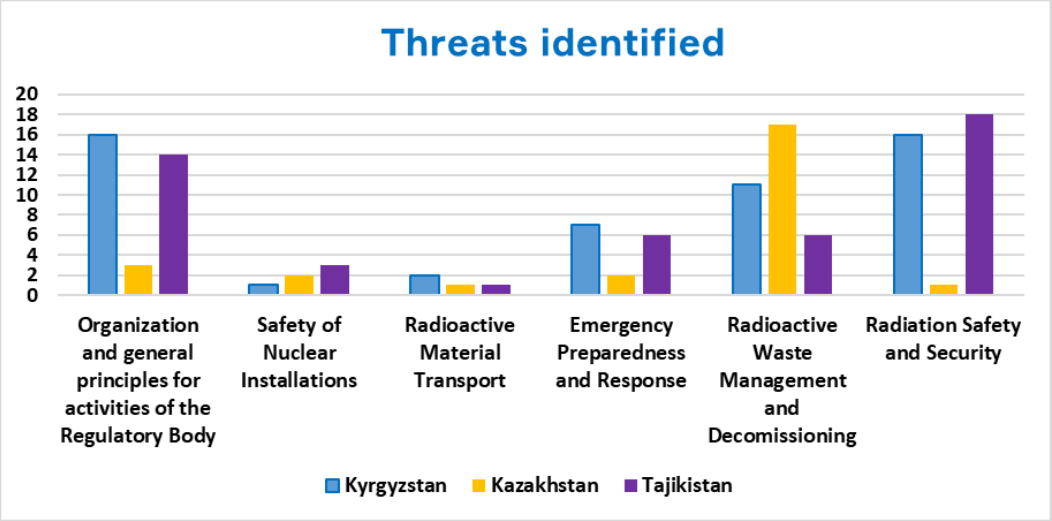

FIG. 1. Summary of regulatory threats identified each topical area [10]

At the start of the bilateral cooperation there was a significant need to update and improve the regulatory framework and raise the level of competence, especially in Tajikistan and Kyrgyzstan. A significant number of laws and related regulatory document addressing for nuclear and radiation safety have been drafted for governmental approval in each country, as recorded in Reference [10]. Progress has been significant, especially in Tajikistan However, it has become very clear that political stability and stakeholder involvement are crucial for progress with implementation of regulatory documents and effective regulatory control. In situations where there are very limited resources, as in central Asia, scheduling of a staged approach to an appropriate solution. Careful attention to overall optimization – not just the radiological hazards - is especially important, to identify where resources can be allocated with a real expectation of a feasible and successful outcome within a realistic timescale. This requires close engagement with major government agencies and other organisations, so as to ensure that all the cross-cutting issues are addressed effectively. These issues are being taken into account as projects developed under the road map [10] are implemented.

Following the programs implemented in Russia and central Asia, a similar consultative approach was adopted in 2014 to set up bilateral regulatory cooperation with the main nuclear and radiation safety authority in Ukraine, the State Nuclear Regulatory Inspectorate of Ukraine (SNRIU). The overall aims were to support Ukraine to implement international standards in nuclear and radiation safety regulation, harmonizing the Ukrainian regulatory framework with EU Directives and IAEA standards, and ensuring its compliance with reference levels set by the Western European Nuclear Regulators Association. The scope of activities has included:

- Safety of nuclear installations
- Radioactive waste management, including disposal
- Safety and security of radiation sources
- Emergency preparedness and response
- Remediation of legacies, e.g., the Chernobyl Exclusion Zone (ChEZ) and facilities within it
- Radiation protection
- Transport of radioactive material
- Management of naturally occurring radioactive material
- Medical exposure
- Physical protection.

Following the methodology successfully devised and implemented in DSA's other regulatory cooperation activities, projects addressing specific topics were identified and carried out as outlined in Fig. 2. The results have been openly published to support engagement with relevant stakeholders, mostly recently in Reference [11]. 21 regulatory documents of different levels have been developed including a significant number that have already been put into force and 13 are in different stages of the approval process.

FIG. 2. Projects developed from regulatory threat assessments [11]

The need for flexibility and adaptability identified in the previous discussion has been extensively demonstrated and tested following the further occupation of territories of Ukraine by Russian forces in February 2022. Some of the deliverables already developed have played a useful part, such as the updated protocol on practical arrangements between the SNRIU and the DSA for Early Notification of Nuclear Accidents and for the Exchange of Information on Nuclear Facilities. Further new projects have been put into place rapidly through the bilateral regulatory cooperation program to address new challenges arising from the temporary occupation of areas of Ukraine by Russian forces, such as the loss of control over radiation sources, damage to containment systems and the possible dispersion of radioactive contamination. Two new regulatory documents have been developed under the ZONE project:

- "Statement on the Approach of Safety State Regulation on Nuclear and Radiation Facilities Located in the Chornobyl Exclusion Zone Affected by Hostilities"
- "Safety Requirements and Procedure for Restoring the Safety Level of Nuclear and Radiation Facilities in the Chornobyl Exclusion Zone Affected by Hostilities"

The occupation of the ChEZ by Russian military forces during the period from 24 February to 1 April 2022 gave rise, in effect, to an emergency radiation situation, threatening workers and members of the public residing in the vicinity. To address these threats the SURVEY project was set up with the following objectives:

- Conduct a radiation survey on territories affected by the hostile military occupation in the Kyiv region
- Support efforts to reduce risks of exposure of the public and others due to contact with displaced radioactive sources and contamination
- Allay public anxiety associated with the flow of inaccurate and false information related to the on-going radiation situation.

To meet these objectives a series of survey Missions A to E was conducted to determine the radiation situation in relevant areas, see Fig. 3.

A key result pf the radiation surveys was that there were no signs of radionuclide transfer from the ChEZ territory, e.g., due to military vehicles moving through contaminated areas into the wider environment. A major success of the project was to raise public awareness of the dangers of radiation exposure, about the actions to be taken in case of detection of objects marked with a radiation hazard sign, and related issues. However, perhaps the most important achievement was that the people whose homes were affected by the hostile forces received confirmation that they were safe from the point of view of the radiological impact, which, at least as far as this hazard was concerned, allowed them to stay at their homes. Based on feedback from the public about the project, it is clear that the demand for quality information about the radiological hazards is still high. Meeting this demand can, to some extent, reduce the overall tension among the public in the post-occupation period.

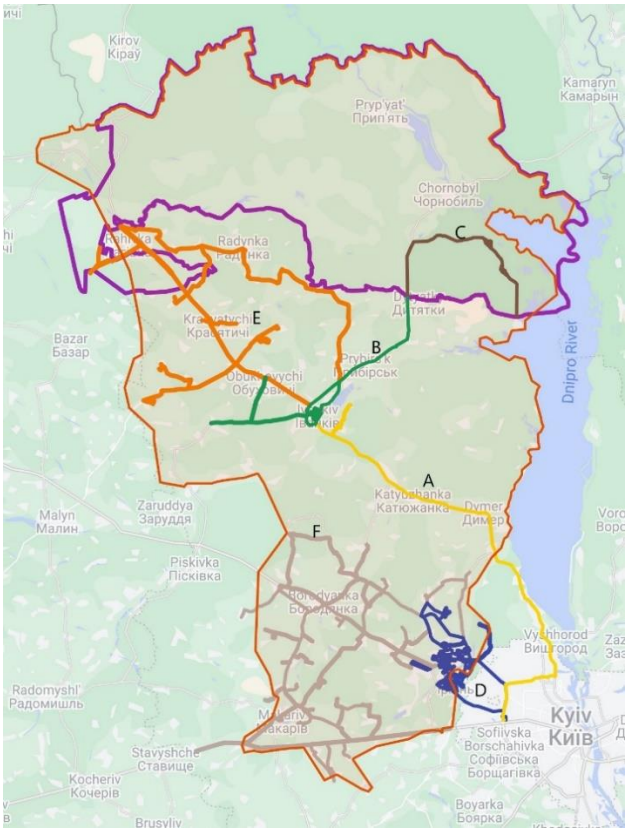

FIG. 3. Routes of the radiation survey. The highlighted area refers to the territory that was under temporary occupation (approx.). The boundaries of the ChEZ (approx.) are shown in purple

The project was able to confirm no significant direct radiological impact in the areas that it was possible to survey, it cannot be ruled out that, as the fighting subsides and extensive de-mining campaigns become possible, opening up access to forests, fields, certain parts of the ChEZ, etc., other radiologically significant impacts might be discovered as a consequence of the Russian military activity. Fuller results and discussion are provided in Reference [12].

Building on this progress and to address continually evolving challenges, further projects have been put in progress. Topics include among others:

- Conduct of a new RTA to address circumstances arising from the activities of Russian forces;
- Improvements in remote radiation monitoring during and after hostile activities;
- Improved communication of the radiation situation, to better inform the public and other stakeholders, and to support the planning of other activities such as workers involved in clearance of mines;
- Approach to safety culture and optimisation during and after hostile activities; and
- Conduct of an international workshop to share and exchange regulatory experience, and improve the design of protocols to manage nuclear and radiation safety during and after military actions.

This last activity reflects that there are no international recommendations on how to regulate and control radiation exposure during and after military activities. Difficult issues include the setting of Reference Levels in the current unplanned circumstances and achieving optimized risk management given the different hazards present. arising from other hazards.

3. LESSONS LEARNED

Regulatory cooperation has been a key element of the strategy to meet the long-term policy objectives set out in the Norwegian Plan of Action on the Nuclear Safety and Security. That Plan and the strategy to implement it have evolved over several decades to reflect changes in circumstances, including significant progress with risk

reduction at the most hazardous sites and facilities, but also developments in international standards, and technological and scientific advances.

A continuing theme of regulatory cooperation has been to link project activities to specific practical issues linked to wider international efforts to support industrial projects. Several important features have been recognized working closely with the regulatory authorities, the operator and TSO on specific problems at sites that are important in successful legacy management. One of them is to take a holistic view of the radiation protection problems, rather than adopt a piecemeal approach to finding solutions. This has meant looking simultaneously in a balanced way across a range of issues: worker as well as public and environmental protection; safety during planned decommissioning and remediation operations as well as in the event of possible accidents and incidents that could occur during those operations; and ensuring coordination and regulatory coherence between remediation activities and radioactive waste management programs. This approach has been followed specifically in order to promote the application of overall optimization and avoid the creation of new legacies for future generations to resolve. This requires the acknowledgement that complex situations are not resolved by simplistic solutions. Part of that complexity arises from the need to engage in cross-cutting dialogues with a wide range of stakeholders in government ministries, industrial organisations, technical and academic institutions, and other bodies that are able to represent the views of the public and workers who are most directly affected.

These conclusions have only been more strongly confirmed following the Russian temporary military occupation of areas of Ukraine. Support to Ukraine is considered by DSA to be a priority for future regulatory cooperation, so as to address the special challenges linked to radiation and nuclear safety regulation during and in the aftermath of military activities.

Broader lessons include:

- Effective nuclear safety and security relies on stable and appropriately resourced nuclear and radiation safety authorities working within a regulatory framework that is based on the application of international standards, recommendations and guidance, and supported by international cooperation and shared national experience of good practice.
- Some flexibility is needed at the national level in the interpretation of international recommendations and guidance, and experience – so-called best practice - of their application. Best practice may not mean doing the same thing in all circumstances. Best practice should mean doing what is best according to local circumstances and so cannot be defined without knowledge and appreciation of local circumstances. This is necessary to allow for national, regional and local economic, cultural and societal factors to be taken into account adequately. Such factors particularly affect regulatory decisions concerning the application of overall optimization and, in the case of existing exposure situations, the selection of references levels. This is especially the case at legacy sites and facilities, where the prevailing circumstances may not have been planned for, and challenges can be unique to a specific location. Such a flexible approach is also important during the review and update of the regulatory framework, in order to keep it fit for application to changing circumstances.
- It is important that the regulatory framework includes not only requirements and rules, but also the procedures for their application, and corresponding guidance documents.
- Successful resolution of major challenges, such as decommissioning of the Lepse, has been the culmination of many years of international cooperation. To ensure safe completion of such projects, it is likely to be necessary to develop, license and apply special technologies and equipment, and to support decisions in novel, non-standard situations. In this way, unnecessary delays in risk reduction can been avoided. In addition, the project should not be considered complete until a solution is found for the final disposal of any radioactive waste arising. Only in this way can the creation of new legacies be avoided.
- Close cooperation and dialogue among the staff of involved organisations is vital to ensure that all partner organizations have adequate understanding of the overall situation, rather than dealing piecemeal with each challenge. However, all those organizations must robustly and transparently continue to operate within and according to their own responsibilities. It follows that an early step in addressing legacy issues, or solving any complex circumstances, is the clarification and allocation of responsibilities and mechanisms for dialogue. This is turn requires an integrated approach to solving problems and the long-term application of a clear policy to support such an approach, developed with the involvement of scientific and technical communities and other relevant stakeholders. Such an approach needs to be planned, integrated, holistic, and innovative.

4. SHARING THE EXPERIENCE: TAKING ON THE CONTINUING CHALLENGES

DSA has taken a significant role in sharing the results of the bilateral regulatory cooperation activities, not only by participating in joint expert groups [3,4] but also in co-organising and hosting and publishing the results of international workshops on topics such as decommissioning and legacy management generally [13] and risk and safety assessments supporting regulatory supervision of decommissioning and waste management for nuclear research and radiation facilities [14]. An important compilation of papers was providing in a recent special issue of the Journal of Radiological Protection[3].

DSA has been contributing to the work of an Expert Group of the NEA Committee on Radiation Protection and Public Health, working on the development of a holistic process for decision making on decommissioning and management of complex sites and facilities. This group significantly builds on the recommendations of Reference [3] but also provides connectivity across the different relevant areas covered by other NEA technical committees, such as the Committee on Decommissioning and Legacy Management, the Regulators' Forum and other groups working on stakeholder engagement and costing.

The DSA has also continued to provide significant support in corresponding IAEA activities such as the preparation of advice on the determination of environmental remediation end states [15] and provides the chair of the European and Central Asian Safety Network (EuCAS)[4], part of the IAEA's Global Nuclear Safety and Security Network (GNSSN). EuCAS has four working groups addressing:

- Regulatory Infrastructure
- Safety of Radioactive Waste Management and Spent Fuel Management
- Environmental Remediation and Decommissioning
- Education and Training.

Providing effective linkages across the four groups is an interesting feature of the work program.

Further international work would be valuable to determine how to balance

- the need for urgent action in order to avoid a major incident or accident in a critical situation against
- the need to avoid creating such an incident or accident by acting to quickly, i.e., before the risk situation is properly understood.

Another complex issue that remains as a challenge is how to achieve a balance between:

- the need for regulatory flexibility that allows adaptation of regulations to a wide variety of prevailing and evolving circumstances, and
- the need to provide precise and detailed requirements and criteria that give clarity to and confidence in the safety standards.

Both of these balancing acts require consideration of the issues discussed above, and that in turn implies cross-cutting dialogue among different parties that may hold widely different objectives and responsibilities. International engagement through a range of forums offers the best way forward.

ACKNOWLEDGEMENTS

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