CANADIAN EXPERIENCE IN IMPLEMENTING NUCLEAR POWERED SUBMARINE DISMANTLING PROJECTS IN RUSSIA: REGULATORY ISSUES.

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ABSTRACT

The Global Partnership Program (GPP) of the Department of Foreign Affairs and International Trade (DFAIT) is funding the delivery of approximately 200 special containers of spent nuclear fuel (SNF) to the Chemical Combine Plant Mayak in the Russian Ural region. This SNF is that recovered from 18 Russian nuclear powered submarines for which Canada is funding their dismantlement.

The paper highlights a selection of practical examples summarizing issues which have arisen since 2004 in the course of operating in the Russian regulatory environment and illustrating how these issues have been successfully resolved.

The paper demonstrates how shipyards worked jointly with the Canadian experts to ensure that the requirements of the Canadian Environmental Assessment Act (CEAA) were satisfied given that the requirements are not entirely consistent with the Russian Environmental Impact Assessment regulations.

In other cases it was found that although Russian regulations are fully consistent with international and western analogues, practical approaches to implementing such regulations have varied between countries. For example Russian radiation protection regulations closely match ICRP guidance, but implementation of the ALARA principle is inconsistent with the approaches adopted in the west. This was found to be to some extent due to differences in dosimetric equipment and related practices.

With regards to Spent Nuclear Fuel management, Canada has focused on ensuring compliance with the Russian regulatory requirements and some differences in approaches have been resolved jointly to ensure maximum levels of safety.

The Russian regulatory system and practical implementation of clearing radioactive materials from regulatory control was found to be very efficient and has resulted in successful recycling of a very large volume of material without incident at the shipyards. This experience, gained in the course of international projects may be used to facilitate clearance during decommissioning projects in Canada and elsewhere.

1. BACKGROUND

The Global Partnership Program (GPP) of the Department of Foreign Affairs and International Trade (DFAIT) is funding the delivery of approximately 200 special containers of spent nuclear fuel (SNF) to the Chemical Combine Plant Mayak in the Russian Ural region. This SNF is that recovered from 18 Russian nuclear powered submarines for which Canada is funding the dismantlement. The International Atomic Energy Agency (IAEA) Contact Expert Group (CEG) is holding a workshop in May 2009 in St Petersburg to discuss SNF and radioactive waste regulatory and licensing Issues for projects in Russia. As an element of the workshop international donors are providing overviews of their own experiences.

This paper is produced with the objective of providing an overview on this subject at the CEG workshop utilising the four years of experience gained by Canada. The focus of the paper is on illustrating Canada's experience by using a selection of practical examples of how Russian regulatory framework has impacted Canadian-funded projects.

2. REGULATORY FREAMEWORK

The Zvezdochka and Zvezda shipyards are responsible for dismantling nuclear powered submarines under the supervision of the Russian environmental and nuclear regulators in accordance with the Russian Federal Laws, Presidential and Governmental decrees, Federal regulations, documents of the oversight authorities, and state and industrial standards.

DFAIT is responsible for the projects to dismantle nuclear powered submarines in the North West and Far East of Russia through the provision of contribution based funds. This funding (total approximately CAD$225 million) fulfils Canadian commitments flowing from Canada's response to the Russian Federation's direct request for assistance in the elimination of its nuclear submarine legacy.

Because the submarine de-fuelling and dismantling projects are not described in the Canadian Environmental Assessment Act (CEAA) Exclusion List Regulations, DFAIT determined that environmental assessments must be conducted for the projects and that Screening Reports must be prepared, pursuant to paragraph 14 of the CEAA Projects Outside Canada Environmental Assessment Regulations.

3. PRACTICAL EXAMPLES

3.1 Environmental Assessment and Public Consultation

In the Russian legal and regulatory frameworks there are three principal concepts relating to Environmental Assessment of projects:

- Evaluation of the Impact on Environment ("OVOS").
- State Ecological Review ("GEE").
- Public Ecological Review ("OEE").

Of these three concepts, OVOS has been developed on the basis of United States (US) Environmental Protection Agency (EPA) Environmental Impact Assessment regulations and closely follows objectives of the Canadian and European requirements for assessing project impact on the environment. OVOS typically includes the following phases:

1. Development of project concept.
2. Assessment of environmental impacts, (including baseline assessment).
3. Identification of ecological consequences (including social and economic impacts).
4. Project review and modification.
5. Preparation of the "Declaration of Ecological Consequences" document.

The “Declaration of Ecological Consequences” document would then be submitted for State Ecological Review (“GEE”). However in practice OVOS has not been required by the Russian authorities for projects to dismantle nuclear powered-submarines funded by Canada. This was due to a fairly selective “triggering” process which screens out a significant number of projects. GEE itself is mandatory for the vast majority of projects implemented in Russia, including those involving submarine-dismantling.

The GEE process stems from the traditional Soviet process of review of the proposed projects by State Planning Committees. GEE has to be organized and conducted by state-appointed government departments and is focused strictly on verifying the project’s compliance against a very large number of Russian laws and regulations (an estimated 800 dealing with nuclear wastes and radiological issues). Based on this review a specially-appointed committee comes to a formal “conclusion”, which may be positive or negative. In the case of negative outcome, projects may be re-submitted following required modification. As such, the process and its objective are focused on verifying compliance with regulatory documents and standards. This is very different from the Environmental Assessment concept applied in Canada and elsewhere in the West.

Public Ecological Review (OEE) is something that may or may not be triggered; typically it is initiated via a request from a public organization(s) to submit the project proposal for public hearings. It has to either precede or be conducted in parallel with the GEE. It provides certain public organizations with a right to access project documentation and to participate in GEE reviews. In practice OEEs are rarely triggered for nuclear-related projects. The most significant constraint on this mechanism of public participation is the inability to start a OEE if “*its object contains commercial or other secrets*”. Project documentation invariably contains “commercial or other secrets”. Thus provisions for public participation in the Russian environmental assessment process are very limited.

In addition to GEEs implemented in line with the Russian regulatory requirements, Canada undertook an Environmental Assessment for each submarine-dismantling project as required under Canadian Environmental Assessment Act (CEAA) [DFAIT 2004, DFAIT 2008]. As the responsible agency for the environmental assessment (EA) under CEAA, DFAIT determined the scope of the project and the scope of the assessment, in accordance with the CEAA and best current practice. DFAIT employed qualified specialists to conduct the assessment, supervised the assessment, conducted stakeholder and public consultation throughout the assessments, and reviewed the results of the assessments. Supplementary to this posture DFAIT also took the initiative to assist each shipyard meet the standards in ISO 14001 through the engagement of the Canadian Standards Board.

For each of the shipyards the impacts of the following activities were assessed:
preparation for transit,

- transportation of submarines from their naval bases
- arrival and acceptance
- preparation for reactor de-fuelling
- reactor de-fuelling,
- management of spent nuclear fuel
- preparation for submarine dismantlement

- construction of three-compartment unit
- dismantlement of fore & aft compartments
- preparation of reactor compartment for transportation
- transportation of reactor compartment
- management of radioactive and non-radioactive wastes and products.

Conventional and nuclear accidents have been also assessed in the context of each of the above.

Environmental impacts of each of the activities have been assessed in terms of radiological safety, atmospheric effects, surface water, aquatic and terrestrial ecology, geology and hydrogeology and socio-economic and health implications.

Draft Environmental Assessment reports were placed into local libraries in Russia and public inputs were sought via public consultations which involved local public meetings (Figure 1).

Figure 1. Public consultation meeting held in Bolshoi Kamen on April 5th 2008.

Questions raised by the public focused on practical economical impacts of the project as well as on potential radiological risks to the local public. The meetings proved useful in giving the local public and other stakeholders an opportunity to express their concerns and priorities and for such to be incorporated into the planning process. They were also instrumental in overcoming a surprising lack of awareness of the objectives of international involvement with a number of participants expressing suspicions that western countries were transferring their own wastes and submarines for processing at local shipyards.

In Canada, Environmental Assessments are used as a tool to ensure environmental impacts are minimized not just prior to commencement of each project but throughout project implementation. To this purpose a comprehensive follow-up programme, called "Environmental Management Plan" has been prepared for each project to demonstrate compliance with the assumptions made in the Environmental Assessments. Canadian environmental, nuclear and conventional safety oversight is also provided in terms of regular technical monitoring visits and in accordance with comprehensive Environmental Management Plans. The Plans for each facility are updated at regular intervals to account for changes in production methods, completion of targets and any new issues that may arise.

In several instances, specific environmental issues identified in the course of Canadian environmental assessments were later independently identified by the Russian regulators. Recent examples included regulatory concerns raised in relation to open-air incineration of non-radioactive wastes and poor management of hydro-carbon wastes at one of the facilities. As such Environmental Assessments may be used to minimize project implementation risks as well as to minimize negative impacts on the environment.

3.2 Worker Dose Limits, ALARA and Dose Optimization

The effective dose limit for Nuclear Energy Workers, as prescribed by the NRB-99 regulations is 100 mSv (10,000 mrem) in a five year period (with a maximum of 50 mSv in any given year or an average of 20 mSv/yr over 5 years) for whole-body exposure. For Radiation Users and "members of the public" the corresponding limit is 1 mSv (100 mrem) per year. This is fully consistent with ICRP and Canadian guidance and standards [ICRP 2007, CNSC 2000] as are the other limits such as limits for skin and eye exposure.

When new facilities are constructed or for submarine dismantling projects, the dose planning process is conducted at the safety assessment stage and is designed to ensure compliance with the above limits. Compliance is confirmed at the shipyards via the use of proportional counter dosimeters used by all categorized personnel and by ensuring that staff approaching their regulatory radiation dose limits are transferred to other (non radiological) duties.

The ALARA principle is specified in the NRB-99 regulations as "optimization principle" requirement: "*doses should be supported at the lowest possible achievable level taking economic and social factors of individual exposure into account and taking into account the number of irradiated people…"*

However in practice this requirement is not generally implemented at the shipyards; dose restriction is only focused on compliance with the regulatory limits. The Canadian monitoring team has facilitated implementation of the ALARA principle for tasks where the existing or potential radiation hazards may result in workers accumulating significant doses, such as reactor de-fuelling or transportation of nuclear powered submarines from the naval bases. ALARA requirements for such operations involve development of detailed work plans. The radiation protection component of work plans should include the following, but not necessarily be limited to:

1. Radiological surveys of the hazards present in advance of carrying out the project,

2. Implementation of engineering controls such as shielding, containment and HEPA-filtered ventilation,

3. Estimates of optimum time to be spent by workers in radiation fields,

4. An estimate of doses to the workers involved,

5. Identification of protective equipment and clothing to be used,

6. Segregation of areas,

7. Actions, e.g. back-out, to be taken should the anticipated dose or dose rate be exceeded,

8. Training of personnel,

9. Reviews of check-lists with measures designed to minimize exposure.

ALARA reviews should be completed prior to and following completion of each project stage. Setting radiological performance targets and determining which targets are met enable management and workers to focus their efforts on those areas of radiation protection that require improvement. A target may be defined in terms of a statistic such as average dose or collective dose during a specified period or frequency of contamination incidents, not necessarily in terms of individual dose. The specified period is the time interval that has been chosen for monitoring performance (e.g., each quarter, semi-annually). A review of the performance in meeting these targets may also suggest that the licensee set more stringent targets for subsequent periods.

The review of work plans by management, radiation protection staff, and those conducting the work prior to and following execution of the work also contribute to keeping the doses ALARA. Reviews following the completion of a project enable the experience gained to be used when planning future jobs of a similar nature with a view to further reducing worker doses where possible.

Figure 2. Ad-hoc repairs carried out at a radioactive waste management facility.

In practice, implementation of this process has been focused on taking definitive measures at the shipyards to minimize doses, such as introduction of mirrors for observing fuel position during the de-fuelling process to minimize worker exposure to external radiation. ALARA planning and review has been limited due to lack of shipyards' capability to conduct analysis of worker doses by tasks as opposed to the usual three-monthly intervals.

Specific dose minimization measures, such as zoning are implemented with various degrees of efficiencies. The Canadian team will continue to work with the shipyards to facilitate best practices.

It has also been noted that minimal dose planning is involved in implementing design change procedures. In cases of equipment malfunction or in order to achieve additional efficiency shipyards sometimes introduce new temporary design features without conducting extensive design, safety, dose and environmental reviews normally required at western nuclear facilities (Figure 2).

3.3 Spent Nuclear Fuel Management

The Overall concept of spent nuclear fuel management at the shipyards is almost identical to that at nuclear facilities in Canada. An extensive list of proscriptive Russian regulations is meticulously followed to ensure safety and compliance. The Canadian monitoring team relies on the existing regulatory regime and existing rules and systems for SNF handling to minimize extra workload. Inspections are limited to observations of key operations, verification of fuel transfers and confirmation that the appropriate regulatory authorizations have been secured.

The differences between western SNF handling practices and those adopted at the shipyards have been investigated in more detail in the course of Environmental Assessments. These can be summarized as follows:

1. High-level Fuel Transfer.

As part of safety and licensing process regulators at western shipyards have sometimes instigated the requirement of low-level fuel transfer, resulting in extensive work having to be carried out to ensure that the fuel is never raised beyond a metre of the ground.

Although this is not the current practice at Russian shipyards, adequate safety analysis has been carried out to demonstrate that the risk levels resulting from dropped fuel accidents are acceptable.

2. “Dry” De-fuelling.

The Russian practice of removing coolant prior to de-fuelling enhances safety margins and minimizes the risk of criticality incidents during de-fuelling. This is feasible thanks to significant periods lapsing between reactor shut down and commencement of de-fuelling, thus ensuring that short-lived radionuclides have decayed and doses incurred by personnel in the course of de-fuelling are very low. The approach may have to be reviewed in cases if the shut-down period is relatively short as other methods may have to be used to minimize the risk of criticality, such as adding “poison” to the primary coolant.

3. De-fuelling Afloat.

The practice of de-fuelling using PM “Malina” vessels is practiced in Russia. It introduces additional risks due to relative movement between the two vessels involved in de-fuelling and an increased number of fuel transfers resulting in a higher risk of dropped fuel than during de-fuelling at land-based de-fuelling facilities.

Canada has strictly adopted the approach of funding reactor de-fuelling operations only at land-based de-fuelling facilities.

From these examples it can be seen that the Canadian Global Partnership program has successfully operated within the Russian SNF management regulatory regime with minimal impact on planning and operations. In other cases project planning had to be adjusted to satisfy Russian regulatory requirements.

In the course of planning the project to decommission nuclear submarines at Zvezda shipyard, it transpired that SNF casks stored within the storage facility at the shipyard had exceeded their licensed storage life. SNF casks stored within the storage facility are licensed for a 2-year storage period to minimize the risk of corrosion. The storage bottleneck resulted from inability to transport the fuel to Mayak due to the poor condition of the local railway link. In order to satisfy Russian regulatory requirements Canada agreed to fund repairs to the railway link to Bolshoi Kamen. Furthermore, contrary to the usual practice, it was agreed that Canada would fund transfers of old casks exceeding the licensed storage period as a priority in preference to fuel removed from submarines de-fuelled under the Global Partnership Program.

3.4 Clearance of Materials

All materials originating from submarine dismantling are initially treated as potentially radioactive waste. The shipyard’s health physics personnel are responsible for designating materials either as radioactive waste or as being suitable for clearance (free release for reuse/recycling or disposal).

Russian clearance criteria are specified in SPORO-2002 as follows:

- 100 Bq/g for β-emitters;
- 10 Bq/g for α-emitters;
- 1 Bq/g for transuranic contaminants.
- Surface dose rate at 0.1 m of 0.001 mGy/h in excess of background for specified measurement techniques.

Additional radionuclide-specific limits are to be found in the Appendix 4 of NRB-99.

Similar to these Russian regulations international regulatory requirements and guidance are typically based on specific levels of radioactivity for individual radionuclides (see Table 2). In practice most countries adopt more generic non-nuclide specific criteria, which vary significantly even within European Union [Gerchikov et al 2003]. Similar to Russia, practical levels of clearance are often linked to equipment-specific levels of detection.

Table 2: Examples of Clearance Levels of Radioactive Materials.

Radionuclide	IAEA unconditional clearance level RS-G-17 (Bq/g)	EU unconditional clearance level RP122 (Bq/g)	Metal Scrap recycling EC RP89 Bq/g
H-3	100	100	1000
C-14	1	10	100
Co-58	1	0.1	1
Co-60	0.1	0.1	1
U-235	1	1	1

For example scrap metals shipyards apply more stringent Sanitary Rules 2.6.1.993-00 treating as radioactive waste materials with a surface contamination level of over 0.4 Bq/cm^2 for β and 0.04 Bq/cm^2 for α–emitters. In addition, materials designated for clearance must have dose rates at 0.1 m from the surface of ≤0.2 μSv/h or equipment level of detection. The latter has to be at least 0.05 μSv/h at 10 cm. Spectrometric analysis is normally conducted in the plant laboratory to confirm radionuclide composition in solid and liquid materials prior to release.

In early stages of the project, certain shortcomings in the implementation of this process were identified in the course of project monitoring. There have been limited cases of equipment with very low levels of radioactive contamination which were transported off site without proper authorization. In order to minimize the risk of such events, Canada provided assistance in procuring portal monitors for alerting to the presence of radioactivity in scrap metal. Canada has also funded the purchase of additional Spectrometric analysis equipment.

To ensure compliance with the Russian clearance approach practiced at the shipyards equipment had to be able to measure dose rates of 0.05 μSv/h at 10 cm from transport vehicle. The Yantar system supplied to the shipyard ensured a detection limit of 3-5 nSv/h which is consistent with the above limit as the detectors are located at a distance of 0.5-1.5 m from the railcar.

This approach has proved to be very successful in ensuring that very large volumes of cleared material are recycled without any incidents of gamma-emitting radioactive materials escaping undetected. By ensuring that clearance requirements and equipment are similar at the place of origin and at smelting plants, the Russian approach arguably provides a more practical solution than potentially less stringent but more complex radionuclide-specific guidance developed by IAEA and the EU. Western nuclear facilities have found it difficult to implement these regulations due to a high risk of setting off false alarms at portal monitors at scrap yards leading to potential public relation incidents.

4. CLOSING COMMENTS

As a result of five years' successful experience of working with the Russian shipyards and authorities and operating within the Russian regulatory regime, Canada has accumulated valuable experience in ensuring that both Russian and Canadian legal and regulatory requirements are followed on joint international projects.

The paper described how shipyards worked jointly with the Canadian experts to ensure that the requirements of the Canadian Environmental Assessment Act (CEAA) are satisfied given that the requirements are not entirely consistent with the Russian Environmental Impact Assessment regulations.

In other cases it was found that although Russian regulations are fully consistent with international and western analogues, practical approaches to implementing such regulations have varied between countries. For example Russian radiation protection regulations closely match ICRP guidance, but implementation of the ALARA principle is inconsistent with the approaches adopted in the west. This was found to be to some extent due to differences in dosimetric equipment and related practices.

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5. REFERENCES

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