OPTIMIZING THE REMOVAL OF SAFEGUARDS IN THE MANAGEMENT OF CONTAMINATED WASTE STREAMS

J. WHITLOCK[1], D. KOOPMAN[2], K. DUNCAN[2]

[1]McMaster University, Hamilton, Canada
[2]Canadian Nuclear Laboratories, Chalk River, Canada

Abstract

Canadian Nuclear Laboratories (CNL) has over 80 years of experience in the safe management of all classes of radioactive waste. Increasingly (particularly with decommissioning activities) these waste streams involve levels of Special Fissionable Material contamination that exceed regulatory exemption but would still be candidates for safeguards termination as 'practicably irrecoverable' measured discards. The removal of safeguards accountancy obligations on this material is key to efficient waste management, but the process of safeguards termination itself must also be efficient for this to be fully realized. The paper describes a proposed safeguards-by-design approach by which waste generating activities at CNL, whether through decommissioning, environmental remediation or R&D projects, incorporate safeguards termination at the earliest planning stage, allowing engagement with the regulator and IAEA at an optimum time for effective and efficient safeguards removal, and the application of a resulting agreed protocol to subsequent waste generating activities with minimal regulatory or IAEA interaction.

1. INTRODUCTION

Canadian Nuclear Laboratories (CNL, with main campus at Chalk River, Ontario located about 200 km northwest of Ottawa) is the largest and most diverse nuclear science and technology organization in Canada, operating under contract to Atomic Energy of Canada Limited (AECL). CNL's operations support a broad national mandate that includes reducing Canada's nuclear liability through complex decommissioning of nuclear facilities, and the advancement of nuclear science and technology that includes radioisotope development, nuclear security and emergency preparedness, clean energy and advanced reactor development, and other emerging nuclear technologies.

CNL has over 80 years' experience in the safe management of all classes of radioactive waste. Low and intermediate-level waste streams that contain Special Fissionable Material (SFM) as contamination (e.g., soils, waste from R&D projects, facility demolition debris) are subject to International Atomic Energy Agency (IAEA) safeguards and necessitate either an application for exemption, if at sufficiently low SFM contamination levels, to the Canadian Nuclear Safety Commission (CNSC, Canada's nuclear regulator and safeguards authority), or continued management under safeguards accountancy within a Material Balance Area (MBA).

The continued management of these materials under safeguards accountancy includes controls for characterization, traceability, reporting and verification beyond those normally applied for radioactive waste management alone. This presents a physical, administrative and financial burden to operations that is disproportionate to the waste stream's general low level of sensitivity from a safety and security perspective, while also arguably disproportionate to its proliferation risk. The waste streams are typically high in volume, diverse in form, and significantly inhomogeneous, which lead to inherent challenges in effective characterization, significant measurement uncertainty, and ultimately delays in final processing and transfer to waste management. The burden extends to both the CNSC and IAEA as key stakeholders in the safeguards process.

2. SAFEGUARDS AND WASTE CONTAMINATED WITH NUCLEAR MATERIAL

Canada's safeguards agreement [1] includes the option to request termination of safeguards by the IAEA on nuclear material (SFM or source material) contained in waste if it can be shown to have been consumed, diluted in such a way that it is no longer usable for any nuclear activity, or has become practicably irrecoverable. The term "practicably irrecoverable" is not defined in Canada's safeguards agreement and is thus open to interpretation; however, the IAEA, based upon previous consultation with experts from Member States, employs

a risk-informed interpretation dependent upon waste form, quantity, level of conditioning, and specific nuclear material(s) in the waste, as discussed (without quantification details) in IAEA public guidance [2].

The IAEA reserves the right to approve requests for termination on a case-by-case basis. The IAEA will require notification of the location of the waste at the time of termination, and the State's agreement to report subsequent transfers of the waste to other locations. Additionally, the IAEA can require the State's agreement to inform the IAEA in advance of planned chemical or physical processing for recovery of nuclear material contamination (despite being assessed as practicably irrecoverable at the time of termination), and to re-apply safeguards before commencing such processing.

Waste material approved for termination from safeguards under the above conditions will typically be classified as Measured Discard in an MBA's nuclear material accountancy. The definition of Measured Discard in Canada's safeguards agreement includes the requirement of "disposal in such a way that it is not suitable for further nuclear use".

A key element of effective waste management is resource efficiency, involving yearly planning, application of the "reduce, reuse, recycle" hierarchy to minimize radiological risk and volume, and minimization of long-term institutional controls. Maintenance of safeguards measures on waste containing contamination-level quantities of nuclear material runs counter to this principle, and in some circumstances can even become a barrier to effective waste management. Thus, termination of safeguards is a recommended pathway to effective disposal.

Termination of safeguards reduces the burden to all stakeholders in the implementation of safeguards – facility operator, CNSC, and the IAEA – and is desirable in principle by all parties, providing that fundamental obligations and rights under Canada's safeguards agreement continue to be observed.

3. A PRACTICAL PROCESS FOR SAFEGUARDS TERMINATION

To optimize its waste management and safeguards processes, CNL developed a modified approach that incorporates a safeguards assessment and consideration of termination at a much earlier stage in the waste generation process. As illustrated in Figure 1, the safeguards assessment, typically occurring once the waste is conditioned and packaged (when characterization and verification are typically the most challenging), is moved forward in the process to a stage prior to the waste being generated. The safeguards implementation onus is thus effectively removed from post-conditioning characterization and placed on pre-generation prediction. A declaration of expected contamination level from a given process is submitted to the regulator and IAEA, along with a request for "blanket" termination of safeguards on waste generated from the process. The IAEA retains its right to verification, both at the time of termination and throughout the process (if deemed necessary), and the details of this verification access are also agreed between the operator, regulator and IAEA beforehand.

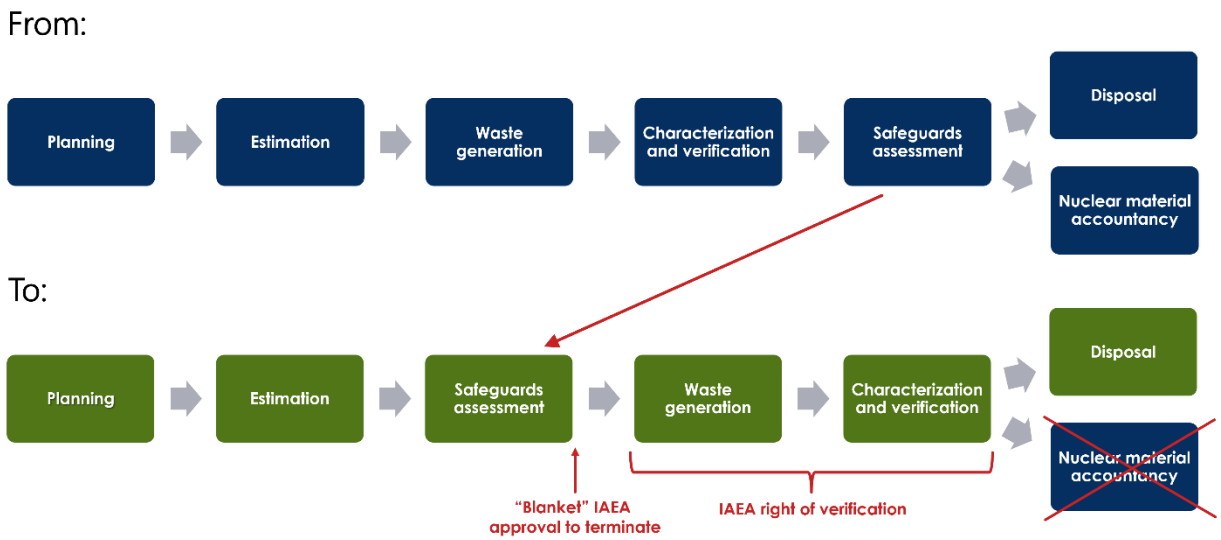


FIG. 1. Comparison of the nominal previous and new processes for safeguards assessment on waste streams. (Note: for complex decommissioning projects characterization often occurs prior to waste generation)

The main benefit of this modified process to all stakeholders (particularly those associated with safeguards implementation at the site, State, and IAEA levels, in addition to site waste management planning and implementation), is efficiency through early notification and engagement: an assessment of suitability for safeguards termination is made once at an early stage of a process, rather than at multiple times during execution as waste is generated. This creates significantly less uncertainty in the timing of a project, and less administrative burden for all stakeholders (with the IAEA, as noted, retaining its right to verify at any point downstream in the process). The ideal outcome is a waste stream free of safeguards accountancy obligations, supporting the principal of resource efficiency in effective waste management and ensuring that this principle applies at all points in the process – including final disposal.

4. THE NEED FOR EARLY ENGAGEMENT

The key paradigm shift in this approach is the promotion of radioactive waste safeguards considerations from an "afterthought" once waste is generated, to a critical component of nuclear project planning. This requires forward thinking and early engagement of all safeguards stakeholders – i.e., the safeguards staff at CNL, the CNSC, and the IAEA. Such a safeguards-by-design approach has the potential to modify planning for a project; for example, early stakeholder discussions may lead to stipulation of a nuclear material concentration limit enabling safeguards termination, or a preferred type of waste conditioning or level of final inhomogeneity in the waste matrix. These modifications can be made early (months or even years before a project initiates) when they are easiest to accommodate, with benefits accruing to all stakeholders potentially years down the road for extended projects and possibly considered for re-application to future similar projects.

The process is necessarily case-by-case, with agreement on advance safeguards termination applying only to a given project and implying no commitment by the regulator or IAEA to other projects. This is necessary to maintain confidence in the approach, particularly given the diversity of processes to which it can be applied.

As one example, consider the case of a project to decommission and demolish a legacy bulk-handling facility. Typically, such a complex project takes years of planning, to which advance safeguards termination of the estimated nuclear-material-contaminated waste stream would now be added. Under this approach, a pre-assessment is made of residual contamination prior to demolition, a discussion takes place with the regulator and IAEA regarding requirements for safeguards termination, and both stakeholders are invited to verify the pre-assessment while the building is still standing and characterization/verification easiest. Once satisfied, the IAEA grants an advance approval of safeguards termination on the contaminated waste stream (as Measured Discard), subject to verification as needed to provide confidence in the supporting assessment.

5. CURRENT STATUS OF THE PROCESS

The process described herein is currently under discussion with the regulator (CNSC) and IAEA, with potential application at CNL to legacy decommissioning projects, R&D projects, legacy waste remediation projects, and waste received from external generators. A pilot of the process will be chosen from the above possibilities in order to determine its effectiveness and highlight any unforeseen hurdles.

A number of items will need to be fully understood before all stakeholders have the necessary confidence to green-light this process. These items include the desired level of pre-characterization (which may potentially exceed the nominal level of characterization for such projects required for radiological safety and security), the degree of accuracy and timeliness required for this pre-characterization, IAEA expectations for verification, and how (or if) the process can be applied to contaminated waste already in process.

6. SUMMARY

CNL has developed a safeguards-by-design approach by which waste-generating activities, whether through decommissioning, environmental remediation or R&D projects, initiate a safeguards termination process at the earliest planning stage, allowing engagement with the regulator and IAEA at an optimum time for effective and efficient safeguards removal, and the application of a resulting agreed protocol to subsequent waste generating activities with minimal regulatory or IAEA interaction. The process is risk-informed, case-dependent, and

designed to proceed as confidence builds, with the IAEA retaining its right of verification at all downstream points in a project as needed. The expected outcome of this process is higher efficiency, reduced uncertainty, lower costs, lower radiation exposure, and shorter timeframes for processing radioactive waste streams.

REFERENCES

[1] Agreement Between the Government of Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/164, IAEA, Vienna (1972).

[2] International Safeguards in the Design of Radioactive Waste Management Programmes, NW-T-1.28, IAEA, Vienna (2025).