Canadian SMR Roadmap

Regulatory Readiness Working Group
Final Report

August 1, 2018

Executive Summary

A small modular reactor (SMR) is any fission reactor that is smaller than the conventional size. These new reactor technologies are designed with the intent to have enhanced safety features and more modular construction approaches for ease of installation, operation and removal. They are being developed to address different market needs than traditional large on-grid power reactors.

SMRs are at the early stage of development in Canada, and their future success involves risks and cost to both the private and public sectors across the country. A pan-Canadian approach on SMRs is necessary to guide important decisions by private and public leaders, reducing uncertainty for investors and providing clarity for policymakers. A *roadmapping* process is being used to develop this pan-Canadian approach.

The SMR Roadmap needs to be fully informed on key issues pertaining to finance and economics, regulation, public and aboriginal engagement, waste, and technology. Therefore, Working Groups have been established for each of these five areas to add analytical value and act as a centre of expertise to support the SMR Roadmap project.

The objective of this report is to summarize the SMR Roadmap Regulatory Readiness Working Group (RRWG) key findings on barriers and challenges to the deployment of SMRs under current regulatory regime and provides recommendations for the Steering Committee to support the SMR Roadmap project.

The RRWG has identified that the pending Bill C-69 legislation poses a risk to the future of SMR deployment in Canada, particularly for the small off-grid applications. The RRWG concludes that including SMR in the "Project List" for consideration under the pending Impact Assessment Act could result in undue timelines and costs for SMR project approval, which are likely to be an impediment to SMR deployment. The nuclear industry has been active in providing feedback and perspective on this issue during the Bill C-69 comment period.

The conclusions of this report are that there are generally no major impediments to the licensing of SMRs for deployment in Canada. Some areas have been identified as requiring additional discussion with the Canadian Nuclear Safety Commission (CNSC) and other regulatory bodies as they have the potential to pose unnecessary requirements on potential SMR operators, particularly those applications used in off-grid and remote communities. These specific areas include the topics of nuclear liability, staff training, accident management (analysis) and emergency preparedness requirements as well as security requirements for Class I nuclear facilities. The CNSC are already aware of all of these identified issues through workshops and other public consultations and they are actively engaged with industry on working towards a better understanding of what is needed to resolve these issues. The RRWG is confident that an equitable and timely resolution to these issues can be obtained through further dialogue between industry and the regulator.

Glossary of Terms

AECL Atomic Energy of Canada Limited

AOO Anticipated Operational Occurrence

BDBA Beyond Design Basis Accident

CEAA Canadian Environmental Assessment Act

CNL Canadian Nuclear Laboratories

COG CANDU Owners Group

EA Environmental Assessment

CNSC Canadian Nuclear Safety Commission

CSA Canadian Standards Association

DBA Design Basis Accident

DNNP Darlington New Nuclear Project

EA Environmental Assessment

EP Emergency Preparedness

FHA Fire Hazard Assessment

FOAK First of a kind

FSSA Fire Safe Shutdown Analysis

IAA Impact Assessment Act

IAEA International Atomic Energy Agency

IST Industry Standard Toolset

LCH Licence Conditions Handbook

LTPS Licence to Prepare Site

MWe Megawatt Electrical

MWth Megawatt Thermal

NBCC National Building Code of Canada

NFCC National Fire Code of Canada

NOAK Nth of a kind

NSCA Nuclear Safety and Control Act

NPP Nuclear Power Plant

NRCan Natural Resources Canada

PROL Power Reactor Operating Licence

PSA Probabilistic Safety Analysis

RRWG*:* Regulatory Readiness Working Group

SMR*:* Small Modular Reactor

Table of Contents

1.0 Introduction

1.1 Objective

The objective of this report is to summarize the Small Modular Reactor (SMR) Roadmap Regulatory Readiness Working Group (RRWG) key findings on barriers and challenges to the deployment of SMRs under current regulatory regime and provides recommendations for the Steering Committee to support the SMR Roadmap project.

1.2 Mandate

Identify barriers and challenges to the deployment of SMRs under current regulatory regime.

Key Activities:

- Analysis of the current Canadian regulatory regime for SMR deployment.
- Identification of gaps in regulatory regime, and proposed way forward.
- Identification of areas of excessive regulatory cost or burden for SMR deployment.

1.3 Background

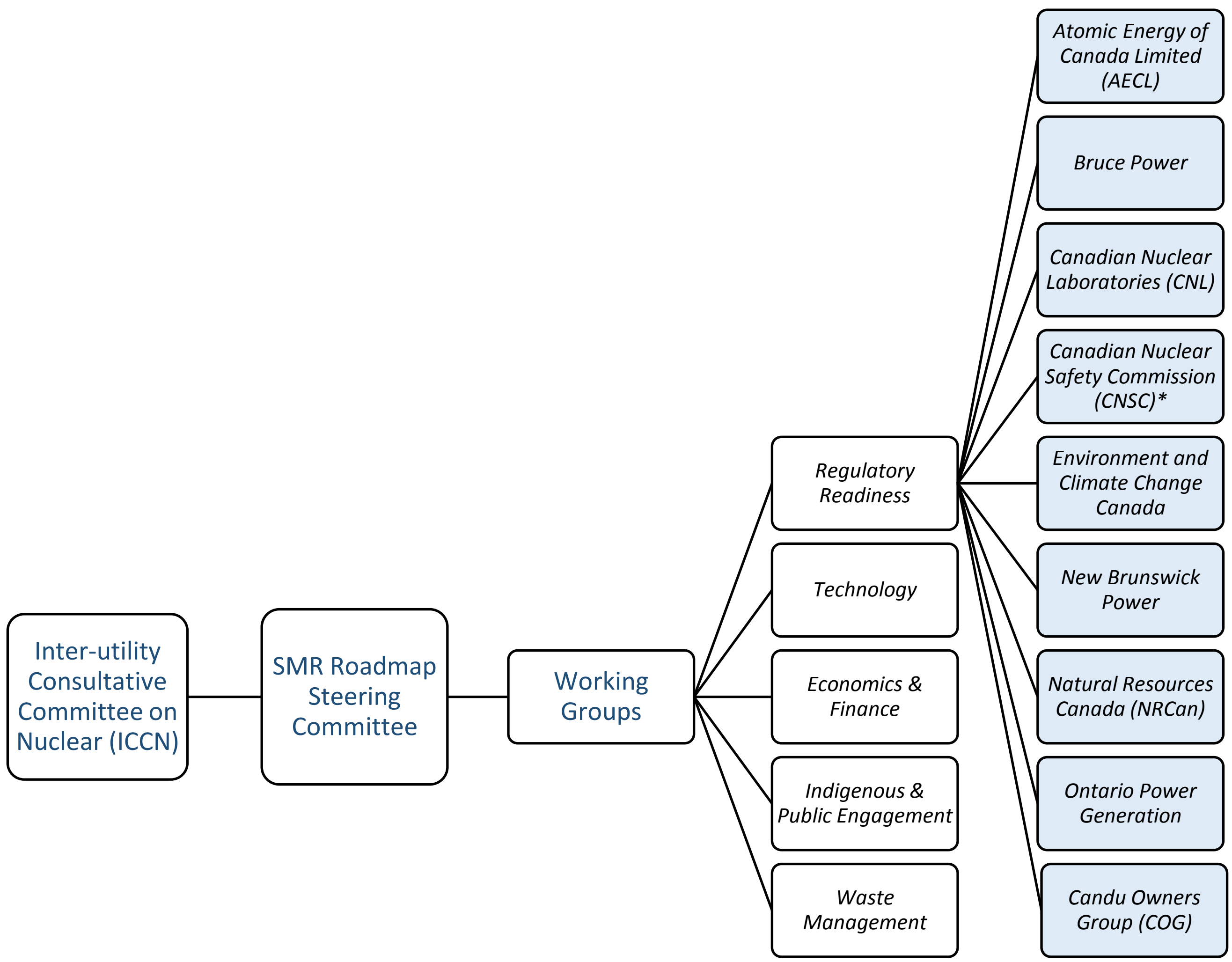
A SMR is any fission reactor that is smaller than the conventional size These new reactor technologies are designed with the intent to have enhanced safety features and more modular construction approaches for ease of installation, operation and removal. They are being developed to address different market needs than traditional large on-grid power reactors.

While technologies vary and some may be different from the typical technologies used in North American Nuclear Power Reactors, SMRs range in physical size and electrical output, making them suitable for applications that require a small footprint or a relatively small amount of power compared to a larger CANDU reactors. They are designed to be purchased and constructed in primarily a modular method, meaning that additional units could be added as needs change in time. This modular approach also drives down costs through volume manufacturing, which in turn helps reduce the risk for investors. It is worth noting that the definition of SMR includes designs which vary in electrical output from as high as 300 MWe per module for grid-connected reactors, down to 3 MWe per module (or even smaller micro SMRs), which could be best suited for remote or industrial applications.

In a Canadian context, SMRs could have at least three broad applications:

- on-grid power generation;
- on- and off-grid combined heat and power for natural resource extraction; as well as
- off-grid power and district heating for northern and remote communities, weather stations or military installations.

SMRs are at the early stage of development in Canada and internationally, and their future success involves risks and cost to both the private and public sectors across the country. A pan-Canadian approach on SMRs, is necessary to guide important decisions by private and public leaders, reducing uncertainty for investors and providing clarity for policymakers. A *road mapping* process is being used to develop this pan-Canadian approach.



The governance structure of the RRWG is depicted in Figure 1. A RRWG is established as one of the five areas to add analytical value and act as a centre of expertise to support the SMR Roadmap project.

Figure 1: Governance Structure

* Canadian Nuclear Safety Commission (CNSC) provided support to the SMR Roadmap initiative as an observer providing regulatory clarifications.

1.4 Regulatory Readiness Working Group

RRWG CO-Chairs

The RRWG is led by the following two co-chairs:

- Robin Manley, Vice-President, Nuclear Regulatory Affairs and Stakeholder Relations, Ontario Power Generation
- Maury Burton, Bruce Power, Senior Director, Regulatory Affairs, Bruce Power

Working Group Members

The RRWG is inclusive of the following nine organizations represented to date.

Each organization has a Single Point of Contact (SPOC) assigned (see Table 1), who is accountable to provide support required for the Pan-Canadian SMR Roadmap. The responsibilities were supported by staff in their organization for internal coordination and ensure progress of actions and deliverables.

CNSC provided support to the SMR Roadmap initiative as an observer providing regulatory clarifications. Contributions by CNSC to working groups are from the perspective of the mandate of the CNSC as the Canadian Nuclear Regulator to disseminate technical and regulatory information.

Table 1: Regulatory Readiness Working Group Members

Organization	Single Point of Contact (SPOC)	Support Team
Atomic Energy of Canada Limited (AECL)	SPOC: John Osborne, Vice President, Capital Program, Operations & Security Oversight	
Bruce Power	SPOC: Maury Burton, Senior Director, Regulatory Affairs	Colin Elwood
Canadian Nuclear Laboratories (CNL)	SPOC: David Garrick, Director, Safety, Engineering and Licensing	Michael Sim
Canadian Nuclear Safety Commission (CNSC)	SPOC: Christian Carrier, Director, New Major Facilities Licensing Division	Chantal Morin Laura Andrews Sean Belyea
CANDU Owners Group (COG)	SPOC: Rachna Clavero, Director, Nuclear Safety and Environmental Affairs	
Environment and Climate Change Canada	SPOC: Nardia Ali, Manager, Compliance Promotion and Expert Support (Nuclear)	Duck Kim
New Brunswick Power	SPOC: Paul Thompson, Strategic Advisor	
Natural Resources Canada (NRCan)	SPOC: Jacques Henault Advisor, Nuclear Liability, Energy Sector	Daniel Brady

Ontario Power Generation	SPOC: Robin Manley, Vice President, Nuclear Regulatory Affairs and Stakeholder Relations	David Train Saad Khan

1.5 Structure of Report

Section 3 of this report describes the scope of information contained in this report and how it was prepared. Within Section 3 are specific sections which describe the methodology used in determining the scope of the review, and a description of what types of recommendations are made. Section 3 also provides a discussion on the rationale applied by the RRWG for excluding particular legislation/regulation and codes and standards from further review within the confines of this report.

Section 4 of the report documents the results of the literature review. The results are presented under the following topic areas.

- General
- Licence Application
- Nuclear Liability
- Training/Staffing
- Fire Protection
- Nuclear Security
- Safeguards/Non-proliferation
- Nuclear Emergency Preparedness and Response
- Safety Analysis
- Design and Commissioning Requirements
- Environment
- Licensing timelines
- Ownership Models
- Transportation

Section 5 of the report provides a summary of the key recommendations and suggestions arising from the review of the report.

Section 6 summarizes the conclusions of the assessment performed by the RRWG as part of this initiative.

2.0 Scope of Information Presented in this Report

2.1 Overview

The scope of work for the RRWG includes the following:

1. Identify relevant legislation, regulations, and guidance to support SMR licensing in Canada.
    - An initial list of the existing Canadian legislative documents, CNSC regulatory documents and applicable codes and standards for literature review and impact screening (level of priority to SMRs) has been provided in Appendix A, B, C and D of this document.
    - Prioritize and confirm the list of documents in Appendix A, B, C and D and a common review template.
    - Assign team members to perform review of the regulatory documents listed in Appendix A, B, C and D.
2. Develop an in-depth understanding of key aspects influencing a potential future pan-Canadian SMR industry based on applications.
    - Conduct a broad on-grid power, on and off-grid heavy industry and off-grid remote communities and weather station/military installations application focused review of the Canadian regulatory regime.
    - Identify areas where regulatory requirements need clarification to ensure appropriate application to SMRs commensurate with risk for SMR deployment.
    - Consider added complexities introduced where, for example, an SMR may be designed by one organization, constructed by another organization, located at an existing nuclear site licensed by a third organization, and ultimately operated by a fourth organization (who may not be the land owner).
    - Consider the approvals required through the project lifecycle, and the organizations (site licensee and operator) responsible for obtaining the approvals as the licensee.
3. Perform gap analysis of the existing body of knowledge
    - Gather stakeholder input from the post-workshop debriefs and “What We Heard” reports.
    - Assess the current regulatory framework, conduct a gap analysis and summarize findings
4. Identify opportunities and challenges, and propose new work required to fill the gaps.

- Identify potential opportunities and challenges in the Canadian regulatory regime and develop a strategy to address the gaps.

- Engage with enabling partners including (but not necessarily limited to) the Canadian Standards Association (CSA), CANDU Owners Group (COG), and International Atomic Energy Agency (IAEA) SMR Task Force on previous completed efforts and potential for new work required to fill the gaps.

5. Provide recommendations to the Steering Committee on prioritizing the next steps for regulatory readiness under the SMR Roadmap.

    - Recommendations may include developing a robust Industry and regulatory strategy to allow approval to site, construct and operate an SMR based on industry needs and timelines, without compromising safety or environmental protection.

    - Recommendations should acknowledge associated roles and responsibilities for the various areas of regulatory readiness. For example:

        - CSA Standards
        - CNSC Regulatory Readiness
        - Applicant Readiness for Licensing

      Note that Industry and Government Infrastructure issues relate to regulatory readiness in that they can have significant impacts and should be considered. An example would be the required provincial and municipal governmental bodies in place required to support emergency management

2.2 Methodology

The following is the general methodology used in the preparation of this report.

- The RRWG compiled a list of relevant legislation/regulation/standards, which were in the opinion of the RRWG applicable for consideration to SMR deployment.
- The relevant documents were assigned amongst RRWG members based on relevant experience with the specific documents, personal preference and staff availability.
- In some cases, multiple industry reviewers were assigned to particular documents in order to provide a broad range of industry perspective on the regulatory landscape.
- All reviewers were asked to consider the impact of the particular document under review from several perspectives. Specifically, reviewers were expected to consider each reviewed document for:
    - Does the documents present specific challenges from a technical or economic perspective related to SMR deployment?
    - Are there specific challenges identified which would exist based on intended use of the SMR or its geographical location? For example, is there an issue which can be addressed by a larger SMR

being used in an on-grid application located near an urban population but which would pose undue challenges to a smaller off-grid installation located in a remote site?

- Reviews were focussed specifically on SMR deployment. They were not intended to provide a platform to re-iterate previous industry concerns related to regulation associated with existing nuclear facilities.
- All comments prepared by the individual reviewers were compiled in a central repository (included in Appendices A and B of this report) and sent out to the RRWG for review and comment.
- Where documents had been previously commented on by industry (Bill C-69 for example), those industry comments were used as the basis for the RRWG assessment.

2.3 Outputs

A key deliverable of the RRWG report on Regulatory Readiness is identifying areas where Legislative frameworks or regulatory requirements need clarification to ensure appropriate application of SMRs commensurate with risk which if not addressed could potentially limit future opportunities for SMR deployment. If such an issue is identified, the RRWG recommendations are provided to resolve the concern.

Two types of recommendations are considered in the context of this report

- **Key Recommendations**

  These recommendations are in the view of the RRWG essential, and if not implemented they would have a detrimental effect on ability to deploy and operate SMRs in Canada in a timely and cost effective manner.

- **Suggestions**

  These are suggestions coming from the document review. They are seen as suggestions where there is a potential opportunity for efficiency improvement in existing regulatory requirements as applied to SMRs. While these suggestions would improve the licensing process, they are not seen as crucial for the successful deployment of SMRs.

2.4 Material Reviewed

Appendices A-D summarize the sources of legislation and positions/presentation that were considered for review as part of the RRWG mandate.

The RRWG elected to screen out provincial and municipal legislation from the review, as the mandate of the RRWG was to review from the perspective of a pan-Canadian approach rather than a particular region of the country. Furthermore, the majority of the legislation reviewed is independent of geography. Given that there are no SMRs yet sited in any locale within Canada, it was considered premature at this stage to focus on locale specific governance. Thus, while typical provincial/municipal regulations have been identified in Appendix A for completeness they are not being evaluated further at this time.

Some federal legislation in Appendix A were also screened out from further assessment. Exclusions justified on the basis that the legislation was either not pertinent to SMRs (Class II Regulations for example) or did not pose an incremental impact to SMRs that would not be required for any other nuclear licence (Administrative Monetary Penalties, for example).

Appendix C consists of codes and standards, primarily CSA nuclear standards. These codes and standards are generally not mandatory requirements unless specifically referenced in the CNSC issued licence for a given facility. The contents of codes and standards delve much deeper into specific technical requirements than are generally present in the Act and Regulations.

The RRWG agreed to leverage the existing body of knowledge prepared by other Canadian organizations, such as COG and the CSA, whom have their own internal review processes concerning SMR. As a summary, the industry has determined that:

- The CSA Nuclear Standards are generally written with respect to light water (e.g. pressurized water reactors) or heavy water (CANDU) coolant based designs, with some CANDU-specific documents being exceptions.
- The CSA Nuclear Standards do not cover the full depth of technologies being considered for Advanced Reactors and SMR, e.g. liquid fuel, metal coolants, gas coolants, etc.

Industry has commented that they do not consider this fundamental barrier to deploying an SMR in Canada, given that that the Canadian regulator accepts the use of licensing basis documents and guidance not normally used in Canada, with an appropriate assessment such as a gap analysis.

A line-by-line review of the existing CSA standards (or the wider Appendix C list of standards for that matter) is unlikely to significantly change the above assessment or add significant details. The high-level take away is that SMRs may feature new and innovative technologies, which are not covered by existing codes and standards in the traditional Canadian regulatory framework. This will not prevent deployment, but creates economic risks given that new requirements will need to be developed or taken from 'non-traditional' sources, which adds time and risk to the licensing process.

Appendix D is a compendium of relevant presentations/positions on SMR applications. Appendix D provides a useful reference for recent presentations by both industry and regulatory representatives related possible applications of SMRs. However, any potential future licensing of SMRs in Canada will be based on formal legislation, regulations, regulatory documents, and codes and standards, not position papers and conference proceedings. On this basis the RRWG concluded that an in-depth analysis of these by the team was of limited value for the mandate of this working group at this time.

2.5 Experience from Research Reactors

There are several small research reactors situated across Canada at various academic institutions (Ecole Polytechnique, Royal Military College, McMaster University, Saskatchewan Research Council, and until 2016 University of Alberta). All are SLOWPOKE designs with the exception of the McMaster pool reactor. The SLOWPOKE units were installed in the 1970-80's and all received 10-year license renewals in 2013. The McMaster research reactor was built in the late 1950's and continues operation today following receipt of a 10-year operating license in 2014.

While the regulatory framework under which these facilities were sited and constructed may have changed since they were built, they all operate today under the current CNSC licensing framework for Class 1 facilities (essentially a risk-informed, scaled-down version). Historically, the CNSC has licensed a variety of reactor facilities based on application of graded approach including ZED-2 (200 Wth), Slowpokes (20kWth), McMaster (5MWth), NRU (~135 MWth), and larger facilities (1500+ MWth).

A review of these facilities revealed a number of common attributes with SMRs. These include:

- Small facilities (<10 MWth) more comparable in size to vSMRs than large CANDU.
- Claims of enhanced safety compared to large reactors has been used by both the operator and the regulator when describing the SLOWPOKE design, as well as with SMRs.
- Use of enriched fuel
- "minimum" complement can be one operator
- Training requirements for CNSC "certified" operators not as extensive as for CANDU reactors.
- Security infrastructure less than large NPP
- SLOWPOKE designs use essentially a fleet approach to licensing (common safety report of ~50 pages and synchronized hearing for re-licensing all 4 SLOWPOKE in 2013)
- SLOWPOKE allow for remote control for up to 18 hours
- Located in "high density" areas (university campuses)
- Nuclear liability limited to $500k, far less than $1B for large NPP.
- Emergency response resources are typically local municipal first responders. No site specific Emergency Response Team.

Each of the SLOWPOKE facilities applied for and received individual operating licensing. The Commission also had one day of hearings in 2013 for all for licensees where these licence applications were essentially heard "en masse". The CNSC staff presentation for the hearing was also common to all facilities with site-specific information as required. The records of decision issued by the Commission for each of the four SLOWPOKE applicants also share many common attributes.

During the hearings, there were references to graded application of licensing to acknowledge that these designs were "inherently safe" and due to their size and design constituted a much lower risk than a conventional power reactor.

The SLOWPOKE units have much smaller power output than the lower spectrum of proposed SMRs yet they share some technical commonalities (negative temperature coefficient, natural convection cool, enriched fuel, minimal operator intervention, etc.). Thus, while a direct comparison of the licensing complexity between these research reactors and any proposed SMR cannot be made, the licence application does demonstrate that the existing Canadian regulatory framework is capable of being appropriately applied based on potential risk.

3.0 Main Findings

3.1 General

Documents Reviewed: **Nuclear Safety and Control Act**
General Nuclear Safety and Control Regulations
Radiation Protection Regulations
Class I Facility Regulations
CNSC Cost Recovery Fee Regulations
CNSC Discussion Paper DIS-16-04 Small Modular Reactors: Regulatory Strategy, Approaches and Challenges
CNSC What We Heard Report DIS-16-04

The reviewed documents in this section are Acts and regulations that apply to nuclear activities in Canada. They would also apply equally to SMRs although SMRs are not specifically mentioned.

Note: Per the diagram below, regulations are supported by Regulatory Documents. These are discussed in subsequent sections of the report.

Figure 2: Canadian Regulatory Framework

SMRs would be considered Class I facilities. The Class I facilities Regulations do not sub-categorize reactor types.

Specific clauses in the *Class I Nuclear Facilities Regulations* are discussed in more detail in this report. Recommendations are identified the relevant section.

> Section 6(k) of the *Class I Nuclear Facilities Regulations* pertains to emergency response and activities required by the licensee to mitigate the effects of an accidental release.
>
> Section 6(l) of the *Class I Nuclear Facilities Regulations* discusses proposed measures to prevent acts of sabotage at the facility.
>
> Section 9 of the *Class I Nuclear Facilities Regulations* discusses the requirement for certification of staff for identified positions at the nuclear facility.

Section 8 of the *Radiation Protection Regulations* requires licensees to use a licensed dosimetry service. This is typically a separate licence and the service can be provided by a third party, which does not have to be located at the specific SMR site. SMR facilities situated in remote locations will need to consider the timeliness and accessibility to dosimetry service providers if they elect to not perform these activities themselves.

In general, the RRWG found that the licensing process has no fundamental barriers to the deployment of an SMR in Canada. Some areas have been identified as requiring additional discussion with the CNSC and other regulatory bodies as they have the potential to pose unnecessary requirements on potential SMR operators, particularly those applications used in off-grid and remote communities. These issues are further detailed in the subsequent sections.

The CNSC are already aware of many of these identified issues through workshops and other public consultations and they are actively engaged with industry on working towards a better understanding of what is needed to resolve these issues. Many of the CNSC processes, such as the Vendor Design Review and work being done to apply a graded-approach to regulatory documents and processes, has been singled out as enabling SMR deployment in Canada.

3.2 Licence Application

Documents Reviewed: **REGDOC 1.1.1 Licence to Prepare Site and Site Evaluation of New Reactor Facilities**
RD-369 Licence Application Guide: Licence to Construct a Nuclear Power Plant
REGDOC-1.1.2, Licence Application Guide: Licence to Construct a Nuclear Power Plant
REGDOC 1.1.3 Licence Application Guide: Licence to Operate a Nuclear Power Plant
REGDOC-1.1.5, Licence Application Guide: Small Modular Reactor Facilities
CNSC Discussion Paper DIS-16-04 Small Modular Reactors: Regulatory Strategy, Approaches and Challenges
CNSC What We Heard Report DIS-16-04

Regulatory document REGDOC-1.1.1, Licence to Prepare Site and Site Evaluation for New Reactor Facilities, sets out requirements and guidance for site preparation and site evaluation. It also addresses requirements and guidance for a licence to prepare site. This document refers to both nuclear power plants and small reactor facilities as "reactor facilities". Its content also addresses the information needed for subsequent lifecycle phases of construction and operation. REGDOC 1.1.1 includes reference to the use of a graded approach.

This document replaces the previously published RD-346, Site Evaluation for Nuclear Power Plants. REGDOC-1.1.1 updates RD-346 by incorporating lessons learned from the Fukushima nuclear event of March 2011. The updates were made to address findings from INFO-0824, CNSC Fukushima Task Force Report, and the subsequently issued action plans as applicable to RD-346.

REGDOC-1.1.1 is intended to form part of the licensing basis for a regulated facility or activity within the scope of the document. It is intended for inclusion in licences as either part of the conditions and safety and control measures in a licence, or as part of the safety and control measures to be described in a licence application and the documents needed to support that application. REGDOC 1.1.1 allows for the application of a risk informed “graded approach” to the requirements outlined in the REGDOC and makes specific reference to “small reactor facilities”.

REGDOC 1.1.5 Licence Application Guide: Small Modular Reactor Facilities is currently under development by the CNSC. REGDOC 1.1.5 was not yet published; therefore, the impact could not be evaluated.

In order to obtain a licence to construct for a nuclear power plant in Canada, a formal application must be submitted to the CNSC. RD-369 provides guidance and identifies the information that should be submitted to support such an application.

RD-369 is scheduled to be superseded by REGDOC-1.1.2, *Licence Application Guide: Licence to Construct a Nuclear Power Plant*. It is anticipated that REGDOC-1.1.2 will follow a similar format to REGDOC 1.1.1 and REGDOC 1.1.3 where there is specific mention of the use of a graded approach as well as differentiation between nuclear power plants and small reactor facilities.

REGDOC 1.1.3, Licence Application Guide: Licence to operate a Nuclear Power Plant, is the continuation of REGDOC 1.1.1 (LTPS), RD-369 (construct) and REGDOC 2.5.2, Design of Reactor Facilities: Nuclear Power Plants. Similarly, it makes specific reference to RD-204 and the other REGDOCS continued in this literature review. All comments made under those reviews are relevant to REGDOC 1.1.3.

There are no specific recommendations coming out of the review of the documents discussed in this section.

3.3 Nuclear Liability

Documents Reviewed: Nuclear Liability and Compensation Act
Nuclear Liability and Compensation Regulations

The *Nuclear Liability and Compensation Act* establishes a compensation and liability regime in the unlikely event of a nuclear accident resulting in civil injury and damages. This new law entered into force on January 1, 2017 and replaced the *Nuclear Liability Act*, legislation which dated back to the early 1970s.

Under the new Act, the operator of a power reactor will now be responsible to pay up to $1 billion for civil damages resulting from an accident at that plant. This is a major increase from the $75 million that operators were required to pay under the old Act. The $1 billion amount is being phased in from $650 million in 2017 to $1 billion beginning in 2020.

The new Act applies to Canadian nuclear facilities listed in Regulations, such as nuclear power reactors, nuclear research reactors, fuel processing plants and facilities for managing nuclear fuel waste. For the purposes of the legislation, these facilities are defined as "nuclear installations" to distinguish them from other nuclear facilities such as uranium mines, to which the legislation does not apply.

The level of risk is different for the activities of each class of nuclear installation, so the operator of a particular class is assigned a liability amount that is very roughly proportional to the level of risk posed by that class of nuclear installation.

The liability amount for each class of nuclear installation must be re-assessed at least once every five years and, based on the assessment, the Government of Canada may increase the amounts by Regulation.

The Regulations rank facilities from the highest to lowest risk in the following order and apply the following limits for liability:

Rank	Description	Liability
1	Power Reactor* * any reactor with capacity to produce electricity for commercial purposes	$1 billion
2	reactor of over 7 MWth;	$180 million
3	nuclear fuel waste processing facility;	$40 million
4	nuclear fuel waste management facility;	$13 million
5	nuclear fuel conversion facility;	$3.3 million
6	nuclear fuel production facility;	$2.3 million
7	reactor of 1 MWth to 7 MWth;	$1.3 million
8	radioactive waste management facility; and	$1 million
9	reactor of less than 1 MWth.	$0.5 million

The current regulatory structure would impose a $1B requirement on any power reactor used for commercial electricity production, regardless of size. Similarly, the limit for any small reactor above 7MWth is $180M. This is an unrealistic burden on heavy industry or off-grid installations, which will typically be much smaller in terms of energy output than a typical large power reactor used by utilities for the commercial generation of power. Furthermore, the advances in passive safety features inherent in many SMR designs effectively makes their risk profile much lower than a large traditional water cooled reactor and more in line with current small research reactors.

It is anticipated that the economic burden imposed on a small operation in order to maintain $1B of nuclear liability could result in an unsupportable business model. Given that the current values of nuclear liability are already imposed on a risk informed graded scale it is recommended that a similar approach be applied to SMRs.

Key Recommendation #1: Revise the Regulations to apply nuclear liability limits to SMRs on a graded scale based on risk-informed criteria.

3.4 Training/Staffing

Documents Reviewed: **G-323 Ensuring the Presence of Sufficient Qualified staff at Class I Nuclear Facilities – Minimum Shift Complement**
G-276 Human Factors Engineering Program Plans
G-278 Human Factors Verification and Validation Plans
REGDOC 2.2.2 Personnel Training
REGDOC 2.2.3 Personnel Certification: Certification of Persons Working at Nuclear Power Plants (Draft)
RD-204 Certification of Persons Working at Nuclear Power Plants

All Class I nuclear facility licensees are required to ensure the presence of a sufficient number of qualified workers to carry on the licensed activity safely in accordance with the Nuclear Safety and Control Act (NSCA), the Regulations made under the NSCA, and the facility licence. One aspect of ensuring the presence of a sufficient number of qualified workers is defining the minimum number of workers with specific qualifications who will be available to the nuclear facility at all times, known as the minimum staff complement. The number and qualifications of workers in the minimum staff complement must be adequate to successfully respond to all credible events, including the most resource-intensive conditions for any facility state.

Regulatory Guide G-323 provides guidelines for ensuring the presence of sufficient qualified staff (minimum complement) at all Class 1 nuclear facilities (i.e. any SMR). As outlined in G-323 it is expected that use of this guide will vary with the complexity of facility operations and the consequences of potential events on the environment, health and safety of persons, and maintenance of national security and measures required to implement international obligations.

G-323 requires a licensee to use a systematic analysis to determine the minimum complement of staff for a facility. The regulatory framework is not prescriptive in mandating a specific headcount for a nuclear facility however it does require that the number determined by the licensee is based on an assessment of the resources required under the conditions mentioned above, on an assessment of human factors and validated. Specific considerations around human factors and the requirements for validation are documented in G-276 and G-278 respectively.

Certification of staff for specific positions at nuclear power plants is documented in RD-204 which is currently being revised to REGDOC 2.2.3. For clarity, RD-204 defines a Nuclear Power Plant as any fission reactor that has been constructed to generate electricity on a commercial scale. Based on this definition it is reasonable to assume that REGDOC 2.2.3 would apply to any SMR facility where the energy from the reactor is being used for commercial purposes.

RD-204 is prescriptive with respect to training requirements for certified staff at nuclear power plants. While not specific to CANDU, it is structured to cater to the certified training requirements of a large water-cooled commercial nuclear power plant. RD-204 and the pending REGDOC 2.2.3 specify the scope and depth of the required training, examination requirements, use of a simulator as well as qualifications of approved training staff. The expectation is that training staff are current or former certified staff at the nuclear power plant. Given these prescriptive restrictions, it is unlikely that sufficient qualified individuals could be found to fill such training roles for future SMRs.

A comparison of requirements for staff certification at existing Canadian nuclear power plants with other research type reactors within Canada indicates that a risk-informed approach can be applied to smaller facilities. For example, the research reactor facilities do not require certified positions to be trained in accordance with RD-204, although they have to follow REGDOC 2.2.2. Rather the certification requirements are typically included in appendices to the Licence Conditions Handbook (LCH). These requirements are less prescriptive than outlined in RD-204 and REGDOC 2.2.3, do not require the use of a full scope simulator and do not prescribe the qualifications of the training/examination staff. Again, this graded approach to staff certification is appropriate for these smaller facilities, based on a risk informed assessment. RD-204/REGDOC 2.2.3 are not appropriate for many of the smaller SMR designs, many of which incorporate "safety by design", requiring minimal operator intervention both during normal operation as well as non-standard operating conditions.

Suggestion: Certification requirements for persons operating SMRs need to be applied on a graded scale based on risk-informed criteria similar to existing Class I facilities other than current commercial NPP.

3.5 Fire Protection

Documents Reviewed: CSA N293 Fire Protection for Nuclear Power Plants

All power reactors currently licensed in Canada are required to follow the requirements of CSA N293, Fire Protection for Nuclear Power Plants as this standard is included in each licensees' PROL/LCH. The smaller research Class 1 facilities do not have this requirement and are only required to follow the National Building Code of Canada (NBCC) and the National Fire Code of Canada (NFCC). The requirement to follow CSA N293 is also included in the licence for CNL's NRU reactor although it is not classified as a power reactor.

CSA N293 provides the minimum fire protection requirements for the design, construction, commissioning, operation, and decommissioning of nuclear power plants, including structures, systems, and components (SSCs) that directly support the plant and the protected area. It is applicable to any nuclear facility where its requirements are specified in the site licence.

The intent of CSA N293 is to ensure that fundamental nuclear safety objectives are achievable in the event of a fire at a nuclear facility. The plant shall be capable of;

a) achieving and maintaining the reactor in subcritical conditions;
b) achieving and maintaining decay heat removal;
c) maintaining the integrity of the fission product boundaries; and
d) limiting the release of radioactive materials that are located outside the reactor.

Many SMR designs provide these nuclear safety objectives in the absence of operator mitigating actions or reliance on external engineered sources of cooling or electrical supply. It is therefore unclear what, if any, incremental safety margin would be gained from requiring these reactor designs to comply with all the requirements of CSA N293. It is anticipated the CNSC will be pragmatic in applying CSA N293 requirements.

CSA N293 also requires fire protection systems in nuclear power plants to demonstrate life safety performance objectives. It requires that the following life safety performance objectives shall be met during all operational modes and plant configurations:

- Fire hazard controls shall be included in design and operational stages.
- Fire notification means shall be provided.
- Safe egress and/or areas of refuge shall be provided for occupants for use in the event of a fire.
- A safe environment and other required supports shall be provided for essential staff so that they can perform all necessary plant control functions during and following a fire.
- Protection for personnel performing emergency services shall be provided both during and following a fire.
- Access and emergency lighting shall be provided

A full clause-by-clause assessment of CSA N293 has not been completed as part of the RRWG activities. However, a high-level review concludes that CSA N293 may be unnecessarily prescriptive in many areas and could prove onerous to implement at an SMR facility, particularly those in remote locations. It is structured on the basis that it applies to a large water-cooled reactor facility with primary and secondary control rooms, attached turbine halls, etc. The Standard prescribes power plant design requirements to be implemented as well as specific requirement on the engineered fire detection and suppression systems, which are to be installed in a NPP.

CSA N293 also prescribes the on-going fire protection programs which need to be in place including staffing and training of fire response forces. The requirements of CSA N293 already pose a substantial burden of existing large scale nuclear facilities located in close proximity to urban centres where some of the prescribed support infrastructure already exits. Application of similar requirements on industrial or remote location SMR facilities would likely not be economically supportable nor practical based on proposed staffing levels for the facility.

As stated previously many of the nuclear safety objectives in the event of a fire at a facility would be met by virtue of the inherent safety built in to many SMR designs and similarly life safety is ensured through compliance with NBCC and NFCC. Thus, it is unclear what additional safety margin could be provided through imposition of CSA N293 requirements on SMRs.

Two possible solutions are provided for consideration.

The first solution is to perform the detailed FHA and Fire Safety Shutdown Analysis (FSSA) for the SMR facility and show how the intent of CSA N293 is met through design. The licensing basis for the facility will reflect this.

The second solution would be to rely heavily on Section 4.4 (Alternatives and performance-based approaches) of CSA N293. Application of Section 4.4 is a recognized process to demonstrate that an alternative means (alternate compliance) can be capable of providing equivalent or better than performance than stipulated via code.

Based on a very preliminary review the RRWG considers that an initial assessment to exclude a particular SMR design from the requirements of CSA N293 would be more efficient over the life of the facility than clause-by-clause exemption requests. It is recognized that this approach may be highly technology dependent and therefore a generic recommendation to exclude all SMRs from the requirements of CSA N293 cannot be made at this time. The concern with CSA N293 Fire Protection standard being too prescriptive is noted by the CSA would be reviewed and the N293 Technical

Committee plans to review how the standard details would be applied or what further discussions are required.

Suggestion: The requirement to comply with CSA N293 as a licence condition for any SMR installation should be determined based on the results of the FHA/FSSA for that facility, not based on current definition of a nuclear power plant per CSA N293.

3.6 Nuclear Security

Documents Reviewed: **Nuclear Security Regulations**
CNSC Discussion Paper DIS-16-04 Small Modular Reactors: Regulatory Strategy, Approaches and Challenges
CNSC What We Heard Report DIS-16-04
CNSC Stakeholder Workshop Report: Periodic Review of the Nuclear Security Regulations.
CNSC Workshop on Amendments to the Nuclear Security Regulations, January 31 2017

A key part of the CNSC's mission is to regulate the security of nuclear material and nuclear facilities. The *Nuclear Security Regulations* set out security requirements that are applicable to certain nuclear materials and certain nuclear facilities. Part 1 of the *Nuclear Security Regulations* applies to Category I, II and III nuclear material (described in Schedule 1 of the *Nuclear Security Regulations*) and nuclear power plants. Part 1 includes general obligations and additional requirements for high-security sites (a nuclear power plant or a nuclear facility where Category I or II nuclear materials are processed, used or stored). Part 2 of the *Nuclear Security Regulations* sets out requirements that are specific to the nuclear facilities listed in Schedule 2 of the *Nuclear Security Regulations*, such as nuclear fuel fabrication facilities and nuclear substance processing facilities.

The volume of fissile material required for the operation of a SMR will typically be much smaller than that for a traditional large water-cooled nuclear power plant. Thus, the security requirements could be reasonably assumed to be less restrictive than those required for a traditional NPP. However, the quantity and type of fissile material present in a SMR will typically result in the nuclear material being classified as Category I or Category II based on anticipated levels of enrichment.

The *Nuclear Security Regulations* require Category II material to be used and stored within a "protected area" of the nuclear facility and Category I material within an even higher security "inner area". The presence of Category I or II material at a facility defines the facility as a high security site and the security requirements for such sites are prescribed in the *Nuclear Security Regulations*. These requirements are prescriptive in both the required physical barriers and intrusion detection systems as well as the need for a continuous armed response force.

These security requirements in the *Nuclear Security Regulations* apply to the large conventional nuclear power plants that operate in Canada today. However, implementation of these requirements could prove onerous for smaller SMR facilities, particularly those located in remote locations.

Developers of SMR technologies are seeking alternative approaches to security, such as security by design, in order to reduce the need for security personnel.

The *Nuclear Security Regulations* generally permit a measure of flexibility in the use of alternative approaches while ensuring security will remain commensurate with the proposed activities. The Regulations permit the application of a graded approach particularly as they apply to the security requirements for nuclear material. For example, sabotage scenarios would need to be considered taking into account all features and consider where inventory is stored and in what state the material inventory is in (e.g., fresh fuel, waste fuel, in the core and others).

Vendor feedback on Discussion Paper DIS-16-04 indicated that SMRs would require new approaches to site security because the credible threats to these units may be completely different from those faced by existing facilities. Should nuclear material not be stored onsite, other than in the reactor, vulnerability would be significantly reduced. The use of passive systems may eliminate most of the systems that are traditionally vulnerable to sabotage.

Commenters also stated that, in view of potential enhanced inherent and passive safety characteristics, a smaller security force than for a conventional nuclear power plant could be justified and that regulatory guidance on this would be useful. The general consensus was that while there are no insurmountable security related roadblocks to licensing small modular reactors under the existing regulatory framework, amendments to the *Nuclear Security Regulations* should be considered. For example,

- The *Nuclear Security Regulations* enable a graded approach to security however they specifically require onsite security officers and an onsite nuclear response force. This will be challenging for small and/or remotely located SMRs.
- Current Regulations do not allow a facility that would employ a fully engineered security system in conjunction with an offsite response force.
- The traditional sized a security staff will pose a significant burden on small plants. The inherent SMR “security by design” should result in reduced need for staff.
- The threat-risk assessment could be used to justify significantly reduction or elimination of an on-site security force.

This information is being considered as part of the review of the *Nuclear Security Regulations*, and a CNSC workshop was held with SMR stakeholders early in 2017 to collect additional information. It is important to note that the use of "security by design" is possible under the existing regulations and that a graded approach to security can be applied to meet requirements based on security risk-informed considerations.

Key Recommendation #2: Revise the Security Regulations to cover high level principles similar to other regulations and remove prescriptive requirements. CNSC REGDOC should then be produced providing necessary details and including the concept of a graded approach.

Suggestion: Industry partners continue to collaborate on amendments to *Nuclear Security Regulations* and build on feedback from January 2017 workshop.

Suggestion: *Nuclear Security Regulations* be amended to allow a licensee to propose a facility that would employ a fully engineered security system in conjunction with an offsite response force.

3.7 Safeguards/Non-proliferation

Documents Reviewed: **Nuclear Safeguards Verification**
Non-proliferation Import and Export Control Regulations
REGDOC 2.13.1 Safeguards and Nuclear Material Accountancy
REGDOC 2.13.2 Import and Export
CNSC Discussion Paper DIS-16-04 Small Modular Reactors: Regulatory Strategy, Approaches and Challenges
CNSC What We Heard Report DIS-16-04

The IAEA has an important independent verification role, aimed at assuring the international community that nuclear material, facilities and other items subject to safeguards are used only for peaceful purposes.

Canada has entered into safeguards agreements with the IAEA (INFCIRC/164) pursuant to its obligations under the Treaty on the Non-Proliferation of Nuclear Weapons. The objective of this agreement is for the IAEA to provide assurance on an annual basis to Canada and to the international community that all nuclear materials in the country are being used peacefully.

Every nuclear reactor facility type, whether a research reactor, SMR, or full-scale nuclear power plant, must have a safeguards program in place to cover the following specific areas:

- nuclear material accountancy and control (taking into account changes to fuel composition over time)for initial fuel arrival onsite through to spent fuel management
- access and assistance to the IAEA for verification inspections
- operational and design information
- safeguards equipment, containment and surveillance

The safeguards measures applied are based on the design and operation of the facilities. REGDOC 2.13.2 indicates that the SMR designers (or more correctly licence applicants) will need to provide design and features to the IAEA and CNSC at the early phase so that early consultation can be made with both IAEA and CNSC to incorporate safeguards implementation requirements in its design and construction.

Industry feedback to the CNSC on DIS-16-04 indicated that in general, the safeguards arrangements – as defined by the International Atomic Energy Agency (IAEA) and supplemented by the CNSC's additional requirements described in regulatory document RD-336, Accounting and Reporting of Nuclear Material - should be acceptable. However, commenters indicated that some designs may require special techniques to verify the accounting of fuel being added and removed from the core offsite (and possibly outside Canada).

Commenters also noted that there may be some technical challenges with safeguards for SMRs, as outlined in the regulations and in licences. These include factors such as SMRs sited at remote locations with limited IAEA inspector access, and SMRs with long-life sealed cores as well as those with high initial excess reactivity. Responders also indicated that some of these challenges are also potential benefits. For example, a remote location makes diversion more difficult and the same is true of a sealed long-life core.

Safeguards requirements for SMRs will depend on the reactors' design and operation. These requirements or measures typically involve the controlling, tracking and reporting of nuclear materials to ensure that the material remains in peaceful activities and that nuclear facilities are used only for peaceful purposes. This means that safeguards measures will vary with design and operation, such as open or sealed-core structures, and fuel types. Specific measures may therefore be needed to cover construction and operational activities to ensure safeguards effectiveness for the SMRs.

It is understood that how safeguards requirements are implemented at a particular SMR site will be strongly influenced by the SMR specific design as well as site location and security. As a result the RRWG has no specific recommendations coming from the review of safeguards obligations as they will be determined on a case by cases basis.

Nuclear Non-proliferation Import and Export Control Regulations outline the requirements to import/export nuclear components and/or information from Canada as part of Canada's obligations under the Treaty on non-proliferation of Nuclear Weapons. Included in the *Nuclear Non-proliferation Import and Export Control Regulations* is a comprehensive list of components/information which will require a licence for import or export. This list is not specific to large water-cooled reactors and it is anticipated that SMRs will contain components which are included in these regulations. As well, it is possible that some of the new technologies being considered for some of the SMR designs would necessitate amendments to these regulations or at least require vendors/licensees to apply for import/export licences for components which are unfamiliar to operators of large water-cooled reactors. There are no specific recommendations being made at this time as inevitably the need to obtain such import/export licences will be highly dependent on the SMR technology.

3.8 Nuclear Emergency Preparedness and Response

Documents Reviewed: Emergency Management and Civil Protection Act
REGDOC 2.10.1 Nuclear Emergency Preparedness and Response
CNSC Discussion Paper DIS-16-04 Small Modular Reactors: Regulatory Strategy, Approaches and Challenges
CNSC What We Heard Report DIS-16-04

REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response*, sets out the emergency preparedness requirements and guidance of the CNSC related to the development of emergency measures for licensees and licence applicants of Class I nuclear facilities.

This regulatory document lists and discusses the components and supporting elements that licensees shall implement and consider when establishing an emergency preparedness program (EP program) to prepare for, to respond to, and to recover from the effects of accidental radiological/nuclear and/or hazardous substance releases from Class I nuclear facilities. REGDOC-2.10.1 refers primarily to nuclear events, but the planning basis must also address releases of hazardous materials. In addition, REGDOC-2.10.1 addresses how licensees shall test the implementation measures of their EP programs through the conduct of exercises. An EP program should be developed in a manner that is commensurate with the complexity of the facility's associated undertakings, as well as the probability and potential severity of the emergency scenarios associated with the operation of the licensed facility.

This regulatory document applies to all Class I nuclear facilities. Some requirements in this document are specifically designated as applying only to nuclear power plants and research reactors with a thermal output capacity greater than 10 MW thermal. As it is expected that most proposed SMR installations will fit in to this category it is anticipated that all requirements of REGDOC 2.10.1 will apply to SMRs, similar to a large conventional water-cooled nuclear power plant. REGDOC 2.10.1 stipulates that a graded approach, commensurate with risk, may be defined and used when applying the requirements and guidance contained in this regulatory document.

It is important to recognize that accident management interfaces closely with but is distinct from emergency preparedness, which provides emergency responses to mitigate the onsite and offsite impacts of an accident to workers and the public. Both accident management and emergency preparedness form part of the defence-in-depth provisions. During a nuclear emergency, the practical goals of emergency response are:

An effective response to an emergency requires strong linkages between accident management and emergency preparedness. The fundamental premise underlying accident management is that the organization operating a nuclear reactor must be able to respond to any accident that cannot be practically eliminated in order to:

- prevent the escalation of the accident
- mitigate the consequences of the accident
- achieve a long-term safe stable state after the accident

Thus, accident management provides capability to respond to an accident within the reactor facility. The typical accidents which a large traditional water-cooled reactor needs to consider are discussed in REGDOC 2.3.2 (Accident Management). It is anticipated that many SMR designs will preclude many of these scenarios <u>by design</u>.

REGDOC 2.10.1 outlines specific requirements and guidance for each of the following subject areas related to emergency planning and preparedness:

- Planning basis
    - Emergency response plan and procedures
    - Emergency response organization and staffing
    - Emergency categorization, activation and notification
    - Emergency assessment requirements
    - Interface and support for offsite response organizations
    - Emergency personnel protection
    - Emergency response facilities and equipment
    - Public emergency information
    - Recovery

    - Validation of the emergency response plan and procedures
- Preparedness
    - Training and qualification
    - Maintenance of emergency response facilities and equipment
    - Testing the implementation of emergency measures
    - Public preparedness requirements

Within each of the above subject areas REGDOC 2.10.1 outlines both general requirements for all licensees as well as specific requirements for Class I facilities and incremental requirements on Class I reactors greater than 10 MW thermal. Most anticipated SMR applications would likely be subject to these incremental requirements.

The incremental EP requirements for reactors above 10 MW thermal are applied today to all large commercial power reactors in Canada, many of which are located to large urban centres. These requirements are not necessarily appropriate nor practical for implementation in remote SMR locations nor with particular SMR designs which preclude many of the design basis accident around which these EP measures were originally designed to help mitigate.

The requirements outlined in REGDOC 2.10.1 are intended to provide a framework by which licensees and other offsite agencies (municipal, provincial, federal) can provide a coordinated response to an emergency originating at a large nuclear facility. The need to apply an equivalent program to much smaller facilities needs to be reviewed. Furthermore, the intended location of many SMRs in remote, sparsely populated regions, may reduce the need for many measures identified in REGDOC 2.10.1. Examples of this include the need to have offsite emergency response facilities, the need to conduct large scale emergency response exercises, the maintenance of a permanent emergency response force and the local availability of emergency response equipment.

Suggestion: Revise REGDOC 2.10.1 to eliminate the 10MW thermal lower limit for application of the full suite of requirements in REGDOC 2.10.1. The need to apply the full suite of requirements should be based on risk-informed criteria, not an arbitrary low limit on reactor thermal power.

Suggestion: Revise REGDOC 2.10.1 to allow the requirements to conduct full-scale drills etc. should be applied in a graded approach commensurate with the risk posed.

Suggestion: Revise REGDOC 2.10.1 or prepare a new REGDOC to allow a licensee to propose a facility that would include engineered systems that either preclude certain event categories or provide sufficient time for an offsite response force, rather than permanent on-site emergency response staff and equipment.

3.9 Safety Analysis

Documents Reviewed: **REGDOC 2.3.2 Accident Management: Severe Accident Management Program for Nuclear Reactors**
REGDOC 2.3.3 Periodic Safety Reviews
REGDOC 2.4.1 Deterministic Safety Analysis

REGDOC 2.4.2 Probabilistic Safety Assessment (PSA) for Nuclear Power Plants
CNSC Discussion Paper DIS-16-04 Small Modular Reactors: Regulatory Strategy, Approaches and Challenges
CNSC What We Heard Report DIS-16-04

The purpose of safety analysis is to establish and confirm the design basis, derive operational limits and establish and validate accident and management procedures and guidelines. One of the objectives of the safety analysis is to demonstrate that the systems in an NPP can prevent unacceptable consequences of an event. Mitigating systems are usually identified with safety systems.

Regulatory documents REGDOC 2.4.1 (Deterministic Safety Analysis) and REGDOC 2.4.2 (Probabilistic Safety Assessment for Nuclear Power Plants), outline the requirements and guidance for the preparation and presentation of safety analysis that demonstrates the safety of a nuclear facility. To the extent practicable, these documents are technology-neutral. Both documents make reference to the use of graded approach, commensurate with risk, which may be defined and used when applying the requirements and guidance contained in the regulatory documents.

Both documents require that computer codes used in the safety analysis shall be developed, validated, and used in accordance with a quality assurance program that meets the requirements of CSA-N286.7-99, *Quality Assurance of Analytical, Scientific, and Design Computer Programs for Nuclear Power Plants*. This requirement may pose a challenge to SMR vendors located outside of Canada and those who are developing SMRs using novel technologies which are different from traditional large water cooled reactors licensed in Canada. As per DIS-16-04 it is the expectation of the CNSC that:

"…all computer codes, including simulation technologies, intended for use in safety analyses and R&D activities are expected to be verified and validated by using experimental data….

…SMR designs are exploring alternative approaches to meeting safety requirements, such as the use of passive and inherent features. The use of such alternative approaches can introduce uncertainties to safety analysis, and need to be addressed with suitable experimental evidence to support the computer codes and simulations used to analyze operational and accident sequences…

…When considering the use of existing proven industry computer codes, it is important to understand and disposition the technological differences that an SMR design presents and how this may impact the validity and proven-ness of those codes…"

The Industry Standard Toolset (IST) program is a consolidation of the qualification, development and maintenance activities on different computer codes used for the design, safety analysis and operational support of CANDU reactors. It is a suite of industry codes that have been developed, benchmarked and validated over years or decades of use to ensure a high degree of confidence in their ability to accurately predict the response of the CANDU fleet under normal and accident conditions. All of these codes have been validated by comparing to experimental programs over years of laboratory comparison and code to code comparison. The code validation may have to be done on a case-by-case and technology-by technology basis, which would be a substantial burden for the applicants.

This IST is designed specifically to support the existing CANDU fleet. It is unclear how many of these computer codes could be readily applied to SMR designs which will use different technologies.

Furthermore it is anticipated that the novelty of many of the proposed SMR design will rely on proprietary vendor computer codes that will not have the same pedigree as the CANDU IST. These proprietary computer codes have comparable international benchmarking completed due to the relative infancy of some of the vendors and the early stages of their design work.

The CANDU IST was developed (and continues to evolve) to provide on-going analytical capability to support a mature CANDU technology. A similar program does not exist to support the multitude of potential new SMR designs. Both the potential licensee and the CNSC will need to be able to have confidence that the proposed SMR design is safe to licence and a large part of that confidence will come from having assurance that a robust and validated set of analytical tools was used to predict the response of the SMR.

Suggestion: Determine how to meet the requirements of CSA-N286.7-99 for SMR designs where the current IST will not be applied.

As identified in Appendix B, many SMR reactor technologies will employ passive safety systems. This potentially can challenge the identification of levels of Defense in Depth as well as the categorization of events into anticipated operational occurrence (AOO) and design basis accident (DBA). This then introduces further challenges when determining how safety requirements will be applied for such events.

Suggestion: CNSC staff and industry work to clarify safety requirements for reactor designs that preclude traditional accident scenarios by design.

Regulatory document REGDOC-2.3.3, *Periodic Safety Reviews*, sets out the CNSC's requirements for the conduct of a periodic safety review for a nuclear power plant. A PSR involves an assessment of the current state of the plant and its performance to determine the extent to which it conforms to applicable modern codes, standards and practices, and to identify any factors that would limit safe long-term operation. REGDOC 2.3.3 is primarily used to examine the suitability of an existing facility for extended operation, typically in the context of a life extension or refurbishment. A periodic safety review is required every 10 years and typically aligns with the current license duration of Canada's large power reactor fleet.

In the context of SMRs, the applicability of REGDOC 2.3.3 is unknown at this time. The nature of some SMR applications may result in them being installed at a facility for a period of less than 10 years before the reactor units are potentially swapped out for new units or the need for the facility ends (mine or heavy industry application no longer required). While some of the larger on grid applications could foreseeably operate for multiple decades (and hence require a PSR assessment per REGDOC 2.3.3), other heavy industry of remote community applications may not require the same life expectancy. As with REGDOC 2.4.1 and REGDOC 2.4.2, REGDOC 2.3.3 makes reference to the use of graded approach, commensurate with risk, which may be defined and used when applying the requirements and guidance contained in the regulatory document.

REGDOC-2.3.2, *Accident Management*, sets out the requirements and guidance of the CNSC for the development, implementation and validation of integrated accident management for reactor facilities. Accident management is a commitment to the defence-in-depth approach and is an important component in the licensee's overall capabilities to ensure the risks from nuclear reactors remain low.

Accident management provides capability to respond to an accident within the reactor facility. The typical accidents which operators of a large traditional water-cooled reactor need to consider are discussed in REGDOC 2.3.2 (Accident Management). It is anticipated that many SMR designs will preclude many of these scenarios by design. As a result, many of the design basis accident upon which accident management and emergency preparedness programs may be structured for a SMR may be greatly simplified from those required of a traditional nuclear power plant. However, other design-specific design basis accidents will need to be considered and addressed.

As stated in REGDOC 2.3.2 the processes and activities for accident management shall be commensurate with the relative risk posed by the licensed activities of a reactor facility, which may be influenced by the reactor thermal power and available protective systems. It may be possible to show that certain accident management elements are unnecessary or do not apply. It is evident from the review of REGDOC 2.3.2 that its primary intended use is for application to traditional large water cooled reactors, not SMRs with many passive safety features.

REGDOC 2.3.2 in conjunction with REGDOC 2.10.1 stipulate regulatory requirements and supporting guidance for licensees to develop, implement and evaluate integrated accident management for nuclear reactor facilities, excluding reactors with a thermal output capacity less than 10 MW thermal. As mentioned in the discussion on emergency preparedness, this 10MW thermal is an arbitrary limit intended to exclude all research reactors in Canada from their application, with the exception of the now shutdown NRU facility at Chalk River. There is no technical reason why 10MW thermal should be used as a criteria as these small facilities should be excluded on the basis of their potential (or lack thereof) to cause an accident which would necessitate mobilizing of a large coordinated emergency response force, as is the case for current power reactors.

Suggestion: Revise REGDOC 2.3.2 to eliminate the 10MW thermal lower limit for application of the requirements in REGDOC 2.3.2. The need to apply the full suite of requirements should be based on risk-informed criteria, not an arbitrary low limit on reactor thermal power.

3.10 Design and Commissioning Requirements

Documents Reviewed: **REGDOC 2.5.2 Design of Reactor Facilities: Nuclear Power Plants**
RD-367 Design of Small Reactor Facilities
REGDOC 2.3.1 Conduct of Licensed Activities: Construction and Maintenance Programs
CNSC Discussion Paper DIS-16-04 Small Modular Reactors: Regulatory Strategy, Approaches and Challenges
CNSC What We Heard Report DIS-16-04

REGDOC-2.5.2 Design of Reactor Facilities: Nuclear Power Plants, sets out requirements and guidance for new licence applications for water-cooled nuclear power plants (NPPs or plants). It establishes a set of comprehensive design requirements and guidance that are risk-informed and align with accepted international codes and practices.

This document provides criteria pertaining to the safe design of new water-cooled NPPs. All aspects of the design are taken into account, and multiple levels of defence are promoted in design considerations. To the extent practicable, the requirements and guidance provided herein are technology-neutral with respect to water-cooled reactors.

RD-367 Design of Small Reactor Facilities sets out the requirements of the CNSC for the design of new small reactor facilities. It establishes a set of design requirements that aligns with accepted national and international codes and standards.

RD-367 defines a small reactor facility as a reactor facility containing a reactor with a power level of less than approximately 200 megawatts thermal (MWth) that is used for research, isotope production, steam generation, electricity production or other applications. RD-367 indicates that a graded approach may be used for the design of small reactor facilities. RD-367 is scheduled to be superseded by REGDOC 2.5.3, Design of Reactor Facilities: Small Reactors, currently being prepared by CNSC staff.

As noted in Appendix B, both REGDOC 2.5.2 and RD-367 are highly detailed with regards to the system design requirements for the proposed installation. REGDOC 2.5.2 caters primarily to large water cooled nuclear power plants and while RD-367 is not as focused on technology as REGDOC 2.5.2 it nevertheless describes requirements that may not be relevant to some of the SMR technologies being developed. RD-367 also imposes requirements which may be unjustifiably onerous to meet, particularly for small SMR facilities located in remote regions with minimal infrastructure and staff. For example, Section 7.1.3 of RD-367 states "*…laboratory facilities shall be provided to determine the concentration of radionuclides in fluid process systems…"* SMR design may negate this requirement and geographical location of the site may pose a logistical challenge to implementing such a requirement on site.

While REGDOC 2.5.2 is primarily intended to apply to large water cooled reactors, it does allow alternate approaches to be applied. Specifically, Section 11 (Alternative Approaches) provides the applicant with flexibility in proposing alternative designs for CNSC consideration provided that the design can demonstrate an equivalent or superior level of safety. Similarly, RD-367 indicates that a graded approach may be used for the design of small reactor facilities.

Although highly prescriptive, both REGDOC 2.5.2 and RD-367 appear to allow for the use of a graded approach and are open to licensees demonstrating alternative means to achieving the objectives outlined in these documents. On this basis there are no specific recommendations being made related to these documents. In cases where REGDOC 2.5.2 and RD-367 appear to prescribe conflicting requirements, it is expected that any potential licensee will engage the CNSC at the appropriate time and obtain clarification as to which requirement is to take precedence.

3.11 Environment

Documents Reviewed: **Bill C-69**
Consultation Papers on Bill C-69 and Designated Project List
CEAA 2012
Designated project list

The majority of discussion in this section focuses on Bill C-69 (Impact Assessment Act). While CEAA-2012 is the current environmental assessment legislation, the Impact Assessment Act (IAA) is expected to come into effect in 2019, and depending on the Designated Project List, will be applicable legislation for some or all future proposed SMRs.

The comments and recommendations provided in the Canadian Nuclear Association (CNA) submission on Bill-69 to the House of Commons Standing Committee on Environment and Sustainable Development on April 6, 2018 are comprehensive and represent a thorough review applicable for SMRs. This section of the report relies extensively on this CNA review, with supplements as needed to support any additional comments not covered in the CNA review.

Summary of some key elements of the IAA

The IAA will shift Canada's environmental assessment practices to impact assessment based on the principle of sustainability, and broaden the scope of assessments to include positive and negative environment, economic, social and health impacts, as well as require gender-based analysis in order to support holistic and integrated decision-making. An assessment of the impacts of a project on Indigenous peoples and their rights would be required. Decision will be based on whether the adverse effects are in the public interest, in light of the following factors:

- designated project's contribution to sustainability
- Extent of impacts and mitigation measures
- impacts on Indigenous peoples and rights; and
- Impact on Government of Canada's environmental obligations and climate change commitments

Also included in the IAA is a mandatory early planning and engagement phase for better project design and integration of science and indigenous traditional knowledge. There is also a requirement for early and inclusive engagement and participation of indigenous peoples at every stage, with the aim of securing consent through processes based on recognition of Indigenous rights. Indigenous governments will have greater opportunities to exercise powers and duties under the proposed Act.

The preamble and enactment list the government's goals with respect to timeliness of decisions, and mention the importance of innovative technologies to reduce adverse changes to the environment and to health, social or economic conditions. These sections also identify the benefits of the early planning and consultation phases in arriving at more socially acceptable designs. However, timely decision making based on the past experience with nuclear projects, because this is "nuclear", timely decision making if all the elements that are listed above have to factor into the decision will be a challenge under such a broad impact assessment process.

Technical Barriers for SMRs

There were no specific technical barriers identified but IA approvals for SMRs could take many years especially if they end up on the Project List and have to go through review panels led by the IAA agency.

Advance engagement with northern communities, indigenous people and public interest groups and the Canadian public in general to explain the environmental and community benefits of these low emitting technologies will be critical. Social acceptance will drive progress on assessments under this legislation since deadlines can be changed in response to public opposition. Communication material with non-technical terminology will be required to convince stakeholders of the benefits.

Economic Feasibility Challenge:

The provisions in the IAA that allow changing of timelines based on different factors and the extensive consultation for the first projects assessed under this new legislation could result in expensive delays that could in turn result in project abandonment or low investor confidence.

Provisions that allow some sort of threshold under which the life cycle regulator (CNSC) conducts an IA that focuses on the Safety case and waste management could also help with economic feasibility and investor confidence.

Industry Discussion on Bill C-69

Review of the proposed Impact Assessment Act (IAA) by industry has flagged several areas where the IAA has the potential of creating lengthy timelines and where the IAA could be used as an avenue by intervenors to discuss broader policy issues (such as climate change and Indigenous reconciliation) instead of project specific concerns. The assessment should focus on the impact of the project not the policy.

Key Recommendation #3: Bill C-69 should be implemented in such a way to ensure that the IAA addresses the specific impact of a project rather than be used as a venue to debate a specific policy.

Industry Discussion on Review Panels

The Bill proposes that a single government agency be responsible for impact assessment reviews. In the case of the nuclear industry, the Bill only provides for the option of an agency led review panel. While the review panel is not new (nuclear projects have had joint review panels in the past) the mandating of the review panel is not an improvement over the current process.

As a full-life cycle regulator, the CNSC licensing regime and regulatory framework already covers the entire life-cycle of the project and is subject to the NSCA and its regulations. This allows the CNSC to not only conduct the IA in the planning phase of the project but also to ensure that monitoring programs and follow up conditions required by IA are directly integrated into the licensing process throughout the various stages of the projects. Nuclear projects have highly special technical topics and the CNSC uniquely has the expertise to best oversee review and approval of nuclear projects.

Key Recommendation #4: Amend Bill C-69 so that the CNSC shares equal responsibility with the Agency for the conduct of the entire review panel process including the Early Planning and Engagement Phase

The Project List

The Project List identifies the physical activities associated with the carrying out of projects (e.g. construction of a mine or construction of a hydroelectric generation facility) that may require an impact assessment. Each physical activity includes a description and in most cases a corresponding threshold, which serves as a representation of scale or size. Whereas the Project List currently includes entries related to the CNSC, going forward all projects prescribed in the Project List would be assessed by the Impact Assessment Agency of Canada in cooperation with these life-cycle regulators.

The Impact Assessment Agency of Canada will conduct all impact assessments of projects on the Project List. This will take place as part of the impact assessment process. Projects with potential for smaller effects in areas of federal jurisdiction would continue to be subject to other federal regulatory processes such as those under life-cycle regulators (e.g. CNSC).

Projects may also be designated for an impact assessment by the Minister of Environment and Climate Change, taking into consideration the potential for adverse effects on areas of federal jurisdiction, including impacts on Indigenous rights, or public concerns and any relevant regional or strategic assessment. For non-designated projects proposed on federal lands, there would also be a requirement to conduct an assessment of environmental effects under the proposed Impact Assessment Act. For example, this specific requirement would impose the requirement to conduct an assessment of environmental effects for proposed physical works and activities located at an AECL/CNL facility. Additional requirements with respect to these assessments include notification to the public, transparently sharing information and a legislated list of factors to guide the assessments.

Industry Discussion on Project List

The Bill makes provisions for a Designated Project List to be created by regulation. This list determines what projects are subject to review by the new agencies and – by default - what projects will be left to be reviewed by the life-cycle regulator in the case of the nuclear industry. This makes it difficult to fully consider the impact and consequences of the Impact Assessment Agency without fully understanding what projects the IAA will apply to. As currently written the Designated Project List would include all nuclear reactors, regardless of size.

The focus of the Project List should be on major projects. For a project to be listed, it should be a: 1) major project of national significance; and 2) have the potential to cause adverse impacts in areas of federal authority, where the potential impacts are not already managed through other federal legislation. Endorsing this principled approach will ensure that small/medium-sized proposals, with smaller environmental impacts, are not captured.

A facility or project should undergo one impact assessment for its lifecycle. As drafted, Section 43 could be interpreted as to require an IA for any activity at a facility regulated under the NSCA in addition to potential requirements under "physical activities" regulations. Maintenance, technological and capital upgrades are fully regulated by the lifecycle regulator, provincial regulators or other federal authorities already and there is no need for a new IA for these on going activities.

In addition, many existing nuclear sites are large with significant space for new facilities, including new reactors and research facilities that could require an IA under the new agency. Most nuclear sites have undergone full environmental assessments and have continuous environmental monitoring, and their environmental impact is well known. If a new project were to occur on one of those existing sites, it should not require a full IA but rather an assessment of the delta between what has already been done and what the new proposed project aspects would be. The review could best be done by the life-cycle regulator.

Key Recommendation #5: The Designated Project List be limited to those projects of national significance on "greenfield" sites.

Industry Discussion on Ministerial Powers

The following statement is in the Project Paper:

> *"Projects may also be designated for an impact assessment by the Minister of Environment and Climate Change, taking into consideration the potential for adverse effects on areas of federal jurisdiction, including impacts on Indigenous rights, or public concerns and any relevant regional or strategic assessment."*

Final regulations must firmly establish the scope of application of the *Impact Assessment Act* and the power of the Minister to designate other projects for review must be circumscribed and used only in exceptional circumstances. The Government must also clearly explain how it will determine whether there is a sufficient level of "public concern" for that factor to be considered in the development of the Project List. Clear, comprehensive Project List criteria are critical to creating a stable investment climate in Canada. Providing additional clarity around Ministerial discretion will help all those involved navigate the process.

Key Recommendation #6: Bill C-69 must firmly establish the scope of application of the Impact Assessment Act, provide guidelines on weighting carried by the different factors considered in IAA decision making and the power of the Minister to designate other projects for review must be circumscribed and used only in exceptional circumstances.

Industry Discussion on IAA application to SMRs

A threshold should be established for exclusion of certain SMRs from the Project List. SMRs are new innovative technologies that have a small environmental footprint and low safety risk. In addition, they use inherent passive safety systems. These reactors have a much lower impact and environmental risk than many other projects and in keeping with the government's intent to focus on projects that have the greatest potential for impact, SMRs should not be on the project list. As with other new technologies, FOAK SMRs do however have much smaller economic margins than some other technologies and the requirement to go through a Panel Review that by the Agency's own estimates would be in access of five years prior to licensing would virtually eliminate the opportunity for SMR deployment due to excessive regulatory cost, disproportionate to risk and benefits.

Should SMRs be excluded from the Project List, they would still be subject to a comprehensive environmental risk assessment under the CNSCs licensing process. The CNSC licensing process is arguably one of the most comprehensive and detailed regulatory processes that exists. There are numerous and significant opportunities for public and Indigenous engagement as well as public hearing process. In addition, the CNSC conducts a vigorous inspection program, holds an annual public review process, and performs periodic licence reviews.

Based on the above, a lower threshold should be applied, as there are for other forms of electricity generation currently on the Project List. This would enable advance innovation around Small Modular

Reactors (SMRs) for installation in remote communities and mine sites that are relying heavily on diesel generation. SMR development will be severely hampered, if not prevented, if it is made subject to the impact assessment process that is used for on-grid nuclear reactors. Therefore, the RRWG recommends that the Project List regulation include a lower end threshold based on risk-informed criteria. At the least, SMRs that are located off-grid or for industrial (e.g. mining) applications should be excluded.

Key Recommendation #7: It is recommended to exclude all SMR applications below the 200MW(e) threshold from the Project List to be consistent with the proposed exemption threshold for hydroelectric dams. It is further recommended that SMRs up to an including 300MW(e) also be considered to be excluded on the basis of low safety and environmental risk (a risk informed approach) plus their positive contribution to low carbon energy production.

The basis for this higher value was identified in the submission by the CNA and includes the considerations that SMRs are a generation IV category and have a much higher level of passive and in many cases inherent safety built into the designs. They also have a smaller environmental footprint than the current generation of reactors, which in themselves have consistently shown to have no significant environmental impacts. As also identified, the CNSC has a proven process and track record for dealing responsibly on environmental and engagement aspects.

3.12 Licensing Timelines

Documents Reviewed: **REGDOC 3.5.1 Information Dissemination: Licensing Process for Class I Nuclear Safety and Control Act Nuclear Facilities and Uranium Mines and Mills**

Section 8 of REGDOC 3.5.1 provides timelines for the CNSC to perform its review and obtain a Commission decision.

The following timelines are provided by CNSC (months).

- Licence to prepare site (LTPS) 24
- Licence to construct 32
- Licence to construct and operate 40
- Licence to operate 24
- Licence to decommission 24

These timelines apply to CNSC activities only and include time needed to:

- ensure the initial licence application has sufficient information, including a comprehensive set of documentation submitted in support of the application
- complete a technical assessment of the application
- conduct a public hearing for the licensing decision related to the application
- publish the Commission’s decision

The timelines do not include the time:

- required by the applicant(s) to prepare the site assessment, environmental impact assessment, perform stakeholder consultation/engagement or application preparation
- that the CNSC waits for a response to a request for information that is required to complete the review
- to accommodate an applicant's request to extend the schedule for submitting required information
- to address matters outside the CNSC's control, such as the time for other jurisdictions to participate in and complete an environmental assessment

The above timelines indicate approximately 6.5 years of regulatory review time from application to prepare site to approval to operate. The required time for applicant submission preparation, reviews by other external agencies, and the time to construct the facility is a total of approximately 9 years. It should be noted however that these estimates are based on the assumption of the timelines for a large traditional nuclear power plant at a greenfield site.

For planning purposes for an SMR on an existing nuclear site, it would be reasonable to assume that the Licence to Prepare Site (LTPS) could be reduced considerably and that the licence to construct and licence to operate could proceed in a staggered parallel manner rather than sequentially. Furthermore, for a repeat design being operated by an experience Canadian nuclear operator it should be possible to apply directly for a licence to operate and include the licence to construct request in the same application. Based on these assumptions it may be possible to reduce the licensing time period down from 9 years to 4 years or even less for simple repeat designs with an established operator (the fleet approach), however this assumption would be subject to a number of risk factors as follows:

- Quality of the applicants' submission (VDRs and partnerships with existing licensees can help in this area)
- Complexity of technology and how well it is established (conceptual vs solid experimental basis vs. Nth of a kind)
- Willingness of regulators /public to accept new technologies
- Scope and depth of EA
- IAA and potential to delay
- Graded approach to licensing process vs treating like existing large power reactor.
- Location of the proposed development and local public familiarity and support for nuclear projects.

3.13 Ownership Models

Ownership models should not have major impact on licensing applications. The current Regulations for each type of licence identify requirements for the "Applicant" and the "Licensee" but do not indicate they have to be the same entity for subsequent licences. CNSC will require each subsequent licence applicant(s) to demonstrate that there has been sufficient handover of all material, resources, documentation, etc to allow the subsequent applicant to be "qualified" for the license activity they are applying for. The onus will be on each applicant to show they are ready and capable, i.e. qualified for the requested licensed activity for which they are applying.

3.14 Transportation

Documents Reviewed: Transportation of Dangerous Goods Act
Transportation of Dangerous Goods Regulations

The Act prescribes an Emergency Response Assistance Plan for a person transporting dangerous goods, with nuclear substances being one Class of such dangerous goods. The Act similarly prescribes need for a Security Plan.

For remotely-located reactors, particularly with centralized/off-site monitoring, additional challenges may exist in terms of logistics between these components of the required emergency and security response capability.

In addition, discussions will likely be needed on potential challenges related to the transportation of pre-assembled and loaded nuclear cores.

There is no specific recommendation coming out of this review; the above identified issues are for awareness only.

4.0 ♣ Summary of Recommendations

The following table summarizes the key recommendations by subject area based on the reviews discussed in Section 4.

#	Subject Area	Key Recommendation
1	Nuclear Liability	Revise the Regulations to apply nuclear liability limits to SMRs on a graded scale based on risk-informed criteria.
2	Nuclear Security	Revise the Security Regulations to cover high level principles similar to other regulations and remove prescriptive requirements. CNSC REGDOC should then be produced providing necessary details and including the concept of a graded approach.
3	Environment	Bill C-69 should be implemented in such a way to ensure that the IAA addresses the specific impact of a project rather than be used as a venue to debate a specific policy.
4	Environment	Amend Bill C-69 so that the CNSC shares equal responsibility with the Agency for the conduct of the entire review panel process including the Early Planning and Engagement Phase
5	Environment	The Designated Project List be limited to those projects of national significance on “greenfield” sites.
6	Environment	Bill C-69s must firmly establish the scope of application of the Impact Assessment Act, provide guidelines on weighting carried by the different factors considered in IAA decision making, and the power of the Minister to designate other projects for review must be circumscribed and used only in exceptional circumstances.
7	Environment	It is recommended to exclude all SMR applications below the 200MW(e) threshold from the Project List to be consistent with the proposed exemption threshold for hydroelectric dams. It is further recommended that SMRs up to an including 300MW(e) also be considered to be excluded on the basis of low safety and environmental risk (a risk informed approach) plus their positive contribution to low carbon energy production.

5.0 Conclusions

The objective of this report is to summarize the Small Modular Reactor (SMR) Roadmap Regulatory Readiness Working Group (RRWG) key findings on barriers and challenges to the deployment of SMRs under the current and projected near-future regulatory regime, and to provide recommendations for the Steering Committee to support the SMR Roadmap project.

The conclusions of this report are that there are generally no major impediments to the future licensing of SMRs for deployment in Canada. Some areas have been identified as requiring additional discussion with the CNSC and other regulatory bodies as they have the potential to pose unnecessary requirements on potential SMR operators, particularly those applications used in off-grid and remote communities. As summarized in Section 5 these specific areas include the topics of nuclear liability, staff training, accident management (analysis) and emergency preparedness requirements as well as security requirements for Class I nuclear facilities. The CNSC are already aware of these issues through workshops and other public consultations and they are actively engaged with industry on working towards a better understanding of what is needed to resolve these issues. The RRWG is confident that an equitable and timely resolution to these issues can be obtained through further dialogue between industry and the regulator.

The RRWG has also identified that the pending Bill C-69 legislation poses a risk to the future of SMR deployment in Canada, particularly for the small off-grid and industrial applications. The RRWG concludes that including SMRs in the "Project List" for consideration under the pending Impact Assessment Act would result in unjustified delays timelines and costs for SMR project approval not commensurate with the impacts and benefits. The nuclear industry has been active in providing feedback and perspective on this issue during the Bill C-69 comment period.

6.0 References

[1] http://nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents/index.cfm

[2] Regulatory Readiness Working Group Work Plan, March 29, 2018

[3] CNA, Submission on Bill C-69 to the House of Commons Standing Committee on Environment and Sustainable Development, April 6, 2018

Appendix A: Potential List of Legislative Documents for Impact Screening for NRCan SMR Roadmap

No.	Topics	Acts, Regulations, Codes, Agreements	Administered by + Identify List of Approval Required	Priority High Medium Low Screen Out	Identification of Regulatory Gap On-Grid Power Generation Application Technical Barrier	 On-Grid Power Generation Application Economic Feasibility Challenge	 On- and Off-Grid Combined Heat and Power Application (*for Natural Resource Extraction*) Technical Barrier	 On- and Off-Grid Combined Heat and Power Application (*for Natural Resource Extraction*) Economic Feasibility Challenge	 Off-Grid Power and District Heating Application (*for northern and remote community, and Government Facilities*) Technical Barrier	 Off-Grid Power and District Heating Application (*for northern and remote community, and Government Facilities*) Economic Feasibility Challenge	CNSC observations
1-1	**General Nuclear**	*Nuclear Safety and Control Act*	Federal, CNSC	**Low**	S.7 – could allow for Commission to exempt SMRs in part or in whole based on fuel source. Unlikely, possibly leverage for some temporary exemptions? S.24 (1) – could allow for a separate class(es) of licence for SMRs. S.26 – captures SMRs. S.44 (1) – allows Commission to create new regulation(s) for for SMRs. S.44 (5) – allows GofC to create new regulation(s) for SMRs. NSCA is a high level document which establishes the CNSC. Definition of "Nuclear Facility" would apply to SMRs.						CNSC should not be proposing exemptions on applicant's behalf. It is incumbent on the applicant to justify a request for an exemption. CNSC staff are not sure what a separate class of licence for SMRs would do? – Explanation of this comment is needed Currently, there is no global consensus on what defines an SMR.
1-2		General Nuclear Safety and Control Regulations	Federal, CNSC	**Low**	S.3 – these sections are open-ended and require some definition of expectations as it relates to SMRs. GNSCR provide high level requirements for all license applications and obligations of Licensees. Definition of "licensed activity" would apply to SMRs.			S.3 (1) – this section is tailored to a one site – one facility model (includes multiple units within one facility). May restrict the manufacturing of multiple units at one facility unless manufacturing can be defined as an activity.			There is no section 1.1(a) & (b) – This is likely referring to section 3 – SMRs will have to be designed to meet IAEA safeguards requirements, in fact design info has to be submitted as soon as a technology is selected for a project, and this is in advance of a construction licence application Wrt S3(1) the NSCA and regs readily apply reactor manufacturing - I think manufacturing could be defined as an activity (perhaps not far off from construction, it could be construed as a variant of construction). There is a section of the licence that describes the licensed activity - this provides flexibility visa-a-vis the licensed activity
1-3		Administrative Monetary Penalties Regulations	Federal, CNSC	**Screen Out**							
1-4		Radiation Protection Regulations	Federal, CNSC	**Low**	RP Regulations outline high level requirements for licensees to implement a radiation protection programs.		RP Regulations outline high level requirements for licensees to implement a radiation protection programs.				Nothing in the regulations prevent posting in all applicable languages, as long as they include French and English.

No.	Topics	Acts, Regulations, Codes, Agreements	Administered by + Identify List of Approval Required	Priority	Identification of Regulatory Gap						CNSC observations
				High Medium Low Screen Out	On-Grid Power Generation Application		On- and Off-Grid Combined Heat and Power Application (*for Natural Resource Extraction*)		Off-Grid Power and District Heating Application (*for northern and remote community, and Government Facilities*)		
					Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	
					Defines obligations of Licensees and Nuclear energy workers (NEW) Definition of “licensed activity” would apply to SMRs.		Defines obligations of Licensees and Nuclear energy workers (NEW) Definition of “licensed activity” would apply to SMRs. Section 8 requires every licensee to use a licensed dosimetry service to measure and monitor doses of radiation received by and committed to NEW. A licensed dosimetry service is a separate license (Section 18). Remote locates may need to rely on third party licensed dosimetry service. Section 20-21 defines signage requirements in both official languages. Potential issue in northern communities and Indigenous languages?				
1-5		Class I Nuclear Facilities Regulations	Federal, CNSC	**Low**	None Identified. SMR would meet definition of a Class 1A nuclear facility. Definition of “licensed activity” would apply to SMRs. Section 5(f), acceptance criteria for safety analysis report may be technology dependent and different from traditional water-cooled. Section 8.01 (2) definition of a **nuclear power plant** may not apply to some FOAK	Section 5(m), some SMR design may not justify full-scope training simulator. Section 8.3(1) stipulates commission will render LTPS decision within 24 months of notice. For “NOAK” this may not be economically feasible.	As for on-grid	As for on-grid plus Section 6 (k) LTO, the emergency response measures as outlined in this section may not be practical for remote sites. Section 9 Certification needs to be different from traditional large water cooled reactors. See comments on RD-204. Requirements for re-certification every 5 years could be onerous for small scale applicants and potentially not necessary based on reduced complexity of many SMR designs.	As for on-grid	As for on-grid plus Section 6 (k) LTO, the emergency response measures as outlined in this section may not be practical for remote sites. Section 9 Certification needs to be different from traditional large water cooled reactors. See comments on RD-204. Requirements for re-certification every 5 years	- The safety analysis report is described on our new build web page (http://www.nuclearsafety.gc.ca/eng/reactors/power-plants/new-nuclear-power-plants/index.cfm)… the methodologies and details will be technology specific - Agreed that Section 8.01 (2) may not apply (this definition is problematic …) - Wrt section 8.3(1). It sets a maximum timeline taking into account public decision making processes. Less is possible but industry will need to propose how exiting public processes that permit stakeholder participation will be considered. Licensing reviews and decision-making will occur in a timely manner, and full credit will be given to the FOAK review when doing NOAK reviews. 24 months is a maximum time for the LTPS. - wrt 6(k), the applicant will have to describe the measures that will be put in place. All of these things will have to be addressed, what the provisions look like will have to be acceptable to all

No.	Topics	Acts, Regulations, Codes, Agreements	Administered by + Identify List of Approval Required	Priority	Identification of Regulatory Gap						CNSC observations
				High Medium Low Screen Out	On-Grid Power Generation Application		On- and Off-Grid Combined Heat and Power Application (*for Natural Resource Extraction*)		Off-Grid Power and District Heating Application (*for northern and remote community, and Government Facilities*)		
					Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	
					demonstration units.					could be onerous for small scale applicants and potentially not necessary based on reduced complexity of many SMR designs.	stakeholders (not doing these things is not an option.) - wrt certification, applicants can propose alternatives, provided that the intent of certification is met …. This was presented in the deck for the Nov 24 Graded approach workshop. The demands wrt certified staff will be dependent of the complexity of operating the facility during normal operation and with regards to controlling events. Applicants will have to provide credible information supporting their case. Requirements: “An applicant or licensee may put forward a case to demonstrate that the intent of a requirement is addressed by other means and demonstrated with supportable evidence.” •Guidance: “…elaborate further on requirements or … provide direction to licensees and applicants on how to meet requirements. ….. Licensees are expected to review and consider guidance; should they choose not to follow it, they should explain how their chosen alternate approach meets regulatory requirements.” •Licensees can make a case for not addressing specific clauses in CNSC regulatory documents or industry standards. Why is re-certification every 5 years onerous? How do applicants propose to demonstrate certified staff remain qualified to carry out their activities? Industry could develop a proposal that will show how a longer interval between recertification will maintain safe competent behaviour taking into account scientific information from Human Factors.

No.	Topics	Acts, Regulations, Codes, Agreements	Administered by + Identify List of Approval Required	Priority High Medium Low Screen Out	Identification of Regulatory Gap						CNSC observations
					On-Grid Power Generation Application		On- and Off-Grid Combined Heat and Power Application (*for Natural Resource Extraction*)		Off-Grid Power and District Heating Application (***for northern and remote community, and Government Facilities***)		
					Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	
											Airline pilot recertification is a good example….retraining and reinforcement are needed to overcome long term effects of 'boredom' that lead to complacency.
1-6		Class II Nuclear Facilities and Prescribed Equipment Regulations	Federal, CNSC	**Screen out**							
1-7		Uranium Mines and Mills Regulations	Federal, CNSC	**Screen out**							
1-8		Canadian Nuclear Safety Commission Cost Recovery Fees Regulations	Federal, CNSC	**Medium**	**Technical** S.21 (b) – new packaging may be required for SMRs which will require certification.			**Economic** S.3 (a) – likely captures SMRs unless a new exemption, new limitation, or a new licence class is developed. S.21 (a) – fees may be applicable to SMRs. S.25 (a), (b) & (c)- this section could be triggered if SMRs are classified as Special Projects.			S3(a) yes S21(a) – justify, this will mean significant changes to he NSCA and regs … There is no provision for a certification regime for SMR designs and this is a long term discussion, not a short term deliverable requiring extensive discussion with the Commission. SMRs will not be classified as Special Projects under the existing legal processes. Regardless of how the activity is classified, CNSC will have to recover costs ….
1-9		Canadian Nuclear Safety Commission By-laws	Federal, CNSC	**Screen out**							
1-10		Canadian Energy Regulator Act (Bill C-69)	Federal, Canadian Energy Regulator (CER)	**Low**							
1-11		Canada Labour Code		**Low**							
1-12		Nuclear Energy Act	Federal,	**Low**	None identified.						
1-13		Hazardous Materials Information Review Act		**Low**							

No.	Topics	Acts, Regulations, Codes, Agreements	Administered by + Identify List of Approval Required	Priority	Identification of Regulatory Gap						CNSC observations
				High Medium Low Screen Out	On-Grid Power Generation Application		On- and Off-Grid Combined Heat and Power Application (*for Natural Resource Extraction*)		Off-Grid Power and District Heating Application (*for northern and remote community, and Government Facilities*)		
					Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	
2-1	**Environment**	*Canadian Environmental Assessment Act (CEAA), 2012* (being replaced by the Impact Assessment Act) (Bill C-69)	Federal, <u>Canadian Environmental Assessment Agency</u>	**High**	**Summary of some key elements of the IAA**: The IAA will move from environmental assessment based on the principle of sustainability and broaden the scope of assessments to include positive and negative environment, economic, social and health impacts, as well as require gender-based analysis in order to support holistic and integrated decision-making. An assessment of the impacts of a project on Indigenous peoples and their rights would be required. Decision on whether the adverse effects are in the public interest, in light of the following factors: 1. designated project's contribution to sustainability 2. Extent of impacts and mitigation measures 3. impacts on Indigenous peoples and rights; and 4. Impact on Government of Canada's environmental obligations and climate change commitments Mandatory early planning and engagement phase for better project design and integration of science and indigenous traditional knowledge. Early and inclusive engagement and participation of indigenous peoples at every stage, with the aim of securing consent through processes based on recognition of Indigenous rights. Indigenous governments will have greater opportunities to exercise powers and duties under the Act. The preamble and enactment list a lot of good intentions of the government with respect to timeliness of decisions, and mention the importance of innovative technologies to reduce adverse changes to the environment and to health, social or economic conditions. These sections also mention the benefits of the early planning and consultation phases in arriving at more socially acceptable designs. However because this is "nuclear" timely decision making if all the elements that are listed above have to factor into the decision will be a challenge. **The comments and recommendations provided in the Canadian Nuclear Association submission on Bill-69 are comprehensive and represent a thorough review applicable for SMRs. It is recommended that this working group use the CNA review and just supplement with any additional comments not covered**. **Technical Barriers for SMRs** No specific technical barriers but IA approvals for SMRs could take a long time especially if they end up on the Project List and have to go through Joint Panel Reviews led by the IAA agency. Advance consultations with northern communities, indigenous people and public interest groups and the Canadian public in general to explain the environmental and community benefits of these low emitting technologies, emphasize safety of operation and effective waste management plans is key. Social acceptance will drive progress on assessments under this legislation since deadlines can be changed in response to public opposition. Communication material with non-technical terminology will be required to convince stakeholders of the benefits. NWMO has done extensive consultation/communication and may be able to advice on communities and areas that will be more receptive to SMRs. This would be useful to advise siting decisions. Siting decisions should seriously consider social acceptance of nearby communities, vulnerability to external hazards such as flooding and develop potential adaptations or design factors to address changing climate						Understood, however, much of the technical content is common between a federal EA and under the LTPS (or for LTC or LTO – if an applicant chooses to roll LTPS info into the LTC or LTO – which may happen for NOAK). REGDOC-291 + REGDOC-111 + CSA N288.6 provide the vast majority of expectations regarding the ERA that supports EA and licensing. Furthermore, indigenous engagement and public hearings are major part of the licensing process under the NSCA.

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Identify List of Approval Required</th><th>Priority</th><th colspan="6">Identification of Regulatory Gap</th><th rowspan="2">CNSC observations</th></tr>
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<tr><td></td><td></td><td></td><td></td><td></td><td colspan="6">Economic Feasibility Challenge:
The provisions in the IAA that allow changing of timelines based on different factors and the extensive consultation for the first projects assessed under this new legislation could result in expensive delays that could cause project abandonment or low investor confidence. One opportunity which is not found in the CNA submission is the concept of a bounding scenario to get an Impact Assessment done for a variety of technologies as was done with the Darlington New Build Scenario.
Provisions that allow some sort of threshold under which the life cycle regulator (CNSC) conducts an IA that focuses on technology Safety case and waste management could also help with economic feasibility and investor confidence.

Review of IAA:

General Comments:

-multiple references to Indigenous Peoples consultation and to traditional knowledge.

-multiple references to best available technologies.

-multiple references to consideration of alternatives to project.

-multiple references to contributions to sustainability, environmental contributions, and commitments to climate change goals.

-the Agency or RP continue to exist until the end of the follow-up program not just the end of the IA.

-internet site must allow public access to virtually all submitted information – this may be challenging wrt sensitive information (timely assessment of ATIA) as well as the Public's ability to review both the quantity and complexity of the information in a timely manner.

S.6(1)(e - g), & (j) – elevates consultation with indigenous peoples which likely jeopardizes timeliness.

S.6(1)(k) – assessment of alternative means and use of best available technologies will put pressure on scope and schedule.

S.6(1)(m) – cumulative effects will put pressure on scope and schedule especially in the absence of regional assessments.

S.9(1) – permits any project to be deemed a designated activity regardless of being on the Project List.

S.10(2) – it is not clear how long the Agency has to post the Project Description – may affect when the 180 day clock begins.

S.11 – does not specify a max or min public consultation period.

S.12 – requires Indigenous Peoples consultation which will challenge the 180 day clock.</td><td></td></tr>
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<tr><th rowspan="2">No.</th><th rowspan="2">Topics</th><th rowspan="2">Acts, Regulations, Codes, Agreements</th><th rowspan="2">Administered by

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Identify List of Approval Required</th><th>Priority</th><th colspan="6">Identification of Regulatory Gap</th><th rowspan="2">CNSC observations</th></tr>
<tr><th>High Medium Low Screen Out</th><th colspan="2">On-Grid Power Generation Application</th><th colspan="2">On- and Off-Grid Combined Heat and Power Application
(for Natural Resource Extraction)</th><th colspan="2">Off-Grid Power and District Heating Application
(for northern and remote community, and Government Facilities)</th></tr>
<tr><th></th><th></th><th></th><th></th><th></th><th>Technical Barrier</th><th>Economic Feasibility Challenge</th><th>Technical Barrier</th><th>Economic Feasibility Challenge</th><th>Technical Barrier</th><th>Economic Feasibility Challenge</th><th></th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="6">S.17(1) – allows for a project exemption.

S.18(3), (4) & (6) – allow for multiple extensions of the 180 day clock to issue a Notice of Commencement.

S.27(5)(a), (6), (7), & (9) - allow for multiple extensions of the 300 day clock on issuing a report.

S.27(5)(b) – allows for an shortened clock (< 300 days).

S. 31 to 35 (Substitution) – could allow the CNSC Licensing Process to be used instead (although S.32(a) and S. 43) make this unlikely).

S.37(1) –SMR IAs must be referred to a RP (S.43) and the shortest duration will be 645 days.

S. 37(2)(a), (3), (4), & (6) - allow for multiple extensions of the 600 day clock on issuing a report.

S.37(2)(b) – allows for an shortened clock (< 600 days).

S.39(2) – excludes SMR projects from being Joint RPs.

S.41(1) & S.44(2) – “or” statement allows a RP member to only have knowledge in Indigenous Peoples concerns and interests – may result in an indigenous person being appointed as a panel member that does not have a science based background.

S.43(a) – will require SMR IAs to be referred to a RP.

S.46 – allows the RP to exercise the powers of the CNSC.

S.43(b) & S.50(b) – requires at least one RP member to from the CNSC.

S.51(2) – IA report can for the basis for determination of a licence.

S.63(a), (d) & (e) – in deciding public interest must consider contribution to sustainability, impacts to rights of Indigenous Peoples, and contribution to meeting Canada’s environmental obligations and commitments to climate change.

S.65(3), (4), (5) & (6) - allow for multiple extensions of the 30-90 day clock on issuing a decision statement.

S.67(1) – allows conditions of the IA to become part of the NSCA licence.

S.84(a) & (b) – requires consideration of impacts to the rights of Indigenous Peoples and traditional knowledge for projects on federal lands.

S.92 & 95 – SMRs for remote communities will likely trigger Regional and/or Strategic Assessments which will likely add to timelines for initial projects. Both Assessments could be open ended – scope is not defined.</td><td></td></tr>
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					On-Grid Power Generation Application		On- and Off-Grid Combined Heat and Power Application (*for Natural Resource Extraction*)		Off-Grid Power and District Heating Application (*for northern and remote community, and Government Facilities*)		
					Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	
					S.119(1) – may not have access to some or any of the traditional knowledge used in any decision. Activities related to SMR construction/operation would be included under the designated project list for CEAA-2012 and require EA. Act designates the CNSC as the responsible authority for nuclear projects.						
2-2		Regulations Designating Physical Activities		High	S.3 – invokes NSCA which will capture SMRs. Schedule Item 33 (c) – could capture SMR manufacturing facility. Schedule Item 35 – captures SMRs. Project List Note: SMRs situated on indigenous lands and federal lands will likely trigger a project list review unless specifically exempt. Need to determine relevance wrt Impact Assessment. Activities described in Section 35-37 would include SMR.						Industry needs to ensure proper characterization of manufacturing facilities. For example, if the manufacturing facility includes fuel load and commissioning with the fuel in-place, a federal EA could be justified, In this case, it's falling "just short' of being an operating reactor facility
2-3		*Prescribed Information for the Description of a Designated Project Regulations*		Medium	Need to determine relevance wrt Impact Assessment.						
2-4		*Cost Recovery Regulations*		Low							
2-5		Canadian Environmental Protection Act	Federal, Environment Canada	Medium	Canadian Environmental Protection Act (CEPA 1999) and its Regulations No obvious technical barriers but certain factors should be considered when SMRs are being designed and developed: CEPA Part 5 deals with Controlling Toxic Substances. SMR technologies should where possible avoid use of substances declared toxic under CEPA by exploring alternatives for substances that have been targeted to be phased out. For instance asbestos gaskets and parts. The New Substances Notification Regulations should be consulted to see if new materials or enriched fuel being manufactured in or imported into Canada meet criteria for risk assessment and reporting. Part 7 of CEPA deals with Controlling Pollution and Managing Waste. As with Fisheries Act, designs that minimize emissions of toxic substances to air and water should be the preferred ones. CEPA contains provisions dealing with international air and water pollution but I am not aware of any cases where they have been applied but there is a slim possibility of these being invoked if any related accidents or spills occur in international waters.						

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					Under Part 7 there are fuels and storage tanks regulations that could apply to back-up power systems for SMR plants. Also Export and Import of Hazardous Waste Regulations could apply to transboundary movement of spent reactors and waste. Part 8 of CEPA is specific to environmental matters related to Emergencies. It provides authority to require emergency plans for certain substances and these plans must address prevention, preparedness, response and recovery. Under this section are the Environmental Emergency Regulations that target specific substances at specified thresholds. So depending on the substances associated with the SMR plant these could apply. Economic Feasibility Challenge: No obvious major challenges. However, depending on how the above considerations and regulatory requirements are addressed, conducting assessments, or obtaining necessary approvals could increase costs and cause project delays						
2-6		Fisheries Act	Federal, Fisheries and Oceans Canada, Environment and Climate Change Canada (Section 36)	**Medium**	No obvious technical barriers but certain factors should be considered when SMRs are being designed and developed: Cooling water/ heated discharges should be minimized if possible with SMR technologies to avoid potential for thermal effects on aquatic biota Where possible the use of toxic substance that could end up in natural waterbodies should be avoided Siting decisions should consider proximity to waterbodies to avoid any impacts of construction such as clearing of riparian vegetation, deposits of silt, dirt, explosives use or other materials into waters frequented by fish Siting decisions should also situations that could create barriers to fish movement Siting should also consider vulnerability to external hazards such as flooding and develop potential adaptations or design factors to address changing climate Economic Feasibility Challenge: Depending on how the above considerations are addressed, conducting assessments, or obtaining necessary approvals could increase costs and cause project delays						
2-7		Fisheries Act *Regulations (Provincial, may have different names in different provinces)*	Provincial	**Medium**							

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		e.g. Ontario Fishery Regulations, 2007 (SOR/2007-237)									
2-8		Migratory Birds Convention Act	Federal, Environment Canada	**Screen Out**							
2-9		Species at Risk Act	Federal, Environment Canada	**High**	None Identified.						
2-10		Environmental Violations Administrative Monetary Penalties Act	Federal	**Screen out**							
2-11		Canada Shipping Act	Federal	**Medium**	None Identified.						Marine transport of fueled reactors **or spent fuel** may, if proposed, lead to the need to further understand regulatory issues both within Canadian waters and where international boundaries are crossed, how changes of regulatory jurisdiction would take place. Industry needs to propose specific scenarios to focus what legal issues to explore such as nuclear liability. In the Russian Federation., marine design regulations were used in reviewing design of floating power plants. Expect little basis to challenge the act, however heads up it is a highly regulated industry (not unlike nuclear) and could be involved and costly especially on a one off basis.
2-12		Environmental Protection Act and Regulations	Provincial*	**Screen Out**							
2-13		Ontario Water Resources Act	Provincial*	**Screen Out**							

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2-14		Environmental Bill of Rights	Provincial*	**Screen Out**							
2-15		Ontario Water Resources Act	Provincial*	**Screen Out**							
2-16		Safe Drinking Water Act	Provincial*	**Screen Out**							
3-1	**Transportation**	Navigation Protection Act *(being replaced by the Navigable Waters Act)* (Bill C-69)	Federal, Transport Canada	**Low**							
3-2		Transportation of Dangerous Goods Act	Federal, Transport Canada	**High**	(None identified.)		The Act prescribes an Emergency Response Assistance Plan for a legal person transporting dangerous goods, with nuclear substances being one Class of such dangerous goods. The Act similarly prescribes a Security Plan. For remotely-located reactors, particularly with centralized/off-site monitoring, additional challenges may exist in terms of logistics between these components of the required emergency and security response capability.		The Act prescribes an Emergency Response Assistance Plan for a legal person transporting dangerous goods, with nuclear substances being one Class of such dangerous goods. The Act similarly prescribes a Security Plan. For remotely-located reactors, particularly with centralized/off-site monitoring, additional challenges may exist in terms of logistics between these components of the required emergency and security response capability.		Agreed. However it is important to note that a "mobile reactor" (i.e nuclear battery) that is placed in service on a site changes from a transport package into a Class 1 nuclear facility. Insurance and liability requirements will change during the transition and the proponent may be a different entity dependent on the transport scenario (i.e. point of origin, areas of temporary storage in transit and final destination. Industry should engage in a long term project to understand how transitions and handovers will occur.
3-3		Transportation of Dangerous Goods Regulations	Federal, Transport Canada	**High**	None Identified. Per Section 1.43, Class 7, Radioactive Materials, are generally exempt from the TDG Regulations provided that they follow the requirements of the 'Packaging and Transportation of Nuclear Substance Regulations'.						

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					Non-radioactive substances required for SMRs (lead or salt coolants, chemical processing, etc.) would be covered by the TDG regulations but no specific issues were noted at this level of review.						
3-4		Dangerous Goods, Transportation Act	Provincial*	**Screen Out**							
4-1	**Occupational Health and Safety/ Labour**	Canada Labour Code	Federal, Employment and Social Development Canada	**Screen Out**							
4-2		*Occupational Health and Safety Act*	Provincial*	**Screen Out**							
4-3		*Canadian Human Rights Act*	Federal	**Screen out**							
4-4		*National Fire Code*	Federal	**Medium**	The Nuclear Specific document is CSA N293 For Balance of Plant associated with heat to electrical conversion, NFC requirements will be the same as those for existing generating stations both conventional and nuclear						Agree in principle – however it will likely require further discussions with the CNSC
4-5		*Fire Protection and Prevention Act*	Provincial*	**Screen Out**							
4-6		Boilers and Pressure Vessels Act and Regulations	Provincial*	**Screen Out**							
4-7		Technical Standards and Safety Act and Regulations	Provincial*	**Screen Out**							
4-8		Building Code Act and Regulations	Provincial*	**Screen Out**							
4-9		Accessibility for Ontarians with Disabilities Act	Provincial*	**Screen out**							

No.	Topics	Acts, Regulations, Codes, Agreements	Administered by + Identify List of Approval Required	Priority High Medium Low Screen Out	Identification of Regulatory Gap: On-Grid Power Generation Application		On- and Off-Grid Combined Heat and Power Application (*for Natural Resource Extraction*)		Off-Grid Power and District Heating Application (*for northern and remote community, and Government Facilities*)		CNSC observations
					Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	
4-10		Employment Standards Act	Provincial*	**Screen out**							
4-11		Human Rights Code	Provincial*	**Screen out**							
4-12		Labour Relations Act	Provincial*	**Screen out**							
4-13		Pay Equity Act	Provincial*	**Screen out**							
4-14		Workplace Safety and Insurance Act	Provincial*	**Screen out**							
5-1	**Nuclear Security**	*Nuclear Terrorism Act*	Federal, Department of Justice	**Medium**	None identified. Definitions for "nuclear facility", "nuclear material" and "radioactive material" would apply to SMR and all locations.						agreed
5-2		Nuclear Security Regulations	Federal, CNSC	**High**	S.7.4 – dependent on CNSC developing a DBT Analysis – which will likely be dependent on SMR design and location. -SMR manufacturing facilities will be considered high-security sites. -high-security sites require a permanent onsite nuclear security force. S.2(a) – this will capture SMR manufacturing facilities and thus the security requirements. S.5 – additional transportation requirements for SMRs.		General: - prescriptive requirements may be logistically and economically constraining on small SMRs and/or remote northern sites. S.35 – Off-site response force arrangements could be logistically challenging for remote communities. S.36 – security drills will be expensive and logistically challenging for remote communities. Comments per on-grid application plus; No mention of cyber security as outlined in CSA N290.7-14. Potential challenge for remote locations and off-site control of systems. Section 5(h) Provision for an alternate transportation route in case of emergency may be impractical for remote locations				CNSC: agreed and CNSC is discussing/considering the various options … and "we are listening". NSR regulations are in the early stages of being amended. It is acknowledged that security by design needs to be considered. In the meantime, the CNSC can regulate by exemption by the Commission – which is currently done for some sites in Canada – e.g., Not all high security sites have an on –site Nuclear response force. "inherent safety" must be demonstrated, not agreed upon before the demonstration is provided. The main difference to be addressed is when fissile material becomes part of the manufacturing and a

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					S.7.1 – will apply to SMR manufacturing facilities to varying degrees dependent on design. S.8, S.9, S.11 – Protected area requirements are prescriptive and not dependent on size of facility or reactor. S.30 – requires onsite presence of nuclear security officers. S.32 – requires an onsite nuclear response force. Definition of **nuclear power plant** would be applicable to on-grid applications Security provisions for on-grid application would likely be similar to those existing Cdn nuclear utilities. However, composition and quantity of nuclear material (Category 1, 2 or 3) on-site may necessitate additional security measures. This will be technology dependent and have potential economic challenges. Section 7(1) would require creation inner area for storage of Category 1 material. Will depend on SMR design based on composition and quantity of nuclear material. Schedule 1 will be SMR technology dependent and drive required security requirements per the regulations. This could have adverse impact on cost.		Section 7.2(1) [Arrangements for off-site response force] may be impractical for remote locations Section 9 is prescriptive wrt protected area barriers. Likely impractical for remote locations. Sections 12-13 [Inner area] Likely impractical for remote locations. Section 15 [Security monitoring room] Likely impractical for remote locations. Requires 24/7 attendance by at least one nuclear security officer. Section 35 Likely impractical for remote locations. Section 36 (4) Requirement to conduct a security drill at the site every 30 days likely impractical for remote locations. Section 47 (1) requirement to have written arrangement with off-site response force likely impractical for remote locations. Section 48 [Supervisory awareness program]. Daly application of this may not be possible at remote locations or with SMR design that potentially can require only 1 operator. Very significant				fully functional fueled reactor may be the end product of a facility. Section 9(3) and 9(2) have 'out clauses' for fences e.g. section 3B "a structure, whether or not combined with other physical protection measures, that provides the same level of protection as the structures referred to in paragraph (a)." Section 36(4) – drills can be made to test the security system that fit within the operating model of an SMR.

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5-3		*Public Agents Firearms Regulations*		**Screen Out**							
5-4		*Explosives Act*	Federal, NRCan	**Screen out**							
5-5		*Police Services Act*	Provincial*	**Screen out**							
5-6		*Security for Electricity Generating Stations and Nuclear Generating Stations Act*	Provincial*	**Screen Out**							
6-1	**Nuclear Energy and Substances**	Nuclear Energy Act	Federal, Natural Resources Canada	**High**	None Identified						
6-2		Radiation Emitting Devices Act	Federal, Health Canada	**Low**							
6-3		Radiation Emitting Devices Regulations	Federal	**Screen out**							
6-4		Nuclear Substances and Radiation Devices Regulations	Federal, CNSC	**Screen out**							
6-5		*Packaging and Transport of Nuclear Substances Regulations*	Federal	**High**	**Technical** General – SMR's may require specialized packaging unless existing IAEA packaging can be used (e.g. use of Type A, B, C, H , IP packaging etc.). Any new packaging would require certification. S.7(e), (f), & (g) – if the SMR is considered a large object then additional design criteria may be applicable with respect to transportation. A special arrangement transport licence will likely be required (this may not apply as it is typically applied to decommissioned material). **Economic**						If an SMR is a package, then the problem is even more complex because you will be drop testing a reactor. There is no way it would survive to be fit for service. The design provisions (100+G shock??) would be too costly. A licensee or proponent could apply to the Commission (with a proper safety case) for permission to transport a fueled reactor.

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					S.6(1)(a) – SMR's will likely contain Category I nuclear substances thus they will require a transportation licence.						
7-1	**Safeguards**	Nuclear Safeguards Verification	Federal, IAEA/CNSC	**Medium**	The INFCIRC/164 is an agreement between Government of Canada and the IAEA for the application of safeguards of special fissionable material. It is applicable to SMRs, INFCIRC/164 contains two parts: Part I is basic understanding of the agreement and Part II specifies the procedures to be applied in the implementation of the safeguards provisions of Part I. The INFCIRC/164/Add.1 is the additional protocol to the agreement between Government of Canada and the IAEA for the application of safeguards of special fissionable material. The focus of additional protocol is nuclear fuel cycle related research and development activities including conversion, enrichment, fuel fabrication, reactors, critical facilities, reprocessing of nuclear fuel and processing of intermediate or high-level waste . For applicants and licensees (which are the case of SMRs) requirements and guidance of safeguards programs are provided in CNSC REGDOC-2.13.1						agreed
7-2		Nuclear Non-proliferation Import and Export Control Regulations	Federal, CNSC	**Medium**	The regulations are applicable to SMRs in respect of application for a licence to import or export of controlled nuclear substances, controlled nuclear equipment and controlled nuclear information. Clause 3 of the regulations outlines the requirement to be satisfied in the application for a licence. Clause 4 of the regulations provides exemptions from licence requirement Schedule Part A lists controlled nuclear substances, equipment and information. Part B lists nuclear-related dual-use Items.						Agreed. Verification of safeguards may be a challenge in remote region.
7-3		*Export and Import Permits Act*		**Medium**	None identified						
8-1	**Waste**	Nuclear Fuel Waste Act	Federal	**High**							
9-1	**Nuclear Liability**	Nuclear Liability and Compensation Act	Federal, Natural Resources Canada	**High**	**Economic** S.7 (4) – will capture floating SMRs. S.9 (1), (2), (4), (5) & (6) – could capture both operators as well as fabricators of SMRs. Fabricators not defined. S.24 (2) (b) – regulation could be utilized to identify liability limits commensurate with SMR risk. S.27 (1) would also benefit from this. S.28 (2) – may allow for a special agreement to be developed for SMR operators. (3) & (4) – would be affected by the any regulation and/or agreement. S.78 (b) – allows for new classes of nuclear installations.						

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					S.80 (b) – maximum SMR damages could be identified and limited by this section.						
10-1	**Emergency Management**	Emergency Management and Civil Protection Act	Federal, Provincial and Municipal	**Medium**		<u>**COG**</u> Challenge around resourcing and financing needs to participate in emergency training and exercises within municipal or provincial mandate; may be some economic considerations when designing the emergency operations centres General Ontario statute applicable to offsite coordination for Ontario based SMR sites.		<u>**COG**</u> Challenge around resourcing and financing needs to participate in emergency training and exercises within municipal or provincial mandate; may be some economic considerations when designing the emergency operations centres General: - may be logistically complicated for remote northern communities.		<u>**COG**</u> Challenge around resourcing and financing needs to participate in emergency training and exercises within municipal or provincial mandate; may be some economic considerations when designing the emergency operations centres General: - may be logistically complicated for remote northern communities.	Agreed, but emergency management is a key aspect of any safety case for operation in remote regions …. Federal rules may exist, but in some cases, provincial/territorial rules and infrastructure may not yet be in place for a nuclear project.
11-1	**Others Acts/By-Laws**	Ontario Energy Board Act	Provincial*	**Screen out**							
11-2		Electricity Act	Provincial*	**Screen out**							

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11-3		Occupier's Liability Act	Provincial*	**Screen out**							
11-4		Public Lands Act	Provincial*	**Screen out**							
11-5		Regional Municipality By-Laws	Municipal*	**Screen out**							
11-6		Health Canada Guideline for Intervention Levels	Federal	**Medium**							

* A similar legislation will be applicable for other Canadian provinces, territories and/or municipalities. Provincial and Municipal regulations were screened out given the large volume of legislation associated with all the potential deployment sites, however nuclear energy is a federal responsibility in Canada and the review of federal legislation and regulations should address the broad requirements of other government levels.

Appendix B: Potential List of CNSC REGDOCs for Impact Screening for NRCan SMR Roadmap

No.	REGDOC #	REGDOC Title	Administered by + List of Approvals Required	Priority	Identification of Regulatory Gap						CNSC observations
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1	REGDOC-1.1.1	Licence to Prepare Site and Site Evaluation for New Reactor Facilities	Federal, CNSC	**High**	Makes specific reference to "graded approach" and "small reactor facilities". REGDOC 1.1.1 applicable to all facilities using graded approach Industry and intervenor comments were previously compiled in Consultation Report for REGDOC 1.1.1. Concerns raised by industry which were not changed during consultation period remain. Majority of comments were not specific to SMR however those which were pointed to requesting a graded approach. For example, "REGDOC 1.1.1 does not make any allowance for the size of the reactor or site in specifying requirements for environmental assessment. Provide a graded approach depending on the size of the intended site or reactor". CNSC response was that ".all criteria in REGDOC 1.1.1 can be applied to a smaller reactor facility using a risk informed approach….CNSC currently developing a parallel regulatory document, specific to licensing a small reactor."						REGDOC-1.1.1 does make allowance for the size of the reactor or site in specifying requirements for environmental assessment.
2	RD-369	RD/GD-369, Licence Application Guide: Licence to Construct a Nuclear Power Plant			General Preface indicates that RD-369 applies to water-cooled nuclear power plants. There is no definition of a NPP. SMR technologies may be different that traditional large water-cooled NPP. Section 5.9.5 (Plant aging Management) This section is looking for a program on integrated aging management. Application for large water-cooled NPP. Some SMR by design are replaced when fuel reaches end of cycle. Long term aging management may not be applicable. Section 5.9.6 (Severe Accident Management). Some SMR designs are "inherently safe" and therefore may not need to SAMG. Section 6.3 (Civil and Structural Design) Considerable discussion about containment structure. SMR designs may not employ a traditional containment. This is technology dependent. Section 6.6.3 (emergency core cooling system). Some SMR design may not have traditional ECCS and rely on other design aspects to keep fuel cool. Section 6.6.3 (Containment systems) See comments under Section 6.3. Section 6.8 (Electrical systems) Highly prescriptive. Simplified SMR technologies may not require this level of power redundancy and complexity. RD-367 applies a graded approach.						RD/GD-369 can be applied to any type of reactor facility. Section 2.2 of RD/GD-369 states: Where the licence application relies on the use of documents not traditionally used in the Canadian nuclear industry, the applicant should submit an accompanying assessment to facilitate a timely review of the submission. This assessment may be a gap analysis between the documents referenced in the application versus Canadian industry-equivalent documents, or an independent assessment of the design against equivalent documents commonly used in Canada.

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					Section 8.4 (Commissioning Program) Written primarily for large water cooled reactors and therefore applicability to SMR may be limited. Phase A indicates testing to be completed prior to fuel load. Some SMR designs may come from factory pre-loaded therefore site specific testing for Phase A not possible. See comments on REGDOC 2.3.1 Overall comments made for REGDOC 2.5.2 are equally applicable to RD-369.						The section should include declarations of the design's compliance with the codes and standards used. This section should provide information pertaining to cases where the expectations contained in any of the various regulatory documents and other applicable codes and standards are not met. The safety significance of the deviations should be assessed and where necessary, a separate and complete justification should be provided for each deviation. This justification should include all the information necessary to assure the CNSC that any deviations from CNSC requirements and expectations will not negatively affect the facility's overall level of safety. This justification should be included in each of the applicable sections or documented in referenced documents provided with the application. Wrt section 5.9.5, applicants will have to demonstrate how aging of SSCs over

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											the life of the facility will be taken into account Wrt section 5.9.6. CNSC will consider the safety case in its entirety. Applicants are welcome to propose alternatives provided the intent of requirements are met. Evidence will need to be provided by applicants to demonstrate a severe management accident program is not needed. Wrt 6.3, applicants can propose to use confinement structures – provided they demonstrate that dose limits for dose to the public are met Wrt section 6.6.3, applicants have to demonstrate cooling means, where applicable Wrt section 6.8, as above, applicants may propose alternatives Wrt Construction and Commissioning – as above, applicants may propose alternatives and demonstrate the intent of requirements are met. It is fairly straightforward to articulate the objectives of commissioning.
3	REGDOC-1.1.3	License Application Guide*: Licence to operate a Nuclear Power Plant*		**High**	No specific mention of SMR but does make specific references to use of graded approach. REGDOC 1.1.3 is the continuation of REGDOC 1.1.1 (LTPS), RD-369 (construct) and REGDOC 2.5.2 (Design). Similarly it makes specific reference to RD-204 and the other REGDOCS continued in this literature review. All comments made under those reviews are relevant to REGDOC 1.1.3.						Noted, see comments wrt application of graded approach and proposal of alternatives

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											The graded approach is used by the CNSC when applications for a licence are assessed..
4	REGDOC-3.1.1	Reporting Requirements for Nuclear Power Plants		**Screen out**							
5	RD/GD 99.3/ REGDOC-3.2.1	Public Information and Disclosure		**Medium**							
6	REGDOC-3.2.2	Aboriginal Engagement		**High**		Engagement may be less of a concern with on-grid sites if they are situated near urban areas or existing nuclear facilities.		Many eligible northern sites will be in or near aboriginal lands and and/or communities thus requiring engagement. There is no mention of who funds this engagement, but will likely default to the Licensee.		Many eligible northern sites will be in or near aboriginal lands and and/or communities thus requiring engagement. There is no mention of who funds this engagement, but will likely default to the Licensee.	Indigenous engagement for on-grid applications should not be under-estimated. Applicants are expected to carry out activities in accord with REGDOC-3.2.2
7	RD-204	Certifications of Persons Working at Nuclear Power Plants		**High**	RD Not suited		RD Not suited		Should not apply for remotely operated. Not clear what would	RD is "hard wired" to positions and terminology of large Candu Plants. Needs to be replaced	See comments above – yes discussion is needed, but applicants have to make the case for certification of staff and how they will demonstrate that staff are qualified to operate the facility and respond to events …..
8	REGDOC-2-.1.2	*Safety Culture*		**Low**							

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9	REGDOC-2.2.2	Personnel Training		**High**	None Identified.						
10	REGDOC-2.3.2	Accident Management: Severe Accident Management Programs for Nuclear Reactors		**High**	General note: The version of REGDOC-2.3.2 reviewed is the latest edition – Version 2, issued 2015 September. The title of this version is "Accident Management", though it does include Severe Accident Management elements. Reactors with thermal output capacity less than 10 MW thermal are explicitly excluded from the scope of the document. It should be clarified what the intent of the exclusion is – whether a more limited set of conditions is applied by other governance and regulatory documentation, or if there are no specific requirements at all. Advice is given that staff responsible for accident management strategies should have training and experience regarding accident management in a nuclear facility. The amount of such expertise available within the regulatory body in Canada for non-water cooled reactor types that have been proposed for SMR development should be considered. Many illustrative examples given are technology-specific to water cooled reactors. As one specific example of this: Advice is given that physically designed features and controls should 'practically eliminate' core melt and		For the purposes of accident management, spent fuel pools are explicitly considered parts of the nuclear facility. Further to this point, the accident analysis is required to cover any transit period between the reactor and storage location. For small installations, where fuel storage may not be local, new challenges exist when considering that one facility's staff may be tasked with responding to events in more than one geographically distant location. Reactors with thermal output capacity less than 10 MW thermal are explicitly excluded from the scope of the document. It should be clarified what the intent of the exclusion is – whether a more limited set of conditions is applied by other governance and regulatory documentation, or if there are no specific requirements at all. Advice is given that staff responsible for accident management strategies should have training and experience regarding accident management in a nuclear facility. The amount of such expertise available within the regulatory body in Canada for non-water cooled reactor types that have been proposed for SMR development should be considered. The regulatory document assumes the reactor (or set of reactor units) possesses redundant emergency response capabilities, including a primary control room, secondary control room, and emergency response facilities. For remotely-located reactors, particularly with centralized/off-site monitoring, additional challenges may exist in terms of logistics between these components of the required emergency response capability. Many illustrative examples given are technology-specific to water cooled reactors. As one specific example of this: Advice is given that physically designed features and controls should 'practically eliminate' core melt and hydrogen detonation event sequences. This may not a good fit to non-water cooled reactor types, which may have other, similarly severe dominant accidents.				Applicants can propose alternatives to REGDOCs, and can make the case for practical elimination of events (and not follow the REGDOC so prescriptively…), The intent of REGDOC-2.3.2 is to have provisions to mitigate AOO, DBA and Beyond Design Basis Accident (BDBAs) that have not been practically eliminated. The intent of REGDOC-2.3.2 should be clear - fundamental principles should be addressed for all facilities, no matter if they are larger or smaller than 10 Mw. The spent fuel waste will likely be covered under another licence, with a supporting safety case. This will include provisions to manage accidents that could occur. Wrt to control rooms and emergency response facilities, the applicant will have to have some form of back-up facility, and can propose provisions based on the behavior of their facility under various accident conditions. Provisions in requirements exist to develop deterministic Safety Analysis results (e.g. postulated initiating events, etc) specific to each technology and then develop a safety case from

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					hydrogen detonation event sequences. This may not a good fit to non-water cooled reactor types, which may have other, similarly severe dominant accidents.						there. But the methodology remains the same.
11	REGDOC-2.3.3	Periodic Safety Reviews		**Medium**	General Considerations: Standard allows for a graded approach to be applied. Challenge for SMRs is the periodic timing of the PSR (10 years may be too long); and applicability of modern codes & standards						Noted, Can be addressed in the licence….particularly for a FOAK.
12	REGDOC-2.4.1	Deterministic Safety Analysis		**High**	The standard distinguishes small reactor facilities as a separate section enabling the use of a graded approach. SMRs may be subject to some of the requirements for power reactors above those identified for small reactors. 7.1 Deterministic Safety Analysis Objectives Challenges may arise with respect to the identification of Levels of Defence in Depth for SMR reactor technologies that often employ passive safety systems. This will be a challenge across any RegDoc/ Std that makes reference to Defence in Depth Section 8.2.3 Classification of Event The use of passive systems may result in challenges when categorizing events into AOOs and DBAs due to the use of passive safety systems. This then introduces challenges when determining how safety requirements will be applied for AOO and DBA events BDBA may be difficult to separate from DBA due to passive systems. 8.4.3 Computer Codes Challenge to meet verification and validation of computer codes used to model new fuels 8.4.4. Challenge in determining level of conservatism due to the lack of data with respect to proposed new technology 8.6.2Update of Deterministic safety analysis						Applicants can illustrate how defence-in-depth is achieved. There is no prescriptive formula wrt how to achieve defence-in-depth, it is technology dependent. An applicant will have to demonstrate the effectiveness of the passive features and systems Wrt classification of events, this will have to include the information supporting the performance and effectiveness of passive features and systems. There is not a prescriptive formula, each case/situation will have to be evaluated based on it 's own merits Computer codes will have to be verified and validated – if not, what confidence is there in the predictions made by these codes? What would industry propose instead? Appendix A may be a suitable basis for event classification.

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					Due to the nature of new technology, it is very likely that new data will become available. Industry has dealt with this in the past when CANDU technology was being implemented. The change in regulatory expectations may mean that the approach used for CANDU may be suitable for SMR. Appendix A SMRs may be asked to also use these criteria for those SMRs that are intended for on grid applications. In cases where the identified events are not applicable due to technology, the document may need to be updated with new events to reflect SMR technology Appendix C Table C1 & C2 will need to be updated to capture how SMR design aim to meet the high level safety requirements						Appendix C could be updated – but still provides a good foundation to build on as is.
13	REGDOC-2.4.2	Probabilistic Safety Assessment (PSA) for Nuclear Power Plants		**High**	Under Section 3 Challenges in how PSA can be effectively used on reactor configurations where safety features are passive Defining what a severe core damage for a particular SMR core which claims that conditions do not exist that will result in core melt. SMRs may be deployed as single or multiple units. This leads to challenges with respect how relationships between units will be handled Under Section 4 4.5 Realistic assumptions and data – what body of evidence will be used to provide this 4.10 Sensitivity and Uncertainty Analyses – what body of evidence will be used to provide this						Core damage may be different for different reactor types, but it still needs to be understood regardless of how small the probability of it happening is. It is part of understanding where the limits are when you are designing features. In some cases the fuel may not melt, but it could get hot enough that it melts other things such as containment and control mechanisms. Applicants will have to demonstrate that passive features are truly passive. If they are semi-passive (squib valves,, water tanks that rely on a valve to open), they will have to provide information supporting the claims made about the performance of these features Applicants will have to provide realistic data where possible, and clearly indicate uncertainties in data and carry

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											out appropriate sensitivity analyses taking the knowledge-base into account
14	REGDOC-2.5.2	*Design of Reactor Facilities: Nuclear Power Plants*		**High**	General States in Preface and Section 1 that REGDOC "..sets out requirements and guidance for new license applications for water-cooled nuclear power plants". Requirements may be different for other SMR technologies. However Section 1 also states "…It is recognized that specific technologies may use alternative approaches. If a design other than a water-cooled reactor is to be considered for licensing in Canada, the design is subject to the safety objectives, high-level safety concepts and safety management requirements associated with this regulatory document. However, the CNSC's review of such a design will be undertaken on a case-by-case basis." Section 4.2.2 safety goals is different that RD-367 (Design of SMR). Small and large release frequency is tied to activity release not just CDF. Section 5.3 Reference to CSA N286.7 (Computer codes used for safety analysis). International vendors would be required to demonstrate equivalency. Section 6.1 (Application of Defense in Depth) discusses 5 levels of defence in depth. Specifically for Level 4 "…adequate protection shall be provided for the confinement function by way of a robust containment design". SMR technologies may preclude the need for a traditional containment structure. Section 7.3.4 (Design Extension Conditions) "The design shall identify radiological and combustible gas accident source term…this source term is referred to as the reference source term and shall be based on a set of representative core damage accidents.." Some SMR technologies may preclude core damage or combustible gas generation. However remainder of Section 7.3.4 appears to allow for graded approach and elimination of certain events if not possible. Section 7.7 (Pressure retaining structures, systems and components) makes specific reference to N285 (CANDU specific) but appears to allow alternatives if can demonstrate equivalency. Section 7.7 also discusses concept of leak-before-break to be incorporated into designs. This may be different for non water-based SMR designs.						It is acknowledged that in some sections, RD-367 has more appropriate wording Yes wrt computer codes & N286.7, see above, and see the wording in section 2.2 of RD/GD-369 on alternate codes and standards Wrt 6.1, alternatives can be proposed, provided higher level safety objectives are met (and emergency response times are adequate relative to the location of the facility Correct observations on sections 7.3.4, 7.7, 7.13, 7.15 Wrt sections 7.9.3 and 7.11 applicants may propose alternatives See above comments wrt back-up control rooms / facilities to deal with accidents. Applicants may propose alternatives supported by suitable information Most of section 8 is technology neutral. Alternatives may be proposed – and REGDOC-2.5.2 states "To the extent practicable, the requirements and guidance provided herein are technology-neutral with respect to water-cooled reactors. An applicant or

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					Section 7.9.3 (Accident Monitoring Instrumentation) guidance of what should be monitored is for large water-cooled reactors (including specific CANDU). SMR technologies may support reduction in monitoring or different parameters. Section 7.11 (GSS) "The design shall provide two independent means of preventing recriticality from any pathway or mechanism when the reactor is in GSS". Some SMR designs may employ different approach. Section 7.13 (Seismic qualification and design). Many specific requirements and standards referred to. RD-367 (SMRs) is much more general. Section 7.15 (Civil structures). Many specific requirements and standards referred to. RD-367 (SMRs) is much more general. Section 7.21 (Human factors). Multiple references to secondary control room. SMRS (particularly remote locate) likely will not require or have. RD-367 (SMRs) appears to allow for graded approach in this area and secondary control room not mandatory. Section 8 (System specific requirements). This section is entirely technology dependent and is written around large water-cooled reactor concepts. Section 8.1.1 (fuel elements, assemblies and design). "fuel elements <u>shall</u> be designed to permit adequate inspection of their structure and components prior to and following irradiation. SMR technologies may preclude this in-situ capability. Other guidance in this section on fuel rod failure and fuel coolability of based on water cooled technology which may not be applicable to SMR designs. Section 8.4 (Means of shutdown) "The design <u>shall</u> include two separate, independent and diverse means of shutting down the reactor…At least one means of shutdown <u>shall</u> be independently capably of <u>quickly</u> rendering the reactor subcritical. To improve reliability, stored energy <u>shall</u> be used in shutdown actuation". These requirements are the same as specified in RD-367 and could be overly prescriptive to SMR technologies. Section 8.6 (Containment) "Each nuclear reactor <u>shall</u> be installed within a containment structure". Too prescriptive. SMR technologies may not require and RD-367 talks about confinement vs containment. Section 8.9 (Electrical Power systems) Highly prescriptive. Simplified SMR technologies may not require this level of power redundancy and complexity. RD-367 applies a graded approach. Section 8.10.2 (Secondary Control Room) "The design <u>shall</u> provide a SCR that is physically and electrically separate from the MCR". Simplified SMR technologies may not require this level of redundancy and complexity. RD-367 applies a graded approach.						licensee may put forward a case to demonstrate that the intent of a requirement is addressed by other means and demonstrated with supportable evidence." Wrt section 8.1.1, some means of inspection fuel elements will likely be needed, to confirm fuel is fit-for-service of the projected fuel life-cycle (very technology-specific). One should ask what the intent of this expectation is – It is to confirm fuel elements and associated components remain fit-for-service. Wrt section 8.4, there will have to be "two separate, independent and diverse means of shutting down the reactor…At least one means of shutdown <u>shall</u> be independently capably of <u>quickly</u> rendering the reactor subcritical." It should be noted that "quickly" is relative, and the speed needed should be based on characteristics of the specific technology. Agree that "To improve reliability, stored energy <u>shall</u> be used in shutdown actuation" is prescriptive. However the intent of section 8.4 will have to be met. Wrt section 8.6,8.9 and 8.10.2 - It is noted that RD-267 and REGDOC-2.5.2 use different approaches. – Whichever document is used, all proposals will

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					Section 8.10.2 (Emergency Support Facilities). "The design shall provide for onsite emergency support facilities that are separate from the plant control rooms…" Simplified SMR technologies may not require this level of redundancy and complexity. RD-367 applies a graded approach. Section 8.12.3 (Detection of failed fuel) "The design shall provide a means for allowing reliable detection of fuel defects in the reactor, and the subsequent removal of failed fuel, if action levels are exceeded." Some SMR technologies may preclude the in-situ removal of failed fuel. Section 8.13.3 (Radiation Monitoring) "…laboratory facilities shall be provided to determine the concentration on selected radionuclides…taken from plant systems or the environment". Some SMR technologies. Could pose logistical issues for some locations. Section 11 (Alternative approaches) Alludes to graded approach and different technologies as long as an equivalent or superior level of safety is achieved.						have to be supported by suitable evidence Wrt section 8.12.3, and the statement "Some SMR technologies may preclude the in-situ removal of failed fuel.", if fuel is defective, they will have to show how the problem is dealt with Wrt 8.13.3 - applicants will have to show how the intent of this clause will be met
15	RD-367	*Design of Small Reactor Facilities*		**High**	Provides definition of "small reactor facility" Specific mention of application of graded approach and factors to be considered. Alludes to application of whole site risk for sites where multiple units are installed. Section 6.4 (proven engineering practices) states "Structures, systems and components important to safety shall be of proven designs and shall designed in accordance to appropriate codes and standards". Many SMR introduce new technology FOAK) for which there may not be applicable codes and standards available at this time. In is unclear how license applicants would comply with these requirements.		As for on-grid applications plus Section 7.1.3 (Monitoring) "…laboratory facilities shall be provided to determine the concentration of selected radionuclides in fluid process systems..." This may not be applicable to some SMR designs or practical for small off-grid/remote locations. Section 7.25 (robustness against malevolent acts) "…design shall provide multiple barriers for protection against malevolent acts…" Some SMR technologies will preclude such events by design. In other cases a graded approach to physical security protections systems/programs will need to be considered accounting for physical limitations and practicality of implementing at remote locations. Section 8.10.4 (Equipment requirements for accident conditions) specifies 15 minute for operator action in MCR or 30 minute for field action. This is legacy from CANDU fleet and may not be required nor practical for SMRs in remote locations with minimal or no on-site staffing.				Wrt section 7.13, see comments on section 8.13.3 in REGDOC-2.5.2 Wrt section 7.25, applicants can propose alternatives supported by suitable information Wrt section 8.10.4 – this can be discussed, and is appropriate for CANDU reactors. SMR applicants can propose alternatives supported by suitable information – but many SMRs are being designed for much longer operator action times. With regards to section 6.4, applicants may propose alternatives supported by suitable information - somewhere along the way, engineers / designers should know enough about loads, materials properties, operational stresses to be able to design SSCs - using fundamental principles – good

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					Section 8.8 (Emergency Heat Removal System) "the design shall include an emergency heat removal system which provides for removal of residual heat to ensure fuel design limits and reactor coolant boundary condition limits are met. Some SMR designs may preclude fuel failure by design or rely on natural phenomenon. Need to ensure that this section is not interpreted as mandating a full "engineered" system when not required. Section 8.12.2 (Handling and Storage of Irradiated Fuel) "The design shall…+19 requirements" Depending on the SMR technology some of these may be redundant or impractical						scientific and engineering practices, supported by appropriate R&D wherever possible It is acknowledged that this will have to be addressed on a case-by-case basis.
16	REGDOC-2.6.1	*Reliability Programs for Nuclear Power Plants*		**Medium?**	3.1 Guidance used to determine Systems Important to Safety (SIS) based on PSA methods may not be adequate to capture passive safety systems. Level-2 and Level-3 PSAs may not exist for some SMR designs. 3.6.2 Failure modelling of passive safety features is more difficult (expensive) than classical component failure modelling.						The methodology for identifying systems important to safety for SMRs (and all new reactors) is provided in section 7.1 of REGDOC-2.5.2. The approach outlined in REGDOC-2.6.1 is for existing facilities REGDOC-2.5.2 states: SSCs important to safety shall include: • safety systems • complementary design features • safety support systems

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											• other SSCs whose failure may lead to safety concerns (e.g., process and control systems) Appropriately designed interfaces shall be provided between SSCs of different classes in order to minimize the risk of having SSCs less important to safety adversely affecting the function or reliability of SSCs of greater importance.
17	REGDOC-2.6.2	*Maintenance Programs for Nuclear Power Plants*		**Low**	None identified		3.3.1 In some SMR designs there may be no preventative maintenance. 3.3.2 In some SMR designs the licensee may not have the capability to perform corrective maintenance. No guidance provided for 'battery-like' SMR designs, which will have no preventative maintenance, limited capability for corrective maintenance, and possibly require refurbishment/life extension by the manufacturer in lieu of maintenance. 3.2.2 The organizational structure assumes a monolithic organization, throughout responsibilities lie on the licensee which may actually be assumed by the designer or manufacturer. 3.6 Responsibility for spares on licensee may not be required based on distribution model.				All reactors will require some form of preventative maintenance – even if it involves exercising equipment for freedom of movement and verifying reliability. The licensee is responsible for procuring spares, and the licensee has overall responsibility for maintenance. However they may contract maintenance out, provided that they are qualified and fully capable to undertake the maintenance
18	REGDOC-2.6.3	Aging Management		**Low**	None identified						
19	REGDOC-2.9.1	Environmental Protection: Environmental Principles, Assessments and Protection		**High**							

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		Measures									
20	REGDOC-2.10.1	Nuclear Emergency Preparedness and Response		**High**		Clause 2.2.1 – Emergency response organization and staffing: If remote monitoring is desirable then staffing for EP or maintaining an ERO can be a challenge 2.3.4 Public preparedness requirements: Distribution and education of ITB pills may be a cost factor	Clause 2.2.6 Emergency response facilities and equipment: could pose economic challenges to maintain ER facilities if remote monitoring and shutdown is desirable 2.3.4 Public preparedness requirements: Distribution and education of ITB pills may be a cost factor General: the requirement of emergency mitigating equipment may be inversely correlated in remote sites given the challenge of utilizing existing local/regional resources as well as response times for any offsite support. S.2.2.3 – items 5 to 8 – the real-time continuous monitoring/ modeling/ assessing may prove challenging for small SMRs in remote sites. S.2.2.4 – coordination with offsite response organizations may prove challenging as any remote SMR site response requirements may overwhelm the available offsite resources. There may be response time constraints. Public evacuations may require external support (air support). S.2.2.5 – acknowledges that remote sites may be without offsite assistance for extended periods of time – infers that the remote sites need to demonstrate how they will be self-sufficient under these scenarios. S.2.2.6 – may be logistically challenging to have an offsite emergency response facility (ERF) for small SMR remote sites. S.2.3 – preparedness drills, maintenance of ERF, and testing of emergency equipment will be significantly more costly to perform in remote locations. **COG** Coordination of Emergency Management if there are multiple reactors on site or if sited with existing nuclear facilities needs to be considered.				Different reactors in different areas will present different logistical challenges – which a licensee is then able to address in an appropriate manner using alternatives or a graded approach which is commensurate with risk.

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21	REGDOC-2.12.1	High Security Sites: Nuclear Response Force		**High**	**Restricted**						
22	REGDOC-2.12.2	Site Access Security Clearance		**Low**							
23	REGDOC-2.13.2	*Import and Export*		**High**	The version of REGDOC-2.13.1 reviewed is the latest edition – Version 1, published 2018 February REGDOC-2.13.1 will be used to assess new licence applications (this would include SMRs). The REGDOC is flexible and recognizes other means to meet requirements as follow: *Provision is provided if licensees (applicable to SMRs) select to choose alternate approach `` Licensees are expected to review and consider guidance; should they choose not to follow it, they should explain how their chosen alternate approach meets regulatory requirements`. *The document allows for use of graded approach (applicable to SMRs) when applying the requirements and guidance contained in this regulatory document. *A licensee may put forward a case to demonstrate that the intent of a requirement is addressed by other means and demonstrated with supportable evidence (applicable to SMRs) REGDOC-2.13.1 sets out for licensees CNSC requirements and guidance for the establishment and maintenance of a safeguards program to facilitate Canadian compliance with Canada's safeguards agreements with the IAEA. Monitoring and verifying nuclear material (safeguards) is administered in Canada by the CNSC and verified by the IAEA. Section 1.2 and Appendix C of the REGDOC provide guidance on materials not subject to safeguards. Section 2 of the REGDOC defines group of nuclear materials and provides information for exemption from some reporting and verification obligations (may be applicable to SMRs). Section 4, licensee shall have a documented safeguards program that fulfill the requirements (SMRs will need to meet this requirements). Section 7, nuclear material accounting and reporting and the establishment of material balance areas where flows and inventory of nuclear material can be determined. This may represent some challenges for SMRs based on molten salt fuel technology. Section 8, Licensees shall have measures in place to prevent the compromise of safeguards-relevant information. The REGDOC referees to CSA standard N290.7-14, Cyber Security for Nuclear Power Plants and Small Reactor Facilities for guidance on cyber security for safeguards systems.						

No.	REGDOC #	REGDOC Title	Administered by + List of Approvals Required	Priority	Identification of Regulatory Gap						CNSC observations
				High, Medium Low Screen out	On-Grid Power Generation Application		On- and Off-Grid Combined Heat and Power Application (*for Natural Resource Extraction*)		Off-Grid Power and District Heating Application (*for northern and remote community, and Government Facilities*)		
					Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	
					Section 8.1.4 CNSC considered special arrangement for spent fuel inventory of CANDU stations. Guidance is provided that at licensee request, the CNSC will consider similar arrangements for other large, homogenous inventories. This provide some flexibility for special considerations that may be required for SMRs. Section 8.1.5, this provision may apply to very SMRS. In instances where a licensee possesses small inventories of nuclear material, at the licensee's request, the CNSC may waive the requirement to create and report a Physical-key measurement point inventory summary for Group 1A material. Section 8.1.6, this provision may apply to very SMRS. When a licensee possesses small inventories of nuclear material, at the licensee's request, the CNSC may waive the requirement to create and report a reconciliation statement.						
24	RD-363	Nuclear Security Officer Medical, Physical and Psychological Fitness		**High**	General: - If SMR manufacturing facilities are deemed high-security sites then they will be required to comply with this REGDOC.						
25	RD-321	Criteria for Physical Protection Systems and Devices at High Security Sites		**High**	**Restricted**						
26	RD-361	Criteria for Explosive Substance Detection, XRay Imaging and Metal Detection at High Security Sites.		**High**	**Restricted**						
27	REGDOC-2.13.2	*Import and Export*		**High**	None identified						
28	REGDOC-2.14.1	*Information Incorporated by Reference in Canada's Packaging and Transport of Nuclear Substances Regulations, 2015*			**Technical** General – SMR's may require specialized packaging unless existing IAEA packaging can be used (e.g. use of Type A, B, C, H , IP packaging etc.). Any new packaging would require certification. S.7(e), (f), & (g) – if the SMR is considered a large object then additional design criteria may be applicable with respect to transportation. A special arrangement transport licence will likely be required (this may not apply as it is typically applied to decommissioned material). **Economic** S.6(1)(a) – SMR's will likely contain Category I nuclear substances thus they will require a transportation licence.						

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				High, Medium Low Screen out	On-Grid Power Generation Application		On- and Off-Grid Combined Heat and Power Application (*for Natural Resource Extraction*)		Off-Grid Power and District Heating Application (*for northern and remote community, and Government Facilities*)		
					Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	
29	REGDOC-3.5.1	Information Dissemination: *Licensing Process for Class I Nuclear Facilities and Uranium Mines and Mills*, version 2		**Medium**	None identified Applies to Class 1 facilities therefore applicable to SMRs. No mention of graded approach. Provides a high level overview of the licensing process and provides a cross references other pertinent REGDOC associated with specific licensing activities. Section 8.1 mentions 24 month timeline for LTPS for Class 1 facility. This may not meet the needs of NOAK SMR applications Section 8.2.1 lays out timelines for Class 1 license applications. Given simplistic design of many SMR and need to show proof of concept for FOAK and viability of future NOAK, these cumulative timelines are un-realistic and would not support commercial development for intended applications, particularly smaller off-grid/remote installations. Similar comments for Appendix B.						REGDOC-3.5.1 provides an overview of the licensing process for Class I nuclear facilities and uranium mines and mills in Canada, taking into consideration the requirements of the *NSCA* and associated regulations. The intent of the document is to give a licensing overview. Many of the timelines are built on assumptions (e.g. FOAK reactor impacts or construction times may not be applicable to all facilities) which can change. The intent of this document is to provide an overview of the process. The process and timelines described are not mandatory in all cases, and may change from reactor to reactor or site to site.
30	REGDOC-3.5.2	Compliance and Enforcement: *Administrative Monetary Penalties, version 2*		**Screen out**							
31	REGDOC-3.6	*Glossary of CNSC Terminology*		**Screen out**							
32	INFO-0795	Licensing Basis Objective and Definition		**Screen Out**							
33	G-206	Financial Guarantees for the Decommissioning of Licensed Activities		**High**	Applicable to decommissioning of all activities licensed by CNSC so applicable to SMR. No mention of graded approach, financial guarantees must be sufficient to cover the cost of the decommissioning work resulting from licensed activities that have taken place. Potential to be underestimated by SMR vendors and potential new licensees. Preparation of preliminary decommissioning plans and costing estimate could prove challenging for FOAK units.						
34	P-119	Policy on Human Factors		**High**	None identified. High level CNSC policy document describing how the CNSC will take human factors into account when conducting its activities. No mention of graded approach.						

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					Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	
35	G-276	Human Factors Engineering Program Plans		**High**	Applies to Class 1 facilities therefore applicable to SMRs. No mention of graded approach. Depth and complexity of HFE plan should be reflective of technology and potential for human error. Section 6.4 and 6.6. should allow for limiting scope of plan based on complexities of design and inherent safety characteristics which designs include.						Agreed, will need case-by-case discussions
36	G-278	Human Factors Verification and Validation Plans		**High**	Applies to Class 1 facilities therefore applicable to SMRs. No mention of graded approach. Depth and complexity of verification and validation activities should be reflective of technology and potential for human error. Would expect a simplified scope compared that that for current generation NPP.						Agreed, will need case-by-case discussions
37	G-323	Ensuring the Presence of Sufficient Qualified Staff at Class I Nuclear Facilities - Minimum Shift Compliment		**High**	Applies to Class 1 facilities therefore applicable to SMRs. No mention of graded approach. General approach is that licensee defines the required training and number of staff (minimum) to adequately respond to most resource-intensive conditions under all operating states. Needs to also describe strategy for qualified relief workers In addition to certified staff Section 5.1.4 indicates additional positions (fuel handling for example) which would comprise minimum complement and require licensee to justify not including. Many SMR designs are anticipated to require far fewer staff than large water cooled reactor therefore this reduced need to minimum complement staff will need to be substantiated by the Licensee.						"…reactor therefore this reduced need to minimum complement staff will need to be substantiated by the Licensee." Is correct
38	G-129	Keeping Radiation Exposures and Doses "As Low As Reasonably Achievable (ALARA)"		**Low**							
39	G-228	Developing and Using Action Levels		**Low**							
40	P-223	Protection of the Environment		**Screen Out**							
41	G-219	Decommissioning Planning for Licensed Activities		**Low**							
42	RD-327 & GD-327	Nuclear Criticality Safety		**Medium**	Potential gap in knowledge as majority of existing Cdn licensees do not deal with enriched fuel on regular basis. A complex REGDOC which sets out the requirements for nuclear criticality safety during the handling, storage , processing and transportation of fissionable material and the long term management of waste.						

No.	REGDOC #	REGDOC Title	Administered by + List of Approvals Required	Priority	Identification of Regulatory Gap						CNSC observations
				High, Medium Low Screen out	On-Grid Power Generation Application		On- and Off-Grid Combined Heat and Power Application (*for Natural Resource Extraction*)		Off-Grid Power and District Heating Application (*for northern and remote community, and Government Facilities*)		
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					Highly technical wrt enrichment levels and geometries. Anticipate this document will be applicable to most SMR designs. Potential for significant impact on SMR designs, fuel storage, transportation of SMRs to remote sites, etc. SMR vendors and potential licensees need to review and understand requirements.						
44	REGDOC-2.3.1	Conduct of Licensed Activities: Construction and Commissioning Programs		**Medium**	Applies to "reactor facilities" which includes NPP and small reactor facilities. Allows for graded application of requirements based on risk-informed manner. Section 8.2 discussions staff training requirements with reference to RD-204 and suggested topic areas. Certain topic areas may not be applicable to some SMR designs. See RD-204 specific comments in this document. Section 10.1 allows alternate means of demonstrating compliance when it is deemed impractical to fully test the functionality of a SSC important to safety. However, if this is done via analysis then Section 10.3 stipulates that CSA N286.7 <u>shall</u> apply. Many SMR designs will not be based on the CANDU industry toolset for analysis. Section 11 is written primarily for large water cooled reactors and therefore applicability to SMR may be limited. Phase A indicates testing to be completed prior to fuel load. Some SMR designs may come from factory pre-loaded therefore site specific testing for Phase A not possible. Appendices A-D written primarily for large water-cooled (many CANDU specific) applications. Unique designs of SMR and possible off-grid applications would require graded approach/relaxation of some testing criteria as they would not be applicable.						Applicants can propose alternatives to show that SSCs are ready to support fuel load … It has to be demonstrated that SSCs will perform their intended function The appendices state "The following tests, as applicable to the facility, should …" the appendices are recommendations and are provided for illustrative purposes

Appendix C: Potential List of Codes and Standards for Impact Screening for NRCan SMR Roadmap

No.	Document #	Document Title	Administered by + Identify List of Approvals Required	Priority	Identification of Regulatory Gap						Identify Multi-Organizational Complexities and Proposed Way Forward
				High Medium Low Screen Out	On-Grid Power Generation Application		On- and Off-Grid Combined Heat and Power Application (*for Natural Resource Extraction*)		Off-Grid Power and District Heating Application (*for northern and remote community, and Government Facilities*)		
					Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	
1	CSA N290.11	Requirements for heat sink removal capability during outage of nuclear power plants	CSA*								
2	CSA N286	Management Systems	CSA								
3	CSA N287.1	General requirements for concrete containment structures for CANDU nuclear power plants	CSA								
4	CSA N287.2	Material requirements for concrete containment structures for CANDU nuclear power plants	CSA								
5	CSA N287.3	Design requirements for concrete containment structures for CANDU nuclear power plants	CSA								
6	CSA N287.4	Construction, fabrication, and installation requirements for concrete containment structures for CANDU nuclear power plants	CSA								
7	CSA N287.5	Examination and testing requirements for concrete containment structures for CANDU nuclear power plants	CSA								
8	CSA N287.6	Re-operational proof and leakage rate testing requirements for concrete containment structures for	CSA								

		CANDU nuclear power plants										
9	CSA N289.2	Ground motion determination for seismic qualification of CANDU nuclear power plants	CSA									
10	CSA N289.3	Design procedures for seismic qualification of CANDU nuclear power plants	CSA									
11	CSA N289.4	Testing procedures for seismic qualification of CANDU nuclear power plants	CSA									
12	CSA N289.5	Seismic instrumentation requirements for CANDU nuclear power plants	CSA									
13	CSA N290.1	Requirements for the shutdown systems of nuclear power plants	CSA									
14	CSA N290.2	General requirements for emergency core cooling systems for nuclear power plants	CSA									
15	CSA N290.3	Requirements for containment system of nuclear power Plants	CSA									
16	CSA N290.4	Requirements for reactor controlsystems of nuclear power plants	CSA									
17	CSA N290.5	Requirements for electrical power and instrument air systems of CANDU nuclear power plants	CSA									
18	CSA N290.6	Requirements for monitoring and display of nuclear power plant safety functions in the event of an accident	CSA									
19	CSA N290.12	Human factors in design for nuclear power plants	CSA									
20	CSA N290.14	Qualification of pre-developed software	CSA									

21	CSA N290.16	BDBAs	CSA								
22	CSA N290.18	PSRs	CSA								
23	CSA N290.19	RIDM (Not issued yet)	CSA								
24	UFC 3-340-02	Structures to Resist the Effects of Accidental Explosions									
25	ASME B31.1	Power Piping	ASME								
26	ASME B31.3	Process Piping Code	ASME								
27	ASME B31.5	Refrigeration Piping and Heat Transfer Component Code	ASME								
28	ASME	Boiler and Pressure Vessel Code	ASME								
29	CSA B51	Boiler, Pressure Vessel and Piping	CSA								
30	NFPA 20	Standard for the Installation of Stationary Pumps for Fire Protection									
31	NFPA 24	Standard for the Installation of Private Fire Service Mains and Their Appurtenances									
32	CSA N285.6 Series	General requirements for pressure-retaining systems and components in CANDU nuclear power plants/material standards for reactor components for CANDU nuclear power plants	CSA								
33	CSA N285.8	Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors	CSA								
34	CSA N285.4	Periodic inspection of CANDU nuclear power plant components – 2014 edition	CSA								
35	CSA N292.2	Interim dry storage of irradiated fuel	CSA								
36		National Building Code of Canada (NBCC)									

* A list of CSA standard titles applicable to SMR is available through CSA SMR Task Force.

Appendix D: Other Relevant Documents for Review

No.	Document Type	Document Title	List of Approvals Required	Priority	Identification of Regulatory Gap						Identify Multi-Organizational Complexities and Proposed Way Forward
				High Medium Low Screen Out	On-Grid Power Generation Application		On- and Off-Grid Combined Heat and Power Application (*for Natural Resource Extraction*)		Off-Grid Power and District Heating Application (*for northern and remote community, and Government Facilities*)		
					Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	Technical Barrier	Economic Feasibility Challenge	
1	IAEA	• Nuclear Security Series No. 4, Technical Guidance: Engineering Safety Aspects of the Protection of Nuclear Power Plants Against Sabotage • Nuclear Security Series No. 13, Recommendations: Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5) • Nuclear Security Series No. 17, Technical Guidance: Computer Security at Nuclear Facilities • • IAEA – SSR-6 Regulations for the Safe Transport of Radioactive Materials		**Low**							
2	CNSC Outreach	• Nuclear Security Regulations – General workshop, with an SMR specific component on January 31, 2017 - Presentation ○ Stakeholder workshop report: Periodic Review of the *Nuclear Security Regulations* (Draft) - Link to HTML Report • *DIS-16-04, Small Modular Reactors: Regulatory Strategy, Approaches and Challenges* – Released for Comment November 14, 2016 ○ Consultation Page ○ What We Heard report – Released September 18, 2017 • Presentation by Doug Miller on the use of the graded approach in regulation – August 10, 2017 ○ Workshop report in progress		**High**							

		• Petroleum Technology Alliance of Canada – Alternative Energy Solution Conference - June 6, 2017 – Calgary, Alberta
		    ○ Presentations on the use of SMRs for oil sands process heat and energy
		• Presentation by President Michael Binder to Ontario Power Generation’s Board of Directors Generation Oversight Committee **– Nov 8, 2017**
		    ○ Topics included the Canadian Nuclear Safety Commission’s roles and responsibilities as regulator, and its work in the areas of emergency preparedness, small modular reactors, Indigenous engagement and public outreach
		• Event- Cameco Key Lake **-** Remarks by Jason Cameron to Canadian Nuclear Laboratories **– October 13, 2017**
		    ○ An overview of the CNSC’s work on the subject of small modular reactors
		• Presentation by Ramzi Jammal to the International Nuclear Regulators Association on Canada’s readiness to regulate small modular reactors **– Sept 19, 2017**
		    ○ The presentation describes the CNSC’s strategy for the regulation of small modular reactors in Canada
		• Presentation by Ramzi Jammal at the Nuclear Energy Agency Workshop: Multilateral Cooperation in the Regulatory Reviews of Small Modular Reactors **– August 18, 2017**
		    ○ The presentation focused on small modular reactor regulation in Canada
		Micro-reactors for the Arctic, 29-30 November 2016, Yellowknife (Presentation)									