CNSC CCSN
5095568

ADMIN 2016OCT04

September 28, 2016

Mr. B. Torrie
Director General, Regulatory Policy Directorate
Canadian Nuclear Safety Commission
P.O. Box 1046
280 Slater Street
Ottawa, Ontario
K1P 5S9

1.03.02

FILE DOSSIER	1-8-8-0
REFERRED TO REFÉRÉ À	Torrie, B.

Dear Mr. Torrie:

Canadian Nuclear Association Comments on DIS-16-04: Small Modular Reactors: Regulatory Strategy, Approaches and Challenges

The Canadian Nuclear Association (CNA) would like to thank the CNSC for the opportunity to comment on DIS-16-04: Small Modular Reactors: Regulatory Strategy, Approaches and Challenges. The CNA and its members believe that the DIS-16-04 provides a good starting point to licence new small modular reactors (SMRs). We do not see any insurmountable obstacles in the existing regulatory and licencing approach however there are a number of areas within the discussion paper that we believe require additional work. The CNA worked with its members to compile the attached list of comments outlining those areas. I would however like to highlight the following points:

- The CNA strongly encourages the CNSC to coordinate its SMR efforts with other government organizations to ensure no policy conflicts or contradictions. This is particularly important with regard to the Canadian Environmental Assessment Agency. For SMRs to be successful, it is essential that proponents not be forced to repeat the same process over and over for the same reactor design. The CNA recommends creating a class EA and adopting a similar approach in licensing for the same SMR design.

- The CNA recommends that the CNSC streamline its licencing process to recognize that unlike existing reactors, SMRs will largely be factory-manufactured, identical units. In our view, once a SMR design has been licenced, the process for subsequent, duplicate units should be shortened and simplified. If SMRs are to be viable, these smaller, modular designs will need to be manufactured, installed and operated in a standardized, reproducible manner. The CNA believes that the same principle should apply to how they are sited, licensed and regulated. For a site initially licensed with one or more identical modules, we suggest it should be relatively straightforward to add further modules at a later time using the original environmental assessment and licensing decision.

The future is NU. Le nucléaire, voie de l'avenir.

- The CNA also believes it is important to recognize that SMRs feature new designs that contain advanced safety features. Unlike existing reactors which are viewed in the context of thermal power, SMRs can feature a wide range of designs that vary significantly from current reactors and should not be considered in that context. They do however have some common features which set them apart from current designs including more passive safety designs, potential for small operating staff numbers and the potential to remove the entire reactor as a whole during decommissioning. The CNA and its members believe that the CNSC needs to take these factors into consideration when licensing SMRs

- The CNA and its members appreciate the approach the CNSC has taken to engage the industry in dialogue on the discussion paper and we encourage the CNSC to continue with this approach. The CNA and its members look forward to being engaged with the CNSC in further discussions as we move forward.

Once again, thank you for the opportunity to provide input into D!S-16-04. Please do not hesitate to contact me should you require more information.

Yours sincerely,

Steve Coupland
Director, Regulatory and Environmental Affairs
Canadian Nuclear Association

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	General Comment and Observation		
1.	An SMR in and of itself does not inherently pose any particular challenge to regulatory requirements in Canada. For example, an SMR which is just a smaller version of an existing water-cooled NPP, with all the safety characteristics of such Generation III reactors, should be able to be licensed using all existing CNSC regulatory documents and guides. The difference arises if an SMR uses novel technology to achieve greater inherent and/or passive safety than existing NPPs – the question then is how can the regulatory process be aligned to permit offsets in regulatory requirements for such aspects (i.e. a graded approach), while acknowledging the burden of proof on the proponent to establish the effectiveness of the novel technology. The Discussion Paper does not really deal with this aspect. While we do not believe that new regulations are needed, guidance on application of the graded approach (which is already acknowledged at a Policy1 level by the CNSC) could be useful. Note that part of the issue is the use of the term SMR, which can encompass a broad range of reactor technology, from conventional to highly innovative.		
	Section 2.2: Technical Information, Including Research and Development Activities used to Support a Safety Case The CNSC would like to know are requirements regarding the scope and adequacy of supporting information sufficiently clear. Of particular interest are whether existing R&D requirements are clear in key regulatory documents such as REGDOC-2.5.2, *Design of Reactor Facilities: Nuclear Power Plants*, RD-367, *Design of Small Reactor Facilities*, REGDOC-2.4.1, *Deterministic Safety Analysis*, and other documents related to facility		

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	lifecycle (e.g., REGDOC-2.6.3, *Fitness for Service: Aging Management*).		
2.	**Graded Approach to Licencing**: An important aspect of licensing SMRs in Canada is CNSC's Graded Approach, where the regulatory requirements are commensurate with the risks. Hence, it is important to articulate how Graded Approach is applied and how it can benefit very small modular reactors. • CNSC's Graded Approach is based partly on IAEA's Safety Requirements document NS-R-4 "Safety of Research Reactors". NS-R-4 seems to limit the applicability of the Graded approach to "several tens of megawatts" and excludes nuclear reactors used for the production of electricity. This is different than CNSC's definition of "Small Reactor Facilities" with power levels <200MWt and may produce electricity. What are, if any, the implications of the difference in the scopes on the application of the Graded Approach? • Is there any past experience where graded approach has been used and facilitated the licensing process?		
3.	**Applicable Standards**: CSA standards form a key part of the CNSC's regulatory framework. Unlike CNSC documents, which attempt technology neutrality, most CSA standards are very CANDU-Specific. For non-CANDU SMR technologies, these standards may have to be updated. The whitepaper should address this issue		
4.	For components of some innovative SMRs, existing Canadian		

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	industry codes and standards may not be applicable (e.g. CSA Standards), especially for non-water-cooled designs. If there are applicable international codes and standards, the vendor / licensee will need to make the case to use them, to the CNSC. However even international codes and standards may not be applicable, and development of an applicable Canadian Standard can take a very long time. It is important that the CNSC is willing and able to licence an SMR based on the case made by the applicant, in the absence of any existing and/or applicable (Canadian or international) standard.		
5.	**1. Design Codes**: What codes and standards can be used for non-water cooled systems? **2. Licensing of nth of a kind Reactors (Economy-of-scale in licensing cost)**: SMRs will be factory-manufactured to be economically competitive. After the licensing of the first unit, the identical units should be easier (cheaper) to licence. Addressing the licencing requirements for the repeat units would be a useful addition.		
6.	**Definitions (Section 1):** Although it is defined in some of the references, definitions of Class 1 and Class 2 facilities and material categories would be helpful in the discussion paper.		
7.	CNSC requirements appear to allow for flexibility in meeting safety objectives. This should be viewed positively but does have the potential for requiring additional interpretation of requirements.		

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	SMR viability will depend on the ability to produce a large number of identical reactor modules. In practical terms this will require that multiple countries accept an essentially identical design. This is particularly important for a country like Canada. To support SMR vendors interested in the Canadian market, CNSC should closely monitor the SMR licensing progress in countries such as the US and UK and clarify the applicability of CNSC requirements to SMRs in light of the licensing in other countries. The overall goal should be to provide guidance relative to which specific licensing approaches accepted in other countries will be most effectively considered in Canada.		
8.	What we are calling the 'principle of reproducibility' Is in short, that the secret of success for the majority of SMR business models is that they are produced, installed and operated in a standardized, reproducible manner. The same notion needs to apply to how SMRs are sited, licensed and regulated. This could mean, in effect, that if one SMR facility is licensed under a given set of boundary conditions, it can be licensed elsewhere (perhaps simultaneously) provided it can be demonstrated that the boundary conditions are the same. Barring unique local environmental conditions the approach should be to license a fleet. This general principle is our input for sections 2.3, 2.5, and 2.6.1.		The current CNSC process requires that the licensee take a financial risk on nth of a kind plants The industry and the licensees are taking a financial risk in licensing nth of a kind plants and the CNSC needs to take steps to help the licensee manage this risk including the risk involved in licensing nth of a kind reactors .This includes also reduction in the risk of having to complete environment assessments for nth of a kind reactors using the same process used for the first of a kind reactor.

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
9.	The CNSC expectations for the scope and adequacy of supporting information for a safety case require integrating the expectations in REGDOC-2.5.2 Section 5.4 or RD-357 Section 6.4, REGDOC-2.4.1 Section 4.4.3, and REGDOC-2.6.3 Section 3.1. In particular, REGDOC-2.5.2 Section 5.4 and RD-357 Section 6.4 both state: *"When a new SSC design, feature or engineering practice is introduced, adequate safety shall be demonstrated by a combination of supporting research and development programs and by examination of relevant experience from similar applications."* The expectation that a new SSC design, feature or engineering practice requires a combination of supporting research and development and examination of relevant experience from similar applications needs some clarification. The CNSC expectations should be made clearer regarding the expectations for the quality of operational historical recorded data from previously operated plants of similar design that could be used on a case-by-case basis to justify not needing some new supporting research and development programs. For example, to support the design of SSCs for new SMRs that are based on previously operated plants of similar design, the operational data could include:	**MAJOR**	If the CNSC expectation is that new supporting research and development programs are always required for the safety cases for SMR designs, this expectation could become a significant barrier for SMR designers.

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	• Data from the operation and maintenance of components and systems in previous plants of similar design, including the effects of aging and wear of SSCs, and the effectiveness of aging management experience, and failure rates for components, • Data on the performance of components and systems in plants of similar design during tests under transient conditions and postulated initiating event conditions, and • Evaluations of the effects and interactions between mechanical, thermal, chemical, electrical, physical, biological and radiation stressors on materials properties, materials aging and degradation processes.		
10.	With respect to application of the requirements in REGDOC-2.5.2 and RD-367 to non-water-cooled reactors, the CNSC should ensure that there is flexibility in interpretation of the existing REGDOCs. The work done by the US NRC for their Draft Advanced Reactor Criteria Table and the work being done by the Generation IV Forum on safety design criteria are sources of information for developing the CNSC guidance.	**MAJOR**	Gas-cooled, sodium-cooled, lead-cooled and molten salt SMRs need safety design requirements that are not the same as those for water-cooled reactors. While the SMRs designers are developing their own criteria, guidance is needed from the CNSC on the CNSC's expectations.
	Section 2.3: Licensing Process for Multiple Module Facilities on a Single Site The CNSC would like comments on: • Whether or not clarifications are needed to REGDOC-3.5.1, *Licensing Process for Class I Nuclear Facilities and Uranium Mines and Mills*? • In order to be better prepared for the use of replaceable reactor core modules or relocatable facilities, the CNSC is seeking information on facility deployment strategies being considered by developers, including impacts of such an approach on areas such as worker and public safety, environmental assessment and decommissioning.		

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	• The CNSC will use this information for future more-detailed workshops to discuss regulatory implication of different deployment approaches.		
11.	**Non-Permanent SMRs** – Special consideration needed for non-permanent sites (VSMR that are small enough to fit onto one or a few trucks and moved to where the power is required. i.e. to provide steam for the oil sands)		
12.	Licensing multiple reactor units on a single site is not new and has been done in Canada and internationally. Canadian examples are Pickering A (4 units), Pickering B (4 units), Bruce A (4 units), Bruce B (4 units) and Darlington (4 units). In each of these examples, the licenses were granted for each group of four units at a time. For the Pickering and Bruce sites, the entire licensing process from environmental assessment and license to prepare site to operating license was executed for the A reactor units and subsequently for the B reactor units. Note that the installation of the multiple reactor units all occurred during the respective construction licenses. Furthermore, the original construction licensing of the Pickering A and B units and of the Bruce A and B units could be viewed as a large scale version of deployment of multiple reactors on a site. The licensing process considered each 4 unit facility at a time. However, the concepts for deploying multiple modules for SMRs on a single site will need to be considered with a different approach than has been used in the past, because the installation of multiple reactor core modules could occur during the	**MAJOR**	A regulatory approach for controlling changes to an SMR facility under an operating license is needed to enable a licensee to deploy additional or replacement reactor core modules. This regulatory approach should strive to minimize the administrative burden.

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	operating license period with the first units in full operation for some time before deploying addition units. Hence, the deployment of multiple SMR modules may not occur in the same way as the deployment of the multi-unit CANDU station, which all occurred during the construction license. An approach could be considered where the environmental assessment accounts for all expected SMR modules, and provisions made in the licenses to facilitate addition of SMR modules at later dates. REGDOC-3.5.1 should be revised to include guidance to license applicants for deploying multiple reactor core modules in multiple deployment phases and on replacing a reactor core module under the operating license. However, this approach to licensing the SMR reactor module would not alleviate the requirement to address the safety concerns associated with common cause failures that affect all SMR modules simultaneously.		
13.	When the SMR module design and manufacture are taking place in one or multiple jurisdictions, and the target market is multinational, it would be desirable to establish a licensing basis that allows the SMR module to be more readily accepted by regulatory jurisdictions in Canada and internationally. This would	**MAJOR**	Establishing a regulatory approach that increases the harmonization of regulatory requirements between Canada and international jurisdictions would implement a common-sense regulatory approach that meets the expectations in the Government of Canada's Red Tape Reduction Action Plan.

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	enable the regulators in each country to decide on whether the modules can be used with or without additional review. There is a precedent for this approach. The Packaging and Transport of Nuclear Substances Regulations under the Nuclear Safety and Control Act incorporates the requirements of the Regulations for the Safe Transport of Radioactive Material, published by the IAEA, as amended from time to time. CNSC regulatory document RD-364, Joint Canada-United States Guide for Approval of Type B (U) and Fissile Material Transportation Packages, provides the example on regulatory guidance to enable license applicants to prepare that thoroughly and completely demonstrate the ability of the given package to meet either Canadian or U.S. regulations, as applicable. While licensing the complete SMR facility is unlikely to be amenable to this type of licensing approach, the fuel and reactor core modules should be amenable to this type of licensing approach.		This suggested regulatory approach would continue to enable the CNSC to perform all license applications for SMR facilities, and would provide a more efficient regulatory approach for regulatory review of replacement modules or additional modules after the initial construction of the SMR facility.
14.	RegDoc 3.5.1 allows under Section 6. Licensing Process for Class I Nuclear Facilities, to apply for "*A single licence may also be issued for multiple facilities, each at a different stage in their lifecycle*".	**MAJOR**	Under this process, is there a potential impact on streamlining the regulatory process and its <u>timelines</u>? As per Appendix B.1 Class IA nuclear facilities (reactor facilities) the licensing timeframe is typically 9 years – could that be shortened for individual SMR modules or sites under a single licence, or does CNSC expect that each installation would take a 9 year licensing

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
			process?
15.	Replacement of core modules should not be seen as an issue in the context of multi-module facilities. It is a technical issue and, depending on the choice of SMR technology, an aspect related to transportation and packaging, safeguards, security, waste management, but not a particular multi module facility issue. Some of the related regulations (e.g., transport) probably need to be augmented to address fueled modules.	**MAJOR**	Review and, if needed, revise the packaging and transport Regulations to specifically allow for this.
16.	Relocation of transportable reactors between sites is not clearly addressed by existing Canadian Regulations	**MAJOR**	Review for how best to incorporate requirements in the regulatory framework
	Section 2.4: Licensing Approach for a New Demonstration Reactor The CNSC would like comments on: • Whether or not additional clarification or information beyond that found in RD/GD-369, *Licence Application Guide: Licence to Construct a Nuclear Power Plant*? If yes, what needs to be clarified or added? • With respect to addressing uncertainties introduced by the application of integrated multiple novel features in a demonstration facility, are requirements regarding the scope and adequacy of supporting information sufficiently clear? • What, if any, requirements need to be revisited to address activities involving demonstration reactors? For example, are additional requirements or guidance needed to address operational restrictions if the facility is being used to gather operating experience that would be normally be needed for commercial facility licences?		
17.	Vendors/proponents may want to employ a range of R&D options, e.g., facilities (demonstration or prototype), experimental rigs, test assemblies, etc., in support of the safety case. These could make use of radioactive sources and/or be subcritical facilities, etc. Currently, there seems to be no clear	**MAJOR**	Owners / investors / operators need to know if proposed demonstration and/or prototype facilities would take same time to licence and need to know upfront what are the applicable regulations, requirements, and CNSC expectations for such facilities.

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	guidance or mapping of the licensing framework, regulations and requirements that are expected to apply for such options.		Would all such options be considered Class 1A, or would a graded approach apply to test facilities which are sufficiently small scale demonstration reactors? Otherwise, regulatory burden may be excessive for the risk.
18.	We do not believe that any special licensing approach needs to be put in place for a Demonstration Reactor – many of these will become commercial plants in any case, after an initial period of operation. The licensing case for any reactor has to demonstrate that the plant is safe to operate. Given that each SMR design will be different, it is unlikely that general requirements can be written on "the scope and adequacy of supporting information" beyond those that exist for current NPPs. CNSC has had considerable experience licensing first-of-a-kind designs, such as research reactors. Some SMRs will use the commissioning phase of the first commercial plant to confirm behavior that can only be done on a real reactor, given that building a prototype or test reactor may not be feasible. Effectively the R&D program for each design may extend into the commissioning phase of the first commercial plant. This first plant will have a longer and more extensive commissioning phase, likely more instrumented than subsequent		

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	plants or cores, to validate integral behavior. CNSC may wish to place more hold points in the Commissioning program to make sure results are as expected. As discussed earlier, it would be useful for the licensee to propose acceptance criteria in advance for such commissioning tests. Exceptionally, novel commissioning tests might require CNSC approval in advance on an individual basis. However none of these activities in our view require further regulations.		
19.	RD/GD-369 allows utilization of licensing bases documents and guidance not normally used in Canada with an appropriate assessment such as a gap analysis. Because SMRs are expected to be international designs applicable to multiple countries, implementation of this process is critical.		The gap analysis would typically be the responsibility of the applicant.
20.	With respect to addressing uncertainties introduced by the application of integrated multiple novel features in a demonstration facility, the requirements regarding the scope and adequacy of supporting information are not sufficiently clear. A demonstration reactor facility can be considered as a full-scale, fully integrated demonstration of the collection of novel features. A purpose for the demonstration reactor facility would be to obtain operating experience on the integrated performance of the novel features. With this idea in mind, the degree of confidence in the design of the demonstration reactor facility would be less than that for a replication of the production version of the reactor facility. In light of the greater degree of	**MAJOR**	By its very nature, a demonstration reactor is expected that the degree of confidence in the performance of the integrated novel features in the demonstration reactor facility would be less than that for a replication of the production version of the reactor facility. The licence application process can be improved by providing guidance on the CNSC's expectations for risk control measures that the licence applicant should consider including in the operation of a demonstration SMR.

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	uncertainty, RD/GD-369 should provide guidance regarding the CNSC's expectations for the adequacy and quality of the supporting research and development information that would be acceptable for a demonstration reactor facility. Guidance is also needed on how best to meet the CNSC expectations in the application of a risk-informed approach for new demonstration reactors for each of the safety and control areas. The discussion paper does not mention the use of any risk-informed decision making process and benefit-cost analysis process. The CNSC expectations for a risk-informed decision making process and a benefit-cost analysis process is needed as guidance for the licence applicants of new demonstration SMRs since not only novel features may be used in the design, but novel approaches may be used to justify the minimum staff complement and operational programs for each safety and control area.		
21.	With the expectation that the supporting operational experience for a demonstration SMR is less than what is expected for a production SMR, the additional activities to acquire the operating experience from the demonstration SMR should be discussed with the CNSC.	**MAJOR**	The licence application process can be improved by providing guidance on the CNSC's expectations for risk control measures that the licence applicant should consider including in the operation of a demonstration SMR.
22.	With respect to operational restrictions for demonstration SMRs while accumulating operational experience, the CNSC should make available information on the typical types of licence	**MAJOR**	Providing guidance on the licence conditions and the expectations for verification criteria will help licence applicants to a priori develop their programs for each safety and control

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	conditions that may be used while accumulating the operational experience.		area.
23.	The existing CNSC document, RD/GD-98, is defines requirements for identifying systems important to safety for the licensee's reliability program. The guidance in RD/GD-98 recommends making use of the PSA for a nuclear power plant as a systematic method for identifying the systems important to safety.	**MAJOR**	Consider whether further guidance is needed in RD/GD-98 for SMR designs.
	Section 2.5: Licensing Process and Environmental Assessments for Fleets of SMRs The CNSC would like comments on: • How do you envision proposals for such fleets across large geographical territories proceeding through licensing and environmental assessments? • How would the principles discussed in REGDOC-3.5.1, *Licensing Process for Class I Nuclear Facilities and Uranium Mines and Mills* be applied and where might challenges exist?		
24.	Many characteristics of SMRs designs (some mentioned in the Introduction section of DIS-16-04) make the SMRs suitable to expect a graded approach in regulatory requirements application. However, there are two issues to note: i) First, it is not known how the "*graded approach*" concept will be concretely applied by the CNSC staff in their review, as the concept is subjective and open to interpretation. ii) Second, although noting the willingness of CNSC to apply risk informed and "*graded approach*" application of regulatory requirements, there is no clear acknowledgement that the	**MAJOR**	Industry (owners / licensees) may be less interested in SMRs if licensing timelines are same (long durations) as for classic Candu/PWR/BWR reactors. The CNSC should review the licensing timelines (and potentially adjust some processes) that are published in REGDOC-3.5.1, taking into account the features of SMRs. Could the License Conditions Handbook process (14 SCA) be used to manage EA for a fleet of SMRs?

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	licensing timeline for Class 1A nuclear facilities can be reduced below the 9 years' duration as provided by RegDoc 3.5.1. There is thus no indication what that duration may be for SMRs (and other facilities, including prototypes and demonstration) that would make significant use of the risk-informed and "*graded approach*" concepts. This is a significant item of interest for stakeholders such as vendors, applicants, owners/investors and warrants addressing.		
25.	Allowing a single license on multiple sites, especially for the same or similar SMR designs and for same licensee should be encouraged and streamlined. It may be the case that the only differences could be in EA factors if sites are significantly different. The regulatory process to allow single license but different EAs (if significantly different site characteristics) should certainly be a focus point for the CNSC.	**MAJOR**	Having a single license for multiple sites, and taking credit for regulatory reviews (including EA) of other licensees' same/similar SMRs facilities, would be expected to result in streamlined and shorter licensing timelines.
26.	An alternative approach to licensing for deploying SMRs across large geographical territories would be to consider using the first SMR site as the lead plant for the construction and operating licence, and basing the licensing for subsequent deployment of SMRs on the licensing approvals granted for the first facility.	**MAJOR**	A licensing approach to license a generic design would help to reduce the commercial risks on costs and timescales for a fleet of one SMR design across large geographical territories.
27.	Most of the technical information for the environmental assessment can be provided in a generic environmental impact statement with a Plant Parameter Envelope that effectively brackets the range of variables to be assessed. This generic environmental impact statement would then need to be assessed	**MAJOR**	A regulatory approach to completing environmental assessments where generic Plant Parameter Envelopes are used would help to reduce the commercial risks on costs and timescales for a fleet of one SMR design across large geographical territories.

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	against the site specific conditions to confirm that the Plant Parameter Envelope does bracket the site specific conditions. This approach could reduce the cost and timescales for completing site specific environmental assessments.		
	Section 2.6: Management System Considerations: Licensees of Activities Involving SMRs The CNSC would like comments on: • Preparing for alternative ownership and operating models that would be used in SMR deployment, more details (such as case studies) are sought including. • How deployment of different SMR concepts (e.g., factory fueled transportable concepts)would proceed • How oversight for such deployments would be conducted • How issues such as licensee performs inspections of key components (e.g., a reactor module)when received from a vendor • How alternative ownership models will address requirements in CSA Group's standardN286-12, *Management system requirements for nuclear* facilities and in CNSC regulatory requirements		
28.	**Sealed Cores:** Sealed cores/modules pose a number of license and operational issues. A licensee would be responsible for the condition of a module received (and that it is not damaged during transportation). One of many options might be to have the core sealed at the factory for transportation and non-proliferation purposes, and then, can be unsealed at the site under observation (by the regulator and/or the IAEA) for inspection and acceptance and sealed again for operation. While *pre-service* inspection may benefit from access to subsequently sealed components, a *baseline* inspection, conducted with the same access limitations as periodic or in-		

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	service inspections is still needed as reference for aging management programs.		
29.	Regarding procurement of sealed cores SMR modules, such long lead items (including integral vessel designs) could be designed and manufactured outside Canada under different nuclear jurisdiction requirements, codes and standards, before a decision to site and operate them in Canada. It is not clear in regulatory framework how management system requirements will be used for such designs.		
	Section 2.6.1: Management System: Minimum Complement in SMR Facilities The CNSC would like to know are the regulatory requirements and guidance related to minimum complement sufficient and clear as applied to activities involving SMRs? What, if any, proposed changes should be considered for the existing regulatory requirements? For example, in conjunction with the question in section 2.12, is additional guidance needed to address human coverage for failure of automated systems?		
30.	**Minimum On-Site Staffing Level**: As the CNSC develops changes to G-323 , they may want to consider innovative approaches to defining minimum shift complement that takes into account new designs and technology		
31.	The requirements for minimum complement should not be solely related to the use of automation for plant operation and maintenance, but also to the level of safety conferred by the use of inherent and passive safety features in the design.	*Clarification*	
32.	Security may require a significantly different staffing approach from existing large units. A traditional size of security staff might pose a significant burden on small plants. The inherent SMR design could result in a reduced need for security staff. This may		

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	require a review and revision of the nuclear security regulations.		
	Section 2.7: Safeguards Implementation and Verification The CNSC would like to hear if its current framework provides enough clarity to effectively ensure safeguards verification of novel fuels and new designs.		
33.	In general the safeguards arrangements, as they are defined by the IAEA with the CNSC's additional requirements of RD-336, should be accepted as they are. However, some designs remove/replace/transport the entire core, which will no doubt require special techniques to verify fuel being added and removed from the core off-site (and possibly outside of Canada). There may be some technical challenges with safeguards for SMRs, as outlined in the regulations and licences e.g. remote location with limited access of IAEA inspectors, long-life sealed core, high initial excess reactivity, etc. Some of these challenges are also potential benefits; i.e., a remote location makes it more difficult for diversion; the same is true of a sealed long-life core.	*Clarification*	
34.	The current framework for safeguards, as described in RD-336 and GD-336 relies on an item (e.g., individual fuel assembly) and inventory accounting approach for maintaining Continuity of Knowledge of containment and surveillance (C/S) data of the nuclear fuel throughout the operational life of the reactor. Water cooled reactors have been amenable for using item and inventory accountancy and periodic independent verification of the accountancy and C/S data by visually inspections and scanning of	**MAJOR**	Since the license applicant is required to demonstrate that the facility design meets Canada's international obligations for nuclear non-proliferation, it is unclear how a safeguards program can be developed by the license applicant for non-water cooled SMRs. It is also unclear what features the SMR designers need to include in their designs to facilitate the implementation of safeguards.

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	the fuel assemblies. • However, the nuclear material accountancy requirements in RD-336 and GD-336 may not be appropriate for many SMRs that are not water-cooled reactors. Further discussions will be needed to agree on appropriate approaches to fulfilling Canada's international obligations for nuclear non-proliferation for each type of SMR.		
	Section 2.8: Deterministic/Probabilistic Safety Analyses The CNSC would like to know are the regulatory requirements and guidance clear for the kinds of alternatives that might be proposed for Deterministic/probabilistic safety analyses for SMR facilities. Do the existing requirements permit the establishment of a suitable level of probabilistic safety analysis for different novel designs? Does enough information currently exist to apply probabilistic safety analysis to novel designs?		
35.	The regulatory framework for SMRs has to take into account designs that include (extensive) use of passive features that render some or most of the traditional PIEs and scenarios to have no effect on core damage or on releases of radioactive materials in the environment. Traditional PSAs may be difficult to be employed, and alternate techniques should be recognized as applicable or acceptable for safety cases.	**MAJOR**	Use of alternate (simpler) methods in lieu of traditional PSAs should be acknowledged by and be acceptable to the CNSC.
36.	Approaches to and requirements for probabilistic safety analysis continue to be in a state of development for both large reactors and SMRs. To avoid overly detailed and expensive PSA efforts, the scope should be limited to feasible events. The SMR passive		

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	designs will typically eliminate many of the accident scenarios used in the past. Level 1 and Level 2 PSA should be adequate to indicate level of safety.		
	Section 2.9: Defense In-Depth and Mitigation of Accidents The CNSC would like comments on: • Given some of the novel safety approaches that vendors are proposing are the existing requirements and guidance around defence in depth adequately clear for prevention and mitigation of accidents? • Consider this question with particular attention to the following topics and combinations thereof: • Application of inherent and/or passive safety features • Application of alternative instrumentation and control strategies (e.g., remote monitoring and intervention of a fully-automated facility) • Non-water cooled technologies • Transportable sealed and factory fuelled SMRs (see section 2.11) • Facilities proposed to be located in highly remote regions		
37.	The five levels of defence in depth have obvious relevance to traditional water-cooled reactors. It must be recognized that this is at least partly because the entire notion of "defence in depth" itself has evolved with experience from operating LWRs and HWRs. The basic principles of these reactors have not substantially changed since their genesis in the first decades of nuclear technology, but just as the technology has become more mature and refined, so have the safety and regulatory concepts. When taking in to account the novel and passive safety features in the proposed SMR designs, however, the distinction between some of the levels of defence in depth becomes unclear. The description of a "beyond design basis" accident, necessary to		

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	distinguish between levels three and four, is replete with examples of containment challenges in water-cooled reactors. This reflects how experience with water-cooled reactors has shaped the regulatory framework. When bringing novel technologies up for licensing, a vendor then has to consider: • What inherent or passive features of the design should be credited in the analysis of a design basis accident (level three)? Should some be withheld so that they can be applied beyond design basis (level four)? • If the design basis covers a significant range of events up to and including those which would be considered beyond design basis in contemporary water-cooled reactors, does that mean that extremely extraordinary events need to be considered to fulfill the requirements for defense in depth?		
38.	The innovative safety features of SMRs (passive/inherent safety characteristics that will account for the safety benefits) can constitute the basis for a change in traditional safety design practices. This may lead to a change in the relative importance of the 5 different levels of defence in depth.	*Clarification*	Existing framework used for evaluating defense-in-depth for conventional NPP should be adapted for SMRs. Oversimplifying a bit, advanced SMRs typically put much more emphasis on Levels 1 and 2 of defence-in-depth in the design than do conventional power reactors, and require less on Levels 3, 4 and 5. For example, if a large Reactor Coolant System (RCS) pipe break is not possible because of the absence of large RCS pipes, and if spontaneous pressure-vessel failure (e.g. at a nozzle) is practically eliminated, and if there are no accident scenarios such

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
			as un-terminated loss of reactivity control or loss of heat sink which would induce vessel failure, then the Emergency Core Cooling system and the containment need not be designed for LBLOCA – i.e. Level 3 defence-in-depth is less important for LBLOCA.
39.	The general approach of defense in depth is applicable to SMRs. The difference will be in the array of events that must be defended against. It is expected that this scope will be reduced by the inherent design features. This will require a review to determine which events are addressed with Level 1 and Level 2 defenses without adding mitigation features.		
40.	The implementation of practical elimination should be further clarified in discussions between the nuclear industry and the CNSC. The nuclear industry and the CNSC should achieve mutual understanding of the expectations for the degree of substantiation and degree of confidence when implementing practical elimination. It is recognized that probabilistic estimates of accident sequences for SMRs may have larger uncertainties, and alternative methods for risk assessment may be used. Hence, practical elimination of an accident sequence should include consideration of features in SMR designs such as multiple layers of protection, enhanced safety margins, and passive safety features.	**MAJOR**	Since SMR designs are relying on being able to make safety cases for greater safety by the use of passive safety features and novel design features, clarity on the extent of demonstration of these features is needed.

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	Section 2.10: Emergency Planning Zones The CNSC would like to know are the requirements and guidance related to EPZs sufficiently clear to enable an organization to submit a license application for a facility-specific EPZ while still meeting the CNSC's expectations regarding the environment and worker health and safety. Are there specific considerations that need to be incorporated into requirements and guidance for specific siting cases like remote regions?		
41.	We believe the CNSC discussion paper covers the issue well, namely that there is already sufficient flexibility in the requirements for emergency planning zones so that no further regulatory guidance is needed. Again we expect the case for a smaller EPZ to be based not only on projected releases in accidents, but also in the confidence that the calculated releases are bounding, such confidence being related to the degree of passive/inherent safety of the plant. Remote regions represent a special case of the above, in that short-term off-site emergency measures are difficult to implement, making it even more imperative that they are not needed (unless they can be done in a timely and reliable fashion by local personnel such as police).		
	Section 2.11: Transportable Reactor Concepts The CNSC is seeking information about deployment scenarios for further discussion. Examples of questions to inform future discussions include: • How might deployment of such concepts proceed? (The CNSC seeks examples such as case studies.) • What nature of activities will occur at the factory or service facility versus the site and how will those activities interface with one another from a management-system perspective? • What would environmental impact statements look like? • What would the relationship between the manufacturing facility, the facility fuelling the reactor modules, the carrier transporting the modules and the site operator entail?		

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	• How would post-shipment inspections be conducted and addressed by the licensee of the deployment site facility? • How would these scenarios be impacted if major components or modules were imported or exported? • How would transport be conducted such that transport requirements would be met throughout the deployment journey? • What is the strategy for performing safety analysis for all deployment activities? • How would these scenarios be impacted if major components or modules were imported or exported? • How would transport be conducted such that transport requirements would be met throughout the deployment journey? • What is the strategy for performing safety analysis for all deployment activities?		
42.	While Canada has Certified Packages for used nuclear fuel, the packages for new and used reactor cores could possibly be developed by the vendor, approved in a foreign country, and then certified in Canada. A cursory review of the PTNSR Regs does not indicate any show-stoppers for SMRs however this needs to be confirmed. However, for the area of nuclear materials transportation, an import/export licence can complicate the whole process. Since the used and new cores both contain fissile material, prevention of both tampering / diversion during transit and criticality will be areas of detailed review.	**MAJOR**	
43.	With respect to the relationship between the manufacturing facilities, the facility fuelling the reactor modules, the transport of the modules and installation at the site, this type of approach will need to consider a safeguards verification approach that starts at the manufacturing facility and maintains a continuity of knowledge through the installation at the site. For SMR designs where conventional safeguards verification methods for water-cooled reactors cannot be used, alternative safeguards	**MAJOR**	The safeguards verification methods for MSRs could impose new requirements on the design, manufacturing, transport and installation of SMR modules. The SMR designers need guidance.

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	verification methods will need to be developed.		
	Section 2.12: Increased use of Automation for Plant Operation and Maintenance The CNSC would like to know is additional clarity needed in existing requirements and guidance related to the implementation of automation strategies for SMRs. Specific to autonomous operation with remote monitoring and intervention, what safety and control measures could be taken to help prevent/mitigate communication loss between the SMR and the monitoring facility?		
44.	One aspect that may deserve attention is the increased automation of maintenance through computerized aids (e.g. virtualization). Generally this should increase the reliability, efficiency, safety and effectiveness of maintenance. However it also introduces the possibility of errors in the maintenance software or underlying data, and the effect thereof on plant safety. This needs to be considered in the plant safety case, and perhaps follow similar graded qualification and development approaches as used for computerized control and monitoring equipment for the plant systems as covered by CSA-N290.14. With respect to autonomous operation, it may be useful to first develop for example CSA standards on reliability and performance requirements of remote control/monitoring, as a precursor to regulatory prescription. The design would have to cater to a long operator response time (possibly through inherently safe design features) and also to the fact that the communication link extends outside the plant boundary and hence is subject to additional hazards and reduced reliability. Dedicated communication links may be an option to improve reliability and additional measures may be necessary to address		

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	cyber security. There may also be lessons learned from satellite control. We have already noted that there would need to be a safe "fallback" of plant behavior in case remote communication / monitoring all fail, giving enough time to allow an operator`s return to the site for corrective actions using the local facilities.		
	Section 2.13: Human/Machine Interfaces in Facility Operation The CNSC would like to know is additional clarity needed in existing requirements and guidance for HMIs used for facility operation and maintenance. If so, what areas could benefit from additional clarity?		
45.	We agree that the existing requirements cover most of the design aspects required to design Human/Machine Interfaces (HMIs) capable to support oversight and control of SMRs. One prospective area that could benefit from additional clarity would be guidance for HMI technology selection. This is area is not specific for SMRs but for new NPPs in general. The regulatory guidance should encourage approaches that permit the selection of the best available technologies that can be qualified for system operation and maintenance. Human performance and operational safety and effectiveness should be major deciding factors in choosing technologies. Designers need to consider various trade-offs associated with alternative perceptual and interaction modalities such as touch, voice, and gesture interaction. Technology selection will require accounting for mental and physical demands (by the characteristics of the device, physical workspace, and collaboration among personnel). This in turn means that there is a need for guidance for levels of		

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	automation, computational intelligence, operator support systems, and other methods of reducing complexity, to optimize human automation interaction (building further to our response to question in Section 2.12 regarding autonomous operation). New HMI technologies such as tablets or handheld devices, large and high-resolution displays, wearable devices, and augmented reality systems have been introduced into other industries and can be expected to become predominant options for the nuclear industry, particularly for new builds. Most new reactor designs will employ first of a kind (FOAK) technology in this industry (i.e. having not been used in the older generation of NPPs). FOAK designs need to define new models of human automation collaboration, the need for integrated system validation, and new concepts of operation. This can be achieved through use of simulation, test beds, and prototypes, for example, as methods to provide proof-of-concept evidence of the appropriate use of new HMIs prior to acceptance. Through following verification and validation activities in the existing guidance (e.g. G-278), these new designs should fit the existing requirements and guidance for HMIs used for facility operation and maintenance. Furthermore, CSA N290.12-14, "Human factors in design for nuclear power plants", addresses the challenge of integration by the requirement, "HSIs [Human System Interfaces] and functionality shall be treated not only as an assembly of discrete controls, indicators, systems or SSCs, but also as an integrated		

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	whole".		
	Section 2.14: The impact of New Technologies on Human Performance The CNSC would like to know is additional clarity needed in existing requirements and guidance for human performance in an SMR environment.		
46.	The existing human performance requirements and guidance are sufficiently clear with respect to new technologies. Perhaps greater emphasis should be placed on system knowledge in the personnel training requirements documents, due to the potential increase in system complexity that may accompany the introduction of new technologies. Essentially advanced technology may reduce the workload of personnel but knowledge of how the system works is required to properly respond in the event of malfunction.		
47.	With more passive design features likely to be included in SMR designs, it is expected the focus of HF will shift even more onto the design aspects and phases of the SMRs. CNSC regulatory documents should be reviewed to ensure that they are not too closely structured to older (and especially CANDU) designs, and that they allow for flexibility in approach (e.g. to more passive safety features).	*Clarification*	
	Section 2.15: Financial Guarantees for Operational Continuity The CNSC would like to know is additional clarity needed in existing requirements and guidance related to the implementation of financial guarantees for operational continuity to ensure safe termination of licensed activities? Are there other financial instruments not listed in G-206 that would be useful in helping put financial guarantees in place?		
48.	In fact, Financial Guarantees are now required for all licenses in Canada, to our knowledge, not just for major nuclear facilities,	**MAJOR**	It would be useful to know which financial guarantee regime would apply for small prototype facilities – similar to that for

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	mines and mills.		existing nuclear reactors, or more aligned to those for licensees of sources and labs.
49.	REGDOC-3.5.1 section 2.1 states that applicants must be aware of and comply with the Nuclear Liability and Compensation Act (formerly the Nuclear Liability Act). The discussion paper does not mention the financial requirements in the Nuclear Liability and Compensation Act. Since the CNSC has acted in an advisory role to the Minister of Natural Resources on the designation of non-power reactor facilities under the Regulations, the CNSC should provide information how they will advise the Minister of Natural Resources on the need for a Regulation that is applied to SMRs to account for the range of nuclear liabilities associated with increasing the number of SMR modules deployed at a site.	**MAJOR**	The owner and operator would need to know the financial commitments for nuclear liability insurance before making the decision to build an SMR facility. These financial commitments would affect the operating costs for the SMR facility.
	Section 2.16: Site Security Provisions The CNSC would like to know: • What regulatory issues may present challenges to deployment scenarios for SMR facilities? • How could subsurface or civil structures be implemented as part of the security by design approach? • How might security provisions differ for SMRs with a very limited onsite staff and located in a remote region? • How would possibly lengthy offsite response times be addressed? • How would security provisions be addressed for offsite monitoring/control of facilities if used?		
50.	SMRs will require a completely fresh look at site security because the credible threats will potentially be completely different. If nuclear material is not stored on site other than in the reactor that significantly reduces the vulnerability. Use of passive systems may eliminate most of the systems vulnerable to sabotage. While		

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	the regulatory framework may be applicable, the operating plant experience may not be applicable.		
	Section 2.17: Waste Management and Decommissioning The CNSC would like to know • What are some of the key strategies for waste management, spent fuel management and decommissioning that the CNSC and licensees need to consider for various SMR deployment scenarios? • For example, for companies considering a fleet of SMRs across a wide geographical area, how would waste and decommissioning be addressed? • In implementing these strategies, where are the challenges that exist in interpretation of current requirements and guidance?		
51.	SMRs with factory fueled cores within a lower range of operating life (e.g., 5-10 years) need to address storing of the used cores, as the size and/or layout of the sites may not allow storage of too many of the cores (assuming they are not exported back to the country of origin).. CNSC regulatory framework will need to be flexible enough to adapt to various scenarios, not just on-site dry storage.	*Clarification*	
52.	REGDOC-3.5.1 section 2.1 states that applicants must be aware of and comply with the Nuclear Waste Act. The discussion paper does not mention the financial requirements in the Nuclear Fuel Waste Act The current Nuclear Fuel Waste Act would need to be revised if the operator of an SMR does not meet the definition of a nuclear energy corporation in article 2 of the Nuclear Fuel Waste Act. Furthermore, articles 10(1) and 10(2) would need to be revised to having a funding formula to account for increasing the amount of nuclear fuel waste as a function of the number of	**MAJOR**	The owner and operator would need to know the financial commitments for nuclear fuel waste before making the decision to build an SMR facility. These financial commitments would affect the operating costs for the SMR facility.

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	SMR modules that would be deployed at a site.		
	Section 2.18: Subsurface Civil Structures Important to Safety The CNSC would like to know • Where SMR industry work is being performed in this area to address aging management issues in codes and standards? • Of particular interest is ongoing work being done on technologies necessary to reliably demonstrate that such structures remain fit for service over the life of the facility including provisions for safe storage and decommissioning plans?		
53.	As noted in the discussion paper, this is not a new issue and for some modern pool-type reactors, CANDU spent fuel bays, etc. underground location is an essential part of defense-in-depth. Given the lack of experience on underground SMRs, however, it might be useful for industry to lead in writing a "best practices" summary of engineering underground reactors, before the CNSC steps in with regulatory guidance. There are already a number of CSA standards dealing with some of these aspects, with CNSC specialists participating actively in the development of these standards. As an example CSA N287.8-15, which was issued recently, deals with "Aging management for concrete containment structures for nuclear power plants"; it builds on REGDOC 2.6.3 and IAEA NS-G-2.12. This specific standard can be expanded to provide the necessary details by the industry and CNSC. Another example is the CSA N287, CSA N289 and CSA N291 series of standards, which already cover the design consideration for concrete containments, seismic and safety-related structures. These standards can be expanded to provide more details for		

#	Comments/ Responses to CNSC Questions	Major Comment/ Request for Clarification	Impact on Industry, *if major comment*
	subsurface civil structures. Several aspects of the design such as loads, load combinations, analysis, acceptance criteria for stresses and strains, reinforcement covers, documentation etc. are already covered by these standards and the additional details required by the industry and CNSC can be provided in these series of standards. It should be stressed that subsurface civil structures design, analysis and construction are considered well established in civil engineering practice. There are several ASCE (American Society of Civil Engineers) publications and standards dealing with these areas. The role of the industry and CSA, with CNSC participation, is to build on this practice by accounting for the unique additional requirements of the nuclear industry.		
	Section 2.19: From Section Three: Fusion Technologies The CNSC would like to know: • Wwhat are the types and magnitudes of risks and hazards that would be posed by different fusion technologies (conventional and radiation hazards)? • With this in mind, how would the risks posed by activities involving fusion reactors differ from current nuclear fission reactors? • Should fusion reactors be regulated differently than fission reactors?		
54.	Industry suggests that these are all excellent questions for which a thorough review of the regulatory framework would be required. Without more information on fusion reactor designs, we cannot comment further.	*Clarification*	