# United States and Canada Cooperation on SMR Design Reviews - Successes in Collaboration

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**Abstract**

Since 2019, the U.S. Nuclear Regulatory Commission (USUSNRC) and the Canadian Nuclear Safety Commission (CNSC) have been collaboratively performing safety reviews of advanced reactor and small modular reactor designs that are expected to be deployed in both countries. This collaborative effort aims to gain efficiencies by making joint observations or identifying and addressing where differing regulatory approaches may result in different outcomes. CNSC and USNRC leverage each other’s regulatory reviews and make joint findings that can support licensing in both countries. The effort focuses on strategic technical areas, both generic and design specific. Since initiation, both regulators developed eleven work plans for collaborative projects, collaborated on six reactor designs, and issued eight joint reports. In response to lessons learned, processes were established to enable more efficient execution and optimize results including identifying criteria to strategically select projects, creating a strategic plan to prioritize next projects, developing criteria to determine when additional regulators should be invited to join, and developing administrative protocols and templates for preparation, approval, legal review, and publication of joint reports. The feedback from reactor designers has been positive noting that the engagements are constructive, and that gaps are being identified early. The collaborative effort is returning value for regulators and designers in the form of complex technical issues resolved and resources saved. Regulators work transparently and publish results online.

## INTRODUCTION

In 2019, the USNRC and the CNSC embarked on a first of a kind effort to collaboratively perform safety reviews of advanced reactor and SMR designs that are expected to be constructed in both countries. This mutually beneficial collaboration addresses challenging topics in licensing advanced reactor and small modular reactor (SMR) designs under review in both countries. CNSC and USNRC see tremendous value in the collaboration that was formalized under a Memorandum of Cooperation (MOC). CNSC and USNRC strategically choose projects that will support efficient licensing in both countries, gain benefits for both regulators, and not hinder either regulator in performing timely reviews.

The USNRC and CNSC staff include vendors as active participants in the collaborative process to reach alignment on the scope of collaboration and establish an understanding of how this collaboration can result in both near term and long-term useful products. To date, USNRC and CNSC staff issued five joint products for specific designs and three joint products applicable to multiple designs.

The goal of this effort is to gain efficiencies by making joint observations. The products of the joint reviews provide positions that both regulators agree to or identify where differing regulations may result in different regulatory decisions. Collaboration improves the ability of each regulator to make risk-informed licensing decisions by leveraging the knowledge and experience of the other regulator. In addition, the collaboration is expected to result in more standardized designs as the regulators strive to align on common resolutions to unique licensing challenges. The regulators also look for opportunities to gain review efficiencies by leveraging previous evaluations, and by sharing training and computer code input decks.

After the initial successes of the MOC, other regulators expressed interest in participating in the cooperation. In 2023, CNSC and USNRC staff developed criteria to determine whether a regulator should be invited to join as a participant or observer. Using this criteria, the United Kingdom’s Office of Nuclear Regulation (ONR) has been successfully integrated into the collaborative activities. A trilateral MOC was signed by CNSC, ONR and USNRC in March 2024.

## Success and outcomes

Tangible benefits have been realized from this initiative in the form of joint products that can be utilized in licensing decisions. Generic products provide benefit for a wide range of end-users such as comparisons of review approaches. The first joint product issued was a comparison of the licensing modernization project (LMP) used in the U.S. with the CNSC approach to technology-inclusive, risk-informed reviews. Comparing the Canadian and U.S. regulatory approaches was a first step in enhancing understanding of each regulator’s framework to enable greater cooperation and collaboration on advanced reactor designs that are contemplated for deployment in both countries. The joint report concluded that there is much common ground in safety case assessment reviews and acceptance criteria that can be used as a foundation for technical reviews performed by one regulator to be leveraged by the other.

 The report suggested further work to assess the basis of key regulatory criteria where differences could exist and where additional regulatory convergence could be achieved. The areas suggested for further work include safety classification of structures, systems and components. A separate project was undertaken to compare safety classification in each country. The review determined that the commonalities in the regulatory approaches would support joint reviews by the CNSC and USNRC, as well as provide the opportunity for applicants to leverage information developed for one regulatory body in developing a licence application for the other regulatory body.

Another generic project established a common regulatory position on Tri-structural Isotropic particle (TRISO) fuel. The joint review identified potential design-dependent gaps that should be addressed to enable TRISO use in advanced reactor licensing applications. The report summarized the data, criteria, and approaches that can help support fuel-related regulatory findings for TRISO-fueled reactor designs and areas for future work by vendors.

USNRC and CNSC staff also performed cooperative reviews of specific technical and regulatory issues as part of pre-application interactions for reactor designs under consideration in both countries. The projects were strategically chosen to support efficient licensing in both countries, gain benefits for both regulators, and not hinder either regulator in performing timely reviews. USNRC and CNSC staff issued joint products for specific technical topics as part of pre-application engagement including a joint report on X-energy’s Xe-100 reactor pressure vessel construction code assessment and a joint report on Terrestrial Energy’s methodology for developing a postulated initiating events list for its integral molten salt reactor. CNSC and the USNRC also issued a joint report on the method for predicting the conditions inside the containment vessel following a loss-of-coolant accident for the GE-Hitachi BWRX-300.

In 2022, the Tennessee Valley Authority and Ontario Power Generation announced plans to jointly work to deploy the GE-Hitachi BWRX-300 in Canada and the U.S. and proposed technical topics for USNRC and CNSC staff to address collaboratively. GEH, OPG, and TVA meet frequently with the regulators to identify licensing topics for potential cooperative reviews, and to communicate challenges with applying existing guidance or frameworks. In 2024, the UK ONR was added as a participant to the collaborative work. **The CNSC, ONR and USNRC collaboration is intended to reduce duplication of licensing review efforts, jointly utilize third party verification, identify areas for lifecycle verification activities, share expertise and leverage analysis performed by each organization. CNSC and USNRC staff** issued joint reports on the steel-plate composite containment vessel and reactor building structural design and the safety strategy for the BWRX-300. The regulators are also exchanging information on several additional technical areas of the design. In particular, the regulators have held joint technical discussions with GEH, OPG and TVA on the proposed approaches to break exclusion zone, means of shutdown, and safety strategy for the BWRX-300. These discussions allow regulators the opportunity to seek inputs from international peers to support risk informed decision making while ensuring regulatory sovereignty. Through its interactions, CSNC, USNRC and ONR have shared information that supports each other’s evaluations, with the goal of standardizing the design in all three countries. To expand the impact of the collaboration, Poland’s National Atomic Energy Agency has been invited to participate as an observer in some activities since an application for the BWRX-300 has been submitted in Poland.

While each regulator retains its independent authority to make licensing decisions, the joint reports provide confidence to applicants of what is acceptable to each regulator and can be referenced in license application reviews. In addition, the reports provide valuable information for other regulators considering the same designs. By leveraging each other’s evaluations to approve a novel design feature or an exemption from requirements, that feature of the design can be standardized for deployment in both countries.

In performing the joint reviews, CNSC and USNRC have issued joint requests for information and conducted joint audits -- a process by which the regulators review additional applicant documents to support a licensing review. These joint efforts result in resource savings to both the regulators and applicants by addressing one set of questions and avoiding redundant interactions. In addition, CNSC and USNRC have shared the results of earlier work to support each other’s reviews. For example, USNRC has provided computer code input decks that were developed for the BWRX-300 allowing CNSC to perform verifications with less resource and time expenditures. In addition, CNSC leveraged previous USNRC reviews of the GNF2 fuel product as part of its review of OPG’s license to construct. Leveraging USNRC reviews of the fuel reduced the level of effort required to CNSC staff on the order of months. For situations in which a regulator is faced with reviewing a technology that they do not have significant experience with, the other regulator has provided cost-free training to the staff; training that would have taken time and resources to develop on their own. For example, to support the BWRX-300 joint reviews, the USNRC provided two weeklong virtual training sessions on GE BWR technology to staff from the CNSC. As part of some MOC projects, CNSC and USNRC have exchanged staff on a part-time or full-time basis. By embedding staff in the other regulatory agency, the staff were able to perform joint reviews even more effectively while learning how the other agency operates which will enhance future collaboration.

In addition, several intangible benefits have been realized from the joint reviews. The structure of the MOC provides for direct access to staff in each agency without constraints. The MOC specifies that information shared under the MOC is protected consistent with the terms of the Memorandum of Understanding between the regulators which provides for the secure exchange of proprietary and protected information consistent with import/export license. Working groups of staff in each agency are formed to evaluate an aspect of the design and the working group members communicate frequently and openly. The working group members in each country have access to the same information and are treated as one staff technical organization. Staff inform each other of positions issued and any differences in approach proposed by the applicants in each country. This real time exchange of information provides important awareness and enhances consistency in positions taken.

The frequent interaction between staff in each agency has enhanced the confidence in the other’s technical ability and a greater understanding of decisions made. This increased confidence enhances the prospect of one country adopting the findings of the other. For applicants, successful collaboration among the regulators provides improved confidence in the ability to license their design in multiple countries and greater regulatory certainty.

## lessons learned, best practices and improvements

This cooperation has enabled CNSC and the USNRC to gain valuable insights into the benefits, as well as complexities, associated with joint reviews. CNSC and USNRC staff are continually identifying lessons learned to improve this first of a kind cooperation and expect that successful implementation of this collaboration can be a model for other regulators to follow. Below are some best practices that are being used to improve the collaboration.

3.1 Project Selection

A critical element of effective cooperation is choosing the right projects. The timing of vendor submittals to each regulator will impact whether the activity will be mutually beneficial to all regulators. Submissions should be aligned in timing for the most effective cooperation. For designs which are at significantly different stages of review in each country, the focus of collaboration will be on information sharing, rather than developing joint observations. Prior to embarking on a joint project, both regulators ensure that they have dedicated resources to make the joint review successful, and that the schedules and resources needed on each side are not increased as a result of the collaboration. The schedule for the joint review and issuance of a joint report is developed to support the licensing needs in each country. Joint reports are issued separately from licensing documents, ensuring that the regulators retain authority for making licensing decisions in their country while leveraging the joint work.

A Strategic Working Group developed a prioritized list of projects (both current and future) and meets on a regular basis to review the list and consider if additional projects should be added. The Strategic Plan includes a defined list of goals and priorities and is reviewed frequently and communicated to senior management in both agencies. The strategic plan helps manage multiple projects at a time and establish a prioritization of potential projects for the future.

3.2 Effective communication

Effective communication with all parties before and throughout reviews maximizes the benefits of cooperation. Alignment through multi-party meetings that include all utilities, vendors, and regulators for a specific design prior to submittals ensures that the topics chosen for joint reviews will benefit all parties and the same information is provided to each regulator. These communications are held periodically throughout the collaborative review. For example, discussions that led to development of the BWRX-300 charter were successful in defining the scope of the projects. In addition, routine meetings of the 6-parties (CNSC, USNRC, ONR, GEH, OPG and TVA) are beneficial in aligning all participants throughout project development and implementation.

3.3 Access to information

Consistent access by regulators to vendors’ documents is necessary to ensure an efficient collaborative review. Protocols have been developed to ensure equal access by regulators to vendors’ documents, including proprietary information. Any documents that are relied on for licensing purposes are submitted by vendors to the regulator that is making the regulatory finding and MOC protocols require vendors to also provide these documents to the other regulators involved in the collaborative review. The vendor is responsible for ensuring that each regulator has the information that is within the scope of collaboration submitted via the appropriate submission processes. Project leads verify that both regulators have the same vendor information. The MOC and related MOUs provide controls to ensure that when sensitive information is provided by the vendors, it is appropriately protected.

3.4 Familiarity with requirements, practices and experience

Having an understanding of both regulatory frameworks supports development of joint positions and minimizes the need for reviewers to seek clarification during a collaborative review. To support this, USNRC and CNSC provided training to subject matter experts on each other’s regulatory processes and approaches. In addition, each organization provides opportunities for the other agency’s staff to participate in technical training, makes training materials available, or shares information from similar reviews when regulatory counterparts have limited experience with the technology. For example, to support the BWRX-300 joint reviews, the USNRC provided two weeklong virtual training sessions on GE BWR technology to staff from the CNSC.

3.5 Expansion to other countries

After the initial successes of the MOC, other regulators expressed interest in participating in the cooperation. In 2023, CNSC and USNRC developed criteria to determine whether a regulator should be invited to join as a participant or observer. The criteria include things such as project timeline alignment, ability to share information, and availability of sufficient resources to effectively participate. Using these criteria, the United Kingdom’s Office of Nuclear Regulation has been successfully integrated into the collaborative activities. A tri-lateral MOC was signed by CNSC, ONR and USNRC in March 2024 and the ONR staff are actively participating in BWRX300 joint reviews. USNRC and ONR are in the planning stages of additional joint review for designs that are under consideration in both the U.S. and UK.

3.6 External feedback

In addition to routinely performing lesson learned, CNSC and USNRC seek feedback from external stakeholders, particularly from advanced reactor and small modular reactor vendors. In particular, the regulators meet routinely with the organizations involved in licensing the BWRX-300. OPG, TVA and GEH regularly share feedback on the effectiveness and benefits of the cooperation between USNRC and CNSC.

In September 2023, the Nuclear Energy Institute (NEI) and the Canadian Nuclear Association (CNA) issued a report titled “Canadian and United States Regulatory Cooperation for New Nuclear Deployment: Recommendations for the Implementation of the International Regulatory Efficiency Framework.” This report articulates the industry’s perspective on the long-term goals for the cooperation, and additional near-term actions that the U.S. and Canada can take to achieve these goals. The report includes recommendations for action by regulators, standard development organizations, government, and industry. Several of the recommendations raised in this report have already been implemented or are being considered by CNSC and USNRC.

## next steps

This cooperation has evolved since the MOC was signed in 2019. Initial interactions consisted of sharing the results of completed evaluations and identified the similarities and differences between processes and requirements. That knowledge was used to identify where positions align on specific technical issues in pre-application reviews. Going forward, CNSC, USNRC and ONR are working to jointly find approaches to address novel technical considerations. The collaborative processes will be applied to joint reviews of portions of license applications as the projects move into licensing phases.

The MOC subcommittee continually seeks opportunities to expand the list of vendors and technologies for joint reviews and strategically expand cooperation in areas of mutual interest. In addition, for international collaboration to be truly successful it cannot end with the issuance of a construction licence; collaboration must continue throughout the lifecycle. Future collaboration will include other stages of the reactor lifecycle such as construction oversight and vendor inspection to further the benefits of regulatory efficiency. Finally, as the MOC is the gold standard for international collaboration on SMRs and advanced reactors, the CNSC, USNRC and ONR are committed to ensuring our collective success can be leveraged by other regulators who are assessing the same reactor designs.

References

1. USNRC, CNSC, and ONR, Memorandum of Cooperation on Advanced Reactor and Small Modular Reactor Technologies Between the United States Nuclear Regulatory Commission, the Canadian Nuclear Safety Commission, and the United Kingdom Office of Nuclear Regulation 2023.
2. USNRC and CNSC, Terms of Reference for the Memorandum of Cooperation on Advanced Reactor and Small Modular Reactor Technologies Between the Nuclear Regulatory Commission and the Canadian Nuclear Safety Commission, 2019
3. USNRC and CNSC, Joint Report Concerning X Energy’s Reactor Pressure Vessel Construction Code Assessment White Paper, June 2021
4. USNRC and CNSC, Joint Report on GE Hitachi’s Containment Evaluation Method - A Collaborative Review by the U.S. Nuclear Regulatory Commission and the Canadian Nuclear Safety Commission, April 2022
5. USNRC and CNSC, Final Joint Report concerning Tristructural Isotropic (TRISO) Fuel Qualification, June 2023
6. USNRC and CNSC, Technology Inclusive and Risk-Informed Reviews for Advanced Reactors: Comparing the US Licensing Modernization Project with the Canadian Regulatory Approach, August 2021
7. USNRC and CNSC, Interim Joint Report Concerning Classification and Assignment of Engineering Design Rules to Structures, Systems and Components, June 2023
8. USNRC and CNSC, Joint Report on GEH BWRX-300 Safety Strategy White Paper, July 2023
9. USNRC and CNSC, Joint Report on GEH BWRX-300 Steel-Plate Composite (SC) Containment Vessel (SCCV) and Reactor Building Structural Design White Paper, June 2023