

Preparing Canada's nuclear industry for world-class performance



The CSA N299 series of standards are helping Canada's nuclear supply chain apply a new level of quality assurance specifications, thereby strengthening the industry's capability to deliver the performance needed to ensure its role in the clean energy systems of a net-zero world.

Nuclear power was the critical enabler of the 2014 phase-out of coal in Ontario's electricity system, making the province one of the lowest carbon-emitting jurisdictions in the world. Today, more and more Canadian jurisdictions as well as countries around the globe are considering the role of nuclear as they seek to decarbonize their energy and civil infrastructure to

reach net-zero goals while simultaneously ramping up energy output to power their future economies.

Canada's nuclear leadership, built on more than seven decades of expertise, positions our country as a desired global partner in helping the world meet both its sustainable development and climate change goals. However, the ability to capitalize on this strength relies on consistent, demonstrated performance and improvements in cost, efficiency, environmental protection, and safety. Perhaps more than other industries, in nuclear, those are the table stakes to ensure the confidence of the ultimate consumers, everyday Canadians, and the decision-makers who contract for power.



The critical role of quality assurance in the nuclear field

More than 60,000 employees are connected with the Canadian nuclear industry, working for utility companies and within a supply chain that spans several tiers of sub-suppliers. Everyone involved must understand how crucial safety, reliability, and cost are and, importantly, their own role in ensuring these.

Quality assurance is critical from the utility workforce right down to the smallest provider in the deepest part of the supply chain.

Strong, clear, and relevant standards are a key tool in performance management.

So, when the nuclear industry realized its procurement quality assurance (QA) practices needed updating and had become cumbersome for utilities and suppliers alike, key players recognized the need to modernize the specifications.

They also knew that developing modern standards to meet the industry's evolving needs required a 360-degree view of the landscape, with input from the entire nuclear community.

Given the long history of working with the Canadian nuclear industry on standards, CSA Group was an ideal choice to facilitate this work.

The early adoption of QA standards

In the 1970s, the CSA Z299 Series of Quality Assurance Program Standards was selected for procurement of goods and services by Ontario Hydro, the operating utility for Canada's first commercial nuclear power station, Pickering Nuclear, and most of Canada's other nuclear plants that followed. Although CSA Z299 was a series of commercial standards, not a nuclear-specific one, many of the QA processes and specifications within it were based on earlier practices developed by Ontario Hydro.

Atomic Energy Canada Ltd. (AECL), the original equipment manufacturer for CANDU, the made-in-Canada reactor design used in all Canadian nuclear power plants currently operating, also adopted CSA Z299. Consequently, the CSA Z299 standards were embedded in the design basis of all nuclear power stations and some utility-owned nuclear facilities licensed in Canada.

When the CSA N286 Series of Standards on Quality Assurance for Nuclear Power Plants were developed in the late 1970s, they referenced CSA Z299 as the recommended quality assurance standards.

When AECL sold CANDU reactors to six other countries, the CSA Z299 standards became broadly used both nationally and internationally. The standards were also a precursor to the ISO 9000 series of quality management standards.

Later, as most commercial bodies adopted ISO 9001 as their foundational quality standard, the CSA Z299 series stayed in use by the nuclear industry. Over time, the CSA Z299 series was withdrawn as a national standard. Nonetheless, it remained a frame of reference for the nuclear industry.

Revitalizing a Canadian nuclear QA standard

As ISO 9001 has evolved into a consolidated, generic management system standard, it has become less prescriptive than its predecessors and no longer establishes a graded approach to assuring quality. There have been mixed approaches in the nuclear industry internationally to address this shift, from augmenting ISO 9001 to creating entirely new standards.

In Canada, Ontario Power Generation (OPG), the successor of Ontario Hydro, and Bruce Power, Ontario's other nuclear operator, worked through a CANDU Owners Group joint project to create a set of graded specifications that aligned with the original CSA Z299 series. The goal was to minimize the impact on the design basis and to transition the relevant content from CSA Z299, which they saw as being the best starting point for a new standard.

"At OPG, the design documents, manuals, and drawings had [CSA] Z299 all through them – from the seventies, eighties, and nineties," explains OPG's Senior Manager, Quality Services, Mihai Pletosu. "We felt we needed to revive it. We developed a quality specification and updated it. When we finished that, that's where CSA Group came in, facilitating the development of the new standard to bring us up to date with current business practices."

Work on the new standard, this time designated as the CSA N299 series, began in 2014 with the joint project seed document. CSA Group also organized a workshop to broaden the participation of Canadian industry in the development of CSA N299 standards. The workshop attracted 41 representatives from Ontario nuclear operator utilities, about a dozen Tier 1 and 2 supplier organizations, and the nuclear regulator. The Organization of Canadian Nuclear Industries (OCNI), representing more than 250 of Canada's suppliers of all tiers and sizes, also participated and later nominated



a member to participate on the CSA Group technical committee formed to develop the nuclear-specific CSA N299 standards.

The goal of the committee was to update CSA Z299 in a way that reflected current needs, including operating experiences, current best practices, and harmonization with other national and international standards.

Transitioning to the new standards

The first edition of CSA N299 was published in 2016. The utilities began their own internal transition before requiring the supplier community to implement the standards.

"It was a lot of work internally, but it was critical to close the gaps created by the withdrawal of [CSA] Z299," says Pletosu. "We had a lot of work to do to reconcile [the previous and new standards]; there were documents to revise, processes to revise."

Once the internal work was completed, it required a lengthy education of the supplier community. In particular, the industry recognized it needed to build knowledge about the unique requirements of the nuclear environment among some of the smaller suppliers or those for whom nuclear is only one facet of their work.

"So now they are required to understand they are not providing items or services to just a regular customer. They understand what they need to do to ensure they are not having a negative impact on nuclear safety," says Pletosu.

Some of the most significant changes from the former CSA Z299 and ISO 9000 standards to the new CSA N299 were additional requirements critical to nuclear performance, including nuclear safety culture, human performance, and systems to prevent the infiltration of counterfeit, fraudulent, and suspect items.

Ron Oberth, past President and CEO of OCNI (from 2011–2022), says that for some OCNI members, it took a substantial upfront effort to learn the new standards and close the gaps in both knowledge and process. To help address this, OCNI worked with CSA Group, offering information workshops. OCNI also recommended companies that could help suppliers on their path to compliance with the standard.

“At the end of the process, though, there are some big efficiency gains to be had for the suppliers,” says Oberth.

“The biggest value for the suppliers is that the three major utilities – OPG, Bruce Power, and New Brunswick Power – now all speak the same language. So, once you meet the standard, you are able to supply to all three organizations. If you go into partnership with other suppliers or bring in sub-suppliers, you know that they are also working to the same standard.”

A graded approach

“One of the most attractive features of the new standard series is its graded approach,” says Pletosu. “We have one set of requirements, and we have the beautiful grading of requirements, which everybody admires. It’s not one-size-fits-all like in other jurisdictions,” he says. “You reduce the requirement based on the scope of work, complexity, and safety significance. This is the most helpful approach and one that other countries are interested in exploring.”

Oberth agrees. “Many companies don’t aspire to get into the critical safety area or areas where you could have a major economic impact, so suppliers can be audited to the level adequate to the scope of what they supply.”

How far they choose to take their certification dictates the type of work they can bid on and puts that control in their hands, he says.

The graded approach is addressed through four categories of the standard. CSA N299.4 is the entry level for suppliers with a lower impact on the plant’s

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operations, rising to CSA N299.1, which provides the most comprehensive set of requirements for suppliers whose services and products could have the greatest bearing on plant performance and safety.

From development to implementation

“The amount of effort it takes to revamp internal processes and gain compliance to the appropriate CSA N299 category also depends, in part, on how embedded the company already is in the nuclear industry,” says Tracy Mason, Director of Corporate Quality Assurance at Black and McDonald, a long-time engineer, procure and construct (EPC) Tier-1 nuclear supplier, and member of the committee that developed the CSA N299 standards.

Black & McDonald provides construction, maintenance, and services for various nuclear facilities and customers. The company is also a nuclear manufacturer and fabricator, so it implements the standard from two perspectives.

Mason says he gained a good appreciation of the value of CSA Group’s technical committee structure during the development of the standard.

He says committee members gave each other “respectful challenges” in their collaboration and considered the practicalities of implementing the new requirements and where they might be excessive.

“Collectively as a committee, when you have different backgrounds and perspectives, it evolves the standard to a point where it serves the interests of all stakeholders. It was very good in that regard,” he says.

The development process allowed the committee to delve into the standard’s purpose and identify an opportunity to encourage continuous improvement within the industry by addressing behaviours in critical areas that can either be the industry’s strength or greatest challenge.



“When we developed the first edition of the CSA N299 standards, we recognized this was going to be a major progression for the industry because we introduced many new concepts like nuclear safety culture and counterfeit, fraudulent, and suspect item screening,” says Mason.

The supply chain was mostly used to ISO quality management standards that did not have these components integrated into them. For large suppliers with nuclear-based work like Black and McDonald, the payoff in adding the new requirements was easy to see. It also fitted with work and expectations familiar to them. But the committee knew some of the sub-supply companies would struggle and that some might decide the effort to transition to CSA N299 might not be worthwhile for their businesses.

“The real challenge was and still is with suppliers that provide niche products, but their core business is not focused solely on the nuclear industry.”

Mason says companies like his had to step up and help work through the standard with their own suppliers. With a few years of that work now behind them, “it’s getting better,” he says. “People are gaining experience. We are progressing as an industry in how we understand and use the standard.”

Implementation from a perspective of a general supplier

Unlike Black and McDonald, Lakeside, a process automation and instrumentation company based in Mississauga, has a product and service line that can be as relevant to dog food production as electricity generation. Depending on the application, Lakeside can serve as a Tier-1 nuclear industry supplier all the way down to a Tier-7 supplier.

Lakeside’s Manager of Inside Sales, Michele Cheng-Newson, says despite the fact her company is not solely focused on the nuclear field, Lakeside decided to approach the adoption of the new standard as a business opportunity. It was a way to get accreditation, improve their processes, and potentially identify ways to attract more business along the way.

Lakeside viewed the standard through the lens of their 5 to 10 year business interests. They used a spider chart to “look at what we are doing today, what we want to be doing tomorrow, and what are the additional opportunities for other products, depending on how we selected our categorization within the standard,” she says.

The company was audited at a Category 4 level but prepared for Category 3. This strategy allowed them to manage their risk, ensuring a successful audit for what they supply today but also served to identify additional opportunities and ready the company to take them on.

For Lakeside, says Cheng-Newson, the greatest added advantage to the process was gaining a deeper understanding and familiarity with safety culture and human performance, not only for their nuclear business but more generally as best practices for success.”

“The CSA N299 was perfect timing. I think we would have been challenged if this hadn’t come before the nuclear refurbishments [at OPG and Bruce Power]. With this information, it made it much clearer for the utilities’ purchasing and from our standpoint to invoke that from our suppliers,” she says.

“Additionally, it opened the doors for us to understand and learn what safety culture means. It is well beyond health and safety standards. It includes business continuity, how managers are coaching employees, and making sure there are no weak links in our processes.”

Safety culture is an important pillar of our company, says Cheng-Newson. The standard helped reinforce this aspect of management and contributed to creating a company of excellence.

“It complemented our own efforts in business continuity and employee engagement,” she says.

Cheng-Newson is also complimentary of the processes of development of CSA N299, managed by CSA Group.

“Overall, CSA Group took a supportive position in listening to the different stakeholders throughout the development process. As well, the committee appeared to be a very balanced group. I saw there was a lot of rigour the project managers went through to maintain the proper mix of the participants in the committee.”

Further updates to the CSA N299 standards

As the industry continued implementing the 2016 standard, the committee shifted its work to further refining the standard and “addressing ‘parking lot issues’ not fully addressed in the 2016 publication,” says Pletosu.

The second edition of the CSA N299 series was published in 2019. It addressed issues raised during the implementation of the 2016 standard and delved deeper into general concepts such as management responsibilities, independent verification, use of experience, and protection against infiltration of counterfeit parts and suspect items (CFSI).

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The utilities set a deadline of April 2021 for supplier compliance with the 2016 standard. Pletosu says they will allow more soak time for the industry to get comfortable with the 2016 edition before adding more building blocks.

Regardless, there is recognition within the nuclear community that new elements around CFSI, human performance, and safety culture introduced in the CSA N299:16 series and strengthened in the 2019 edition could create a competitive advantage for Canadian suppliers as the standard helps the industry gain bench strength in those areas. And that advantage could be valuable when Canada’s supply chain is competing abroad.

“The requirement on CFSI is the first in the world aiming to prevent counterfeit items from getting into the supply system. There were some enhanced requirements and some completely new requirements,” says Pletosu.

Adds Oberth, “It’s important that the standard is broad enough to help suppliers understand those bigger issues. What does it mean to have all your people understand what safety culture means? Quality is all about behaviours, not making errors, attention to detail, and taking care in everything you do. Having a standard that’s broad enough to require such a change in behavior across an organization is valuable.”

Creating a foundation for clean energy systems of the future

Like Cheng-Newson and Mason, Oberth sees the added value for the supplier community in both the standard development process and its implementation. He says the benefits can go beyond supply chain auditing and compliance and help build key strengths for future industry growth.

Canada's nuclear industry has been built on traditional scale CANDU reactors. Today, it is diversifying. Thanks to refurbishment projects, much of the CANDU fleet will be around for decades to come. In addition, new technologies like small modular reactors (SMRs) are making their way into the policy discussion: currently, four Canadian provinces have signed a memorandum of understanding to develop SMRs as part of their decarbonization plans.

Oberth says the CSA N299 series and the process improvements it is driving will position Canada well in this new technology market. A 2021 document prepared for OCNI called *Roadmap to Becoming a Nuclear Qualified Supplier* provides guidance for "new to nuclear" suppliers on the steps they should take to meet the requirements of CSA N299 as well as the CSA pressure boundary and management systems standards.

"Having [CSA] N299 as the backdrop is very helpful for new suppliers. If a company in New Brunswick wants to supply to [SMR designers] Moltex or ARC, for example, the standards will be very helpful to them in setting up their systems and the elements they need to have in place." These are elements that ensure nuclear performance will hit the targets on cost, safety, and reliability needed to secure the industry as a linchpin of the clean energy systems of the future.

"Quality, in the long run, saves you money. Quality can go up, and cost can actually come down. There's less downtime, fewer rejected components, fewer part failures, less rework. If you put the quality upfront and follow a rigorous QA process, over time, it will improve your bottom line as a supplier. It will improve your performance, the utility's performance, and the industry's performance," Oberth says.

"A well-performing industry meant the Government of Ontario has invested in refurbishments and major component replacement projects. Rising tides lift all boats. Our industry has demonstrated it can perform, and that has benefited all of us," he adds.

The same suppliers working to meet the new expectations of the CSA N299 series today are the same ones who stand to gain in the decades ahead.

More importantly, as Canada looks to rapidly transition to net zero, in large part through clean energy systems, it appears the country will be counting on that performance to leverage the low-carbon power of nuclear to combat climate change, support civil infrastructure, and ensure Canada's competitiveness in a global low-carbon economy. The CSA N299 standards provide an important set of tools to help utilities and their suppliers achieve just that.