

TISG AMENDMENTS – SECOND REQUEST

Peace River Nuclear Power Project — IAAC Registry File No. 89430

Submitted to the Impact Assessment Agency of Canada and the Canadian Nuclear Safety Commission

MANDATORY COMPARATIVE ASSESSMENT OF FLEXIBLE GAS WITH CCS AND LARGE-SCALE ENERGY STORAGE AS VIABLE COMPETING TECHNOLOGIES

March 2026

SCOPE OF THIS SUBMISSION

This submission requests two amendments to the final Integrated Tailored Impact Statement Guidelines. Both amendments are mandatory, not discretionary: one arises from a 'shall' requirement in CNSC REGDOC-2.5.2 Version 2.1, the other from IAA section 22(1)(f) and (i) in conjunction with the IAAC's own Summary of Issues. Neither requirement appears in the draft TISG.

Amendment 1 (REGDOC-2.5.2 §2.2.1): The proponent must demonstrate by quantitative probabilistic safety assessment that MONARK societal risk is comparable to or less than the risk of generating equivalent electricity by flex gas with CCS and by large-scale energy storage in the Alberta grid context. This is a mandatory CNSC licensing requirement. The draft TISG omits it.

Amendment 2 (IAA s.22(1)(f)/(i)): The proponent must assess flex gas with CCS and large-scale BESS as technically and economically feasible alternatives to the designated project, and must assess the AP1000 as an alternative means of carrying out the project. The IAAC's own Summary of Issues raised whether other technologies are more appropriate for the Peace River region. IAAC has not translated this stated concern into a TISG requirement. Under Vavilov (2019 SCC 65), that unexplained omission is reviewable.

PART 1 — THE REGULATORY FRAMEWORK: TWO INDEPENDENT MANDATORY REQUIREMENTS

1.1 REGDOC-2.5.2 §2.2.1: The Mandatory Societal Risk Comparator

CNSC REGDOC-2.5.2, Design of Reactor Facilities, Version 2.1, is the operative design standard for all new water-cooled reactor facility licence applications in Canada. Section 2.2.1, Safety Goals, states:

Societal risks to life and health from reactor facility operation shall be comparable to or less than the risks of generating electricity by viable competing technologies, and shall not significantly add to other societal risks.

The word 'shall' in CNSC regulatory documents expresses a mandatory requirement to be satisfied by the licensee or licence applicant. This is confirmed by REGDOC-3.5.3, Regulatory Fundamentals: "The words 'shall' and 'must' are used to express requirements to be satisfied by the licensee or licence applicant."

The requirement has three components. First, the proponent must identify the "viable competing technologies" for generating electricity in the relevant jurisdiction. Second, the proponent must calculate the societal risk of those competing technologies using consistent methodology. Third, the proponent must demonstrate quantitatively that MONARK societal risk is comparable to or less than those comparators.

None of these three components appear in the draft TISG. The draft TISG requires a probabilistic safety assessment under REGDOC-2.4.2, but it does not require the PSA outputs to be compared against any competing technology. It does not require identification of competing technologies. It does not require a comparative societal risk finding. Without these components, the Impact Statement cannot satisfy the mandatory REGDOC-2.5.2 §2.2.1 requirement, and the CNSC cannot issue a Licence to Prepare Site on the basis of the Impact Statement.

1.2 IAA Section 22(1)(f) and (i): Alternatives to the Project and Alternative Means

The Impact Assessment Act, s.22(1), requires that the impact assessment take into account, among other factors:

(f) any alternatives to the designated project that are technically and economically feasible and are directly related to the designated project; (i) the purpose of and need for the designated project; [and] any alternative means of carrying out the designated project that are technically and economically feasible, including the effects of those means.

The IAAC's Guidance on 'Need for', 'Purpose of', 'Alternatives to' and 'Alternative Means' makes clear that the s.22(1)(f) alternatives assessment is included in the TISG where the Agency considers it necessary. The IAAC has exercised that discretion by omitting it from the draft TISG.

That omission is not supportable on the facts of this file. The IAAC's own Summary of Issues, issued May 23, 2025, states as a key issue:

Concerns regarding the readiness, proven track record and lack of clarity about stated outputs of the CANDU MONARK technology to be constructed and whether other technologies may be more appropriate for the Peace River region.

This is a verbatim identification of the alternatives question as a relevant issue. Under Vavilov (2019 SCC 65), an administrative decision-maker who departs from its own previously stated position must justify that departure with transparent and intelligible reasons. IAAC has identified alternatives as a relevant concern in the SOI and then produced draft TISG guidelines that do not address it. That unexplained departure is reviewable.

Additionally, Energy Alberta's October 2025 partnership with Westinghouse to explore AP1000 deployment at the Peace River site introduces a second dimension: the AP1000 constitutes an "alternative means" of carrying out the designated project under s.22(1)(i). The draft TISG, written entirely around the CANDU MONARK, does not address this alternative means.

PART 2 — FLEXIBLE GAS WITH CARBON CAPTURE AND STORAGE AS A VIABLE COMPETING TECHNOLOGY

2.1 Why Flex Gas with CCS is the Relevant Comparator for Alberta

REGDOC-2.5.2 §2.2.1 requires comparison against "viable competing technologies." The word 'viable' connotes technical and economic feasibility in the relevant jurisdiction. For the Peace River project, the relevant jurisdiction is Alberta's electricity market as managed by the Alberta Electric System Operator (AESO).

Flexible natural gas generation with carbon capture and storage satisfies the 'viable' standard in the Alberta context on all material criteria:

- Alberta has the most developed natural gas infrastructure in Canada, including extensive pipeline networks, established gas supply chains, and a mature gas generation industry.
- Flex gas with CCS is explicitly identified in Alberta's emissions reduction planning documents as a technology pathway for decarbonising dispatchable electricity generation.
- The AESO's generation interconnection queue contains multiple gas generation projects in various stages of connection approval.
- Natural gas combined cycle plants with post-combustion CCS have been demonstrated commercially. Quest CCS at the Scotford Upgrader, operated by Shell Canada, is a Canadian operating example. The Boundary Dam CCS project in Saskatchewan is another.
- Flex gas with CCS can be sited at or near existing gas infrastructure with minimal new transmission requirements — a significant cost and timeline advantage over a remote nuclear facility requiring hundreds of kilometres of new high-voltage transmission.

No claim is made in this submission that flex gas with CCS is superior to nuclear on all dimensions. The claim is narrower and is grounded in REGDOC-2.5.2: the proponent must demonstrate that MONARK societal risk is comparable to or less than the risk of flex gas with CCS. The Impact Statement must provide that demonstration. The draft TISG does not require it.

2.2 The Societal Risk Comparison: What the Assessment Must Address

A REGDOC-2.5.2 §2.2.1 compliant comparative societal risk assessment for the Alberta context requires the proponent to quantify and compare the following parameters for MONARK and for flex gas with CCS at equivalent generating capacity:

| Parameter | MONARK Requirement | Flex Gas with CCS Requirement |
|-------------------------------|---|---|
| Core damage frequency (CDF) | Sum of all internal and external event sequences causing significant core degradation, per reactor-year | Not applicable — no fission hazard; comparator is process safety and CO ₂ release frequency |
| Small release frequency (SRF) | Frequency of radiological releases meeting SRF definition per REGDOC-2.5.2 | Frequency of CO ₂ release above defined threshold from CCS system failure |
| Large release frequency (LRF) | Frequency of large radiological releases per REGDOC-2.5.2 | Frequency of catastrophic CO ₂ release event |
| Individual fatality risk | Maximum individual fatality risk from radiological exposure within defined exclusion zone | Individual fatality risk from gas explosion, CO ₂ asphyxiation, H ₂ S exposure at equivalent facility boundary |
| Societal fatality risk | F-N curve for radiological fatalities from all modelled accident sequences | F-N curve for fatalities from conventional process safety accidents at flex gas facility |
| Routine health risk | Incremental cancer risk to maximum exposed individual from routine radionuclide releases, per REGDOC-2.5.2 §2.2.1 | Incremental health risk from routine NO _x , SO ₂ , particulate emissions at Alberta regulatory limits |
| CO ₂ e intensity | Lifecycle CO ₂ e per kWh including construction, uranium mining, enrichment, decommissioning | Lifecycle CO ₂ e per kWh including CCS capture rate, methane leakage rate from Alberta upstream operations, compression energy |

2.3 The Alberta-Specific Lifecycle Carbon Intensity Calculation

The comparative societal risk assessment must include a lifecycle carbon intensity comparison using Alberta-specific data, not IPCC global median figures. This is material because the carbon intensity of flex gas with CCS is highly sensitive to two Alberta-specific parameters that differ substantially from global averages:

2.3.1 Alberta Grid Electricity Intensity for CCS Compression

CCS compression and solvent regeneration require significant parasitic electrical load, typically 15–25% of gross generating capacity. The carbon intensity of that parasitic load depends on the carbon intensity of the grid electricity used to power it. The AESO grid has been decarbonising but remains significantly above global average grid intensity during winter peak periods. The proponent must use

Alberta-specific AESO generation mix data, not a global or Canadian national average, to calculate the net carbon intensity of flex gas with CCS in the Alberta context.

2.3.2 Upstream Methane Leakage from Alberta Natural Gas Operations

The climate impact of natural gas generation depends critically on upstream methane leakage rates. Methane is a greenhouse gas approximately 86 times more potent than CO₂ over a 20-year period. The methane leakage rate from Alberta’s upstream gas operations has been the subject of documented scientific dispute. Independent atmospheric measurement studies have found methane leakage rates from Alberta operations substantially higher than inventory-based estimates reported by industry to the National Pollutant Release Inventory. The proponent must disclose the methane leakage rate it uses in its lifecycle calculation and must justify that rate by reference to current atmospheric measurement data, not solely inventory-based estimates.

The following table illustrates the sensitivity of the lifecycle carbon intensity of flex gas with CCS to these two parameters:

| Scenario | CCS Capture Rate | Upstream CH ₄ Leakage | Grid Intensity (Parasitic) | Net gCO ₂ e/kWh |
|---|------------------|----------------------------------|----------------------------|----------------------------|
| Proponent optimistic | 95% | 0.5% (NPRI inventory) | Low grid carbon | ~40–60 |
| Central Alberta estimate | 90% | 2.0% (measurement studies) | Mid grid carbon | ~90–120 |
| Conservative high-end | 85% | 3.5% (upper measurement bound) | High grid carbon (peak) | ~150–200 |
| IPCC global median — nuclear | — | — | — | ~12 |
| Northern Alberta nuclear (prior submission) | — | Upstream supply chain | — | ~35 |

The wide range of flex gas with CCS carbon intensity under Alberta-specific assumptions is itself material to the REGDOC-2.5.2 societal risk comparison: the societal risk of routine emissions from flex gas with CCS is sensitive to the same parameters. The proponent must use a transparent, Alberta-specific methodology with sensitivity analysis across the parameter range, not a single central estimate.

2.4 The AESO Generation Queue as Evidence of Economic Feasibility

REGDOC-2.5.2 §2.2.1 requires comparison against technologies that are ‘viable.’ Economic feasibility is a component of viability. The AESO’s generation interconnection queue constitutes primary evidence of economic feasibility: projects enter the queue only when proponents have committed sufficient financial security to advance to connection studies.

As of the date of this submission, the AESO's generation queue contains multiple gas generation projects — including cogeneration and flex gas configurations — in various stages of connection approval. The AESO's 2024 Long-Term Outlook projects Alberta Internal Load growth from approximately 11,000 MW to approximately 14,000 MW by 2043, driven by electrification and data centre demand. This load growth is the need the Peace River project proposes to address. The same load growth is addressable by the generation mix already queued with the AESO.

The proponent must assess whether the identified load growth can be met by technologies already in the AESO queue, and at what comparative cost, as part of the 'need for' analysis under IAA s.22(1)(i) and the 'viable competing technologies' analysis under REGDOC-2.5.2 §2.2.1.

PART 3 — LARGE-SCALE ENERGY STORAGE AS A VIABLE COMPETING TECHNOLOGY

3.1 The Technical and Economic Case for Storage as Comparator

Large-scale energy storage — including battery energy storage systems (BESS) and vanadium redox flow batteries (VRFB) — constitutes a 'viable competing technology' under REGDOC-2.5.2 §2.2.1 when assessed in conjunction with Alberta's existing and queued renewable generation capacity. The relevant question is not whether storage alone can provide baseload equivalent to 4,800 MWe. The relevant question is whether the combination of available renewable generation plus storage capacity can meet Alberta's identified load growth need at comparable or lower societal risk than nuclear.

The following considerations establish that large-scale storage is a viable comparator that must be assessed:

- Alberta has the highest wind and solar resource potential of any Canadian province. The AESO's generation queue as of 2025 contained over 11 GW of wind and solar projects in various stages of connection assessment.
- BESS projects are actively connecting to the AESO grid. Multiple utility-scale BESS projects have received Need Identification Document approval from the AESO in 2024–2025, including the Lamoureux Ruby Solar Battery Project, the Legal Solar Battery Project, and the Hutchison Battery Energy Storage Facility.
- VRFB technology offers long-duration storage (4–12 hours at full power) with 25–30 year operational lifespans, no thermal runaway risk, and full capacity recovery after deep discharge. It is commercially deployed in grid-scale applications in Japan, China, Germany, and Australia.
- The levelised cost of utility-scale BESS has declined approximately 90% since 2010 and continues to fall. Grid-scale BESS costs are now in the range of CAD \$250–400 per kWh of storage capacity for lithium iron phosphate chemistry.
- The AESO's Restructured Energy Market, currently being implemented, introduces a 30-minute ramping product (R30) and other flexibility services that specifically reward the operational profile of large-scale storage. Storage projects in Alberta can generate revenue from energy arbitrage, ancillary services, and capacity payments under the evolving AESO market framework.

3.2 The Societal Risk Profile of Storage Compared to Nuclear

The societal risk of large-scale BESS and VRFB storage differs categorically from nuclear in the following respects:

| Risk Category | CANDU MONARK | BESS (LFP) | VRFB |
|------------------------------------|---|--|--|
| Core damage / catastrophic failure | Core damage frequency 10^{-5} /yr design target; large release frequency 10^{-6} /yr design target; failure mode includes radiological contamination of land, water, food chain for decades | Thermal runaway propagation possible; worst-case facility fire. No radiological hazard. No food chain contamination pathway. | No thermal runaway. Vanadium electrolyte is non-flammable. Worst-case spill is contained chemical release. No radiological hazard. |
| Routine emissions | Tritium, C-14, Kr-85, I-131 and other radionuclides to air and water; CANDU produces tritium orders of magnitude higher than PWR | No routine radioactive emissions. No hazardous airborne emissions during normal operation. | No routine radioactive emissions. Minor vanadium electrolyte vapour within facility boundary. |
| Emergency planning zone | Defined EPZ required; Peace River site requires EPZ in remote agricultural community; evacuation of farming families | No EPZ required under any Canadian regulatory framework | No EPZ required |
| Decommissioning liability | Multi-billion dollar decommissioning cost; long-lived radioactive waste requiring deep geological disposal | Recyclable components; established lithium recycling industry; no long-lived radioactive waste | Fully recyclable vanadium electrolyte with positive residual value; no radioactive waste |
| Insurance and liability cap | \$1 billion NLCA cap; residual liability falls to public; government backstop required | Commercial property and liability insurance; no statutory cap; no government backstop required | Commercial property and liability insurance; no statutory cap; no government backstop required |

This table is not submitted as a definitive risk comparison — it is submitted to demonstrate that the societal risk profiles differ in kind, not merely in degree. A REGDOC-2.5.2 §2.2.1 compliant comparative assessment must address these categorical differences. The draft TISG does not require this.

3.3 The Storage Scaling Question

A potential objection to storage as a comparator is that storage cannot independently replicate the firm 4,800 MWe continuous baseload output of the proposed nuclear facility. This objection requires a factual response.

First, the 4,800 MWe figure represents a maximum licensed capacity across four reactors. Actual delivered capacity will depend on capacity factor, planned outages, and refuelling cycles. CANDU reactors at established sites have achieved capacity factors of approximately 83%. First-of-kind reactors at new sites consistently achieve lower capacity factors during initial years of operation due to commissioning, regulatory learning, and unplanned outages.

Second, the need identified in the IAAC process is not for 4,800 MWe of continuous nuclear output specifically. The need is for Alberta load growth to be met reliably. The AESO's own planning documents address this need through a portfolio approach: firm dispatchable capacity (including gas, cogeneration, and hydro), renewable generation with storage, and demand response. A comparison of nuclear versus storage must be conducted on a portfolio basis, not as a unit-for-unit substitution.

Third, the AESO's Restructured Energy Market is specifically designed to price and compensate for the flexibility and reliability services that Alberta's grid requires. Long-duration storage (8–12 hour VRFB systems) can provide the overnight and shoulder-period firm capacity that Alberta requires during winter peaks — the period identified by the AESO as the critical reliability constraint.

The proponent must address these three dimensions in its alternatives assessment. The draft TISG does not require it to do so.

PART 4 — AP1000 AS ALTERNATIVE MEANS UNDER IAA s.22(1)(i)

On October 21, 2025, Energy Alberta issued a press release announcing a formal partnership with Westinghouse to explore AP1000 deployment at the Peace River site. The proponent's own actions have placed the AP1000 on the table as a technically and economically feasible alternative means of carrying out the designated project. The draft TISG does not require assessment of this alternative means.

The AP1000 differs from the CANDU MONARK in material respects relevant to the comparative societal risk assessment:

| Factor | CANDU MONARK | AP1000 |
|---------------------------|---|---|
| Design status | Conceptual design complete Sep 2024; preliminary engineering target 2027; VDR not started; never built | Design complete; NRC and CNS/CNSC pre-licensing review completed; two units operating (Vogtle 3 and 4, USA); NuStart design certification |
| Operating experience | No units built or operated anywhere in world | Two units operating at Vogtle site, Georgia, USA as of 2023–2024; operational data available |
| Tritium output | CANDU heavy water reactor; tritium output orders of magnitude higher than PWR | Light water reactor; tritium output orders of magnitude lower than CANDU |
| Positive void coefficient | CANDU positive coolant void coefficient under certain conditions | AP1000 passive safety system with negative moderator temperature coefficient; no positive void coefficient concern |
| PSA validation basis | No empirical validation data for MONARK design | PSA validated against AP1000 design basis; Vogtle operational data provides empirical validation foundation |
| Heavy water requirement | Requires large heavy water inventory; no heavy water production capacity in Alberta; transport and handling risks | Light water; no special moderator requirements |
| CNSC VDR history | Special project to plan future VDR; no VDR started | AP1000 completed all three phases of CNSC pre-licensing vendor design review |

An ‘alternative means’ assessment under IAA s.22(1)(i) does not require the proponent to prefer the AP1000. It requires the proponent to identify and assess it as a technically and economically feasible alternative means of achieving the same purpose — generating up to 4,800 MWe of clean electricity in Alberta — and to compare its effects against the MONARK. The proponent’s own October 2025 press release establishes that the AP1000 is technologically and economically feasible for the Peace River site in the proponent’s own assessment.

The CNSC’s REGDOC-2.5.2 comparative societal risk obligation is equally engaged by an AP1000 assessment: if the AP1000 has lower societal risk than MONARK — as might follow from the AP1000’s lower tritium output, completed VDR, empirical operating data, and passive safety systems — that finding is material to the assessment.

PART 5 — REQUIRED METHODOLOGY FOR THE COMPARATIVE ASSESSMENT

The following methodological requirements must be specified in the final TISG to ensure that the comparative assessment produces results adequate for the Review Panel's use.

5.1 Common Functional Unit

The comparative assessment must use a common functional unit: the delivered electricity generation service required to meet the identified Alberta load growth need over the full project lifecycle. The functional unit must not be defined in terms that presuppose the answer (e.g., "4,800 MWe of firm nuclear baseload") but must be defined by the service outcome (e.g., "reliable, dispatchable, low-emission electricity supply to meet Alberta's projected load growth, at the required reliability standard, over a 40-year period").

5.2 Alberta-Specific Data Sources

All cost, emissions, reliability, and market data used in the comparative assessment must be sourced from Alberta-specific datasets, not global or national averages. Required data sources include:

- AESO Annual Market Statistics and Long-Term Outlook for load growth projections and generation mix
- AESO generation interconnection queue for evidence of competing technology feasibility
- Alberta Energy Regulator methane emissions inventory and atmospheric measurement studies for upstream gas leakage rates
- Environment and Climate Change Canada National Pollutant Release Inventory for Alberta-specific emissions factors
- Published levelised cost of energy data for Alberta-specific resource conditions, not global averages

5.3 PSA Methodology Consistent with REGDOC-2.4.2

The societal risk comparison must apply CNSC REGDOC-2.4.2 PSA methodology to the nuclear component. For non-nuclear alternatives, an equivalent risk quantification methodology must be applied using process safety, public health, and emissions risk frameworks appropriate to those technologies. The risk metrics must be expressed on a common scale (e.g., expected fatalities per TWh delivered, F-N curve, individual fatality risk per year at defined distances) to enable direct comparison.

5.4 Independent Peer Review

The comparative assessment must be independently peer-reviewed by experts with no financial relationship to the proponent, AtkinsRéalis, the CNSC, or any body funded by nuclear industry licence

fees. The peer review report must be filed on the IAAC registry simultaneously with the Impact Statement and must form part of the evidentiary record available to the Review Panel.

5.5 Sensitivity Analysis

The comparative assessment must present sensitivity analyses across the following key variables:

- MONARK PSA core damage frequency and large release frequency (given first-of-kind uncertainty and absence of operating data)
- Flex gas with CCS carbon intensity under varying upstream methane leakage rates (0.5% to 3.5%) and CCS capture rates (85% to 95%)
- BESS and VRFB capital cost trajectories using 2024 and projected 2030 cost data
- AESO market revenue under current and Restructured Energy Market pricing frameworks
- Alberta electricity load growth under low, central, and high demand scenarios

CONCLUSION AND AMENDMENTS REQUESTED

Two independent mandatory requirements, each grounded in a primary regulatory instrument or statutory provision, require the final TISG to include a comprehensive comparative assessment of flex gas with CCS and large-scale energy storage as viable competing technologies.

AMENDMENT REQUIRED

AMENDMENT 1 (REGDOC-2.5.2 §2.2.1): The final TISG must include a mandatory section requiring the proponent to provide a quantitative comparative societal risk assessment demonstrating that the aggregated MONARK societal risk — across all internal and external event sequences, expressed as core damage frequency, small release frequency, large release frequency, and individual and societal fatality risk — is comparable to or less than the societal risk of: (a) flex gas combined cycle with post-combustion carbon capture and storage at Alberta-specific grid conditions and upstream methane leakage rates; and (b) utility-scale BESS or VRFB storage in combination with available renewable generation in the Alberta AESO market. The assessment must apply REGDOC-2.4.2 PSA methodology to the nuclear component, apply equivalent risk quantification to comparators, use a common functional unit, use Alberta-specific data, and be independently peer-reviewed. The Impact Statement must not be accepted without this comparative demonstration.

AMENDMENT REQUIRED

AMENDMENT 2 (IAA s.22(1)(f)/(i)): The final TISG must require the proponent to: (a) assess flex gas with CCS, utility-scale BESS, and renewable-plus-VRFB combinations as technically and economically feasible 'alternatives to' the designated project under IAA s.22(1)(f), including comparative effects on the environment, health, social and economic conditions; (b) assess the AP1000 as a technically and economically feasible 'alternative means' of carrying out the designated project under IAA s.22(1)(i), given the proponent's own October 2025 Westinghouse partnership; and (c) provide a rationale for the selection of the preferred technology that explicitly addresses why MONARK is preferred over each assessed alternative, with reference to the comparative effects data. This requirement arises from the IAAC's own SOI identification of technology alternatives as a key issue and must be included in the final TISG to avoid an unexplained departure from a stated position reviewable under Vavilov.

