Comments on the Project Description (PD) for the
Micro Modular Reactor™ Project at Chalk River, Reference Number: 80182.

Two noteworthy findings of the CNSC's Phase 1 Pre-Licensing Vendor Design Review (VDR) Executive Summary for the MMR™, February 7th 2019[1] were to request additional information to confirm:

- *the adequacy of the R&D activities to substantiate MMR™ safety claims and the fuel qualification program, including the role of a first-of-a-kind reactor, and*
- *the applicability of the operating experience data from previous high-temperature gas-cooled reactors to the MMR™ design and safety analyses.*

The importance of just these two sample CNSC requests suggest to this reviewer that the PD was insufficiently complete and that releasing the PD for public comment at this stage was premature. Comments below provide specific examples, relevant to these requests, where the reviewer believes inadequate design information and other examples of fundamental project information are lacking in the PD.

The PD provides no evidence of any agreement or assurance from AECL of an MMR™ site at CNL. Such evidence should be a prerequisite, prior to the Phase 1 PD release. Regardless, on March 20, 2019, Global First Power submitted an application for a licence to prepare the site for the MMR™ on AECL property at CNL[2]. Phase 2, Pre-Licensing Assessment for Any Potential Fundamental Barriers to Licensing[3] however, requires further details needed to identify any fundamental barriers to licensing the vendor's design in Canada. Submitting a licence application for site preparation before Phase 2 thus does not appear to be a logical step of a licensing process.

Moreover, CNL is identified only as a potential user of the reactor heat output. Similarly, the local area electrical grid is only a proposed electrical power customer. There is no indication on whether the grid capability is adequate. Without commercial agreements of any type being in place for thermal or electrical production, the claim that the MMR™ is an economically competitive commercial deployment seems unrealistic. While commercial viability is neither relevant to the VDR, nor to the Canadian Environmental Assessment Act (CEAA) 2012, the PD should at least provide some detail, or references, to justify the claim of a commercially competitive facility, if it is made. Vague statements on what the

[1] https://nuclearsafety.gc.ca/eng/reactors/power-plants/pre-licensing-vendor-design-review/executive-summary-ultra-safe-nuclear-corporation.cfm

[2] https://www.globalfirstpower.com/post/global-first-power-submits-a-licence-to-prepare-site-ltps-application-to-the-cnsc

[3] http://www.nuclearsafety.gc.ca/eng/reactors/power-plants/pre-licensing-vendor-design-review/index.cfm#p2

very output of the facility is supposed to be used for, means even the basic technical scope is still unclear for public reviewers.

Key project activities, related to a first-of-a-kind reactor in Canada and relevant to a PD, are also not disclosed. Examples are the unidentified manufacturing sources of the most important and costly components of the MMR™; enriched fuel; licensed enriched fuel fabrication facility; reactor-grade graphite; reactor vessel module and the turbo-generator. There are no Canadian manufacturers identified for any of these components, so shipping activities will be significant. Many years of fuel testing will also be required, but is not mentioned in the PD. There is no fuel and materials test reactor in Canada to support this important requirement. While not relevant for the PD, the marketing claim made of providing Canada with economic benefits, would thus seem doubtful, in view of the absence of Canadian suppliers for all the above key components. Accompanying technical credibility, relevant to the PD, might then also seem doubtful.

The Canadian Nuclear Research Initiative[4] (CNRI) also claims that experimental studies in the CNL ZED-2 critical assembly facility will be used to support the project. The current ZED-2 safety case and the facility support equipment are specifically applicable for heavy water reactor physics calibrations. The safety case and the facility would require very significant changes to obtain licensing approval to provide any useful experiments for an MMR™.

According to other MMR public information, the reactor core will be shipped in a sealed transportable module designed for a 20-year or so operating life, with no need, nor any provision for refuelling. If any core changes were needed, as a result of ZED-2 calibrations, how these would be done if the core is factory sealed, is not discussed. Exhibit 3.6 appears to show that a fuel 'element' comprises of a hexagonal graphite moderator block, containing stacks of fuel pellets. It is not clear whether the so-called full-length fuel channels are simply holes penetrating the graphite or utilize some type of liner. There is very limited information on the TRISO fuel particles and there is no information on the fuel pellet sheath/container (Exhibit 3-6) and the material to be used for this. The most important parameter, the fuel enrichment required, is also not mentioned. The project definition of a fuel element is quite different from that as understood in RD-367[5]: This fuel design feature will also involve shipping enriched fuel in a unique manner into Canada, a significant transnational activity, not mentioned in the PD.

RD-367 requires design information to be provided on all components of the fuel elements and assembly, as well as fuel interfacing systems. The PD does not provide even the most basic information on these components. Historical international operating experience, with somewhat similar fuel, is well established and documented in the literature. Yet not a

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[4] https://www.cnl.ca/en/home/commercial/cnl-s-canadian-nuclear-research-initiative-.aspx

[5] https://nuclearsafety.gc.ca/pubs_catalogue/uploads/RD-367-Design-of-Small-Reactor-Facilities_e.pdf

single reference on this topic, let alone on the project fuel-testing plan, is provided in the PD.

To obtain a lifetime fuel core, a burnable poison is needed and again there is no mention of how this most important feature will be achieved. A reviewer of the PD thus cannot comment on whether the important claim for a lifetime core is at all technically credible, even in a general way.

The reactor module is sealed for life and the fuel is not accessible. RD-367 requirements, that fuel assemblies shall be designed to permit adequate inspection and that provisions in the design shall allow for fuel integrity and inspection of irradiated fuel monitoring, thus appear to be precluded from the MMR™ design. This key design feature then seems to be mutually exclusive with the RD-367 requirement for inspection and yet merits no mention in the PD. Similarly the RD-367 requirement that the coolant pressure boundary shall be designed to permit adequate inspections throughout the lifetime of the reactor facility also seems mutually excluded by the design; at least as far as vessel internal inspections are concerned. It would seem that at least some rationale for both of these very basic design/operational issues, novel to all historical and existing Canadian reactors, should have been provided in the Phase 1 PD. These two particular issues, would be captured within the general topics listed in footnote [1]. Yet [1] (last paragraph) notes:

Notwithstanding the above, these issues are foreseen to be resolvable and will be followed up on in future Vendor Design Reviews.

This implies the CNSC has already foreseen solutions will be resolved in advance, although such issues themselves are not even identified in the PD.

The PD states that the reactor modules will be sized to allow usage of ISO standard shipping containers to expedite transport and site installation. Transnational shipping, of enriched fuel combined with graphite moderator in a sealed core, presumably also with pre-installed reactivity control devices, in a 'standard' shipping container does not appear to be credible, without further explanation. How a factory-sealed core after shipping to site, is then inspected to ensure reactor grade graphite (which exhibits brittle and quasi-brittle properties) and fuel integrity is maintained, would be worthy of some discussion at this preliminary stage.

With a lifetime core, fuel failures of any degree are not acceptable during lifetime operation. A fuel-testing program will be needed to demonstrate assurance of this. Yet the PD provides no information on fuel testing and Canada has no fuel / materials test testing reactor to support such a program.

The complete lack of useful detail in the PD on the most important aspect of fuel design contrasts by comparison with trivial information such as the location of a vehicle access road displayed in Exhibit 3-4. This indicates a lack of technical balance in the PD. While terminology might also perhaps be viewed as unimportant, the use of terms such as 'micro reactor' and 'station power' seems particularly inappropriate, to represent a facility

producing a power of 15 MW(th). Such unsuitable descriptions will likely encourage public comments that could be avoided by using appropriate terminology at the outset.

The reviewer also notes the Phase 2: Pre-Licensing Assessment for Any Potential Fundamental Barriers to Licensing[6] objective that:

This phase goes into further details with a focus on identifying any potential fundamental barriers to licensing the vendor's nuclear power plant design in Canada.

To ascertain whether the project is technically feasible to be licensed seems then to have already been prejudged in Phase 1, judging from the CNSC's Phase 1 review comment:

USNC has demonstrated its intent to comply with CNSC regulatory requirements and expectations for new reactors, as specified in REGDOC-2.5.2 and/or RD-367. In some cases, due to the unique characteristics of their design, USNC is proposing alternative approaches to meeting CNSC regulatory requirements.

In the reviewer's opinion, as a minimum, a list of the unique characteristics of the design, either not covered in RD-367, or unable to be in compliance with RD-367, should have been provided in the PD, with at least some mention of the approaches to be taken to meet regulatory requirements. This lack of technical information and the various other omissions mentioned above, lead to the conclusion that the PD is incomplete and prematurely released for public comment.

[6] http://www.nuclearsafety.gc.ca/eng/reactors/power-plants/pre-licensing-vendor-design-review/index.cfm