REQUEST FOR INFORMATION (RFI) No. 5000047166

Date: August 14, 2019 **File #:** R636.1

Subject: Request for Information (RFI) regarding Project ***"Fundamentals of Hydride Formation and Fracture"***

1. Background and Purpose of this RFI

The purpose of this RFI is to obtain information before finalizing the requirements definition and procurement strategy for the subject project which is being carried out by the Canadian Nuclear Safety Commission (CNSC).

The CNSC is undertaking this project to enhance fundamental knowledge of the mechanical behaviour of Zr-2.5Nb material with hydrides under stress. This study will review existing literature and develop an experimental approach to study the mechanical behaviour of zirconium hydrides and zirconium hydrides in Zr-2.5Nb material.

The details of the project and requirements are further outlined in Annex "A" – Statement of Work to this RFI.

2. Nature of this RFI

This Request for Information (RFI) is simply intended to solicit feedback from industry with respect to the matters described in this RFI and shall not be construed to be a bid solicitation and no agreement/contract will be entered into with/awarded to any vendor based on responses to this RFI, and it shall in no way be considered as authorization by Canada for vendors to undertake any work. This RFI shall in no way be considered as authorization by the CNSC for respondents to undertake any work, which would result in costs to the CNSC. The CNSC shall not be liable for, nor shall it reimburse any of the respondents, or any third-party, for any costs, fees or expenses, incurred in the preparation or submission of a response to this RFI.

Nothing in this RFI shall be construed as a commitment to issue a bid solicitation. Response to this RFI will not create any obligation. The CNSC shall not be bound by anything stated herein. Respondents shall not be bound by any aspect of their response to this RFI.

3. Nature and Format of Responses Requested

Respondents are requested to provide their responses to questions in Section 5.

4. Treatment of Responses

a) **Use of Response:** Responses will not be formally evaluated. All responses to this RFI will be held by the CNSC on a confidential basis (subject to applicable legislation) and remain the property of

the CNSC once they have been received. Respondents are advised, however, that information submitted may be used in the development of future bid solicitation documents.CNSC will review all responses received by the RFI closing date. CNSC may, in its discretion, review responses received after the RFI closing date. Not responding to this RFI shall in no way penalize bidders to any future bid solicitation.

b) **Confidentiality:** Respondents should mark any portions of their response that they consider proprietary or confidential. The CNSC will handle the responses in accordance with the Access to Information Act.

c) **Follow-up Activity:** The CNSC may contact any respondents to follow up with additional questions or for clarifications of any aspect of a response.

5. Questions to Interested Parties of this RFI

1) Would you/your organization be able to provide the services outlined in Annex "A" – Statement of Work (SOW) and be interested in bidding on any solicitation that may be issued related to the SOW?
2) Could the work be completed within the estimated dates related to the deliverables/milestones in the SOW and an estimated budget of $100,000.00 Canadian dollars, excluding applicable taxes but all-inclusive of travel etc.?
3) What would the estimated level of effort be to complete the work (in person days)?
4) What types of resources (human and otherwise) are required to complete the work including experience and qualifications?
5) Is the Statement of Work clear and reasonable?
6) Do you have any general comments or concerns regarding the SOW and/or suggestions for improvements to the SOW?

6. Submission of Responses to Questions to Interested Parties

a) **Response addressee:** Responses are to be sent by email to:

cnsc.solicitation-demandedesoumission.ccsn@canada.ca

b) **Closing Date for Submission of Responses:** Suppliers interested in providing a response shall submit their responses no later than 2:00 PM (EDT), September 16, 2019.

c) **Responsibility of Timely Delivery:** Each respondent is solely responsible for ensuring its response is delivered on time per the instructions specified in this RFI.

d) **Language of Response:** Responses may be in English or French at the preference of the respondent.

7. Response Preparation Costs

CNSC will not reimburse any respondent for expenses incurred in responding to this RFI.

8. Enquiries

Because this is not a bid solicitation, the CNSC will not necessarily respond to enquiries in writing or circulate answers to all potential suppliers/respondents. However, respondents with questions regarding the RFI may direct their enquiries by email to cnsc.solicitation-demandedesoumission.ccsn@canada.ca.

ANNEX "A" – STATEMENT OF WORK

1.0 Title

Fundamentals of Hydride Formation and Fracture (R636.1)

2.0 Objectives

The objective of this project is to enhance the fundamental understanding of the mechanical behaviour of Zr-2.5Nb material with hydrides under stress as observed in aged pressure tubes and fracture tests. This would include studies on hydride formation, reorientation, mechanical behaviour, deformation and fracture in blank specimens (i.e. without introduced macroscopic cracks and before a macroscopic crack).

This investigation would provide complementary information to existing data on the mechanical behaviour of Zr-2.5Nb material with hydrides.

3.0 Background

Pressure tubes exposed to reactor coolant environments show an increase in hydrogen equivalent concentration, [H_{eq}] with operating time. Zirconium hydrides can form during thermal cycles when precipitation conditions are satisfied. Fundamental studies on formation, reorientation and fracture of zirconium hydrides are required to understand the mechanical behaviour of pressure tube materials as they age. The experimental results of pressure tube material with zirconium hydride typically show considerable variability accounted by statistical models. Statistical models should consider the material's mechanical behaviour to avoid any considerable uncertainties in the model.

4.0 Scope of Work

The scope of work includes the following:

- Literature review on the formation, reorientation, mechanical behaviour, deformation and fracture of zirconium hydrides in zirconium alloys under biaxial stress, and ahead of cracks.
- Detailed experimental investigation (possibly using X-ray diffraction) to determine zirconium hydride morphology and reorientation of pressure tubes operating under stress conditions and thermal transients for Zr-2.5Nb material with hydrogen concentrations of 60 ppm [H_{eq}] to 160 ppm [H_{eq}].
- Detailed experimental investigation (possibly using X-ray diffraction) to determine the mechanical behaviour, deformation and fracture toughness of zirconium hydrides in Zr-2.5Nb material with hydrogen concentrations of 60 ppm [H_{eq}] to 160 ppm [H_{eq}]. This investigation is for blank specimens (e.g. either flat or curved) and specimens with axially oriented macroscopic cracks.

- Present findings in conference proceedings or international journals.

Un-irradiated Zr-2.5Nb pressure tube material will be provided (in the same condition after a typical manufacturing process) upon request.

5.0 Tasks to be Performed

1. Participate in a start-up meeting at the CNSC head office via teleconference to discuss and clarify an envisioned approach to ensure that the project objectives will be met. The contractor shall prepare a presentation for the CNSC staff with the above purpose in mind.
2. Develop a detailed work plan subject to CNSC review and acceptance based on the approach discussed at the start-up meeting/teleconference.
3. Perform a review of the formation, reorientation, deformation and fracture of hydrides in zirconium alloys under biaxial stress, and ahead of macroscopic cracks. Publish a review paper in conference proceedings or international journals.
4. Experimentally investigate hydride morphology and reorientation under different stress conditions and thermal transients in Zr-2.5Nb material with hydrogen concentration 60 ppm [H_{eq}] to 160 ppm [H_{eq}]. This investigation is for blank specimens and specimens with axially oriented through-wall cracks.
5. Experimentally investigate deformation and fracture of hydrides in Zr-2.5Nb material with hydrogen concentration 60 ppm [H_{eq}] to 160 ppm [H_{eq}]. This investigation is for blank specimens and specimens with axially oriented through-wall cracks.
6. Prepare reports subject to CNSC review and acceptance, and disposition of CNSC comments if any.
7. Prepare and give a presentation summarizing findings, conclusions and recommendations.
8. Any other tasks as identified in the CNSC approved work plan proposed by the contractor.

6.0 Deliverables

All deliverables are to be submitted to the Project and Technical Authority.

6.1 Start-up Meeting

Date: Within two (2) weeks of contract award.

Location: Via Tele/Videoconference or CNSC Head Office, Ottawa, as required.

Purpose: To discuss and clarify the proposed approach, work plan and schedule to ensure achievement of the contract objectives. The contractor shall make a presentation with the above purpose in mind.

6.2 Progress Meetings

Dates: Bi-monthly.

Location(s): CNSC head office or via tele/videoconference.

Purpose: To assess the degree to which the agreed project objectives are being achieved as planned and thus to facilitate timely adjustments (if necessary) to ensure the project success.

6.3 Detailed Work Plan

Due Date: Two (2) months after contract award.

Copies: One electronic copy via email to the Project and Technical Authority.

Format and style requirements: As specified in the Final Report.

6.4 Progress Report #1 (subject to CNSC review and acceptance)

The report shall include the following:

- A table of contents
- Discussion of initial findings
- Reference the Detailed Work Plan and give an update of work completed to-date

Due Date: Eight (8) months after contract award

Copies: One electronic copy via email to the Project and Technical Authority.

Format and style requirements: As specified in Section 7.0.

6.5 Progress Report #2 (subject to CNSC review and acceptance)

The report shall include the following:

- A table of contents
- Discussion of findings
- Reference the Detailed Work Plan and give an update of work completed to-date

Due Date: Fifteen (15) months after contract award

Copies: One electronic copy via email to the Project and Technical Authority.

Format and style requirements: As specified in Section 7.0.

6.6 Draft Final Report

The report shall include the following:

- Abstract
- A table of contents
- Discussion of major findings and achievements, and confirmation that the project objectives as outlined in Section 3.0 were met
- Reference the Work Plan and confirm the scope of work outlined in Section 4.0 was satisfied
- Reference the Work Plan and confirm the tasks outlined in Section 5.0 were completed

Due Date: Twenty two (22) months after contract award

Copies: One electronic copy via email to the Project and Technical Authority.

Format and style requirements: As specified in Section 7.0.

6.7 Presentation

Due Date: Twenty two (22) months after contract award

Location: The CNSC Head Office, Ottawa

Purpose: To present the project findings, conclusions and recommendations documented in the Draft Report.

6.8 Final Report

Due Date: Twenty three (23) months after contract award

Copies: One electronic copy via email to the Project and Technical Authority. The contractor shall submit the Final Report in a format compatible with Microsoft Word 2010. The contractor shall also submit the Final Report in PDF format.

Any pressure tube material specimens provided by the CNSC should be returned to the CNSC upon completion the contract.

6.9 Final Report Abstract/Summary

Due Date: Twenty three (23) months after contract award

Copies: One electronic copy via email to the Project Authority

Format and style requirements: 300 words or less providing a stand-alone statement that conveys the

essential information of the Final Report. The abstract shall include the following: a) context; b) purpose/objective of the research; c) approach/scope/method/findings. The abstract shall be written in a style that can be widely understood by the general public. The CNSC reserves the right to modify or translate of the Abstract into French or English.

7.0 Format of Deliverables

To be specified by the Project Authority. The font Times New Roman 12 is to be used. Electronic copies shall be provided in a format readable by Microsoft Word with minor formatting changes. Any electronic files that cannot be read or require major formatting changes when opened are not acceptable and may be returned to the contractor for correction. The CNSC reserves the right, at its own discretion, to have the final report printed under CNSC cover, and to distribute it publicly. Translation of the abstract into French or English, CNSC report covers and the publication number will be provided by the CNSC.

8.0 Government Furnished Equipment/Information

The CNSC will provide un-irradiated Zr-2.5Nb pressure tube material (in the same condition after a typical manufacturing process) upon request.

9.0 Language of Work

The Contractor shall provide all project deliverables in English.

10.0 Travel Requirements

The contractor may be required to travel to Ottawa, ON for progress meetings and to give the final presentation at the CNSC head office.

11.0 Location of Work

All work shall be completed at the contractor's location. The contractor shall give their final presentation at the CNSC head office in Ottawa, ON.