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Canadian Nuclear Safety Commission (CNSC)

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**REQUEST FOR PROPOSAL (RFP)**

**Proposal to: Canadian Nuclear Safety Commission (CNSC)**

We hereby offer to sell to Her Majesty the Queen in right of Canada, in accordance with the terms and conditions set out herein, referred to herein or attached hereto, the goods and services listed herein and on any attached sheets at the price(s) set out thereof.

**Instructions: See herein**

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Canadian Nuclear Safety Commission

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<b>Title:</b> R674.1 - Investigation of two-phase flow phenomena in reactor headers	
<b>Solicitation no.:</b> 87055-17-0173/A	<b>Date:</b> December 18, 2017
<b>File No. – N° de dossier:</b>	
<b>Solicitation closes:</b>  <u>At 2 p.m. / 14 h,</u> <u>January 31, 2018</u>	<b>Time zone:</b>  Eastern Standard Time Time (EST)
<b>Address inquiries to:</b> Robert Kardum, Senior Contracting Officer	
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<b>Destination:</b> See herein	

<b>Delivery required:</b>  (see herein)	<b>Delivery offered:</b>
<b>Supplier name and address:</b>	
<b>Telephone:</b>	
<b>Fax:</b>	
<b>Name and title of person authorized to sign on behalf of supplier (type or print):</b>	
<b>Signature</b>	<b>Date</b>



## **Bid Solicitation**

### **For the Provision of**

# **R674.1 - Investigation of Two-Phase Flow Phenomena in Reactor Headers**



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## **PART 1 – GENERAL INFORMATION**

It is understood that the procurement of services for the Canadian Nuclear Safety Commission (CNSC) falls under the provisions of the *Nuclear Safety and Control Act*, S.C. 1997, c. 9.

### **1.1 Introduction**

The bid solicitation is divided into six parts plus attachments and annexes, as follows:

Part 1 General Information: provides a general description of the requirement;

Part 2 Bidder Instructions: provides the instructions, clauses and conditions applicable to the bid solicitation;

Part 3 Bid Preparation Instructions: provides Bidders with instructions on how to prepare their bid;

Part 4 Evaluation Procedures and Basis of Selection: indicates how the evaluation will be conducted, the evaluation criteria that must be addressed in the bid, and the basis of selection;

Part 5 Certifications and Additional Information: includes the certifications and additional information to be provided;

Part 6 Resulting Contract Clauses: includes the clauses and conditions that will apply to any resulting contract.

#### **List of Annexes to the Resulting Contract:**

[Annex “A” Statement of Work](#)

[Annex “B” Basis of Payment](#)

#### **List of Attachments to Part 3 (Bid Preparation Instructions) :**

[Attachment 1 to Part 3 – Pricing Schedule](#)

#### **List of Attachments to Part 4 (Evaluation Procedures and Basis of Selection) :**

[Attachment 1 to part 4 – Evaluation Procedures](#)

### **1.2 Security Requirement**

There is no security requirement associated with the requirement.

### **1.3 Statement of Work**

The work to be performed is detailed in [Annex A](#) attached to this request for proposals.



## 1.4 Debriefings

After a contract is awarded, bidders may request a debriefing on the results of the bid solicitation process. Bidders should make the request to the contracting authority within 15 working days of receipt of the results of the bid solicitation process. The debriefing may be in writing, by telephone or in person.



## **PART 2 – BIDDER INSTRUCTIONS**

### **2.1 Standard Instructions, Clauses and Conditions (A0000T – 2012-07-16 – modified)**

2.1.1 All instructions, clauses and conditions incorporated by reference in the bid solicitation (number, date and title) are set out in the [Standard Acquisition Clauses and Conditions \(SACC\) Manual](http://buyandsell.gc.ca/policy-and-guidelines/standard-acquisition-clauses-and-conditions-manual) ([buyandsell.gc.ca/policy-and-guidelines/standard-acquisition-clauses-and-conditions-manual](http://buyandsell.gc.ca/policy-and-guidelines/standard-acquisition-clauses-and-conditions-manual)) issued by Public Works and Government Services Canada. All of the clauses of this document are legally binding on the parties.

2.1.2 Bidders who submit a bid agree to be bound by the instructions, clauses and conditions of the bid solicitation and accept the clauses and conditions of the resulting contract.

2.1.3 The [2003 \(2017-04-27\) Standard Instructions – Goods or Services – Competitive Requirements](#) are incorporated by reference into and form part of the bid solicitation. The following changes are made:

a) delete section 02 in its entirety;

b) in section 03, delete “Pursuant to the Department of Public Works and Government Services Act (S.C. 1996, c.16),”

c) Revise subsection 2d of section 5, Submission of Bids, to read:

*“send its bid only to the CNSC as specified on page 1 of the bid solicitation”.*

d) Revise subsection 4 of section 05, Submission of Bids, as follows:

Delete: sixty (60) days

Replace with: one hundred and eighty (180) days

e) In sections 06 and 07

Delete: “PWGSC”

Replace with: “CNSC”

f) Delete section 8, Transmission by Facsimile, in its entirety.

g) Delete subsections 1a and 1b of section 12, Rejection of Bid, and replace with:

a) Bidders are advised that the CNSC reserves the right to consider, as part of its evaluation, any unsatisfactory performance in a previous or current project performed by the bidder, proposed subcontractor or individual proposed resource either on contract or under previous CNSC employment.

b) Additionally, bidders shall take note that once awarded, the performance of the contractor during and upon completion of the work shall be evaluated by the CNSC. The evaluation may include all or some of the following criteria: quality of deliverables, timeliness of completion of the work, project management, contract management, and cost. Should the contractor's performance be considered unsatisfactory, the contractor may be declared ineligible for future CNSC contracts.



h) Add the following paragraphs to section 18, Conflict of Interest – Unfair Advantage:

**Conflict of Interest – Performance of the Work**

- i. The CNSC reserves the right to review real, potential or apparent conflict(s) of interest. Bidders must disclose any of their activities related to the subject of the statement of work that are licensed by the CNSC. Bidders are also required to disclose any involvement in previous, current or planned work undertaken for a CNSC licensee that is or may be related to the subject of the statement of work. Such activities or work are not in themselves grounds for rejection; however, proposals to review previous work contributed by the bidder on behalf of a CNSC licensee, and proposals to make recommendations affecting the CNSC licensing decisions in which the bidder has a financial or non-financial interest may be rejected.
- ii. Bidders must address in detail, in their submitted bids, any real, potential or apparent conflict(s) of interest they may encounter while performing the work, and must substantiate which measures they are taking to prevent the conflict(s). If in doubt about a particular situation, bidders may contact the Contracting Authority before bid closing. The CNSC reserves the right to reject any bids in which a real, potential or apparent conflict of interest exists.

i) Delete subsection 2 of section 20, Further Information, in its entirety.

## **2.2 Submission of Bids**

- 2.2.1 Bids must be submitted only to the CNSC by the date, time and place indicated on page 1 of the Request for Proposal.
- 2.2.2 Due to the nature of the bid solicitation, bids transmitted by facsimile to the CNSC will not be accepted.

## **2.3 Former Public Servant**

See [Part 5 – Certifications, Certification](#) required with the bid and section [6.6 of Part 6 – Resulting Contract Clauses](#).

## **2.4 Enquiries – Bid Solicitation Period**

- 2.4.1 All inquiries must be submitted in writing to the contracting authority no later than four (4) calendar days before the bid closing date. Inquiries received after that time may not be answered.
- 2.4.2 Bidders should reference as accurately as possible the numbered item of the bid solicitation to which the inquiry relates. Care should be taken by bidders to explain each question in sufficient detail in order to enable the CNSC to provide an accurate answer. Technical inquiries that are of a proprietary nature must be clearly marked "proprietary" at each relevant item. Items identified as "proprietary" will be treated as such except where the CNSC determines that the inquiry is not of a proprietary nature. The CNSC may edit the questions or may request that the bidder do so, so that the proprietary nature of the question is eliminated, and the inquiry can be answered with copies to all



bidders. Inquiries not submitted in a form that can be distributed to all bidders may not be answered by the CNSC.

## **2.5 Applicable Laws**

2.5.1 Any resulting contract must be interpreted and governed, and the relations between the parties determined, by the laws in force in Ontario.

2.5.2 Bidders may, at their discretion, substitute the applicable laws of a Canadian province or territory of their choice without affecting the validity of their bid, by deleting the name of the Canadian province or territory specified and inserting the name of the Canadian province or territory of their choice. If no change is made, it acknowledges that the applicable laws specified are acceptable to the bidders.





## **PART 3 – BID PREPARATION INSTRUCTIONS**

### **3.1 Bid Preparation Instructions**

3.1.1 The CNSC requests that bidders provide their full company name and address, as well as a contact name, telephone number and fax number.

3.1.2 The CNSC requests that bidders provide copies of their bid in separate sections, as follows:

Section I: Technical Bid (1 copy by email)

Section II: Financial Bid (1 copy by email)

Section III: Certifications (1 copy by email)

3.1.3 **Prices must appear in the financial bid only.** No prices must be indicated in any other section of the bid.

### **3.2 Section I: Technical Bid**

- a) In their technical bid, bidders should explain and demonstrate how they propose to meet the requirements and how they will carry out the Work.
- b) Technical bids should address clearly and in sufficient depth the elements that are subject to the evaluation criteria against which the bid will be evaluated. Simply repeating the statement contained in the bid solicitation is not sufficient. In order to facilitate evaluation of bids, the CNSC requests that bidders address and present topics in the order of the evaluation criteria and under the same headings. To avoid duplication, bidders may refer to different sections of their bids by identifying the specific paragraph and page number where the subject topic has already been addressed.
- c) Technical bids must demonstrate compliance with all mandatory evaluation criteria and should specifically respond to each of the point-rated technical evaluation criteria.
- d) If a mandatory evaluation criterion is not complied with, the bid will be considered non-responsive and will not receive further consideration. Variations on mandatory criteria will not be accepted.

### **3.3 Section II: Financial Bid**

- a) Bidders must submit their financial bids **in Canadian dollars**, in accordance with the pricing schedule detailed in [Attachment 1 to Part 3](#) of this bid solicitation. The total amount of Applicable Taxes must be shown separately, if applicable. Bidders must also reference [Annex B: Basis of Payment](#), when preparing their financial bids.



### 3.4 Section III: Certifications

Bidders must submit the certifications required under [Part 5](#) of this bid solicitation.



### ATTACHMENT 1 TO PART 3 – PRICING SCHEDULE

1. The bidder must complete this pricing schedule and include it in its Financial Bid.
2. Any estimated level of effort specified in this pricing schedule is provided for bid evaluated price determination purposes only. It is only an approximation of the requirements and is not to be considered as a contract guarantee. Levels of effort are provided as estimates only, and must not be construed as a commitment by the CNSC to respect those estimated in any resulting contract.

Firm all-inclusive price for each deliverable:

Deliverable	Delivery date	All-inclusive Firm price
First Formal Progress Report (del. 5.3)	Within one year of granting the contract (April 2019)	\$ _____
Second Formal Progress Report (del. 5.4)	Within the second year of the contract period (April 2020)	\$ _____
Draft Final Report (del 5.5)	Within six months of the second progress report (October 2020)	\$ _____
Presentation (del. 5.6)	Within three months of the submission of the draft final report (by January 31st, 2021)	\$ _____
Final Report (del. 5.7)	By February 28, 2021	\$ _____
<b>Total evaluated firm price*</b> (applicable taxes extra)		\$ _____
* <b><u>Must not exceed the overall maximum funding of \$210,000 plus applicable taxes</u></b>		

The bidder may propose a different deliverables schedule in the bid; however, all payments must be linked to specific deliverables with at least 20 percent reserved for final payment.



## **PART 4 – EVALUATION PROCEDURES AND BASIS OF SELECTION**

### **4.1 Evaluation Procedures**

- (a) Bids will be assessed in accordance with the entire requirement of the RFP, including the technical and financial evaluation criteria.
- (b) An evaluation team composed of CNSC representatives will evaluate the bids.

#### **4.1.1 Technical Evaluation**

##### **a) Mandatory technical criteria**

Refer to [Attachment 1 to Part 4](#) of this RFP.

##### **b) Point-Rated technical criteria**

Refer to [Attachment 1 to Part 4](#) of this RFP. Point-rated technical criteria not addressed in the bid will be given a score of zero.

#### **4.1.2 Financial Evaluation**

- a) Refer to [Attachment 1 to Part 3](#) of this RFP.
- b) For bid evaluation and contractor(s) selection purposes only, the evaluated price of a bid will be determined in accordance with the Pricing Schedule detailed in [Attachment 1 to Part 3](#) of this RFP.

#### **4.1.3 Evaluation of Price**

The price of the bid will be evaluated in Canadian dollars, with Applicable Taxes excluded, FOB destination, Canadian customs duties and excise taxes included.

### **4.2 Basis of Selection**

#### **(a) Basis of Selection – Highest Rated Within Budget (A0036T – 2007-05-25)**

1. To be declared responsive, a bid must:
  - a. comply with all the requirements of the bid solicitation; and
  - b. meet all mandatory technical evaluation criteria; and
  - c. obtain the required minimum of 75 points overall for the technical evaluation criteria which are subject to point rating. The rating is performed on a scale of 100 points.
2. Bids not meeting any of the requirements set out above in subsection 1 will be declared non-responsive.



3. The responsive bid with the highest number of points will be recommended for award of a contract, provided that the total evaluated price does not exceed the budget available for this requirement.

(b) **Maximum Funding**

The maximum funding available for the Contract resulting from the bid solicitation is **\$210,000.00** (applicable taxes extra). Bids valued in excess of this amount will be considered non-responsive. This disclosure does not commit Canada to pay the maximum funding available.

(c) Bidders should note that all contract awards are subject to Canada's internal approvals process, which includes a requirement to approve funding in the amount of any proposed contract. Despite the fact that the Bidder may have been recommended for contract award, a contract will only be awarded if internal approval is granted according to Canada's internal policies. If approval is not granted, no contract will be awarded.



## ATTACHMENT 1 TO PART 4 – EVALUATION PROCEDURES

### 1. Mandatory Technical Criteria

- 1.1 The bid must meet the mandatory technical criteria specified below. The bidder must address each criterion separately and provide the necessary documentation to support compliance with each criterion.
- 1.2 Any bid that fails to meet the mandatory technical criteria will be declared non-responsive and will receive no further consideration.

No.	Mandatory technical criteria	Met/Not met	Bidder's cross-reference to proposal
M1	The project lead investigator must have as minimum MSc. Degree in engineering or in a related discipline from a recognized university		
M2	The bidder must demonstrate that they have at least 10 years of research experience the field of thermal hydraulics and safety of nuclear power plants.		



## 2. Point-Rated Technical Criteria

- 2.1 Any bid that meets all the mandatory technical criteria will be evaluated and scored in accordance with the following table. The Bidder must provide the necessary documentation to demonstrate its qualifications and capabilities in relation to each criterion.
- 2.2 Any bid that fails to obtain the required minimum number of points specified will be declared non-responsive and will receive no further consideration.

#	RATED CRITERIA	SCORES TO BE ASSIGNED BASED ON THE FOLLOWING	WEIGHT FACTOR	MAX POINTS	Bidder's Cross Reference to Proposal
R1	<p><b>Understanding of scope and objectives</b></p> <p>The bidder should demonstrate that they understand the objectives and scope.</p> <p>The Bidder should include a short introduction with a brief evaluation of the need for the project, the objectives of the proposed Work, and the reasons for carrying it out as proposed and the benefits to be derived.</p>	<p><b>0 Points</b> - incorrect understanding of scope and objective</p> <p><b>1 Point</b> – given verbatim from RFP and understanding is not fully demonstrated</p> <p><b>3 Points</b> - good understanding of scope and objectives</p> <p><b>5 Points</b> - in-depth understanding of scope and objective fully demonstrated</p>	x2	<b>10</b>	
R2	<p><b>Recognition of problems and solutions proposed</b></p> <p>The bidder should identify potential or anticipated major</p>	<p><b>0 Points</b> - fails to identify any potential problems</p> <p><b>1 Point</b> - 1 to 2 major difficulties identified; proposed solutions will not adequately resolve</p>	x2	<b>10</b>	



	problems and/or difficulties that could affect the outcome of the work and address how these will be addressed and resolved.	<p>all</p> <p><b>2 Points</b> - 1 to 2 major difficulties identified; proposed solutions adequately resolve all</p> <p><b>3 Points</b> - 3 to 4 major difficulties identified; proposed solutions will not adequately resolve all</p> <p><b>4 Points</b> - 3 to 4 major difficulties identified; proposed solutions adequately resolve all</p> <p><b>5 Points</b> - 5 or more difficulties identified, proposed solutions are innovative</p>			
<b>R3</b>	<p><b>Proposed work feasibility, approach and methodology</b></p> <p>The Bidder should clearly outline its approach and proposed methodology to meet the requirement as well as the degree of success expected. The proposed approach should be compliant with the requirements of the Statement of Work provided as part of the bid solicitation. Sufficient detail should be provided to demonstrate the Bidder's grasp of the requirement and the Bidder's competence to meet it.</p>	<p><b>0 Points</b> - not addressed in proposal</p> <p><b>1 Point</b> - approach and methodology does not expand from RFP</p> <p><b>3 Points</b> - approach and methodology address the RFP requirements with adequate level of success</p> <p><b>5 Point</b> - approach and methodology address the RFP requirements with high level of level of success</p> <p><b>7 Points</b> - novel benchmarking approach /methodology with an adequate level of success</p> <p><b>10 Points</b> - novel benchmarking approach/methodology with a high level of success</p>	X2	<b>20</b>	
<b>R4</b>	<b>Adequacy of work plan,</b>	<u>Work Plan/ Tasks to be Performed (Max. of 2</u>	x1.5	<b>15</b>	





	<p><b>level of effort (per person/task) and schedule</b></p> <p>The bidder should provide a work plan include a list of specific tasks and deliverables, the level of effort (per person, per task) in hours or days, and the proposed schedule for completion or delivery.</p>	<p><b>points)</b></p> <p><b>0 Points</b> - not addressed in proposal</p> <p><b>1 Point</b> - work plan does not expand from RFP</p> <p><b>2 Points</b> - work plan is well explained and meets the requirements of the RFP</p> <p><u>Schedule (Max. of 2 points)</u></p> <p><b>0 Points</b> - not addressed in proposal</p> <p><b>1 Point</b> - schedule is as per RFP with no indication that <u>bidder feels</u> it is realistic</p> <p><b>2 Points</b> - adequate schedule</p> <p><u>Level of Effort (Max. of 6 points)</u></p> <p><b>0 Points</b> - not addressed in technical proposal</p> <p><b>2 Points</b> - adequate total level of effort; critical work performed by junior personnel</p> <p><b>4 Points</b> - adequate total level effort, critical work performed by appropriate mix of junior/senior personnel</p> <p><b>6 Points</b> - adequate total level of effort; critical work performed by recognized subject matter experts</p>			
<p><b>R5</b></p>	<p><b>Proposed management of the project and the qualifications and relevant experience of the Project Manager, including position within the organization</b></p>	<p><u>Experience (Max. of 3 points)</u></p> <p><b>0 Points</b> - no project mgmt experience; experience not demonstrated in proposal</p> <p><b>1 Point</b> - 2 to 4 years project mgmt experience</p> <p><b>3 Points</b> - 5+ years project mgmt experience</p>	<p>x1</p>	<p><b>5</b></p>	



	<p>The Bidder should identify the Project Manager who will be assigned to this requirement, demonstrating position with organization, experience, education, and qualifications. His/her curriculum vitae should also be included.</p>	<p><u>Position (Max. of 2 points)</u>  <b>0 Points</b> - not addressed  <b>1 Point</b> - no authority to (re)direct resources  <b>2 Points</b> - authority to (re)direct resources</p>			
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For 6.1, 6.2, 6.3 and 6.4 please note that the main resource assigned to perform the related task(s) shall be evaluated for the associated experience required. If the main resource has not been identified and two or more resources with different experience levels have been named, the score assigned will be the average of the sum of the individual resource scores (e.g. manager level resource and subject matter expert identified with no clear assignment the score given shall be  $(3+5)/2 = 4$ )

<p><b>R6.1</b></p>	<p>The bidder should demonstrate proven experience in the field of two-phase flow theory and modeling.</p>	<p><b>0 Points</b> - no demonstrated experience  <b>1 Point</b> - less than 2 years demonstrated experience  <b>2 Points</b> - less than 4 years but more than 2 years demonstrated experience  <b>4 Points</b> - less than 10 years but more than 4 years demonstrated experience  <b>5 Points</b> - more than 10 years demonstrated experience  <b>6</b></p>	<p>x1</p>	<p><b>5</b></p>	
<p><b>R6.2</b></p>	<p>The bidder should demonstrate proven experience in the design and conduct of experiments in the field</p>	<p><b>0 Points</b> - no demonstrated experience  <b>1 Point</b> - less than 2 years demonstrated experience  <b>2 Points</b> - less than 4 years but more than 2</p>	<p>x1</p>	<p><b>5</b></p>	



	of thermal and fluid engineering	<p>years demonstrated experience</p> <p><b>4 Points</b> - less than 10 years but more than 4 years demonstrated experience</p> <p><b>5 Points</b> - more than 10 years demonstrated experience</p>			
<b>R6.3</b>	The bidder should demonstrate proven experience in the field of computational fluid dynamics applications( development of computer codes and numerical schemes)	<p><b>0 Points</b> - no demonstrated experience</p> <p><b>1 Point</b> - less than 2 years demonstrated experience</p> <p><b>2 Points</b> - less than 4 years but more than 2 years demonstrated experience</p> <p><b>4 Points</b> - less than 10 years but more than 4 years demonstrated experience</p> <p><b>5 Points</b> - more than 10 years demonstrated experience</p>	x1	<b>5</b>	
<b>R6.4</b>	The bidder should demonstrate proven experience in the thermal-hydraulic design and analysis of CANDU reactors	<p><b>0 Points</b> - no demonstrated experience</p> <p><b>1 Point</b> - less than 2 years demonstrated experience</p> <p><b>2 Points</b> - less than 4 years but more than 2 years demonstrated experience</p> <p><b>4 Points</b> - less than 10 years but more than 4 years demonstrated experience</p> <p><b>5 Points</b> - more than 10 years demonstrated experience</p>	x1	<b>5</b>	
<b>R7</b>	<b>Proposed organization, including availability of team members, reporting structure, quality assurance of reported information</b>	<p><b>0 Points</b> - not addressed in proposal</p> <p><b>2 Points</b> - defined reporting structure; proposed team with no apparent quality assurance program</p> <p><b>3 Points</b> - well defined reporting structure; proposed organization have internal review process to validate the reported information</p>	x2	<b>10</b>	



	<p>The Bidder should include a description of the team, the reporting structure, major subcontractors as applicable, as well as the measures/ procedures in place to ensure correctness and truthfulness of reported information.</p>	<p><b>5 Points</b> - well defined reporting structure; proposed organization have well established quality assurance program.</p>			
<p><b>R8</b></p>	<p><b>Bidder’s organization, including subcontractors - its relevant experience and competence proven by similar work in nature and size, and resource capability</b></p> <p>The Bidder should demonstrate the background and experience of its organization, particularly as it relates to this requirement, as well as the background and experience of proposed subcontractors. Also, where subcontractors are proposed as part of the project team, the Bidder should provide a list of the individual</p>	<p><b>0 Points</b> - not addressed in proposal</p> <p><b>1 Point</b> - bidder/subcontractor has experience with 1 to 2 successful prior relevant project</p> <p><b>3 Points</b> - bidder/subcontractor has experience with 3 to 4 successful prior relevant project</p> <p><b>5 Points</b> - bidder/subcontractor are well known in field of study with 5+ successful prior relevant projects</p>	<p>x2</p>	<p><b>10</b></p>	



	subcontracts proposed, describe the work to be performed by each one and include/explain the proposed basis of selection for each one.				
	<b>TOTAL</b>			<b>100</b>	

The Bidder must obtain a minimum pass mark of 75% of the overall points (75/100) for its bid to be considered responsive.



## **PART 5 – CERTIFICATIONS**

Bidders must provide the required certifications and additional information to be awarded a contract.

The certifications provided by Bidders to Canada are subject to verification by Canada at all times. Unless specified otherwise, Canada will declare a bid non-responsive, or will declare a contractor in default if any certification made by the Bidder is found to be untrue, whether made knowingly or unknowingly, during the bid evaluation period or during the contract period.

The Contracting Authority will have the right to ask for additional information to verify the Bidder's certifications. Failure to comply and to cooperate with any request or requirement imposed by the Contracting Authority will render the bid non-responsive or constitute a default under the Contract.

### **5.1 Certification Required With the Bid**

Bidders must submit the following duly completed certifications as part of their bid.

#### **5.1.1 Integrity Provisions - Declaration of Convicted Offences**

In accordance with the *Ineligibility and Suspension Policy* (<http://www.tpsgc-pwgsc.gc.ca/ci-if/politique-policy-eng.html>), the Bidder must provide with its bid the required documentation, as applicable, to be given further consideration in the procurement process:

- Integrity Declaration Form: <http://www.tpsgc-pwgsc.gc.ca/ci-if/declaration-eng.html>

Note: An Integrity declaration form must be submitted **only** when:

1. the supplier, one of its affiliates or a proposed first-tier subcontractor has been charged with or convicted of a criminal offence in a country other than Canada that, to the best of the supplier's knowledge and belief, may be similar to one of the listed offences in the *Ineligibility and Suspension Policy*; and/or
2. the supplier is unable to provide any of the certifications required by the [Integrity provisions](#).

### **5.2 Certifications Precedent to Contract Award and Additional Information**

The certifications and additional information listed below should be submitted with the bid but may be submitted afterwards. If any of these required certifications or additional information is not completed and submitted as requested, the Contracting Authority will inform the Bidder of a time frame within which to provide the information. Failure to provide the certifications or the additional information listed below within the time frame specified will render the bid non-responsive.

#### **5.2.1 Integrity Provisions – List of Names**

In accordance with the *Ineligibility and Suspension Policy* (<http://www.tpsgc-pwgsc.gc.ca/ci-if/politique-policy-eng.html>), the Bidder must provide the required documentation, as applicable, to be given further consideration in the procurement process:

- List of names for integrity verification form (<http://www.tpsgc-pwgsc.gc.ca/ci-if/ln-form-eng.html>)

Note:

- Suppliers including those bidding as joint ventures, whether incorporated or not, must provide a complete list of the names of all current directors



- Privately owned corporations must provide a list of the owners' names
- Suppliers bidding as sole proprietors, including sole proprietors bidding as joint ventures, whether incorporated or not, must provide a complete list of the names of all owners
- Suppliers that are a partnership do not need to provide a list of names

## 5.2.2 Federal Contractors Program for Employment Equity – Bid Certification

By submitting a bid, the Bidder certifies that the Bidder, and any of the Bidder's members if the Bidder is a Joint Venture, is not named on the Federal Contractors Program (FCP) for employment equity "[FCP Limited Eligibility to Bid](http://www.labour.gc.ca/eng/standards_equality/eq/emp/fcp/list/inelig.shtml)" list ([http://www.labour.gc.ca/eng/standards\\_equality/eq/emp/fcp/list/inelig.shtml](http://www.labour.gc.ca/eng/standards_equality/eq/emp/fcp/list/inelig.shtml)) available from [Human Resources and Skills Development Canada \(HRSDC\) - Labour's](#) website.

CNSC will have the right to declare a bid non-responsive if the Bidder, or any member of the Bidder if the Bidder is a Joint Venture, appears on the "[FCP Limited Eligibility to Bid](#)" list at the time of contract award.

## 5.2.3 Former Public Servant – Competitive Bid

Contracts awarded to former public servants (FPS) in receipt of a pension or of a lump sum payment must bear the closest public scrutiny, and reflect fairness in the spending of public funds. In order to comply with Treasury Board policies and directives on contracts awarded to FPSs, bidders must provide the information required below before contract award. If the answer to the questions and, as applicable the information required have not been received by the time the evaluation of bids is completed, CNSC will inform the Bidder of a time frame within which to provide the information. Failure to comply with CNSC's request and meet the requirement within the prescribed time frame will render the bid non-responsive.

### Definitions

For the purposes of this clause, "former public servant" is any former member of a department as defined in the [Financial Administration Act](#), R.S., 1985, c. F-11, a former member of the Canadian Armed Forces or a former member of the Royal Canadian Mounted Police. A former public servant may be:

- a. an individual;
- b. an individual who has incorporated;
- c. a partnership made of former public servants; or
- d. a sole proprietorship or entity where the affected individual has a controlling or major interest in the entity.

"lump sum payment period" means the period measured in weeks of salary, for which payment has been made to facilitate the transition to retirement or to other employment as a result of the implementation of various programs to reduce the size of the Public Service. The lump sum payment period does not include the period of severance pay, which is measured in a like manner.

"pension" means, in the context of the fee abatement formula, a pension or annual allowance paid under the [Public Service Superannuation Act](#) (PSSA), R.S.C, 1985, c. P-36, and any increases paid pursuant to the [Supplementary Retirement Benefits Act](#), R.S., 1985, c.S-24 as it affects the PSSA. It does not include pensions payable pursuant to the [Canadian Forces Superannuation Act](#), R.S.C, 1985, c. C-17, the [Defence Services Pension Continuation Act](#), R.S.C. 1970, c.D-3, the [Royal Canadian Mounted Police Pension Continuation Act](#), 1970, c.R-10, and the [Royal Canadian Mounted Police Superannuation Act](#), R.S.C, 1985, c. R-11, the [Members of Parliament Retiring Allowances Act](#), R.S.C, 1985, c. M-5, and that portion of pension payable to the [Canada Pension Plan Act](#), R.S.C, 1985, c. C-8.

### Former public servant in receipt of a pension

Is the bidder a FPS in receipt of a pension as defined above? **Yes** ( ) **No** ( )



Is the bidder or the bidder's employee a former CNSC/AECB (Atomic Energy Control Board) employee? **Yes ( ) No ( )**

If so, the bidder must provide the following information:

- a. name of former public servant
- b. date of termination of employment or retirement from the Public Service

By providing this information, Bidders agree that the successful bidder's status, with respect to being a former public servant in receipt of a pension, will be reported on departmental websites as part of the published proactive disclosure reports in accordance with [Contracting Policy Notice: 2012-2](#) and the [Guidelines on the Proactive Disclosure of Contracts](#).

### **Workforce Adjustment Directive**

Is the Bidder a FPS who received a lump sum payment pursuant to the terms of a Work Force Adjustment Directive? **Yes ( ) No ( )**

If so, the bidder must provide the following information:

- a. name of former public servant;
- b. conditions of the lump sum payment incentive;
- c. date of termination of employment;
- d. amount of lump sum payment;
- e. rate of pay on which lump sum payment is based;
- f. period of lump sum payment including start date, end date and number of weeks;
- g. number and amount (professional fees) of other contracts subject to the restrictions of a work force adjustment program.

For all contracts awarded during the lump sum payment period, the total amount of fees that may be paid to a FPS who received a lump sum payment is \$5,000, including Applicable Taxes.

### **5.2.4 Status and Availability of Resources (A3005T – 2010-08-16)**

1. The Bidder certifies that, should it be awarded a contract as a result of the bid solicitation, every individual proposed in its bid will be available to perform the Work as required by Canada's representatives and at the time specified in the bid solicitation or agreed to with Canada's representatives. If for reasons beyond its control, the Bidder is unable to provide the services of an individual named in its bid, the Bidder may propose a substitute with similar qualifications and experience. The Bidder must advise the Contracting Authority of the reason for the substitution and provide the name, qualifications and experience of the proposed replacement. For the purposes of this clause, only the following reasons will be considered as beyond the control of the Bidder: death, sickness, maternity and parental leave, retirement, resignation, dismissal for cause or termination of an agreement for default.
2. If the Bidder has proposed any individual who is not an employee of the Bidder, the Bidder certifies that it has the permission from that individual to propose his/her services in relation to the Work to be performed and to submit his/her résumé to Canada. The Bidder must, upon request from the Contracting Authority, provide a written confirmation, signed by the individual, of the permission given to the Bidder and of his/her availability. Failure to comply with the request may result in the bid being declared non-responsive.





### 5.2.5 Education and Experience (A3010T – 2010-08-16)

The Bidder certifies that all the information provided in the résumés and supporting material submitted with its bid, particularly the information pertaining to education, achievements, experience and work history, has been verified by the Bidder to be true and accurate. Furthermore, the Bidder warrants that every individual proposed by the Bidder for the requirement is capable of performing the Work described in the resulting contract.

### 5.3 Certifications

By submitting a bid, the Bidder certifies that the information submitted by the Bidder in response to the above requirements is accurate and complete.

\_\_\_\_\_  
**Signature of Bidder's Authorized Representative**

\_\_\_\_\_  
**Date**



## **PART 6 – RESULTING CONTRACT CLAUSES**

It is understood that the procurement of services for the Canadian Nuclear Safety Commission (CNSC) falls under the provisions of the *Nuclear Safety and Control Act*, S.C. 1997, c. 9.

The following clauses and conditions apply to and form part of any contract resulting from the bid solicitation.

### **6.1 Security Requirement**

There is no security requirement associated with the requirement.

### **6.2 Statement of Work (B4007C – 2014-06-26)**

The contractor must perform the work in accordance with the statement of work in Annex A and the contractor's technical bid entitled \_\_\_\_\_, dated \_\_\_\_\_ (*insert date*).

### **6.3 Standard Clauses and Conditions (A0000C – 2012-07-16 – modified)**

6.3.1 All clauses and conditions incorporated by reference in the contract (number, date and title) are set out in the *Standard Acquisition Clauses and Conditions (SACC) Manual* ([buyandsell.gc.ca/policy-and-guidelines/standard-acquisition-clauses-and-conditions-manual](http://buyandsell.gc.ca/policy-and-guidelines/standard-acquisition-clauses-and-conditions-manual)) issued by Public Works and Government Services Canada. All of the clauses of this document are legally binding on the parties. The following changes are made:

For the purposes of this contract, all references to "Canada", "Crown", "Her Majesty", "the Government" or "the Minister" in the clauses and conditions included herein, including those incorporated by reference, shall mean Her Majesty the Queen in right of Canada as represented by the Canadian Nuclear Safety Commission and its presiding Minister as appropriate.

#### **6.3.2 General Conditions**

[2010B \(2016-04-04\), General Conditions – Professional Services \(Medium Complexity\)](#) apply to and form part of the contract. The following change is made:

- a) Replace section 27 with the following:
  - i. The contractor acknowledges that individuals who are subject to the provisions of the Conflict of Interest Act (S.C. 2006, c. 9, s. 2) the Conflict of Interest Code for Members of the House of Commons, the Values and Ethics Code for the Public Sector, the Treasury Board Policy on Conflict of Interest and Post- Employment, the CNSC Values and Ethics Code, the CNSC Conflict of Interest and Post-Employment Policy, the CNSC Directive on Reporting and Managing Financial Conflicts of Interest and/or all other codes of conduct applicable within specific federal organizations cannot derive any direct benefit resulting from the contract.
  - ii. Contractors, subcontractors, or any of their respective employees working full-time on CNSC premises must comply with the Values and Ethics Code for the Public Sector, *the Treasury Board Policy on Conflict of Interest and Post- Employment*, the CNSC Values and Ethics Code, *the CNSC Conflict of Interest and Post-Employment Policy* and the CNSC Directive on Reporting and Managing Financial Conflicts of Interest.
  - iii. Post-employment procedures apply to individuals who have left the public sector.



- iv. The *CNSC Values and Ethics Code, CNSC Conflict of Interest and Post-Employment Policy* and the *CNSC Directive on Reporting and Managing Financial Conflicts of Interest* can be found at <http://www.nuclearsafety.gc.ca/eng/about-us/values-and-ethics/index.cfm>

### 6.3.3 Supplemental General Conditions

[4007 \(2010-08-16\) Canada to Own Intellectual Property Rights in Foreground Information](#), apply to and form part of the Contract.

## 6.4 Term of Contract

### 6.4.1 Period of the Contract (A9022C – 2007-05-25)

The period of the contract is from date of contract to **February 28, 2021** inclusive.

## 6.5 Authorities

### 6.5.1 Contracting Authority

The contracting authority for the contract is:

Robert Kardum  
Senior Contracting Officer  
Canadian Nuclear Safety Commission  
Corporate Services Branch  
P.O. Box 1046, Station B  
280 Slater Street  
Ottawa, Ontario K1P 5S9  
Canada

Telephone: 613-996-6724  
Fax: 613-995-5086  
Email: [robert.kardum@canada.ca](mailto:robert.kardum@canada.ca)

The contracting authority is responsible for the management of the contract and any changes to the contract must be authorized in writing by the contracting authority. The contractor must not perform work in excess of or outside the scope of the contract based on verbal or written requests or instructions from anybody other than the contracting authority.

### 6.5.2 Project Authority

*Fill in at contract award only.*

The project authority for the contract is:

Name:  
Title:  
Canadian Nuclear Safety Commission  
P.O. Box 1046, Station B  
280 Slater Street



Ottawa, Ontario K1P 5S9  
Canada

Telephone: 613-9xx-xxxx (*insert applicable telephone number*)  
Fax: 613-995-5086  
Email: \_\_\_\_\_@canada.ca

The project authority is the representative of the CNSC and is responsible for all matters concerning the technical content of the work under the contract. Technical matters may be discussed with the project authority; however the project authority has no authority to authorize changes to the scope of the work. Changes to the scope of the work can only be made through a contract amendment issued by the contracting authority.

### 6.5.3 Contractor's Representative

*Fill in at contract award only.*

Name:  
Title:

Telephone:  
Fax:  
Email:

## 6.6 Proactive Disclosure of Contracts with Former Public Servants (A3025C – 2013-03-21)

By providing information on its status, with respect to being a former public servant in receipt of a [Public Service Superannuation Act](#), R.C.S. 1985, c. P-36 pension, the contractor has agreed that this information will be reported on departmental Web sites as part of the published proactive disclosure reports, in accordance with [Contracting Policy Notice: 2012-2](#) of the Treasury Board Secretariat of Canada.

## 6.7 Payment

### 6.7.1 Basis of Payment

For the satisfactory performance of the contract, the contractor shall be paid in accordance with the basis of payment, which is found in Annex B attached to this contract.

### 6.7.2 Method of Payment – Deliverables Payments

Payment will be made in accordance with the schedule of deliverables set out in Annex B attached to this contract.

### 6.7.3 T1204 – Information Reported by Contractor (A9116C – 2007-11-30 - modified)

- 6.7.3.1 Pursuant to paragraph 221 (1)(d) of the [Income Tax Act](#), R.S.C. 1985, c.1 (5<sup>th</sup> Supp.), payments made by departments and agencies to contractors under applicable services contracts (including contracts involving a mix of goods and services) must be reported on a T1204 Government Service Contract Payments slip.
- 6.7.3.2 To enable departments and agencies to comply with this requirement, the contractor must provide the following information prior to signature of the contract:



- a. the legal name of the contractor, i.e. the legal name associated with its business number or social insurance number (SIN), as well as its address and postal code;
- b. the status of the contractor, i.e. an individual, a sole proprietorship, a corporation, or a partnership;
- c. the business number of the contractor if the contractor is a corporation or a partnership and the SIN if the contractor is an individual or a sole proprietorship. In the case of a partnership, if the partnership does not have a business number, the partner who has signed the contract must provide its SIN;
- d. in the case of a joint venture, the business number of all parties to the joint venture who have a business number or their SIN if they do not have a business number.

6.7.3.3 The information must be sent to the contracting authority. If the information includes a SIN, the information should be provided in an envelope marked "Protected".

## 6.8 Invoicing Instructions

6.8.1 Invoices can be emailed to [cnscc.finance@canada.ca](mailto:cnscc.finance@canada.ca) **OR** be mailed to the following address:

Canadian Nuclear Safety Commission  
Finance Division  
P.O. Box 1046, Station B  
Ottawa, ON  
Canada K1P 5S9

6.8.2 The Contractor shall include the contract number and appropriate Applicable Taxes registration number on all invoices pertaining to the contract.

6.8.3 The last and final invoice under the contract shall be clearly marked "final invoice".

## 6.9 Certifications

### 6.9.1 Instructions to Bidders/Contractors (A3015C – 2008-12-12)

The continuous compliance with the certifications provided by the Contractor in its bid and the ongoing cooperation in providing associated information are conditions of the Contract. Certifications are subject to verification by the CNSC during the entire period of the Contract. If the contractor does not comply with any certification, fails to provide the associated information, or if it is determined that any certification made by the Contractor in its bid is untrue, whether made knowingly or unknowingly, the CNSC has the right, pursuant to the default provision of the Contract, to terminate the Contract for default.

### 6.9.2 SACC Manual Clauses

[A9014C \(2006-06-16\) – Specific Person\(s\)](#)  
[G1005C \(2016-01-28\) – Insurance – No Specific Requirement](#)  
[A2000C \(2006-06-16\) – Foreign Nationals \(Canadian Contractor\)](#)  
[A2001C \(2006-06-16\) – Foreign Nationals \(Foreign Contractors\)](#)  
[C2000C \(2007-11-30\) - Taxes - Foreign-based Contractor](#)  
[A7017C \(2008-05-12\) – Replacement of Specific Individuals](#)

## 6.10 Applicable Laws

The contract must be interpreted and governed, and the relations between the parties determined, by the laws in force in Ontario.



## 6.11 Priority of Documents

The following documents form part of the legally binding agreement between the parties. If there is a discrepancy between the wording of any documents that appear on the list, the wording of the document that first appears on the list has priority over the wording of any document that subsequently appears on the list.

- (a) the Articles of Agreement;
- (b) the Supplemental General Conditions [4007 \(2010-08-16\) Canada to Own Intellectual Property Rights in Foreground Information](#);
- (c) the General Conditions [2010B \(2016-04-04\) – General Conditions – Professional Services \(Medium Complexity\)](#);
- (d) Annex A – Statement of Work;
- (e) Annex B – Basis of Payment; and
- (f) the contractor's bid dated (*insert date of bid*) (*If the bid was clarified or amended, insert at the time of contract award: “, as clarified on \_\_\_\_\_” or “, as amended on \_\_\_\_\_” and insert date(s) of clarification(s) or amendment(s)*)

## 6.12 Intellectual Property

### 6.12.1 Canada to Own Intellectual Property Rights in Foreground Information (4007 – 2010-08-16)

1. Supplemental General Conditions 4007 shall form part of the contract.
2. The CNSC has determined that any intellectual property arising from the performance of the work under the contract will vest in Canada, for the following reason:
  - i. where the main purpose of the Crown procurement contract, or of the deliverables contracted for, is to generate knowledge and information for public dissemination

### 6.12.2 Publication Rights (K3053C – 2008-05-12)

1. In this section,
  - (a) "copyright work" means any work in which a copyright may subsist, produced in or as a result of performing the Contract;
  - (b) "publication" or "publish" do not include disclosure to an academic supervisor or appraiser, for the sole purpose of academic evaluation.
2. Canada grants to the contractor and to the author a royalty-free non-exclusive license to publish or have published any copyright work in the course of the normal dissemination of knowledge in the subject field. The contractor or the author must not however publish or have published any copyright work during the performance of the contract or for a period of eighteen (18) months after without obtaining before the written consent of Canada.
3. Any copyright work published by or on behalf of the contractor or the author must acknowledge that the work was performed under the contract with Canada, unless specified otherwise by Canada.

### 6.12.3 License to Intellectual Property Rights in Foreground Information (K3305C – 2008-05-12)

1. Subject to subsection 2, if the contractor wishes to make use of the foreground information for purposes of its commercial exploitation or further development, the contractor may make a written request for a license to the



CNSC. Such a request should be made within thirty (30) working days following the performance of the work. The Contractor must give the CNSC an explanation as to why such a license is required. The CNSC must respond in writing to the request within a reasonable period of time. If the request is refused the response must provide an explanation for the refusal. If the CNSC agrees to grant the license, it will be on conditions to be negotiated between the contractor and the CNSC.

2. When the work under the contract involves the preparation of a database or other compilation using information or data supplied by the CNSC, or personal information (as this term is defined in the *Privacy Act*, R.S.C, 1985, c. P-21) collected by the contractor as part of the work, then the license referred to in subsection 1 will be restricted to the intellectual property rights in foreground information that are capable of being exploited without the use of such information or data or personal information.

#### 6.12.4 **No Right for Contractor to Sub-License (K3310C – 2008-05-12)**

The contractor does not have the right to sub-license or otherwise authorize any party to exercise any of the intellectual property rights in the foreground information.

#### 6.12.5 **License to Intellectual Property Rights in Canada-owned Information (K3315C –2008-05-12 – modified)**

If the contractor wishes to make use of certain Canada-owned information for purposes of the commercial exploitation or further development of the foreground information licensed to the contractor, the contractor may make a written request to the CNSC for a licence to exercise the required intellectual property rights in such Canada-owned information. The contractor must give the CNSC an explanation as to why such a license is required. The CNSC must respond in writing to any request for such a licence within a reasonable period of time. If the CNSC agrees to grant such a licence, it will be on conditions to be negotiated between the contractor and the CNSC. It is understood that those conditions may include payment of compensation to Canada.

### 6.13 **Dispute Resolution**

6.13.1 The parties must first attempt to resolve disputes arising in connection with this contract through direct good-faith negotiations. Such negotiations shall be undertaken for a maximum period of 30 working days unless resolved earlier. The parties may agree to an extension of the 30 working day period upon agreement in writing by each party.

6.13.2 All disputes, questions or differences arising in connection with this contract which cannot be resolved by the parties as set out in subsection 1 shall be resolved in an efficient and cooperative manner through mediation or any other such third-party assistance process as may be appropriate and agreed upon. Such a process shall be undertaken for at least 20 working days unless resolved earlier. The parties may agree to an extension of this 20 working day period upon agreement in writing by each party.

6.13.3 All disputes, questions or differences arising in connection with this contract, which the parties cannot resolve themselves through direct negotiations or the appropriate dispute resolution efforts discussed in subsection 2 shall be finally settled by binding arbitration.

6.13.4 The parties shall appoint a single arbitrator. The appointment of an arbitrator shall occur within 30 calendar days of the decision to proceed to binding arbitration. If such appointment has not occurred within this 30 calendar day period, then the parties shall apply to a Justice of the Ontario Court (General Division) in Ottawa to have an arbitrator appointed.

6.13.5 The arbitration shall be in accordance with the *Commercial Arbitration Act*, R.S.C., 1985,c.17 and shall take place in Ottawa, Ontario.



6.13.6 The arbitrator may appoint a secretary with the prior written permission of the parties. The fees of the sole arbitrator and of the secretary shall be shared equally by each of the parties. Notwithstanding the above, the arbitrator shall be authorized to require any party to pay the whole or part of the fees, costs and expenses. In such case, payments shall be made in accordance with the award and the award shall be final and shall not be subject to appeal.

6.13.7 This section does not apply in respect of the interpretation or application of constitutional, administrative, criminal or tax law or other law as may be determined and agreed upon by the parties. Except with respect to the laws expressly listed herein, if no agreement is reached regarding this article's application with respect to other areas of law, then the matter shall be subject to binding arbitration.

6.13.8 The parties understand that the Procurement Ombudsman appointed pursuant to subsection 22.1(1) of the *Department of Public Works and Government Services Act* will, on request, and consent of the parties, to participate in an alternative dispute resolution process to resolve any dispute between the parties respecting the interpretation or application of a term and condition of this contract and their consent to bear the cost of such process, provide to the parties a proposal for an alternative dispute resolution process to resolve their dispute. The Procurement Ombudsman will also review a complaint filed by the Contractor respecting administration of this contract if the requirements of subsection 22.2(1) of the *Department of Public Works and Government Services Act* and Sections 15 and 16 of the *Procurement Ombudsman Regulations* have been met, and the interpretation and application of the terms and conditions and the scope of the work of this contract are not in dispute. The Office of the Procurement Ombudsman may be contacted by telephone at 1-866-734-5169 or by e-mail at [boa.opo@boa.opo.gc.ca](mailto:boa.opo@boa.opo.gc.ca).





## ANNEX A – STATEMENT OF WORK

**Title:** Investigation of two-phase flow phenomena in reactor headers

### 1.0 Background

The primary heat transport system of CANDU reactors consists of a large number of horizontal fuel channels connected by small multi-section feeders to large horizontal inlet and outlet headers. The coolant is circulated through the primary circuit by primary heat transport system (PHTS) pumps. The PHTS heavy water cools the nuclear fuel bundles located in the pressure tubes. The vast majority of radioactive products is formed in the UO<sub>2</sub> fuel and is contained by several physical barriers, including the fuel matrix, the Zircaloy sheath of the fuel elements and the pressure boundary of PHTS. Demonstration of integrity of these barriers under various postulated initiating events is of paramount importance for regulatory acceptance of plant design and operation. In licensing submissions, CANDU headers are typically represented as single well-mixed volumes (lumped) or one-dimensional, and their simple models rely heavily on empirical information to predict flow and void outflows to individual fuel channels. This simplified/stylized approach is acceptable for scenarios where single-phase (liquid or vapor) in headers is predicted. However, for scenarios where two-phase flow in reactor headers can occur, the local parameters can be different than the volume averaged values. Ultimately, such models and their uncertainties directly impact the assessment of fuel and fuel-channel integrity during various accident scenarios, such as small break loss of coolant accidents (SBLOCA). During SBLOCA, two-phase flow can occur in the reactor headers and this may affect flow distribution in the fuel channels, such that some fuel channels may receive larger amounts of steam than others, thus impairing adequate fuel cooling.

The experiments conducted to scale down facilities indicated that the flow in reactor headers is highly complex and three-dimensional, especially in two-phase flow regimes. Some specific phenomena such as liquid entrainment or vapor pull-through may distort the flow distribution significantly.

Current methods of thermalhydraulic safety analysis for CANDU reactors are almost exclusively one-dimensional, as exemplified by the system codes CATHENA and TUF. The regulatory reviews of safety analyses performed with many conservative assumptions (e.g. limit of operating envelope) indicated that the simplified header modelling is acceptable on the basis that the large conservatism offsets various modelling uncertainties, including the uncertainty of flow distribution in various feeder groups. However, the process of reactor ageing tends to erode the initial safety margins, thus the industry adapted their safety analysis methodology towards more detailed modelling of PHTS and more realistic analysis assumptions. In recent submissions for aged reactors, the PHTS is modelled with a higher level of detail, very often using multiple channel groups in system simulations and detailed single channel simulations for all fuel channels in the broken pass. Coupling between reactor physics, system thermalhydraulics and/or detailed fuel calculation codes are usually employed. However, the detailed single channel simulations apply the transient boundary conditions derived from system simulations that use lumped or one-dimensional representation of reactor headers. In these situations, a more detailed modeling of flow distribution in reactor headers would be more consistent with the level of detail which the other reactor components are modelled. In order to address these concerns, the Canadian industry plans to improve the Industry Standard Toolset (IST) system codes by incorporating sophisticated and complex flow models and methodologies in the safety analysis. Nevertheless, it is recognized that two-phase computation fluid dynamics (CFD) modeling is under development for power reactor applications and its validation database in incipient stage. There are wide differences of opinions among internationally recognized experts regarding the potential applicability and utility of such methods in the analysis of vapour-liquid flows in nuclear-reactor systems. CNSC staff needs authoritative advice concerning the ability of this technology to aid the resolution of the longstanding safety issues related to the multidimensional thermalhydraulic effects in CANDU-type headers and to verify that current safety margins established through the one dimensional models are still valid when the more realistic three-dimensional models are utilized. The results of this investigation could potentially necessitate revisiting the currently used models and methodologies



## 2.0 Objectives

The main objectives of this research project are to:

- Perform experimental studies of flow and phase distribution in a horizontal manifold simulating CANDU headers under different two-phase flow regimes.
- Utilize recent advancements in multidimensional two-phase flow modeling and numerical technologies to simulate the three-dimensional two-phase (gas/liquid) flow and phase in a CANDU header
- Advise CNSC staff on the capabilities of modern, three-dimensional numerical simulation methodologies to assist the safety analyses of existing CANDU reactors by improved modelling of reactor headers and verify the adequacy of safety margins.

## 3.0 Scope of Work

The purpose of this research program is to perform experimental and three-dimensional numerical studies of the phase and flow distribution in a scaled down reactor header pipe under two-phase conditions. The program will include the following:

- Critical review of the general capabilities and application of CFD methods in the area of two-phase, gas-liquid flows in horizontal manifolds and T-junctions.
- Measurements of key parameters characterizing two-phase behavior in the header manifold including: pressure, gas and liquid flows at the header entrance, liquid levels in the header, gas and liquid flow rates in the attached pipes simulating feeders.
- Observe and document the flow patterns for various break orientations.
- Perform steady-state and transient numerical simulations for header conditions relevant to SBLOCA. The effects of break orientation are to be considered.
- Assess the applicability of experiments performed in scaled down facilities to validation and benchmarking of two-phase CFD models/tools.
- Document all the findings and provide recommendations about the extent to which Multiphase CFD can address the two-phase flow phenomena expected to occur in reactor headers for scenarios of interest, the main sources of uncertainties and feasibility and potential issues of coupling system codes with CFD codes/CFD components.

## 4.0 Tasks to be Performed

- 4.1 Review the applicability of state-of-the-art two-phase flow models and methodologies in reactor headers: main features, strengths/weaknesses, feasibility for nuclear reactor applications.
- 4.2 Review of relevant experimental data available in open literature.
- 4.3 Carry out experimental studies of phase and flow distribution in a horizontal manifold of CANDU – type headers under steady state, two-phase conditions, taken into consideration the effect of break orientation.



- 4.4 Benchmark the most common models against experimental data and rank their applicability to header flow.
- 4.5 Perform numerical simulations for transients at flow conditions relevant to blow-down phase of SBLOCA and assess the applicability of two-phase CFD methods to assist safety analysis in predicting the header behaviour.
- 4.6 Prepare a consolidated report that documents the previous activities and includes:
- Background
  - Literature review
  - Benchmark results
  - SBLOCA results
  - Conclusions and recommendations

## 5.0 **Deliverables**

### 5.1 Start-up Meeting

Date: Within a month of granting the contract

Location: The CNSC Head Office, Ottawa

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.

### 5.2 Progress Meetings

Dates: First meeting within six months of the start-up, followed by a progress meeting every six months thereafter

Location(s): The CNSC Head Office, Ottawa or the contractor facility; whichever deemed suitable

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.

### 5.3 First Formal Progress Report

Due Date: Within one year of granting the contract

Copies: One electronic copy via email to the Project Authority

Format and style requirements: To be specified by the Project Authority. The font Times New Roman 12 is to be used.

### 5.4 Second Formal Progress Report



Due Date: Within the second year of the contract period

Copies: One electronic copy via email to the Project Authority

Format and style requirements: To be specified by the Project Authority. The font Times New Roman 12 is to be used.

#### 5.5 Draft Final Report

Due Date: Within six months of the second progress report

Copies: One electronic copy via email to the Project Authority

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

#### 5.6 Presentation

Due Date: Within three months of the draft final report

Location: The CNSC Head Office, Ottawa

Purpose: To present the project findings, conclusions and recommendations

#### 5.7 Final Report

Due Date: February 28, 2021

Copies: Two electronic copies on CD. In addition to the source file, a PDF version of the final report is to be included on each CD. The source file is not to be password protected or in a read-only format (i.e. must be fully editable by the CNSC). Four bound copies and one unbound, unpunched, single-sided reproducible master.

#### Format & style requirements:

The font Times New Roman 12 is to be used. Electronic copies must be provided in a format readable by Word 2003 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.



## ANNEX B – BASIS OF PAYMENT

### 1.0 Basis of Payment – Firm Price – Deliverables

#### 1.1 Deliverable Schedule

In consideration of the contractor satisfactorily completing all of its obligations under the contract, the contractor will be paid the following firm all-inclusive price in accordance with the following deliverable schedule. FOB destination, Customs duties are included and Applicable Taxes are extra.

Deliverable	Delivery date	All-inclusive Firm price
First Formal Progress Report (del. 5.3)	Within one year of granting the contract (April 2019)	\$ _____
Second Formal Progress Report (del. 5.4)	Within the second year of the contract period (April 2020)	\$ _____
Draft Final Report (del 5.5)	Within six months of the second progress report (October 2020)	\$ _____
Presentation (del. 5.6)	Within three months of the submission of the draft final report (by January 31st, 2021)	\$ _____
Final Report (del. 5.7)	By February 28, 2021	\$ _____
<b>Total evaluated firm price</b> (applicable taxes extra)		\$ _____

#### 1.2 Limitation of Price (C6000C – 2011-05-16)

Canada will not pay the Contractor for any design changes, modifications or interpretations of the work unless they have been approved, in writing, by the contracting authority before their incorporation into the work.