Advance Contract Award Notice
87055-15-0226

1.0 Introduction

The Canadian Nuclear Safety Commission (CNSC) has a requirement to:

1) Engage an expert (individual or organization) in the area of thermal hydraulic codes, well versed in the use of RELAP5 for the simulation of the major CANDU reactor process systems (such as primary heat transport system and steam supply system) under accident conditions.

2) To gain confidence in the evaluation and capability of RELAP5 to predict the thermalhydraulic behaviour of a scaled facility in natural circulation.

The purpose of this advance contract award notice (ACAN) is to signal the CNSC's intention to award a contract for these services to:

McMaster University
1280 Main Street West
Hamilton, Ontario, Canada
L8S 4L7

Before awarding a contract, however, the CNSC would like to provide other suppliers with the opportunity to demonstrate that they are capable of satisfying the requirements set out in this ACAN, by submitting a statement of capabilities within the posting period for this ACAN, which is 15 calendar days.

If, during the posting period, other potential suppliers submit a statement of capabilities that meets the requirements set out in this ACAN, the CNSC may proceed to a full tendering process via the Government Electronic Tendering Service or by inviting bids directly from suppliers.

If no other supplier submits, on or before the closing date, a statement of capabilities meeting the requirements set out in the ACAN, a contract will be awarded to the above-noted supplier.

2.0 Requirement #1

The CNSC has a requirement to engage an expert (individual or organization) in the area of thermal hydraulic codes, well versed in the use of RELAP5 for the simulation of the major CANDU reactor process systems (such as primary heat transport system and steam supply system) under accident conditions. The work will involve the following:

Background

In the event of a severe accident occurring at a Canadian nuclear power plant, the nuclear fuel needs to be kept cool. Normally there are plant systems which direct water to cool the fuel; however, the events at Fukushima demonstrated that it is possible for these systems to be unavailable during an accident. In the event of a loss of all normal, standby and emergency

power, the current strategy is to depressurize boilers to allow boiler makeup by gravity from the deaerator tank, and later to inject water from portable pumps.

However, the thermalhydraulic behaviour of the reactor systems in response to water being injected is not well modelled by existing computer codes, hence the outcome of the strategy is uncertain. This strategy may work as intended and lead to establishing of heat removal, or it may be inefficient if core flow is inadequate. Therefore in order to determine how effective the addition of external make-up water is in halting the accident, CNSC staff requires a contractor to perform simulations to assess the thermal hydraulic behaviour of the make-up water once it is injected.

The knowledge gained in this project will be of importance in in-depth assessments of core damage mitigation strategies for scenarios involving natural circulation. This is a spot check on the response to a station blackout scenario using a computer code independent of those used by licensees.

Objectives

To engage an expert (individual or organization) in the area of thermal hydraulic codes, well versed in the use of RELAP5 for the simulation of the major CANDU reactor process systems (such as primary heat transport system and steam supply system) under accident conditions. Such an expert would consider a number of accident scenarios, requiring the use of gravity and external make-up water and model these cases using thermal hydraulic RELAP5 to determine the consequences, both beneficial and detrimental, of injecting make-up water into the reactor systems. The outcome of this work will allow for the confirmation of the effectiveness of strategies for response to station blackout.

Depending on the contractor's access to the proposed simulation tools and required datasets, the simulations may be performed either for a "generic' CANDU reactor, with no proprietary data explicitly involved, or for a specific reactor design. CNSC staff may be able to facilitate access to plant data required to achieve the objectives, if the contractor's own access is limited. These issues need to be addressed clearly in the proposal.

Scope of Work

The scope of work includes:

1) Detailing the set of CANDU reactor accident scenarios to be simulated
2) Running simulations with RELAP5
3) Performing sensitivity studies
4) Drawing conclusions from the results of the simulations
5) Preparing a technical report at the end of the work

Advance Contract Award Notice
87055-15-0226

Tasks to be Performed

The tasks to be performed are as follows:

1) Prepare a detailed work plan, specifying all the activities of the contractor and the necessary contributions (if any) of CNSC staff.
2) In consultation with CNSC staff, develop a set of CANDU accident scenarios for investigation. This would include scenarios with assumed gravity makeup followed by injection of external make-up water to the boilers.
3) Simulate the progression of the accident scenarios using RELAP5, assessing aspects such as:
   a) efficiency in re-establishing the core heat removal
   b) modelling of natural circulation (single phase, two-phase and reflux condenser modes)
4) Perform sensitivity studies of the modelling of boilers, in particular, provision of parallel flowpaths to represent the primary volume of the boiler tubes.
5) Perform sensitivity studies, varying certain parameters related to the injection of make-up water, such as time of boiler depressurization, temperature of injected water, rate of injection.
6) Perform sensitivity studies related to primary leakage, e.g. via pump seals.
7) Document the results of the simulations and prepare a technical report detailing the results of the prediction of the station blackout scenario.

The following should be considered:

Boiler crash cool and water make-up to maintain the secondary side as a heat sink during a prolonged station blackout is the accident mitigation action to be modelled.

The detailed simulations of the primary and secondary systems should be performed with appropriate sensitivities investigated. The key questions to address are as follows:

1) Can water make-up by gravity feed and with the portable equipment maintain thermalhydraulic conditions that maintain core cooling?
2) How long and at what conditions the natural circulation heat removal can be maintained, with and without inventory loss in the heat transport system (the primary system inventory may be decreasing as a result of leak in the heat transport system pump seals)?
3) At what conditions can the reflux condensation be credited and sufficient to prevent fuel overheating?
4) What is the effect of boiler tube modelling on the results?

Deliverables

1. Work plan

Date: 2 weeks after the contract initiation

Copies: One electronic copy via email

Advance Contract Award Notice
87055-15-0226

2. Start-up meeting

Date: 3 weeks after the contract initiation

Location: CNSC Head Office, Ottawa or McMaster University, Hamilton

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.

3. Progress reports

Dates: The first working day of every month for the duration of the contract

Copies: One electronic copy via email

4. Progress meetings

Dates: Approximately every 3 months, as required

Location(s): CNSC Head Office, Ottawa or McMaster University, Hamilton

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. Draft Final Report

Prepare and submit a draft report which summarizes the findings of the reviews, including recommendations.

Date: 2 month prior the contract completion date

Copies: One electronic copy via email

6. Final Report

Revise the draft report to address the written comments received from the CNSC Technical Authority

Date: 2 weeks prior to the contract completion date

Copies: One electronic copy via email to the persons designated in 5.3 above.

Format & style requirements: Electronic copies must be provided in a format readable by MS Word. 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 font Times New Roman 12 is to be used for the report. The report must have an Executive Summary (or Abstract) and should contain a Table of Contents. The CNSC reserves the right, at its own

discretion, to have the final report printed and distributed publicly. CNSC report covers and the publication number will be provided by the CNSC.

The estimated value of Requirement #1 is $20,000.00 to $25,000.00 CAD. Applicable taxes are extra.

3.0 Requirement #2

The CNSC has a requirement to gain confidence in the evaluation and capability of RELAP5 to predict the thermalhydraulic behaviour of a scaled facility in natural circulation. The work will involve the following:

Background

Events at Fukushima demonstrated that during an accident it is possible for normal electrical systems to be unavailable. In the event of a loss of all normal, standby and emergency power, natural circulation is relied upon to remove heat from the core to the boilers.

However, the thermalhydraulic behaviour of the reactor systems in natural circulation reflux condenser mode, in particular involving steam generators, is not always well modelled by existing computer codes. CNSC staff requires a contractor to assess the capability of the RELAP5 computer code to simulate the thermal hydraulic behaviour of primary and secondary cooling systems in natural circulation.
The knowledge gained in this project will be of importance in selecting suitable tools for use in reactor simulations of scenarios involving natural circulation.

Objectives

The objective of this research project is to gain confidence in the evaluation and capability of RELAP5 to predict the thermalhydraulic behaviour of a scaled facility in natural circulation. The outcome of this project will provide a benchmark of RELAP5 capability in this particular area of interest and, if successful, may lead to further validation studies. Results from this project will allow CNSC staff to know whether RELAP5 is a sufficient tool to use for verification/validation for scenarios involving natural circulation.

Scope of Work

The contractor must be well versed in the use of RELAP5 for simulation of scaled integral thermalhydraulics test facilities. The contractor would be expected to consider available information regarding such facilities used to simulate natural circulation processes in a reactor, in particular, experiments involving reflux condenser mode of primary heat removal.

The scope of work includes:

1. Identification of suitable integral test facilities and suitable test(s)
2. Developing an input dataset for the facility
3. Running simulations of the selected test(s) and performing sensitivity studies
4. Drawing conclusions from the results of the simulations
5. Preparing a technical report at the end of the work

Tasks to be Performed

The tasks to be performed are as follows:

1. Prepare a detailed work plan, specifying all the activities of the contractor and the necessary contributions (if any) of CNSC staff.
2. In consultation with CNSC staff, identify and select a suitable integral test facility and test (or series of test) that demonstrate the behaviour of interest, namely natural circulation reflux condenser mode.
   a) Simulate the progression of the scenarios using RELAP5, assessing code capability for modelling of natural circulation (single phase, two-phase and reflux condenser modes).
3. Perform sensitivity studies of the modelling of boilers, in particular, provision of parallel flow paths to represent the primary volume of the boiler tubes.
4. Document the results of the simulations and prepare a technical report detailing the results of the prediction of the selected experiment.

The following should be considered:

Modelling of reflux condenser mode of natural circulation in the system including steam generators is the prime interest.
The detailed simulations of the primary and secondary systems should be performed with the use of applicable experimental data and expert judgment. The key questions to address are as follows:

1. What is the performance of the code in predicting primary water distribution during natural circulation (all modes)?
2. What is the performance of the code in predicting event timings (e.g. transitions between modes of natural circulation, core heat up)?
3. What is the effect of boiler tube modelling on the predictions?

Deliverables

1. Work plan

Date: 2 weeks after the contract initiation

Copies: One electronic copy via email

Advance Contract Award Notice
87055-15-0226

2. Start-up meeting

Date: 3 weeks after the contract initiation

Location: CNSC Head Office, Ottawa or McMaster University, Hamilton

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.

3. Progress reports

Dates: The first working day of every month for the duration of the contract

Copies: One electronic copy via email

4. Progress meetings

Dates: Approximately every 3 months, as required

Location(s): CNSC Head Office, Ottawa or McMaster University, Hamilton

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. Draft Final Report

Prepare and submit a draft report which summarizes the findings of the reviews, including recommendations.

Date: 2 month prior the contract completion date

Copies: One electronic copy via email

6. Final Report

Revise the draft report to address the written comments received from the CNSC Technical Authority

Date: 2 weeks prior to the contract completion date

Copies: One electronic copy via email to the persons designated in 5.3 above.

Format & style requirements: Electronic copies must be provided in a format readable by MS Word. 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 font Times New Roman 12 is to be used for the report. The report must have an Executive Summary (or Abstract) and should contain a Table of Contents. The CNSC reserves the right, at its own discretion, to have the final report printed and distributed publicly. CNSC report covers and the publication number will be provided by the CNSC.

The estimated value of Requirement #2 is $20,000.00 to $25,000.00 CAD. Applicable taxes are extra.

Advance Contract Award Notice
87055-15-0226

4.0 Minimum Mandatory Requirements

Any interested supplier must demonstrate by way of a statement of capabilities that it meets the following requirements:

- Access to RELAP5
- Significant experience in the application of the RELAP5 code
- Significant experience of modelling nuclear power plants with RELAP5
- Significant experience related to reactor thermalhyraulics, particularly as it relates to natural circulation
- Independence from industry

5.0 Justification for the Pre-selected Supplier

Supplier being a recognized subject matter expert in the field and a lack of alternative or substitute, for technical reasons:

McMaster has extensive experience with applications of the thermal hydraulics codes for simulations of transients at a wide range of reactors and experimental facilities. In particular, McMaster has recognized expertise in use of RELAP5 which appears to be the most suitable code for the task at hand.

6.0 Intellectual Property

Ownership of any foreground intellectual property arising out of the proposed contract will vest in the contractor.

7.0 Statement of Capabilities

Suppliers who consider themselves fully qualified and available to meet the specified requirements may submit a statement of capabilities in writing to the contracting authority identified in this notice on or before the closing date of this notice. The statement of capabilities must clearly demonstrate how the supplier meets the advertised requirements.

The closing date and time for accepting statements of capabilities is December 14, 2015 at 2:00 p.m. EST.

Advance Contract Award Notice
87055-15-0226

8.0 Contact Information

Inquiries and statements of capabilities are to be directed in writing to:

Dan Simard
Senior Contracting Officer
280 Slater Street
P.O. Box 1046, Station B
Ottawa ON K1P 5S9
Canada

Telephone: 613-996-6784
Fax: 613-995-5086
Email: dan.simard@canada.ca

9.0 Policy Information

Government Contracts Regulations: section 6(*d*): “only one person is capable of performing the contract.”