

ORDER FOR SUPPLIES OR SERVICES

PAGE OF PAGES

1 27

IMPORTANT: Mark all packages and papers with contract and/or order numbers.

1. DATE OF ORDER 05/01/2018		2. CONTRACT NO. (If any) 31310018D0002		6. SHIP TO: a. NAME OF CONSIGNEE NUCLEAR REGULATORY COMMISSION	
3. ORDER NO. 31310018F0058		4. REQUISITION/REFERENCE NO. NRR-18-0007		b. STREET ADDRESS NUCLEAR REGULATORY COMMISSION	
5. ISSUING OFFICE (Address correspondence to) US NRC - HQ ACQUISITION MANAGEMENT DIVISION MAIL STOP TWFN-07B20M WASHINGTON DC 20555-0001				c. CITY WASHINGTON	
				d. STATE DC	e. ZIP CODE 20555-0001
7. TO: a. NAME OF CONTRACTOR SOUTHWEST RESEARCH INSTITUTE				f. SHIP VIA	
b. COMPANY NAME				8. TYPE OF ORDER	
c. STREET ADDRESS 6220 CULEBRA RD				<input type="checkbox"/> a. PURCHASE REFERENCE YOUR:	<input checked="" type="checkbox"/> b. DELIVERY
d. CITY SAN ANTONIO				e. STATE TX	f. ZIP CODE 782385166
9. ACCOUNTING AND APPROPRIATION DATA See Schedule				10. REQUISITION NG OFFICE OFF OF NUCLEAR REACTOR REGULATION	

Except for billing instructions on the reverse, this delivery order is subject to instructions contained on this side only of this form and is issued subject to the terms and conditions of the above-numbered contract.

Please furnish the following on the terms and conditions specified on both sides of this order and on the attached sheet, if any, including delivery as indicated.

11. BUSINESS CLASSIFICATION (Check appropriate box(es)) <input type="checkbox"/> a. SMALL <input type="checkbox"/> b. OTHER THAN SMALL <input type="checkbox"/> c. DISADVANTAGED <input type="checkbox"/> d. WOMEN-OWNED <input type="checkbox"/> e. HUBZone <input type="checkbox"/> f. SERVICE-DISABLED VETERAN-OWNED <input type="checkbox"/> g. WOMEN-OWNED SMALL BUSINESS (WOSB) ELIGIBLE UNDER THE WOSB PROGRAM <input type="checkbox"/> h. EDWOSB				12. F.O.B. POINT	
13. PLACE OF a. INSPECTION Destination		14. GOVERNMENT B/L NO.		15. DELIVER TO F.O.B. POINT ON OR BEFORE (Date) 11/30/2019	16. DISCOUNT TERMS 30
b. ACCEPTANCE Destination					

17. SCHEDULE (See reverse for Rejections)

ITEM NO. (a)	SUPPLIES OR SERVICES (b)	QUANTITY ORDERED (c)	UNIT (d)	UNIT PRICE (e)	AMOUNT (f)	QUANTITY ACCEPTED (g)
	Accounting Info: 2018-X0200-FEEBASED-20-20D008-5000-11-4-149-251A-11-4-149-5000 Period of Performance: 08/01/2018 to 11/30/2019					

18. SHIPPING POINT		19. GROSS SHIPPING WEIGHT		20. INVOICE NO.		17(h) TOTAL (Cont. pages)
21. MAIL INVOICE TO:						
a. NAME FISCAL ACCOUNTING PROGRAM						\$0.00
b. STREET ADDRESS (or P.O. Box) ADMIN TRAINING GROUP AVERY STREET A3-G BUREAU OF THE FISCAL SERVICE PO BOX 1328						\$152,370.00
c. CITY PARKERSBURG		d. STATE WV	e. ZIP CODE 26106-1328			17(i) GRAND TOTAL

22. UNITED STATES OF AMERICA BY (Signature) 05/01/2018		23. NAME (Typed) SHARLENE M. MCCUBBIN TITLE: CONTRACTING/ORDER NG OFFICER	
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CONTRACTOR ACCEPTANCE OF TASK ORDER 31310018F0053

Acceptance of Task Order No. 31310018F0058 under Contract No. 31310018D0002 should be made by having an official, authorized to bind your organization, execute two copies of this document in the space provided and return one copy to the Contracting Officer. You should retain the other copy for your records.

Accepted Task Order No. 31310018F0058 under Contract No. 31310018D0002:

Name

Title

Date

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SECTION B - Supplies or Services/Prices

B.1 BRIEF DESCRIPTION OF WORK

(a) The title of this project is: Technical Assistance for Analysis of Software “NARWHAL,” to Calculate the Conditional Failure Probabilities Associated with the Effects of Debris, for Calvert Cliffs Nuclear Power Plant, as Related to NRC Generic Letter 2004-02

(b) Summary work description: The objective of this task order is to obtain technical assistance for the review of the licensee’s (Exelon Generating Company, LLC) submittal for Calvert Cliffs Nuclear Power Plant, Units 1 and 2 to address issues identified in GSI-191 and respond to GL 2004-02. In particular, the contractor shall provide critical assessment of licensee risk-informed GL 2004-02 analyses and validate the computer programs used to determine the probabilities failures that potentially lead to core damage.

B.2 CONSIDERATION AND OBLIGATION— TASK ORDERS (AUG 2011)

(a) The total ceiling of this contract for the products/services under this contract is \$152,370.00, of which [REDACTED] represents costs and [REDACTED] represents fee.

(b) This order is subject to the minimum and maximum ordering requirements set forth in the contract.

(c) The amount presently obligated with respect to this order is [REDACTED] of which [REDACTED] represents costs and [REDACTED] represents fee. The obligated amount shall, at no time, exceed the order ceiling as specified in paragraph (a) above. When and if the amount(s) paid and payable to the Contractor hereunder shall equal the obligated amount, the Contractor shall not be obligated to continue performance of the work unless and until the Contracting Officer shall increase the amount obligated with respect to this order, in accordance with FAR Part 43 - Modifications. Any work undertaken by the Contractor in excess of the obligated amount specified above is done so at the Contractor's sole risk and may not be reimbursed by the Government.

(d) The Contractor shall comply with the provisions of FAR 52.232-22 - Limitation of Funds, for incrementally-funded delivery orders or task orders.

B.3 PRICE/COST SCHEDULE

[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]
TOTAL	\$152,370.00

SECTION C - Description/Specifications

Statement of Work

C.1 BACKGROUND

The U.S. Nuclear Regulatory Commission (NRC) issues Generic Communications to the industry (Licensees) in the form of: Information Notices and Generic Letters and Bulletins pertaining to or resulting from particular events that may have occurred at nuclear power plants; results from licensee and vendor deficiency reports; other inspection results of a generic nature; potential generic safety questions or concerns resulting from events or inspections; or the results of research findings. Occasionally, particularly in the case of Generic Letters, licensees are requested to provide NRC with a response describing the effect(s), if any, of a particular event occurrence or other matter pertinent to their facility, the extent of the potential safety consequence of the effect on their facility, and whether or not they have sufficient measures in place to effectively mitigate any potential adverse safety situations or their consequences. (Additional background can be found in Attachment 1).

C.2 OBJECTIVE

The objective of this task order is to obtain technical assistance for the review of the licensee's (Exelon Generating Company, LLC) submittal for Calvert Cliffs Nuclear Power Plant, Units 1 and 2 to address issues identified in GSI-191 and respond to GL 2004-02. In particular, the contractor shall provide critical assessment of licensee risk-informed GL 2004-02 analyses and validate the computer programs used to determine the probabilities failures that potentially lead to core damage.

C.3 SCOPE OF WORK

The Contractor shall perform the following tasks associated with the licensees' GL 2004-02 responses based on risk-informed approaches to addressing the issues in GSI-191:

Task 1: Review Licensee Analysis

Review the NARWHAL analysis to confirm that the licensee accurately translated NRC-reviewed and accepted technical data into probability distributions and associated uncertainties, and that NARWHAL accurately samples the distributions and propagates uncertainties. Prepare a technical report documenting the results of the review.

Task 2: Review the licensee's method for calculating individual weld LOCA frequencies

Using the data contained in NUREG-1829, "Estimating LOCA Frequencies through the Expert Elicitation Process," (ADAMS Accession No. ML080630013), validate the licensee's method for calculating weld LOCA frequencies.

2.1 Confirm that the probability density functions associated with each break size are consistent with NUREG-1829.

2.2 Verify that the sampling process used by the licensee accurately quantifies the istemic uncertainty associated with LOCA frequency, and that the state of knowledge correlation has been correctly applied.

2.3 Confirm that uncertainty associated with random variables is correctly passed between NARWHAL and the licensees' PRA models.

2.4 Perform sensitivity analyses on input parameters that are significant contributors to the PRA.

Prepare a technical report documenting the results of the review.

Task 3: Request for Additional Information

3.1 Prepare and Submit Requests for Additional Information (RAIs).

Draft RAIs, as appropriate, to obtain additional information necessary to complete the review of the licensee's NARWHAL evaluation, as directed by the Contracting Officer's Representative (COR). Provide the RAIs to the COR for review, who will determine which RAIs get sent to the licensee. If needed, the contractor will attend a site visit to review supporting analyses of the NARWHAL software.

3.2 Review RAI Responses

Once responses to the RAIs are provided by the licensee, review and evaluate the responses to determine if they address the RAIs. Provide evaluation to COR.

Task 4: Prepare Technical Evaluation Report (TER)

4.1 Prepare and submit a Draft TER, for NRC review

Prepare a Draft TER that details the results of the contractor's review. The Draft TER shall state whether or not the licensee's evaluation methods meet acceptable statistical analysis standards as well as whether or not the probability density functions proposed by the licensee are appropriate. The Draft TER shall include a detailed analysis, with basis, for finding the licensee's analysis acceptable or unacceptable. The report will be the basis for the NRC staff safety evaluation of the licensee's risk-informed request. The NRC staff will review the Contractor's Draft TER and provide comments by e-mail and/or by conference call for any areas requiring revision, correction, or further information.

4.2 Prepare and submit Final TER Report

The Contractor shall resolve all NRC staff comments and submit the necessary revisions in a Final TER Report.

Task 5: ACRS Meeting Support

As needed and requested by the COR, provide technical support to the staff during ACRS meetings related to discussing the results of the review of the licensee submittal as follows:

5.1 Prepare presentation slides that address the issues to be presented to the ACRS.

5.2 Attend ACRS Meetings. Assist COR and NRC technical staff in responding to questions or comments raised by ACRS during the meeting.

5.3 Assist NRC staff with addressing any outstanding questions or issues, if any, which result from the meeting. Provide written input to the responses to the questions raised by ACRS.

C.4 APPLICABLE DOCUMENTS AND STANDARDS

The contractor shall comply with the following applicable regulations, publications, manuals, and local policies and procedures:

NUREG-1379, NRC Editorial Style Guide.

<http://pbadupws.nrc.gov/docs/ML0932/ML093280744.pdf>

C.5 DELIVERABLES AND DELIVERY SCHEDULE

Section #	Deliverable	Due Date	Format	Submit to
C.3	Task 1: Technical Report on NARWHAL analysis	3 months after receiving licensee submittal	Electronic Word Document	COR
C.3	Task 2 : Technical Report containing analysis and Input for licensee’s method for calculating individual weld LOCA frequencies (Tasks 2.1 – 2.4)	3 months after receiving licensee submittal	Electronic Word Document	COR
C.3	Task 3.1: RAIs	1 month after completing review of licensee’s submittal	Electronic Word Document	COR
C.3	Task 3.2 RAI Response Evaluation	2 weeks after receiving licensee’s response to RAIs	Electronic Word Document	COR
C.3	Task 4.1 Draft TER	1 month after providing RAI response evaluation	5 printed copies and 3 copies on CD-ROM	COR
C.3	Task 4.2 Final TER	1 month after receiving NRC staff comments on draft TER	5 printed copies and 3 copies on CD-ROM	COR

Section #	Deliverable	Due Date	Format	Submit to
C.3	Task 5.1 ACRS Presentation Slides	3 weeks prior to scheduled meeting	Electronic Power Point Presentation	COR
C.3	Task 5.3 Address issues/questions from ACRS meeting	2 weeks after scheduled meeting	Electronic Word Document	COR
	*Monthly Letter Status Report (MLSR) per Section F.2 of the Base Contract	20 th calendar day of the following month	Electronic Adobe PDF	CO/COR

*If no work was performed during the prior month, the contractor shall not prepare and submit an MLSR.

In all deliverables, include the following information: Cost Center No., Task No., the applicant, the facility, CAC No., and NRC/NRR Branch. The contractor shall provide all data produced under this contract to the COR at the conclusion of the task order.

The COR will review all draft deliverables (and coordinate any internal NRC staff review, if needed) and provide comments back to the contractor. The contractor shall revise the draft deliverable based on the comments provided by the COR, and deliver the final version of the deliverable, unless otherwise specified in the deliverable table. When mutually agreed upon between the contractor and the COR, the contractor may submit preliminary or partial drafts to ensure the contractor understands the particular work requirement.

Technical Directions

The COR may issue Technical Directions (TDs) from time to time throughout the duration of this task order. These TDs must be within scope of the task order SOW and shall not constitute new assignments of work or changes of such a nature as to constitute a change to the task order cost or period of performance. Any modifications to the scope of work, cost, or period of performance of this task order must be issued by the Contractor Officer (CO) and will be coordinated with the COR. The COR may issue TDs for the purpose of making adjustments or clarifications to the timing and performance of the tasks and/or the delivery schedule of the documents within this task order.

In the event that the contractor believes that any of these TDs have an impact in terms of changing the scope, cost or period of performance of the task order, prior to taking action on the TD in question, the contractor shall immediately inform the task order CO and request appropriate guidance prior to taking action on the TD in question.

C.6 REQUIRED LABOR CATEGORIES (KEY PERSONNEL)

Program Manager

The Contractor shall provide a Program Manager, and an alternate who shall act for the Contractor when the manager is absent, who shall be responsible for the performance of the work. The Program Manager or alternate shall have full authority to act for the Contractor on all contract/order matters relating to daily operation of this order. The Program Manager shall have at a minimum, a bachelor's degree in engineering or

science and experience in nuclear engineering and in U.S. nuclear power plant technology, systems, and operations. The Program Manager shall also have significant experience with program or project management and NRC regulatory requirements.

Subject Matter Expert(s)

The Contractor shall provide an appropriate number and staff of qualified Subject Matter Experts (SMEs) who shall be responsible for the performance of the work and the task assignments for this order. The SMEs shall have expert experience in

Performance Assessment Engineering- Risk-based performance evaluations of nuclear systems sufficient to review and analyze the adequacy of licensee analyses pertaining to GSI-191 issues associated with PWR/BWR ECCS sump screen designs and downstream effect evaluation. Shall also have experience with NRC regulatory requirements, and with the development and drafting of technical evaluation reports.

Thermal-Hydraulics Engineering: Nuclear power plant emergency core cooling systems, and performance analysis.

It is the responsibility of the contractor to assign technical staff, employees, subcontractors, or specialists who have the required educational background, experience, or combination thereof to meet both technical and regulatory objectives of the work specified in this Statement of Work (SOW). The NRC will rely on representations made by the contractor concerning the qualifications of the personnel assigned to this project including assurance that all information contained in the technical and cost proposals, including resumes, is accurate and truthful.

C.7 GOVERNMENT-FURNISHED PROPERTY

The COR will provide the contractor when available (estimated to be August 2018), prior to start of Task 1, with the licensee's submittal for addressing GSI-191 and responding to GL 2004-02, as well as any additional supplements and documentation provided by the licensee for the NRC staff's review of the submittal and data.

C.8 PLACE OF PERFORMANCE

Work will be performed at Center for Nuclear Waste Regulatory Analyses (CNWRA) facilities, expect for travel as identified in Section C.9.

C.9 CONTRACTOR MEETINGS/TRAVEL

For purposes of preparing a proposal, assume the following meeting and travel requirements:

- FY 18: One, two-person, four-day trip to ENERCON or Exelon Generation Company, LLC site to review supporting analyses
- FY 19: Two, two-person, 2-day trips to NRC headquarters for ACRS presentations
- Participate in task order kick-off meeting via teleconference call to discuss the scope of work, expectations, task order management, and performance requirements of the task order.
- Participate in bi-weekly telephone calls with NRC staff to identify potential issues, as needed

The contractor shall request and obtain written approval from the COR before incurring any travel costs. The contractor shall be authorized travel expenses consistent with the Federal Travel Regulations and the limitation of funds for this task order.

C.10 SECURITY

Work on this task order may involve the handling of documents that contain proprietary information. The contractor shall safeguard documents containing proprietary information against unauthorized disclosure. After completion of work, the contractor must either destroy the documents or return them to the NRC. If they are destroyed, please confirm this in an e-mail to the COR with a copy to the CO and include the date and manner in which the documents were destroyed.

Background on NRC Request for Pressurized Water Reactor (PWR) Licensees to Study Emergency Core Cooling Systems in Generic Letter 2004-02:

In June, 2003, the NRC identified Generic Safety Issue 191 (GSI-191), involving the potential for clogging of recirculation sump screens in pressurized water reactors (PWRs). Based on the NRC findings of the GSI-191 study on Emergency Core Cooling System (ECCS) suction/containment sump clogging in PWRs, the NRC issued Generic Letter (GL) 2004-02 (Agency wide Documents Access and Management System (ADAMS) Accession No. ML042360586) requesting licensees of operating PWRs to perform an evaluation of the ECCS and containment spray system (CSS) recirculation function (in light of the information provided in the GL) and take additional action to ensure system function. The GL also requested licensees submit specific information regarding their evaluations.

Specifically, the safety concerns are that the ECCS and CSS in a PWR that are designed to safely shut down the plant and remove decay heat from the core and reactor building following a loss of coolant accident (LOCA), could be adversely affected by debris in the circulated cooling water. These systems initially draw cooling water from a clean source located outside of the containment building (e.g., reactor water storage tank) and deliver it to the reactor vessel or the containment spray system, as applicable. Once the source of clean water is depleted, the respective system pumps are realigned to draw spilled water from the containment building floor by way of the containment ECCS sump(s), cool the water, and return it to the reactor vessel or the containment spray headers, as appropriate, to remove decay heat. The concern identified in GSI-191 is that latent debris deposited on surfaces inside the containment building and debris generated by the LOCA could be transported to and block flow through the ECCS suction strainer and prevent adequate coolant flow from reaching the core. This concern was later expanded in GL 2004-02 to examine the potential for debris to pass through the ECCS strainer and cause wear and/or blockage in critical ECCS components and reactor pressure vessel (RPV) that could prevent the components from performing their safety-related functions or to prevent adequate flow from reaching the reactor core.

In response to the GL, the Nuclear Energy Institute (NEI) and the PWR Owners Group (PWROG) separately developed guidance that licensees could use to develop their evaluations and responses. As the industry proceeded with their evaluations, it became evident that the resolution was very complex and would require significantly more time. Therefore, in 2010, the NRC issued Staff Requirements Memorandum (SRM) SECY-10-0113, "Closure Options for Generic Safety Issue 191," (ADAMS Accession No. ML103570354) directing NRC staff to allow time for licensees to complete their testing and analyses. The SRM also included the option to use risk-informed methods to resolve issues identified in GSI-191. In July 2012, this directive was refined in SRM SECY 12-0093, (ADAMS Accession No. ML121320270) to provide direction for specific options that could be followed for resolving GSI-191, including a risk-informed option that follows the guidance in Regulatory Guide (RG) 1.174, Revision 2, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," (ADAMS Accession No. ML100910006). Several licensees (approximately 10) have stated that they plan to implement the risk-informed option, in whole or in part, to address the issues identified in GSI-191.

Pilot Plant for Risk-Informed Approach to Resolve GSI-191:

The licensee for South Texas Project (STP) nuclear plant, STP Nuclear Operating Company

(STPNOC), developed a risk-informed pilot program for addressing the GL that employs a “no transition break size” analysis following the methods and guidance described in RG 1.174. STPNOC submitted its risk-informed GL 2004-02 response describing how it has resolved the issues identified in GSI-191 on June 19, 2013, as supplemented through January 19, 2017.

The STP approach to resolving GSI-191 shows that the effect of debris suspended in the circulated containment pool minimally increases the core damage frequency (CDF) as well as large early release frequency (LERF) that are calculated in the PRA of record and, therefore, satisfies the criteria for minimal increase in these parameters stated in RG 1.174.

The change in CDF and LERF is determined by comparing the results of two models: one with no source material in the containment capable of producing any GSI-191 effects and one representing the current plant conditions that includes both fibrous insulation that might be liberated following a LOCA and latent material found in the containment building.

Based on the work on the pilot plant and the need for guidance associated with the proposed 10 CFR 50.46c rule, the NRC developed a draft Regulatory Guide in order to provide guidance for risk-informing debris issues associated with long-term core cooling. The draft Regulatory Guide is RG 1.229 (ADAMS Accession No. ML15023A025).

Exelon Generating Company, LLC Approach to Resolve GSI-191 for Calvert Cliffs Nuclear Power Plant, Units 1 and 2:

By letter dated May 16, 2013 (ADAMS Accession No. ML13140A010) Constellation Energy (now Exelon Generating Company, LLC) submitted its proposed path to resolve GL 2004-02 for Calvert Cliffs Nuclear Power Plant, Units 1 and 2 (Calvert Cliffs). Therein, the licensee indicated its intention to pursue the Option 2 deterministic approach, with refined chemical effects testing and the risk-informed resolution path, as described in SECY-12-0093. The licensee determined that performing refined chemical effects testing may demonstrate the reduced potential for recirculation sump strainer blockage and in-vessel blockage sufficiently to resolve GSI-191 through a deterministic approach. In parallel, the licensee stated that it would also pursue the risk-informed approach partnering with the South Texas Project as an alternate solution if the refined chemical effects testing fails to resolve GSI-191 through a deterministic approach. The refined chemical effects testing performed in pursuit of the deterministic resolution will complement the risk-informed approach.

The licensee for Calvert Cliffs and the NRC staff have held a series of public meetings to discuss the methodology that Calvert Cliffs intends to use to evaluate issues associated with GL 2004-02. During these meetings, the licensee indicated its intention to use software developed for use by ENERCON if a risk-informed method is required to resolve the issues. The ENERCON software is discussed below. The licensee and NRC staff discussed that a license amendment request would be required to implement the risk-informed method at Calvert Cliffs. During the public meetings, the licensee provided significant detail regarding the analysis and testing that has been completed and the assumptions that the licensee intends to use in its evaluation. The licensee determined that the amount of fiber that may enter the reactor core following a LOCA is small at Calvert Cliffs. Therefore, the licensee stated that it would use in-vessel acceptance criteria based on topical report WCAP-16793, Rev. 2 and the associated NRC staff SE.

Description of Technical Review:

The technical review shall evaluate the PWR plant design and post-LOCA conditions. The following description is provided to highlight the post-LOCA phenomena that enter into the probability distribution evaluations that are used in developing the input to the plant PRA to determine the change in CDF and LERF due to debris in the circulated coolant.

A postulated break in the reactor coolant system (RCS) piping at a PWR would result in a high energy, two-phase jet emanating from each end of the break. Depending on the size and location of the break, it is possible for the jet to destroy a large quantity of insulation on nearby piping and equipment. During the RCS blow-down phase of the event, some of the insulation debris may be blown to upper containment and some may be blown to lower regions of the containment.

Per plant design, the ECCS and CSS would be automatically initiated, drawing water from the refueling water storage tank (RWST).¹ The CSS may wash some debris from upper containment down to the containment floor. Debris on the containment floor could be transported by the high-velocity sheeting flow as the pool fills. Some debris may be transported into inactive cavities below the containment floor (such as the reactor cavity), or directly to the ECCS sump strainers. After the RWST source is depleted, the ECCS and CSS pumps would be realigned to draw spilled water from the ECCS sump, located in the containment building basement, and circulate it through the reactor vessel and containment spray headers. (In some PWRs, CS may be secured after the containment pressure is reduced or may not be initiated at all, if pressure does not exceed the initiation setpoint. Some plants may rely on the containment air coolers). This system alignment is maintained for the duration of the accident (typically, a 30-day duration is assumed). Some debris in the containment pool would be transported to the ECCS sumps. As debris collects on the strainer, the head loss across the strainer would rise. Corrosion of various containment metals, and dissolution of insulation debris and other materials in the buffered and borated containment pool may result in the formation of chemical precipitates. These precipitates can accumulate on the strainer debris beds increasing the overall head loss. If the head loss across the strainer exceeds either the net positive suction head (NPSH) margin for the ECCS or CSS pumps, or the strainer structural margin, long-term core cooling may be compromised. Some of the fine debris (particulate, dissolved chemicals, chemical precipitate, and fiber fines) could pass through the strainer and cause blockage or wear of various downstream components, or cause blockage of coolant flow through the fuel channels within the reactor core.

Description of Licensee's Risk-Informed Approach:

The Exelon analysis relies on ENERCON software tools called Nuclear Accident Risk Weighted Analysis (NARWHAL) and Break Accident Debris Generation Evaluator (BADGER). NARWHAL is a computer program that evaluates the probability of GL 2004-02 failures by holistically analyzing break specific conditions in a time-dependent manner. BADGER uses containment building CAD models to automate calculation of debris quantities for a range of breaks (e.g. double ended guillotine breaks (DEGBs), single ended guillotine breaks (SEGBs), partial breaks, and longitudinal breaks). Results from BADGER are used as one of the input parameters to NARWHAL.

¹ The nomenclature for this tank varies by the supplier of the nuclear steam supply system; however, the function is similar.

The NARWHAL methodology accounts for failures due to multiple variables such as strainer structural limits, flashing, deaeration, in-vessel, and net positive suction head (NPSH) loss limits. NARWHAL has the capability to evaluate all potential breaks for a specific input case. For the bulk case, where all potential breaks for a specific input case are evaluated, a relatively general result is obtained which can detail when acceptance criteria are exceeded. Alternately, a single break can be evaluated and time dependent results of calculated variables can be obtained. Notably, NARWHAL does not terminate calculations once a failure is identified; the program continues calculations to determine if subsequent failures may occur, when they occur, and to gain other insights regarding the plant response.

With regards to transport of debris to the suction strainer, the transport metrics can be changed based on several factors including break location, debris type/characteristics, flow rates, number of strainers in service, and whether containment sprays initiate.

A few capabilities/features of NARWHAL include:

- NARWHAL can accommodate multi-unit (2 or 3 unit) plants using one, two, or three models depending on how similar the units are.
- NARWHAL relies on thermal-hydraulic analysis input calculated outside of the NARWHAL software. These inputs are used to determine values such as break sizes that would result in containment spray actuation and/or accumulator injection.
- NARWHAL can accommodate plants with spray additive tanks.
- A user defined latent debris penetration for fiber transported during pool fill is included in NARWHAL to account for effects, such as increased latent debris causing reduced strainer penetration.
- Head loss test data can be used in a straightforward manner in NARWHAL. When a debris limit is exceeded it is assumed that the head loss increases to the head loss from the next higher debris load. Other extrapolations can be made based on approved guidance.
- NARWHAL version 1 has the capability to perform sensitivity analyses and version 2 will include a statistics package with the capability to accept probability distributions for pertinent uncertain input parameters and propagate them through the model.

As discussed above, BADGER uses containment building CAD models to automate calculation of insulation debris quantities for a range of breaks. DEGBs are assumed for lines that are isolated within 10 pipe diameters (D) of the break. For longitudinal breaks, the maximum break size is the square-root of 2 times D, or the DEGB value. BADGER postulates breaks along length of the longitudinal weld between the circumferential welds. These breaks are placed a maximum of 1/2 D along the weld, for Calvert Cliffs, this value is less than the 5 feet (ft.) metric provided in approved guidance for break selection (NEI 04-07, Volumes 1 and 2, ADAMS Accession Nos. ML050550138 and ML050550156, respectively). The methodology assumes that a longitudinal weld can occur on either side of a pipe.

A few assumptions/features of BADGER include:

- BADGER assumes that there is a one inch layer of coating on the surface and then multiplies by the dry film thickness for calculations of coating debris amount.
- For fibrous debris sizing, BADGER calculates a centroid of mass of the insulation and determines the size distribution based on the centroid.

BADGER uses 2, 1, and 0.5 inch increments for 2-14, 15-27, and greater than 27 inch break sizes, respectively. This approach allows for additional refinement (smaller increments) for breaks that are more likely to result in equipment failures (bigger breaks).

The software tools (NARWHAL and BADGER) discussed above are used to analyze LOCA sequences in a realistic time-dependent manner, with uncertainty propagation, to determine the probabilities of various failures potentially leading to core damage from a spectrum of location-specific pipe breaks (i.e. LOCAs). These conditional probabilities of failure, which are based in part on equipment availability, are combined with the break probability and input into Exelon's plant-specific PRA to determine the overall change in CDF and LERF. The specific failure modes considered are:

1. Strainer head loss exceeds the NPSH margin for the pumps, causing some or all of the ECCS and CSS pumps to fail.
2. Strainer head loss exceeds the strainer structural margin, causing the strainer to fail, which could subsequently result in larger quantities and larger sizes of debris being ingested into the ECCS and CSS.
3. Air intrusion exceeds the limits of the ECCS and CSS pumps, causing degraded pump performance or complete failure due to gas binding.
4. Debris penetration exceeds ex-vessel effects limits, causing a variety of potential equipment and component failures due to wear or clogging.
5. Debris penetration exceeds in-vessel effects limits, resulting in partial or full core blockage with insufficient flow to cool the core.
6. Buildup of oxides, crud, LOCA-generated debris, and chemical precipitates on fuel cladding exceeds the limits for heat transfer, resulting in unacceptably high peak cladding temperatures.
7. Boron concentration in the core exceeds the solubility limit, leading to boron precipitation, impairing heat removal.

Note: Not all of the phenomena listed above may be modeled in a specific plant PRA because some of these phenomena may be addressed deterministically or may not be relevant at that plant.

Design Input to NARWHAL:

A wide range of input variables are used in the various GSI-191 analysis areas. In some cases, the input may consist of a single value, in other cases the input may change over time. The significant input variables that are developed as part of the Calvert Cliffs risk-informed GL 2004-02 evaluation project are in the following areas:

- Containment Building physical CAD Model (BADGER)
- Thermal Hydraulics Model
- LOCA Frequency Evaluation based on NUREG-1929
- LOCA-Jet Formation Model

- Coatings and Crud Debris Calculations
- Water Volume/Level Calculation
- Chemical Effects Testing
- Debris Transport Calculation
- Strainer Head Loss Testing
- NPSH Calculation
- Strainer Penetration Testing
- In-vessel Effects Evaluation

Calvert Cliffs developed the above input variables (either single value or distribution) by (1) using NRC-accepted methods, (2) performing plant-specific testing of the parameter of interest, or (3) evaluating industry information that is relevant to the parameter.

SECTION D - Packaging and Marking

D.1 BRANDING

The Contractor is required to use the statement below in any publications, presentations, articles, products, or materials funded under this contract/order, to the extent practical, in order to provide NRC with recognition for its involvement in and contribution to the project. If the work performed is funded entirely with NRC funds, then the contractor must acknowledge that information in its documentation/presentation.

Work Supported by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation, under Contract number 31310018D0002/31310018F0058.

(End of Clause)

D.2 PACKAGING AND MARKING

(a) The Contractor shall package material for shipment to the NRC in such a manner that will ensure acceptance by common carrier and safe delivery at destination. Containers and closures shall comply with the Surface Transportation Board, Uniform Freight Classification Rules, or regulations of other carriers as applicable to the mode of transportation.

(b) On the front of the package, the Contractor shall clearly identify the contract number under which the product is being provided.

(c) Additional packaging and/or marking requirements are as follows: Not Applicable.

(End of Clause)

SECTION E - Inspection and Acceptance

E.1 INSPECTION AND ACCEPTANCE BY THE NRC (SEP 2013)

Inspection and acceptance of the deliverable items to be furnished hereunder shall be made by the NRC Contracting Officer's Representative (COR) at the destination, in accordance with FAR 52.247-34 - F.o.b. Destination.

(End of Clause)

SECTION F - Deliveries or Performance

F.1 TASK/DELIVERY ORDER PERIOD OF PERFORMANCE (SEP 2013)

This order shall commence August 1, 2018 and will expire on November 30, 2019.

(End of Clause)

F.2 PLACE OF DELIVERY-REPORTS

The items to be furnished hereunder shall be delivered, with all charges paid by the Contractor, to:

a. Contracting Officer Representative:

Refer to Section G.1 CONTRACTING OFFICER'S REPRESENTATIVE AUTHORITY

b. Contracting Officer (CO) (1 electronic copy):

(End of Clause)

SECTION G - Contract Administration Data

G.1 CONTRACTING OFFICER'S REPRESENTATIVE AUTHORITY

(a) The contracting officer's authorized representative hereinafter referred to as the COR for this contract is:

Name: Andrea Russell
Telephone Number: 301-415-8553
Email: Andrea.Russell@nrc.gov
Mail Stop: O-10A1

Name: Joshua Borromeo
Telephone Number: 301-415-1217
Email: Joshua.Borromeo@nrc.gov
Mail Stop: O-10A1

Address: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555

(b) Performance of the work under this contract is subject to the technical direction of the NRC COR. The term technical direction is defined to include the following:

(1) Technical direction to the contractor which shifts work emphasis between areas of work or tasks, authorizes travel which was unanticipated in the Schedule (i.e., travel not contemplated in the Statement of Work or changes to specific travel identified in the Statement of Work), fills in details, or otherwise serves to accomplish the contractual statement of work.

(2) Provide advice and guidance to the contractor in the preparation of drawings, specifications, or technical portions of the work description.

(3) Review and, where required by the contract, approve technical reports, drawings, specifications, and technical information to be delivered by the contractor to the Government under the contract.

(c) Technical direction must be within the general statement of work stated in the contract. The COR does not have the authority to and may not issue any technical direction which:

(1) Constitutes an assignment of work outside the general scope of the contract.

(2) Constitutes a change as defined in the "Changes" clause of this contract.

(3) In any way causes an increase or decrease in the total estimated contract cost, the fixed fee, if any, or the time required for contract performance.

(4) Changes any of the expressed terms, conditions, or specifications of the contract.

(5) Terminates the contract, settles any claim or dispute arising under the contract, or issues any unilateral directive whatever.

(d) All technical directions must be issued in writing by the project officer or must be confirmed by the COR in writing within ten (10) working days after verbal issuance. A copy of the written direction must be furnished to the contracting officer. A copy of NRC Form 445, Request for Approval of Official Foreign Travel, which has received final approval from the NRC must be furnished to the contracting officer.

(e) The contractor shall proceed promptly with the performance of technical directions duly issued by the COR in the manner prescribed by this clause and within the COR's authority under the provisions of this clause.

(f) If, in the opinion of the contractor, any instruction or direction issued by the COR is within one of the categories defined in paragraph (c) of this section, the contractor may not proceed but shall notify the contracting officer in writing within five (5) working days after the receipt of any instruction or direction and shall request that contracting officer to modify the contract accordingly. Upon receiving the notification from the contractor, the contracting officer shall issue an appropriate contract modification or advise the contractor in writing that, in the contracting officer's opinion, the technical direction is within the scope of this article and does not constitute a change under the "Changes" clause.

(g) Any unauthorized commitment or direction issued by the COR may result in an unnecessary delay in the contractor's performance and may even result in the contractor expending funds for unallowable costs under the contract.

(h) A failure of the parties to agree upon the nature of the instruction or direction or upon the contract action to be taken with respect to the instruction or direction is subject to 52.233-1 - Disputes.

(i) In addition to providing technical direction as defined in paragraph (b) of the section, the COR shall:

(1) Monitor the contractor's technical progress, including surveillance and assessment of performance, and recommend to the contracting officer changes in requirements.

(2) Assist the contractor in the resolution of technical problems encountered during performance.

(3) Review all costs requested for reimbursement by the contractor and submit to the contracting officer recommendations for approval, disapproval, or suspension of payment for supplies and services required under this contract.

(End of Clause)

G.2 2052.215-78 TRAVEL APPROVALS AND REIMBURSEMENT - ALTERNATE 1 (OCT 1999)

(a) Total expenditure for travel may not exceed [REDACTED] without the prior approval of the contracting officer.

(b) All foreign travel must be approved in advance by the NRC on NRC Form 445, Request for Approval of Official Foreign Travel, and must be in compliance with FAR 52.247-63 Preference for U.S. Flag Air Carriers. The contractor shall submit NRC Form 445 to the NRC no later than 30 days prior to the commencement of travel.

(c) The contractor will be reimbursed only for travel costs incurred that are directly related to this contract and are allowable subject to the limitations prescribed in FAR 31.205-46.

(d) It is the responsibility of the contractor to notify the contracting officer in accordance with the FAR Limitations of Cost clause of this contract when, at any time, the contractor learns that travel expenses will cause the contractor to exceed the travel ceiling amount identified in paragraph (a) of this clause.

(e) Reasonable travel costs for research and related activities performed at State and nonprofit institutions, in accordance with Section 12 of Pub. L. 100-679, must be charged in accordance with the contractor's institutional policy to the degree that the limitations of Office of Management and Budget (OMB) guidance are not exceeded. Applicable guidance documents include OMB Circular A-87, Cost Principles for State and Local Governments; OMB Circular A-122, Cost Principles for Nonprofit Organizations; and OMB Circular A-21, Cost Principles for Educational Institutions.

SECTION H - Special Contract Requirements

H.1 2052.209-72 CONTRACTOR ORGANIZATIONAL CONFLICTS OF INTEREST. (JAN 1993)

(a) Purpose. The primary purpose of this clause is to aid in ensuring that the contractor:

(1) Is not placed in a conflicting role because of current or planned interests (financial, contractual, organizational, or otherwise) which relate to the work under this contract; and

(2) Does not obtain an unfair competitive advantage over other parties by virtue of its performance of this contract.

(b) Scope. The restrictions described apply to performance or participation by the contractor, as defined in 48 CFR 2009.570-2 in the activities covered by this clause.

(c) Work for others.

(1) Notwithstanding any other provision of this contract, during the term of this contract, the contractor agrees to forego entering into consulting or other contractual arrangements with any firm or organization the result of which may give rise to a conflict of interest with respect to the work being performed under this contract. The contractor shall ensure that all employees under this contract abide by the provision of this clause. If the contractor has reason to believe, with respect to itself or any employee, that any proposed consultant or other contractual arrangement with any firm or organization may involve a potential conflict of interest, the contractor shall obtain the written approval of the contracting officer before the execution of such contractual arrangement.

(2) The contractor may not represent, assist, or otherwise support an NRC licensee or applicant undergoing an NRC audit, inspection, or review where the activities that are the subject of the audit, inspection, or review are the same as or substantially similar to the services within the scope of this contract (or task order as appropriate) except where the NRC licensee or applicant requires the contractor's support to explain or defend the contractor's prior work for the utility or other entity which NRC questions.

(3) When the contractor performs work for the NRC under this contract at any NRC licensee or applicant site, the contractor shall neither solicit nor perform work in the same or similar technical area for that licensee or applicant organization for a period commencing with the award of the task order or beginning of work on the site (if not a task order contract) and ending one year after completion of all work under the associated task order, or last time at the site (if not a task order contract).

(4) When the contractor performs work for the NRC under this contract at any NRC licensee or applicant site,

(i) The contractor may not solicit work at that site for that licensee or applicant during the period of performance of the task order or the contract, as appropriate.

(ii) The contractor may not perform work at that site for that licensee or applicant during the period of performance of the task order or the contract, as appropriate, and for one year thereafter.

(iii) Notwithstanding the foregoing, the contracting officer may authorize the contractor to solicit or perform this type of work (except work in the same or similar technical area) if the contracting officer determines that the situation will not pose a potential for technical bias or unfair competitive advantage.

(d) Disclosure after award.

(1) The contractor warrants that to the best of its knowledge and belief, and except as otherwise set forth in this contract, that it does not have any organizational conflicts of interest as defined in 48 CFR 2009.570-2.

(2) The contractor agrees that if, after award, it discovers organizational conflicts of interest with respect to this contract, it shall make an immediate and full disclosure in writing to the contracting officer. This statement must include a description of the action which the contractor has taken or proposes to take to avoid or mitigate such conflicts. The NRC may, however, terminate the contract if termination is in the best interest of the Government.

(3) It is recognized that the scope of work of a task-order-type contract necessarily encompasses a broad spectrum of activities. Consequently, if this is a task-order-type contract, the contractor agrees that it will disclose all proposed new work involving NRC licensees or applicants which comes within the scope of work of the underlying contract. Further, if this contract involves work at a licensee or applicant site, the contractor agrees to exercise diligence to discover and disclose any new work at that licensee or applicant site. This disclosure must be made before the submission of a bid or proposal to the utility or other regulated entity and must be received by the NRC at least 15 days before the proposed award date in any event, unless a written justification demonstrating urgency and due diligence to discover and disclose is provided by the contractor and approved by the contracting officer. The disclosure must include the statement of work, the dollar value of the proposed contract, and any other documents that are needed to fully describe the proposed work for the regulated utility or other regulated entity. NRC may deny approval of the disclosed work only when the NRC has issued a task order which includes the technical area and, if site-specific, the site, or has plans to issue a task order which includes the technical area and, if site-specific, the site, or when the work violates paragraphs (c)(2), (c)(3) or (c)(4) of this section.

(e) Access to and use of information.

(1) If, in the performance of this contract, the contractor obtains access to information, such as NRC plans, policies, reports, studies, financial plans, internal data protected by the Privacy Act of 1974 (5 U.S.C. Section 552a (1988)), or the Freedom of Information Act (5 U.S.C. Section 552 (1986)), the contractor agrees not to:

(i) Use this information for any private purpose until the information has been released to the public;

(ii) Compete for work for the Commission based on the information for a period of six months after either the completion of this contract or the release of the information to the public, whichever is first;

(iii) Submit an unsolicited proposal to the Government based on the information until one year after the release of the information to the public; or

(iv) Release the information without prior written approval by the contracting officer unless the information has previously been released to the public by the NRC.

(2) In addition, the contractor agrees that, to the extent it receives or is given access to proprietary data, data protected by the Privacy Act of 1974 (5 U.S.C. Section 552a (1988)), or the Freedom of Information Act (5 U.S.C. Section 552 (1986)), or other confidential or privileged technical, business, or financial information under this contract, the contractor shall treat the information in accordance with restrictions placed on use of the information.

(3) Subject to patent and security provisions of this contract, the contractor shall have the right to use technical data it produces under this contract for private purposes provided that all requirements of this contract have been met.

(f) Subcontracts. Except as provided in 48 CFR 2009.570-2, the contractor shall include this clause, including this paragraph, in subcontracts of any tier. The terms contract, contractor, and contracting officer, must be appropriately modified to preserve the Government's rights.

(g) Remedies. For breach of any of the above restrictions, or for intentional nondisclosure or misrepresentation of any relevant interest required to be disclosed concerning this contract or for such erroneous representations that necessarily imply bad faith, the Government may terminate the contract for default, disqualify the contractor from subsequent contractual efforts, and pursue other remedies permitted by law or this contract.

(h) Waiver. A request for waiver under this clause must be directed in writing to the contracting officer in accordance with the procedures outlined in 48 CFR 2009.570-9.

(i) Follow-on effort. The contractor shall be ineligible to participate in NRC contracts, subcontracts, or proposals therefor (solicited or unsolicited) which stem directly from the contractor's performance of work under this contract. Furthermore, unless so directed in writing by the contracting officer, the contractor may not perform any technical consulting or management support services work or evaluation activities under this contract on any of its products or services or the products or services of another firm if the contractor has been substantially involved in the development or marketing of the products or services.

(1) If the contractor under this contract, prepares a complete or essentially complete statement of work or specifications, the contractor is not eligible to perform or participate in the initial contractual effort which is based on the statement of work or specifications. The contractor may not incorporate its products or services in the statement of work or specifications unless so directed in writing by the contracting officer, in which case the restrictions in this paragraph do not apply.

(2) Nothing in this paragraph precludes the contractor from offering or selling its standard commercial items to the Government.

(End of Clause)

H.2 2052.215-70 KEY PERSONNEL. (JAN 1993)

(a) The following individuals are considered to be essential to the successful performance of the work hereunder:

[REDACTED]

[REDACTED]

*The contractor agrees that personnel may not be removed from the contract work or replaced without compliance with paragraphs (b) and (c) of this section.

(b) If one or more of the key personnel, for whatever reason, becomes, or is expected to become, unavailable for work under this contract for a continuous period exceeding 30 work days, or is expected to devote substantially less effort to the work than indicated in the proposal or initially anticipated, the contractor shall immediately notify the contracting officer and shall, subject to the concurrence of the contracting officer, promptly replace the personnel with personnel of at least substantially equal ability and qualifications.

(c) Each request for approval of substitutions must be in writing and contain a detailed explanation of the circumstances necessitating the proposed substitutions. The request must also contain a complete resume for the proposed substitute and other information requested or needed by the contracting officer to evaluate the proposed substitution. The contracting officer and the project officer shall evaluate the contractor's request and the contracting officer shall promptly notify the contractor of his or her decision in writing.

(d) If the contracting officer determines that suitable and timely replacement of key personnel who have been reassigned, terminated, or have otherwise become unavailable for the contract work is not reasonably forthcoming, or that the resultant reduction of productive effort would be so substantial as to impair the successful completion of the contract or the service order, the contract may be terminated by the contracting officer for default or for the convenience of the Government, as appropriate. If the contracting officer finds the contractor at fault for the condition, the contract price or fixed fee may be equitably adjusted downward to compensate the Government for any resultant delay, loss, or damage.

(End of Clause)

SECTION J - List of Documents, Exhibits and Other Attachments

Attachment Number	The following Attachments were provided under the Base Contract and applicable to this task order
1	Template Contractor Spending Plan
2	Monthly Letter Status Report Instructions For Contracts And Orders
3	Billing Instructions Cost-Reimbursement Type Contracts
4	Organizational Conflicts of Interest