ORDER FOR SUPPLIES OR SERVICES

IMPORTANT: Mark all packages and papers with contract and/or order numbers. BPA NO.

1. DATE OF ORDER: SEP 14 2007
2. CONTRACT NO. (If any): GS10F0145T
3. ORDER NO.: DR-04-07-107 MODIFICATION NO.:
4. REQUISITION/REFERENCE NO.: RES-07-107 FFS #: RES-C07-245
5. ISSUING OFFICE (Address correspondence to):
U.S. Nuclear Regulatory Commission
Div. of Contracts
Attn: Nicole A. Pratt 301-415-0236
Mail Stop T-7-I-2
Washington, DC 20555

6. SHIP TO:
a. NAME OF CONSIGNEE: U.S. Nuclear Regulatory Commission
b. STREET ADDRESS: Office of Nuclear Regulatory Research
Attn: Aladar Csontos, Mail Stop T10 M5
c. CITY: Washington
d. STATE: DC
e. ZIP CODE: 20555
f. SHIP VIA

7. TO:
a. NAME OF CONTRACTOR: ENGINEERING MECHANICS CORPORATION OF COLUMBUS EMC2
b. COMPANY NAME
c. STREET ADDRESS: 3518 RIVERSIDE DR STE 202
d. CITY: COLUMBUS
e. STATE: OH
f. ZIP CODE: 432211735

8. TYPE OF ORDER
[ ] a. PURCHASE
REFERENCE YOUR _____
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.
[X] b. DELIVERY
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.

9. ACCOUNTING AND APPROPRIATION DATA
76015111127 N6433 252A 31X0200.760
Duns: 014083161 **OBLIGATE: $250,000.00**

10. REQUISITIONING OFFICE: RES

11. BUSINESS CLASSIFICATION (Check appropriate box(es))
[X] a. SMALL
[ ] b. OTHER THAN SMALL
[ ] c. DISADVANTAGED
[ ] g. SERVICE-DISABLED VETERAN-OWNED
[ ] d. WOMEN-OWNED
[ ] e. HUBZone
[ ] f. EMERGING SMALLBUSINESS

12. F.O.B. POINT: Destination

13. PLACE OF
a. INSPECTION: Rockville, MD
b. ACCEPTANCE: Rockville, MD

14. GOVERNMENT B/L NO.

15. DELIVER TO F.O.B. POINT ON OR BEFORE (Date)

16. DISCOUNT TERMS: Net 30

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)
	The Contractor shall provide the U.S. Nuclear Regulatory Commission with services titled, **"Component Integrity Analytical Support,"** in accordance with the attached statement of work and the terms and conditions of the GSA Contract No. GS-10F-0145T, at the prices stated in the attached schedule. PERIOD OF PERFORMANCE: **Date of Acceptance through twenty-eight (28) months** (See page 2 of this document) ** SEE PAGE 3 FOR COMPLETE SCHEDULE OF SUPPLIES/SERVICES**					

SEE BILLING INSTRUCTIONS ON REVERSE

18. SHIPPING POINT
19. GROSS SHIPPING WEIGHT
20. INVOICE NO.

17(h) TOTAL (Cont. pages): $966,399.61

21. MAIL INVOICE TO:
a. NAME: U.S. Nuclear Regulatory Commission
Division of Contracts, Mail Stop T7 I2
b. STREET ADDRESS (or P.O. Box): Attn: DR-04-07-107
c. CITY: Washington
d. STATE: DC
e. ZIP CODE: 20555

17(i). GRAND TOTAL: $966,399.61

22. UNITED STATES OF AMERICA BY (Signature)

23. NAME (Typed): Stephen M. Pool
TITLE: CONTRACTING/ORDERING OFFICER

TEMPLATE - ADM001
AUTHORIZED FOR LOCAL REPRODUCTION
PREVIOUS EDITION NOT USABLE

SUNSI REVIEW COMPLETE OCT 31 2007

ADM002

OPTIONAL FORM 347 (REV. 4/2006)
PRESCRIBED BY GSA/FAR 48 CFR 53.213(f)

Please indicate your acceptance of this contract by having an official who is authorized to bind your organization execute three copies of this document in the spaces provided below and return two copies to the Contract Officer. You should retain the third copy for your records.

ACCEPTED:

Name

Research Leader

Title

9/19/2007

Date

COST SCHEDULE

Date of Award (Pg. 2) through Twenty-Eight (28) Months

Labor Category	Fixed Rate	Est. Hours	Totals
President	[redacted]	[redacted]	$ 90,683.04
Vice-President	[redacted]	[redacted]	$ 76,385.50
Research Leader	[redacted]	[redacted]	$293,268.48
Principal Engineer	[redacted]	[redacted]	$ 39,294.00
Research Engineer	[redacted]	[redacted]	$347.885.72
Sr. Regulatory Advisor	[redacted]	[redacted]	$ 9,067.50
Electronics Specialist	[redacted]	[redacted]	$ 59,844.00
Master Technician	[redacted]	[redacted]	$ 24,755.85
TOTAL LABOR		[redacted]	**$941,184.09**
2.5% LABOR DISCOUNT			(- $ 24,779.48)
Travel			$ 49,995.00
TOTAL COST			**$966,399.61**

NOTE: [redacted] LABOR DISCOUNT SHALL BE APPLIED TO ALL SUBMITTED INVOICES.

Component Integrity Analytical Support

I. BACKGROUND

Component integrity analysis involves evaluating the mechanical design and effects of potential degradation mechanisms on the continued performance of various pressure boundary components. Many pressurized water reactor (PWR) primary pressure boundaries contain nickel-based alloys, including Alloys 82, 182, 52, and 152. Primary coolant water and the operating conditions of PWR plants have been shown to cause cracking of Alloy 82 and 182 weld material through a process called primary water stress corrosion cracking (PWSCC). The occurrences of cracking have been identified through various means, including the discovery of boric acid deposits resulting from through-wall cracking in the primary system pressure boundary. PWSCC in nickel-based alloy primary pressure boundary components is a safety concern due to the potential for reactor pressure boundary leaks and the associated potential of boric acid corrosion of low alloy steels and the development of flaws in piping or welds. Either condition, depending on the size and location of the flaws, could result in a loss of coolant accident.

NRC generic communications document the emergence of PWSCC and its effects on the primary system of PWRs. Generic Letter 97-01, "Degradation of Control Rod Drive Mechanism Nozzle and Other Vessel Closure Head Penetrations," dated April 1, 1997, provided a brief history of PWSCC in reactor vessel head penetrations to date and requested that PWR licensees provide a description of past inspections and plans to inspect the vessel head penetrations. Between November 2000 and April 2001 leaks were discovered from 15 reactor vessel top head CRDM nozzles at Oconee 1, 2 and 3 and Arkansas Nuclear One-1. As a result, the NRC issued NRC Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles," dated August 3, 2001, to address PWSCC of control rod drive mechanism penetrations and other penetrations in the reactor pressure vessel (RPV) upper heads of PWRs. NRC Bulletin 2002-01, "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity," dated March 18, 2002, addressed the issue of boric acid corrosion of low-alloy steel components as a result of leakage through PWSCC-induced flaws in the reactor coolant pressure boundary (RCPB). NRC Bulletin 2002-02, "Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Programs," dated August 9, 2002, followed up on NRC staff concerns about the adequacy of visual examinations as a primary inspection method for the RPV upper head and associated penetrations.

Furthermore, instances of PWSCC have occurred in reactor vessel head penetrations (VHPs) in plants around the world. In September 1991, cracks were found in an Alloy 600 VHP in the reactor head at Bugey 3, a French PWR. Examinations in PWRs in France, Belgium, Sweden, Switzerland, Spain, and Japan were performed, and additional VHPs with axial cracks were detected in several European plants. An action plan was implemented by the NRC staff in 1991 to address PWSCC of Alloy 600 VHPs at all U.S. PWRs.

PWSCC also appeared in Alloy 600 nozzles used in pressurizer heater nozzles and pressurizer instrument nozzles. Information Notice No. 90-01, "Primary Water Stress Corrosion Cracking (PWSCC) of Inconel 600," identified instances of PWSCC at San Onofre Nuclear Generating Station in February 1986 and at Calvert Cliffs Unit 2 in spring 1989. While this information notice is limited to Alloy 600, it marks early concerns of the NRC to Alloy 600 related material degradation. The chemical composition of Alloy 600 and Alloys 82 and 182 are similar, and cracking in Alloy 82 or 182 can propagate into Alloy 600 material and vice versa. The NRC staff identified PWSCC as an emerging technical issue to the Commission in 1989, after the cracking noted in Alloy 600 pressurizer heater sleeve penetrations at Calvert Cliffs Unit 2. In recent years, operational experience indicates that Alloy 82/182/600 butt welds are susceptible to PWSCC in PWR environments as well:

- In 1993, Palisades discovered a leak through a circumferential crack in the Alloy 600 safe end on the pressurizer nozzle for the power-operated relief valve. The circumferential extent of the crack was about 3 inches in the 4-inch diameter pipe. Metallurgical analysis of a sample characterized the cracking as PWSCC of the Alloy 600 safe end material in the heat-affected zone of the Alloy 82 and 182 weld. This was the first instance of PWSCC associated with butt welds at a U.S. reactor licensed by the NRC.
- In 2000, ultrasonic examination of a reactor pressure vessel (RPV) hot leg nozzle-to-safe end DM weld at Ringhals 4 in Sweden revealed four axial part-through-wall flaws. Metallurgical analysis attributed the cracking to PWSCC. Two small axial indications were identified in a Ringhals 3 RPV hot leg nozzle-to-safe end DM weld. These indications were left in service until a follow up inspection in 2001, at which time, the indications were sampled and analyzed to be PWSCC.
- In 2000, a large accumulation of boric acid deposits was observed during a refueling outage at V.C. Summer which led to the discovery of cracking in the "A" hot leg pipe-to-RPV nozzle DM weld. The weld contained a through-wall axial flaw and small part-through-wall axial flaws, as well as a circumferential flaw. Metallurgical analysis attributed the cracking to PWSCC. Small axial and circumferential cracks were identified in the "B" hot leg pipe-to-RPV nozzle DM welds; a small circumferential crack was identified in the "C" hot leg pipe-to-RPV nozzle DM weld; and a small circumferential crack was found in both the "A" and "C" cold leg pipe-to-RPV nozzle DM welds.
- In 2003, ultrasonic examination of the pressurizer surge line hot leg nozzle-to-safe end weld at Three Mile Island Unit 1 revealed an axial part-through-wall indication in a DM weld. The licensee attributed the indication to PWSCC.
- In 2003, Tsuruga 2 in Japan observed boron deposits on the surface of a pressurizer relief valve nozzle that led to the discovery of three axially oriented flaws in the nozzle-to-safe end DM weld. Subsequent nondestructive examination (NDE) of the safety valve nozzle revealed two additional axial flaws in the nozzle-to-safe end DM weld. Metallurgical analysis of the flaws identified PWSCC as the mechanism for flaw initiation and growth.
- In 2003, ultrasonic examination revealed a shallow axial indication in the pressurizer-to-surge line weld at Tihange 2 in Belgium. This indication was attributed to PWSCC.
- In 2005, ultrasonic examination identified two axial part-through-wall indications approximately 180 degrees apart in a 2 inch hot leg drain nozzle-to-safe end DM weld at Calvert Cliffs Unit 2. The Licensee attributed the indications to PWSCC.
- In 2005, ultrasonic examination identified an axial part-through-wall indication in a pressurizer nozzle-to-safe end DM weld for the pressurizer safety valve at D. C. Cook Unit 1. The licensee attributed the indication to PWSCC.
- In 2006, ultrasonic examinations at Calvert Cliffs Unit 1 identified an axial indication in the pressurizer relief nozzle-to-safe end DM weld and a circumferential indication in the hot leg surge line nozzle-to-safe end DM weld and a hot leg drain nozzle-to-safe end DM weld. The circumferential indication in the hot leg to surge line nozzle-to-safe end was 2.4 inches in length and approximately 25 percent through-wall in depth. The circumferential indication in the hot leg drain nozzle was 0.45 inches in length and approximately 18 percent through-wall in depth.
- Most recently in October 2006, Wolf Creek reported five circumferential indications in three pressurizer DM welds. Three indications were in the pressurizer surge line nozzle-to-safe end weld, and one indication was found in each of the safety and relief nozzle-to-safe end welds. The relief nozzle-to-safe end flaw was measured as 11.5 inches long as projected on the outside diameter of the weld.

The industry response to this phenomenon is coordinated through the Materials Reliability Program (MRP) in a comprehensive, multifaceted effort. Although the industry program is addressing many of the issues raised by these cracking occurrences, the Office of Nuclear Reactor Regulation (NRR) has identified several issues requiring additional consideration regarding the generic implications of these

events. In a memorandum dated June 5, 2001, NRR provided a user need request (NRR-2002-018) to the Office of Nuclear Regulatory Research (RES) to evaluate issues involving cracking in Alloy 82/182 welds and Alloy 600 base metal at several domestic and overseas plants. The user need request supersedes NRR-2002-018 and identifies NRR's current needs in the area of PWSCC of nickel-base alloy primary pressure boundary components.

Component integrity analysis is not only focused on metallic alloys. Since general and microbiologically influenced corrosion plague carbon steel piping in service water systems in operating reactors, the nuclear power industry believes that the use of plastic piping, similar to that used in petrochemical applications, is a viable option for nuclear applications. During a meeting on June 27, 2005, Duke Power indicated that it plans to submit a license amendment request to replace safety-related portions of the Catawba Nuclear Station low pressure service water system with polyethylene piping. Duke has proposed criteria for the production, design, installation and inspection of the polyethylene piping. Duke cited the following material specifications as applicable to polyethylene piping; ASTM D-3350, ASTM D-3035, and ASTM D-2837. Duke also indicated that it has ten years of experience with the use of polyethylene piping in the non safety-related portions of its low pressure service water system. However, this operating experience does not demonstrate the acceptability of the polyethylene piping for seismic loads. NRR will request Duke Power to provide a technical basis for establishing the adequacy of polyethylene piping under all loading conditions, including seismic loads.

The industry efforts in this plastic pipe arena have been coordinated through the ASME Code process over the past few years. In a memorandum dated March 18, 2006, NRR provided a user need request to the RES to assist NRR in the development of a technical basis to support the staff's review of the proposed use of polyethylene piping for low pressure safety-related piping systems at nuclear power plants. Overall, the deliverables from this project will provide the NRC staff with information needed to enhance the evaluation of industry generic assessments and plant-specific activities and to support long term regulatory actions that provide reasonable assurance of public health and safety in the area of component integrity analysis.

II. OBJECTIVE

The objective of this project is to provide technical analytical support to RES to develop the technical basis for future regulatory decisions related to enhanced component integrity analysis of reactor systems and components.

III. SCOPE OF WORK

Task 1: Weld Metal Properties and Flaw Evaluation

Task 1a: Evaluate the effects of flaws in weld materials for Alloy 182/82 and determine the effects of weld mechanical properties on complex flaws in Alloy 152/52/52M. Use current field data of similar numbers of construction related indications found in new RPVH partial penetration welds. Include an ASME Code Section III stress limit analysis to determine acceptable levels of construction related indications in new RPVH partial penetration welds for 60-year new RPVH lifetimes.

Task 1b: As part of a cooperative effort with the industry, develop and compile the full set of mechanical properties used in typical weld residual stress modeling and flaw evaluation procedures for Alloy 82, 182, 52, and 152 through either literature searches or tensile testing. If tensile testing is required, the NRC, in concert with the industry, will provide the sample weld materials in the as-welded condition and the contractor shall provide the full stress-strain curves for the conditions below per the ASTM E8 standard:

- as-welded condition: room temperature, 300°F, and 600°F

• solution-annealed condition: room temperature, 300°F, 600°F, 1000°F, 1400°F, and 1800°F

Task 1c: Determine the structural integrity of a current (Alloy 600) and a replacement (Alloy 690) RPVH with a simulated set of indications in partial penetration welds.

Deliverable Schedule: Task 1a: Provide a technical letter report to the NRC program manager within 12 months of project initiation.
Task 1b: Provide a technical letter report to the NRC program manager within 18 months of project initiation.
Task 1c: Provide a technical letter report to the NRC program manager within 28 months of project initiation.

Task 2: Complex Crack Growth Model

Task 2a: Develop a fracture mechanics based circumferential crack growth model using the complex crack shape methodology with realistic and bounding assumptions related to RPVH penetration nozzles and dissimilar metal butt welds in PWRs.

Task 2b: Compare and contrast the complex circumferential crack growth analysis results to MRP work related to this specific research topic including base assumptions, computer codes used, and operational experience supporting results.

Task 2c: Provide technical assistance to the NRC staff in reviewing pertinent industry reports, guidelines, and licensee submittals related to crack growth modeling. This may include participation in meetings and on conference calls.

Deliverable Schedule: Task 2a: Provide a technical letter report to the NRC program manager within 12 months of project initiation.
Task 2b: Provide a technical letter report to the NRC program manager within 18 months of project initiation.
Task 2c: Provide assistance as required.

Task 3: Update and Improve Probabilistic Fracture Mechanics Model and Leak-Rate-Estimation Methodology

Task 3a: Update and improve the PRO-LOCA probabilistic fracture mechanics model from earlier versions to include the following:
• improvements to the PRO-LOCA PWSCC initiation and growth models
• the complex crack growth model
• additional dissimilar metal butt-weld and weld overlay geometries and residual stress profiles into the PRO-LOCA code database
• the effect of repair welds on the distribution of residual stresses
• other emergent phenomena that warrant inclusion into the PRO-LOCA code.

Task 3b: Update and improve the Seepage Quantification of Upsets in Reactor Tubes (SQUIRT) leak-rate estimation methodology from earlier versions. Specifically, develop additional crack morphology parameters for PWSCC cracks with an updated crack opening displacement dependent crack morphology relationship.

Task 3c: Compare and contrast the projected leak rates for PWSCC cracks between the SQUIRT and AREVA leak rate code named KRAKFLO.

Deliverable Schedule: Task 3a: The contractor shall provide the updated version of the PRO-LOCA model and software along with a technical letter report detailing the changes made within 18 months of contract initiation.
Task 3b: The contractor shall provide the updated version of the SQUIRT model and software along with a technical letter report detailing the changes made within 18 months of contract initiation.
Task 3c: The contractor shall provide a technical letter report within 28 months of contract initiation.

Task 4: Probabilistic Fracture Mechanics Analysis

Task 4a: Using the probabilistic analysis models developed under Task 3, assess the risk of failure and leakage caused by PWSCC of nickel-base alloys in reactor pressure boundary components, i.e., RPVH penetration nozzles and butt welds, for conditions specified by the NRC.

Task 4b: Compare and contrast results with the information provided in MRP-105, "Probabilistic Fracture Mechanics Analysis of PWR Reactor Pressure Vessel Top Head Nozzle Cracking," and MRP-116, "Probabilistic Risk Assessment of Alloy 82/182 Piping Butt Welds."

Task 4c: Provide technical assistance to the NRC staff to:
- Review pertinent industry reports, guidelines, and licensee submittals related to probabilistic fracture mechanics modeling.
- Assess MRP work in these areas, including base assumptions, computer codes used, and operational experience.

This assistance may require participation in meetings and on conference calls.

Deliverable Schedule: Task 4a: Provide a technical letter report within 18 months of contract initiation.
Task 4b: Provide a technical letter report within 18 months of contract initiation.
Task 4c: Provide assistance as required.

Task 5: Evaluate RPVH Overlay

Simulate the effects of a 3-layer weld overlay on the outside diameter (OD) of the improved stress analysis for RPVH Penetration Nozzles; determine the effective change on stresses on the inside diameter of the penetration nozzle and on the OD above the weld; and assess the effectiveness of the weld overlay repair process, i.e. ensure that the overlay does not increase RPVH penetration nozzle susceptibility to PWSCC over the lifetime of the repair.

Deliverable Schedule: Provide a technical letter report to the NRC program manager within 12 months of the project initiation.

Task 6: Evaluate Residual Stress Profiles of Representative Dissimilar Butt-Weld and Weld Overlay Configurations

Task 6a) The contractor shall construct a finite element model to predict the residual stress profile of one each of a dissimilar metal butt-weld and weld overlay mockup with and without weld repairs. For this modeling effort, the NRC will provide the detailed fabrication specifications and welding parameters for each butt-weld and weld overlay mockup with and without weld repairs. The fabrication specifications and welding parameters for the

representative butt-weld and weld overlays will be provided to the contractor by the NRC within 8 months after the contract award date.

Task 6b) Provide Technical assistance to the NRC staff for:

- Industry coordination efforts, proposals, meetings, and conference calls
- Advisory Committee for Reactor Safeguards (ACRS)/NRC meetings - provide technical expertise to the NRC as necessary
- Reviewing pertinent industry reports related to weld residual stresses.

Deliverable Schedule: Provide a technical letter report detailing the finite element model results for the butt-weld and weld overlay mockups 12 months after contract award date.

Task 7: Slow Crack Growth Testing of High Density Polyethylene

The objective of this task is to confirm industry-developed slow crack growth (SCG) data for high density polyethylene (HDPE) materials that are being considered for ASME Class 3 safety related service water piping applications at nuclear power plants. ASME is in the process of developing a Code Case for the aforementioned application and testing is required to support the hydrostatic design basis and the hydrostatic design stress. The industry, through the Electric Power Research Institute (EPRI), plans to perform testing to develop the supporting data. The data will be confirmed by performing testing at the extremes of the temperatures and stresses evaluated by EPRI using a combination of small-scale laboratory tests and finite element analysis.

The material to be tested initially shall be HDPE 4710. This task shall include designing the testing approach and performing the testing necessary to obtain pertinent and relevant SCG data including crack growth rate, time to failure initiation, and time to final failure at multiple applied stresses and temperatures. The test most likely to meet these objectives is the PENT test per ASTM F1473 modified appropriately to obtain crack growth rate. Other test methods may be proposed by the contractor and submitted for NRC approval. The data shall be analyzed with respect to the performance of the candidate HDPE material compared to other HDPE materials of similar molecular weight (i.e. ASTM D 3350 cell classification). In addition, the SCG rate data obtained from the PENT test shall be used to predict the long term service life of flawed piping using finite element (FE) modeling. The effect of the notch depth and radius shall be considered in the analysis.

Deliverable Schedule: Provide a technical report that includes a description of the material(s) tested, the experimental approach, the results, the analysis of the results and the conclusions due to the NRC program manager within 12 months of the project initiation.

IV. RESEARCH QUALITY

The quality of NRC research programs are assessed each year by the Advisory Committee on Reactor Safeguards. Within the context of their reviews of RES programs, the definition of quality research is based upon several major characteristics:

Results meet the objectives (75% of overall score)

Justification of major assumptions (12%)

Soundness of technical approach and results (52%)

Uncertainties and sensitivities addressed (11%)

Documentation of research results and methods is adequate (25% of overall score)

Clarity of presentation (16%)

Identification of major assumptions (9%)

It is the responsibility of the contractor to ensure that these quality criteria are adequately addressed throughout the course of the research that is performed. The NRC project manager and technical monitor will review all research products with these criteria in mind.

V TECHNICAL AND OTHER SPECIAL QUALIFICATIONS REQUIRED

The program manager, key personnel, and any other senior technical staff performing work under this contract shall have expertise, experience, and/or education in the following key areas:

a. Expertise in materials and structural mechanics.
b. Expertise in finite element analyses.
c. Expertise in developing probabilistic codes.
d. Expertise in leakage detection methodology and leak-rate calculations with existing leak-rate codes.
e. Detailed knowledge of pressurized water reactor piping system design and manufacturing methods including material property information.
f. Detailed knowledge of techniques used to evaluate residual stresses in pipe welds, e.g. weld sequencing.
g. Detailed knowledge of industry and NRC staff analyses regarding reported occurrences of primary water stress corrosion cracking and NRC actions, e.g., notices, bulletins, etc.

VI. DELIVERABLES AND DELIVERY SCHEDULE

All reports shall be submitted electronically as a Microsoft Word, WordPerfect, or PDF file to the Project Officer and Contracting Officer.

Task 1 Deliverable Schedule:	Task 1a: Provide a technical letter report to the NRC program manager within 12 months of project initiation. Task 1b: Provide a technical letter report to the NRC program manager within 18 months of project initiation. Task 1c: Provide a technical letter report to the NRC program manager within 28 months of project initiation.
Task 2 Deliverable Schedule:	Task 2a: Provide a technical letter report to the NRC program manager within 12 months of project initiation. Task 2b: Provide a technical letter report to the NRC program manager within 18 months of project initiation. Task 2c: Provide assistance as required.
Task 3 Deliverable Schedule:	Task 3a: The contractor shall provide the updated version of the PRO-LOCA model and software along with a technical letter report detailing the changes made within 18 months of contract initiation. Task 3b: The contractor shall provide the updated version of the SQUIRT model and software along with a technical letter report detailing the changes made within 18 months of contract initiation. Task 3c: The contractor shall provide a technical letter report within 28 months of contract initiation.
Task 4 Deliverable Schedule:	Task 4a: Provide a technical letter report within 18 months of contract initiation. Task 4b: Provide a technical letter report within 18 months of contract initiation. Task 4c: Provide assistance as required.
Task 5 Deliverable Schedule:	Provide a technical letter report to the NRC program manager within 12 months of the project initiation.

Task 6 Deliverable Schedule:	Provide a technical report that includes a description of the material(s) tested, the experimental approach, the results, the analysis of the results and the conclusions due to the NRC program manager within 12 months of the project initiation.
Monthly Reports:	Technical Progress Report and Monthly Financial Status Report per established contract procedures.

VII. MEETING AND TRAVEL REQUIREMENTS

Biweekly phone progress reports shall be conducted with the NRC Project Officer for approximately one-hour in duration throughout the period of performance.

Up to ten three-day trips for up to three people to Rockville, MD or NRC-designated location to provide expertise related to this program.

VIII. GOVERNMENT FURNISHED MATERIALS

There will be no government furnished materials for this program.

TASK ORDER TERMS AND CONDITIONS

B.1 CONSIDERATION AND OBLIGATION

(a) The total not to exceed estimated amount of this contract is **$966,399.61**.

(b) The amount presently obligated with respect to this contract is **$250,000.00**. The Contractor shall not exceed the obligated amount.

B.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 con-currence 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.

B.3 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.

B.4 PROJECT OFFICER AUTHORITY (November 2006)

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

Name:	Aladar Csontos
Address:	11545 Rockville Pike Mailstop T10 M5 Rockville, MD 20852-2738
Telephone Number:	(301) 415-6352

(b) Performance of the work under this contract is subject to the technical direction of the NRC project officer. 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 (SOW) or changes to specific travel identified in the SOW), fills in details, or otherwise serves to accomplish the contractual SOW.

(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, approval of 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 project officer 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 project officer 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 project officer in the manner prescribed by this clause and within the project officer's authority under the provisions of this clause.

(f) If, in the opinion of the contractor, any instruction or direction issued by the project officer is within one of the categories as 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 the 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 project officer 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 thereto is subject to 52.233-1 - Disputes.

(i) In addition to providing technical direction as defined in paragraph (b) of the section, the project officer 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.

(4) Assist the contractor in obtaining the badges for the contractor personnel.

(5) Immediately notify the Security Branch, Division of Facilities and Security (SB/DFS) (via e-mail) when a contractor employee no longer requires access authorization and return of any NRC issued badge to SB/DFS within three days after their termination.

(6) Ensure that all contractor employees that require access to classified Restricted Data or National Security Information or matter, access to sensitive unclassified information (Safeguards, Official Use Only, and Proprietary information) access to sensitive IT systems or data, unescorted access to NRC controlled buildings/space, or unescorted access to protected and vital areas of nuclear power plants receive approval of SB/DFS prior to access in accordance with Management Directive and Handbook 12.3.

(7) For contracts for the design, development, maintenance or operation of Privacy Act Systems of Records, obtain from the contractor as part of closeout procedures, written certification that the contractor has returned to NRC, transferred to the successor contractor, or destroyed at the end of the contract in accordance with instructions provided by the NRC Systems Manager for Privacy Act Systems of Records, all records (electronic or paper) which were created, compiled, obtained or maintained under the contract.

B.5 2052.235-70 PUBLICATION OF RESEARCH RESULTS (OCT 1999)

(a) The principal investigator(s)/contractor shall comply with the provisions of NRC Management Directive 3.8 (Vol. 3, Part 1) and NRC Handbook 3.8 (Parts I-IV) regarding publication in refereed scientific and engineering journals or dissemination to the public of any information, oral or written, concerning the work performed under this contract. Failure to comply with this clause shall be grounds for termination of this contract.

(b) The principal investigator(s)/contractor may publish the results of this work in refereed scientific and engineering journals or in open literature and present papers at public or association meetings at interim stages of work, in addition to submitting to NRC the final reports and other deliverables required under this contract. However, such publication and papers shall focus on advances in science and technology and minimize conclusions and/or recommendations which may have regulatory implications.

(c) The principal investigator(s) shall coordinate all such publications with, and transmit a copy of the proposed article or paper to, the NRC Contracting Officer or Project Officer, prior to publication. The NRC agrees to review and provide comments within thirty (30) days after receipt of a proposed publication. However, in those cases where the information to be published is (1) subject to Commission approval, (2) has not been ruled upon, or (3) disapproved by the Commission, the NRC reserves the right to disapprove or delay the publication. Further, if the NRC disagrees with the proposed publication for any reason, it reserves the right to require that any publication not identify the NRC's sponsorship of the work and that any associated publication costs shall be borne by the contractor.

B.6 COMPLIANCE WITH U.S. IMMIGRATION LAWS AND REGULATIONS

NRC contractors are responsible to ensure that their alien personnel are not in violation of United States Immigration and Naturalization (INS) laws and regulations, including employment authorization documents and visa requirements. Each alien employee of the Contractor must be lawfully admitted for permanent residence as evidenced by Alien Registration Receipt Card Form 1-151 or must present other evidence from the Immigration and Naturalization Services that employment will not affect his/her

immigration status. The INS Office of Business Liaison (OBL) provides information to contractors to help them understand the employment eligibility verification process for non-US citizens. This information can be found on the INS website, http://www.ins.usdoj.gov/graphics/services/employerinfo/index.htm#obl.

The NRC reserves the right to deny or withdraw Contractor use or access to NRC facilities or its equipment/services, and/or take any number of contract administrative actions (e.g., disallow costs, terminate for cause) should the Contractor violate the Contractor's responsibility under this clause.

B.7 SEAT BELTS

Contractors, subcontractors, and grantees, are encouraged to adopt and enforce on-the-job seat belt policies and programs for their employees when operating company-owned, rented, or personally owned vehicles.