

2. AMENDMENT/MODIFICATION NO. M005	3. EFFECTIVE DATE See Block 15c.	4. REQUISITION/PURCHASE REQ. NO. 42-07-468 T2 M5 0746802131	5. PROJECT NO. (if applicable)
SUBMITTED BY U.S. Nuclear Regulatory Commission Div. of Contracts Attn: Jeffrey R. Mitchell, 301-492-3639 Mail Stop: TWB-01-B10M Washington, DC 20555	CODE 3100	7. ADMINISTERED BY (If other than Item 6) U.S. Nuclear Regulatory Commission Div. of Contracts Mail Stop: TWB-01-B10M Washington, DC 20555	CODE 3100

8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code) ENERGY RESEARCH, INC. ATTN: TRACEY MULLINIX 6167 EXECUTIVE BLVD. ROCKVILLE MD 208523901	(X)	9A. AMENDMENT OF SOLICITATION NO.
CODE 621211259 FACILITY CODE		9B. DATED (SEE ITEM 11)
		10A. MODIFICATION OF CONTRACT/ORDER NO. GS23F0110M NRC-T002
	X	10B. DATED (SEE ITEM 13) 05-14-2008

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers  is extended,  is not extended. Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:  
 (a) By completing Items 8 and 15, and returning \_\_\_\_\_ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required) 025-15-171-103 Q4131 252A 31x0200 Obligate \$25,000.00

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

(X)	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
X	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF: Bilateral Mutual Agreement of the Parties
	D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor  is not,  is required to sign this document and return 1 copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)  
 .....REFER TO ATTACHMENT PAGE TWO FOR A DESCRIPTION OF MODIFICATION NO. FIVE.....

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print) MOHSEN KHATIB-RAMBAR President	16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print) Jeffrey R. Mitchell Contracting Officer
15B. CONTRACTOR OFFEROR Moh Khatib Rambar (Signature of person authorized to sign)	15C. DATE SIGNED 9/25/10
15D. UNITED STATES OF AMERICA BY Jeffrey R. Mitchell (Signature of Contracting Officer)	16C. DATE SIGNED 9/24/2010

TEMPLATE - ADM001 SUNSI REVIEW COMPLETE SEP 29 2010 ADM002

The purpose of this modification is to (1) to incorporate the revised task order Statement of Work, (2) increase the contract ceiling by \$32,140.24 from \$250,284.38 to \$282,424.62, (3) provide incremental funding in the amount of \$25,000.00 thereby increasing the total obligations from \$250,284.38 to \$275,284.38, (4) extend the period of performance from December 31, 2010 to March 31, 2011 and (5) revise the price/cost schedule to incorporate new billing rates. Accordingly, the subject task order is modified as follows:

Refer to the Task Order No. 2 "Statement of Work" is here by deleted in its entirety and replaced with the following Statement of Work attached to this Modification No. 5 entitled "Statement of Work Rev 1".

Refer to "CONSIDERATION AND OBLIGATION--COST REIMBURSEMENT (JUN 1988)" paragraph (a) and (b) first sentence are revised as follows:

(a) The total estimated cost to the Government for full performance under this contract is \$282,424.62.

(b) "The amount obligated by the Government with respect to this contract is \$275,284.38." This obligated amount may be unilaterally increased from time to time by the Contracting Officer by written modification to this contract. The obligated amount shall, at no time, exceed the contract 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 contract. Any work undertaken by the Contractor in excess of the obligated amount specified above is done so at the Contractor's sole risk.

Refer to the "DURATION OF CONTRACT PERIOD (MAR 1987)" is hereby deleted in its entirety and replaced with the following:

"This contract shall commend on April 18, 2008 and will expire on March 31, 2011"

Refer to the "PRICE/COST SCHEDULE" is hereby deleted in its entirety and replaced with the following:

PRICE/COST SCHEDULE TASK ORDER NO. 2							
CLIN	LABOR CATEGORY	EST HOURS	RATE 04/18/08 - 12/31/08	RATE 01/01/09 - 12/31/09	RATE 01/01/10 - 12/31/10	RATE 01/01/11 - 03/31/11	ESTIMATE (Blended Rate)
001	Executive	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
002	Executive Engineer/ Scientist	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
003	Senior Engineer/ Scientist	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
004	Engineer / Scientist	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
005	Travel	1 Lot	Not to Exceed (NTE)				[REDACTED]
006a	Other Direct Cost (Copies)	[REDACTED] pages	\$ [REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
006b**	Other Direct Cost (Phone & Courier)	1 Lot (NTE)	Actual Cost	Actual Cost			[REDACTED]
							\$282,424.62

(b) \*\* These items are Open Market and do not apply to the Federal Supply Schedule Terms and Conditions. These items must comply with the following clauses incorporated by reference:

REFERENCE	NUMBER	TITLE	DATE
REFERENCE	FAR 52.212-4	CONTRACT TERMS AND CONDITIONS COMMERCIAL ITEMS	MARCH 2001
REFERENCE	FAR 52.212-5	CONTRACT TERMS AND CONDITIONS REQUIRED TO IMPLEMENT STATUES OR EXECUTIVE ORDERS – COMMERCIAL ITEMS	MARCH 2001

A summary of obligations from the date of this order is provided below:

FY08 Obligations (Award)	\$150,000.00
FY08 Obligations (Mod 1)	\$75,000.00
FY10 Obligations (Mod 4)	\$50,284.38

Cumulative total of NRC Obligations \$275,284.38

\*\*\*\*ALL OTHER TERMS AND CONDITIONS OF THE SUBJECT TASK ORDER REMAIN UNCHANGED\*\*\*\*

**MODIFICATION NO. 5**  
**TASK ORDER STATEMENT OF WORK**  
**REVISION NO. 1**

JCN/Contract No. Q-4131 NRC-42-07-468	Contractor Energy Research, Inc.	Task Order No. 2
Applicant AREVA	Design/Site EPR	Docket No. 05200020
Title/Description  Technical Support of Review of Level 2 PRA, Deterministic Severe Accident Reviews, and SAMDAs for U.S. EPR		
TAC No. RX0300	B&R Number 125-15-171-103	SRP Section(s) or ESRP 19
NRC Technical Assistance Project Manager (TAPM) Tracy Clark (301) 415-1474 Tracy.Clark@nrc.gov		
NRC Technical Monitor (TM) Todd Hilsmeier (301) 415-6788 Todd.Hilsmeier@nrc.gov		

**1. BACKGROUND**

The U.S. EPR is the latest evolution of AREVA's pressurized water reactor (PWR) technology, for which AREVA has submitted an application to the NRC to certify the design for construction and licensing in the United States. Chapter 19 of this application includes a description of the required Probabilistic Risk Assessment and a summary of its results, as well as a Severe Accident Evaluation. In order for the NRC to grant a certificate, the staff needs to review the application and prepare a safety evaluation report concluding that the design is indeed safe and meets the NRC's risk criteria. The work described below will assist the staff in its review of Chapter 19.

The U.S. EPR is an evolutionary plant, featuring active safety systems for accident mitigation. Therefore, there is no need to review non-safety systems.

To support its application for certification of the U.S. EPR design, AREVA submitted a Severe Accident Topical Report in August 2006 for NRC review, requesting a safety evaluation that concludes that its technical bases for severe accident assessment, including the testing programs and the models and methods used for severe accident analyses, are adequate to meet the policies established in SECY 93-087 and to support the U.S. EPR probabilistic risk assessment (PRA). The Staff reviewed this document, prepared RAIs, and issued a SER that approved AREVA's request with some qualifications.

The U.S. EPR PRA is a Level 1 and Level 2 PRA. The Level 2 portion of the PRA is supported by deterministic analyses of severe accident progression based on the MAAP computer code. Key severe accident phenomena associated with debris coolability via the Core Melt Stabilization System (CMSS) are further assessed through supporting calculations with the

MELTSREAD and WALTER codes. There are also a number of systems designed to mitigate the consequences of severe accidents. The Severe Accident Heat Removal System (SAHRS) works along with the CMSS to cool the debris. There is a Severe Accident Depressurization System designed to avoid direct contain heating and induced steam generator tube ruptures by lowering the RCS pressure prior to significant core damage. There is also a Combustible Gas Control System, featuring passive autocatalytic recombiners to prevent excess buildup of hydrogen in the containment building. There are a number of other mitigative features as well. An evaluation of severe accident mitigation design alternatives (SAMDA) is also included in the application.

The primary objectives of the review are: to establish that the Level 2 PRA is complete and that its results meet the Commission's risk requirements; to develop insights into severe accident progression/phenomenology, containment performance, and important risk contributors and design features; to identify any structures systems or components (SSCs) that should be subject to additional regulatory controls (i.e., ITAAC or COL action items); and to evaluate potentially cost-beneficial SAMDAs pursuant to the National Environmental Policy Act (NEPA). The contractor shall prepare written evaluations for each review topic in a form that can be incorporated into an NRC staff safety evaluation report (SER) with minimal changes. The specific U.S. EPR review topics to be addressed are identified in Table 1 below. The scope and depth of the reviews in each of these areas are expected to be similar to that for the corresponding reviews performed for ESBWR, ABWR, and/or AP1000 design certification.

In support of the U.S. EPR review, the NRC Office of Research (RES) is sponsoring confirmatory calculations using the MELCOR computer code. The contractor shall closely coordinate with RES and their contractors in this effort, and consider the results of these calculations during both the preparation of RAIs and SER inputs.

### **OBJECTIVE**

The objective of this task order is to obtain expert technical assistance from the contractor to support and assist the NRC staff in performing an independent evaluation of the completeness and technical adequacy of AREVA's Level 2 PRA, deterministic severe accident evaluations, and SAMDA analysis for the U.S. EPR design. The scope of work includes: (1) completion of the review of AREVA's PRA and severe accident evaluations in Section 19 of the FSAR; (2) preparation of additional RAIs, with accompanying draft technical evaluation report (TER) sections describing the technical issue and how the requested information supports issue closure; (3) review of supplemental submittals and RAI responses; and (4) preparation of written evaluations for each review topic in a form that can be readily incorporated into an NRC staff safety evaluation report (SER). Although the emphasis of the review is on internal events while at-power, the review scope also includes AREVA's treatment of containment performance for external events and events during shutdown. It will be necessary to participate in an audit of AREVA's PRA, and it may also be necessary to review any of AREVA's severe accident analyses not covered in the Topical Report.

### **TECHNICAL AND OTHER SPECIAL QUALIFICATIONS REQUIRED**

The contractor shall provide specialists with expertise and experience in the following areas: (a) development and peer review of Level 2 PRAs and deterministic severe accident evaluations, including treatment of internal and external events during at-power and shutdown conditions; (b) PWR plant systems, containment systems, and severe accident features; (c) thermal-hydraulic,

severe accident progression, and offsite consequence analyses, including familiarity with the MAAP, MELCOR, and CONTAIN computer codes; (d) specialized techniques for treatment and quantification of severe accident phenomena (e.g., ROAAM); (e) PRA quality standards and the use of PRA methodologies and results in commercial nuclear reactor applications; and (f) NRC regulations, technical specifications, and inspections related to commercial nuclear power plant operations.

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 the technical and regulatory objectives of the work specified in this task order SOW. The NRC will rely on representations made by the contractor concerning the qualifications of the personnel assigned to this task order including assurance that all information contained in the technical and cost proposal, including resumes, is accurate and truthful.

The use of key personnel and any proposed change to key personnel on this task order contract is subject to the NRC Project Manager's approval. This includes proposed use of principal persons (i.e., key contributors) during the life of the contract.

If any work would be subcontracted or performed by consultants, The contractor shall obtain the NRC Project Manager's written approval of the subcontractor or consultant prior to initiation of the subcontract effort. Conflict of interest considerations shall apply to any subcontracted effort.

## **WORK REQUIREMENTS**

The contractor shall provide personnel with PRA and other required expertise necessary to perform work in the following tasks:

### **Tasks**

1. **Review U.S. EPR Level 2 PRA and Deterministic Severe Accident Evaluations and Prepare Draft TER with RAIs**

The contractor shall perform a review of AREVA's Level 2 PRA and deterministic severe accident evaluations for the U.S. EPR design. The focus of the review will be on: establishing that the technical quality of the Level 2 PRA is sufficient to assure that the Commission's risk requirements are satisfied; developing insights into severe accident progression and phenomenology, containment performance, and important risk contributors and design features; and identifying any structures systems or components (SSCs) that should be subject to additional regulatory controls (i.e., ITAAC or COL action items). The contractor will consider the results of NRC-sponsored confirmatory calculations during both the preparation of RAIs and TER inputs.

The contractor shall perform a focused evaluation of dominate severe accident scenarios resulting from a steam line break inside containment and Anticipated Transients without Scram (ATWS). This should include close coordination with the RES-sponsored plant-specific MELCOR confirmatory calculations for U.S. EPR. The results of this assessment which will include comparisons between any documented analyses in the FSAR (based on MAAP4 or other computer codes) and the RES MELCOR analyses for the aforementioned sequences should be reported as part of the TER.

The contractor shall document the results of the evaluation with possible open items in a draft TER. The TER will consist of written evaluations for each review topic in a form that can be incorporated into an NRC staff safety evaluation report (SER). The specific review topics to be addressed are identified in Table 1 below. The scope and depth of the reviews in each of these areas are expected to be similar to that for the corresponding reviews performed for ESBWR, ABWR, and/or AP1000 design certification. The contractor shall identify any additional information needed to resolve possible open items. This information shall be provided to the NRC in the form of an RAI for transmittal to the applicant.

2. Review U.S. EPR SAMDA Analysis and Prepare Draft TER with RAIs

The contractor shall conduct a preliminary review of AREVA's SAMDA submittal provided in the Environmental Report. The emphasis of the review shall be on the completeness of design alternatives considered and the reasonableness of the analyses of risk reduction and costs for each candidate improvement. In assessing completeness, The contractor shall evaluate the rigor of the process used by the applicant to identify potential SAMDAs (e.g., importance analyses or cutset examination), and shall consider the results of the process relative to the leading risk contributors. The applicant's cost/benefit methodology shall be assessed for consistency with the regulatory analysis guidance provided in NUREG/BR-0058, Rev.4, and NUREG/BR-0184. The contractor shall review the treatment of externally-initiated events and uncertainty in core damage frequency and risk estimates within the applicant's analysis, and address these factors in their assessment of the adequacy of the SAMDA identification and evaluation process.

The contractor shall document the results of the preliminary evaluation with possible open items in a draft TER containing the following: (i) an assessment of the adequacy of the applicant's evaluation of SAMDAs, in terms of completeness, reasonableness of results, and potential for further risk reductions, (ii) identification of any additional SAMDAs which should be considered further, and (iii) independent estimates of risk reduction and costs for selected SAMAs, as appropriate. The contractor shall identify any additional information needed to resolve possible open items. This information shall be provided to the NRC in the form of an RAI for transmittal to the applicant.

3. Review Supplemental U.S. EPR Submittals and RAI Responses for PRA and Severe Accident Analysis

The contractor shall review AREVA's responses to all issues raised during the review of the Level 2 PRA and deterministic severe accident evaluations, including new and revised analyses requested in response to RAIs. Any additional information needed to resolve any remaining technical concerns shall be identified by the contractor, and provided to the NRC in the form of an RAI for follow-up discussion with the applicant. The contractor shall support further interactions with the applicant, as appropriate, to ensure that the issues are well understood and to arrive at an acceptable path to resolution.

4. Review Supplemental U.S. EPR Submittals and RAI Responses for SAMDA

The contractor shall review AREVA's responses to all issues raised during the review of the PRA that could impact the SAMDA evaluation. Any additional information needed to resolve any remaining technical concerns shall be identified by the contractor, and

provided to the NRC in the form of an RAI for follow-up discussion with the applicant. The contractor shall support further interactions with the applicant, as appropriate, to ensure that the issues are well understood and to arrive at an acceptable path to resolution.

5. Prepare Final TERs

The contractor shall provide support in the following areas:

- a. **Support NRO in the resolution of open items related to the risk of severe accidents at full-power and shutdown conditions. This includes resolution of issues related to materials interactions between molten core debris and the Zirconia layer on the reactor pit, SGTR source term, SAMG plan, and a number of other severe accident and source term issues.**
- b. **Assess the implications of the potential for maldistribution of combustible gases inside various containment compartments during severe accidents, especially, under degraded passive autocatalytic recombiner conditions (PARs) (e.g., poisoning of PARs). Determine the potential for deflagration-to-detonation transition.**
- c. **Assess the implications of the potential for maldistribution of combustible gases inside various containment compartments during DBA LOCA conditions, including various hydrogen sources.**
- d. **Perform confirmatory assessment of the US EPRTM Combustible Gas Control System Design Basis Analysis, which is described in further detail in Attachment 1.**

The contractor shall update the draft TERs for PRA and severe accidents and for SAMDA to reflect the resolution of **the above assessments** and any previously identified open items, and overall conclusions of the review. The updating of the draft TERs will be performed after completion of Tasks 3 and 4. The contractor shall incorporate NRC comments on the updated TERs and issue the documents as final TERs.

It is expected that during the course of the review (on an as-needed basis by request of the NRC technical monitor), the contractor will participate in technical meetings with the NRC staff concerning severe accident evaluations and analyses, and in technical meetings and conference calls between NRC and AREVA staff. As necessary, the contractor will also provide presentations to the Advisory Committee for Reactor Safeguards (ACRS), Commission, and industry groups, and/or support to the NRC staff in preparing such presentations.

**SCHEDULE AND DELIVERABLES**

The work shall be performed on the following schedule. This schedule may be adjusted in consultation with the NRC Technical Monitor.

<u>Task</u>	<u>Completion Date</u>
1. Draft TER and RAIs on Level 2 PRA and severe accidents	Four months after start of task
2. Draft TER and RAIs on SAMDA	Four months after start of task
3. Review Level 2 PRA RAI responses; prepare follow-up RAIs	Two weeks after receipt of responses to RAIs
4. Review SAMDA responses; prepare follow-up RAIs	Two weeks after receipt of responses to RAIs
5. Prepare Final TERs	
Level 2 PRA and severe accidents	
- Draft	<b>11/30/2010</b>
- Final	<b>12/31/2010</b>
SAMDA	
- Draft	<b>11/30/2010</b>
- Final	<b>12/31/2010</b>

**Technical Reporting Requirements**

1. At the completion of Task 1, submit a draft TER with open items, and description of additional information needed to resolve the open items. The TER will consist of written evaluations for each review topic in a form that can be incorporated into an NRC SER with minimal changes. The additional information needed should be in the form of an RAI for transmittal to the applicant.
2. At the completion of Task 2, submit a draft TER with open items, and a description of any additional information needed to resolve the open items. The TER will be similar in format and content to recent SAMA evaluations for operating reactor license renewal. The additional information needed should be in the form of an RAI for transmittal to the applicant.
3. Following the completion of the PRA and severe accident review under Task 3, submit a description of any additional information needed to resolve any remaining technical concerns regarding Level 2 PRA or severe accidents in the form of an RAI for follow-up discussion with the applicant.

4. Following the completion of the SAMDA review under Task 4, submit a description of any additional information needed to resolve any remaining technical concerns regarding SAMDA in the form of an RAI for follow-up discussion with the applicant.
5. At the completion of Task 5, submit updated TERs for use in developing Chapter 19 of the NRC staff SER for the U.S. EPR. Incorporate NRC comments on the updated TERs and issue the documents as final TERs.

The TERs should be submitted to the NRC Technical Monitor with a copy of the cover or transmittal letter to the Project Officer. All technical letter reports submitted for acceptance by NRC staff must meet NRC expected quality standards.

**PERIOD OF PERFORMANCE**

The period of performance for this task is projected to be through **03/31/2011**.

**MEETINGS AND TRAVEL**

The following meeting and travel requirements are anticipated for planning purposes:

1. Three 2-person, 1-day trips to NRC Headquarters in Rockville, Maryland to meet with the NRC and/or GE staff to discuss the results of the evaluations, and to prepare or provide presentations to the ACRS, Commission and industry groups.
2. One 2-person, 3-day trip to Boston, MA to review the Level 2 PRA and discuss issues with the AREVA Staff.

Additional travel will be coordinated with the NRC Project Manager and Technical Monitor as the need for such travel is identified to ensure it supports the timely completion of work.

**NRC FURNISHED MATERIALS**

Upon acceptance of this task order, the NRC Technical Monitor will provide to the contractor any supplemental U.S. EPR PRA and severe accident submittals necessary to facilitate successful completion of this project.

**OTHER APPLICABLE INFORMATION**

**License Fee Recovery**

The work specified in this SOW is licensee fee recoverable under 10 CFR Part 52.

Table 1 – U.S. EPR Review Topics to be addressed

Topic	Subtopic	Section
Design/operational features for mitigating the consequences of core damage and preventing releases from containment		19.1.3.2
Design/operational features for mitigating the consequences of releases from containment		19.1.3.3

Safety insights from the Level 2 Internal Events PRA for operations at power	Level 2 PRA methodology	19.1.4.2.1
	Significant accident sequences and Accident Classes Contributing to Containment Failure	19.1.4.2.2
	Leading contributors to containment failure from the Level 2 Internal Events PRA	19.1.4.2.3
	Risk-Significant equipment, functions, design features, phenomena, challenges, and human actions	19.1.4.2.4
	Insights from the uncertainty, importance, and sensitivity analyses	19.1.4.2.5
Safety Insights from the Level 2 External Events PRA for operations at power	Results and insights from seismic risk evaluations, internal fires PRA, internal flooding PRA, tornado PRA, and other external events PRA	19.1.5
Safety Insights from the Level 2 PRA for other modes of operation	Results and insights from the Level 2 internal events low-power and shutdown operations PRA	19.1.6.1
	Results and insights from the Level 2 external events low-power and shutdown operations PRA	19.1.6.2
Severe accident evaluation		19.2
Severe accident prevention	ATWS	19.2.2.1
	Mid-loop operation	19.2.2.2
	SBO	19.2.2.3
	Fire protection	19.2.2.4
	ISLOCA	19.2.2.5
	Other severe accident preventive features	19.2.2.1.4
Severe accident mitigation	Overview of containment design	19.2.3.1
	Severe accident progression	19.2.3.2
SA mitigation features	External reactor vessel cooling	19.2.3.3.1
	H2 generation and control	19.2.3.3.2
	Core debris coolability	19.2.3.3.3
	High-pressure melt ejection	19.2.3.3.4
	Fuel-coolant interaction	19.2.3.3.5
	In-vessel steam explosion	19.2.3.3.5.1
	Ex-vessel steam explosion	19.2.3.3.5.2
	Containment bypass	19.2.3.3.6
	Steam generator tube rupture	19.2.3.3.6.1
	ISLOCA	19.2.3.3.6.2
	Equipment survivability	19.2.3.3.7
	Equipment and instrumentation necessary to survive	19.2.3.3.7.1
	Severe accident environmental conditions	19.2.3.3.7.2

	Basis for acceptability	19.2.3.3.7.3
	Non-safety-related containment spray	19.2.3.3.8
Containment performance capability		19.2.4
Accident management		19.2.5
SAMDA / TMI Item II.B.8, 10CFR50.34(f)(1)(I)		19.2.6

**Attachment 1**  
**Assessment of US EPRTM Combustible Gas Control System Design Basis Analysis**

**Introduction**

The Combustible Gas Control System (CGCS) in the US EPRTM is designed to satisfy the 10 CFR 50.44 "Combustible Gas Control for Nuclear Power Reactors" requirement that the containment must have a capability for ensuring a mixed atmosphere (i.e. the concentration of combustible gases in any part of the containment is below a level that supports combustion or detonation that could cause loss of containment integrity) during design-basis accidents.

The FSAR analyses for the CGCS design include an evaluation of the design basis accident scenarios. The following two design basis accident scenarios will be evaluated:

- Double ended Hot Leg Break
- Double ended Pressurizer Surge line Break

The confirmatory calculations will be performed using the previously developed MELCOR 1.8.6 severe accident model for the US EPRTM, and updated for the design basis analysis. The calculations will include several base- and sensitivity-cases.

**Objective**

To analyze the US EPRTM containment design to demonstrate that for design bases accidents, the hydrogen concentration in containment, neither locally nor globally, exceeds 4% (which is the lower concentration threshold for combustion) during and following an accident that releases an equivalent amount of hydrogen as would be generated from a 1% fuel cladding-coolant reaction.

**Proposed Technical Approach**

Update the US EPRTM MELCOR model for the design basis analysis.

Insure that the following features of the CGCS are adequately represented:

- Convection Foils
- Rupture Foils
- Mixing Dampers
- Safety Related doors in the pressurizer area
- All PARs at actual locations

Incorporate the following hydrogen sources for the design basis accident (assumed the same for all design basis accident scenarios):

- Oxidation of the zirconium in the cladding (assumed 1% fuel clad reaction)
- Radiolysis of water (RCS and IRWST) and jacketed cable
- Corrosion of Zinc from painted surfaces
- Corrosion of Zinc from steel structures
- Corrosion of aluminum in containment

**Proposed Calculation Matrix**

Case	Hot leg break	PRZR surge line break
Base case	√	√
All PARs active	√	√
Location of Hydrogen sources	√	√
FSAR mass and energy releases	√	

**Deliverables**

The contractor shall document the results of the confirmatory assessment in a TER.