

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 24, 2014

Dr. Ali Mosleh
Regents of the University of California, Los Angeles
11000 Kinross Avenue, Suite 211
Box 951406
Los Angeles, CA 90095-1406

VIA Electronic Mail:
Mosleh@ucla.edu

SUBJECT: GRANT NO: NRC-HQ-60-14-G-0013

Dear Dr. Mosleh:

Pursuant to the authority contained in the Federal Grant and Cooperative Grantee Act of 1977 and the Atomic Energy Act of 1954, the Nuclear Regulatory Commission (NRC) hereby awards to Regents of the University of California, Los Angeles (hereinafter referred to as the "Grantee" or "Recipient"), the sum of \$217,355 to provide support for "Methodological and Software Enhancements of Dynamic PRA Platforms for Event Assessment Applications".

This award is effective as of the date of this letter and shall apply to expenditures made by the Grantee furtherance of program objectives during the period beginning with the effective date of September 30, 2014 and ending September 29, 2016.

This award is made to the Recipient on condition that the funds will be administered in accordance with the terms and conditions as set forth in Attachment A (the Schedule); Attachment B (the Program Description); and Attachment C (the Standard Provisions); all of which have been agreed to by your organization.

Based on the pre-award compliance review conducted by NRC's Small Business and Civil Rights Office (SBCR), your institution is placed in a periodic status pending resolution of concerns raised during the review. Within 60 days, SBCR will conduct a periodic review to ensure compliance with applicable Civil Rights statutes. Your cooperation with SBCR is essential. The continued eligibility of Federal financial assistance is conditioned upon compliance with anti-discrimination regulations.

Please ensure individuals selected as beneficiaries of support under this grant meet the legal requirements consistent with recent Supreme Court Decisions including *Fisher*, *Gratz*, and *Grutter*.

Please sign the enclosed grant to acknowledge your receipt of the award, and return as a pdf file to Mr. Daniel App by email at Daniel.App@nrc.gov.

Sincerely yours,

Sheila Bumpass

Sheila Bumpass
Grants Officer
Acquisition Management Division

Attachments:

Attachment A – Schedule
Attachment B – Program Description
Attachment C – Standard Terms and Conditions

TEMPLATE - ADM002

SUNSI REVIEW COMPLETE

OCT 01 2014

ADM002

Grant and Cooperative Agreement

CHOOSE ONE:

- ☐ COOPERATIVE AGREEMENT
- ☒ GRANT

CHOOSE ONE: ☐ EDUCATION ☐ FACILITIES ☒ RESEARCH ☐ SDCR ☐ TRAINING

| | | | | | | | |
|--|------------|----------------------|--------------|---|--|--------------------|--|
| 1. GRANT/COOPERATIVE AGREEMENT NUMBER NRC-HQ-60-14-G-0013 | | 2. SUPPLEMENT NUMBER | | 3. EFFECTIVE DATE 09/30/2014 | | 4. COMPLETION DATE | |
| 5. ISSUED TO NAME/ADDRESS OF RECIPIENT (No., Street, City/County, State, Zip) UNIVERSITY OF CALIFORNIA, LOS ANGELES Attn: Marcia L Smith 11000 KINROSS AVENUE, SUITE 102 BOX 951406 LOS ANGELES CA 900951406 | | | | 6. ISSUED BY U.S. NRC - HQ Mailing Address: Acquisition Management Division Mail Stop: 3WFN-05-C64MP Washington DC 20555-0001 | | | |
| 7. TAXPAYER IDENTIFICATION NO. (TIN) | | | | 9. PRINCIPAL INVESTIGATOR/ORGANIZATION'S PROJECT OR PROGRAM MGR. (Name & Phone) Professor Ali Mosleh Email: Mosleh@ucla.edu Phone:310-825-6559 | | | |
| 8. COMMERCIAL & GOVERNMENT ENTITY (CAGE) NO. | | | | | | | |
| 10. RESEARCH, PROJECT OR PROGRAM TITLE Methodological and Software Enhancements of Dynamic PRA Platforms for Event Assessment Applications | | | | | | | |
| 11. PURPOSE See Schedule | | | | | | | |
| 12. PERIOD OF PERFORMANCE (Approximately) 09/30/2014 through 09/29/2016 | | | | | | | |
| 13A. | | AWARD HISTORY | | 13B. | | FUNDING HISTORY | |
| PREVIOUS | | \$0.00 | | PREVIOUS | | \$0.00 | |
| THIS ACTION | | \$217,355.00 | | THIS ACTION | | \$217,355.00 | |
| CASH SHARE | | \$0.00 | | TOTAL | | \$217,355.00 | |
| NON-CASH SHARE | | \$0.00 | | | | | |
| RECIPIENT SHARE | | \$0.00 | | | | | |
| TOTAL | | \$217,355.00 | | | | | |
| 14. ACCOUNTING AND APPROPRIATION DATA 2014-X0200-FEEBASED-60-60D002-11-6-213-1052-4110 | | | | | | | |
| PURCHASE REQUEST NO. | | JOB ORDER NO. | | AMOUNT | | STATUS | |
| RES-14-0455 | | | | | | | |
| | | | | | | | |
| 15. POINTS OF CONTACT | | | | | | | |
| | NAME | MAIL STOP | TELEPHONE | E-MAIL ADDRESS | | | |
| TECHNICAL OFFICER | CHON DAVIS | | 301-251-7567 | Chon.Davis@nrc.gov | | | |
| NEGOTIATOR | | | | | | | |
| ADMINISTRATOR | DANIEL APP | | 301-287-0939 | Daniel.App@nrc.gov | | | |
| PAYMENTS | | | | | | | |
| 16. THIS AWARD IS MADE UNDER THE AUTHORITY OF: PURSUANT TO SECTION 31B AND 141B OF THE ATOMIC ENERGY ACT OF 1954, AS AMENDED | | | | | | | |
| 17. APPLICABLE STATEMENT(S), IF CHECKED: <input type="checkbox"/> NO CHANGE IS MADE TO EXISTING PROVISIONS <input type="checkbox"/> FDP TERMS AND CONDITIONS AND THE AGENCY-SPECIFIC REQUIREMENTS APPLY TO THIS GRANT | | | | 18. APPLICABLE ENCLOSURE(S), IF CHECKED: <input type="checkbox"/> PROVISIONS <input type="checkbox"/> SPECIAL CONDITIONS <input type="checkbox"/> REQUIRED PUBLICATIONS AND REPORTS | | | |
| UNITED STATES OF AMERICA | | | | COOPERATIVE AGREEMENT RECIPIENT | | | |
| CONTRACTING/GRANT OFFICER SHEILA H. BUMPASS <i>Sheila Bumpass</i> | | DATE 09/24/2014 | | AUTHORIZED REPRESENTATIVE | | DATE | |

Grant and Cooperative Agreement

| ITEM NO. (A) | ITEM OR SERVICE (Include Specifications and Special Instructions) (B) | QUANTITY (C) | UNIT (D) | ESTIMATED COST | |
|-----------------|---|-----------------|-------------|-------------------|---------------|
| | | | | UNIT PRICE (E) | AMOUNT (F) |
| | <p>CFDA Number: 77.009</p> <p>Payment will be made through the Automated Standard Application for Payment (ASAP.gov) unless the receipt has failed to comply with the program objectives, award conditions, Federal reporting requirements or other conditions specified in 2 CFR 215 (OBM Circular A110).</p> <p>Delivery: 09/29/2016</p> <p>Delivery Location Code: NRCHQ</p> <p>US NUCLEAR REGULATORY COMMISSION- MAIL PROCESSING CENTER 4930 BOILING BROOK PARKWAY ROCKVILLE MD 20852 USA</p> <p>Payment: ASAP GRANT FUNDS REIMBURSEMENT SYS US TREASURY</p> <p>Period of Performance: 09/30/2014 to 09/29/2016</p> | | | | |

ATTACHMENT A - SCHEDULE**A.1 PURPOSE OF GRANT**

The purpose of this Grant is to provide support to the "Methodological and Software Enhancements of Dynamic PRA Platforms for Event Assessment Applications" as described in Attachment B entitled "Program Description."

A.2 PERIOD OF GRANT

1. The effective date of this Grant is September 30, 2014. The estimated completion date of this Grant is September 29, 2016.

A. GENERAL

| | |
|--------------------------------|---|
| 1. Total Estimated NRC Amount: | \$217,355.00 |
| 2. Total Obligated Amount: | \$217,355.00 |
| 3. Activity Title: | Methodological and Software Enhancements of Dynamic PRA Platforms for Event Assessment Applications |
| 4. NRC Project Officer: | Chon Davis |
| 5. NRC Technical Monitor | Michelle Gonzalez |
| 6. DUNS No.: | 092530369 |

A.3 BUDGET

Revisions to the budget shall be made in accordance with Revision of Grant Budget in accordance with 2 CFR 215.25.

| | Year 1 | Year 2 |
|--------------------|---------------|---------------|
| Personnel | \$ 52,396.00 | \$ 54,130.00 |
| Fringe | \$ 4,195.00 | \$ 4,386.00 |
| Travel | \$ 2,000.00 | \$ 2,000.00 |
| Supplies | \$ 1,500.00 | \$ 750.00 |
| Other Direct Costs | \$ 15,091.00 | \$ 15,091.00 |
| Total Direct Cost | \$ 75,182.00 | \$ 76,358.00 |
| Indirect Cost | \$ 32,590.00 | \$ 33,225.00 |
| Total | \$ 107,772.00 | \$ 109,583.00 |

All travel must be in accordance with the Regents of the University of California, Los Angeles Travel Regulations or the US Government Travel Policy absent Grantee's travel regulation.

A.4 AMOUNT OF AWARD AND PAYMENT PROCEDURES

1. The total estimated amount of this Award is \$217,355.00 for the two year period.
2. NRC hereby obligates the amount of \$217,355.00 for program expenditures during the period set forth above and in support of the Budget above. The Grantee will be given written notice by the Grants Officer when additional funds will be added. NRC is not obligated to reimburse the Grantee for the expenditure of amounts in excess of the total obligated amount.
3. Payment shall be made to the Grantee in accordance with procedures set forth in the Automated Standard Application For Payments (ASAP) Procedures set forth below.

Attachment B – Program Description

Title: Methodological and Software Enhancements of Dynamic PRA Platforms for Event Assessment Applications

1. BACKGROUND and MOTIVATION

Simulation Based PRA methodologies (also known as Dynamic PRA, DPRA) [1-3] are essentially model-based simulations to generate risk scenarios and associated probabilities. To do so, rules of stochastic and deterministic behaviours of the system and its elements (hardware, software, human operators, process variables, and environmental conditions) are developed as building blocks of a computer simulation platform. The simulation platform tracks possible changes in the functional state and parameters associated with the elements of the system as a function of time. By accounting for the nature and impact of the interactions and interdependencies among the system elements, risk scenarios are generated by a simulation engine. Depending on the particular method chosen for scenario generation, probabilities of individual or clusters of scenarios are calculated for the system "end states" of interest. Dynamic methodologies are particularly powerful when the system includes control loops, and/or complex hardware/process/ software/human interactions. They provide a natural environment to include physical models, such as thermal-hydraulic codes for NPPs, and mechanistic models of hardware failure, and those of natural hazards.

Dynamic PRA methodologies fall into two main categories: continuous-time methods, and discrete-time methods [4]. Many of the DPRA research tools have adopted the latter approach [4-6]. In this style of simulation, scenarios are generated by branching to new sequences based on changes in the states of system elements and other physical variables, at user-specified time intervals. For each scenario, a time dependent probability is calculated based constituent branch probabilities.

Simulation-based approaches offer several key advantages over the traditional "static" Fault Tree/Event Tree PRA method. They can capture the impact of event sequence timing, provide a better representation of thermal-hydraulic success criteria, and permit more detailed and realistic modeling of operator response. Furthermore in DPRAs much of the complexity of enumerating scenarios is delegated to scenario generating algorithms, with reduced analyst-to-analyst variability of the results as an added benefit. DPRA allows heterogeneous models of various phenomena to be devolved and used at different levels of detail. Simulation tracking can provide desired information on nature of scenarios ("white box" simulation). To cope with the possible "scenario space" exploration, smart algorithms have been explored for produce

dominant risk scenarios at reasonable simulation time. These include advanced Quantitative Biasing (biased sampling), and Qualitative Biasing or “simulation planning”. Examples of DPRA platforms are ADS-IDAC [6-12] and ADAPT [4]

Dynamic PRA however has its own challenges as outlined in [13]

- Development of physical models can be resource intensive and validation/accreditation of models can be difficult, particularly for rare events
- Obtaining a complete risk profile, i.e., ensuring that a complete solution space is examined and representative samples are chosen still requires further research
- Methods are needed for aggregating, interpreting, and communicating results. Simulation-based approaches can produce expansive amounts of data and as such identifying and focusing on key accident scenarios can be difficult
- Efficient methods are lacking for uncertainty analysis as certain types of uncertainty and variability can actually alter the structure of risk scenarios as they evolved over the time.

Despite these challenges Coyne et al [13] see some near term benefits for regulatory applications:

- As a tool to preform event and condition assessment (for cases involving complex dependencies and success criteria, degraded equipment, and variability in human response)
- Support in expert elicitation/expert judgment based decision-making. Simulation Based PRA can provide useful insights and benchmarks for expert judgment process (plant response, accident phenomenology), and help establish a narrative of accident scenarios
- As a supplementary tool to support traditional PRA modeling. DPRA is a natural platform to combine probabilistic and deterministic modeling approaches, in developing success criteria, identifying causes, forms, and consequences of human actions, and in structuring event trees. It can also help foster better understanding of the consequences of uncertain assumptions in conventional PRAs.

Recent advances in the field provide credible evidence that with modest research effort the more advanced dynamic PRA platforms such as ADS-IDAC can be prepared for practical applications in all three areas mentioned above. This is the aim of this proposed research. ADS-IDAC has three main modeling modules: plant hardware module, plant Thermal-Hydraulics module, and the IDAC Crew Response module Appendix A provides a summary of the basic elements of ADS-IDAC modeling approach and simulation platform. Appendix B highlights some of the recent major enhancements to ADS-IDAC. [12, 14-21]

2. OBJECTIVES and APPROACH

2.1 Objective

The main objective of the proposed research is to develop needed features to make the ADS-IDAC dynamic PRA platform a more practical and realistic analysis tool for specific applications, primarily event assessments, and as a supplementary tool to analyze highly dynamic and complex accident scenarios in support of conventional PRAs. The modeling enhancements envisaged include more advanced system (hardware) and crew modeling capabilities, more comprehensive quantification features, and new post processing capabilities to extract risk insights from dynamic simulation runs. All these capabilities also require additional user-friendly graphical interfaces.

More specifically, the features will include

- Comprehensive quantification rules (full scenario dynamic probability calculations)
- More realistic model of team characteristic including those related to communication, tasking, and decision making (based on results from PI's previous NRC grants)
- Extension of IDAC model for account for potential complexities in the action execution phase of crew response (a major post-Fukushima concern)
- Capability to use traditional Fault Tree models to explicitly define the impact of Support System failures on accident progression (through their impact on Frontline Systems)
- Post processing rules and software capability for extracting risk insights from large number of dynamic event tree scenarios generated typical by simulation runs
- Graphical User Interface to support the above features and also facilitate analysis of precursor events. This will include improved EOP editing capabilities.

2.2 Approach and Tasks

Major tasks of the proposed collaborative research project are:

- (1) Introduction of comprehensive set of quantification rules to enable dynamic calculation of branch probabilities and complete risk scenario probabilities. This will include:
 - a. Dynamic calculation of probabilities of hardware failure branch points based on dynamically linked support system fault trees (to be included through a separate task)
 - b. Full implementation of a human error probability (HEP) rules developed in an earlier version of ADS-IDAC project [12] and previous NRC research grants. In particular the HEP quantification rules developed as part of the Phoenix HRA method [23-24] based on a wide range of HEP data sources and methods will be included. Subject matter expert review of the estimation process and estimated numbers is included in this task. Participation of HRA experts among NRC research staff is envisioned as part of the proposed collaborative research grant. The proposed quantification rules will explicitly account for HEP dependencies based on shared of Performance Shaping Factors (using the Bayesian Belief Network, BBN, model of PSFs developed in the Phoenix Method)
- (2) Improved IDAC Crew Response Model. This will include
 - a. Addition of more realistic model of team characteristic including those related to communication, tasking, and decision-making (based on results from PI's previous NRC grant [22,].
 - b. Extension of IDAC model for more modeling of potential complexities in operator action execution phase (a major post-Fukushima concern)
 - c. Implementation of a simplified version of the "hybrid response mode" (Knowledge-based Procedure Following) that was developed in PI's previous NRC research grants [16-19]). This feature will be developed for a generic PWR. Methodology will be general so that it can be extended to BWRs.
- (3) Development of capability to incorporate Support System Fault Tree models into dynamic simulation runs. This will include

- a. Algorithms for incorporating binary logic of system failures into dynamic branching rules of the dynamic event trees
 - b. Addition of graphical user interface to create and link fault trees (capability to be primarily based one of PI's previous Federal Government research project [25]).
- (4) Addition of post processing rules and software capability for extracting risk insights from large number of dynamic event tree scenarios generated typical by simulation runs. At a minimum this will include
- a. Rules to cluster dynamic event tree scenarios based on criteria defined by the analyst (e.g., based on end state type, time, or contributing events)
 - b. Rules to rank scenarios based on probability, and algorithms to identify significant contributors to risk scenarios
- (5) New Graphical User Interface and User Guide to
- a. Support functional introduced in above tasks
 - b. Facilitate event assessment and precursor analysis.
 - c. Provide improved EOP editing capabilities over previous versions of ADS-IDAC
- (6) Trial Applications in at least two previously conducted precursor studies by NRC

A number of these tasks can be performed in parallel, for instance Tasks 1.a and 1.b, and Tasks 2 and 3. Since the research is proposed as a collaborative effort, areas of participation by NRC technical staff are also identified including NRC input to Task 1.b, Task 5, and Task 6.

3. RESEARCH TEAM and QUALIFICATIONS

3.1 Research Team

The proposed research will be conducted by a team of 3 researchers, including Dr. Ali Mosleh, the project Principle Investigator (PI), a Postdoctoral Scholar, and a Graduate Student Researcher (GSR). The role of the PI is to develop the overall technical roadmap and supervise its implementation by the graduate student and Postdoc. The role of the graduate student is to develop and implement the actual models and necessary computational procedures and tools. Postdoc's responsibility is to develop example applications, and test the software platform features. In addition, as a collaborative research project it is anticipated that NRC will agree to allow several of its personnel with expertise in Dynamic PRA, HRA, plant operations, and Event Assessment and other potential regulatory applications to participate in some of the technical deliberations with the CRR team.

3.2 PI CV and Qualifications in Developing Methods and Tools for Dynamic PRA and HRA

Dr. Ali Mosleh is Distinguished University Professor, and Evelyn Knight Chair in Engineering, and also director of the Center for Risk and Reliability at the University of California, Los Angeles. Prior to that *Dr. Mosleh was the Nicole J. Kim Eminent Professor of Engineering and the Director of the Center for Risk and Reliability at the University of Maryland. He was elected to the US National Academy of Engineering in 2010, and is a Fellow of the Society for Risk Analysis, and the American Nuclear Society, recipient of several scientific achievement awards, and consultant and technical advisor to numerous national and international organizations, including appointment by President George W. Bush to the U.S. Nuclear Waste Technical Review Board, a position in which he continued to serve in the administration of President Obama. He conducts research on methods for probabilistic risk analysis and reliability of*

complex systems and has made many contributions in diverse fields of theory and application. These include risk and reliability of hybrid systems of hardware, human and software; complex systems prognostics and health monitoring with limited information; dynamic systems reliability; Bayesian methods of inference with uncertain evidence; reliability growth prediction; methods for software reliability and cyber security; cognitive models for human performance in complex systems, and models of the influence of organizational factors on system reliability and safety. On these topics he holds several patents, and has edited, authored or co-authored over 450 publications including books, guidebooks, and technical papers. In 2013 he received the American Nuclear Society Tommy Thompson Award for his numerous contributions to improvement of reactor safety. Dr. Mosleh has led many major studies on risk and safety of complex systems such as space missions, nuclear power plants, commercial aviation, communication networks, and healthcare systems. He has chaired or organized numerous international technical conferences and is on the editorial board of several technical journals

PI's Qualifications in This Topic

- Project lead in development of the various versions of the ADS Dynamic PRA platform
- Project lead in development of the IDAC crew response model and several other HRA methods
- Developer of the original Accident Precursor/Near Miss Methodology
- Author or co-author of over 50 articles and reports on the subject

Appendix A

Overview of the ADS-IDAC Modeling Modules and Integrated Platform

A.1 Overview of ADS Dynamic PRA Platform: Due to the variety, quantity, and relatively detailed nature of the input information, and also the complexity of applying its internal rules, the IDAC model is presently only implemented through a computer simulation. Currently IDAC has been implemented as the HRA module of the Dynamic PRA computer code ADS. With its embedded models of a nuclear power plant including the RELAP5 thermal hydraulic simulation code and a plant hardware model, ADS simulates accident scenarios that form the context for the IDAC operator response model.

ADS uses the Discrete Dynamic Event Tree (D-DET) approach to generate possible time dependent scenarios based on dynamically changing states of various systems and operator response. Similar to the conventional event trees, D-DETs start with an initiating event (e.g., a pipe break) occurring at a specific time. Branches are then generated at discrete points in time following the initiating event based on probable outcomes of system/operator state changes (Figure A.1). Also, as in conventional PRAs, the probability of a scenario is calculated as the product of conditional probabilities of branches that constitute the scenario.

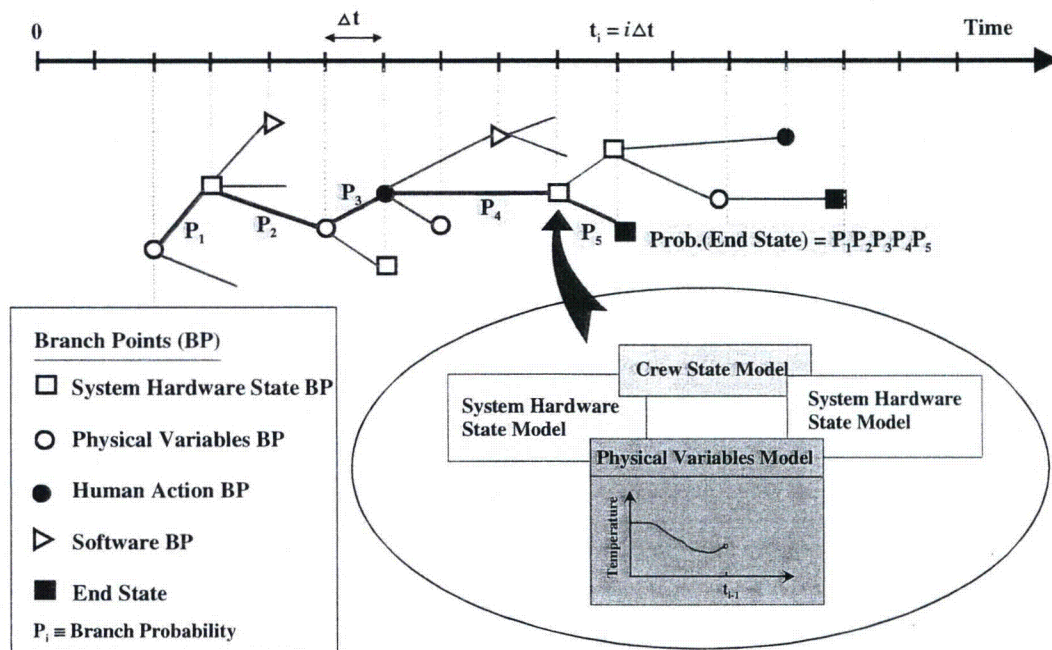


Figure A.1- High Level View of the ADS Dynamic PRA Framework and Dynamic Event Tree Framework

A.2 Overview of IDAC Operator Model: IDAC is an operator behavior model developed based on many relevant findings from cognitive psychology, behavioral sciences, neuroscience, human factors, field observations, and various first and second-generation HRA methodologies. It models individual operators behavior in a crew context and in response to plant abnormal conditions. Three generic types of operators are modeled: Decision Maker (e.g., Shift Supervisor), Action Taker (operators at the control panel), and Consultant (e.g., resource experts in the control room). IDAC models constrained behavior, largely regulated through training, procedures, standardized work processes, and professional discipline. These constraints significantly reduce the complexity of the problem, when compared to modeling general human response. IDAC covers the operator's various dynamic response phases, including situation assessment, diagnosis, and recovery actions. At a high level of abstraction, IDAC is composed of models of information processing (**I**), problem solving and decision-making (**D**), action execution (**A**), of a crew (**C**). Given incoming information, the crew model generates a probabilistic response, linking the context to the action through explicit causal chains. Figure A.2 is a schematic representation of the main elements of the IDAC modeling concept and its key elements in form of the umbrella I-D-A dynamic loop for each member of the crew.

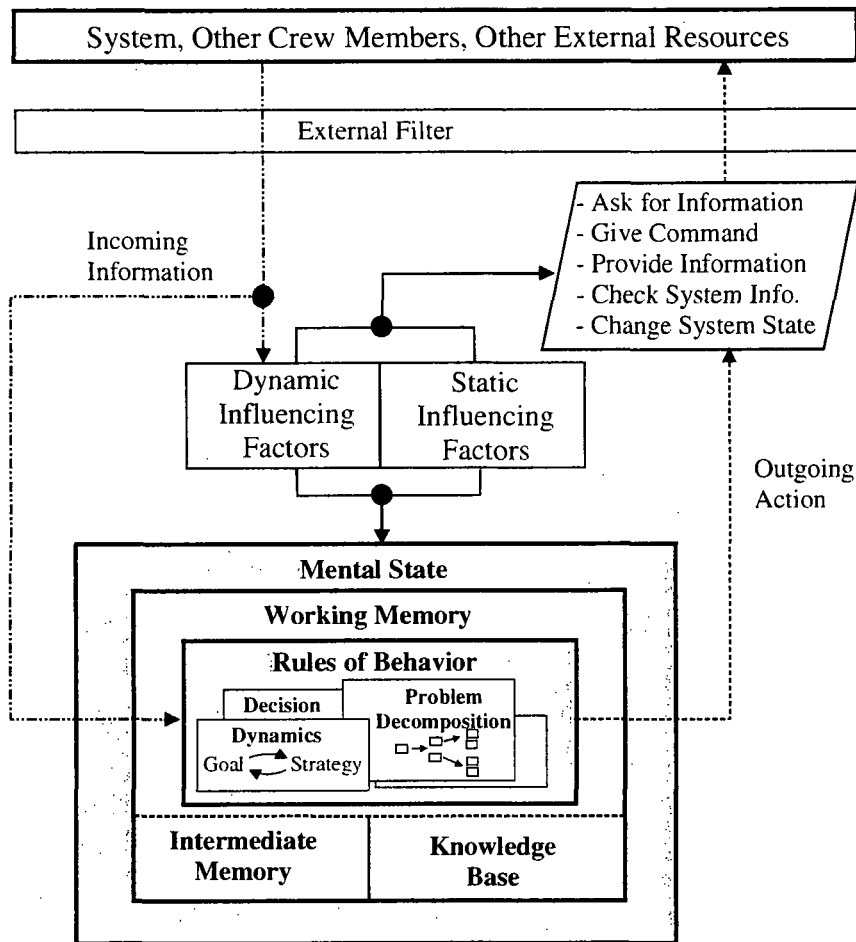


Figure A.2- High Level View of the IDAC Dynamic Response Model

IDAC is composed of (1) a Problem Solving Model, (2) Mental State and Engine of Cognition, (3) Memory and Knowledge Base Model, (4) Casual Model of Internal and External Performance Shaping Factors. Cognitive engine of IDAC combines the effects of rational and emotional dimensions forming a small number of generic rules of behavior that govern the dynamic response of the operator. The architecture of IDAC is such that its main modeling elements can be repeatedly embedded in a layered and progressively detailed representation of the cognitive process. The various elements of the IDAC architecture are briefly described in Appendix A.

A. 3 The ADS-IDAC Integrated Platform: The ADS-IDAC is the integration of the IDAC crew model with the ADS Dynamic PRA computer code. The ADS-IDAC platform simulates situational contexts that might lead to human error events. The operator actions in turn impact the key plant parameters and potentially change the trajectory of accident scenarios. Therefore, in generating the D-DET sequences dealing with operator response, ADS provides the IDAC module the values of the set of dynamically changing factors (e.g., plant physical process parameters, and system states). The IDAC crew model then tracks the operators' internal responses to the situation, and generates dynamically changing values of the indicators of psychological states, and resulting cognitive behaviors or physical actions. The spectrum of the

potentially very large set of event sequences that could be generated reflect the probabilistic outcomes of operator and plant interactions as modeled by ADS-IDAC modules. Predefined rules and dynamic parameters within ADS-IDAC govern the timing of these events. Scenarios are terminated when a set of predefined plant states are realized, or when scenario probabilities drop below a pre-specified truncation limit, or when the simulation time limit reached. In post-simulation analyses, the generated histories can be examined to identify the contributing factors. The scenarios typically includes branch points corresponding to key plant hardware events and alarms, "cognitive events" related to situation assessments and recovery actions, execution of procedural steps, communications among the operators, and the operators' actions on the plant.

The most recent released version of the ADS-IDAC Platform contains six modules (Figure A.3). The User Interface Module enables the user to edit the inputs, such as system and operator initial conditions and control the analysis parameters. The Scheduler Module implements the D-DET algorithms and produces the set of risk scenarios. The operators, plant processes, and equipment states are represented, respectively, by the Crew Module (IDAC), the Indicator Module (the human-machine interface), the System Module (currently RELAP5, plus a model of plant control logic and hardware), and the Component Reliability Module. The Scheduler Module coordinates the interactions among these modules.

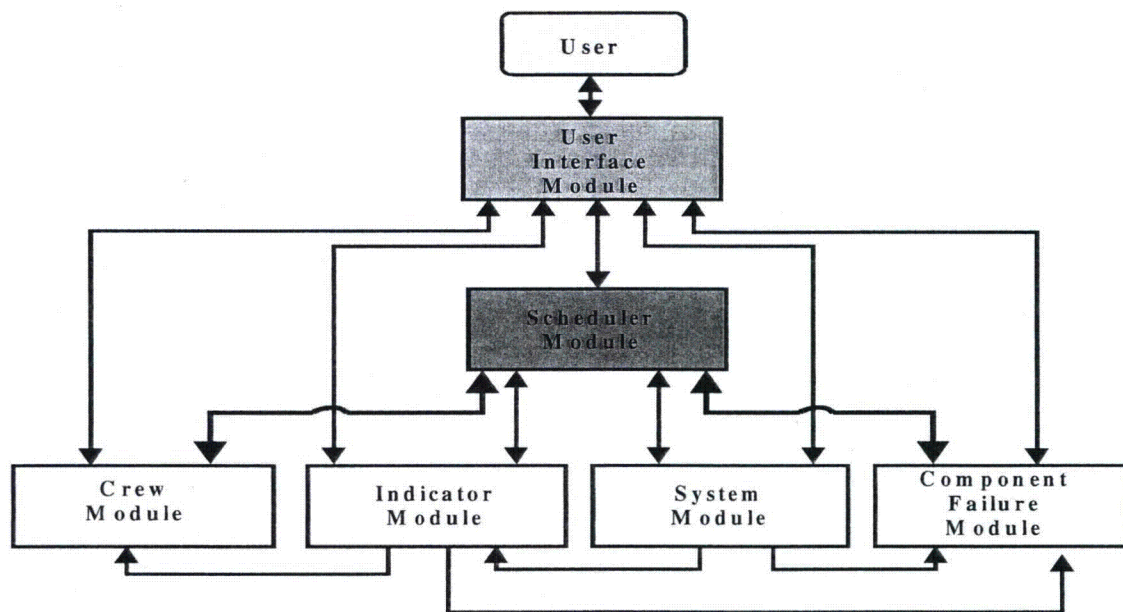


Figure A.3- Overview of Modules of the ADS-IDAC Platform

The ADS-IDAC has gone through an evolutionary process over the past 25 years with a number of software versions. These versions have some similarities as well as differences, both in capabilities and focus on different aspects of advanced HRA and dynamic PRA analysis. Recent additions to the ADS-IDAC simulation model have dramatically improved its ability to realistically represent operator knowledge, skills, and problem-solving styles. The recent implementation of dynamic PSFs reinforces the man-machine feedback loop and strengthens the transient modeling capabilities of ADS-IDAC. Taken together, these factors improve the ability of ADS-IDAC to model dependencies among operator behaviors such as skipping steps, selection of problem solving strategies, and information gathering.

The following are some of the several recent advances in the ADS-IDAC simulation approach:

- The thermal-hydraulic reactor plant model has been expanded to provide a more realistic representation of the controls and instruments available to actual control room operators
- The control room crew model has been enhanced to allow better modeling of crew interactions and variations in operator behaviors.
- The addition of dynamic performance influencing factors have dramatically improved the coupling between the nuclear plant model and the operator's mental state and actions

An information perception model simulates the ability of an operator to shift their focus to pertinent instruments during a plant event. These modeling improvements dramatically extend the simulation capabilities of ADS-IDAC compared to earlier versions .

Two more realistic full-scale capability demonstrations of the ADS-IDAC platform are:

1. Analysis of pressurized thermal shock (PTS) risk scenarios (Oconee Nuclear Power Plant). In these scenarios the probability of pressure vessel cracking depends on the time behavior of the primary pressure and temperature. Thus, the timing of automatic responses and operator actions are key in the determination of the risk. This ADS-IDAC application was done under a collaborative research project between UMD and Paul Scherrer Institute (Switzerland).
2. Participation in the OECD Halden Reactor International HRA Empirical Study goal of the HRA empirical study was to obtain a better understanding of the relative strengths and weaknesses of HRA methodologies by comparing the performance of actual control room crews during simulated accidents to the human behavior predictions from a spectrum of HRA methods. The HRA empirical study provided an ideal opportunity to calibrate and validate the IDAC model. The empirical study consists of two phases. During the first phase, the UMD team demonstrated that ADS-IDAC is capable of modeling actual crew-to-crew variability's during steam generator tube rupture accidents using a relatively small number of behavior rules. The second phase of the empirical study provided the opportunity to further validate the ADS-IDAC approach during two "loss of feedwater" scenarios.

Appendix B

Recent Advances in ADS-IDAC Capabilities

The following are several recent advances in the ADS-IDAC simulation approach

Plant TH Module: The current version of ADS-IDAC utilizes the RELAP5/MOD 3.2 computer code to provide a transient simulation of nuclear power plant operation. The RELAP5 code can simulate a wide variety of accident initiators and provides the capability to model key safety systems, controls, and instruments. Adaption of ADS-IDAC to a more versatile thermal-hydraulic engine, such as the TRACE or MELCOR code, has been identified as a research activity. TH Model of any plant can be used in the ADS-IDAC simulation program. The version used to conduct research over the past two years includes a three-loop, pressurized water reactor nuclear power plant RELAP model. The current plant model includes over 75 controls, 180 indicators, and 70 alarms. To improve feedback to the operator, the plant model includes reactivity and core power control features such as control rod movement, boration, and turbine load adjustment. Where necessary, controls for major pumps and valves in all front line safety

systems (e.g., emergency core cooling and auxiliary feed water) were also added to the existing RELAP input model. All major components referenced in the plant emergency procedures have been represented in the ADS-IDAC thermal-hydraulic model. ADS-IDAC provides four possible control inputs for each modeled component: (1) changing the component operating mode (e.g., automatic vs. manual mode), (2) setting a specific control value for a component (e.g., throttling control valve to 50% open), (3) incrementing the control setting of a component (e.g., throttling open a control valve by an additional 10%), and (4) setting a control value based on a perceived parameter (e.g., setting the steam dump target pressure equal to the perceived main steam header pressure). These capabilities provide sufficient flexibility to realistically model all significant operator interactions with the plant model.

The Operating Crew Module: The ADS-IDAC crew model currently includes a senior reactor operator (SRO) and a reactor operator (RO). Similar to an actual control room, each operator has unique roles and responsibilities. The SRO selects the high level goal and directs all written plant procedures. The RO performs all interactions with the nuclear power plant model through the ADS-IDAC control panel. ADS-IDAC currently supports three high level goals: maintain normal operation, troubleshoot abnormal conditions, and mitigate accident conditions. Any of four problem-solving strategies can be used to achieve these high level goals:

- Wait and Monitor – a passive information gathering strategy
- Instinctive Response – perform simple skill based actions that are activated by matching perceived information to memorized situation-response profiles
- Follow Written Procedures – implement formal written procedures (e.g., abnormal or emergency operating procedures)
- Knowledge-Based Reasoning – use a diagnostic process to guide crew actions in order to balance the flow of mass and energy within plant systems

The selection of a specific goals and strategies is based on the plant information perceived by the operator and performance influencing factors.

Operator Profile: Each individual operator in ADS-IDAC is provided with profiling data that guide their behavior. The majority of the operator profile is devoted to the operator's knowledge base. The knowledge base includes rules for diagnosing plant events, a functional decomposition and mapping of plant controls, indicators, and alarms; and rules for activating instinctive response actions. In addition to the knowledge base, the operator profile also includes data needed to: (1) calculate performance influencing factors; (2) define the operator's tendencies to skip procedure steps or pursue specific problem solving strategies; (3) manage memorized information; and (4) establish the timing of actions and communications. The flexibility afforded by the operator profile allows the simulation of a variety of operator performance tendencies. Specifically, PSFs associated with problem solving styles, perception and appraisal of information, and utilization of memorized information can all be captured within the operator profile.

Coordinating Crew Activities and Problem Solving Strategies: Within ADS-IDAC, the crew can interact with the plant model by manipulating components or gathering information from instruments and alarms. For computational convenience, all crew interactions with the nuclear plant model follow a standard sequence of events (termed the "action block" process). Because only the RO is permitted to interact with the ADS-IDAC control panel, any task initiated by the SRO must first be communicated to the RO. If the RO is not occupied with another task, the RO executes the requested action and communicates the status of the task back to the SRO.

The SRO then compares the status report information to the expectations for the initial request and either: (1) proceeds to the next task request or (2) performs a contingency action. If the RO is busy when the SRO initiates an action request, the request is held in an "ordered action" queue until the RO is able to execute the task.

To ensure that crew actions are coordinated, an order of precedence for problem solving strategies has been developed. A set of rules governs the transition between problem solving strategies. Also while generally, a written procedure is continued until the procedure is completed, the procedure flow may be interrupted by procedure transfers (which direct the crew to a different procedure), activation of an instinctive response action, or abandonment of the "Follow Written Procedure" strategy. Two types of procedure transfers can be modeled: (1) a permanent procedure transfer and (2) a temporary transfer to an auxiliary procedure followed by resumption of the initial procedure. An example of the first type of procedure transfer is the transfer from a general reactor trip procedure to a more specific emergency procedure (e.g., transfer from the Westinghouse E-0 to E-3 procedures during a steam generator tube rupture event). The second type of transfer supports implementation of functional recovery guidelines that are used to temporarily interrupt the current procedure to address a degraded condition.

Dynamic PSFs: As stated earlier ADS-IDAC employs both static and dynamic performance shaping factors (PSFs) to influence and shape operator behavior. As the name suggests, static PSFs are constant parameters intended to represent the fixed environmental and organizational factors that affect crew behavior. Conversely, dynamic PSFs reflect transient conditions and model variations in the operator's mental state during a scenario. Dynamic PSFs provide an important mechanism for providing transient feedback to the operator model. Although certain static PSFs might be expected to change over time (e.g., the impact of increased training effectiveness on crew performance), the main distinction between static and dynamic PSFs is the time scale over which these factors change. Because an ADS-IDAC analysis is generally limited to the early phases of an accident scenario, any factor that does not change significantly over a few hours is considered to be static. The ADS-IDAC simulation currently includes three dynamic PSFs: information load, time constraint load, and criticality of system condition. These PSFs serve as the main feedback mechanism between the thermal hydraulic model and the operator's mental state. The value for each of these dynamic PSFs ranges from 0 to 10. For these PSFs, a higher PSF value indicates a more adverse condition (e.g., higher information load, more time constrained situation, or degraded system condition).

Structured Reasoning Model: ADS Ver. 3.0 introduced an advanced reasoning capability and structured knowledge representation to enhance the realism and predictive power of in the IDAC model for situations where crew behaviors are governed by both the Emergency Operating Procedure (EOP) and their knowledge of the plant. This was achieved by:

- (1) Developing and implementing a cognitive architecture to simulate operators' understanding of accident conditions and plant response, their reasoning processes and knowledge utilization to make a diagnosis. A reasoning module was added to the individual operator model within IDAC model to mimic operators knowledge-based reasoning processes;
- (2) Developing and applying a comprehensive set of Performance Shaping Factors (PSF) to model the impacts of situational and cognitive factors on operators' behaviors. The effects and interdependencies of PSFs are incorporated the reasoning module; and
- (3) Performing a calibration and validation of the model predictions by comparing the simulation results with results of a number of plant-crew simulator exercises

Attachment C – Standard Terms and Conditions

The Nuclear Regulatory Commission's Standard Terms and Conditions for U.S. Nongovernmental Grantees

Preface

This award is based on the application submitted to, and as approved by, the Nuclear Regulatory Commission (NRC) under the authorization 42 USC 2051(b) pursuant to section 31b and 141b of the Atomic Energy Act of 1954, as amended, and is subject to the terms and conditions incorporated either directly or by reference in the following:

- Grant program legislation and program regulation cited in this Notice of Grant Award.
- Restrictions on the expenditure of Federal funds in appropriation acts, to the extent those restrictions are pertinent to the award.
- Code of Federal Regulations/Regulatory Requirements - 2 CFR 215 Uniform Administrative Requirements For Grants And Agreements With Institutions Of Higher Education, Hospitals, And Other Non-Profit Organizations (OMB Circulars), as applicable.

To assist with finding additional guidance for selected items of cost as required in 2 CFR 220, 2 CFR 225, and 2 CFR 230 this URL to the Office of Management and Budget Cost Circulars is included for reference: http://www.whitehouse.gov/omb/circulars_index-ffm.

Any inconsistency or conflict in terms and conditions specified in the award will be resolved according to the following order of precedence: public laws, regulations, applicable notices published in the Federal Register, Executive Orders (EOs), Office of Management and Budget (OMB) Circulars, the Nuclear Regulatory Commission's (NRC) Mandatory Standard Provisions, special award conditions, and standard award conditions.

Certifications and Representations: These terms incorporate the certifications and representations required by statute, executive order, or regulation that were submitted with the SF424B application through Grants.gov.

I. Mandatory General Requirements

The order of these requirements does not make one requirement more important than any other requirement.

1. Applicability of 2 CFR Part 215

All provisions of 2 CFR Part 215 and all Standard Provisions attached to this grant/cooperative agreement are applicable to the Grantee and to sub-recipients which meet the definition of "Grantee" in Part 215, unless a section specifically excludes a sub-recipient from coverage. The Grantee and any sub-recipients must, in addition to the assurances made as part of the application, comply and require each of its sub-awardees employed in the completion of the project to comply with Subpart C of 2 CFR 215 and include this term in lower-tier (subaward) covered transactions.

Grantees must comply with monitoring procedures and audit requirements in accordance with OMB Circular A-133.

2. Award Package

§ 215.41 Grantee responsibilities.

The Grantee is obligated to conduct project oversight as may be appropriate, to manage the funds with prudence, and to comply with the provisions outlined in 2 CFR 215.41. Within this framework, the Principal Investigator (PI) named on the award face page, Block 11, is responsible for the scientific or technical direction of the project and for preparation of the project performance reports. This award is funded on a cost reimbursement basis not to exceed the amount awarded as indicated on the face page, Block 16, and is subject to a refund of unexpended funds to NRC.

The standards contained in this section do not relieve the Grantee of the contractual responsibilities arising under its contract(s). The Grantee is the responsible authority, without recourse to the NRC, regarding the settlement and satisfaction of all contractual and administrative issues arising out of procurements entered into in support of an award or other agreement. This includes disputes, claims, protests of award, source evaluation or other matters of a contractual nature. Matters concerning violation of statute are to be referred to such Federal, State or local authority as may have proper jurisdiction.

Subgrants

Appendix A to Part 215—Contract Provisions

Sub-recipients, sub-awardees, and contractors have no relationship with NRC under the terms of this grant/cooperative agreement. All required NRC approvals must be directed through the Grantee to NRC. See 2 CFR 215 and 215.41.

Nondiscrimination

This provision is applicable when work under the grant/cooperative agreement is performed in the U.S. or when employees are recruited in the U.S.

The Grantee agrees to comply with the non-discrimination requirements below:

- Title VI of the Civil Rights Act of 1964 (42 USC §§ 2000d et seq)
- Title IX of the Education Amendments of 1972 (20 USC §§ 1681 et seq)

- Section 504 of the Rehabilitation Act of 1973, as amended (29 USC § 794)
- The Age Discrimination Act of 1975, as amended (42 USC §§ 6101 et seq)
- The Americans with Disabilities Act of 1990 (42 USC §§ 12101 et seq)
- Parts II and III of EO 11246 as amended by EO 11375 and 12086.
- EO 13166, "Improving Access to Services for Persons with Limited English Proficiency."
- Any other applicable non-discrimination law(s).

Generally, Title VI of the Civil Rights Act of 1964, 42 USC § 2000e et seq, provides that it shall be an unlawful employment practice for an employer to discharge any individual or otherwise to discriminate against an individual with respect to compensation, terms, conditions, or privileges of employment because of such individual's race, color, religion, sex, or national origin. However, Title VI, 42 USC § 2000e-1(a), expressly exempts from the prohibition against discrimination on the basis of religion, a religious corporation, association, educational institution, or society with respect to the employment of individuals of a particular religion to perform work connected with the carrying on by such corporation, association, educational institution, or society of its activities.

Modifications/Prior Approval

NRC's prior written approval may be required before a Grantee makes certain budget modifications or undertakes particular activities. If NRC approval is required for changes in the grant or cooperative agreement, it must be requested and obtained from the NRC Grants Officer in advance of the change or obligation of funds. All requests for NRC prior approval, including requests for extensions to the period of performance, should be made, in writing (which includes submission by e-mail), to the designated Grants Specialist and Program Office 30 days before the proposed change. The request should be signed by the authorized organizational official. Failure to obtain prior approval, when required, from the NRC Grants Officer, may result in the disallowance of costs, or other enforcement action within NRC's authority.

Lobbying Restrictions

The Grantee will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

The Grantee will comply with provisions of 31 USC § 1352. This provision generally prohibits the use of Federal funds for lobbying in the Executive or Legislative Branches of the Federal Government in connection with the award, and requires disclosure of the use of non-Federal funds for lobbying.

The Grantee receiving in excess of \$100,000.00 in Federal funding shall submit a completed Standard Form (SF) LLL, "Disclosure of Lobbying Activities," regarding the use of non-Federal funds for lobbying within 30 days following the end of the calendar quarter in which there occurs any event that requires disclosure or that materially affects the accuracy of the information contained in any disclosure form previously filed. The Grantee must submit the SF-LLL, including those received from sub-recipients, contractors, and subcontractors, to the Grants Officer.

§ 215.13 Debarment And Suspension.

The Grantee agrees to notify the Grants Officer immediately upon learning that it or any of its principals:

(1) Are presently excluded or disqualified from covered transactions by any Federal department or agency;

(2) Have been convicted within the preceding three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, tax evasion, receiving stolen property, making false claims, or obstruction of justice; commission of any other offense indicating a lack of business integrity or business honesty that seriously and directly affects your present responsibility;

(3) Are presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State, or local) with commission of any of the offenses enumerated in paragraph (1)(b); and

(4) Have had one or more public transactions (Federal, State, or local) terminated for cause or default within the preceding three years.

b. The Grantee agrees that, unless authorized by the Grants Officer, it will not knowingly enter into any subgrant or contracts under this grant/cooperative agreement with a person or entity that is listed as Exclusion on SAM (<http://sam.gov>).

The Grantee further agrees to include the following provision in any subgrant or contracts entered into under this award:

'Debarment, Suspension, Ineligibility, and Voluntary Exclusion'

The Grantee certifies that neither it nor its principals is presently excluded or disqualified from participation in this transaction by any Federal department or agency. The policies and procedures applicable to debarment, suspension, and ineligibility under NRC-financed transactions are set forth in 2 CFR Part 180.

Drug-Free Workplace

The Grantee must be in compliance with The Federal Drug Free Workplace Act of 1988. The policies and procedures applicable to violations of these requirements are set forth in 41 USC 702.

Implementation of E.O. 13224 -- Executive Order On Terrorist Financing

The Grantee is reminded that U.S. Executive Orders and U.S. law prohibits transactions with, and the provision of resources and support to, individuals and organizations associated with terrorism. It is the legal responsibility of the Grantee to ensure compliance with these Executive Orders and laws. This provision must be included in all contracts/sub-awards issued under this grant/cooperative agreement.

The Grantee must comply with Executive Order 13224, Blocking Property and Prohibiting Transactions with Persons who Commit, Threaten to Commit, or Support Terrorism. Information about this Executive Order can be found at: www.fas.org/irp/offdocs/eo/eo-13224.htm.

Procurement Standards § 215.40-48

Sections 215.41 through 215.48 set forth standards for use by Grantees in establishing procedures for the procurement of supplies and other expendable property, equipment, real property and other services with Federal funds. These standards are furnished to ensure that such materials and services are obtained in an effective manner and in compliance with the provisions of applicable Federal statutes and executive orders. No additional procurement standards or requirements will be imposed by the Federal awarding agencies upon Grantees, unless specifically required by Federal statute or executive order or approved by OMB.

Travel

Travel must be in accordance with the Grantee's Travel Regulations or the US Government Travel Policy and Regulations at: www.gsa.gov/federaltravelregulation and the per diem rates set forth at: www.gsa.gov/perdiem, absent Grantee's travel regulations. Travel costs for the grant must be consistent with provisions as established in Appendix A to 2 CFR 220 (J.53). All other travel, domestic or international, must not increase the total estimated award amount.

Domestic Travel:

Domestic travel is an appropriate charge to this award and prior authorization for specific trips are not required, if the trip is identified in the Grantee's approved program description and approved budget. Domestic trips not stated in the approved budget require the written prior approval of the Grants Officer, and must not increase the total estimated award amount.

All common carrier travel reimbursable hereunder shall be via the least expensive class rates consistent with achieving the objective of the travel and in accordance with the Grantee's policies and practices. Travel by first-class travel is not authorized unless prior approval is obtained from the Grants Officer.

International Travel:

International travel requires **PRIOR** written approval by the Project Officer and the Grants Officer, even if the international travel is stated in the approved program description and the approved budget.

The Grantee will comply with the provisions of the Fly American Act (49 USC 40118) as implemented through 41 CFR 301-10.131 through 301-10.143.

Property and Equipment Management Standards

Property and equipment standards of this award shall follow provisions as established in 2 CFR 215.30-37.

Intangible and Intellectual Property

Intangible and intellectual property of this award shall generally follow provisions established in 2 CFR 215.36.

Inventions Report - The Bayh-Dole Act (P.L. 96-517) affords Grantees the right to elect and retain title to inventions they develop with funding under an NRC grant award ("subject inventions"). In accepting an award, the Grantee agrees to comply with applicable NRC policies, the Bayh-Dole Act, and its Government-wide implementing regulations found at Title 37, Code of Federal Regulations (CFR) Part 401. A significant part of the regulations require that the Grantee report all subject inventions to the

awarding agency (NRC) as well as include an acknowledgement of federal support in any patents.

Patent Notification Procedures - If the NRC or its Grantees, without making a patent search, knows (or has demonstrable reasonable grounds to know) that technology covered by a valid United States patent has been or will be used without a license from the owner, EO 12889 requires NRC to notify the owner. If the Grantee uses or has used patented technology under this award without license or permission from the owner, the Grantee must notify the Grants Officer. This notice does not mean that the Government authorizes and consents to any copyright or patent infringement occurring under the financial assistance.

Data, Databases, and Software - The rights to any work produced or purchased under a NRC federal financial assistance award, such as data, databases or software are determined by 2 CFR 215.36. The Grantee owns any work produced or purchased under a NRC federal financial assistance award subject to NRC's right to obtain, reproduce, publish or otherwise use the work or authorize others to receive, reproduce, publish or otherwise use the data for Government purposes.

Copyright - The Grantee may copyright any work produced under a NRC federal financial assistance award subject to NRC's royalty-free nonexclusive and irrevocable right to reproduce, publish or otherwise use the work or authorize others to do so for Government purposes. Works jointly authored by NRC and Grantee employees may be copyrighted but only the part authored by the Grantee is protected because, under 17 USC § 105, works produced by Government employees are not copyrightable in the United States. On occasion, NRC may ask the Grantee to transfer to NRC its copyright in a particular work when NRC is undertaking the primary dissemination of the work. Ownership of copyright by the Government through assignment is permitted under 17 USC § 105.

Records Retention and Access Requirements

Grantee shall follow established provisions in 2 CFR 215.53.

Conflict Of Interest Standards

Conflict of Interest Standards for this award will follow OCOI requirements set forth in Section 170A of the Atomic Energy Act of 1954, as amended, and provisions set forth at 2 CFR 215.42 Codes of Conduct.

Dispute Review Procedures

- a. Any request for review of a notice of termination or other adverse decision should be addressed to the Grants Officer. It must be postmarked or transmitted electronically no later than 30 days after the postmarked date of such termination or adverse decision from the Grants Officer.
- b. The request for review must contain a full statement of the Grantee's position and the pertinent facts and reasons in support of such position.
- c. The Grants Officer will promptly acknowledge receipt of the request for review and shall forward it to the Director, Office of Administration, who shall appoint an intra-agency Appeal Board to review a grantee appeal of an agency action, if required, which will consist of the

program office director, the Deputy Director of Office of Administration, and the Office of General Counsel.

d. Pending resolution of the request for review, the NRC may withhold or defer payments under the award during the review proceedings.

e. The review committee will request the Grants Officer who issued the notice of termination or adverse action to provide copies of all relevant background materials and documents. The committee may, at its discretion, invite representatives of the Grantee and the NRC program office to discuss pertinent issues and to submit such additional information as it deems appropriate. The chairman of the review committee will insure that all review activities or proceedings are adequately documented.

f. Based on its review, the committee will prepare its recommendation to the Director, Office of Administration, who will advise the parties concerned of his/her decision.

Termination and Enforcement

Termination of this award will follow provisions as established in 2 CFR 215.60-62.

Monitoring and Reporting § 215.50-53

Grantee Financial Management systems must comply with the provisions in 2 CFR 215.21

- Payment – 2 CFR 215.22
- Cost Share – 2 CFR 215.23
- Program Income – 2 CFR 215.24
 - Earned program income, if any, will be added to funds committed to the project by the NRC and Grantee and used to further eligible project or program objectives or deducted from the total project cost allowable cost as directed by the Grants Officer or the terms and conditions of award.
- Budget Revision – 2 CFR 215.25
 - The Grantee is required to report deviations from the approved budget and program descriptions in accordance with 2 CFR 215.25 and request prior written approval from the Program Officer and the Grants Officer.
 - The Grantee is not authorized to rebudget between direct costs and indirect costs without written approval of the Grants Officer.
 - The Grantee is authorized to transfer funds among direct cost categories up to a cumulative 10 percent of the total approved budget. The Grantee is not allowed to transfer funds if the transfer would cause any Federal appropriation to be used for purposes other than those consistent with the original intent of the appropriation.
 - Allowable Costs – 2 CFR 215.27

Federal Financial Reports -

The Grantee shall submit a "Federal Financial Report" (SF-425) on a quarterly basis for the periods ending March 31, June 30, September 30, and December 31, or any portion thereof, unless otherwise specified in a special award condition. Reports are due no later than 30 days following the end of each reporting period. A final SF-425 is due within 90 days after expiration of the award. The report should be submitted electronically to the following:

1. Grants_FFR.Resource@NRC.gov (NOTE: There is an underscore between Grants and FFR);
2. RESGrants.Resource@NRC.gov;
3. Technical Analyst; and
4. Grants Officer.

Period of Availability of Funds 2 CFR § 215.28

If a funding period is specified, a Grantee may charge to the grant only allowable costs resulting from obligations incurred during the funding period and any pre-award costs authorized by the NRC.

Unless otherwise authorized in 2 CFR 215.25(e)(2) or a special award condition, any extension of the award period can only be authorized by the Grants Officer in writing. Verbal or written assurances of funding from other than the Grants Officer shall not constitute authority to obligate funds for programmatic activities beyond the expiration date.

The NRC has no obligation to provide any additional prospective or incremental funding. Any modification of the award to increase funding and to extend the period of performance is at the sole discretion of the NRC.

Automated Standard Application For Payments (ASAP) Procedures

Unless otherwise stated, grantee payments are made using the Department of Treasury's Automated Standard Application for Payment (ASAP) system <http://www.fms.treas.gov/asap/index.html>, through preauthorized electronic funds transfers. To receive payments, Grantees are required to enroll with the Department of Treasury, Financial Management Service, and Regional Financial Centers, which allows them to use the on-line method of withdrawing funds from their ASAP established accounts. The following information is required to make ASAP withdrawals: (1) ASAP account number – the award number found on the cover sheet of the award; (2) Agency Location Code (ALC) – 31000001; and Region Code. Grantees enrolled in the ASAP system do not need to submit a "Request for Advance or Reimbursement" (SF-270).

II. Audit Requirements

Audits

Organization-wide or program-specific audits are performed in accordance with the Single Audit Act Amendments of 1996, as implemented by OMB Circular A-133, "Audits of States, Local Governments, and Non-Profit Organizations." Grantees are subject to the provisions of OMB Circular A-133 if they expend \$500,000.00 or more in a year in Federal awards.

The Form SF-SAC and the Single Audit Reporting packages for fiscal periods ending on or after January 1, 2008 are submitted online.

1. Create your online report ID at <http://harvester.census.gov/fac/collect/ddeindex.html>;
2. Complete the Form SF-SAC;
3. Upload the Single Audit;
4. Certify the Submission;
5. Click "Submit."

Organizations expending less than \$500,000.00 a year are not required to have an annual audit for that year but must make their grant-related records available to NRC or other designated officials for review or audit.

III. Programmatic Requirements

Performance Progress (Technical) Reports

The Grantee shall submit performance (technical) reports electronically to the NRC Project Officer and Grants Officer on a quarterly for the periods ending March 31, June 30, September 30, and December 31, or any portion thereof, unless otherwise specified in a special award condition. Reports are due no later than 30 days following the end of each reporting period. The report should be submitted electronically to the following:

1. Grants_PPR.Resource@NRC.gov (NOTE: There is an underscore between Grants and PPR);
2. RESGrants.Resource@NRC.gov;
3. Technical Analyst; and
4. Grants Officer.

Unless otherwise specified in the award provisions, performance progress (technical) reports shall contain brief information as prescribed in the applicable uniform administrative requirements 2 CFR §215.51 which are incorporated in the award.

Unsatisfactory Performance

Failure to perform the work in accordance with the terms of the award and maintain at least a satisfactory performance rating, may result in designation of the Grantee as high risk and the assignment of special award conditions. Further action may be required as specified in the standard term and condition entitled "Termination."

Failure to comply with the award provisions may result in a negative impact on future NRC funding. In addition, the Grants Officer may withhold payments; change the method of payment from advance to reimbursement; impose special award conditions; suspend or terminate the grant.

Other Federal Awards With Similar Programmatic Activities

The Grantee will immediately notify the Project Officer and the Grants Officer in writing if after award, other financial assistance is received to support or fund any portion of the program description stated in the NRC award. NRC will not pay for costs that are funded by other sources.

Prohibition Against Assignment By The Grantee

The Grantee will not transfer, pledge, mortgage, or otherwise assign the award, or any interest to the award, or any claim arising under the award, to any party, banks, trust companies, or other financing or financial institutions without the written approval of the Grants Officer.

Site Visits

The NRC, through authorized representatives, has the right to make site visits to review project accomplishments and management control systems and to provide technical assistance as required. If any site visit is made by the NRC on the premises of the Grantee or contractor

under an award, the Grantee shall provide and shall require his/her contractors to provide all reasonable facilities and assistance for the safety and convenience of the Government representative in the performance of their duties.

IV. Miscellaneous Requirements

Criminal and Prohibited Activities

The Program Fraud Civil Remedies Act (31 USC §§ 3801-3812), provides for the imposition of civil penalties against persons who make false, fictitious, or fraudulent claims to the Federal government for money (including money representing grant/cooperative agreements, loans, or other benefits.)

False statements (18 USC § 287), provides that whoever makes or presents any false, fictitious, or fraudulent statements, representations, or claims against the United States shall be subject to imprisonment of not more than five years and shall be subject to a fine in the amount provided by 18 USC § 287.

False Claims Act (31 USC 3729 et seq), provides that suits under this Act can be brought by the government, or a person on behalf of the government, for false claims under federal assistance programs.

Copeland "Anti-Kickback" Act (18 USC § 874), prohibits a person or organization engaged in a federally supported project from enticing an employee working on the project from giving up a part of his compensation under an employment contract.

American-Made Equipment And Products

Grantees are encouraged to purchase American-made equipment and products with funding provided under this award.

Increasing Seat Belt Use in the United States

EO 13043 requires Grantees to encourage employees and contractors to enforce on-the-job seat belt policies and programs when operating company-owned, rented or personally-owned vehicle.

Federal Leadership of Reducing Text Messaging While Driving

EO 13513 requires Grantees to encourage employees, sub-awardees, and contractors to adopt and enforce policies that ban text messaging while driving company-owned, rented vehicles or privately owned vehicles when on official Government business or when performing any work for or on behalf of the Federal Government.

Federal Employee Expenses

Federal agencies are barred from accepting funds from a Grantee to pay transportation, travel, or other expenses for any Federal employee unless specifically approved in the terms of the award. Use of award funds (Federal or non-Federal) or the Grantee's provision of in-kind goods or services, for the purposes of transportation, travel, or any other expenses for any Federal employee may raise appropriation augmentation issues. In addition, NRC policy prohibits the acceptance of gifts, including travel payments for Federal employees, from Grantees or applicants regardless of the source.

Minority Serving Institutions (MSIs) Initiative

Pursuant to EOs 13256, 13230, and 13270, NRC is strongly committed to broadening the participation of MSIs in its financial assistance program. NRC's goals include achieving full participation of MSIs in order to advance the development of human potential, strengthen the Nation's capacity to provide high-quality education, and increase opportunities for MSIs to participate in and benefit from Federal financial assistance programs. NRC encourages all applicants and Grantees to include meaningful participations of MSIs. Institutions eligible to be considered MSIs are listed on the Department of Education website: <http://www.ed.gov/about/offices/list/ocr/edlite-minorityinst.html>

Research Misconduct

Scientific or research misconduct refers to the fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results. It does not include honest errors or differences of opinions. The Grantee organization has the primary responsibility to investigate allegations and provide reports to the Federal Government. Funds expended on an activity that is determined to be invalid or unreliable because of scientific misconduct may result in a disallowance of costs for which the institution may be liable for repayment to the awarding agency. The Office of Science and Technology Policy at the White House published in the Federal Register on December 6, 2000, a final policy that addressed research misconduct. The policy was developed by the National Science and Technology Council (65 FR 76260). The NRC requires that any allegation be submitted to the Grants Officer, who will also notify the OIG of such allegation. Generally, the Grantee organization shall investigate the allegation and submit its findings to the Grants Officer. The NRC may accept the Grantee's findings or proceed with its own investigation. The Grants Officer shall inform the Grantee of the NRC's final determination.

Publications, Videos, and Acknowledgment of Sponsorship

Publication of the results or findings of a research project in appropriate professional journals and production of video or other media is encouraged as an important method of recording and reporting scientific information. It is also a constructive means to expand access to federally funded research. The Grantee is required to submit a copy to the NRC and when releasing information related to a funded project include a statement that the project or effort undertaken was or is sponsored by the NRC. The Grantee is also responsible for assuring that every publication of material (including Internet sites and videos) based on or developed under an award, except scientific articles or papers appearing in scientific, technical or professional journals, contains the following disclaimer:

"This [report/video] was prepared by [Grantee name] under award [number] from [name of operating unit], Nuclear Regulatory Commission. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the view of the [name of operating unit] or the US Nuclear Regulatory Commission."

Trafficking In Victims Protection Act Of 2000 (as amended by the Trafficking Victims Protection Reauthorization Act of 2003)

Section 106(g) of the Trafficking In Victims Protection Act Of 2000 (as amended as amended, directs on a government-wide basis that:

"any grant, contract, or cooperative agreement provided or entered into by a Federal department or agency under which funds are to be provided to a private entity, in whole or in part, shall include a condition that authorizes the department or agency to terminate the grant, contract, or cooperative agreement, without penalty, if the grantee or any subgrantee, or the contractor or any subcontractor (i) engages in severe forms of

trafficking in persons or has procured a commercial sex act during the period of time that the grant, contract, or cooperative agreement is in effect, or (ii) uses forced labor in the performance of the grant, contract, or cooperative agreement." (22 U.S.C. § 7104(g)).

EXECUTIVE COMPENSATION REPORTING

2 CFR 170.220 directs agencies to include the following text to each grant award to a non-federal entity if the total funding is \$25,000 or more in Federal funding.

Reporting Subawards and Executive Compensation.

a. Reporting of first-tier subawards.

1. *Applicability.* Unless you are exempt as provided in paragraph d. of this award term, you must report each action that obligates \$25,000.00 or more in Federal funds that does not include Recovery funds (as defined in section 1512(a)(2) of the American Recovery and Reinvestment Act of 2009, Pub. L. 111-5) for a subaward to an entity (see definitions in paragraph e. of this award term).

2. Where and when to report.

i. You must report each obligating action described in paragraph a.1. of this award term to <http://www.fsrs.gov>.

ii. For subaward information, report no later than the end of the month following the month in which the obligation was made. (For example, if the obligation was made on November 7, 2010, the obligation must be reported by no later than December 31, 2010.)

3. *What to report.* You must report the information about each obligating action that the submission instructions posted at <http://www.fsrs.gov> specify.

b. Reporting Total Compensation of Recipient Executives.

1. *Applicability and what to report.* You must report total compensation for each of your five most highly compensated executives for the preceding completed fiscal year, if—

i. the total Federal funding authorized to date under this award is \$25,000.00 or more;

ii. in the preceding fiscal year, you received—

(A) 80 percent or more of your annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and

(B) \$25,000,000 or more in annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and

iii. The public does not have access to information about the compensation of the executives through periodic reports filed under section 13(a) or 15(d) of the Securities Exchange Act of

1934 (15 U.S.C. 78m(a), 78o(d)) or section 6104 of the Internal Revenue Code of 1986. (To determine if the public has access to the compensation information, see the U.S. Security and Exchange Commission total compensation filings at <http://www.sec.gov/answers/execomp.htm>.)

2. *Where and when to report.* You must report executive total compensation described in paragraph b.1. of this award term:

- i. As part of your registration profile at <http://www.sam.gov>.
- ii. By the end of the month following the month in which this award is made, and annually thereafter.

c. *Reporting of Total Compensation of Subrecipient Executives.*

1. *Applicability and what to report.* Unless you are exempt as provided in paragraph d. of this award term, for each first-tier subrecipient under this award, you shall report the names and total compensation of each of the subrecipient's five most highly compensated executives for the subrecipient's preceding completed fiscal year, if—

- i. in the subrecipient's preceding fiscal year, the subrecipient received—

(A) 80 percent or more of its annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and

(B) \$25,000,000 or more in annual gross revenues from Federal procurement contracts (and subcontracts), and Federal financial assistance subject to the Transparency Act (and subawards); and

- ii. The public does not have access to information about the compensation of the executives through periodic reports filed under section 13(a) or 15(d) of the Securities Exchange Act of 1934 (15 U.S.C. 78m(a), 78o(d)) or section 6104 of the Internal Revenue Code of 1986. (To determine if the public has access to the compensation information, see the U.S. Security and Exchange Commission total compensation filings at <http://www.sec.gov/answers/execomp.htm>.)

2. *Where and when to report.* You must report subrecipient executive total compensation described in paragraph c.1. of this award term:

- i. To the recipient.
- ii. By the end of the month following the month during which you make the subaward. For example, if a subaward is obligated on any date during the month of October of a given year (*i.e.*, between October 1 and 31), you must report any required compensation information of the subrecipient by November 30 of that year.

d. *Exemptions*

If, in the previous tax year, you had gross income, from all sources, under \$300,000.00, you are exempt from the requirements to report:

i. Subawards,

and

ii. The total compensation of the five most highly compensated executives of any subrecipient.

e. *Definitions.* For purposes of this award term:

1. *Entity* means all of the following, as defined in 2 CFR part 25:

i. A Governmental organization, which is a State, local government, or Indian tribe;

ii. A foreign public entity;

iii. A domestic or foreign nonprofit organization;

iv. A domestic or foreign for-profit organization;

v. A Federal agency, but only as a subrecipient under an award or subaward to a non-Federal entity.

2. *Executive* means officers, managing partners, or any other employees in management positions.

3. *Subaward*:

i. This term means a legal instrument to provide support for the performance of any portion of the substantive project or program for which you received this award and that you as the recipient award to an eligible subrecipient.

ii. The term does not include your procurement of property and services needed to carry out the project or program (for further explanation, see Sec. __.210 of the attachment to OMB Circular A-133, "Audits of States, Local Governments, and Non-Profit Organizations").

iii. A subaward may be provided through any legal agreement, including an agreement that you or a subrecipient considers a contract.

4. *Subrecipient* means an entity that:

i. Receives a subaward from you (the recipient) under this award; and

ii. Is accountable to you for the use of the Federal funds provided by the subaward.

5. *Total compensation* means the cash and noncash dollar value earned by the executive during the recipient's or subrecipient's preceding fiscal year and includes the following (for more information see 17 CFR 229.402(c)(2)):

i. *Salary and bonus.*

ii. *Awards of stock, stock options, and stock appreciation rights.* Use the dollar amount recognized for financial statement reporting purposes with respect to the fiscal year in accordance with the Statement of Financial Accounting Standards No. 123 (Revised 2004) (FAS 123R), Shared Based Payments.

iii. *Earnings for services under non-equity incentive plans.* This does not include group life, health, hospitalization or medical reimbursement plans that do not discriminate in favor of executives, and are available generally to all salaried employees.

iv. *Change in pension value.* This is the change in present value of defined benefit and actuarial pension plans.

v. *Above-market earnings on deferred compensation which is not tax-qualified.*

vi. Other compensation, if the aggregate value of all such other compensation (e.g. severance, termination payments, value of life insurance paid on behalf of the employee, perquisites or property) for the executive exceeds \$10,000.00.