



# Lawrence Livermore National Laboratory

January 29, 2008

Camille Yuan Su-Hoo

DEG  
JAN 31 2008  
By: *[Signature]*

RECEIVED

Manager Livermore Site Office  
National Nuclear Security Administration  
P.O. Box 808, L-293  
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Livermore, California 94551-0808

(b)(5)

Dear Ms. Yuan Su-Hoo,

(b)(5)

Sincerely,

(b)(6)

Cc: w/ attachments  
Paul Ko, LSO  
Anita Martin, LSO  
Jim Shakiba, LSO  
Tony Sy, LSO

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*COL-NLSA 02/01/08 - 8496*

**Preliminary DRAFT 7/2/08**

**Program Requirements Document (PRD)  
for  
High Explosives Research and Development  
Capabilities at Lawrence Livermore National  
Laboratory Main Site**

**Non-Major System Acquisition Project**

**February 2008**

**Lawrence Livermore National Laboratory**

# Preliminary Draft 7/2/08

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**Program Requirements Document  
High Explosives Research and Development Center of Excellence  
Consolidation Project**

**NNSA Signatures and Approvals**

Submitted

\_\_\_\_\_  
(b)(6) Date  
Lawrence Livermore National Laboratory

Concur

\_\_\_\_\_  
(b)(6) Date  
Lawrence Livermore National Laboratory

Concur

\_\_\_\_\_  
Sam Brinker, Assistant Manager Date  
Livermore Site Office  
National Nuclear Security Administration

Approve

\_\_\_\_\_  
Camille Yuan-Soo Hoo, Manager Date  
Livermore Site Office  
National Nuclear Security Administration

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**Change Log**

Rev.	Date	Change Description	Pages Changed

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### 1.0 Introduction and Purpose

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### 2.0 Relationship to Mission Need

The driver for maintaining these high explosive research and development (HE R&D) capabilities are the Department of Energy (DOE) Strategic goals described in the DOE October 2006 Strategic Plan and the National Nuclear Security Administration (NNSA) Strategic Plan. Further discussions of mission needs are provided in the Mission Need Statement document dated February 2008.

### 3.0 Program Assumptions, Constraints, Key Interfaces

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### 4.0 Program Requirements and Goals

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#### 4.2 Mission Requirements

The NNSA will continue to require HE R&D resources sufficient to meet the capability and capacity requirements of the current and projected nuclear weapon mission of research, development, test, certification and qualification of nuclear weapons components, as well as NNSA work in the nuclear weapons survivability, surveillance, and surety missions. The NNSA will have a continued need to conduct this work with classified designs, materials, components, data and information in a classified environment.

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### **4.3.1 Program Technical Requirements**

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### **4.3.2 Program Management Requirements**

The NNSA requires facilities that can be operated reliably and cost effectively, provide ease of maintenance, and provide energy efficiency.

Any modifications and/or additions to existing HE facilities chosen as the selected alternative will need to be configured, and work conducted, in a manner which protects workers from the hazards associated with HE processing.

The selected alternative will need to be designed, constructed, started up, and operated in accordance with applicable state and federal requirements.

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Quality Assurance principles will apply to all aspects of the effort including the design.

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### 5.0 References

- DOE/NA-0013, Complex 2030 – An Infrastructure for a Nuclear Weapons Complex Able to Meet the Threats of the 21<sup>st</sup> Century, October 2006.
- High Explosives Research and Development Capabilities at Lawrence Livermore National Laboratory (LLNL) Main Site Project – Mission Needs Statement, February 2008.
- DOE Order 413.3A, Program and Project Management for the Acquisition of Capital Assets, July 2006.

### 6.0 Applicable DOE Orders, Standards, Rules, and Regulations

#### DOE Policies

DOE P 226.1, Department of Energy Oversight Policy  
DOE P 450.2, Identifying, Implementing and Complying with Environment, Safety and Health Requirements  
DOE P 4504, Safety Management System Policy  
DOE P 450.7, Environment, Safety and Health (ESH) Goals

#### DOE Orders

DOE O 151.1B, Comprehensive Emergency Management System  
DOE O 231.1A, Environment, Safety and Health Reporting  
DOE O 430.1B, Real Property Asset Management  
DOE O 440.1A, Worker Protection Management for DOE Federal and Contractor Employees  
DOE O 414.1C, Quality Assurance  
DOE O 413.3A, Program and Project Management for the Acquisition of Capital Assets  
DOE O 420.1B, Facility Safety  
DOE O 425.1C, Startup and Restart of Nuclear Facilities  
DOE O 430.1B, Real Property Asset Management  
DOE O 451.1B, National Environmental Policy Act Compliance Program - Change 1  
DOE O 5480.19, Conduct of Operations Requirements for DOE Facilities

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### DOE Manuals

DOE M 226.1, Department of Energy Oversight Manual (draft)  
DOE M 231.1-2, Occurrence Reporting and Processing of Operations Information  
DOE M 426.1-1A, Federal Technical Capability Manual  
DOE M 450.4-1, Integrated Safety Management System Manual DOE M 452.2-1,  
Nuclear Explosive Safety  
DOE M 470.4-1

### DOE Guides

DOE G 413.3-1, Management of Design and Construction: A Systems Approach  
DOE G 413.3-2, Quality Assurance  
DOE G 413.3-3, Safeguards & Security  
DOE G 413.3-5, Performance Baselines & Baseline Management  
DOE G 413.3-6, High Performance Sustainable Building  
DOE G 413.3-7, Risk Management  
DOE G 413.3-8, EM Clean-up Projects  
DOE G 413.3-9, Project Reviews  
DOE G 413.3-10, Earned Value Management  
DOE G 413.3-11, Project Management Lessons Learned Process  
DOE G 413.3-12, Cost Estimating  
DOE G 413.3-13, Acquisition Strategies  
DOE G 413.3-14, IT Projects  
DOE G 413.3-15, Project Execution Plans  
DOE G 413.3-16, CD-4  
DOE G 413.3-17, Mission Need Statement  
D DOE G 413.3-18, Integrated Project Teams  
DOE G 420.1-2, Guide for the Mitigation of Natural Phenomena Hazards for DOE  
Nuclear Facilities and Non-Nuclear Facilities  
DOE G 424.1-1A, Implementation Guide For Use In Addressing Un-reviewed Safety

### Question Requirements

DOE G 450.4-1B, Integrated Safety Management System Guide (Volume 1) for use with  
Safety Management System Policies (DOE P 450.4, DOE P 450.5, and DOE P 450.6);  
DOE G 450.4-1B, Integrated Safety Management System Guide (Volume 2) for use with  
Safety Management System Policies (DOE P 450.4, DOE P 450.5, and DOE P 450.6);  
The Functions, Responsibilities, and Authorities Manual; and the DOE Acquisition  
Regulation

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### Codes of Federal Regulations

- 10 Code of Federal Regulations (CFR) Part 820, Procedural Rules for DOE Nuclear Activities
- 10 Code of Federal Regulations (CFR) Part 830, Nuclear Safety Management
- 10 Code of Federal Regulations (CFR) Part 850, Chronic Beryllium Disease Prevention
- 10 Code of Federal Regulations (CFR) Part 851, Worker Safety and Health Program

### Codes and Standards

- DOE-STD-1020-2002, Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities
- DOE STD-1021-93, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components
- DOE STD-1022-94, Natural Phenomena Hazards Characterization Criteria

~~DOE-STD-1023-95, Natural Phenomena Hazards Assessment Criteria~~  
~~DOE-STD-1027-92, Hazard Classification and Accident Analysis Techniques for Compliance with DOE-EO-148023, Nuclear Safety Analysis Reports~~  
~~DOE-STD-1104, Review and Approval of Nuclear Facility Safety Basis Documents (Documented Safety Analysis and Technical Safety Requirements)~~  
~~DOE-STD-1189 (DRAFT)~~  
~~DOE-STD-1073-2003, Configuration Management Program~~  
~~DOE-STD-1083-95, Requesting and Granting Exemptions to Nuclear Safety Rules~~  
~~DOE-STD-3015-2002, Guidance for Preparation of Basis for Interim Operation (BIO) Documents~~  
~~DOE-HA-STD-3016-2006, Hazard Analysis Reports for Nuclear Explosive Operations~~  
~~DOE-STD-3015-2004, Nuclear Explosive Safety Evaluation Process~~  
~~Others contained in the LLNS contract~~

~~The above will form the basis of developing the functional and operational requirements for the selected alternative during the conceptual design.~~

Appendix A

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## Appendix B

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Attachment to Critical Decision 0 Approval Memorandum for  
the HE R&D Capabilities at the Lawrence Livermore National  
Laboratory

**Mission Need Statement  
for  
High Explosives Research and Development  
Capabilities at Lawrence Livermore National  
Laboratory Main Site**

**Non-Major System Acquisition Project**

**May 2008**

**Lawrence Livermore National Laboratory**

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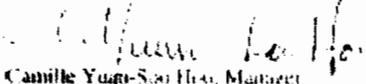
**Mission Need Statement  
High Explosives Research and Development Capabilities  
at LLNL Main Site**

**NNSA Signatures and Approvals**

Submitted (b)(6) 2/26/08  
Date

Concur (b)(6) 2-26-08  
Date

Concur  2/27/08  
Date  
Samuel Brinker, Assistant Manager  
Livermore Site Office  
National Nuclear Security Administration

Concur  2/28/08  
Date  
Camille Yuan-Soo Hsu, Manager  
Livermore Site Office  
National Nuclear Security Administration

Concur \_\_\_\_\_  
Date  
Christopher Deeney  
Director, Office of Defense Science  
NA-113

Concur \_\_\_\_\_  
Date  
William S. Goodrum  
Assistant Deputy Administrator Science, Engineering and  
Production Programs

Approve \_\_\_\_\_  
Date  
Robert L. Smolen  
Deputy Administrator for Defense Programs  
NNSA, NA-10

## **Executive Summary**

The National Nuclear Security Administration (NNSA) is a semi-autonomous agency established by Congress in 2000 within the Department of Energy (DOE). The mission of the NNSA is to strengthen national security through the military application of nuclear energy and by reducing the global threat from terrorism and weapons of mass destruction. To support this mission, NNSA is responsible for maintaining a U.S. nuclear deterrent and for protecting and revitalizing the weapons complex.

An important element of the nuclear weapons research, development, and test program is high explosives research and development (HE R&D). High explosives play an essential role in nuclear weapons to dependably compress and assemble fissile material, uranium or plutonium, of the primary stage from its safe, subcritical storage condition to the precise size and shape and supercritical condition necessary for nuclear detonation. High explosive is also used in the detonators, which initiate detonation of the primary HE to begin its function.

Although five sites in the Nuclear Weapons Complex (NWC) have HE R&D capabilities, each site has unique capabilities as required to execute their respective missions for NNSA. Lawrence Livermore National Laboratory (LLNL) and Los Alamos National Laboratory (LANL) perform most of the R&D related to main charge explosives. The HE R&D mission at LLNL is performed in the High Explosives Applications Facility (HEAF), as augmented by critical HE R&D capabilities currently located at LLNL's Site 300.

NNSA has initiated Complex Transformation and has issued the draft Supplemental Programmatic Environmental Impact Statement (Draft SPEIS). A number of alternatives are proposed in the SPEIS. Among them are:

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**This Mission Needs Statement (MNS):**

- discusses the requirements for maintaining high explosive research and development capabilities at the current level
- identifies the capability gaps that will result if NNSA chose to execute alternative 2b described above
- identifies possible alternatives to eliminate the capability gaps.

## **1.0 Statement of Mission Need**

High explosives (HE) are used in nuclear weapon primaries to provide the energy needed for a modern nuclear weapon to function. HE is also used to actuate non-nuclear components and to drive the hydrodynamic and sub-critical experiments required by the Stockpile Stewardship Program. Within the weapons complex, HE R&D focuses on a wide variety of areas including: new material development, engineering properties, and performance; safety and surety; vulnerability aging; diagnostics; enhanced surveillance, modeling and simulation; and compatibility testing.

HE R&D is required to assure stability and dependability of high explosives in nuclear weapons. It is required to support the improved predictive capability for performance, safety, and aging. HE R&D utilizes experiments with computer modeling and simulation to enhance the understanding of how HE and HE components work and to decrease the amount of testing required in development.

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## 2.0 Alignment With Mission Need

The Mission Needs identified are aligned with the NNSA's Strategic Plan and Mission and are an important element to accomplishing one of the Agency's highest priorities, as explained below.

### **Weapons Complex Infrastructure Must Be Transformed**

DOE stands at the forefront of helping the Nation meet our energy, scientific, environmental, and national security goals. As the steward of the Nation's nuclear weapons stockpile, DOE is responsible for maintaining nuclear deterrents and leading the international nuclear nonproliferation efforts in a world where terrorism is a real threat to national security and world stability.

### **National Nuclear Security Goals**

As NNSA continues to draw-down the nuclear weapons stockpile to the lowest levels since the 1950s, we must consider the long-term effects of aging and the implications of successive warhead refurbishments which take us further away from the tested designs of the Cold War stockpile. The current nuclear weapons complex is not sufficiently responsive to fix technical problems in the stockpile or to react to potential adverse geopolitical change. Therefore, the nuclear weapons stockpile and the supporting infrastructure must be transformed. The Department is working closely with its customers to transform the nuclear deterrent to ensure that it can meet the changing technical, geopolitical, and military needs of the future. This mission is described by Strategic Goal 2.1:

#### **Goal 2.1—Nuclear Deterrent**

“Transform the Nation's nuclear weapons stockpile and supporting infrastructure to be more responsive to the threats of the 21st Century.”

NNSA has developed a preferred planning scenario, which sets out the vision for the nuclear weapons Complex Transformation. A key element of this planning scenario is the need to transform the current nuclear weapons complex into a modernized, cost-effective complex by: reducing the number of sites, and facilities within sites, that possess large quantities of special nuclear materials; consolidating redundant capabilities; operating science assets as shared user facilities; and designing, building, and operating new facilities in a manner that protects public and worker health and safety and the environment.

### **High Explosive Research and Development Capabilities Must Be Maintained**

While transforming the complex, it is critical that NNSA maintain its core scientific and engineering competencies in order to meet its mission of maintaining the enduring stockpile.

One of the core competencies is the area of High Explosives Research and Development (HE R&D)

### **3.0 Capability Gap**

#### **HE R&D Capabilities are Critical to NNSA**

NNSA maintains and enhances the safety, security, reliability and performance of the U.S. nuclear weapons stockpile without nuclear testing. To this end, the DOE adopted a science-based Stockpile Stewardship Program (SSP) that emphasized development and application of technical capabilities to assess the safety, security, and reliability of nuclear warheads without the use of nuclear testing. The NNSA's Office of Defense Programs (DP) is the Program Sponsor responsible for the management and implementation of the SSP to ensure that the nuclear weapons continue to serve their deterrent role.

An important element of the SSP is nuclear weapons research, development, and test program of HE and HE stewardship. High explosive chemical energy plays an essential role in nuclear weapons to dependably compress and assemble fissile material, uranium or plutonium, of the primary stage from its safe, subcritical storage condition to the precise size and shape and supercritical condition necessary for nuclear detonation. High explosive is also used in the detonators, which initiate detonation of the primary HE to begin its function.

High explosive R&D capabilities support the SSP and other DOE and NNSA Programs in the areas of:

- Assessing the safety, security, and reliability of existing nuclear warheads
- Developing one-of-a-kind explosive parts for testing
- Scale-up of synthesis and formulation processes
- Detonation physics: experiments and modeling of HE performance and safety
- Bench-scale synthesis and formulation of new HE/insensitive HE
- Bench-scale synthesis and formulation of new energetic materials for detonators and actuators
- Engineering performance, compatibility and aging
- Follow-up on significant surveillance findings
- Security applications including detection/disablement
- HE Work for Others (WFO) is essential to sustain DP's scientific vitality and to meet the needs of national security stakeholders
- Contributions to the planning and execution of HE R&D elements of the Nuclear Counterterrorism Design Support (NCDS) program to develop information, methods, and equipment for use by (1) nuclear designers in helping to evaluate the range of nuclear materials and designs for their yield-producing potential, and (2) emergency Joint Technical Operations Teams

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- The ability to react quickly to new developments and execute the SSP mission requirements on time.
- Capabilities-based strategy as part of "response infrastructure" in post-cold war nuclear policy in preparation for an uncertain future by sustaining and developing the infrastructure and other capabilities necessary to meet the range of contingencies that the United States could confront in the years and decades ahead including unforeseen technological, military, or political circumstances.

### The LLNL HE R&D Directly Supports NNSA Program Success

The LLNL HE R&D capability directly supports the NNSA Defense Programs Science Campaign and the NNSA Engineering Campaign as well as NNSA Emergency and Non-Proliferation Programs. Highlights of the strategy, and the relationship of HE R&D capability to the strategy goals, are stated below.

The following are specific examples of contributions made by HE technology to the NNSA mission:

- Dependability:** HE chemical energy plays an essential role in nuclear weapons.
- Surveillance:** HE is susceptible over time to aging-induced changes in chemistry and physical properties. A careful program of surveillance tracks these components and their properties, and the laboratories must evaluate the data to determine whether performance and safety remain within acceptable bounds.
- Surety:** HE implantation and materials analysis support development of components required to contribute to the safety, security, reliability and control of nuclear weapons.
- Qualification & Certification:** Weapons and components entering the stockpile must be certified that they meet specified requirements. The certification of weapon performance and safety depends on physics-based, experimentally validated data and models of explosives. Qualification of components and systems is required to support the written annual certification by DOE to Congress and the President that there are no safety or reliability issues with the state of the nuclear stockpile.
- Peer Review:** The "peer review" process between the laboratories is a major component of certification. Nowhere is such peer review more vital than in the absence of nuclear yield testing than in judging the acceptability of issues relating to the HE driven implosion system for the primary stage. This peer review process spans the life of a nuclear weapon: during the feasibility period, as has just occurred on the Reliability Replacement Warhead (RRW) program; at significant milestones during development, such as when design is committed to production; at completion of

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development and before entry into the stockpile; as part of the annual certification process; and as needed when "surprises" occur.

The Emergency Response (ER) Program elements directly support initiatives flowing out of the President's declaration of a national emergency with respect to "weapons of mass destruction" and of the means of delivering such weapons (Executive Order 12938) as well as the Departments' Strategic Goal 2.2. The ER Program is further defined by Presidential Decision Directives (PDDs) 39 and 62.

HEA ER Program Strategic Goal 2.2. The ER Program is further defined by Presidential Decision

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**HEAF. By the physical and chemical nature of high explosives, several important HE parameters, or characteristics, do not scale with charge weights in the 1 gram up to 10 kg sizes. Key material behaviors include ease of shock initiation and the onset of detonation, detonation reaction rate and energy release, and violence of explosive response to mechanical insults. These are all scale dependent, with explosives at the 100 gram size showing very different behavior than explosives at the 10 kg scale. The effect of scale results from competing phenomena of energy loss at boundaries and energy release in the bulk and the inherent heterogeneity of explosives, and the scaling laws are in many cases not well understood. Experiments at different sizes are required. With experimental results ranging from 1 gram to 10 kg, we can scale up to larger charge sizes computationally as needed; furthermore,**

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More specifically, the HEAF at LLNL, as augmented by mission critical HE R&D capabilities located at Site 300, has demonstrated its contribution to the nuclear weapons program in a spectrum of NNSA mission areas. The HE work supports the NNSA Science Campaign, the Engineering Campaign, and Directed Stockpile Work. The NNSA capability provided at the LLNL HEAF provides the following capabilities to the NNSA in support of SSP activities.

- A center for the study of chemical high explosives
- Combines all the capabilities needed to synthesize, formulate, and test new explosive compounds to satisfy the requirements of the Laboratory's weapons program
- High explosives can be safely detonated in specially designed vessels in quantities as high as 10 kg
- Impact experiments can be carried out with a four-inch-bore gun that accelerates flyers to a velocity of several kilometers per second
- Detonation experiments are supported by state-of-the-art diagnostic equipment that includes high-speed, rotating-mirror streaking and framing cameras, electronic image-converter cameras, optical interference velocimeters, and image-forming flash x-ray machines
- Tailoring for performance
- Nuclear detonation and explosive safety in accident scenarios
- Mechanical properties R&D
- R&D insensitivity to aging during long-term exposure to the environment within the weapon package
- Small scale testing in totally environmentally contained firing tanks.

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**5.0 Resource and Schedule Forecast**

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COR-NNSA-2/21/2008-8496

MEMORANDUM FOR DR. DAVID CRANDALL  
ASSISTANT DEPUTY ADMINISTRATOR  
FOR RESEARCH, DEVELOPMENT AND SIMULATION

FROM:

*Camille Yuan-Soo Hoo*  
CAMILLE YUAN-SOO HOO  
MANAGER

SUBJECT: Request for the Critical Decision - 0 "Approve Mission Need" for the High Explosives Research and Development Capabilities at Lawrence Livermore National Laboratory Main Site

As identified in the National Nuclear Security Administration (NNSA) Complex Transformation initiative, NNSA plans to eliminate the Weapons Account funding at Lawrence Livermore National Laboratory's (LLNL) Site 300 which will create a High Explosives Research and Development (HE R&D) capability gap that will need to be filled in order for NNSA to accomplish its Stockpile Stewardship Program mission. The driver for maintaining these HE R&D capabilities are the Department of Energy (DOE) Strategic goals described in the DOE October 2006 Strategic Plan and the NNSA preferred alternative for the Draft Complex Transformation Supplemental Programmatic Environmental Impact Statement.

In order for the High Explosive Application Facility (HEAF) to continue to meet NNSA's current and projected nuclear weapon research mission and HEAF to maintain status as HE R&D Center of Excellence, the Site 300 capabilities should be relocated to Site 200. To relocate the Site 300 capabilities to the HEAF operation, a capital funded line item project would be required. If the program requirements of relocating these critical capabilities from Site 300 to Site 200 are not met, NNSA will not be able to bridge the programmatic gap for HE R&D capability and meet the Complex Transformation guidance to eliminate Weapons Account funding at Site 300.

A Mission Need Statement for HE R&D Capabilities at LLNL Main Site Project (Attachment 1) and a Program Requirements Document for HE R&D Capabilities at LLNL Main Site Project (Attachment 2) are being submitted to support this request for Critical Decision 0, Mission Need, approval for this project.

If you have any questions about this request, please contact Samuel Brinker at (925) 422-0710.

Dr. D. Crandall

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**Attachments: (1) Mission Need Statement for High Explosives Research and Development Capabilities at LLNL Main Site Project  
(2) Program Requirements Document for High Explosives Research and Development Capabilities at LLNL Main Site Project**

**cc (w/att.):**

**M. Thompson, HQ/NA-17**

**S. Jaghoory, HQ/NA-113**

**P. Ko, LSO/AMNSI**

**cc (w/o att.):**

**S. Brinker, LSO/AMNSI**

**J. Shakiba, LSO/AMNSI**

**A. Martin, LSO/AMNSI**

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