RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	**R-1 ITEM NOMENCLATURE** Joint DoD/DOE Munitions **PE 0603225D8Z**

COST *(In Millions)*	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007		Cost to Complete	Total Cost
Total Program Element (PE) Cost	16,516	18,982	25,420	20,671	21,823	22,223	22,270		Continuing	Continuing
DoD/DOE Munitiond/P225	16,516	18,982	25,420	20,671	21,823	22,223	22,270		Continuing	Continuing

(U) A. Mission Description and Budget Item Justification

(U) BRIEF DESCRIPTION OF ELEMENT

(U) This R&D program is a cooperative, jointly funded effort between DoD and DOE to pursue new and innovative warhead, explosive, and fuze technologies in order to bring about major improvements in non-nuclear munitions. This program supports the development and exploration of new munitions concepts and technology preceding system engineering development. Through our funding arrangement with DOE, DoD resources are matched. More importantly, this relatively small DoD contribution effectively taps the annual billion-dollar DOE RDT&E investment by accessing the specialized skills, scientific equipment, facilities and computational tools not available in DoD.

(U) The effort exploits the extensive and highly developed technology base resident in the National Laboratories relevant to achieving the goal of developing capable, cost-effective conventional munitions, and leverages DoD investments with matching DOE investments. The current program supports 38 projects in warhead technology, energetic materials, advanced initiation and fuze development, munitions lifecycle technology, and computer simulation. A specific Service laboratory sponsors each of these projects. The program is administered and reviewed by a Joint Technical Advisory Committee composed of members from the Army, Navy, Air Force, OSD, and DOE. Projects are peer-reviewed semi-annually by DoD Service Laboratory/Technical Center personnel in order to monitor technical excellence and ensure that the technologies under development address priority DoD needs. The program is integrated with Service efforts through the Project Reliance Weapons Panel and participation in the Defense Technology Area Plan for Conventional Weapons. The program is reviewed under the Technology Area Review and Assessment process.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	**R-1 ITEM NOMENCLATURE** Joint DoD/DOE Munitions **PE 0603225D8Z**

COST*(In Millions)*	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007		Cost to Complete	Total Cost
Total Program Element (PE) Cost	16,516	18,982	25,420	20,671	21,823	22,223	22,270		Continuing	Continuing
DoD/DOE Munitiond/P225	16,516	18,982	25,420	20,671	21,823	22,223	22,270		Continuing	Continuing

(U) Project Number and Title: P225 DoD/DOE Munitions

(U) PROGRAM ACCOMPLISHMENTS AND PLANS

(U) **FY 2001 Accomplishments:**

(U) Fuzing is a key element in every Department munition system and advanced initiation is an enabling technology for the next generation of warheads. It supports the development of advanced aimable warheads, target-adaptable warheads, and survivable high-velocity hard target penetrators. This program continues to provide improved component options and new architectures for use in advanced electronic safing, arming and firing systems. The objective is to provide a set of characterized, qualified, generic components (and suppliers) and to demonstrate their use in prototype designs. In FY1997 an effort was initiated to reduce the size and cost of ESADs by a factor of 10 over currently fielded technology. Utilizing newly developed and qualified all-commercial components, a low-energy prototype ESAD was demonstrated last year that represents a factor of 10 reduction in size and a factor of 4 reduction in cost. While this technology enables significant improvement in weapon design and capability, cost remains a barrier to utilization in low-cost, mass-produced munitions. An analysis of the cost drivers shows that we are close to the limits with the current component designs and architectures. Therefore, the focus of the component effort was shifted last year to exploit recent advances in microelectronics, micro-electromechanical systems, micro-lasers and optical initiation. These new technologies offer opportunities for increased operational capability from micro firing systems along with a further order-of-magnitude decrease in size and reduced cost. In FY01 a significant test milestone in the effort to engineer an optically charged fireset was achieved by initiating a high explosive using a multilayer nanostructure capacitor and a high voltage photocell. Efforts continued on component shock hardening and

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	R-1 ITEM NOMENCLATURE Joint DoD/DOE Munitions **PE 0603225D8Z**

packaging in support of Service initiatives in high-velocity penetrators. The accelerometer to be used in new G-hardened fuzes was characterized in two axes in FY 2001 with one observed anomaly that is currently under investigation. Towards miniaturizing fuze systems using nano-technology, early progress has been made in the use of photolithography to deposit 0.5-mil lines and spaces needed for a microtransformer fireset application. Similarly, a nanostructure dielectric film deposition method for further miniaturization of firesets was demonstrated in FY 2001. The computerized knowledge base initiated last year to preserve and transition the advanced initiation technology base developed under this program is now operational and transition to the DoD has begun. This classified tool will ensure experience retention in archives and support government laboratories and contractors. The two knowledge bases distributed this year contain expertise associated with firing circuits and slapper detonators. ($ 3.290 million)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	**R-1 ITEM NOMENCLATURE** Joint DoD/DOE Munitions **PE 0603225D8Z**

(U) DoD and DOE continue to have very similar requirements for energetic materials. Both agencies desire high explosives with increased or tailored performance and decreased sensitivity, and recent accomplishments have benefited both agencies. Like advanced initiation, improved energetic materials are enabling technology for the next generation of weapon systems that will be safer, smaller and more lethal. Under this program a combination of evolutionary and novel technologies are under development. Conventional chemistry has been used to develop more powerful, less sensitive explosives. Nano-structured and engineered materials are being explored to increase energy density and energy on target by factors of three or more. Higher risk efforts are also underway to explore the possibility of metastable High Energy Density Materials (HEDM). Using conventional chemistry, a number of new candidate molecules have been synthesized, characterized and formulated. The development of new materials is based on theoretical molecular design. The structure, performance and sensitivity of new molecules are predicted computationally, then synthesis is attempted. The focus is in two areas: molecules with significantly increased energy over current materials and very insensitive materials with reasonable energies. As reported last year, another new explosive under development is LLM-105. It is dense, thermally stable and very insensitive. With 30% more energy than TNT it has possible detonator and booster applications and is an alternative to TATB in special purpose weapons such as hard target penetrators that have to survive high shock loading. The synthesis, scale-up, and characterization of this material have been completed and its use as insensitive booster material for Navy weapons applications is now being evaluated. Efforts to crystallize the pure form of a newly synthesized energetic material with predicted energy greater than CL-20, LLM-121 continued in FY 2001. Two other very fast burning materials, BTATz and DHT, have been successfully synthesized and are under evaluation as enhanced performance gun and rocket propellant ingredients. Metastable Intermolecular Composites (MIC) developed under this program were the first successful examples of nano-structured energetic materials with significantly enhanced performance. They demonstrated that tailored, ultra-fine reactant particles could dramatically increase the energy release rate of thermite-like materials and provide twice the total energy of high explosives. The first application of this technology is for lead-free percussion primers for small arms ammunition, and this program is now in engineering development under SERDP funding. The current focus is on the optimization of this material for other weapons applications via better diagnostic and measurement methods. A new bulk process for manufacturing nano-structured energetic materials using sol-gel chemistry has been developed with the promise of precise control of material homogeneity, properties, and geometry. Samples of this material were manufactured this year for testing and evaluation in support of reactive warheads that better couple energy to the target and applications that require very high thermal loading. Extended solid HEDMs are also under development. This work uses intense pressure and temperature to force elements into highly energetic bonding states that can be recovered to ambient conditions. Current synthesis techniques have

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	R-1 ITEM NOMENCLATURE Joint DoD/DOE Munitions **PE 0603225D8Z**

produced CO-derived solids and a family of novel nitrogen materials, but in very small quantities. These materials are expected to be highly energetic, but characterizing them, and particularly verifying the energy content, has been difficult due to the microscopic quantities of material available. This year, the energy content of laboratory produced high energy density material was preliminarily measured. A special press was installed for production of milligram sample sizes, which can then be characterized more accurately using standard and improved techniques. The creation of the thermochemical code Cheetah represents a major accomplishment of this program. The code predicts the performance of energetic materials including high explosives, propellants and pyrotechnics and reduces the number of tests necessary to develop a new material. Cheetah 3.0 was released this year to DoD, DOE and DoD contractor users. This version includes new equations of state resulting in greatly enhanced stability and accuracy of the code. A major effort is also underway to develop a suite of codes for use in predicting the response of energetic materials in weapon systems subjected to thermal and mechanical insult. The objective is to reduce the number and cost of the current go/no-go insensitive munitions test protocols required to qualify a new system for military use and to improve our understanding of the physical mechanisms and safety margins. As reported last year, a collaborative effort with the Navy was initiated to experimentally assess and validate codes for use in predicting the response of weapon systems including the violence of reaction in cookoff accidents. Quantitative data on cookoff violence have been generated by both the Navy in small-scale experiments and by DOE in the scaled thermal explosion experiments. Data on both HMX based explosives and PBX-109 have been obtained for use in establishing the accuracy and range of validity of the predictive models. The measured properties were used this year to successfully predict the time to explosion in cookoff tests performed by the Navy. In order to preserve and transition the energetic materials technology generated under this program, two explosives databases have been distributed to government laboratories and contractors. One database, HEAT1, contains over 3,000 chemical structures, and is a compilation of measured heats of formation for a wide range of organic molecules of interest to researchers in the weapons community. A second database is APEX, A Pure Explosives Database. This database contains over 500 energetic materials of different molecular structure to guide the synthesis of new materials and ensure the retention of important characterization data. ($ 4.526 million)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	R-1 ITEM NOMENCLATURE Joint DoD/DOE Munitions **PE 0603225D8Z**

(U) The ability to accurately predict the behavior of weapons in their operating environment of extreme pressure, temperature, and velocity is essential to the development of lethal, accurate, and cost effective systems. Lagrangian and Eulerian hydrocodes, coupled code systems, arbitrary Lagrangian-Eulerian (ALE) codes, and supporting materials models and constitutive relations developed at the nuclear weapons laboratories have been improved and adapted to DoD problems and transitioned to the DoD user community for use in warhead design and evaluation. This program provides prompt and direct access to the substantial investments in computational mechanics and materials modeling by the DOE and acts as the conduit for transition. Specific activities supporting the technology transition include distribution of computational tools to the DoD community, support of DOE codes on centralized DoD computing systems, training of the user community, and consulting as needed. ($ 2.410 million)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	R-1 ITEM NOMENCLATURE Joint DoD/DOE Munitions **PE 0603225D8Z**

(U) A major thrust of this program continues to be hard target defeat. Over the last four years a new concept for hard target weapons, the Monolithic Ballasted Penetrator, has been developed for high-velocity delivery that significantly increases penetration into concrete and payload volume. A 350# penetrator of this design will be able to duplicate the penetration capability of our current 5000# class penetrators. Testing was completed this year with a 2/3-scale prototype launched at 3360 fps into an oblique, layered target that is characteristic of cut-and-cover buried structures. The weapon successfully penetrated a total of 16 feet of concrete interspersed with layers of soil and void. The penetrator maintained a stable trajectory and survived with no indication of deformation or cracking. A patent was awarded on the penetrator design, and it has been selected for use in the TACMS penetrator Demonstration ACTD. An ongoing problem in hard target research has been that differences are observed in the predictions from the various penetrator design codes used by the community. Global parameters such as penetration depth are tending to converge, but differences in important details such as the maximum deceleration and trajectory remain. The results can be contradictory predictions about penetrator survival or weapon effectiveness at conditions near the design envelope. To address this issue an experimental test-bed program was initiated in FY 2000 to collect high-quality data on well-characterized targets for use in code comparisons and validation. A comprehensive series of penetration tests into concrete was completed this year that is expected to resolve questions about the effect of target strength, nose shape, penetrator scale, and penetrator velocity. Results have been distributed to the S&T community for use in benchmarking and validating the current design tools. New munitions applications such as kinetic energy projectile sabots, warhead cases, lightweight gun barrels, and artillery projectiles place several stringent demands on composite material performance. During FY2001, failure characterization of both thermoset and thermoplastic unidirectional composites under multiaxial stress states was completed. This achievement enables analysis, evaluation, and design of stronger, lighter, three-dimensional, composite components for advanced munitions. Metallography, mechanical property, and chemical and processing tests indicated last year that an Air Force identified low alloy steel had good potential as a low-cost replacement for current ultra-high-strength steels being postulated for future high-velocity penetrators. This was corroborated in subsequent studies and in FY 2001 a commercial manufacturer entered into an agreement with government researchers to pursue industrial scale development of this steel for penetrating weapons applications. In an alternative approach to hard target defeat, work continued on developing the concept of using a multiple shaped charge array as a precursor warhead to increase the penetration into concrete of a follow-through penetrator. Last year, tests conducted at China Lake verified the hypothesis that jet interactions can augment structural damage. This year, additional tests were completed against full-scale concrete targets, which demonstrated a large, but unoptimized, hole using warhead dimensions relevant to the Navy's SLAM-ER program. Relating warhead performance to material properties requires a detailed knowledge of material properties under dynamic

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	R-1 ITEM NOMENCLATURE Joint DoD/DOE Munitions **PE 0603225D8Z**

conditions and is considered a fundamental issue in computationally based design of future weapon systems. To evaluate the accuracy of the current materials models, an experimental Ta liner test-bed program was undertaken. In this study, Ta EFP liners have been fabricated to a generic design by four different process routes resulting in four well-characterized microstructures. The resulting liners are currently being loaded with high explosive and will be fired early in FY 2002 in order to soft catch the slugs and compare them to the shapes predicted by the advanced material models. ($ 3.830 million)

(U) DoD and DOE efforts toward munitions lifecycle technologies including stockpile aging, surveillance, demilitarization and disposal are coordinated under the auspices of this program. As the focus for demilitarization and disposal in DoD turns from open-burn and open-detonation to resource recycle and recovery, alternative technologies are required to turn waste materials into useful products. Last year, a process was demonstrated that utilizes waste Explosive D available from demilitarization operations to form picramide, the starting material for synthesis of the insensitive explosive TATB, a high value product for both the DoD and DOE. Since the existing inventory of Explosive D will be consumed by demilitarization activities in a matter of years, the focus of this project has shifted to include TNT as a recyclable material. Scale up of the TNT inclusive picramide to TATB process from 1kg to 10 kg in support of a Navy manufacturing technology program is underway and will be completed by the end of FY 2002. The potential for cutting explosives both bare and encased in steel has been demonstrated using a femtosecond laser. Unlike conventional cutting lasers that melt and vaporize material, the femtosecond laser ablates material with no evidence of heating. It offers unique capabilities for use in munitions demilitarization and manufacture. A dedicated femtosecond laser has been built in conjunction with a small blast chamber for use in scoping experiments. Several experiments were performed to determine cutting depths in different explosives and work continued towards an FY 2003 full scale, live munition demonstration of the laser cutting technology in a 10-kg explosive tank. To provide automated remote capability for munition demilitarization activities, a robotic workcell for disassembling 155-mm projectiles was designed and assembled. High-level software was written for remote disassembly of artillery shells to expose the submunition layers for handling and safing. This year, the capability to disassemble the M483A1 rounds containing 88 bomblets was successfully demonstrated. Age-related degradation of materials within high value weapon systems is studied in order to understand and predict changes in munition safety, performance, and reliability during long term storage. Predictive models for materials and system aging are under development with a focus on solder interconnect reliability, corrosion of electronics with an emphasis on plastic encapsulated microcircuits, the aging of propellants, and the aging and fracture of adhesive joints. In the solder reliability task, physical models were exercised on several applications in an effort to validate its output against test vehicle experiments. The goal of

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	R-1 ITEM NOMENCLATURE Joint DoD/DOE Munitions **PE 0603225D8Z**

the task is to develop a computational tool that predicts the overall reliability of Sn-Pb solder interconnections of any geometry from physically-based calculations of deformation and crack damage by FY 2003. ($ 2.460 million)

(U) FY 2002 Plans:

(U) Improvement of electronic safing, arming and firing systems will continue with a focus on miniaturization, cost reduction and shock survivability for hard target penetrators. The development of a micro firing system will continue with a design goal of a further factor of 10 reduction in size over the recently demonstrated low-energy systems (and a factor of 100 over currently fielded technology). Activities will include component development and evaluation, improved system integration, and demonstration of manufacturing technologies. In support of a viable fuze industrial base, work will commence with Raymond Engineering and other suppliers on improving the manufacturing process for chip detonators and characterizing their performance. The miniature fireset project will focus work on the development of the solid dielectric break down switch. This will utilize much of the same nanolayer technology demonstrated in this year's multilayer capacitor milestone completion. An advantage of this approach is the use of lower voltage trigger circuits, thus smaller size, while maintaining reliability of operation. As low voltage fuze architectures are developed, it is anticipated that the ability to physically move or block fire train elements (e.g. micro energetic materials) will be a primary feature of out-of-line systems. In support of these architectures, the ability to integrate micro energetic materials with MEMS devices will become a crucial technology. Accordingly, in FY 2002 processes to preferentially load or coat simple MEMS structures with film energetic materials will be investigated. The testing program initiated last year to evaluate the long-term performance and reliability of chip slappers in realistic military environments will be continued. Toward the program goal of demonstrating a prototype ESAD in a high-velocity penetrator in FY 2003, characterization of detonators, capacitors, switches, etc. in shock environments for application to hard target munitions will be completed. Design issues causing current oscillations in multipoint detonator arrays utilizing low-energy chip slapper detonators will be resolved and improved design principals will be developed. Preparations will commence for the large multipoint array demonstrations scheduled for FY 2003 and transition of the technology to DoD contractors will begin. Support and development of the knowledge base tool for preservation of advanced initiation technology will be continued with an expanded scope to include other fireset components beyond detonators. A new initiative to focus and apply mature microfuze technology towards expanded and enhanced Special Operations Forces (SOF) warfighting capabilities will be started. ($ 3.949 million)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	R-1 ITEM NOMENCLATURE Joint DoD/DOE Munitions **PE 0603225D8Z**

(U) Work in energetic materials will be aligned with the recommendations from the DoD 2000 Weapons Technology Area Review and Assessment (TARA) and, in particular, will be coordinated with the recently established national initiative in advanced energetic materials. Concern from the DoD 2000 Weapons TARA regarding the need to maintain weapon lethality as weapon and platform size decrease will continue to be addressed in efforts to synthesize, characterize and scale-up new energetic materials with increased or tailored performance and decreased sensitivity. The development and characterization of new insensitive and new high-energy, high power materials will continue with synthesis based on theoretical molecular design. Efforts to crystallize the new high energy molecule, LLM-121, in its pure form will continue. Efforts sponsored under this program will continue to exploit opportunities in nano-energetics by developing nano-structured and engineered energetic materials, including sol-gel derived materials, and evaluating their effectiveness and utility for warhead applications. With the completion of the LLM-105 synthesis and scale-up work, efforts will focus on formulation for evaluation and eventual qualification as a Navy booster material. The creation of new HEDMs will continue, along with the development and implementation of accurate techniques for determining crystal structure and energy content of the newly synthesized materials. With the installation of a special press in FY 2001 designed to produce sample sizes of 100mm3, the feasibility of bulk synthesis on CO-derived and nitrogen HEDMs will be demonstrated and initial measurements of their energy content with larger sample sizes will be completed. The synthesis of additional extended solid HEDMs will also be explored. With the release of Cheetah 3.0, the emphasis in Cheetah development will turn towards implementing more sophisticated kinetic models into the code that account for differences in explosive microstructure including explosive particle morphology and towards generating more accurate equations of state for detonation products. To support this work, a new impulsive stimulated light scattering spectrometer will be used to conduct measurements in a diamond anvil cell to monitor the onset of chemical reactivity at extreme conditions with great accuracy. Efforts to develop and validate computational tools for predicting munition system response to operational threat and accident environments will continue. The first generation of simulation tools for munitions response to accident environments will be exercised against test data to validate the codes and expand their ability to predict weapon system performance and response in accident situations. The joint experimental program with Navy to measure the violence of reaction in cookoff accidents will be expanded to testing and analyses of a full weapon systems. Experiments to determine mechanical property of both fielded high explosives and their constituents will continue for development and validation of high explosive mechanical response models. ($ 5.687 million)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	R-1 ITEM NOMENCLATURE Joint DoD/DOE Munitions **PE 0603225D8Z**

(U) The development of Eulerian, Lagrangian, coupled and ALE codes relevant to the design and evaluation of munitions will continue. Efforts will continue in the development, implementation and validation of material constitutive and failure models supporting the simulation of warhead formation and warhead/target interactions. The program also provides a conduit to the improved materials models emerging from the DOE Advanced Strategic Computing Initiative providing high resolution, accurate predictions of materials behavior and failure relevant to the analyses of weapon systems. The transition and support of these tools and models along with user training will be provided as needed.($ 2.553 million)

(U) Design improvements for hard target penetrators will be explored that add penetration capability and survivability and increase payload volume. Work on the Monolithic Ballasted Penetrator concept will be completed. Analysis of data from the final prototype test performed late in FY 2001 will be evaluated, an industrial supplier will be developed, and the technology transitioned to the TACMS Penetrator Demonstration ACTD. Efforts to resolve differences between various computational models and design tools will continue. Data from the extensive set of penetration experiments into concrete completed in FY 2001 will be used to benchmark and validate current codes. A miniaturized 3-axis accelerometer and data recorder that is able to survive high velocity hard target penetration events will be developed. This new diagnostic will support continued studies of oblique penetration and code validation and benchmarking of tools used to predict lateral loading of the penetrator and its components. Advanced materials will be evaluated for high-velocity applications. A large suite of experiments will be undertaken jointly with Air Force and National Forge Company, a supplier of current penetrator bombs, to study a low-alloy steel that holds promise as a low-cost replacement for the ultra-high-strength steels postulated for future high-velocity penetrators. These experiments and subsequent mechanical property tests will define heat-treat schedules necessary to harden the alloy and maximize its strength and toughness. The composites work will shift attention to understanding the failure of metal matrix composite materials in support of stronger and lighter military systems. A new project will be initiated to develop the underlying technologies needed for a Low Collateral Damage Munition which will provide an enhanced alternative to the use of inert munitions against soft targets in urban areas. The initial effort will focus on the development and characterization of a new explosive material with increased near-field impulse. ($ 4.136 million)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	R-1 ITEM NOMENCLATURE Joint DoD/DOE Munitions **PE 0603225D8Z**

(U) The demonstrated small scale process to convert Explosive D and TNT to TATB will be scaled up from 1kg to 10 kg in collaboration with Mason and Hangar, Amarillo, Texas, in support of an ongoing Navy manufacturing technology program. Exploitation of femtosecond laser cutting and machining of explosives for both munitions demilitarization and manufacturing will continue. The emphasis this year will be on the use of the 10-kg explosive tank for large scale laser cutting in preparation for demonstrations on live munitions in FY 2003. Determination of optimum cutting parameters, safety limits, and geometry limits for munitions related materials and high explosives will be completed. Work on the robotic workcell will focus on adapting the system to the disassembly of Adam mine rounds and completing the vision and control algorithms, as well as the associated hardware, necessary to demonstrate completely automated disassembly of a cluster munition with safing of the individual submunitions by FY 2003. The development of materials and system aging models with a focus on predicting the reliability of solder interconnects, plastic encapsulated microcircuits, propellants, and adhesive joints will be continued. A new project will be initiated to characterize the particle emissions generated from open burn/open detonation (OB/OD) events. The result of the work will be an instrument which can satisfy present and future anticipated regulatory requirements on particle emissions from OB/OD events. Laboratory experiments will be performed to generate particle signatures anticipated in larger scale events. Open air detonation experiments will be conducted in support of sensor development and testing. ($ 2.657 million)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	R-1 ITEM NOMENCLATURE Joint DoD/DOE Munitions **PE 0603225D8Z**

(U) **FY 2003 Plans:**

(U) Continue the development and demonstration of improved components and architectures for robust, low-cost, miniature safing, arming and firing systems. Continue component development and evaluation and explore commercial sources for manufacturing. Demonstrate an integrated capacitor and switch in a single package for use as a next generation microfuze component. Apply and focus current state of the art micro-fuze technology to the Special Operations Forces (SOF) arena in order to enhance and expand SOF capabilities in various mission scenarios. Transition latest miniaturization technology to production-type facilities and to the services in order to begin exploitation. Complete the study to understand instabilities in multiple-slapper, highly miniaturized systems to permit design of highly reliable and uniquely flexible ordnance. Perform experiments and begin to develop the theory and models of microdetonics, the explosive behavior in very small geometry. Continue to work with services in areas of landmine alternatives, multi-mode and multi-mission munitions, integrated logic/fireset functions, and innovative solutions. In FY 2003 and beyond, booster materials resulting from new formulations and the sol-gel process will be characterized and performance tested. In the miniature fireset area, the voltage capability of the solid state dielectric switches will be improved and performance of the high voltage photocell will be enhanced in order to reduce volume, improve light coupling efficiency, and increased charging current. ($ 5.922 million)

(U) Continue efforts to synthesize, characterize and scale-up new energetic materials with increased or tailored performance and decreased sensitivity. Complete development and qualification of an LLM-105 booster explosive. Complete sol-gel metal oxides research and focus on applications development. Complete energy and performance measurements of bulk synthesized CO-derived and nitrogen HEDM's. Explore the synthesis of additional extended solid HEDMs. Continue the development and maintenance of the Cheetah thermochemical code for performance predictions of energetic materials, and provide user support to the DoD community. Complete development of ignition phenomenology model and design of ignition location experiments in support of the effort to validate and expand codes for predicting weapon system performance and response in accident situations. Continue the joint experimental program with Navy to measure the violence of reaction in cookoff accidents for full weapon systems. Continue to populate the explosives databases HEAT1 and APEX to ensure archival retention of critical energetic materials knowledge and transition of the technology. Continue energetic material development in support of Low Collateral Damage Munition and expand SOF focused microfuze technology activities. ($ 7.962 million)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	R-1 ITEM NOMENCLATURE Joint DoD/DOE Munitions **PE 0603225D8Z**

(U) Continue to develop, extend and apply the hydrocodes and associated materials models for warhead design and evaluation. Ongoing code and material model development will continue to focus on greater accuracy, improved physics, and extension to a broader class of real-world problems. Continue to support the transition of these tools, the training and consulting for the DoD user community. ($ 2.807 million)

(U) Continue the study of advanced hard target penetrator concepts and adapt designs to state-of-the-art materials and manufacturing methods. Investigate fabrication processes for the new Air Force low-cost penetrator steel, including weldability and melt processes to optimize properties and castability. Complete the experimental hard target test-bed program by conducting instrumented penetration tests on well-characterized concrete targets using the new miniaturized 3-axis data recorder to gather the data necessary for code validation. The focus will be on obtaining data that reveals the dynamic rotations of the penetrator during entry and the resulting trajectory. The data will be provided to the DoD community for use in validating and benchmarking hard target design tools. Accelerate the development and integration of the computational, explosive, penetration, and composite material technologies required for an enhanced alternative to the use of inert munitions against soft targets in urban areas. Conclude study on the texture effect on a shaped charge jets and evaluate the technique for application to next generation warhead concepts. Complete temperature measurements of shocked materials and provide results to the DoD community for model validation and warhead design. Continue the science-based technology projects relating warhead performance to material properties under dynamic conditions as a prelude to improved computational modeling and the transition of improved warhead designs to developmental and fielded weapon systems. Complete the simulations of the Ta liner test-bed experiments and assess the utility of the new materials models. Continue the development of advanced aimable warheads exploiting the individually controlled, distributed micro-firesets under development in the advanced initiation task.($ 5.541 million)

(U) Demonstrate femtosecond laser technology for demilitarization using live munitions. Begin mid-scale testing of sensors that can detect particle emissions in explosive events. Use small and mid-scale sensor test results to generate a data base and analysis tools for standoff identification and specification of particles generated in detonation events. Initiate efforts to correlate remotely detected gas-phase emissions during detonation events to military damage objectives for Bomb Damage Assessment (BDA). ($ 3.188 million)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	R-1 ITEM NOMENCLATURE Joint DoD/DOE Munitions **PE 0603225D8Z**

(U) B. Program Change Summary	FY 2001	FY 2002	FY 2003	Total Cost
Previous President's Budget Submission	16.670	16.785	15.675	Continuing
Delta	-0.154	2.393	0.000	
FY 2002 Amended President's Budget Submission	16.516	19.178	15.675	Continuing
Appropriated Value	16.670	19.178	0.000	
Adjustments to Appropriated Value				
a. Congressionally Directed Undistributed Reduction	0.000	-0.196	0.000	
b. Rescission/Below-threshold Reprogramming, Inflation Adjustment	-0.154	0.000	0.000	
c. Other	0.000	0.000	9.745	
Current FY 2003 Budget Submission	16.516	18.982	25.420	Continuing

Change Summary Explanation:

(U) **Funding**: FY 2001 reductions reflect Section 8086 adjustments. FY 2002 and FY2003 increases reflect programmatic adjustments.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2002
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense Wide/BA 3	R-1 ITEM NOMENCLATURE Joint DoD/DOE Munitions **PE 0603225D8Z**

(U) **Schedule**: N/A

(U) **Technical**: N/A

(U) **C.** **Other Program Funding Summary Cost**: N/A

(U) **D.** **Acquisition Strategy**: N/A

(U) **E.** **Schedule Profile**: N/A