OSD RDT&E BUDGET ITEM JUSTIFICATION (R2 Exhibit)

February 2008

APPROPRIATION/ BUDGET ACTIVITY	PE NUMBER AND TITLE
RDTE, Defense Wide BA 03	**0603225D8Z - Joint DOD/DOE Munitions**

COST ($ in Millions)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
P225 Joint DOD/DOE Munitions	22.449	23.284	23.727	23.701	23.823	24.141	24.481

A. Mission Description and Budget Item Justification: (U) The mission of the Joint DoD/Department of Energy (DOE) Munitions Technology Development Program (JMP) is to develop advanced technologies needed to meet warfighting needs and bring about major improvements in non-nuclear munitions. A Memorandum of Understanding (MOU) between DoD and DOE provides the basis for the long-term commitment to this effort. Under the auspices of the JMP, the fusion of DOE technologies with Joint Services needs has provided major advances in warfighting capabilities for many years and continues to play a crucial role in the exploration, development, and transition of new technologies needed by the Services. The JMP is aligned with Department strategic plans such as the 2006 Quadrennial Defense Review (QDR) and is developing needed munitions capabilities and modeling tools for urban combat and counter-terrorism efforts. The JMP provides a proven and successful mechanism for the collaboration of DoD and DOE scientists and engineers so they can develop technologies of interest to both Departments, within a structured framework of technical reviews and scheduled milestones. The JMP has strong support from the Services through the leadership by DoD lab managers and technical experts of JMP technical activities and in collaborations on the transition of new capabilities to industry. This interdepartmental cooperation makes use of the substantial historic investment in scientific resources by the DOE, and the budgeted JMP funds represented in this justification are supplemented by matching DOE funds.

(U) A summary of recent JMP accomplishments and transitions is provided below; detailed technical plans, reports, and presentations are also available. Endorsements from DoD labs indicate a strong history of JMP accomplishments and significant Return On Investment (ROI). The Army's Picatinny Arsenal has stated that modeling and simulation (M&S) tools developed by the JMP are now routinely used to design all new warheads, and the use of these tools has reduced the number of validation tests required for each new warhead from about 5 to 1, resulting in substantial savings. The Army also estimated about a one-year reduction in design time for two warheads (Medium Range Munitions and Joint Common Missile), and cost savings of more than $3M. Compared to recent JMP investments in these M&S tools, an ROI of about 3 can be estimated for these warheads alone, and the tools continue to be used.

(U) Over the last several years, there has been increased emphasis on developing technologies of value to counter-terrorism efforts and Military Operations in Urban Terrain (MOUT). Initial successes have already emerged from this JMP focus, with some products already in the field. A new and rapidly emerging JMP technology which employs Multiphase Blast Explosives (MBX) will enable the use of precision lethality munitions in urban settings with minimal collateral damage. Based on modeling and technologies developed by the JMP, preliminary tests of MBX integrated in a composite case successfully destroyed Rocket Propelled Grenades (RPGs) in-flight with minimum collateral damage. In a related activity, the Air Force and the Navy are pursuing a Joint Capability demonstration Program (JCTD) to incorporate MBX technology into the Small Diameter Bomb.

(U) Other JMP transitions include four special-purpose shaped charge munition designs which are now deployed by the Special Operations Command (SOCOM) for Weapons of Mass Destruction (WMD)-defeat in Global War on Terror (GWOT) applications. Also, the Army's Multi-Role Armament & Ammunition System (MRAAS) compact multi-purpose shaped charge warhead was developed by the JMP and exceeds the performance of the Javelin warhead while being 24% smaller in diameter and 41% shorter in length. In addition, modeling and metallurgical technology for rhenium materials needed for the Standard Missle-3 (SM-3) Solid Divert and Attitude Control System (SDACS) was transitioned to the Naval Surface Warfare Center (NSWC)-Dahlgren to resolve a critical system problem. Cheetah, an advanced themochemical predictive code, developed with JMP funds, reached a milestone with the recent release of version four. This code is used by over 300 DoD and DOE scientific and engineering staff to study and select energetic materials for modern munitions. Further, all new fuze designs being developed by DoD and DOE utilize technologies such as highly compact capacitors, transformers, and

sensors developed by the JMP. In addition, state-of-the-art robotic and machine vision discrimination technologies are being successfully applied to munitions demilitarization programs and are being prototyped on several systems. Finally, a major accomplishment was achieved with JMP support in Synthetic Aperture Radar (SAR) technology for guidance and targeting applications. A new prototype "mini-SAR" was designed and built which is both five times lighter and less expensive than the baseline, with no degradation in image quality or resolution. This mini-SAR system was successfully flight-tested in an Unmanned Aerial Vehicle (UAV) and is now being transitioned to industry.

(U) Some technologies being developed by the JMP have been transitioned to other agencies such as NASA, which is using the Laser Dynamic Range Imager to inspect critical underwing areas of the space shuttle while in-flight. This technology was developed by the JMP for munitions guidance applications, but has now been deployed by NASA on all shuttle flights. Pictures from the imager resulted in an unprecedented space walk to repair critical damaged surfaces during the recent Space Transportation System (STS)-114 flight of the Discovery. The imager is considered to be critical equipment by NASA for the safety of the shuttle, and flights are not launched unless it is operational.

(U) The integrated DoD and DOE efforts within the JMP are speeding the realization of new technologies through the advanced development process. The highly challenging technical objectives of the approximately 50 JMP projects require multi-year efforts, and sustained, long-term investments are necessary to achieve success. The JMP is a focal point for collaborative work by over 200 DoD and DOE scientists and engineers, and has been called a model of how the Departments should cooperate, both within their respective organizations (intradepartmental) and with each other (interdepartmental). The JMP also works aggressively, through the Defense Ordnance Technology Consortium (DOTC), to inform industry of the technologies and tools being developed so that they can be transitioned equitably and efficiently for use by our warfighters as quickly as possible.

(U) Projects in the JMP are organized in five munitions technology focus areas. They are: Initiation, Fuzing, and Sensors; Energetic Materials; Computational Mechanics and Material Modeling; Warhead & Penetration Technology; and Munitions Lifecycle Technologies. These focus areas are described more fully in the accompanying R2a project exhibit.

B. Program Change Summary	FY 2007	FY 2008	FY 2009
Previous President's Budget (FY 2008)	22.765	23.488	23.773
Current BES/President's Budget (FY 2009)	22.449	23.284	23.727
Total Adjustments	-0.316	-0.204	-0.046
Congressional Program Reductions		-0.204	
Congressional Rescissions			
Congressional Increases			
Reprogrammings			
SBIR/STTR Transfer	-0.460		
Other	0.144		-0.046

Change Summary Explanation: In FY 2007, GWOT supplemental funding ($0.144 million) has been displayed although it is actually for PE 0305125D8Z.

C. Other Program Funding Summary Not applicable for this item.

D. Acquisition Strategy Not applicable for this item.

E. Performance Metrics: Not Applicable.

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APPROPRIATION/ BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
RDTE, Defense Wide BA 03	**0603225D8Z - Joint DOD/DOE Munitions**	**P225**

COST ($ in Millions)	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate
P225 Joint DOD/DOE Munitions	22.449	23.284	23.727	23.701	23.823	24.141	24.481

A. Mission Description and Budget Item Justification: (U) The Joint DoD/DOE Munitions Technology Development Program (JMP) is a collaborative, jointly-funded effort between DoD and Department of Energy (DOE), which has the mission to develop new and innovative warhead, explosive, initiation, and lifecycle technologies, as well as enabling tools, in order to bring about major improvements in non-nuclear munitions. The JMP supports the development and exploration of advanced munitions concepts and enabling technologies which precede system engineering. Through a Memorandum of Understanding (MOU) arrangement with DOE, DoD resources are evenly matched. More importantly, this relatively small DoD contribution effectively taps the annual multi-billion dollar DOE Research, Development, Test, and Evaluation (RDT&E) investments by accessing technical experts with highly specialized skills, advanced scientific equipment, unique facilities, and computational tools not available within DoD. These efforts take advantage of the extensive and highly developed technology base resident in the DOE national laboratories relevant to achieving the JMP goals of developing capable, cost-effective, conventional munitions.

(U) The JMP is further integrated with Service efforts through participation in the Defense Technology Area Plan (DTAP) for conventional weapons. The JMP has also been reviewed under the DoD's Technology Area Review and Assessment (TARA) process. After reviewing the JMP, a recent Weapons TARA panel assessed the JMP as follows: broad range of products transitioned to DoD as a result of JMP efforts; effectively leverages DOE expertise and funding; critical computational tools provided to DoD; well integrated into Service efforts; Technology Coordinating Groups (TCGs) provide an effective forum for technical collaborations.

(U) The JMP currently supports about 50 projects which can be summarized in five technical focus areas: Initiation, Fuzing, and Sensors; Energetic Materials; Computational Mechanics and Material Modeling; Warhead and Penetration Technology; and Munitions Lifecycle Technologies. The JMP is administered and monitored by the Office of the Secretary of Defense (OSD), and reviewed annually by the Technical Advisory Committee (TAC) composed of over 25 senior executives from the Army, Navy, Air Force, Special Operations Command, the Defense Threat Reduction Agency (DTRA), OSD, and DOE. Projects are organized in ten Technology Coordinating Groups (TCGs) in order to bring together the disciplines necessary to properly evaluate technical content and progress. DoD Service laboratory technical experts lead each of the Technology Coordinating Groups to ensure that the technologies under development address high priority DoD needs; they also coordinate the semi-annual technical peer-review process.

(U) Please see the corresponding R2 exhibit for additional JMP background information and accomplishments. More details about each of the technical focus areas are described below in the Accomplishments/Planned Program sections.

B. Accomplishments/Planned Program:

Accomplishments/Planned Program Title:	FY 2007	FY 2008	FY 2009
Joint DOD/DOE Munitions / Initiators, Fuzes, and Sensors	4.368	4.443	4.138

Initiators, fuzes, and sensors are critical components in every munition system. These components must work together to ensure personnel safety by preventing unintended weapon detonation, allow

arming of a firing mechanism, detect the target through the use of sensors, and initiate detonation when required. With the increasing need for robust, hard-target-defeat capability, advanced fuze systems must be able to survive and function in increasingly higher-velocity and higher-G penetration environments. Methods for these sub-systems to survive high-G environments include the miniaturization, integration, and/or robust packaging of conventional fuze components such as detonators, switches, transformers, capacitors, sensors, and advanced batteries. In support of this technology area, the Joint DoD/DOE Munitions Program (JMP) continues to demonstrate advances in miniaturizing high-voltage Electronic Safe and Arm Devices (ESAD), through research and development of low-energy detonator/booster combinations, and with miniature Capacitive Discharge Units (CDUs). This focus builds on recent advances in micro-detonic/energetic materials research and MicroElectroMechanical Systems (MEMS) device development. Efforts in this portion of the JMP generally advance fuze technology and ultimately provide the DoD and DOE with next generation fuzing components for all weapons, particularly hard-target-defeat munitions (penetrators), and small, intelligent low-cost applications (artillery). Advanced initiation technology is an enabler for the next generation of warheads that can be aimed, are target adaptable, and extremely robust.

FY 2007 Accomplishments: Include advancement of inexpensive ink jet printing techniques to deposit energetic materials onto Micro-Electro-Mechanical System (MEMS) devices. Further, the first set of DoD detonators were fired utilizing High Speed Laser Schlieren Movie diagnostics. This new diagnostic allows extremely short exposure times (5 ns) and complete blockage of the explosive self-light to allow observation even during explosive breakout. In the field of multipoint initiation, advances were made to the FireMod initiation simulation code through inclusion of a physics-based resistivity model. The Miniature-Synthetic Aperture Radar (MiniSAR) technology was developed with reduced size and cost (both by a factor of 5), and a prototype was successfully tested. MiniSAR is being transitioned to the commercial sector. This technology transfer will provide the DoD an extremely robust, all-weather surveillance capability for small UAVs at an affordable price. Finally, the Laser Dynamic Range Imager was successfully transitioned to NASA for use on Space Shuttle flights.

FY 2008/2009 Plans: In this focus area include the further exploration of the effects of firing slappers at the low inductances associated with miniature firing systems, and this slapper and firing systems technology will feed into an integrated fireset demonstration. A "hard-science" question associated with miniature munitions is the transfer of detonation from a miniature detonator into the main charge explosive. This could dramatically affect the performance of a small munition. We will continue to study microdetonics, which refers to detonation initiation, acceleration (buildup), and curvature effects in small explosive systems. We plan to conduct numerous small-scale tests to determine the performance of insensitive high explosives of interest. The other portion of the microdetonics effort is to develop the diagnostics for characterizing detonator/booster explosive behaviors and a design code that will make effective use of the microdetonics data for miniature munitions design. We have multiple tasks associated with a sophisticated experiment to explore initiation sources. We will produce capacitors using the cluster tool (developed perviously by the JMP) baseline processes with enhancements for evaluation in weapons applications. For the mini-SAR development project, existing circuits will be migrated/converted to single Complementary Metal-Oxide Semiconductor (CMOS) Applicattion-Specific Integrated Circuits (ASIC). In addition, 10- and 20-W solid state power amplifiers using gallium nitride (GaN) monolithic integrated circuits will be designed and developed. Finally, the project focused on developing innovative technologies for advanced thermal batteries will proceed to full electrochemical cell fabrication and testing. Over the next five years, this portion of the JMP will work toward demonstrating emerging technologies that support robust, intelligent fuzing that can survive and function in environments exceeding 30,000 G's.

Accomplishments/Planned Program Title:	FY 2007	FY 2008	FY 2009
Joint DOD/DOE Munitions / Energetic Materials	5.533	5.703	5.823

The energetic materials (EM) focus area is aimed at developing the next-generation of EMs that have increased energy density over those in the current inventory, while attempting to provide enhanced insensitivity to extreme environments. There is a need to develop EMs that, when integrated into munitions, offer advantages of enhanced lethality against a variety of targets. Lighter and/or less bulky munitions significantly reduce the logistics burden of military actions and are also highly desirable. Similarly, a decrease in hazard classification brought about by the use of insensitive energetic materials and better designs will greatly decrease transportation and storage costs. Smarter munitions, capable of selectable, differential output, are another advantage to military agility. Hence, there is also a need for advanced EMs that can be used in small-scale devices such as distributed fuzing systems. In addition, as the operational environments have become more severe, EMs must survive setback forces in guns and severe impact forces in hard-target penetration applications. For enhanced lethality effects, the energy in EMs must be released either in the detonation reaction zone, or early enough in the gas expansion process so that it couples to impulse loading or sustains high temperatures. Increased lethality of EMs and munitions while simultaneously reducing collateral damage is of critical importance. Enhanced lethality requires that the energy be released in an appropriate time domain to allow optimized coupling to the target.

Material ingredients that contribute to later energy release offer no enhancement in lethality. For microdevices suitable for distributed fuzing systems, the requirement on energy release is very exacting in order to sustain reaction propagation in environments with extensive shock and heating losses. Like advanced initiation, advanced energetic materials are an enabling technology for the next generation of weapon systems that will be safer, smaller, and more lethal.

FY 2007 Accomplishments: Include the observation of detonation in a deposited microenergetic film of PETN. Also, a new thermo-mechanical model was implemented in the Adagio code, and the interaction effects between RDX and decomposition products of TAGzT were identified. This may explain TAGzT's effect on RDX burning rate. Further, imaging of convective burns by proton radiography in PBX 9501 was demonstrated for the first time. An optimized procedure for preparation of TAGzT, GUzT and BTATz was transitioned to the Navy. Additional major accomplishments include the identification of a previously unknown superionic state of water. Also, a novel molecular beam mass spectrometry apparatus was successfully calibrated for inert and energetic material samples. Further, an updated version (#5) of Cheetah, a thermochemical detonation simulation code widely used in the U.S, was released to the DoD for making enhanced performance predictions for an extended set of energetic materials. Finally, samples of lead-free iron (II) and copper (II) primary complexes were delivered to DoD, industry, and NASA for characterization.

FY 2008/2009 Plans: For EM work include continued development of nanoscale, microscale, and mesoscale energetic materials with enhanced performance which are less sensitive and more cost effective enablers for defense transformation. Specific activities will include the investigation of reaction mechanisms and kinetic parameters for the thermal decomposition of selected energetic materials such as HMX and RDX. Computer codes for modeling cook-off behavior with coupled thermal/mechanical response will also be developed. Specifically, numerical methodologies to deal with the flow of energetic materials within confined volumes are being addressed, and fracture and fragmentation models are being integrated with the multi-physics code ALE-3D to allow estimation of fragment sizes and velocities. Technology will be investigated for producing nanoenergetic explosives based on the formation of fine particles from supercritical solutions. Burn rates are being measured for pristine and damaged materials based on RDX, HMX, and TNT (alone or in combination with each other and other ingredients), and the basic thermal and mechanical properties of the explosives are being measured as needed if they are not available in the literature. The development and characterization of an LLM-105 booster composition will continue.

Accomplishments/Planned Program Title:	FY 2007	FY 2008	FY 2009
Joint DOD/DOE Munitions / Computational Mechanics and Material Modeling	6.678	6.831	7.013

In the area of Computational Mechanics and Material Modeling, the JMP is developing the ability to accurately predict the behavior of weapons in operating environments of extreme pressure, temperature, and velocity. This capability is essential to the development of lethal, accurate, and cost effective systems. To meet the needs of the DoD and DOE communities, there is a requirement for validated models using high-performance computing hardware and software that are capable of carrying out a broad class of continuum mechanics simulations where shock waves, nonlinear dynamics, and multi-materials gas dynamics are important. In particular, this aspect of the JMP focuses on numerical and algorithmic improvements to enhance our problem-solving capabilities for munitions development, advanced energetics, and target lethality predictions with significantly improved material models that accurately represent the materials of interest in dynamic states.

Three general classes of modeling codes offer solutions to the varied requirements posed by the defense community for the shock analysis regime. Eulerian shock physics tools are effective for a large number of conventional weapons and advanced energetics-related simulations. In situations where there is significant material deformation and turbulent mixing, Eulerian formulations are the most efficient. A second class of codes addresses the large, nonlinear dynamics that can be important for weapons design and development. Such Lagrangian calculations provide design information that complements information provided by the Eulerian shock physics codes. For example, many penetration problems involve detailed structural mechanics that are not appropriate for Eulerian codes but can be addressed by Lagrangian methods. A third class of tools combines these capabilities by using Arbitrary Lagrangian-Eulerian (ALE) algorithms to solve the conservation equations appropriate for shock analysis. This class of codes performs a range of simulations such as penetration mechanics, thermal cook-off, and fragment impact, where multi-physics phenomena descriptions are required across a wide range of time scales that cannot be addressed adequately with either Eulerian or Lagrangian codes. These ALE codes and associated validated material models represent the future in modeling complex dynamics encountered in a broad spectrum of applications across the defense community. To date, the Department's utilization of these capabilities has primarily been in the Science and Technology (S&T) community. It is desirable to extend the use of modeling and simulation tools into the engineering design community, and the JMP will pursue this objective and continue to provide and enhance these advanced modeling tools.

FY 2007 Accomplishments: Include new code releases (ALE3D and CTH-PRESTO) for Alpha Tests under the DoD's High Perforamnce Computing Modernization Office (HPCMO) Multiphase Flow, Target Response (MFT) Portfolio. The development of Eulerian, Lagrangian, and ALE codes relevant to the design and evaluation of munitions continued. CTH, a workhorse shock physics code developed by the JMP, is used everywhere from desktop PC's to massively parallel High Performance Computing (HPC) centers across the community. It is the number 1 "go-to" hydrocode for the weapons community, and has been instrumental in the development of a number of DoD weapon systems. CTH continues to be improved and made available to both Departments. Development also continued on the improvement and demonstration of ALE3D, a multi-physics code. Significant progress was made on modeling system level responses, blast loading of structures, and multiphase flow. ALE3D was shown to model slow cook-off experiments with high fidelity, and is now being used to model fast (laser) cookoff experiments. Progress was made in the development of a formalism for treating anisotropic plasticity. The implementation of this formalism in ALE3D has been extended to include dynamic evolution of the yield surface and rate-dependent hardening. The importance of anisotropy to various systems is being evaluated by inserting values of anisotropies in simulations and assessing the significance of the event. The JMP also provides a conduit into the DoD for the improved materials models emerging from the DOE Advanced Simulation and Computing Program (ASC), providing high resolution, accurate predictions of materials behavior and failure relevant to the analyses of weapon systems. The transition and support for these tools and models, along with user training, were provided to the DoD community.

FY 2008/2009 Plans: Includes the continued development, extension, and application of the hydrocodes and associated materials models to warhead and explosives design and evaluation. Ongoing code and material model development will focus on greater accuracy, improved physics, and extension to mixed phase flow problems. The JMP will continue to support the transition of these tools as well as the training of, and consulting for, the DoD user community. New material models will be migrated into CTH. A new task for non-shock initiation of energetic materials has been established to support the broader evaluation of hazards. This task is well aligned with, and supports a new project on, munitions impact response analysis. SIERRA, a new simulation concept for integrating individual physics codes together into a single application is under development and promises to reduce the time needed to apply models to new physical situations. A new emphasis has been placed on improving the multi-phase flow modeling capability in CTH. Numerical methods, e.g. meshless methods, are being developed to overcome deficiencies in hydrocodes to maintain numerical stability and predict damage softening, localization, and failure. These numerical methods will then be incorporated into hydrocodes across DOE and DoD.

Accomplishments/Planned Program Title:	FY 2007	FY 2008	FY 2009
Joint DOD/DOE Munitions / Warhead and Penetration Technology	3.768	3.943	4.088

In the warhead and penetration technology thrust, a major activity continues to be design and development of technologies and warheads for hard-target-defeat. As hard-target weapons evolve, several technical issues need to be addressed, including penetrators, fuzing, and simulation tools, along with associated validation data. Hardened military facilities are being buried in layered earth and concrete, "cut and cover" constructions, tunneled into mountainsides, or mined into rock far beneath the earth's surface. Buried structures accounted for a significant number of targets attacked by our forces during the Gulf, Afghanistan, and Iraq wars, and much of our military planning is being devoted to defeating them. Thus, a major thrust of the JMP continues to be hard-target-defeat. As hard-target weapons evolve, several technical issues need to be addressed. Specifically, penetrators striking targets with obliquity or at high angles of attack experience violent dynamic responses that can cause their cases to fail or interfere with the functionality of fuzes. Similarly, oblique, low velocity target impacts can result in ricochet, undesirable shallow trajectories, or bouncing out of the target. In general, new delivery vehicles tend to be smaller and faster, requiring smaller penetrators that carry less payload, and must survive more stressing impacts. Developing improved penetrating weapons depends on a solid understanding of the physics of penetration as well as affordable materials and processes to execute new designs that require more strength and durability from the penetrator. Although we can predict penetration depth with acceptable confidence, there are some targets for which we have insufficient data and experience; consequently, predicting the path a penetrator will take and whether it will survive is much less certain. The JMP provides a fundamental penetration technology base that addresses many of these issues and enables our future strike weapons. Additionally, warhead concepts which greatly extend the current range of capabilities in speed and tailored target effects are being explored. With increasing emphasis and interest in defeating targets of military interest in civilian areas, and of defeating and neutralizing Weapons of Mass Destruction (WMD) facilities, the application of energy to targets must be thoroughly controlled and understood. This requirement places increased demands on warhead output and is being pursued under the JMP.

FY 2007 Accomplishments: Include obtaining and analyzing calorimetry data which indicates that fast deflagration releases less than 10% of the detonation energy. Also, the shaped charge erosive initiator (SCEI) technology collaboration with ARDEC has resulted in successful demonstration against improvised explosive device (IED) surrogates. The technology was scaled up to a 66mm diameter and demonstrated to safely burn-out explosives and neutralize IEDs without explosive detonation. New multiphase blast liner materials used with fiber composite cases were shown to

provide desirable enhanced blast properties. Tailorable fragmentation technology studies are making progress, with down-selection of relevant microstructures based on practical processing criteria, and quasi-static tensile strength, fracture toughness and high-rate Hopkinson experiments being completed during FY07. The first direct numerical simulation (DNS), multi-field modeling of reactive, metal-bearing explosives was completed.

FY 2008/2009 Plans: Include continued low collateral damage weapon verification and validation testing in comparison with current best baseline munitions. The effort involves the advancement of the science of multi-phase blast explosives (MBX) integrated with composite case penetrators to yield discriminate lethality munitions. This work will include efforts to develop and integrate technology for a new generation of precision lethality munitions based on MBX technology. The goal is to develop the technology for future munitions with two key features: increased near field lethality (at the point of target engagement) and virtually zero, far field collateral damage (no fragmentation). Both of these features are critical for enabling discriminant lethality for military operations in urban terrain (MOUT) and close air support (CAS). The focus of the planned work is on understanding the science of MBX technology (material characterization, modeling and simulation, energetics, and target interaction effects), and integrating it with composite case technology for application to MBX munitions. This includes the ability to model and design warheads and munitions fracture, failure, and post-fracture behavior including fragmentation. High rate continuum modeling technology will be investigated, developed, and demonstrated to provide the capability to predict and therefore control fracture and post-fracture behavior. Studies will continue toward providing a fundamental understanding of the penetration process by conducting carefully designed experiments and analyses. Well-controlled, subscale penetration and perforation experiments are planned with clearly defined experimental variables. Penetrators will be instrumented with on-board accelerometers and data recorders to acquire high quality deceleration data for penetrator response. Data from these experiments not only provide a crucial database on the physical phenomena of the penetration process, but also provide researchers with valuable penetration data to benchmark codes and models.

Accomplishments/Planned Program Title:	FY 2007	FY 2008	FY 2009
Joint DOD/DOE Munitions / Munitions Lifecycle Technologies	2.102	2.364	2.665

Munitions lifecycle technologies, including stockpile aging, surveillance, demilitarization, and disposal, are developed under the auspices of the JMP. The Department has a large and growing inventory of conventional munitions in its demilitarization stockpile. Currently, the stockpile includes more than 400,000 tons and is expanding by about 70,000-100,000 tons per year. As the long-term focus for demilitarization and disposal within the DoD turns from open-burn (OB) and open-detonation (OD) to resource recycle and recovery, alternative technologies are required to turn waste materials into useful products. The technologies developed in this portion of the JMP enhance DoD capabilities to field safe, cost-effective processes for disposal, resource recovery, and reutilization of munitions and munitions components. For an aged weapon stockpile that has not reached end of useful life, reliability and surety may change with time because of age-related degradation of constituent materials. Existing stockpile assessment methods typically focus on addressing materials aging and reliability problems after they occur, rather than on anticipating and avoiding future problems or failure mechanisms. The predictive materials aging and reliability portion of the JMP is focused on improving our ability to understand, measure, predict, and mitigate safety and reliability problems caused by materials aging and possible degradation in weapons systems. Together with complementary demilitarization technologies, this focus provides a base of scientific knowledge and understanding that enhances the Department's ability to efficiently support the late phases of weapon lifecycle.

FY 2007 Accomplishments: Include the development of robotic technologies for disassembly of munitions which made significant progress using machine vision improvements. Two robotic demilitarization processes are being transitioned: one for Area Denial Artillery Munitions (ADAM) and Multiple Launch Rocket Systems (MLRS) grenades. Testing was completed and data complied for the elastic, plastic, and creep properties of lead-free solder, and a Unified Creep Plasticity (UCP) constitutive equation was derived to describe fatigue of soldered connections in defense electronics. Also, a detailed characterization of the MEMSCAP (company's name) Silicon on-Insulator (SOI) fabrication process was completed. Another accomplishment was development of a method to accurately and rapidly measure hydrolysis rates in ultra-thin silane films. Additional accomplishments include the completion of the comparison of the 2nd year of Long Term Dormant Storage (LTDS) data to models of critical electronic components, and electrical mounting of 18,000 LTDS electronic parts in text fixtures was accomplished. Further, the incorporation of methodology for adding alternate measures for aging data into the system models for RAM (Reliability, Assessment, and Maintainability) was implemented. Also completed was the first case-study to test a prototype of the methodology for weapons system, reliability assessment, resource allocation, as was the GROMIT software reliability assessment custom software package.

FY 2008/2009 Plans: For this thrust area include continued studies on predictive material aging of solders, including the investigation of tin wiskers, electronics corrosion, and aging of propellants and adhesives. Further development of the Bayesian approach to system reliability assessment will be conducted. The development of robotic disposal of munitions will be continued, and new

automation technologies for removing and safing sub-munitions that are automatically armed on exit from a projectile will be developed. Chemical kinetic models for combustion of TNT and RDX will be added to the extensive chemical database already existing for combustion processes. A project to develop a network of sensors for monitoring and quantifying the gaseous and particulate metallic species of environmental concern in OB/OD plumes will continue with field tests.

C. Other Program Funding Summary Not applicable for this item.

D. Acquisition Strategy Not applicable for this item.

E. Major Performers Not applicable for this item.