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SENATE

REPORT
113–211

DEPARTMENT OF DEFENSE APPROPRIATIONS BILL, 2015

JULY 17, 2014.—Ordered to be printed

Mr. DURBIN, from the Committee on Appropriations, submitted the following

REPORT

[To accompany H.R. 4870]

The Committee on Appropriations, to which was referred the bill (H.R. 4870) making appropriations for the Department of Defense for the fiscal year ending September 30, 2015, and for other purposes, reports the same with an amendment in the nature of a substitute and recommends that the bill as amended do pass.

New obligational authority

Total of bill as reported to the Senate	$542,771,568,000
Amount of 2014 appropriations	565,093,629,000
Amount of 2015 budget estimate	544,122,025,000
Amount of House allowance	563,865,320,000
Bill as recommended to Senate compared to—	
2014 appropriations	−22,322,061,000
2015 budget estimate	−1,350,457,000
House allowance	−21,093,752,000

88–673 PDF

$20,000,000 for procurement and $10,000,000 for research, development, test and evaluation.

In addition, the Under Secretary of Defense (Comptroller) is directed to continue to provide the congressional defense committees quarterly, spreadsheet-based DD Form 1416 reports for service and defense-wide accounts in titles III and IV of this act. Reports for titles III and IV shall comply with guidance specified in the explanatory statement accompanying the Department of Defense Appropriations Act, 2006. The Department shall continue to follow the limitation that prior approval reprogrammings are set at either the specified dollar threshold or 20 percent of the procurement or research, development, test and evaluation line, whichever is less. These thresholds are cumulative from the base for reprogramming value as modified by any adjustments. Therefore, if the combined value of transfers into or out of a procurement (P–1) or research, development, test and evaluation (R–1) line exceeds the identified threshold, the Secretary of Defense must submit a prior approval reprogramming to the congressional defense committees. In addition, guidelines on the application of prior approval reprogramming procedures for congressional special interest items are established elsewhere in this statement.

PROCUREMENT OVERVIEW

Physical Access Control Systems.—The Committee is concerned with the challenges the Department of Defense continues to face with the efficacy of their physical access control systems that should prevent unauthorized access to Department of Defense installations. The Department of Defense continues to develop and deploy incompatible programs and systems. These solutions increase costs and often fail to meet existing requirements. Commercially available physical access control systems address these shortfalls in that they are affordable, meet Department of Defense requirements, and do not have a significant sustainment cost. Therefore, the Secretaries of the Army, Navy, and Air Force shall perform a business case analysis that examines the development, procurement, and sustainment cost of existing physical access control systems compared to the cost of physical access control systems available commercially. The Secretaries shall provide a report to the congressional defense committees summarizing the outcome of this business case analysis and actions they plan to take to implement the most affordable solution no later than 180 days after enactment of this act.

Rocket Motor Industrial Base.—The Committee is concerned that the domestic industrial base for tactical solid rocket motors continues to be impacted by constrained budgets, the use of foreign vendors, and a lack of competition. For example, a foreign supplier began development and qualification for a new rocket motor on the AMRAAM missile in 2009 after the domestically supplied rocket failed to qualify because of issues with the propellant and the blast tube insulation. The Committee has learned that the Navy may also be exploring a rocket motor source from a foreign vendor for a tactical missile program. Finally, the Committee understands that the Army recently awarded a sole-source contract for rocket motors for the Guided Multiple Launch Rocket System, a program that has been stable and in production for some time.

The Committee is concerned that in these programs, a competition for a new rocket motor vendor was not executed; and in two programs, the Department is becoming more reliant on a foreign supplier. The Committee is closely following these developments across all services, as rocket motors continue to be a critical component of the defense industrial base. The Committee believes that whenever possible, domestic sources should be considered, and full and open competition employed before awarding contracts.

Therefore, the Committee directs the Under Secretary of Defense for Acquisition, Technology, and Logistics to conduct an independent assessment of domestic and foreign-sourced rocket motor propulsion for all Department of Defense tactical missile programs. This report should include the impacts of foreign-sourced rocket motors on domestic suppliers, and the national security impacts on the defense industrial base. This report shall be delivered to the congressional defense committee not later than 180 days of enactment of this act.

The Committee also directs the Government Accountability Office [GAO] to provide a report to the congressional defense committees within 180 days of enactment of this act that outlines the assumptions and analysis utilized by the Army to justify a sole-source contract to develop and qualify new, insensitive munitions-compliant rocket motors for the Guided Multiple Launch Rocket System, and why a competitive acquisition strategy was not used.

Army Organic Industrial Base.—The Committee directs the Secretary of the Army to provide 45-day written notification to the congressional defense committees prior to the Secretary approving civilian reductions in force that will result in an employment loss of 50 or more full-time employees at any Army organic industrial base facility. The notification shall include the impact that the proposed reduction in force will have on the ability to maintain the organic industrial base critical manufacturing capabilities as delineated in the Army Organic Industrial Base Strategy Report, a detailed accounting of the costs of implementing the reduction in force, and an assessment of the cost of, and time necessary, to restore any lost capability to meet future organic wartime manufacturing needs.

Management of Conventional Ammunition Inventory.—The Committee is aware of the Department of Defense's efforts to better manage its conventional ammunition inventory. The Government Accountability Office recently reported in "Actions Needed to Improve Department-wide Management of Conventional Ammunition Inventory" that more work needs to be done, particularly regarding information sharing between the services. Incomplete and unreliable inventory systems can lead to the wasteful destruction of ammunition, duplicative procurement of ammunition that may be available in the stockpiles of another service, and shortages of ammunition required for forward-stationed forces. To use limited resources more efficiently and improve support to our warfighters, the Committee encourages the Department of Defense to accelerate efforts to automate ammunition tracking and inventory accounting, and affirms its support for the reporting requirements directed in

Annual Industrial Capabilities

Report to Congress

October 2013

Under Secretary of Defense
for Acquisition, Technology and Logistics

Office of the Deputy Assistant Secretary of Defense
for Manufacturing and Industrial Base Policy

Preparation of this study cost the
Department of Defense a total of approximately
$125,000 dollars in Fiscal Years 2012-2013.

volume, specialty-demand of the Department. It is working to address these issues, particularly in the areas of castings adaptability and machining. Additional information about these efforts can be found in Section 6.1.1. In addition, the Department is investing in a Title III project to upgrade and refurbish equipment at the single domestic source for heavy forgings for DoD applications including propulsion shafts for surface and sub-surface naval vessels, periscope tubes, ring forgings for bull gears, and reactor vessels. This project will address production constraints and single points of failure that are critical to maintain the supply of heavy forgings to the DoD. For more details, see Appendix C.1.

Recognizing the increasing global demand for materials, the diminishing role of demand from the defense industrial base, and the susceptibility of supply chains to distortion, the Department is engaged in a number of activities aimed at continually assessing the ability of material supply chains to provide reliable and cost-effective products to meet the requirements of the nation's Warfighters. For example, the Department co-chairs (with the Department of Energy) a working group of the recently chartered National Science and Technology Council's (NSTC) Committee on Critical and Strategic Minerals Supply Chains. The working group, Material Criticality Assessment and Early Warning, will assess the material needs associated with the technologies that will be essential to future economic growth, as well as those that will be required by the defense industrial base. This effort provides synergies to efforts undertaken by the Department, such as those in DLA Strategic Materials, which are focused more narrowly on the defense industrial base.

4.6 Munitions and Missiles Sector Industrial Summary

The munitions and missile industrial sector consists of DoD's smart bombs, and tactical, missile defense, and strategic missiles. For this report, it does not include ammunition, mortars, or tank rounds. The munitions and missiles industrial sector is primarily a defense unique sector. The munitions and missiles development and production market has contracted, resulting in aggressive competition for limited new program opportunities. Most current missile development activity consists of modifications to existing systems. Over time, the Department has provided the necessary resources to allow the industrial sector to ramp up production for munitions and missile systems to support Warfighter needs when the country is engaged in conflict, and reduces these resources when the conflict ends. This cycle of rapid ramp-ups followed by precipitous declines of demand and production adds significant supplier capacity management challenges to munitions and missile suppliers and their critical sub-tier providers.

Within the munitions and missile sector, two prime contractors account for roughly 85 percent of the Department's munitions and missile procurement funding. These prime contractors provide a full complement of missile types across the munitions and missiles sector and, for the most part, are able to meet defense unique technical performance requirements, but not without concerns. Roughly half of the

Department's munitions and missile production programs are operating at facility utilization rates equal to or less than 50 percent. DoD's prime contractors and their associated sub-tier supplier base must align company production capacities with expected DoD budget realities, while ensuring the industrial capabilities needed for our next generation weapon systems are sustained.

As already constrained DoD budgets become more strained by continued budget uncertainty and higher priority programs like operational readiness and aircraft and ships procurements, investments in munitions and missile research and development and subsequent procurements may be further reduced. The munitions and missiles industrial sector faces a number of industrial capability challenges. These challenges fall into two broad categories: (1) sustaining our design and engineering teams and (2) sustaining the sub-tier supplier base.

Sustaining Missile Sector Design and Engineering Industrial Capabilities

Most of the research and development funding in the munitions and missile sector is associated with legacy program upgrades or modifications, which limit competitive opportunities. The shortage of new missile program developments inhibits the Department's ability to fully exercise the industrial capabilities necessary– from design concept, system development, and production – to meet current and future national security needs. The Joint Air-to-Ground Missile (JAGM) is the only "new" missile development program in competition and it has been restructured as a technology development program. An indication of the concern for missile design engineering capabilities can be seen through the development of the newest DoD strategic missile in the U.S. inventory, the Trident D5 missile. This missile began its development in 1978, which built upon the development of the Minuteman III that had its inception in the 1960s. Both of these strategic systems, the Trident D5 and the Minuteman III, will eventually reach the end of their operational service lives as currently configured, and will require either modification or replacement. Both the Navy and the Air Force are developing requirements for next generation missiles: Navy Offensive Anti-Surface Warfare (OASuW) and Air Force next gen Air-Launched Cruise Missile (ALCM). However, the Department remains concerned that the design engineering capabilities needed for these systems may not be readily available should the sector atrophy in the absence of demand. The following table provides a sampling of when some of our missile programs began development and lists the current program variant.

DoD Missile Program Updates			
Missile Program	**Development Started**	**Production or Delivery Started**	**Current Variant**
AIM-9 Sidewinder	1946	1953	AIM-9X
AMRAAM	1979	1988	AIM-120D
Hellfire	1974	1982	AGM-114N
TOW	1963	1968	TOW-2B
Patriot	1969	1981	PAC-3 MSE
Standard Missile	1963	1967	SM-6
Trident D5	1978	1987	D5
Minuteman III	1964	1968	MM III
Tomahawk	1970's	1983	Block IV
JASSM	1995	2001	JASSM-ER

Source: DASD(MIBP)

The contraction of the munitions and missile development and procurement market has created a situation where expertise in defense-unique technologies is thinning in both the contractor and the Federal government workforce. Declining munitions and missiles research and development funding, coupled with limited competitive opportunities projected in the near-term for new munitions and missile systems, will make it difficult for the missile sector industry to attract and retain a workforce with the industrial capabilities to design, develop and produce future missile systems that will meet national security requirements. Continuing our S2T2 activities will improve the Department's ability to identify at-risk design capabilities. Two examples of at-risk sub-tier sectors include:

- *Missile Propulsion Systems*: Sustaining the design engineering skills for missile propulsion systems is at risk. The Department relies on the viability of a small number of SRM and turbine fan engine propulsion providers to sustain propulsion technology and design engineering skills. Many of the Department's missile upgrade and modernization programs utilize the existing propulsion system. Decreased Navy Tactical Tomahawk cruise missile production quantities (and the potential for future production quantity reductions), Air Force delays to the JASSM-ER LRIP program, few new start missile or upgrade programs that develop new propulsion systems, and the lack of future research and development technology investments threaten the viability of the missile propulsion technology and engineering capabilities. Developments in foreign nations have led to higher speed, longer-range weapons and advanced air defense capabilities abroad. These increased capabilities will compel the U.S. to pursue improved standoff, survivable and responsive missiles. Without sustainment of the existing missile propulsion industrial base, future development of missile programs could be delayed by five to ten years or more while the U.S. is reconstituting its propulsion design and engineering capabilities. Preserving the existing national missile propulsion capability, with an emphasis on the design engineering team, is of utmost importance.

- *Tri-mode Seekers*: Tri-mode seekers are defense unique systems that offer a technologically advanced capability. Over the years, the Department fought to maintain two competitive sources for these systems to ensure we maintained competitive design teams for current and future applications. These systems require a highly trained and unique design engineering and production workforce. While seekers have a broader cross-defense sector market, they are predominantly provided by the munitions and missile prime contractor because it considers this capability a core competency.

Sustaining Missile Sector Sub-tier Suppliers

The health of sub-tier suppliers in defense unique fields is a serious and valid concern. Examples of defense unique fields in this sector are radomes, infrared domes, sensor arrays, thermal batteries, actuators, advanced electronic components and assemblies, warheads, and propulsion systems. Important sub-tier components in the munitions and missile industrial segment that continually face excess capacity challenges include thermal batteries, solid rocket motors (SRMs), fuzes, jet engines, inertial measurement units (IMUs), global positioning system (GPS) receivers, seekers, and warheads. The suppliers that provide these components are important because these components are used on multiple programs and some require 12 months or more to manufacture. Some of these sub-tier supplier products have broader cross industrial sector and commercial applications that provide a more reliable and stable market base to sustain our industrial design and production capabilities like the IMUs, GPS receivers, and seeker product sectors, while others are more unique to the munitions and missile industrial sector.

The munitions and missile industrial sector is routinely impacted by significant shifts in DoD demand as a result of various factors – including initiation of new conflicts, conflict drawdowns, and the fact that weapons represent the most fungible of the products that the DoD procures in terms of procurement quantities. Decisions on quantities for ships, combat systems, and radars tend to be binary in that one is procured or isn't, but with weapons that isn't the case. This flexibility in weapons procurement quantities has tended to result in weapons being used as bill payers and the resultant impact of a declining business base. The Department is concerned with the ability of our munitions and missile prime contractors to manage and sustain critical sub-tier suppliers during these shifts in demand. Some of these critical sub-tier suppliers are single or sole source providers and some are foreign. As the Department draws down its operations in Iraq and Afghanistan, it is monitoring the impact of reduced demand on the sub-tier supplier base through continuing S2T2 assessments of the defense industrial base, in close cooperation with the Military Departments. The Department expects to identify a growing number of industrial capability risk areas as sub-tier suppliers realign and adjust their industrial capacities to new DoD budget realities. Using data obtained through the S2T2 analytic process, the Department identified several examples of defense unique at-risk areas – the solid rocket motor, thermal batteries, fuzes, and steel forged bomb bodies. Some of these areas of concern are described below.

- *Solid Rocket Motors (SRMs)*: SRMs are predominantly defense unique items upon which the Department depends. The certainty of demand is at risk because munitions and missiles are often used as bill-payers in fiscally constrained environments. The challenge is the high cost of reconstitution should the SRM industry encounter a significant production gap, particularly in the large, over 40-inch diameter segment of the market. NASA's retirement of the Space Shuttle and the transition of the Constellation program to the Space Launch System have resulted in significant under-utilization of existing capacity.

- *Thermal Batteries*: All DoD missiles and Precision Guided Munitions (PGMs) use thermal batteries. Thermal batteries are predominantly defense unique items. The domestic thermal battery industry has historically been dominated by one company, with little participation by other firms. The two other domestic companies that produce thermal batteries constitute less than 20 percent of the DoD thermal battery market. The dependency on one dominant thermal battery supplier makes this industry at risk.

- *Fuzes*: Fuzes are defense unique items. They are used on all munitions and missile programs. While funding for munitions has remained healthy over the last ten years, continued improvements in guided systems significantly reduce the quantity of fuzes required for our current and future systems. This has contributed to excess capacity in the fuzes sector. Excess capacity limits manufacturers from being cost competitive and sustaining a viable design engineering cadre. The U.S. currently has three full-capability fuze design manufacturing suppliers. The fuze prime contractors are aggressively managing several defense unique sub-tier component areas, such as electronic energy devices (e.g., bellows actuators), liquid reserve batteries, and certain obsolete electronic components, to ensure their ability to design and produce fuzes in the future.

- *Steel Forged Bomb Bodies:* Steel forged bomb bodies are a unique defense item. The Department relies on a sole source for the MK80 series bomb bodies used in the 500/1000/2000 lb. bombs. Projected procurements are down drastically. The producer is a large parent company; however, the business unit is at high risk of financial distress due to the projected downturn in procurements. Other technologies have been explored to include Cast Ductile Iron (CDI); however, this technology has not been qualified as a replacement for all applications.

Additionally, the Department has previously identified several sub-tier supplier issues of critical materials that require mitigation. These materials have been identified and provided to decision makers, including the OSD-level Critical Energetic Material Initiative (CEMI), for risk mitigation strategy development and execution. Examples of domestic and foreign source supplier issues are highlighted below:

- *Ammonium Perchlorate (AP)*: One sole U.S. supplier for AP remains for the SRM industry (both small and large diameter systems). The size and grain of the AP used in defense applications is unique to the SRM market. Demand for production of AP is well below historic levels and approaching the minimum sustaining rate (MSR). Volumes have fallen so low that there is a risk that the vendor may not be able or willing to sustain its workforce skill levels and the supply chain, while remaining competitive. The Department is working across the Government to preserve this capability as well as invest in future capabilities.

- *Butanetriol (BT)*: The Department is currently dependent on a foreign source for BT. Butanetriol, identified on the U.S. Munitions List (USML), is a chemical precursor needed for production of butanetriol trinitrate (BTTN), a nitrate ester/plasticizer (part of the binder), used in the production of SRMs for the Army's Hellfire, TOW-2, Griffin and Javelin missile systems. The previous BT source discontinued production of the chemical in 2004. At that time, the Department's BTTN provider acquired the remaining inventory and began looking for another supplier. In 2007, the Army conducted a global search for sources of BT. Only one source was identified that could produce at the quantities and quality required. However, Section 1211 of the National Defense Authorization Act for Fiscal Year of 2006 prohibits the acquisition of items listed on the USML from companies such as this producer unless a waiver is approved. The Secretary of the Army signed a waiver in 2008 and 2011 to prevent a production gap until the Department can develop a domestic source. The U.S. Army expects to have a new source qualified by the end of FY2013.

- *Rayon Precursor Material*: Rayon precursor material is commonly used to produce high thermal resistance in SRM nozzles and other space composite applications. The sole U.S. supplier of rayon precursor material shut down its facility in 1997. However, the Defense Department and NASA were able to purchase the remaining stockpile of rayon precursor material for use while they, along with the SRM prime contractors, are continuously working to qualify another source to fill this supplier void.

- *Triaminotrinitrobenzene (TATB)*: TATB is one of the least sensitive explosive materials known. This material is predominantly used in PBXN-7 and PBXW-14 for fuze applications. TATB has not been produced since 2006. The Department awarded the TATB Phase I Mod and Phase II Facilitization contracts in July and August of 2011. The TATB plant design completed earlier this year is based on the Benziger process and leverages existing infrastructure. Process prove-out, completion of consecutive specification compliant production runs, and formulated production scale batches of PBXN-7/PBXW-14 are expected to be completed in FY2013.

- *Antimony Sulfide*: Antimony Sulfide is a component of energetic compositions used in percussion primers and several fuze/detonator ignition trains that support over 200 DoD munitions. It is also an industrial commodity material used commercially to manufacture flame retardant plastics and textiles. Antimony Sulfide is refined from stibnite ore that is mined underground. Large deposits of stibnite ore are located in the earth's crust. There are no known mines producing acceptable grade ore under U.S. or NATO partner control. China is the largest producer of antimony sulfide and controls its availability on the world market. The Army Research and Development Engineering Center (ARDEC) has ongoing efforts to identify and qualify alternative percussion primer compositions that do not contain antimony sulfide and other similar materials that are foreign dependent or environmentally undesirable.

The Department will continue to monitor at-risk areas within the munitions and missile sector using various analysis tools, to include S2T2 assessments, and will identify additional mitigation strategies, as warranted.

4.7 Shipbuilding Sector Industrial Summary

The shipbuilding industrial base is highly concentrated. In the U.S. shipbuilding and repair industry, the largest 50 companies account for about 90 percent of the combined annual revenue of about $21B. The defense industrial base for shipbuilding is comprised of two major primes, General Dynamics and Huntington Ingalls (formerly a unit of Northrop Grumman) and their subsidiaries, and a thin layer of second tier industrial base suppliers. The result is a shipbuilding and repair supply base that is often one-deep in specialized capabilities.

The industrial base necessary to build and maintain platforms for Defense relies on a complex, heavy industry where ships are procured at very low annual production rates that require significant capital investment and infrastructure, coupled with a wide range of technical capabilities designed for operations at sea, undersea, and air, often requiring unique design and engineering skills. Yet research and development investment is low, and building ship prototypes is infeasible. Accordingly, procurement and modification contracts are key mechanisms for maintaining shipbuilding design engineering skills in the U.S.

In 2012, the shipbuilding sector remained generally stable. However, it is unclear at the writing of this summary what the impact of an extended budget sequestration may have on the mix of future force structure and on the contracts awarded to companies for future year deliveries. Given the reliance of the shipbuilding sector on defense procurement contracts to maintain skills and infrastructure, changes in quantity and/or fleet composition will need to be assessed for impacts on the primes and sub-tier suppliers moving forward.

At the prime level in defense shipbuilding, shipyards and major tier-one suppliers remain in stable financial health with little growth in revenue. As a result of poor fourth-quarter revenues, General Dynamics (GD) Marine Systems reported relatively flat revenues (decrease of 0.6 percent) and an increase of 8.5 percent in operating earnings

Annual Industrial Capabilities

Report to Congress

Required by Section 2504 of title 10, United States Code

August 2012

Under Secretary of Defense
for Acquisition, Technology and Logistics

Office of the Deputy Assistant Secretary of Defense
for Manufacturing and Industrial Base Policy

Preparation of this study cost the
Department of Defense a total of approximately
$98,800 dollars in Fiscal Years 2011-2012

sector. Therefore, maintaining a vibrant commercial manufacturing base is essential to the health of the defense industrial base.

A group of materials with numerous commercial as well as defense applications is the rare earth elements. In general, the domestic supply chain for all end-uses for these materials exists, but is thin. In particular, there is one niche for which there is no domestic production, neodymium-iron-boron magnets (neo magnets). International trade augments the domestic supply chain, but currently, China and Japan are the principal sources for these magnets, and presently, China is the ultimate source of most of the rare earth material required to manufacture the magnets in Japan. With a recent announcement by a major Japanese neo magnet producer who holds the required intellectual property rights, capabilities are increasing within the domestic supply chain for rare earth materials, including the future domestic production of neo magnets. The producer plans to construct a neo magnet facility in the U.S. with a startup planned in mid-2013. In addition, a U.S. company, in a joint venture with two Japanese companies, will produce neo magnets by early next year in Japan using non-Hitachi technology.

Recognizing the increasing global demand for materials, the diminishing role of demand from the defense industrial base, and the susceptibility of supply chains to distortion, the Department is engaged in a number of activities aimed at continually assessing the ability of materials supply chains to provide reliable and cost-effective products to meet the requirements of the nation's Warfighters. For example, the Department co-chairs (with the Department of Energy) a working group of the recently chartered National Science and Technology Council's (NSTC) Committee on Critical and Strategic Minerals Supply Chains. The working group, Critical Material Criteria and Prioritization, will assess the materials needs associated with the technologies that will be essential to future economic growth, as well as those that will be required by the defense industrial base. The Department's Strategic Materials Protection Board (SMPB) met in October 2011, at which time the Chair of the SMPB indicated the Department needed to isolate those materials for which the Department has a specific equity, and that a means of sharing this information with the NSTC Committee's working group would be beneficial.

4.7 Munitions and Missiles Sector Industrial Summary

The munitions and missile industrial sector is primarily a defense unique sector with some elements of the small diameter munitions base also serving commercial and civilian markets. The Department typically acquires munitions systems on an as-needed basis. Over several cycles, the sector has provided necessary resources to ramp up production for munitions and missile systems to support Warfighter needs when the country is engaged in conflict, and reduces production when the conflict ends. This cycle of rapid ramp-ups followed by precipitous declines of demand and production adds significant supplier capacity management challenges to critical sub-tier munitions and missile suppliers.

Within the missile sector, two prime contractors account for approximately 85 percent of the Department's munitions and missile procurement funding. Competition at the sub-tier level exists in some instances, depending on the specific missile system in development. However, many of the sub-tier suppliers service both companies, so competition at the lower tiers is limited. The two prime contractors serve on the majority of defense programs comprised of strategic, tactical, and ballistic missile defense. They are also generally able to meet defense unique technical performance requirements.

As budgets in the future are increasingly constrained, investments in munitions and missile R&D and procurement may be reduced. The munitions and missiles industrial sector faces a number of industrial capability challenges that fall into two broad categories: (1) sustaining design and engineering teams, and (2) sustaining critical suppliers in the sub-tier industrial base.

Most of the R&D funding in the munitions and missile sector is associated with legacy program upgrades or modifications that limit competitive opportunities. The Joint Air-to-Ground Missile (JAGM) is currently the only new missile development program in competition. The newest DoD strategic missile in the U.S. inventory is the Trident D5 missile that was developed in the 1980s with the Minuteman III developed even earlier in the 1960s. Both the Air Force and Navy are developing requirements for next generation missiles: Navy Offensive Anti-Surface Weapon (OASuW) and Air Force next generation Air-Launched Cruise Missile (ALCM). However, the Department remains concerned that the industrial design engineering capabilities needed for these systems may not be readily available should the sector atrophy in the absence of demand.

The shortage of new missile program development limits the Department's ability to fully exercise the industrial capabilities necessary in the missile industrial base – from design concept, system development, and production – to meet current and future national security needs. Additionally, declining munitions and missiles R&D funding, coupled with limited competitive opportunities projected in the near-term for new munitions and missile systems, will challenge the munitions industry's ability to attract and retain a qualified and experienced workforce.

The Department is also concerned with the ability of munitions and missile prime contractors to sustain critical sub-tier suppliers. Many sub-tier suppliers are single or sole source providers and some are foreign-based. The munitions and missile industrial sector is routinely affected by shifts in DoD demand because of various factors; most commonly, by the initiation of new conflicts or the cessation of conflicts. Two examples of at-risk sub-tier suppliers include:

- *Long-range Cruise Missile Propulsion*: The long-range cruise missile propulsion sector is at risk of losing its design and engineering team. The Department relies on the viability of a sole U.S. source for its long-range cruise missile propulsion technology and production. Decreased Navy Tactical Tomahawk cruise missile production quantities (and the potential for future production quantity reductions), Air Force delays to the JASSM-ER LRIP program, coupled with the lack of future R&D technology investments, have threatened the viability of the sole U.S. source for long-range cruise missile propulsion technology. Loss of the U.S. cruise missile propulsion industrial base would adversely affect current procurement of the Department's long-range cruise missiles and its ability to support existing long-range cruise missile weapon systems. The risk is not limited to only current capability. Developments in foreign nations have led to higher-speed, longer-range weapons, and advanced air defense capabilities abroad. These increased capabilities will compel the U.S. to consider material solution options including cruise missiles with enhanced standoff, survivability, and responsiveness. Without sustainment of the existing cruise missile propulsion industrial base, future development of long-range strike (OASuW and ALCM) capabilities could be delayed by 5-10 years or possibly even longer. Preserving the existing national cruise missile propulsion capability, with an emphasis on the design engineering team, is of utmost importance.

- *Tri-mode Seekers*: Tri-mode seekers are defense unique systems that offer a technologically advanced capability. Over the years, the Department fought to maintain two competitive sources for these systems to ensure maintenance of competitive design teams for current and future applications. These systems require a highly trained and unique design engineering and production workforce. While seekers have a broader cross-defense sector market, munitions and missile prime contractors primarily support them, because they consider this capability a core competency.

As the Department draws down its operations in Iraq and Afghanistan, it is monitoring the impact of reduced demand on the sub-tier supplier base through continuing S2T2 assessments of the defense industrial base in close cooperation with the Military Departments. The Department expects to identify a growing number of industrial capability risk areas as sub-tier suppliers realign and adjust their industrial capacities to new DoD budget realities. Using data obtained through the S2T2 analytic process, the Department has identified several examples of defense unique at-risk areas: solid rocket motors, small turbine engine, thermal batteries, and fuzes, some of which are described below.

- *Solid Rocket Motors (SRMs)*: SRMs are predominantly defense-unique items upon which the Department depends. The certainty of demand is at-risk, because munitions and missiles are often used as bill-payers in fiscally constrained environments. The challenge is the high cost for reconstitution should the SRM industry encounter a significant production gap, particularly in the large, over 40-inch diameter, segment of the market. NASA's retirement of the Space Shuttle and cancellation of Constellation have resulted in significant under-utilization of existing capacity.

- *Thermal Batteries*: All DoD Precision Guided Munitions (PGMs) use thermal batteries. Thermal batteries are predominantly defense-unique items and the domestic thermal battery industry has historically been dominated by one supplier with little participation by other firms. Two other domestic companies that produce thermal batteries constitute less than 20 percent of the DoD thermal battery market. The dependency on a dominant supplier of thermal batteries makes this industry at-risk.

- *Fuzes*: Fuzes are defense-unique items. They are used on all munitions and missile programs. While funding for munitions has remained healthy over the last ten years, continued improvements in guided systems significantly reduced the quantity of fuzes required for current and future systems. This has contributed to excess capacity in the fuzes sector. Excess capacity limits manufacturers from being cost competitive and sustaining a viable design engineering cadre. The U.S. currently has three full-capability fuze design manufacturing suppliers . Site visits conducted as part of the Department's S2T2 assessments revealed that fuze prime contractors are aggressively managing several defense unique sub-tier component areas, such as electronic energy devices (e.g., bellows actuators), liquid reserve batteries, and certain obsolete electronic components to ensure their ability to design and produce fuzes in the future.

Additionally, the Department has previously identified several sub-tier supplier issues that require mitigation. Examples are highlighted below:

- *Ammonium Perchlorate (AP)*: One sole U.S. supplier for AP remains for the SRM industry (both small and large diameter systems). The size and grain of the AP used in defense applications is unique to the SRM market. Demand for production of AP is well below historic levels and approaching the minimum sustaining rate (MSR). Volumes have fallen so low that there is a risk that the vendor may not be able or willing to sustain its workforce skill levels and the supply chain, while remaining competitive. The Department is working across the Government to preserve this capability as well as invest in future capabilities.

- *Butanetriol (BT)*: The Department is currently dependent on a foreign source for BT. Butanetriol, identified on the U.S. Munitions List (USML) is a chemical precursor needed for production of butanetriol trinitrate (BTTN), a nitrate ester/plasticizer (part of the binder), used in the production of SRMs for the Army's Hellfire, TOW-2, and Javelin missile systems. The previous U.S.-based BT source discontinued production of the chemical in 2004. At that time, the Department's BTTN provider acquired the remaining inventory and began looking for another supplier. In 2007, the Army conducted a global search for sources of BT. Only one source was identified that could produce at the quantities and quality required. However, section 1211 of the National Defense Authorization Act of 2006 prohibits the acquisition of items listed on the USML from companies such as this producer. The Secretary of the Army signed waivers in 2008 and 2011 to prevent a production gap until the Department can develop a domestic source. The U.S. Army expects to have a new source qualified by the first quarter of FY2013.

- *Rayon Precursor Material*: Rayon precursor material is commonly used to produce high thermal resistance in SRM nozzles and other space composite applications. The sole U.S. supplier of rayon precursor material closed its facility in 1997. However, the Defense Department and NASA were able to purchase the remaining stockpile of rayon precursor material for use while they, along with SRM primes, are continuously working to qualify another source to fill this supplier void.

- *Triaminotrinitrobenzene (TATB)*: TATB is one of the least sensitive explosive materials known. This material is predominantly used in PBXN-7 and PBXW-14 for fuze applications. TATB has not been produced since 2006. The Department awarded the TATB Phase I Mod and Phase II Facilitization contracts in July and August of 2011. TATB plant design completed earlier this year is based on the Benziger process and leverages existing infrastructure. Process prove-out, completion of consecutive specification compliant production runs, and formulated production scale batches of PBXN-7/PBXW-14 are expected to be completed first quarter of FY2013.

The Department will continue to monitor at-risk areas within the munitions and missile sector through sustained S2T2 assessments and will identify additional mitigation strategies, as warranted.

DESIGN TEAMS

The loss or reduction in design teams and specialized engineering skills is a particular Department concern that cuts across multiple defense sectors – most notably the aircraft, missile, space, Command, Control, Communications, Computers (C4) and Information Communications Technology (ICT), and munitions and missiles sectors. The demand for new design and development is at a historic low with significant skill and experience loss expected due to an aging and retiring workforce and a shortage in qualified design engineers. The loss in design expertise may jeopardize U.S. technological edge and increase the execution risks for future DoD programs. Preserving and developing unique and highly-creative talent, skills, and technology are vital to the industrial base's ability to design and produce world-class products.

Science, Technology, Engineering, and Mathematics (STEM) education is essential toward ensuring the nation maintains a workforce capable of understanding and satisfying the technical and advanced design requirements of future defense systems. After a temporary rise during the internet boom of the 1990s, enrollments in university STEM programs have reverted to previous historical levels. There is growing concern within the Department that there may be an insufficient supply of qualified graduates to meet rising defense C4/ICT and other design-unique program requirements.

The Department is addressing STEM education issues with the National Science Foundation and the President's Networking and Information Technology Research and Development Program. DASD(MIBP) is also monitoring potential design team shortages through continued S2T2 assessments.

Annual Industrial Capabilities Report
To Congress

September 2011

Office of Under Secretary of Defense
Acquisition, Technology & Logistics

Office of Manufacturing & Industrial Base Policy

Preparation of this study cost the
Department of Defense a total of approximately
$78,000 dollars in Fiscal Years 2010-2011

Non-Line-Of-Sight Cannon; BAE also received significant reset and upgrade work for the Bradley Fighting Vehicle.

GDLS and BAE along with Navistar, AM General and Lockheed Martin, have received development contracts for the Joint Light Tactical Vehicle (JLTV). The Army currently plans to eventually procure 60,000 JLTVs and the Marine Corps 5,500. However, these numbers are subject to change as each service refines its tactical wheeled vehicle strategy and anticipated budgetary constraints are addressed.

There are "important" component suppliers for the vehicle industry; examples include tracked vehicle transmissions, armament and military unique forgings, castings; and metallic and composite materials used to make armor. Issues that continue to plague the ground vehicles sector include a continued need for overhaul, maintenance and repair of the vehicle fleet; consolidation of tracked vehicle design and manufacturing supplier base; increased survivability and mobility (protection and lighter/stronger armor); and the impact of future MGV and JLTV requirements and the ability of industry to adapt.

3.1.4 Missile Sector Industrial Summary

Missiles are classified into four segments: tactical missiles, strategic missiles, missile defense systems, and smart munitions. Generally, missile subsystems are categorized in four main areas: propulsion; armament, airframe, and navigation; guidance; and control (NGC). Smart munitions do not have a propulsion subsystem.

For roughly the last decade, missile programs and their associated funding profiles have remained fairly stable. However, this trend has recently started to change. For the strategic missile segment, procurement funding is declining. The funding is declining with the conclusion of the Minuteman III Guidance Replacement Program and the Propulsion Replacement Program. The Minuteman III Propulsion Replacement Program came to an end in August 2009 leaving the Navy D5 as the remaining strategic production program. The Air Force Minuteman III warm-line program that supports the solid rocket motor industrial subsector is expected to end in FY12. In the missile defense segment, the Department cancelled the Kinetic Energy Interceptor program and reduced the Ground-based Interceptor program. The procurement funding for missile defense programs has remained stable in part, due to increased foreign military sales. The procurement funding in the missile defense sector is for the PAC-3 and Standard Missile programs. The remaining missile defense funding is mostly in the Missile Defense Agency research and development line. Tactical and smart munitions funding has remained fairly stable thanks in part to increased foreign military sales. However, the Department cannot rely on this trend to continue.

Research, Development, Test and Evaluation (RDT&E) funding is declining. Most of the research and development funding in the missile sector is associated with legacy program upgrades or modifications which limits competitive opportunities. This is significant for strategic missiles since the skills for a new development may already be below threshold or lost altogether and there is no planned new development effort on the horizon. The Joint Air to Ground Missile (JAGM) is currently the only new missile development program. This lack of new missile program development limits our ability to fully exercise the industrial capabilities necessary in the missile industrial base – from design concept, system development, and production – to meet our current and future national security needs. Both the Air Force and Navy are developing requirements for next generation missiles and there is concern that the industrial capabilities needed for those systems may not be readily available. While many industrial sectors that support our national security requirements are supported by the commercial markets, the missile industrial sector is mostly defense unique.

The significant drawdown of defense budgets during the 1990's reduced the number of missile prime contractors from more than twelve to six. However, the prime contractors are not necessarily equal in industrial capabilities. With the cancellation of the Kinetic Energy Interceptor program, four of the primes only operate in one of the missile segments (Boeing – Smart Munitions, General Dynamics – Tactical Missiles, ATK – Tactical Missiles, and Northrop Grumman – Strategic Missiles). Northrop Grumman, ATK and General Dynamics are prime contractors on only one program – Northrop Grumman the MM III program, ATK the AARGM program and General Dynamics the 2.75" rockets (Hydra rockets).

Lockheed Martin and Raytheon account for roughly 85 percent of the Department's missile procurement funding. This indicates that while there is competition in this sector, it appears mostly limited to two contractors. Raytheon and Lockheed Martin are the prime contractors on the majority of the Department's missile programs and both have a mix of missile segment programs (tactical, ballistic missile defense, etc.).

The Department's missile prime contractors are profitable, able to meet their financial obligations, generally consistent in providing value to shareholders, and willing to invest back into the company via research and development or capital expenditures. For the most part, primes are able to meet the Department's technical performance requirements. However, there is a cost risk in the form of increased overhead rates to the Department as the facility utilization rates for missile prime contractors average in the 45 – 60 percent range. There is a need for prime contractors and their associated subtier supplier base to align company production capacities more in line with expected DoD budget realities in the future while ensuring the industrial capabilities needed for next generation weapon systems are sustained.

"Important" components in the missile industry segment include thermal batteries, solid rocket motors (SRMs), jet engines, inertial measurement units (IMUs), GPS receivers, seekers, fuzes, and warheads. The suppliers that provide these components are considered "important" because they are used on multiple programs and some of these components require 12 months or more to manufacture.

The strategic missile segment funding is declining. With the MM III Guidance and Propulsion Replacement Programs ended, the Trident (D5) missile is the only remaining program. Currently there is no development or significant levels of R&D programs planned in this area. The Department is developing a plan to better align industrial capabilities in this segment with DoD requirements and ensure adequate technical and production resources for the large SRM industrial base to support the Department's strategic deterrence mission. The D5 program is producing at minimum viability levels in an over capacity environment.

At this time, the Joint Air-to-Ground Missile (JAGM) is the only major missile program being competed. The Department has established a Prompt Global Strike technology application program and both the Air Force and Navy are projecting a new missile start in the next few years. This small number of new programs is an indication of limited opportunities for industry to maintain their design teams.

As the DoD missiles budgets decline, the Department should expect to identify a growing number of industrial capability risk areas as the subtier supplier base struggles to align its industrial capacities to DoD budget realities. Examples include the solid rocket motor, small turbine engine, and fuze industries.

Declining RDT&E funding coupled with limited competitive opportunities projected in the near-term will make it difficult for the missile sector industry to attract and retain a workforce with the industrial capabilities to design, develop and produce future missile systems.

3.1.5 Services Sector Industrial Summary

In FY10 47.6 percent of all DoD contract spending was classified as supplies, 40.3 percent classified as services, with 12.1 percent classified as Research, Development, Test and Evaluation (RDT&E)[3]. As the dollar value of overall contract spending has increased dramatically, 184 percent since 2000, the percentage of spending in each domain has exhibited noticeable trends that are undoubtedly related to spending on Middle East conflicts. The percentage of supplies increased from 45 percent to 48 percent, the percentage of services remained steady at 40 percent; and the percentage of RDT&E decreased from 15 percent to 12 percent. All DoD contract actions are classified by Federal Supply Class/Service Codes (FSCs), which map to 23 service categories. In order to identify strategic sourcing opportunities, the Office of Strategic Sourcing in the Defense Procurement and Acquisition Policy (DPAP) Directorate consolidated the 23 service categories into eight portfolio groups. These

[3] After correcting for a $13.9B data entry error in Construction Related Services.

SRM Industrial Capabilities Report

to

Congress

Redacted Version

June 2009

Office of Under Secretary of Defense
Acquisition, Technology & Logistics
Industrial Policy

ATK Programs by SRM Segments		
Segment	**Program**	**Facility**
Tactical	Hydra 70	Radford AAP
	ESSM	Rocket Center, WV
	Hellfire	Rocket Center, WV
	TOW 2	Rocket Center, WV
	RAM	Rocket Center, WV
	Tomahawk Gas Generator (GG)	Rocket Center, WV
	AMRAAM	Rocket Center, WV
	AIM-9X Sidewinder	Rocket Center, WV
	NLOS PAM	Rocket Center, WV
	AGM-65 Maverick	Rocket Center, WV
Missile Defense	KEI Gas Generator	Rocket Center, WV
	SM3 BL IA3rd Stage SRM (TSRM)	Elkton, MD
	SM3 BL IA SDACS	Elkton, MD
	SM3 BL IB TSRM - Mk136	Elkton, MD
	SM3 BL IB TSRM - Mk136 add	Elkton, MD
	GMD SRM Stage 1 (Orion)	Bacchus, UT
	GMD SRM Stage 2 (Orion)	Bacchus, UT
	GMD SRM Stage 3 (Orion)	Bacchus, UT
	KEI 2nd Stage (40S)	Elkton, MD
	KEI 1st Stage (40SL)	Bacchus, UT
Strategic	MM III Stage 1	Promontory, UT
	MM III Stage 2	Bacchus, UT
	MM III Stage 3	Bacchus, UT
	D5 Stage 1	Bacchus, UT
	D5 Stage 2	Bacchus, UT
	D5 Stage 3	Bacchus, UT
Space Launch	Shuttle RSRM	Promontory, UT
	Ares RSRMV	Promontory, UT
	Castor IV	Promontory, UT
	Castor 120	Promontory, UT
	GEM 60	Bacchus, UT
	GEM 46	Bacchus, UT
	GEM 40	Bacchus, UT
	STARS 48 motors	Elkton, MD

Table 5

SRM Industrial Capabilities

Prime Level

The ability to produce SRMs and respond to the Department's needs requires industrial capabilities in three essential areas: experienced design engineering personnel, a current touch labor workforce with production facilities, and a viable subtier supplier base that can provide design-unique materials and components. The types of facilities and personnel are similar across SRM manufacturers in function but are different in size and complexity. The major SRM industrial capabilities process areas can be separated into structures, propellant mixing, propellant cast and cure, inspection, final assembly and test. Some of the SRM industrial capabilities common at the prime contractor level include the workforce and facilities necessary for producing SRM case structures, mixing the SRM propellants and pouring the propellant into the case, inspecting the SRMs for bond line and propellant anomalies before and after completion of propellant cure, assembling the SRM into a finished product, testing the system for performance and environmental compliance, and ensuring quality assurance. For the small SRMs, the prime contractor may decide to buy cases instead of producing them, but the general list of characteristics is the same. Table 6 lays out the general industrial capabilities necessary to produce large and small SRMs.

PRODUCTION PROCESSES FOR LARGE AND SMALL SRMS	
SRM Production Process Area	**Process Operations**

Structures	• Case
	  ○ Composite case manufacturing
	  ○ Metal case manufacturing
	  ○ Electron-beam welders
	  ○ Ovens and autoclaves
	  ○ Insulation manufacture, assembly and cure
	• Nozzle
	  ○ Nozzle ablatives manufacturing
	• Nose fairing

Propellant Mix	• Propellant mixing • Oxidizer grinding • Fuels dispensing • Sampling
Propellant Cast/Cure	• Installing SRM case in casting pit • Evacuating pit • Positioning propellant mix bowl • Pouring propellant • Vacuum casting propellant • Curing SRMs in pit
Inspection	• Non-Destructive Inspection for bond line & propellant anomalies • Ultrasonic • X-ray • High energy computed tomography (HECT)
Final Assembly	• Assembly, integration and testing • Final assembly and check-out
Test	• Static test firings • Environmental test

Table 6

Large SRMs

The large solid rocket motor manufacturing facilities in the United States are located at ATK (Bacchus/Promontory, Utah) and Aerojet (Sacramento, CA). This number is down from two decades ago when there were five major vendors. The Department anticipated the downsizing of the industry. Studies ten years ago concluded that there was extensive overcapacity in the industry and some downsizing was necessary, inevitable and probably desirable. The studies also anticipated that a robust commercial space market was in the offing (the private communications market was on a fast growth curve at the time) and that SRM demand for satellite launch would compensate for the reduction in military orders. However, this scenario did not materialize. Additionally, strong foreign competition emerged limiting the commercial opportunities for U.S. companies. The distinguishing characteristics that separate the large SRMs from the small SRMs in large part are associated with the added complexity of size.

Small SRMs

The small SRM manufacturing facilities in the United States are located at ATK (Elkton, MD, and Naval Industrial Reserve Ordnance Plant (NIROP) Allegany Ballistics Laboratory (ABL) in Rocket City, WV) and Aerojet (Camden, AR).

Minuteman III Unique Industrial Capabilities

The MM III SRM is based on designs developed beginning in the 1950s with various modifications resulting in the original production buy ending in the late 1970s. The MM III production historic profile is given in Figure 20.

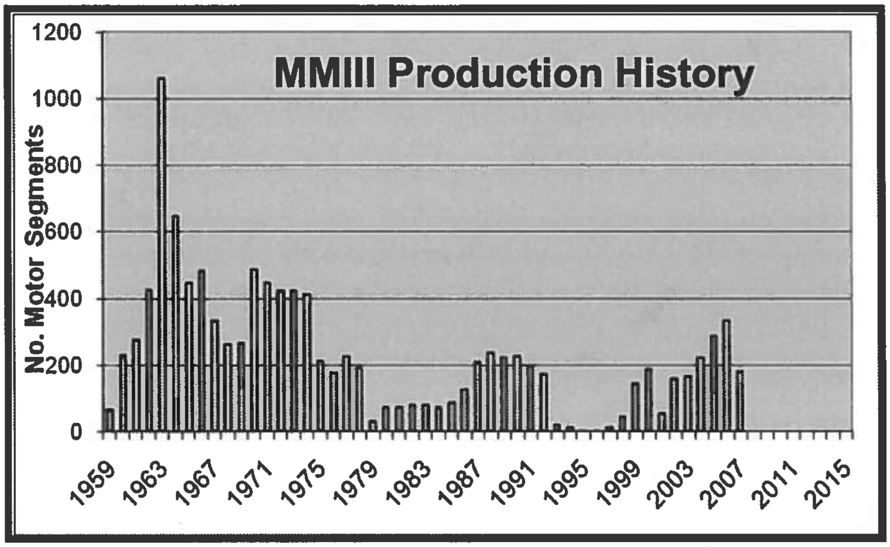

Figure 20

MM III SRMs have many unique characteristics, manufacturing skills and processes, and subtier suppliers that are not supported by other SRM programs. According to the SRM prime contractor, the MM III, D-5, and Shuttle RSRM share approximately 25 percent of their respective supplier bases. The Shuttle RSRM has man-rated requirements and is a reusable system resulting in little to no commonality with the manufacturing and processing systems used in the MM III. The Trident D-5 has a more energetic propellant than the MM III due to the low volume constraints for each SRM which drive significant differences in all manufacturing processes. In addition, the D-5 and commercial market systems use modern state-of-the-art designs with more automated processes making them vastly different from the MM III process and design.

Immediately following the conclusion of repouring MM III stages 2 & 3 in the early 1990's, the Air Force elected to undertake an RDT&E program to address age related degradation and take advantage of evolving technology opportunities rather than immediately return to repouring the stages. The RDT&E program was complex as the contractor was working with a 50-year old design. Specifically, the RDT&E effort was established to address the following issues:

1) Eliminate environmentally prohibited materials (asbestos and Freon);
2) Qualify replacement materials (combination of design changes and manufacturing sources);
3) Incorporate current technologies (transducers, pressure switches, casting, etc.).

The RDT&E effort was a $328M four year program, followed by low rate initial production beginning in FY99. Full-rate production for the Propulsion Replacement Program (PRP) began in 2001. The MM III PRP program comes to an end in FY 2009.

The MM III SRM stages possess unique design and processing characteristics. These 50 year old designs were reproducible only after seven years of development work to recreate the knowledge base necessary for production. Technical understanding of these systems again will decay upon completion of the MM III PRP. Many of the current components may not be reproducible due to obsolescence, and the design expertise necessary to evaluate new material qualification requirements may not be available.

Trident II D-5 Unique Industrial Capabilities

The D-5 is the latest in a line of Navy submarine launched ballistic missiles (SLBMs). Figure 21 shows the different generations of Navy booster systems: Polaris (A3), Poseidon (C3), Trident I (C4) and Trident II (D-5). SLBMs have been in continuous production at ATK (Bacchus/Promontory, UT) since the 1960s with the exception of the A3 First Stage (manufactured at Aerojet/Sacramento). The Navy accomplished this through a well planned and executed series of overlapping development and production programs that combined the latest technological advances with a solid track record of operational success. In this way obsolescence and significant service life issues were minimized. The Trident II D-5 SRM is nearing the end of its design life of twenty-five years on early production missiles that began in 1987. The D-5 Life Extension Program was instituted to address this issue, as well as other missile component life issues.

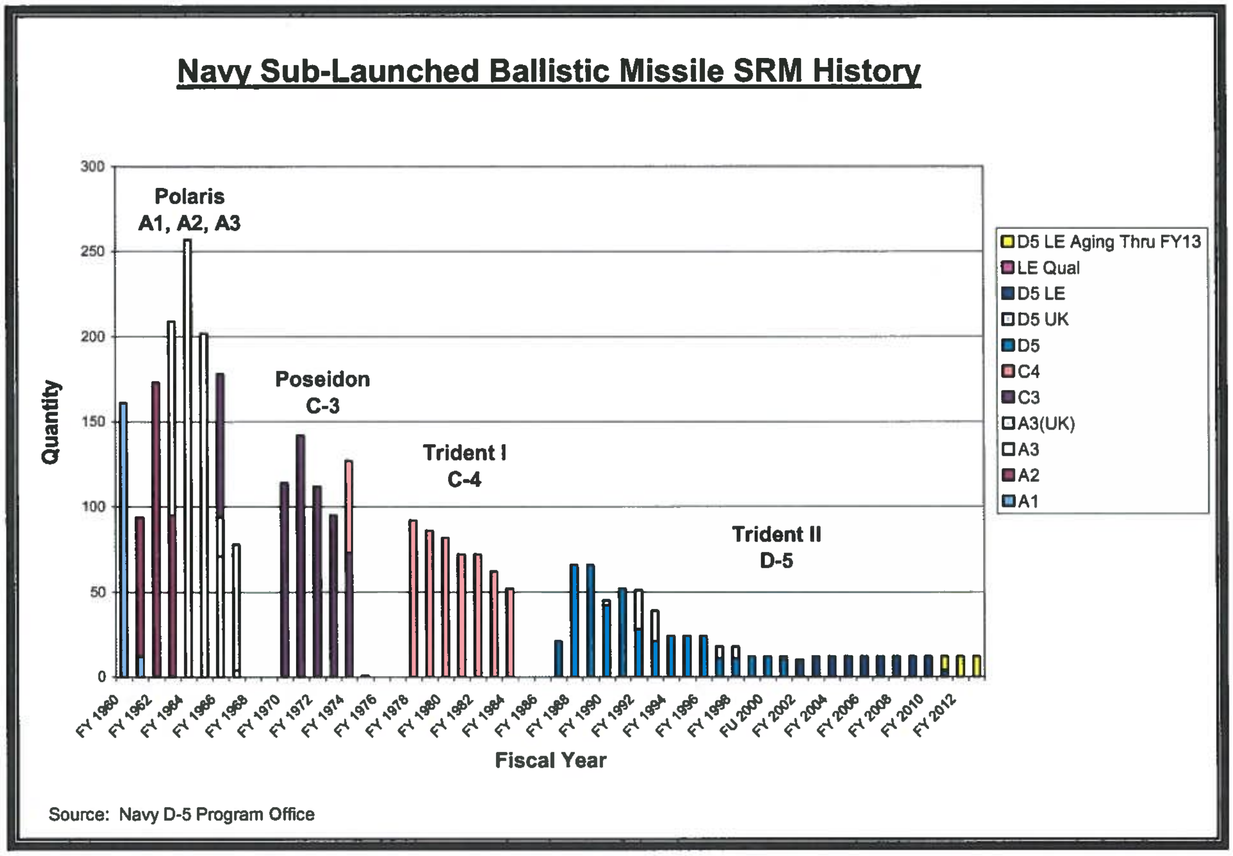

Figure 21

Like the MM III, the D-5 has unique SRM industrial capabilities and characteristics not supported by any other program. The specific requirements for submarine operations drive the need for many of these unique capabilities and skills. The solid propellant must meet high safety criteria because the submarine is a manned platform. The D-5 propellant is a nitrate ester polyether (NEPE) formulation. The D-5 requires this formulation for its high energy and high strain characteristics. The NEPE propellant requires unique manufacturing skills and facilities that are resident at the Bacchus facility.

SRM Industrial Risk Areas

Engineering/Workforce

Declining markets for the development and production of SRM programs will have a negative impact on the SRM industry's ability to maintain design engineering teams and production processes necessary to support current and future SRM requirements. While ATK and Aerojet currently are able to sustain their workforce, both expressed deep concern with their ability to retain and attract the engineering, design, and labor workforce necessary to design, develop, and produce our next generation SRMs with the forecast of so few new SRM programs. Both have an aging workforce. While the total numbers for each company are different as ATK is substantially larger, both face the same "graying of the workforce" issue. This issue challenges the SRM industry with bringing in new talent as the market declines. The aging workforce issue is prevalent in both the engineering and the manufacturing skill sets.

As noted earlier in this report, there are many specialized and unique skill sets and production processes needed for SRM design, analysis, development and manufacturing. These technical skills can be skills needed for day-to-day sustainment of a deployed system; for solving technical problems that surface in an existing system; for modifying a system to extend its life or enhance its capability; or for designing, analyzing and developing a new system. These skills are not easily acquired. ATK experts believe that it takes up to five years to create a skilled SRM engineer and production worker.

The SRM industry is facing a severe "graying of the workforce" challenge as the average age of its engineering and manufacturing workforce is about 50 years old which could result in a large number of people choosing to retire in a short period of time. This will result in the loss of critical engineering and production skills as there is a limited talent pipeline to replace them. Even if there was sufficient talent in the pipeline, there are no new development programs to train and educate the next generation designers, engineers, and technical manufacturers.

Underutilized SRM facilities

The SRM industry has seen a significant consolidation over the last twenty years in terms of the number of companies now developing and producing SRMs. However, this has not resulted in an equivalent amount of reduction in the number of facilities. ATK acquired Thiokol which had 3 facilities that produced SRMs (Promontory, Elkton, and Huntsville) and Hercules which also had 3 facilities (Bacchus, ABL, and McGregor). Of those six facilities, four remain in production today with only the Huntsville and McGregor facilities being shutdown. Aerojet which had the Sacramento facility acquired ARC with its 3 facilities (Camden, Gainesville, and Orange County). All are still functioning with the Gainesville facility used primarily as an engineering complex for its smaller SRMs. United Technologies Chemical Systems Division's (CSD) Coyote facility closed after the two explosions in 2003. Therefore, eight SRM development and production facilities remain from an original eleven. Aerojet and ATK have taken steps to consolidate functions at their facilities to reduce duplication. While both Aerojet and ATK are actively consolidating operations within their facilities, it is not enough to maintain efficient utilization rates at their operating sites.

Time to Restart SRM Production

Restarting production operations for SRMs takes a significant amount of time and money. Once a program is shut down, even if the tooling is mothballed and the engineering and production processes are documented, a company cannot easily replace the in-depth process knowledge that is lost. Prime contractor experience indicates that from a warm base it typically takes 3-5 years to restart SRM production including subtier suppliers. If the Department needs to restart a program from a cold base, the time to reconstitute is estimated to be 6-8 years, if feasible at all.

As stated earlier, the MM III SRM took about seven years to get to full-rate production following a 20 year production gap for stage 1 and 1 and 3 years respectively for stages 2 and 3. ATK had warm production facilities from commercial launch platforms and the D-5 production. A significant part of the long restart time was due to the fact that the MM III stage 1 motor had not been produced for over two decades requiring significant development work to recreate the production processes knowledge base and subtier supplier management to requalify suppliers. The extended length of time between productions also required a large number of static tests.

When the Navy needed to restart the A3R SRM, the effort took six years to complete the necessary requalification. The A3 production had been out of production for more than 10 years which left three significant hurdles to overcome: material obsolescence, lost suppliers, and limited previous production process knowledge base. The material obsolescence problem occurred because many materials either were no longer available or in some cases could not be used due to stringent environmental laws. The A3 encountered subtier supplier issues because several suppliers no longer produced the necessary item or had gone out of business both of which required a substantial requalification effort. The A3 restart took six years despite the fact that the contractor was working from a warm base with an existing subtier supplier base. At the time, the Navy was still acquiring the Trident I C-4 program and the Trident II D-5 program was in development.

Government Regulations

The prime contractors developing and producing SRMs must comply with many different government regulations. Most of these regulations are derived from laws associated with the environment. The environmental laws that affect the SRM industry are:

- Resource Conservation and Recovery Act (RCRA): RCRA is a federal law that gives the Environmental Protection Agency (EPA) the authority to control hazardous waste generation, transportation, treatment, storage, and disposal.
- Clean Air Act (CAA): CAA is a federal law that provides the EPA with broad authority to implement and enforce regulations reducing air pollutant emissions.

- Clean Water Act (CWA): CWA is a federal law that protects the surface water quality in the United States. The law employs a variety of regulatory and nonregulatory tools to sharply reduce direct pollutant discharges into waterways.
- Emergency Planning and Community Right-to-Know Act (EPCRA): EPCRA established a national framework for EPA to mobilize local government officials, businesses, and other citizens to plan ahead for chemical accidents in their communities. EPCRA requires that facilities immediately report to appropriate state, local, and federal officials a sudden release of any hazardous substance that exceeds the reportable quantity.
- Toxic Substance Control Act (TSCA): TSCA is a federal law that provides EPA with the authority to require reporting, record-keeping and testing requirements, and restrictions relating to chemical substances and/or mixtures.
- Safe Drinking Water Act (SDWA): SDWA is the federal law that ensures the quality of American's drinking water. Under SDWA, EPA sets standards for drinking water quality and oversees the states, localities, and water suppliers who implement those standards.
- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA): CERCLA, commonly know as Superfund, is a federal law that provided broad federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment.

Compliance with these environmental laws requires the prime contractor to obtain permits that in some cases must be renewed (most renewals are required every 2 – 5 years) and might require periodic reporting (usual reporting periods vary from annual to every 3 years). Permit renewal is part of the business and usually is comprised of a lengthy and on-going process – even for active operations.

SRM prime contractors and their subtier suppliers face a significant restart risk if development or production operations cease due to gaps caused by cancelled or completed programs. Once development or production operations halt, the associated permits are ended. This is not a problem in some cases because there is little risk of reinstating a permit. However, there could be substantial cost and schedule risk associated with trying to reinstate some permits because permit reapplication may be a multi-year process and the governing body may not be willing to reinstate the permit at the previous level if at all. For instance, ATK explained that it would be highly unlikely for the State of Utah to re-permit open burning activities at current levels which is covered under the RCRA. These activities are necessary for static testing of development and production SRMs.

In summary, the prime contractors allocate substantial resources to maintain their environmental permits. If there are gaps in development or production operations, the contractors permits would lapse and it may be difficult to restart operations because they may not be able to get approval to reinstate the permits to support new contracts.

Subtier Level

The SRM industrial base has been evaluated several times over the past 10 years as mentioned earlier. All successive findings indicate that there is not enough business to sustain two large producers and their subtier suppliers. There is not adequate demand to allow the producers and their suppliers to have a consistent and favorable return on their investments. As a result, when there is a fluctuation in the demand there is a corresponding ripple effect through the supply chain. In many cases, the industrial problem areas are not at the SRM prime level but at the subtier supplier level.

In many defense sectors, the demand for industrial capabilities is supported not only by the defense market but also by the commercial market. Generally, the more commercial the sector, the less dependent the sector is on defense. There is no commercial market for missiles of any size and while there is a limited market for commercial space launch vehicles, foreign competitors dominate that business. This predominantly puts the sustainability burden of the SRM industrial sector on government space launch and defense SRM requirements at a time when both are declining. This scenario presents many challenges not only to the SRM prime contractors but also to the SRM subtier suppliers. Challenges include:

- Maintaining qualified sources
    - Industry is constantly facing the loss of sub-tier suppliers
        - Exits from the industry are often unanticipated by the higher tiers
        - Suppliers are one program cancellation or one catastrophe away from closing business lines
    - Qualification of a new supplier or production process takes time and money
    - Many subtier suppliers are either sole or single sources
    - Many subtier suppliers are foreign owned
- Keeping skilled labor current
- Preserving the production processes
- Surviving downturns in demand and SRM production
    - Sub-tiers are equally affected by the lack of new programs and the decline in current requirements as the SRM prime contractors
- Right-sizing facilities for the market
- Meeting delivery schedules

With all these challenges, the subtier suppliers and niche providers may opt to exit the SRM business with little or no warning rather than support an unprofitable business line. The blue box on the next page titled, "Low Level Subtier Supplier – Big Impact," describes how significant an SRM single or sole source supplier decision to exit the market can be to the industry. If the example supplier had exited the market, 43 programs would have been affected which would have required all the programs to qualify another source. And due to the nature of the SRM business, each system would have required its own requalification which would have accounted for possibly hundreds of millions of dollars and years of schedule delays.

Low Level Subtier Supplier—Big Impact

During a 2005 Missile Defense Agency (MDA) solid rocket motor (SRM) industrial assessment, Sartomer Company, Inc. informed the Department that it may be forced to leave the SRM business as early as the end of calendar year 2006. Sartomer, a sole source domestic producer, supplies the entire hydroxyl-terminated polybutadiene (HTPB) polymer used by DoD, NASA, and commercial space for solid rocket motor propellant and munitions. Sartomer produces two basic formulations of the HTPB; the HTLO product that is predominantly commercial and the R45M that is defense unique. Both are used in DoD solid rocket motors. Sartomer's production facility in Channelview, TX, needed between $7-15 million in capital investments to meet emerging Environmental Protection Agency requirements and make efficiency improvements. There were no additional domestic providers of this product.

Initially, Sartomer's parent company, Total, based in France, decided not to fund the required improvements due primarily to low profitability and their option to meet their commercial customers' needs from their foreign production sites. However, under current practices and procedures, the DoD/NASA programs using this product would be required to requalify the manufacturing processes of another source. Hence, if there were a change in the supplier for HTPB, those programs affected would incur substantial requalification costs and schedule delays.

The Department's practice is to only take action to maintain an industrial capability if the time or cost to regenerate that capability, once lost, would prohibit the Department from meeting its mission needs. The Department performed an assessment and determined that if Sartomer left the business, the impacts could have exceeded $100 million in costs and 18 months to several years in schedule delays.

The Department's SRM Task Force formed in 2006 reviewed the Sartomer issue and explored several options from doing nothing to finding ways for the Department to fund the required improvements to the Sartomer facility.

Before the Department decided on the way forward, Sartomer convinced its parent company to make the necessary investments and the Department was not forced to take any remediation actions. This example helps to emphasize the Department's position to encourage its prime contractors to resolve industrial capabilities issues.

The Department expects the system prime contractors to identify any industrial issues and then implement remedies to resolve them. Alternative means of obtaining supplies generally are not considered until all the prime contractor efforts have been explored or there is a crisis, i.e., a sole supplier announces his exit or reliance on an unreliable foreign supplier is unavoidable.

The SRM primes have identified a few subtier suppliers or materials they consider risk areas. Three of these risk areas are ingredients for the SRM booster. American Pacific is a sole source supplier that provides ammonium perchlorate (AP) for all government needs. Sartomer provides the HTPB binder discussed in the previous blue box. Copperhead Chemical provides Butanetriol Trinitrate (BTTN). The BTTN issue is discussed in the next blue box.

Limited Global Suppliers for Niche Products

Copperhead Chemical Company, located in Tamaqua, PA, is currently the only qualified source for Butanetriol Trinitrate (BTTN), a nitrate ester/plasticizer (part of the binder) used in the production of rocket motors for the Army's Hellfire, TOW-2, and Javelin missile systems. Butanetriol (BT) which is identified on the U.S. Munitions List (USML), is a chemical precursor needed by Copperhead to produce BTTN. Copperhead's previous BT source, Cytec Industries, discontinued production of the chemical in 2004. At that time, Copperhead acquired the remaining Cytec BT inventory and began looking for another supplier.

In 2007, the Army joined Copperhead in searching the globe for sources of BT. Only one source was identified that could produce at the quantities and quality required, Shanghai Fuda Fine Chemicals located in China. Section 1211 of the National Defense Authorization Act of 2006 has a prohibition on buying items listed on the USML from Communist Chinese military companies. Because Shanghai Fuda Fine is part of the defense industrial base of the People's Republic of China, it is a prohibited source.

The Secretary of the Army approved a waiver in November 2008 to allow the Army to buy BT from China on a one time basis. The Department is currently determining if additional waivers may be required because the International Traffic in Arms Regulation legislation states the Department cannot sell or buy items on the USML from specified countries and embargoed nations, including China.

The Indian Head Division, Naval Surface Warfare Center, has the remaining inventory of BT available for the production of BTTN. They originally acquired 20,000 pounds of BT for a program that was later canceled. Copperhead procured 10,000 pounds of Indian Head's BT in 2007. The Indian Head approved the Army request for the remaining 10,000 pounds from Indian Head which could sustain the Department's needs to March 2010.

The Army is working to develop a domestic source for BT. At this time, there are three organizations working to establish the capability to produce BT – ATK- Radford Army Ammunition Plant; Afid Therapeutics; and BAE-Holston Army Ammunition Plant – that could be used by Copperhead to produce BTTN.

If any of these suppliers left the market, the Department would face significant development and requalification costs. At this time, the AP and HTPB binder issues appear to be under control. The Department is carefully working through the issues associated with BTTN. Another risk area is for a rayon precursor material that does not have a supplier. The rayon precursor material was last produced by the North American Rayon Corporation (NARC) in 1997. The industry has been using a stockpile that is expected to run out around 2011. The SRM prime contractors, the Department and NASA are all working to qualify another source of material to fill the void. Rayon alternatives include C2 rayon prepreg manufactured by SNECMA Moteurs of France. This material has been qualified and flown on the Arianne V. Enka produces a textile rayon, similar to NARC, in Germany that has been qualified by the Shuttle program and also for the first, second and third stages of the D-5. The qualification of Enka, however, is for limited use in the exit cone region, not the throat area of the nozzles. The shuttle program is still using NARC for the throat material. MDA is currently qualifying Enka rayon for use on stages 1,2, and 3 of the Orion SRM used for the GMD program. MDA also is evaluating Lyocell which is manufactured by Lenzing.

In many cases, the subtier suppliers for the large and small SRM industries are the same. This is mostly a result of single sources at the materials level. For the most part, the subtier suppliers are able to provide the materials and produce the components needed by the SRM prime contractors. However, if the market continues to decline, the Department and SRM prime contractors can expect to see subtier suppliers choose to exit the SRM business.

SRM Issues/Concerns

As this report has pointed out, the Department, NASA, and the SRM industry are facing many challenges. Some of these challenges and issues are:

Limited Competitive Opportunities: The SRM industry has very few new competitive opportunities on the horizon. With the exception of the JAGM program, the only possible new program being forecast in the Department will be the DoD-wide CPGS concept demonstrator. The only other competitive opportunity is the Ullage Setting Motor on the NASA Ares I program. All other Ares SRMs have been competed and selected.

No Forecast for Future Systems: The Department does not forecast any new replacement for the MM III or D-5 for years. Without the forecast of future programs, SRM primes do not have the ability to retain or attract the high caliber designers, engineers, or labor workforce needed to design and produce DoD future systems.

Findings

- Both ATK and Aerojet have sufficient capacity, equipment, and expertise to compete for new programs in all business segments.
- The production demand for SRMs is declining:
  - The production demand for large SRMs (space launch, strategic missiles, and some missile defense programs) is significantly lower than historic levels primarily due to the completion of the NASA shuttle program, lower strategic requirements, the completion of the MM III PRP and the expectation of a commercial space launch market that never materialized.
  - The demand for missile defense programs is declining roughly 30 percent over the FYDP.
  - The limited commercial space launch business has strong competition from foreign suppliers.
- There are very few DoD opportunities on the horizon for SRM primes to compete for new systems – only the JAGM and the DoD-wide CPGS in the near term.

- There are no plans for a new strategic missile development as the expected operational lives of the MM III has been extended through 2030 and the Trident II D-5 to 2042.

- DoD funding levels for SRM S&T and R&D are declining significantly over the FYDP – 35 percent.

- Consolidation has occurred in terms of the number of prime contractors (five to two), but the actual rationalization of facilities has been limited affecting utilization rates at remaining facilities (11 facilities to 8 facilities remaining).

- In the large SRM sector, NASA programs (the Shuttle and the Ares) are still the key contributors to the viability of the SRM industrial base – prime and subtier.

- Large SRM facilities are experiencing low capacity utilization rates with little near-term projected demand to improve the current situation.

- There are a number of single and sole source suppliers in the SRM subtier sector.

- The SRM prime contractors have an aging workforce with the average age of both the production workers and the engineers around 50 years old.

- Firms at the prime and subtier levels express difficulty retaining skilled staff given low level of business demand.

- Two SRM materials are only available in rapidly dwindling inventories – BT and rayon precursor.

Conclusions

- The SRM industrial base – both prime and subtier suppliers –is capable of meeting most technological and production requirements.

- Inadequate investments are being made in SRM research and development, reducing the reliability and cost effectiveness of the SRM industrial base. If there are no new development programs, the SRM industry will continue to lose its capability to be able to design and produce new generation SRMs.

- The lack of meaningful production orders and limited development efforts for the next decade is not conducive to the long term well-being of the industry. The SRM industry needs deliberate government research & development (R&D) and production investments with corporate entities willing to invest in internal independent research and development (IRAD) to ensure the continued viability of the industrial base for the Department's current and future systems.

- The tactical and missile defense business segments, which generally use smaller SRMs, are positioned better to maintain their industrial capabilities in the near-term than the strategic and space launch business segments, which generally use large SRMs, because smaller SRMs are supported by multiple programs with more overall funding certainty than larger SRM programs.

- The limited competitive opportunities for SRM activities will make it hard for prime contractors to attract and retain a skilled engineering and manufacturing workforce which in turn will make it difficult to retain the design and engineering expertise necessary to develop and produce our next generation large and small SRMs.

- Delays in the NASA Ares program could have significant negative impact on the large SRM prime contractor industrial base and on some of the SRM subtier base, specifically material suppliers.

- While there has been consolidation at the prime contractor level, the low projected demand for large SRMs may cause ATK to consider rationalizing its large SRM facilities at Promontory and Bacchus to one for more efficient operations. A worst-case scenario from a competition standpoint would be further consolidation in the base reducing the number of primes from two to one. Where possible, government should coordinate its SRM activities to develop strategies that maintain competition.

- For Aerojet and subtier companies, liquid and non-rocket businesses help to keep SRM engineers engaged and absorb overhead costs.

- Foreign military sales (FMS) have had a positive impact on small SRM workload in the industry due to requests for tactical and missile defense weapon systems. However, FMS orders are not predictable and should not be expected to sustain the SRM industrial capabilities.

- Adherence to government environmental regulation, both domestic and foreign, has an adverse impact on the viability of the supplier base.

Report to Congress on the Solid Rocket Motor Industrial Base Sustainment and Implementation Plan
Redacted Version

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Washington, DC 20301-3020

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Solid Rocket Motor (SRM) Sustainment Plan

The Department of Defense (DoD) is providing this SRM sustainment plan to the congressional defense committees as directed in section 1078 of the National Defense Authorization Act, Public Law 111-84, dated October 28, 2009. This sustainment plan also documents the Department's implementation of the sustainment plan as directed by section 916 of the National Defense Authorization Act, Public Law 111-383, dated January 7, 2011.

The Department's primary objectives for the SRM Industrial Base Sustainment Plan are to: (1) sustain production capabilities for national assets; (2) keep critical design teams in place for future system needs; and (3) to the extent practical, preserve the option to satisfy new government demand in the future. For the purpose of this study, the DoD used pounds of propellant as an indicator of overall SRM industrial base viability. After careful analysis, the DoD concluded that it can achieve its sustainment goals through a combination of initiatives. The Department needs industry's cooperation to make the effort affordable: industry must first take the lead by "right-sizing" its excess capacity to align with projected demand. The DoD will then invest in SRM science and technology (S&T) and research and development (R&D) along with procurements each year of systems that will sustain the base.

The Department identified the resources within the DoD budget that implement the Department's Sustainment Plan for the SRM industrial base. The Defense budget includes funding for SRM S&T activities, the Air Force R&D Propulsion Application Program, and R&D funding for four defense missiles that are developing new SRMs or are modernizing older SRMs over the FYDP. The budget includes funding for the production of the Trident II D5 SRM motor sets and missile defense and tactical missile programs that contribute to sustaining the SRM industrial base. The budget also includes funding for EELV strap-on SRMs that helps stabilize the large SRM industrial base by purchasing a planned number of boosters each year. The SRM funding portion of the missile defense and tactical missile programs generally ranges between three to twenty percent of the acquisition cost of a missile program.

The DoD needs to sustain the SRM industry because the United States will continue to rely on SRMs over the long term. Large SRMs (40- to 92-inch diameter) propel all of DoD's strategic missiles. Solid rockets are by far the best technology for strategic systems because they offer rapid employment capability, long-term storability, and maximum safety. The recent Nuclear Posture Review described the Department's plan to preserve its strategic systems through the foreseeable future, thus reinforces the need to retain a SRM capability. The Department also uses SRMs for space launch, tactical missiles, and missile defense. Many of these uses require SRMs for the same reasons that strategic weapons require them. The sustainment plan takes advantage of these additional sources of demand to contribute to economic production levels and to hone design teams' technical capabilities.

The Department delivered an interim report in June of 2010 that provided the summary of the significant SRM market decline and discussed the DoD's activities and efforts to develop the SRM industrial base sustainment plan. Last year, the Department established an Interagency Task Force – with members from all the Military Services, Defense Agencies and NASA. The task force identified critical technical and production capabilities across a disparate DoD and NASA enterprise and determined whether the current and projected large-SRM requirements are sufficient to provide an adequate economic base to support those capabilities without intervention, then evaluated alternative business models that may better sustain the industry in the future.

Based on the analysis and findings of the Interagency Task Force, the DoD concludes:

(1) The Department must preserve the scientific, engineering and design skills and production capabilities necessary to support both large- and small-SRMs. The DoD cannot allow the SRM industrial base to shut down until DoD determines its next generation requirements because the potential expense and schedule delays of restarting the industry would be too great. The SRM production capabilities are needed to support the MM III through 2030 and the D5 through 2042.
(2) The Department relies on SRMs to meet many of its national security requirements. Specifically, the DoD must have large SRMs for propulsion of strategic missiles, as well as for heavy space launch applications, which are vital to its national security strategic deterrence mission.
(3) Industry must better align its capacity with the Department's current and future large-SRM market demand.
(4) The Military Services and Defense Agencies need to better define future needs for SRMs beyond the FYDP, at least through 2030, and then communicate those needs to the supplier base. The Office of the Secretary of Defense (OSD) needs to work across program and Service/Agency lines and remain involved in the deliberate management of this vital industrial sector.
(5) Production activities alone will not be sufficient to protect and/or restore critical technical and creative skills necessary for future missile development and current missile sustainment, regardless of what company or what facility executes the production. Research and development programs, such as the Air Force ICBM Demonstration and Validation program, are required to preserve SRM science and technology, engineering and design teams and their critical skills.
(6) The most efficient business model for the large-SRM industry is competition with continued rationalization. The upfront requalification and facilitization costs associated with natural monopoly or a government-owned/contractor-operated model are prohibitive.

While most of the Department's conclusions are directed at the large-SRM industrial base, production of smaller SRMs (less than 40-inch diameter) that are used in missile defense and tactical missile systems can also help sustain some parts of the industrial base. Overall, small- and large-SRM capabilities are not interchangeable. In most cases, large SRMs have size-driven production requirements for ingredient-handling equipment, mixers, casting pits, cranes, and testing fixtures. It may take several large mixing bowls to cast a single large SRM, adding significant complexity to the mixing, pouring, and casting processes. Smaller SRMs, on the other hand, use a common infrastructure that includes commercial handling equipment, cranes, and machining equipment. A single mixing bowl will pour many small SRMs. Furthermore, the design requirements for large and small SRMs also differ, in part because the longer burn times for the larger SRMs limit the materials that can be used. Large SRMs also need particular structural elements to manage vibration and stresses during the launch and boost phases.

Because of these different characteristics in design and production, small SRM demand, which has increased recently and will increase still further in the near-term program of record, will contribute to sustaining the SRM industrial base mostly at the subtier supplier level. Specifically, planned small SRM programs will purchase more than one million pounds of propellant per year.

OSD will continue its efforts with the Services and Defense Agencies to select an appropriate mix of SRM investments that will sustain the SRM industrial base. The DoD also will continue efforts to coordinate investment decisions with NASA to ensure that SRM industrial base sustainment is considered as part of all relevant programmatic decisions and will continue the SRM Inter-Agency Task Force activities: monitoring the SRM industrial base, identifying capability issues at the prime- and subtier- supplier levels, and jointly addressing mitigation options.