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INDUSTRY STUDIES
2000**Munitions****ABSTRACT**

When diplomacy fails, precision guided munitions (PGMs) will continue to be the weaponry of choice. Continuing improvements across the broad spectrum of munitions technology, including sensors, guidance, energetics, composites and fuzing have produced an impressive array of air, sea and ground launched weapons.

Precision guided munitions will make the Joint Vision 2010 objective of full spectrum dominance a reality. PGM technology, however, is still developing. To leverage that technology, industry and government must continue to pursue new and fundamentally different ways of producing such weapons.

Acquisition and other regulatory reforms, enhanced research and development efforts, and a fundamental shift in how we think about munitions production and management are all essential to an effective munitions industrial base in the 21st century.

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PLACES VISITED

Domestic

Air Armament Center, Eglin Air Force Base, Florida

Army Research Laboratory, Aberdeen Proving Grounds, Maryland

Naval Surface Warfare Center, Indian Head, Maryland

Atlantic Research Corporation, Gainesville, Virginia

The Boeing Company, St. Louis, Missouri

Intercontinental Manufacturing Company, Garland, Texas

Lockheed-Martin, Dallas, Texas

Raytheon Missile Systems, Tucson, Arizona

International

The Association of Swedish Defence Industries, Stockholm, Sweden

FOA Defense Research Establishment, Grindsjon, Sweden

FOA Defense Research Establishment Underwater Research, Stockholm, Sweden

FOA Defense Research Establishment University Campus, Linkoping, Sweden

Celsius Bofors Underwater Systems, Motola, Sweden

Celsius Bofors Weapon Systems, Karlskoga, Sweden

Daimler-Chrysler Aerospace, Schrobenshausen, Germany

Diehl, Nonweiler, Germany

Rheinmattal, Celle, Germany

INTRODUCTION

We will move toward a common goal: a joint force- persuasive

in peace, decisive in war, preeminent in any form of conflict.

Joint Vision 2010

Nothing better supports the tenets of Joint Vision 2010 than precision guided munitions. The application of new technology has led to the evolution of the operational concepts of warfare from the traditional functions of maneuver, strike, protection and logistics to the full spectrum dynamics of **dominant maneuver, precision engagement, full dimension protection, and focused logistics.**^[1]

Munitions enable **dominant maneuver** by providing America's weapon platforms with first round kill capabilities at ranges that far exceed the opponent's ability to accurately return lethal fire. Technological leaps in guidance, sensor, targeting and fuzing systems, combined with newer generation stealth capabilities, allow **precision engagement** with effectiveness and accuracy that was unfathomable just a decade ago. Munitions today can not only target a specific building in a city, but they can now also operate autonomously, flying a preprogrammed route to the building with a fuze that will detonate the warhead on a specific floor. Similarly, current and developing interface technologies ensure synchronization across multiple systems, which provides **full dimension protection** for the entire force. Finally, advances in energetics, kinematics, and miniaturization technologies form the foundation for greater but less logistically demanding firepower to support JV2010's **focused logistics** vision. Increased precision and lethality in smaller packages means smaller in-theater logistics footprints and fewer lift requirements.

The munitions industry study program examined the development, testing and production of military munitions in the United States and abroad. Special emphasis was placed on the precision guided munitions that have played such a major role in recent national defense policy. The industry group met with American and European government and private sector representatives of the munitions business in order to evaluate the overall health of the munitions industrial base. Because of

the increasing importance of precision guided munitions, the seminar spent more time visiting and studying the laboratories that develop PGM technologies and the firms that produce those weapons. Specific areas of concern were singled out for further review and analysis and are addressed in detail in the "Essays on Major Issues" portion of this study paper.

THE INDUSTRY DEFINED

Without munitions, military aircraft are simply unscheduled airliners.

- - USAF Munitions Officer

The munitions industrial base consists of two separate but distinct sectors. The first is a legacy of World War II and the Cold War. The focus of this part of the industrial base is high volume production of propellants, explosives, and unguided weapons in a cost-contract environment. The second part of the munitions base applies new technologies in explosives, propellants, and seekers to produce "smarter," more lethal weapons. These weapons are produced in smaller numbers because of their higher cost and heavy reliance on ever-changing technology. Both parts of the industrial base are often found together on the same installation. At the Navy's weapons center at Indian Head, Maryland, for example, World War II-era techniques and equipment operate alongside modernized facilities used to test Tomahawk missiles. This mixing of the old and the new makes it difficult for government and industry officials to trim the industrial base down to its key components.

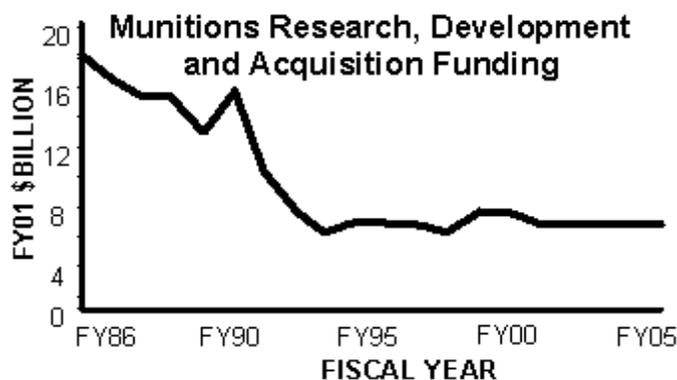
The wholesale munitions stockpile includes over 3.2 million short tons at an acquisition cost of \$32.8 billion in support of all services. To meet the nation's current and future munitions requirements, the industrial base includes government-owned/government-operated (GOGO), government-owned/contractor-operated (GOCO) and contractor-owned/contractor-operated (COCO) facilities. Today, only three GOGO facilities remain, Crane Army Ammunition Activity, McAlester Army Ammunition Plant, and Pine Bluff Arsenal. Private firms under contract to the government manage GOCO facilities. An example is Raytheon Missile Systems in Tucson, Arizona. The U.S. Air Force owns the plant and facilities and Raytheon produces the missiles. Other government-owned facilities are in layaway. COCO facilities, such as the Lockheed-Martin operation in Dallas, Texas, have the capability to support a vast range of advanced munitions for domestic or international use. Since the COCOs primarily support the precision guided category of munitions, we will focus on that part of the industry.

CURRENT CONDITION

The means of destruction are approaching perfection with frightful rapidity.

- - General Henri Jomini, 1862

Like other defense sectors, the munitions business is also facing numerous challenges. Commercial demand for energetics is relatively small, so the U.S. government is essentially the sole customer. Budget impacts, concerns with production and overhead costs, ever-improving technology, and the pressures for “better, cheaper, quicker” have had a dramatic impact on both government and private components of the munitions industry. Though remnants of the older munitions industrial base still exist, and some facilities are producing energetic materials and propellants basically the same way they were produced decades ago, the PGM part of the base is different. Programs such as the Joint Direct Attack Munition (JDAM), Joint Standoff Munition (JSOW), and Joint Air-to-Surface Standoff Weapon (JASSM) are using innovative management and production techniques to produce very sophisticated weapons at prices that were thought impossible just a decade ago.



Over the last two decades, the number of government and contractor owned munitions facilities declined sharply, to the point where the Department of Defense and Congress targeted funding to help stabilize the industry in the mid 1990's (see chart below [ii](#)). Today, Lockheed-Martin, Raytheon and Boeing are among the few remaining major

players in the PGM business, significantly less than the 22 companies active just a few years ago. In many cases, they sub-contract much of their business to smaller second- and third-tier manufacturers. As prime contractors essentially performing system integration, they have reduced their need for capital investment and therefore their financial risk.

Precision guided munitions are not a service unique commodity. Their accuracy and lethality have resulted in paradigm shifts in not only what munitions future forces will program for, but also in the doctrines affecting how these munitions will be employed. Each service has procurement actions programmed or in process to support one or more surface-to-air, surface-to-surface, air-to-air or air-to-surface munitions. These current or projected acquisition programs ensure the health of the precision guided munitions industry well into the future. Major precision systems currently fielded or under development are highlighted below.

Surface Launched. In the surface-to-air business, Raytheon is the major producer and is responsible for the Stinger, Hawk, and Patriot systems, while Lockheed-Martin has been involved in the development of the Theater High Altitude Area Defense (THAAD) system. The desire for a multi-service air defense system has led to HUMRAAM tests, currently ongoing. The HUMRAAM mounts multiple Advanced Medium Range Air-to-Air Missile (AMRAAM) missiles on a HMMWV, providing a versatile, portable and extremely lethal combination. In the surface-to-surface arena, the

Navy Tomahawk and Tactical Tomahawk, produced by Raytheon, are the premier missile systems. Both versions are fire and forget, but the tactical model has enhanced avionics and datalink capability that provides the system the option of loitering over the battlefield while awaiting final targeting instructions. Ground missile systems include the Line-of-Sight Anti-Tank (LOSAT) system, which provides ground forces tremendous capability in the near fight, the Guided Multiple Launch Rocket System (GMLRS) and the Army Tactical Missile System (ATACMS). GMLRS and ATACMS give the ground commander tremendous deep strike capability.

Underwater Systems. This segment of the munitions industry is a study of contrasts between the domestic and international sectors. The domestic industry is experiencing a gap in procurement, with no new systems being bought by the U.S. Navy. Modification programs are now the sole source of industry work. The Mark 48 (heavyweight torpedo) and the Mark 54 (Lightweight Hybrid Torpedo) modifications will have to sustain the domestic industry until the end of the decade. A ray of hope for this sector is the planned privatization of the Intermediate Maintenance facility in Hawaii, which will provide a new source of income.

The international sector is in much better health, with several new programs in production. The most notable of these is the Saab Aerospace Torpedo 2000, which is achieving success in the international market. There is still a great deal of overcapacity in the sector, and consolidation should occur in the next few years as countries abandon protection of domestic companies.

Air Launched. Raytheon is the major player in air-to-air missiles. Systems include the AIM-120 Advanced Medium Range Air-to-Air Missile (AMRAAM), an all-weather, radar-guided anti-air system that can be launched beyond visual range of the target. For shorter ranges, the AIM-9X has enhanced range and greater maneuverability, which allows a much wider target acquisition envelope than before. U.S. air superiority in our most recent engagements has essentially negated the need for any near-term development of new generation systems. Air-to-surface munitions include Boeing's AGM-130 Surface Attack Guided Munition, a rocket powered, retargetable, standoff weapon using inertial navigation and global positioning systems. This weapon was first employed during Operation Desert Fox in 1998 and served as an interim system until sufficient quantities of the Joint Direct Attack Munition (JDAM) were fielded. JDAM incorporates a low-cost guidance kit that converts conventional bombs currently in the inventory into extremely accurate, fire and forget weapons. Lockheed-Martin's Joint Air-to-Surface Standoff Missile (JASSM) is another standoff weapon designed for heavily defended, high priority targets. The range of JASSM allows employment of the weapon outside the air defense capabilities of the opponent. Raytheon's Joint Standoff Weapon (JSOW) is a low-cost glide system that uses inertial guidance and a low-drag airframe to allow highly lethal target strikes at long ranges. Research and development efforts in the air-to-surface arena include munitions used against chemical/biological agents and hard/deeply buried targets (HDBT). European nations are also developing a medium range cruise missile to compliment their Eurofighter and Grippen military aircraft. DaimlerChrysler Aerospace is producing Taurus, a very capable autonomous weapon that maximizes the use of off-the-shelf components and a newly developed hard target penetrator.

The number, variety, and successful performance of these systems demonstrate the creativity and quality of the firms producing PGMs. Foreign developers and manufacturers, impressed with U.S. technology, are eager to work with U.S. government laboratories and firms such as Lockheed-Martin. At the same time,

foreign governments – like the U.S. government – are closing and consolidating government-owned munitions facilities. Overall, the number of private developers of precision guided munitions is declining even as the military value of such weapons is growing.

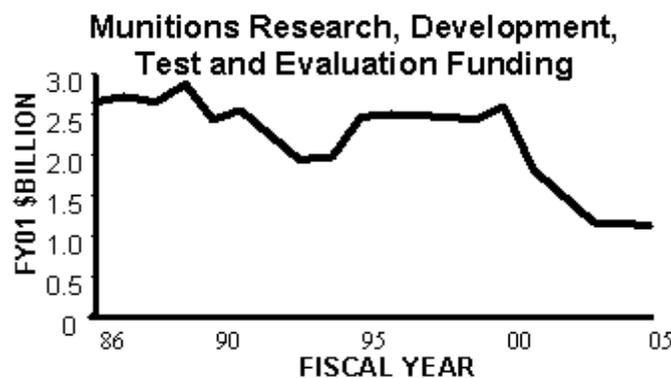
CHALLENGES

The ultimate measure of a man is not where he stands in moments of comfort, but where he stands at times of challenge and controversy.

- - Martin Luther King, Jr.

Munitions Management. A common theme during our study concerned the need for a single munitions point of contact among the services. Separate but redundant management stovepipes exist within each service, creating problems of coordination within and among the services. A unifying management structure would significantly enhance inter/intra-service coordination.

Increasing Global Competition. Overseas, allies who have traditionally relied on U.S. systems are moving to their own munitions and weapons platforms. This trend is partly attributable to Europe's desire to maintain an organic military aircraft and munitions industry. Another key factor is the impact of export licensing agreements in a shrinking global arms market. A European fighter equipped with a U.S. missile, for example, would give the United States veto authority over any proposed export. Future efforts to integrate U.S. and allied weapons platforms and munitions must strike a balance between controlling technology release and foreign sales.



Labs and Research and Development. To maintain technological superiority on the battlefield, we must continue to invest in research and development. U.S. government laboratories possess excellent facilities and intellectual capital. Of vital concern, therefore, is the precipitous

decline in munitions research, development, test and evaluation (RDT&E) funding in the outyears, from over \$2.5 billion in FY00 to less than \$1.5 billion in FY05 (see chart at left [\[iii\]](#)). Without an aggressive RDT&E program, the U.S. stands in danger of losing the technological edge it has maintained over the last several decades.

Acquisition Reform. There is greater domestic munitions production capacity than is necessary. As a result, the number of firms manufacturing munitions has declined drastically. However, ongoing acquisition reform initiatives, including government/industry teaming and price-based acquisition, may preserve this piece of the nation's defense industrial base.

OUTLOOK

Never tell people how to do things. Tell them what to do

and they will surprise you with their ingenuity.

- - George S. Patton

Munitions planning has undergone significant change over the last several decades. Before 1976, the Services stored enough ammunition to meet initial combat requirements until the industrial base could surge. Incremental modifications to this guidance through Program Objective Memorandum (POM) directives issued in 1978, 1979 and 1980 gradually moved the industrial base away from surge planning towards replenishment operations^[iv]. The replenishment policy was based on a "come as you are" scenario, with the industrial base restocking what the warfighters use in one fight to get them ready for the next.

A byproduct of this guidance was the significant downsizing of the conventional munitions industrial base. Between 1978 and 1995, GOGO ammunition production facilities declined 50 percent, from six to three. GOCO facilities came down 77 percent, from 26 to six, and COCO's decreased from 256 in 1978 to only 52 in 1995 - a reduction of over 82 percent^[v]. Shrinkage of the base also led to the establishment of special interest coalitions such as the Munitions Industrial Base Task Force (MIBTF). The MIBTF represents the surviving U.S. munitions manufacturers and is chartered to ensure the viability of the domestic munitions industrial base.

Recent industrial base studies have differed on the impact of these reductions. Some studies have indicated that the industrial base decline has significant readiness implications while others conclude that the base is still adequate to meet current requirements. Regardless, continuing budget reductions and declining ammunition requirements have significantly affected the industry. Uncertainty about future conventional munitions requirements is driving the commercial manufacturers from the conventional munitions base.

A slightly different perspective exists for precision guided munitions. The Gulf War, as well as conflicts in Bosnia and Kosovo, confirmed the devastating effectiveness of precision guided munitions. The ability of a system to attack at long ranges and strike a target with surgical precision, while minimizing crewmember

exposure and collateral damage, makes precision guided munitions extremely desirable in almost all conflicts.

In light of their effectiveness, international demand for precision guided munitions has increased and will continue to do so in the next several decades. The United States currently enjoys a significant technological edge over foreign competitors for a number of reasons, including the desire for interoperability with the United States, proven performance, competitive pricing, and weapon system support after procurement.

However, as our visits to Sweden and Germany confirmed, strong international competition is not far behind. Reduced demands in their own countries means international arms manufacturers must seek markets outside their own borders. Foreign governments openly support efforts to make their manufacturers more competitive by guaranteeing export loans, providing financial incentives to customers, assisting in marketing efforts and limiting export restrictions on military equipment^[vi].

GOVERNMENT GOALS AND ROLE

Government is not reason, it is not eloquence, it is force; like fire, a troublesome servant and a fearful master. Never for a moment should it

be left to irresponsible action.

- - George Washington

Retargeting Limited Research and Development (R&D) Resources.

Contractors readily admit R&D spending is almost exclusively limited to that paid for by the government. Commercial investment is focused on providing the potential for maximum profit, and is usually limited to projects with the potential for major production runs. Most modern munitions, however, are limited to very small production runs. For this reason, manufacturers do not now have sufficient internal funds to invest in major research and development efforts. Yet precision guided munitions have begun to alter the conduct of war. Not only does one shot mean one kill (or multiple kills); the potential target set has significantly expanded. Weapons systems today have pinpoint accuracy and cause minimal collateral damage, providing U.S. forces an offensive initiative across the entire theater. These opportunities must be leveraged to the fullest extent possible. The Department of Defense must evaluate the current prioritization of R&D dollars to maximize the effectiveness of both weapon platform and munitions. Retargeting limited R&D resources to ensure the maximization of weapon platform/munition effectiveness is a step in the right direction.

Foreign Military Sales. The current trend in European arms manufacturer

consolidations is bound to increase competition for the U.S. in munitions sales overseas. Congress should aggressively attack problems in export approval procedures. Specific initiatives should include expediting requests for arms export licenses, access to export financing and government support for private marketing efforts[vii].

Acquisition Reforms. The numerous, low volume procurement programs within the munitions industry make it ideal for testing acquisition reform initiatives. Concepts such as price-based acquisition, warranties, altering progress payment methodologies, and the utilization of integrated process teams could be thoroughly tested and evaluated with planned munitions programs before being implemented throughout the Department of Defense.

The near term assessment is that the precision guided and conventional munitions industry can support the national resource strategy requirements of the nation. Downsizing of the governmental and commercial munitions sectors has reduced the number of inefficient production facilities. Congressional and DoD efforts to maintain minimum funding levels have been essential in ensuring viability of the remaining base. Peripheral problems with unique munitions components provided by second- and third-tier suppliers will continue. Constant monitoring and evaluation is essential. Lack of inter- and intra-service coordination, unwillingness to integrate munitions and weapon systems, munitions management inefficiencies and the long term effects of inadequate R&D funding will degrade the munitions base unless adequately addressed in the near term.

ESSAYS ON MAJOR ISSUES

Munitions Management: The Need for an Ammo Czar

One of the most critical commodities on any battlefield is ammunition. As military force structures evolve to meet future threats, the types and quantities of ammunition must also change. These fluctuations in ammunition requirements have a tremendous impact on budgets, procurement strategies and the responsiveness of the munitions industry.

To meet these future challenges, a responsive, proactive munitions management structure is required. This focal point – an “ammo czar” – would serve as the single voice for the Department of Defense (DoD) on all munitions related issues and concerns, from the early phases of research and development through the entire life cycle of the munition until usage or demilitarization. Advantages of an integrated system include reduced parochialism, elimination of excess munition procurements, enhanced stability within the commercial industry and overall cost savings.

Ammunition management has been undergoing methodical, evolutionary change. Before 1977, each service managed its own bullets and had individual

procurement, accountability, and stock control programs. To reduce duplication, the DoD designated the U.S. Army as the Single Manager for Conventional Ammunition (SMCA). The SMCA is responsible for the acquisition and management of conventional ammunition items such as small arms, bombs, mortars, and other general purpose ammunition, in addition to providing wholesale storage and accountability, maintenance, renovation and demilitarization support for these items.[\[viii\]](#)

While the Army manages conventional ammunition (the so-called “dumb” bombs), service program managers continue to retain responsibility for unique items, particularly precision guided munitions. Examples of munitions programs still individually managed by the services include Navy torpedoes, Air Force air-to-air missiles and Army land combat missiles. In dollar terms, the SMCA essentially manages less than one third of the annual \$5-6 billion research, development and acquisition (RDA) munitions funding. The majority of the RDA account is not managed by the single manager, but rather by individual munitions system program managers within each of the services. These stovepipe management structures result in numerous inefficiencies, most notably duplicative efforts. These problems are exacerbated by the lack of a common automation system that provides real time visibility of munitions across all services.

The DoD and Congress have been slowly moving the services toward a more integrated, synergistic management structure. To standardize how services computed their munitions requirements, DoD established a Capabilities Based Munitions Requirements (CBMR) system in the mid-1990's. The CBMR provided consistency among the Services in munitions, force structure, and modernization by establishing a common methodology for computing munitions requirements.[\[ix\]](#) Congress has also been actively involved in the munitions business. In the FY1999 Authorization Bill, Congress introduced legislation to help protect the domestic munitions base. Section 806 of the Authorization Bill requires the SMCA to limit proposed munitions procurements to national sources for all ammunition items or components determined essential in cases of national emergency or mobilization.

These initiatives toward improving munitions management within the DoD should not be viewed as culminating events, but rather as the initial steps in what should be an ultimate objective of a single DoD Munitions Manager. Integrating the individual service munitions programs would be difficult, but not without precedent. Concerned with the numerous uncoordinated biological and chemical defense programs throughout the services, Congress mandated, in the early 1990's, under Public Law 103-160, the consolidation of all individual service programs under the DoD Chemical and Biological Defense (DoD CBD) Program. The success of the DoD CBD is worth studying and applying as a model to the munitions arena.

Clearly, how we manage our bullets needs to change in order to take advantage of the opportunities for synergy among the services. Additional study is needed – not to determine **if** an integrated munitions management structure is needed, but rather **how** and **when** the changes will be implemented.

Lieutenant Colonel Mike G. Mullins, USA

Advanced Technology Munitions Are Key to Achieving Joint Vision 2010

The JV 2010 tenets of precision engagement, dominant maneuver, full dimension protection and focused logistics will be achieved through the fielding of new weapons, tactics and force structure. Advanced munitions will be key to achieving the JV 2010 force. Technological advances will allow the fielding of munitions with superior capabilities in packages that are greatly reduced in size. These 'brilliant munitions' will provide the military that first fields them a clear advantage and, in doing so, shape its structure.

While technology has improved munitions capabilities for some time, the miniaturization of high technology devices will have a tremendous impact in the near future. MicroElectroMechanical Systems (MEMS) technology takes sophisticated systems and miniaturizes them to the microscopic level. Examples of these electrical and mechanical systems in the commercial sector include inkjet printer cartridges, accelerometers for deploying car airbags, and miniature robots. Today this is a \$10 billion dollar industry, and it is expected to grow to \$34 billion by 2002.

MEMS technology being investigated in defense laboratories will allow small munitions to achieve results previously attained only by weapons such as cruise missiles. At the Naval Surface Warfare Center, Indian Head, for example, MEMS technology is being used to reduce the size of a torpedo arming circuit. Indian Head expects to reduce the circuit to roughly 10% of its former size. At the Army Research Laboratory, MEMS technology is being hardened to withstand the tremendous forces experienced by projectiles. Specialized laboratory test equipment can test circuits under the full flight profile of a projectile. These efforts will result in techniques for fabricating robust MEMS.

Complimenting the advance of MEMS technology is the tremendous increase in processing power being developed by the commercial information industry. This increase in processing power will lead to a rapid growth in munitions capability. This increase in processing power allows even small weapons to act in a sophisticated way. This means that formerly "dumb" weapons can handle the outputs of increasingly sophisticated sensors. One example of this growth in capability is the use of laser detection and ranging, known as LADAR. LADAR can generate a detailed picture of a target. When compared to a signature database carried by a

sophisticated munition, real targets can be distinguished from decoys, and shooters can let their weapon select a target autonomously, without fear that it will miss or attack the wrong objective.

Warhead technology is also advancing rapidly. Systems are on the horizon in the United States and Europe that employ warheads with multiple modes. A warhead of this type possesses the capability to detonate with effects tailored to the target it is trying to destroy. The Low Cost Autonomous Attack System (LOCASS) that is under development by the U.S. Air Force and Lockheed-Martin incorporates a multi-mode warhead that can produce an armor piercing slug or dispersed fragmentation as selected by the missile. The Bofors division of Saab Aerospace has developed a 40 mm round with miniaturized processing that allows the gunner to select one of four modes - air burst, armor piercing, anti-personnel or hard target penetration - just prior to firing. This is the first step in the next phase of munitions development - one that will usher in brilliant munitions in all sizes and applications.

The handwriting is on the wall. Technology on several fronts will come together to give munitions unimaginable capabilities. However, this technology is commercial and not exclusive to the United States or NATO. These weapons will begin to appear worldwide. If the United States and its allies invest wisely in these systems, our munitions will preserve our technological edge and provide the capabilities required to achieve JV 2010.

Mr. Don Hoffer, Department of the Navy

So Why Are We Buying All Of These Cool New Bombs and Missiles When We're Throwing Away Old Stuff??

Though arguably in the process of demobilization after the end of the Cold War, the United States continues to purchase billions of dollars worth of munitions every year. At the same time, the U.S. stockpiles hundreds of thousands of tons of munitions that are obsolete or otherwise unusable. The stockpile has expanded in recent years with the closure of overseas bases and the downsizing of the military and associated weapons requirements. Those tons of munitions require millions of dollars each year to maintain, secure, monitor, inspect, and store. In addition, the closure of many of the Army's old arsenals has placed storage room for newer weapons at a premium. Obviously, there is a need to eliminate, or demilitarize, unneeded munitions.

These are munitions that have reached the end of their service life, those that are obsolete in terms of performance, such as anti-tank rounds that are ineffective against

current armor, and those that were built for weapons platforms no longer in service, such as the old 105mm main battle tank gun. Possibly of more immediate concern are those weapons that are physically deteriorating. In high temperature storage conditions, for instance, liquid can leach out of rocket motors.

In the U.S. military, the Army provides worldwide management and disposition of weapons systems. Of the approximately 3.2 million short tons munitions stockpile, the Army estimates over 500,000 tons require demilitarization, and that quantity is rising every year. In FY95, the Army estimated it would cost \$120 million to destroy about 100,000 tons of weapons. As environmental requirements become more stringent, those costs continue to rise. Although the demil budget has increased from \$35 million/year in FY95 to \$100 million/year through FY01, this is still not enough to allow the Army to achieve its goal of reducing the stockpile to less than 100,000 short tons by the end of FY04.

Previously acceptable methods of demilitarization, especially open burning and open detonation (OB/OD), are generally no longer appropriate. Environmental issues and community concerns dictate that the munitions community develop better methods of munitions disposal. These methods can include complete destruction of the weapon. However, in some cases basic resources can be recovered and essential weapons components recycled. For example, the Munitions Directorate at Eglin Air Force Base is exploring high-pressure water washout systems to reclaim bomb casings and old energetic materials.

The conventional ammunition demilitarization problem has not attracted the publicity or notoriety of the chemical weapons destruction program. In many cases, demil is viewed as a local issue. Sometimes this has been an advantage. For instance, in 1998 Senator Sessions of Alabama specifically earmarked \$6 million to build an Explosive Demilitarization Technology Program at Anniston Army Depot. This facility will test commercial off-the-shelf blast chamber technology to determine if it is a feasible alternative to OB/OD; it will also increase the throughput of weapons compared to traditional destruction methods. Anniston officials estimate the blast chamber is 80% cleaner than OB/OD, fulfilling environmental goals.

While the Army has traditionally performed its own OB/OD activities, it is now using DoD laboratories and other ammunition authorities to study elements of this dilemma. DoD has placed contracts with a variety of commercial firms to determine better methods of demilitarization in order to solve the associated problem of environmental remediation of munitions activities. For instance, a contract was awarded to a commercial firm to work with Indian Head Division, Naval Surface Warfare Center, to examine the feasibility of reusing energy from waste energetic materials to produce steam and electricity. The Army would also like to incorporate waste energetics, including TNT and possibly PBX, as fuel for DoD industrial boilers.

Other countries face the same issue as their munitions inventories are drastically reduced and their militaries rearm with more modern weapons. In northern Europe, environmental concerns are at least as stringent as in the U.S., so those countries also

continue to search for more modern methods of destruction. Of particular interest overseas are the huge stockpiles of weapons left after the breakup of the USSR.

The demilitarization problem worldwide will grow as militaries move to more modern weapons and older munitions deteriorate. DoD has significantly increased funding for demil programs, including research, and these funding levels will have to be maintained to ensure old munitions and their huge infrastructure requirements make way for modern munitions the military will use in the 21st century force.

Lieutenant Colonel Terri Meyer, USAF

Foreign Military Sales - A Time for Change

An area of the defense industry especially hard hit by the last decade of downsizing and budget reductions is ammunition. With the end of the Cold War and the gradual shift away from massive mobilization requirements, munitions funding significantly declined. Between 1978 and 1995, the number of ammunition production facilities dropped almost 80 percent. Companies that were once major defense players, such as GTE, Texas Instruments and Westinghouse, recognized the economic warning signs and have either significantly reduced their programs or gotten out of the business altogether. As more and more companies depart the defense sector, there are indirect impacts on the government. Fewer companies means less competition and reduced capacity for surge production in the event of a major conflict. Foreign Military Sales (FMS) is one possible solution to ensure the future livelihood and responsiveness of the munitions industry.

FMS is a government to government program that facilitates the sale of U.S. defense materiel and services to a foreign nation. For the U.S., foreign sales are an important part of our defense industry, involving billions of dollars and hundreds of thousands of jobs for American workers, in addition to being an instrument of foreign policy. Before the Arms Export Control Act (AECA) of 1976, the President retained all policy-making authority for foreign military sales. Because of the foreign policy implications of FMS, the AECA placed authority over the program in the Department of State and gave Congress the power to review State Department decisions.^[x] Without these controls, the danger of unconstrained proliferation and regional instability could quickly mount.

Foreign arms sales provide a number of benefits to the U.S. government including lower unit prices and active production lines that can accommodate surge and replenishment requirements. Additionally, FMS provides the added benefits of

readiness and interoperability among our allies. That these benefits are significant was shown by recent coalition operations in Europe. At the same, these same operations revealed a growing disparity in defense capabilities between the U.S. and our allies. In “Europe Must Close Technical Gap”, John Hamre, U.S. Deputy Secretary of Defense, attributed the gap to several factors. First, the U.S. spends considerably more on defense - \$283 billion versus a combined NATO total of \$188 billion in FY99 dollars. Second, restrictive U.S. export controls tend to undermine cooperative efforts.^[xi] The difficulty in getting export licensing permits caused DASA (DaimlerChrysler AG’s aerospace group), for example, to begin a policy of phasing out dependence on U.S.-made components.^[xii] A recent Inspector General report validated DASA’s concern, criticizing the State Department for not adequately resourcing its own Defense Trade Controls Office, which is responsible export licenses. According to the IG report, the time required for processing an export license has doubled since 1993, and further delays are expected with the expansion of the commercial satellite industry.^[xiii]

There is general agreement on the need for reforms in international sales procedures. The Department of State and the Department of Defense are currently reviewing a number of proposals. At a recent senior leadership meeting on export control reform, the National Defense Industrial Association proposed several initiatives, including limiting licensing requirements and establishing an independent government agency to provide oversight and guidance.^[xiv] Although an independent agency is unlikely, it is important that industry also be involved in the reform process.

While the government needs to address ways to streamline the licensing process, the key to a successful program is the teaming of industry, defense and state department representatives early in the weapons development process. Unless clearly prohibited (as in the case of weapons of mass destruction), export control arrangements should be acknowledged early on so that industry can engineer the necessary controls to support international sales. Any plans for future cooperative, international development and production efforts should be addressed early with key industry and government players. By getting the primary decision-makers involved from the beginning, military program managers ensure “buy-in” and alleviate any potential problems further down the road.

FMS must shift from being an afterthought to being part of a program’s initial acquisition strategy. FMS must be flexible, customer oriented and streamlined. Such a shift in thinking by both industry and the government will be mutually beneficial. It will provide economic stability to the commercial industry while giving the government an industrial base that can respond in times of peace or war while simultaneously supporting our allies.

Lieutenant Colonel Mike G. Mullins, USA

Undersea Weapons

The munitions sector that produces undersea weapons for the U.S. Navy is in extremis. The two remaining torpedo manufacturers, Raytheon and Northrop-Grumman, had been sustained by weapons modification/modernization contracts after new torpedo production was completed in 1997. Raytheon has captured the lion's share of new contracts (MK48 Heavyweight torpedo modernization; improvements and MK54 Lightweight Hybrid Torpedo program) and Northrop-Grumman's ability to compete for future awards is declining as work winds down on existing contracts.

Northrop-Grumman could leverage its work on other undersea platforms (including sonars and small submersibles) to retain limited expertise until the Navy begins acquisition of the next generation of undersea weapons late in this decade (IOC 2020). The Raytheon MK54 lightweight hybrid torpedo modification program mates existing MK46 torpedo propulsion units with newly manufactured MK50 guidance sections (MK50 production ended in 1997) and new software adopted from MK48 Improvement programs. However, even this program will end before the next generation of weapons enters production, leaving Raytheon with a dilemma: to save or cut its torpedo engineers and artisans.

Overseas, four new-generation torpedo programs are in production (UK-Spearfish, Sweden-Type 62, Germany-SEAHAKE, and the international-Eurotorp Mu90). However, the number of new programs paints an overly optimistic picture of the state of Europe's torpedo sector. The fact that three different heavyweight torpedo programs are in production for a limited market indicates that national interests still take priority over market forces.

British Aerospace could lead European consolidation in this sector as it owns large interests in all four programs (35% share of Saab Aerospace-Type 62, 49% share of STN Atlas-SEAHAKE, 100% of GEC-Marconi-Spearfish, and a share of the Mu90 through its 49% share in Thomson-Marconi Sonar). All future European torpedo programs will likely be joint ventures (like Eurotorp) to spread development costs among participating nations and to decrease unit procurement costs.

The torpedo sector offers a tremendous opportunity for future international cooperation. Although the timing of the U.S. Navy's next generation of torpedoes may not fit European acquisition profiles, it should be structured as an international program to leverage Europe's advances in torpedo technologies (especially propulsion).

Commander Paul Plescow, USN

Munitions Interoperability

Desert Storm was one of the most successful air campaigns in the history of air

warfare. So effective were the aerial strikes and preparation of the battlefield that the ground war lasted a mere 100 hours. Air Force, Navy, and coalition air assets pounded enemy targets with a surprisingly low attrition rate. Precision guided munitions and stealth effectively demonstrated the superior capabilities of the U.S. military and its industrial base.

However, upon closer examination, there are things the U.S. military could have done differently to improve its combat effectiveness and efficiency. The lack of interoperable air-delivered munitions contributed to inefficiencies in its ability to destroy ground targets. The Navy expended their limited supply of GBU-24s.^[xv] The Air Force had additional GBUs available for Navy use. However, these bombs did not meet the Navy's munitions insensitivity specifications. As a result, the Navy was unable to use the Air Force munitions and the opportunity to fully use Navy attack assets was lost, and overall combat effectiveness suffered.

This case highlights the issue of interoperability between our nation's air forces. In general terms, there are three areas where interoperability is a problem. The first of these is the issue of insensitivity, commonly known as "insensitive munitions." The other two are electromagnetic interference and munitions structural integrity.

Insensitive munitions are an issue of great concern to the Navy. Navy personnel are in the unenviable position of having to sleep and work in close proximity to their munitions. The Navy has spent a lot of money to reduce the sensitivity of the explosive fill used in its munitions. Contrast this with the Air Force's use of tritonal (which contains TNT) as a standard fill for their bombs. The main consideration in fill choice is the higher cost of the less sensitive fill, which the Air Force does not feel it can afford to pay. The cost of insensitive Navy fill is nominally 2 to 3 times more expensive than tritonal.

The Navy's electromagnetic environment often places more stress on air-delivered munitions than that faced by the Air Force. Both the Navy and Air Force are very concerned about the electromagnetic interference (EMI) between munitions and aircraft. However, the Navy must also address EMI between munitions and electronic systems on ships. It is imperative that munitions systems do not interact with ship's electronic systems, causing inadvertent initiation of the munitions fuze. Again, this is a cost consideration and design factor not applicable to the Air Force.

The same is true for structural requirements as with EMI. Navy operations involve catapult launches, carrier landings with unexpended ordnance, and saltwater corrosion. Air Force munitions need not meet all of these stringent requirements.

The above aspects of interoperability must be considered as new munitions are developed. The Air Force's Combined Effects Munition and the Sensor Fuzed Weapon are currently not compatible with Navy aircraft. One must ask if developing a new weapon system employable by only one service is a good idea. It appears counterintuitive for the Air Force to develop two single service weapons in an era where "jointness" and efficiencies are the watchwords. Perhaps the Joint Requirements Oversight Council is the proper review authority for such future development efforts. This would ensure that service interoperability considerations receive careful consideration for munition acquisitions. Consolidated munitions requirements management would not only improve interoperability, it would also reap the benefits of economies of scale.

Lieutenant Colonel Greg Owen, USAF

Lieutenant Colonel Dave Schiller, USAF

CONCLUSION

. . . victory over all enemies will be achieved in the last analysis not only by the bravery, skill, and determination of our men, but by our overwhelming mastery in the munitions of war.

- - Franklin D. Roosevelt, Jan '42

The munitions industrial base can support the national resource strategy of our nation in the short term. Continued emphasis on management, research and development, and acquisition reform will ensure the dominance of the industry on the world stage well into the 21st century.

Limited capabilities to surge precision guided munitions production requires a reevaluation of the existing base to determine the proper mix of government and commercial industrial capability. The demand for precision guided munitions will continue to dominate our efforts, but we must also continue to ensure viability of the conventional munitions base.

The government and commercial sectors of the munitions business are averse to risk, reflecting a general reluctance to pursue revolutionary concepts. Integrated munitions management, retargeting of R&D resources, acquisition reforms, and foreign military sales improvements are all essential modifications that will help the munitions base retain its economic viability. It will only be through the aggressive and proactive management of the munitions industry that our nation will be able to realize the Joint Vision 2010 vision of full spectrum dominance.

Sources:

[i] [Joint Vision 2010](#), (Wash, DC, Government Printing Office, undated), p. 19.

[ii] Source: "PB01 Conventional Munitions Total RDT&E and Procurement", OUSD(AT&L),

undated.

[iii] Source: "DoD PB01 Conventional Munitions Total RDT&E", OUSD(AT&L), undated.

[iv] U.S. Government Accounting Office Report, "Ammunition Industrial Base: Information of DOD's Assessment of Requirements" (Wash, DC, U.S. Government Accounting Office, May 1996), pp. 2-3.

[v] Ibid, p. 5.

[vi] Larry Skibbie. "Sales of Defense Systems Abroad Critical to National Security", National Defense (Alexandria, Virginia, April 2000), p. 2.

[vii] Skibbie, p. 2.

[viii] Dennis Zimmerman. Economic Retention of Ammunition Items (McLean, VA, Logistics Management Institute, Jun 98), pp. 2-2 to 2-3.

[ix] "Capabilities-Based Munitions Requirements (CBMR) Process", Department of Defense Instruction (DODI) 3000.4, USD(A&T), 16 Jun 97.

[x] "The Arms Export Control Act of 1976: A Twenty Year Retrospective". Internet. <http://www.lib.utexas.edu.Libs/PAL/pr2/1996/j453.html>. 18 Apr 00.

[xi] John Hamre. "Europe Must Close Technical Gap". Janes. Internet. http://www.janes.com/defence/editors/euro_gap.html. 21 Apr 00.

[xii] Tony Capaccio, "DaimlerChrysler Aerospace Bars U.S.-made Components". Bloomberg News. 29 Oct 99. Internet. <http://www.auto.com/industrywire/quwirb29.htm>. 20 Apr 00.

[xiii] Ibid.

[xiv] "Industry Issues Dominate U.S. Policy Agenda", National Defense, (Arlington, VA, National Defense Industrial Association, Apr 00), p. 43.

[xv] Marvin Pokrant. Desert Storm at Sea, Number 175 (Westport, CT, Greenwood Press, 1999), Chapter 16.

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