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Missiles for Standoff Attack: Air-Launched Air-to-Surface Munitions Programs

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Missiles for Standoff Attack: Air-Launched Air-to-Surface Munitions Programs

Summary

Increasing the standoff range of air-delivered munitions and improving their accuracy and lethality have become matters of major emphasis in U.S. defense plans since the 1991 Gulf War. The 1999 conflict in Kosovo especially highlighted the value of air-to-surface munitions that could be launched from safe standoff ranges and guided to their targets with precision.

Since cancellation in late 1994 of the Tri-Service Standoff Attack Missile (TSSAM) program, various alternatives have been proposed, including development of a new missile or a derivative of currently operational missiles. This report focuses six air-to-surface munition programs: the Joint Air-to-Surface Standoff Missile (JASSM) the Standoff Land Attack Missile Expanded Response (SLAM-ER), the Joint Stand-Off Weapon (JSOW), the Conventional Air-Launched Cruise Missile (CALCM), and the AGM-142 and AGM-130 missiles. All of these weapons are launched from aircraft, in contrast ships and ground-based missile launchers.

The Defense Department's FY2001 budget included requests of $122.3 million for JASSM and $27.9 million for SLAM-ER as well as requests for other standoff munition programs such as JSOW ($284.7 million) and AGM-130 (about $100 thousand). Appropriations conferees recommended funding SLAM-ER as requested, reduced the JASSM request by $4 million and increased the JSOW request by $6.4 million. These standoff munitions programs were funded in FY1999 and FY2000 essentially as requested, with minimal differences between the House and Senate in regard to these programs; however, there are continuing differences between the Air Force and the Navy as to funding priorities and military requirements for JASSM, SLAM-ER, and JSOW.

Issues before Congress include the relative cost and performance of these missile systems; tradeoffs between performance and cost that may be acceptable; perceptions of inventory requirements; emphasis on development of standoff munitions at the expense of other defense programs; and whether derivatives of current munitions should be procured pending development and production of more advanced standoff missiles that may be needed in post-2010 threat scenarios.

The quest for capable and affordable standoff air-to-surface missiles poses a number of interrelated issues for Congress in evaluating the proposed alternatives: (1) the advantages of an entirely new design versus a derivative of currently operational munitions or designs in full-scale development; (2) acceptable tradeoffs between perceived performance requirements in regard to range, payload, accuracy, and stealth; (3) projected inventory requirements for future combat scenarios; (4) the development and production costs and the delivery schedules of proposed alternatives; and (5) reliance on interim standoff munitions pending development of new systems.

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Introduction

Increasing the standoff range of air-delivered munitions and improving their accuracy and lethality have become matters of major emphasis in U.S. defense plans since the 1991 Gulf War and its aftermath of sporadic air attacks on Iraq, which highlighted the value of air-to-surface munitions that could be launched from safe standoff ranges and guided to their targets with precision. The value of such munitions was further demonstrated by operations in the Balkans in 1995 and 1999. During NATO's 78-day air campaign against Yugoslavia (March 24-June 10, 1999) 35 percent of the munitions delivered were precision-guided munitions (PGMs), compared to 10 percent of those used in the 1991 Gulf War.[1]

The downsizing of U.S. forces in the 1990s also underlined the need for more effective and accurate standoff weapons for a smaller force structure in high-threat situations, where the advent of more effective air defenses is expected to make delivery of air-to-surface munitions increasingly difficult. Moving some of the tasks of weapons delivery from the aircraft to its munitions is seen as an effective way to attack a well-defended enemy with reduced risks to U.S. and allied forces.[2] Similar results can be achieved with sea-based or land-based missile systems that are not considered in this report on air-launched air-to-surface munitions.[3]

Standoff missiles with high accuracy and lethality raise the possibility of precision strikes deep in enemy territory with less risk of U.S. and allied casualties and less likelihood of collateral damage to civilians. Advocates of programs to develop such weapons have emphasized their greater standoff launch range – intended to keep U.S. and allied forces out of harm's way – as well as their joint use by two or more services – expected to reduce unit cost via shared development and high-volume procurement. In general, however, the greater the standoff range, the more expensive the missile.

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[1] U.S. Reliance on Precision-Guided Munitions Grows Dramatically. *Aerospace Daily*, April 19, 1999. p. 98-99; Nordeen, Lon. NATO's Arsenal. *Air Forces Monthly,* June 1999. p. 28-34.

[2] Goodman, Glenn W. Mining Silver Bullets – Navy and Air Force Pursue longer Range, Autonomous Standoff Weapons. *Armed Services Journal International*, July 1997. p. 26.

[3] The Navy's sea-based Tomahawk missile is discussed by Ronald O'Rourke in CRS Report RS20162, *Cruise Missile Inventories and NATO Attacks on Yugoslavia: Background and Information*, April 20, 1999. 6 p. The Army's land-based ATACMS is discussed by Robert Shuey in CRS Report 96-427 F, *Smart, Precision-Guided, and Other Guided Conventional Weapons: Information on U.S. programs*, May 10, 1996. 40 p.

Moreover, improvements in the accuracy and lethality of precision-guided munitions (PGMs) also entail more cost and complexity, although the procurement cost is somewhat offset by the smaller number of PGMs needed to destroy a target.[4]

Efforts to develop munitions with greater range, accuracy, and lethality have faced many obstacles, including competing budgetary priorities, major technological problems, and differing perceptions of service requirements in regard to types and inventories of munitions. Maintaining program continuity to develop workable and affordable systems has thus been a major challenge. Commonality of munitions to be launched by air/sea/land-based platforms has often been frustrated by conflicting service requirements for weight, safety, guidance, and communications. For example, weight is more critical for air-delivered munitions than land- or ship-based munitions; safety factors are more critical aboard ship than on airbases; and the services often use different guidance and communications systems. Effectiveness in adverse weather or darkness and resistance to jamming or other countermeasures also pose serious technological challenges to the development of standoff munitions.[5]

The development and procurement of precision-guided air-launched standoff munitions has been linked to the issue of buying more than the currently projected number of B-2 stealth bombers (long-range strategic aircraft). Based on an Institute of Defense Analyses (IDA) study of future bomber requirements, the Defense Department concluded in May 1995 that it would be more cost-effective to develop and procure more accurate standoff munitions than to buy more B-2 bombers. Advocates of continued procurement of the B-2 challenged the conclusions of this study, however, arguing that munitions programs have generally been underfunded in the past and are not likely to be adequately supported in future years. Some General Accounting Office (GAO) analysts have also questioned the affordability of currently projected inventories of standoff missiles and precision-guided munitions (PGMs), arguing that these may not be as inexpensive to develop and procure as predicted and questioning projected inventory requirements.[6]

It has also been argued that standoff missiles and PGMs, if procured in adequate quantities, could reduce requirements for stealth technology in new aircraft, such as the F-22 and F/A-18E/F and the proposed Joint Strike Fighter (JSF). According to this view, munitions with greater standoff range would not require as much stealth (radar evasion features) in the launch aircraft, yielding considerable savings in aircraft cost. Proponents of next-generation combat aircraft argue, however, that stealth aircraft programs assume the use of more advanced standoff PGMs and that more

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[4] Braybrook, Roy. Surgical Precision from a Safe Distance. *Armada International*, May 1994. p. 8-10; Morrocco, John. PGM Strategy Faces Budget, Technical Traps. *Aviation Week & Space Technology*, February 27, 1995. p. 44-47; Nash, Trevor. Stand-off and Deliver. *Armada International*, August/September 1996. p. 48-49.

[5] Cooper, Pat and Hitchens, Theresa. GPS Jamming Dulls U.S. Smart Bombs. *Defense News*, June 19-25, 1995. p. 1, 52.

[6] DOD Won't Buy More B-2s; Will Start TSSAM Follow-on, B-2 Upgrade. *Aerospace Daily*, May 4, 1995. p. 185-186; U.S. General Accounting Office. "*Weapons Acquisitions: Guided Weapon Plans Need to Be Reassessed.* GAO/NSIAD 99-32. December 9, 1998. p. 20-26.

advanced fighter/attack planes will be needed for the most combat-effective use of whatever standoff munitions may be available, given the problems of technology and cost in acquiring PGMs. The numbers of PGMs procured have often been reduced in the face of questionable performance, rising costs, or competing budgetary priorities that tend to favor aircraft over munitions.

Finally, it must be noted that the focus of this paper (precise air-to-surface missiles) should not be interpreted as either advocacy for, or an indication of a movement totally away from "dumb bombs" in the U.S. arsenal. It is expected that unguided or less than precisely guided air-to-surface weapons will continue to be the weapons of choice well into the foreseeable future for a variety of target sets. In general, military planners wish to destroy a given target with the least expensive weapon possible (i.e. seeking to avoid "killing a fly with a sledge hammer."). "Dumb bombs" cost less (in some cases much, much less) than PGMs, and will remain as effective or even more effective than PGMs against stationary, un-hardened targets where collateral damage is not likely. Also, area munitions such as bomblets and combined effects munitions will long remain effective against highly mobile targets such as infantry and armor.

Tri-Service Standoff Attack Missile (TSSAM) Program

The AGM-137 Tri-Service Standoff Attack Missile (TSSAM) was to have been a stealthy cruise missile launched from Air Force and Navy aircraft as well as Army launchers. Weighing about 2,300 lb with a 1000-lb warhead, it could have attacked heavily defended targets at ranges of over 100 miles, and its all-aspect stealth features would have made radar detection from any direction difficult if not impossible.[7] When the TSSAM program was canceled it was in full-scale development by the Northrop Grumman Corporation.

Development began in 1986 as a classified tri-service program for the Air Force, Navy, and Army, with these services then planning to procure some 9,000 missiles over five years. In 1994, however, the Army withdrew from the TSSAM program, stating that its requirements for a long-range surface-to-surface missile would be better served by the MGM-140 ATACMS (Army Tactical Missile System), which was used in the 1991 Gulf War. By 1994, the TSSAM program's projected quantity was down to 4,156 missiles (3,631 for the Air Force; 525 for the Navy), which would be procured over 11 years.

With development and test problems delaying the program about three years, the estimated program cost rose from $8.9 billion in 1986 to $13.9 billion by late 1994 ($4.9 billion for development and $9 billion for procurement and military construction). The procurement cost of each missile rose from an estimated $728,000 in 1986 to an estimate of more than $2 million in 1994. Some $3.5 billion had been

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[7] Zaloga, Steven J. AGM-137 TSSAM. In his *World Missiles Briefing*. Teal Group Corp., December 1994.

spent in full-scale development when the TSSAM program was terminated by the Defense Department on December 9, 1994.[8]

Current Precision-Guided Munition (PGM) Programs

Defense analysts generally agree that some future combat scenarios will require better air-to-surface munitions than those currently available.[9] Since cancellation of the TSSAM program, Air Force officials have emphasized that the service still needs a standoff attack missile with similar characteristics that can be procured at lower costs. According to this view, such a missile would enable launch aircraft to attack high-value and well-defended targets while staying beyond the range of enemy defenses, which are expected to be more robust than those of Iraq in the1990s, given the availability of Russian air defense capabilities such as the SA-10 surface-to-air missile system as well as some advanced European and Chinese air defense systems.

The search for affordable and effective standoff missiles has involved derivatives of operational or developmental missiles that can provide some of TSSAM's promised performance at an acceptable cost. Such derivatives would be used in the interim prior to successful development and fielding of a new Joint Air-to-Surface Standoff Missile (JASSM) for the Air Force and the Navy. Air-launched standoff munitions that can be used in this way include the Navy's Standoff Land Attack Missile Expanded Response (SLAM-ER), the Navy/Air Force Joint Stand-Off Weapon (JSOW), and the Air Force's AGM-86C Conventional Air-Launched Cruise Missile (CALCM), AGM-142 Have Nap missile, and AGM-130 rocket-powered bomb – all of which were used effectively during NATO operations against Serbian forces in Yugoslavia in 1999.[10] None of these except CALCM have the standoff range that JASSM is expected to provide; however, the Defense Department has cited SLAM-ER, JSOW, CALCM, and AGM-130 as programs that will correct some of the shortcomings noted by the General Accounting Office in its critique of U.S. weapons used during the 1991 Gulf War.[11] JASSM and other air-launched standoff PGMs that have been discussed and supported by Congress and the Defense Department since the mid-1990s are reviewed below. For additional information on these missiles, see CRS Report 96-427 F by Robert Shuey.[12]

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[8] U.S. General Accounting Office. *Missile Development – Status and Issues at the Time of the TSSAM Termination Decision*. GAO/NSIAD 95-46. January, 1995. p. 5-7.

[9] Sweetman, Bill. Dossier: CASOM. *International Defense Review*, April 1995. p. 69-70.

[10] Arkin, William M. Kosovo Report Short on Weapons Performance Details. *Defense Daily*, February 10, 2000. p. 2.

[11] U.S. General Accounting Office. *Operation Desert Storm – Evaluation of the Air War*. GAO/PEMD 96-10. July 1996. p. 20.

[12] U.S. Library of Congress. Congressional Research Service. *Smart, Precision-Guided, and Other Guided Conventional Weapons: Information on U.S. Programs*. CRS Report 96-427 F, May 10, 1996. 40 p.

JASSM

The Air Force hopes to find an affordable alternative to TSSAM through the AGM-158 Joint Air-to-Surface Standoff Missile (JASSM) program, which got underway in April of 1995, when Air Force and Navy officials met with industry executives to develop plans for a missile costing about a fourth of TSSAM's estimated procurement unit cost. In April 1996, the Air Force projected a JASSM program of 2,400 missiles with an average unit procurement price of $400,000 to $700,000 (FY1995 $).[13] In December 1998, GAO analysts estimated the total production cost of 2,400 JASSMs at $1,288.8 million current or then-year dollars ($537,000 per missile).[14]

The Defense Department's quarterly Selected Acquisition Report of June 30, 2000, projected a total cost of $2,101.4 million (current or then-year $) for 2,482 JASSMs, including development and production versions ($815,000 per missile). Funding for the program in FY1996-FY2000 totaled some $645 million, including an estimated $166.4 million in FY2000 ($164.4 million in Air Force R&D funds and $2 million in Navy R&D funds). The FY2001 defense budget requested $122.3 million (including $2 million in Navy R&D funding) for the program.

Led by the Air Force, the JASSM program is a joint-service effort to develop a missile to be carried initially by Air Force F-16s and B-52s and later by such aircraft as Air Force B-1s, B-2s, F-15Es and F-117s and possibly by Navy F/A-18E/Fs. The F/A-18E/F was originally expected to use JASSM, but the Navy has not funded the necessary modifications for the missile to be launched by the F/A-18E/F.[15]

The Navy's lack of interest in the JASSM program is due to the fact that the Navy has an alternative in an ongoing upgrade of its Standoff Land Attack Missile (SLAM), known as the SLAM-ER (Expanded Response) version. After TSSAM's demise the Navy shifted its funding for TSSAM into the SLAM-ER program, although since FY1998 Navy funds earmarked for TSSAM have been used in the JASSM program. The Navy's procurement of JASSMs was projected in 1996 as just under 1,000 missiles, with the SLAM-ER being used to meet near-term requirements. (SLAM-ER is discussed in the next section below.)

On June 17, 1996, the Air Force selected Lockheed Martin and McDonnell Douglas (now part of Boeing) for a two-year competition for the JASSM program in which to define their proposed missiles in terms of performance, technology, and

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[13] The procurement price refers to the missile's production cost but does not include research/development and other program costs.

[14] U.S. General Accounting Office. *Weapons Acquisitions – Guided Weapon Plans Need to Be Reassessed.* GAO/NSIAD 99-32. December 1998. p. 40.

[15] Burgess, Lisa. DoD Advances JASSM Despite Navy's Lack of Enthusiasm. *Defense News,* November 16-22, 1998. pp. 4, 36; DoD Sees Options If JASSM Costs Grow. *Aerospace Daily,* November 23, 1998. pp. 300-301.

cost.[16] On April 9, 1998, Lockheed Martin Integrated Systems in Orlando, FL was selected for development and production of its version of JASSM, beginning in FY1999 with a 40-month engineering and manufacturing development (EMD) phase approved on November 9, 1998, and expected to lead to initial production by FY2002. Air Force officials described Lockheed Martin's entry as superior in every respect, and its bid of $275,000 per unit in a buy of 1,165 missiles was well below Boeing's bid of some $390,000 for each of 195 missiles.[17] Some officials in the Defense Department's Cost Analysis and Improvement Group (CAIG) have estimated the missile's unit cost at around $375,000, which would still be less than the 1996 procurement price goals of $400,000 to $700,000 per missile.[18]

The Air Force views affordability as important as capability in the JASSM program, with the three most critical performance features being the missile's range, its mission effectiveness, and its ability to be launched from numerous and varied aircraft. Operational requirements have been described as including: standoff launch range outside the enemy's area defenses (over 100 miles and reportedly 150-180 miles), precision accuracy (e.g., within about eight feet), autonomous guidance with automatic target recognition, ability to destroy fixed and relocatable targets (including "hard targets" such as hardened aircraft shelters, underground command posts, and some port facilities as well as "soft targets" such as buildings, railways, and roads), and delivery by different types of fighter/attack aircraft. TSSAM's all-round stealth features (reducing radar detection from all directions) are not regarded by the Air Force as a critical requirement for JASSM, although its design involves extensive use of stealth technology in regard to shaping and materials to reduce the missile's radar cross-section.[19]

GAO analysts have questioned JASSM's projected cost and schedule, citing the technical difficulties of autonomous guidance protected by antijamming devices and automatic target recognition in all-weather conditions as well as the complexity of integrating JASSM with different aircraft. The GAO report of June 28, 1996, voiced concern "that procurement reforms will not be sufficient to overcome the technical challenges of producing a viable and affordable system in the desired time frames," adding that developing and deploying such an advanced precision-guided munition "in

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[16] Lockheed Martin, McDonnell Douglas Winners in JASSM Contest. *Aerospace Daily,* June 18, 1996. pp. 449, 451. Other contractors in the 1996 competition were Hughes, Texas Instruments, and Raytheon. Hughes Files GAO Protest on JASSM. *Aerospace Daily,* July 1, 1996. p. 3; GAO Denies Hughes JASSM Protest. *Aerospace Daily,* October 32, 1996. pp. 167, 169.

[17] Bender, Bryan. Lockheed Martin Takes the JASSM Prize. *Jane's Defence Week,* 22 April 1998. p. 8.

[18] Snyder, Jim. CAIG Predicts JASSM Production Costs Will Be Higher Than Expected. *Inside the Air Force,* October 16, 1998. pp. 1, 7-8; Castelli, Christopher J. JASSM Expected to Be Approved to Enter 40-Month EMD Phase. *Inside the Navy,* November 2, 1998. p. 11.

[19] JASSM's range is reported to be about 180 miles, with accuracy within about 8 feet. Zaloga, Steven J. JASSM. In his *World Missiles Briefing*. Teal Group Corp., April 1999. p. 1-2.

5 years for no more than $700,000 a missile ... seems optimistic when compared to the cost experience for other less-capable precision-guided munitions."[20]

In March 1998, the Panel to Review Long-Range Air Power, established by congressional direction (FY1998 Defense Appropriations Act, Sec. 8131), applauded the current plans to develop and procure large numbers of new-generation precision-guided munitions as a way to increase the combat effectiveness of U.S. aircraft. An executive summary of the panel's conclusions stated that "the planned buy of the Joint Air-to-Surface Standoff Missile should be substantially increased and the JASSM should be a high priority for integration on each of the bomber types."[21]

In a letter to Congress on April 9, 1998, Secretary of Defense William Cohen stated that based on the Defense Department's congressionally-directed analysis of alternatives he believed JASSM would be more "survivable, lethal, and cost-effective" than a SLAM derivative against "high-priority, highly defended targets during the first phases of war." Accordingly, he made available to the JASSM program about $40 million of the funds provided in FY 1998 to pursue development of a SLAM derivative known as JSLAM to be used by both Air Force and Navy/Marine Corps aircraft. Secretary Cohen added that both the JASSM program and the Navy's SLAM-ER program would continue in the near term, since SLAM-ER "is proven and has demonstrated performance against many JASSM targets," and because JASSM is not yet available, may be too heavy (weighing about 2,300 lb) to be carried safely in carrier-landings, and lacks SLAM-ER's pilot-in-the-loop avionics capability.[22] In approving JASSM's entry into engineering and manufacturing development (EMD) on November 9, 1998, Under Secretary of Defense for Acquisition and Technology Jacques Gansler stated that if JASSM should become unaffordable other alternatives could be considered, including SLAM-ER, JSOW, and other air-launched missiles.[23]

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[20] U.S. General Accounting Office. *Precision-Guided Munitions – Acquisition Plans for the Joint Air-to-Surface Standoff Missile.* GAO/NSIAD 96-144. June, 1996. pp. 4-8; Some analysts note that current U.S. and British missile programs comparable to JASSM generally involve unit costs of at least $1 million. Zaloga, Steven J. JASSM. In his *World Missiles Briefing.* Teal Group Corp., April 1999. p. 6.

[21] Summary of the Principal Findings and Recommendations of the Panel to Review Long-Range Air Power, March 1998. p. 6; U.S. Library of Congress, Congressional Research Service. *B-2 Bomber: Current Debate and Future Long-Range Airpower Issues for Congress.* CRS Report 98-625F, July 14, 1998. pp. 6-7, 30-31.

[22] Conferees on FY1998 defense appropriations provided $43 million for a JSLAM program, directing that these funds not be obligated until the Defense Secretary "notifies the congressional defense committees regarding the acquisition strategy the Defense Department chooses to pursue based on results of the JASSM AOA [Analysis of Alternatives]," when this funding would be available "for the option recommended by the Secretary of Defense." H. Report. 105-265, September 27, 1997. p. 129. Snyder, Jim. Cohen Says JASSM More Survivable, Cost Effective in Early Stages of War. *Inside the Air Force*, April 10, 1998. p. 17. "Pilot-in-the-loop capability" refers to the ability of the pilot/navigator to correct the guidance of the missile for more precise impact on the target.

[23] DOD Sees Options If JASSM Costs Grow. *Aerospace Daily*, November 23, 1998: 300-301; Snyder, Jim. Gansler Approves JASSM for EMD; Supports Air Force Extension Proposal. *Inside the Air Force*, November 13, 1998: 1, 7-8. On November 10, 1998,

As of October 2000, the JASSM program was engaged in EMD flight testing on B-1Bs, F-16s and B-52s. If all test gates are met, the Air force should make a low rate initial production (LRIP) decision in November 2001. Approximately 200 JASSMs would be produced in two lots from FY 2001 to FY 2002. A Milestone III decision in June 2003 would clear the way for full rate production of 250 missiles in the fall of 2003.[24]

SLAM-ER

The Navy's preferred alternative to TSSAM is the AGM-84H Standoff Land Attack Missile – Expanded Response (SLAM-ER), an upgraded version of the air-launched AGM-84E SLAM system produced in 1988-1997 by McDonnell Douglas (part of Boeing since mid-1997). A derivative of the sea-launched Harpoon anti-ship missile, SLAM was first used in the 1991 Gulf War, prior to completing operational testing and evaluation. SLAM is the Navy's only air-launched precision-guided standoff weapon system, and because of its "pilot in the loop" feature, which allows operators to make final aimpoint selections as the missile approaches the target, the SLAM system is the Navy's most accurate standoff weapon. The SLAM-ER variant was also used effectively in the 1999 Kosovo campaign, launched by Navy P-3C Orion maritime patrol aircraft against fixed and mobile air-defense targets and Serbian infrastructure and communications facilities.[25]

Major improvements in the SLAM-ER version since its development began in 1994 have significantly enhanced the effectiveness of the missile in regard to warhead penetration, range and altitude, mission planning, jamming immunity, and automatic targeting. The first SLAM-ER was launched on March 18, 1997, beginning a series of generally successful flight tests in which the missile met all performance thresholds as well as cost and schedule goals.[26] Operational testing and evaluation of SLAM-ERs was completed in February 2000. On June 29, 2000 the Navy announced that the SLAM-ER had entered into full rate production.

The SLAM-ER program would meet most of TSSAM's requirements through an affordable and low-risk approach, according to Navy officials. They state that SLAM-ER provides essentially the same lethality as TSSAM through the use of a new penetrating warhead derived from the 700-lb warhead of the Tomahawk Block III cruise missile, which might also be used by JASSM; a Tomahawk-derivative wing extends SLAM's range from over 50 nmi to at least 150 nmi; improved aerodynamic performance yields better survivability and maneuverability; and major software

Lockheed Martin was awarded a $132.8-million contract for a 40-month EMD phase of JASSM to be produced at Lockheed Martin's plant in Troy, AL.

[24] de France, Linda. JASSM, in test, fails to fly entire route. *Aerospace Daily*. September 21, 2000.

[25] Burgess, Richard R. Orion + SLAM, "A Match Made in Heaven." *Sea Power,* October, 1999. p. 49.

[26] SLAM ER Evolves into an Advanced Multirole Missile. *Jane's International Defense Review,* June 1998. p. 17; Zaloga, Steven J. AGM-84E SLAM. In his *World Missile Briefing*. Teal Group Corp., April 1999. p 2-3, 6-7.

changes provide better pilot-in-the-loop performance and enhanced target-seeker effectiveness, with accuracy within about three meters (9.75 feet versus JASSM's projected 8 feet).[27] SLAM-ER proponents argue that it is a low-risk program based on the successful Harpoon/SLAM evolution, which can provide improved capabilities by upgrading existing inventories of a missile already in production. Its critics argue that SLAM-ER has less range than JASSM's projected range (reportedly 150-180 miles) and has a smaller warhead than CALCM, which can carry a 3,000-lb equivalent fragmentation warhead over a range of about 750 miles.[28]

The Navy procured some 800 SLAMs through FY1996, including 75 missiles funded in FY1996 as SLAMs but configured as SLAM-ER versions that were delivered during 1998. In FY1997, the Navy began upgrading its SLAM inventory to the Expanded Response (ER) configuration, with 60 missiles upgraded to SLAM-ERs in FY1997, 42 in FY1998, and 54 in FY1999. Congress added funding to the Navy's FY1997 request of $45.2 million for SLAM-ER, appropriating $75.3 million for the program. In FY1998, the $50.6 million requested was appropriated, as were the FY1999 request of $46.7 million in procurement and R&D funding and the FY2000 request of $39.7 million in procurement and R&D funding.

The Administration's FY2001 defense budget requested $27.9 million for procurement of 30 SLAM-ERs. Moreover, Navy officials listed SLAM-ER as one of the many programs that they considered inadequately funded by the proposed FY2001 budget, stating in their February 9, 2000 "Unfunded Requirements List" that an additional $30 million in FY2001 could be used to "procure an additional 60 SLAM-ERs to reduce the risk for 2 MTW [Major Theater Wars] and contingency operations,"[29] by replacing SLAM-ERs expended in the 1999 Kosovo campaign.

SLAM-ER was identified in JASSM's Milestone II Acquisition Decision Memorandum of November 9, 1998, as an alternative weapon system if JASSM does not proceed as currently planned. Some DOD officials view Boeing's SLAM-ER program and Lockheed Martin's JASSM program as competing in regard to acceptable performance capabilities and affordable acquisition costs, with competitive pressures expected to restrain the production costs of these systems. As Defense Secretary Cohen stated in April 1998, when announcing his decision to continue both programs, "This acquisition strategy allows us to maintain competition between the JASSM and SLAM-ER programs."[30]

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[27] Abel, David. SLAM-ER Missile To Enter Full-Rate Production. *Defense Week,* July 26, 1999. p. 3.

[28] SLAM ER Evolves into an Advanced Multirole Missile. *Jane's International Defense Review*, June 1998. p. 17; SLAM-ER Will Provide Enhanced Hardened Target Defeating Capability. *Inside the Navy,* December 2, 1996. p. 15; Arkin, William M. Kosovo Report Short on Weapons Performance Details. *Defense Daily,* February 10, 2000. p. 2.

[29] U.S. Department of Defense. News Release, February 9, 2000. Letter from Adm. Jay Johnson, Chief of Naval Operations, to Rep. Floyd Spence, Chairman of House Armed Services Committee. Enclosure 1, p. 4.

[30] Snyder, Jim. Cohen Says JASSM More Survivable, Cost Effective in Early Stages of War. *Inside the Air Force,* April 10, 1998. p. 17.

SLAM-ER has found strong support in Congress, with the House Appropriations Committee in 1997 opposing FY1998 funds for JASSM while recommending funding for development of a joint version of SLAM-ER – termed JSLAM – that could be used by both Navy and Air Force planes. House and Senate conferees agreed to appropriate some $43 million to be used for either JSLAM or JASSM, depending on the recommendations of the Secretary of Defense. In April 1998, Defense Secretary Cohen recommended that most of this amount should be allocated to the JASSM program.

JSOW

The AGM-154 Joint Stand-Off Weapon (JSOW) program is a Navy-led joint effort by the Navy and Air Force to develop an air-launched unpowered glide vehicle that will dispense precision-guided submunitions to attack a variety of surface targets at day or night and in adverse weather conditions.[31] The AGM-154 can be launched by Navy F/A-18s, Marine Corps AV-8Bs, and Air Force F-16s as well as other aircraft (e.g., the F-15E, B-52, B-1 and B-52). JSOW is a mid-range standoff weapon system guided by INS/GPS (inertial navigation and global positioning systems), with a range of some 40 nautical miles and accuracy within about 35 feet.[32] First used in combat on January 24, 1999, when launched by a Navy F/A-18 against an Iraqi air defense site, JSOWs were also used against Yugoslav targets during Operation Allied Force (March 24 - June 10,1999).

Raytheon Missile Systems in Tucson, AZ is the prime contractor for the JSOW program, which began in the late 1980s when Texas Instruments (part of Raytheon since 1997) won a competition with several other firms to develop this submunitions dispenser. JSOW's submunitions are the BLU-97, made by Aerojet of Sacramento, CA, and the BLU-108, made by Textron of Wilmington, MA. The program includes three JSOW variants: the baseline AGM-154A version, delivering 145 BLU-97 bomblets to attack fixed area targets; the anti-armor AGM-154B version, delivering submunitions to attack armored targets and mobile surface-to-air weapons; and the unitary AGM-154C version, which would deliver a single 500-lb warhead (BLU-111) with more lethality and better target discrimination and accuracy for attacking hardened fixed targets. The Navy is the lead service in the program, buying more units and getting them earlier. The Air Force will procure the baseline A version and the anti-armor B variant but does not expect to buy the unitary C variant, which would be used only by the Navy.[33] The program entered full-scale development in 1992, with low-rate initial production deliveries of the A version completed in 1999

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[31] *Department of Defense Dictionary of Military and Associated Terms* (JCS Pub 1-02, December 1, 1989) defines submunition as "Any munition that, to perform its task, separates from a parent munition." As used in this report, submunitions are warheads dispensed from a parent munition-delivery vehicle above targets to which the warheads are guided by various techniques.

[32] Seigle, Greg. AGM-154 JSOW Enters USAF Arsenal. *Jane's Defence Week*, 24 February 1999. p. 8.

[33] Zaloga, Steven J. AGM-154 JSOW. In his *World Missiles Briefing*. Teal Group Corp., March 1999.

and with full-rate production of AGM-154As to begin in 2000, when delivery of low-rate initial production of the AGM-154B version would start.[34]

As of June 30, 2000 the Defense Department estimated the development and procurement cost of a 19,124-missile JSOW program at about $6 billion, with a unit cost of about $315,000 per missile. The number of missiles to be procured was reduced by 4,800 in this estimate, which also lowered the projected program cost by almost $1.3 billion. There is some uncertainty about how many JSOW-B anti-armor variants the Air Force will buy, since it is competing for funding with the service's Sensor-Fuzed Weapon (SFW) program.[35] Production of the Navy's JSOW-C unitary variant, which is still in development, has also been at issue, with the Navy now expected to buy only 3,000 instead of the 7,800 originally projected.[36] Recent improvements to the Joint Direct Attack Munition (JDAM), have increased its range to almost 40 km.[37] This growth in capability has caused some analysts to wonder whether the cheaper, smaller JDAM could now compete with JSOW-A for some targets.

The Administration's FY1999 budget requested $265.4 million for the program in Navy and Air Force procurement and R&D funding to procure 328 JSOWs for the Navy and 100 for the Air Force. The Navy's JSOW-C unitary variant was criticized in the House Appropriations Committee report, which recommended termination of this part of the program, arguing that the single-warhead variant "as currently designed is more expensive and significantly less capable than other weapon systems," such as SLAM-ER and JASSM.[38] House and Senate conferees agreed to fund the JSOW program at $232.9 million of the $265.4 million requested in FY1999.

The FY2000 defense budget requested $275.9 million in Navy and Air Force procurement ($235 million) and R&D ($40.9 million) funding for JSOW. Congress provided somewhat less than the amounts requested, procuring 518 of the 615 JSOWs requested for the Navy and 74 of the 193 requested for the Air Force. The House Appropriations Committee criticized the JSOW-B anti-armor variant, citing "GAO reports that current technology does not allow strike aircraft sensors to target moving vehicles at long ranges."[39]

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[34] Raytheon's JSOW Contract Includes Provisions for Follow-on Production. *Aerospace Daily*, January 15, 1999. p. 79; Castelli, Christopher. Navy Says JSOW Program on Track, As Air Force Reduces BLU-108 Buy. *Inside the Navy*, December 28, 1998. p. 14-15.

[35] USAF Compares Cost, Effectiveness of SFW, JSOW. *Aerospace Daily*, March 9, 1998. p. 350; SFW, JSOW Consolidation Seen as Problematic. *Aerospace Daily*, March 17, 1998. p. 396.

[36] JSOW Unitary Buy May Be Cut by More Than 50%. *Aerospace Daily*, April 3, 1998. p. 21; Pentagon Cuts Down U.S. Navy Buy of JSOWs. *Defense Week*, December 6, 1999. p. 2.

[37] Bender, Bryan. JDAM's Range is Trebled. *Jane's Defense Weekly*. May 3, 2000.

[38] House Appropriations Committee. FY1999 Defense Appropriations Bill (H.R. 4103). H. Report 105-591, June 22, 1998. p. 210.

[39] House Appropriations Committee. FY2000 Defense Appropriations Bill (H.R. 2561). H. Report 106-244, July 22, 1999. p. 177. See also p. 149.

For FY2001, the Administration requested $284.7 million in Navy and Air Force procurement ($262.4 million) and R&D ($22.3 million) funds for the program, procuring 810 JSOWs – 636 for the Navy and 174 for the Air Force. Navy officials also included JSOW in their 9 February, 2000 "Unfunded Requirements List," which stated that an additional $36 million in FY2001 could be used to "accelerate procurement of 180 JSOW baseline [A versions] to reduce risk for contingency operations and 2 MTW [Major Theater Wars] requirements,"[40] by replacing those JSOW-A missiles expended in the 1999 Kosovo campaign.

CALCM

The AGM-86C/D Conventional Air-Launched Cruise Missile (CALCM), produced since the late 1980s by Boeing, is a conventionally armed version of the nuclear-armed ALCMs carried by B-52 strategic bombers. Since these ALCMs are now augmented by the nuclear-armed AGM-129 Advanced Cruise Missile and because of reductions in the B-52 force structure, the Air Force decided in the mid-1990s that some 300 ALCMs could be modified as CALCMs without reducing U.S. strategic missile capabilities. Later the Air Force decided to convert additional ALCMs into conventional cruise missiles as well as to upgrade some of the earlier CALCM versions. Some of these upgraded CALCMs will be the AGM-86D Block II configuration, which has a hard-target penetrating warhead provided by Lockheed Martin.[41]

First used in the 1991 Gulf War against high-value targets in northern Iraq, CALCMs were again used against Iraqi targets in September 1996, and some 90 CALCMs were launched by B-52 bombers during the December 17-20, 1998, attacks on Iraq in Operation Desert Fox.[42] At the start of Operation Desert Fox there were reportedly 238 CALCMs in the inventory. When NATO air operations against Yugoslavia began (March 24,1999), some 148 CALCMs were available for use by B-52H bombers based in England, and up to 75 CALCMs were reportedly expended in that conflict.[43]

The B-52H can carry eight CALCMs in its bomb bay and up to 20 CALCMs by using under-wing pods and with in-flight refuelings.[44] These derivatives of the ALCM

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[40] U.S. Department of Defense. News Release, February 9, 2000. Letter from Adm. Jay Johnson, Chief of Naval Operations, to Rep. Floyd Spence, Chairman of House Armed Services Committee. Enclosure 1, p. 1.

[41] Tirpak, John A. The State of Precision Engagement. *Air Force Magazine,* March, 2000. p. 27; Zaloga, Steven J. AGM-86 ALCM. In his *World Missiles Briefing.* Teal Group Corp., March 2000; Lockheed Martin To Make CALCM Warhead. *Aerospace Daily,* December 3, 1999. p. 350.

[42] Lennox, Duncan. 'Fox': The Results. *Jane's Defense Week,* January 13, 1999. p. 25.

[43] Arkin, William M. Kosovo Report Short on Weapons Performance Details. *Defense Daily,* February 10, 2000. p.2.

[44] B-1B, Enhanced CALCM See First Operational Use Against Iraq. *Aerospace Daily,* December 21, 1998. p. 441; Successful Campaign Highlights Cruise Missile Need. *Aerospace Daily,* December 22, 1998. p. 447.

strategic missile have a standoff range of about 700 miles, with a 3,000-lb equivalent warhead and a subsonic speed of 550 mph. Current treaty provisions on conventional versions of nuclear missiles could affect CALCM's use by aircraft other than the B-52 bomber. The START I treaty, in effect since December 5, 1994, considers all types of air-launched cruise missiles with ranges over 600 km (323 n mi) that were flight-tested for heavy bombers before 1989 to be nuclear-armed. Thus, any long-range air-launched cruise missile derived from the ALCM, such as CALCM, would be considered nuclear-armed, and any U.S. aircraft equipped to carry such missiles would count as 10 nuclear warheads under START I limits, regardless of the number of missiles carried and their type of explosive, unless that treaty were renegotiated.

The inventory of these cruise missiles was significantly reduced in the course of the NATO air campaign against Yugoslavia (March 24-June 10,1999), which has been a matter of some concern in Congress.[45] Sec. 132 of the FY2000 Defense Authorization Act (P.L. 106-65, Oct. 5, 1999) directed the Secretary of the Air Force to determine the requirements met by CALCM and to submit to the armed services committees "a report on the replacement options for that missile." The report would consider options for continuing to meet the requirements for CALCM as its inventory is depleted, including (1) resumption of production of /the missile, (2) acquisition of a new weapon with equivalent or superior lethality, and (3) use of existing or planned munitions or such munitions with appropriate upgrades. In late 1999, Boeing proposed production of a follow-on variant of the current CALCM with a unit procurement price of under $700,000 (FY2000 $) for 1,000 missiles.

CALCM has been viewed as a low-cost way to convert excess nuclear weapons into conventional standoff missiles. For FY1995, Congress provided $37.4 million for the CALCM program, with the Senate Armed Services Committee calling for conversion of up to 300 ALCMs at less than $200,000 per missile. For FY1996, Congress provided $15 million for conversion of 100 ALCMs ($150,000 per missile), followed by conversion of another 100 ALCMs in FY1997. Congress appropriated $18 million for the program in FY1997 ($15 million in procurement; $3 million in research-development funds), with no funding in FY1998 and only $10 million for CALCM in FY1999. In February 1999, Gen. Michael Ryan, Air Force Chief of Staff, listed the conversion of ALCMs to CALCMs as first among the service's twenty modernization priorities not included in the Administration's FY2000 budget. During 1999, funding was provided for 322 CALCMs to replace those used against Iraqi and Yugoslav targets: $41.5 million in April for 95 and $81.2 million in July for 227 missiles.[46]

Although funding for CALCM was not included in the Administration's FY2001 budget, the Air Force requested $178 million in FY2001 supplemental funds to convert 322 ALCMs into CALCMs. Further evolution of this cruise missile may also be funded through another program. In a February 9, 2000 list of unfunded

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[45] U.S. Library of Congress. Congressional Research Service. *Cruise Missile Inventories and NATO Attacks on Yugoslavia: Background and Information.* CRS Report RS20162 by Ronald O'Rourke, April 20, 1999. 6 p.

[46] Whitley, Gigi. Air Force Moves To Restock Air-Launched Cruise Missile Inventory. *Inside the Air Force*, July 23, 1999. p. 15.

priorities in FY2001-FY2005, General Michael Ryan, Air Force Chief of Staff, included some $690 million in R&D and procurement funds to start a new "extended range cruise missile" program costing $86.1 million in FY2001 and peaking at $163 million in FY2003, with delivery of missiles in FY2004 if this program gets underway in FY2001.[47] As envisioned by the Air Force, this program would produce 618 missiles, with a program unit cost of $1.1 million and a projected unit production cost of $650,000 (about half the cost of earlier CALCM conversions). Termed CALCM-ER (Extended Range), the new missile is to have about twice the 700-mile range of the current CALCM. Air Force officials stated in early 2000 that in addition to a next-generation CALCM, a longer-range version of Lockheed Martin's JASSM (with a projected range of 150-180 miles) as well as a conventional version of the long-range nuclear-armed AGM-129 Advanced Cruise Missile (produced by Hughes, now owned by Boeing and Raytheon) would also be considered in this program for competitive reasons. [48]

AGM-142

Based on Israel's Popeye missile, the AGM-142 (also known as Have Nap) has been co-produced by Rafael Armament in Israel and Martin Marietta (now part of Lockheed Martin) since the late 1980s. Since 1998 production has been shifted to Lockheed Martin facilities in Troy, AL, and Orlando, FL, producing AGM-142s for the U.S. Air Force as well as Israel and other allies.[49] U.S. procurement began in FY1989, and through FY1998 the Air Force funded procurement of some 260 of these medium-range precision-guided missiles to equip the B-52G bomber for air-to-surface attack missions.

Effective against such high-value targets as missile sites, power plants, bridges, bunkers, or ships, the AGM-142 has standoff ranges of up to about 50 miles, depending on altitude and trajectory, which allows it to be launched outside of enemy point defenses. It delivers an 800-lb hardened-target penetrator warhead or a 750-lb blast/fragmentary warhead, with terminal guidance by TV or Imaging Infra-Red (IIR) sensors for day or night operations. A smaller and lighter version can be launched by the F-16.[50] When the AGM-142 was first used in combat on May 11, 1999, during the Kosovo conflict, two missiles missed their targets, which reportedly was due to

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[47] Letter from Gen. Michael Ryan, Air Force Chief of Staff, to Rep. Floyd Spence, Chairman of House Armed Services Committee, February 9, 2000; USAF Plans for Converting CALCM to Longer Range Variant. *Aerospace Daily,* March 21, 2000. p. 436.

[48] Hebert, Adam J. Extended Range Missile To Double CALCM Range – Air Force Seeking New, Rapid Solution to Cruise Missile Shortages. *Inside the Air Force,* March 3, 2000. p. 1, 16-17.

[49] Opall, Barbara. Popeye Missile Production Will Shift to U.S. Facility. *Defense News*, January 12-18, 1998. p. 26; Whitley, Gigi. Foreign Military Sales Revive AGM-142 Precision Weapon Program. *Inside the Air Force*, September 4, 1998. p. 3.

[50] Zaloga, Steven J. AGM-142. In his *World Missiles Briefing*. Teal Corp., March 1999.

software problems that were later resolved, as demonstrated by successful test results.[51]

Although the Air Force has not regarded the AGM-142 as a major budgetary priority, the program has found support in the Congress. In 1995, the House National Security Committee supported procurement of AGM-142s as an interim replacement for TSSAM, while the House Appropriations Committee supported the AGM-142 as a near-term precision-guided weapon for the B-52 bomber. Although funding for procurement of the missile was not requested in the FY1996 defense budget; Congress appropriated $38 million for procurement of 54 AGM-142s in FY1996. This funding was rescinded in early 1996, but most of it was later provided. The FY1997 and FY1998 defense budgets also included no procurement funding for AGM-142s, but procurement was again recommended by the defense committees, and $34.9 million was appropriated for procurement of AGM-142s in FY1997 as was $25 million in FY1998. In 1998 the Air Force combined congressional funding in FY1997 and FY1998 to award a $68 million contract for production of about 90 U.S. and Israeli AGM-142s.[52] Since 1998, funding for procurement of the AGM-142 has not been requested by the Air Force or provided by Congress.

AGM-130

The AGM-130 standoff attack missile is a rocket-powered version of the GBU-15 glide bomb, with a standoff attack range of up to 40 miles and a 2,000-lb warhead or a hard-target penetrator, guided by TV or Imaging Infra-Red (IIR) sensors. Produced for the Air Force since 1990 by Rockwell International (now part of Boeing), the AGM-130 is launched from F-15E fighter/attack planes. It could also be used by the F-16 and could be adapted for use by long-range bombers (B-52, B-1, and B-2) against high-value targets such as air defense sites, command/control centers, airfields, and bridges, although there would be significant integration costs.

The Air Force considers the AGM-130 a successful and cost-effective program that can provide standoff precision-guided munitions pending delivery of JASSM (probably around 2005). Modifications proposed by Boeing promise to double the current range of the AGM-130, which was first used against Iraqi targets in early 1999 and later used in larger numbers against Yugoslav forces in March-June 1999.[53] The Administration's FY1996 and FY1997 budgets included no funding for AGM-130 buys, but in FY1996 Congress funded procurement of 100 AGM-130s for $109.3 million, and for FY1997 Congress appropriated $35 million for procurement of AGM-130s. The Air Force procured 702 AGM-130s in FY1990-FY1997. The small

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[51] Whitley, Gigi. Software Glitch Caused Have Nap Missiles To Miss During Allied Force. *Inside the Air Force,* October 29, 1999. p. 6; Bender, Bryan. USAF Tests AGM-142 with New Software. *Jane's Defense Week,* December 1, 1999. p. 6.

[52] Whitley, Gigi. Foreign Military Sales Revive AGM-142 Precision Weapon Program. *Inside the Air Force,* September 4, 1998. p. 3.

[53] Snyder, Jim. Boeing Modified AGM-130 Offers Double the Standoff of Current Fleet. *Inside the Air Force,* September 25, 1998. p. 15-16; Bender, Bryan. US Weapons Shortages Risked Success in Kosovo. *Jane's Defence Weekly,* October 6, 1999. p.3.

amounts of procurement funding provided for the AGM-130 program since FY1997 have funded modifications and upgrades of missiles in the inventory. The FY2001 defense budget requested $100,000 in Air Force procurement funding for the AGM-130 program, for which FY2000 funding was estimated at $700,000. [54]

Congressional Action in 1995-1999

In 1995, Congress provided funding in the conference report on the FY1996 defense appropriations bill (H.Rept. 104-344, November 16, 1995) for procurement of three current types of standoff munitions: 100 CALCMs ($15 million), 100 AGM-130s ($109.3 million), and 54 AGM-142s ($38 million); continued development of the Navy's SLAM-ER ($53.5 million) and the Navy and Air Force JSOW ($152.1 million); and development of a new Joint Air-to-Surface Standoff Missile (JASSM), for which $25 million was appropriated in FY1996. The funding of these programs reflected congressional interest in both near-term readiness and long-term modernization of air-launched standoff munitions. The Administration's original FY1996 budget requested funds only for SLAM-ER and JSOW; however, during hearings in 1995, the Air Force requested additional funding to initiate the JASSM program and for procurements of CALCM, AGM-130, and AGM-142.[55]

In 1996, Congress authorized FY1997 funding as requested for JASSM and JSOW and more than was requested for SLAM-ER as well as for conversion of 100 CALCMs and procurement of 100 AGM-130s and 50 AGM-142s. Conferees on the FY1997 defense appropriations bill (H. Rept. 104-863, September 28, 1996) provided less than was authorized for JASSM ($168.6 million), AGM-130 ($35 million), and AGM-142 ($34.9 million) and more than was authorized for SLAM-ER ($75.3 million), JSOW ($197.9 million), and CALCM ($18 million), as shown in Table 1 below.

In 1997, the conferees on the FY1998 defense appropriations bill (H.R. 2266 P.L. 105-56, October 8, 1997) agreed in H.Rept. 105-265 to provide funding as requested for SLAM-ER ($50.6 million) but less than the $203 million requested for JASSM ($128 million) and more than was requested for JSOW ($189 million), AGM-130 ($25 million), and AGM-142 ($25 million), as shown in Table 2 below. The conferees also provided $43 million for either JSLAM, a proposed joint Navy-Air Force variant of SLAM-ER, or JASSM, depending on the recommendation of the Secretary of Defense, who decided in April, 1998, to allocate $40.3 million of this amount to the JASSM program instead of developing a JSLAM variant.[56] FY1998 defense authorization legislation (H.R. 1119/P.L. 105-85, November 18, 1997)

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[54] U.S. Department of Defense. *Procurement Programs (P-1), FY2001.* February, 2000. p. F-4.

[55] For House and Senate action on FY1996 defense authorizations and appropriations, see *Missiles for Standoff Attack: Alternatives to the TSSAM Program* by Bert Cooper. CRS Report 95-889 F, December 6, 1995.

[56] Defense Appropriation Act FY1998; Conference Report to accompany H.R. 2266. H. Rept. 105-265: 129.

approved funding for these programs as appropriated. The conferees on the authorization bill also directed the Secretary of Defense to review the JASSM and SLAMER-ER programs and relevant alternatives and report to Congress within sixty days of enactment of the FY1998 Defense Authorizations Act (P.L. 105-85, November 18, 1997).[57]

In 1998, the conferees on the FY1999 defense appropriations bill (H.R. 4103 P.L. 105-262, October 17, 1998) agreed in H. Rept. 105-746 to fund JASSM at $135 million ($129.9 million of the $132.9 million requested in Air Force R&D funds and $2.1 million in Navy R&D funds requested for"TSSAM" but now available for JASSM). JSOW was funded at $232.9 million of the $265.4 million requested in Navy and Air Force procurement and R&D funds. Funding was provided as requested for SLAM-ER ($46.7 M), CALCM ($10 M), and AGM-130 ($341,000). Congress combined the amounts requested in Navy procurement and R&D funds for "Harpoon modifications" and "unguided conventional air-launched weapons" to fund the SLAM-ER program, which in previous years was funded through these two line items in the defense budget. Except for the criticism of JSOW's single-warhead unitary variant in the House Appropriations Committee report, there was no critical discussion of these standoff munition programs in the FY1999 authorizations and appropriations reports. See Table 3 below for more details on FY1999 funding for these programs.

In 1999, FY2000 funding was authorized and appropriated as requested for most standoff munition programs; e. g., JASSM — $168.4 million ($166.4 million in Air Force R&D and $2.0 million in Navy R&D funding, referred to as "TSSAM"); SLAM-ER — $39.7 million ($38.1 million in Navy procurement funds for 56 missiles and $1.6 million in Navy R&D funds); and AGM-130 — $220,000 in Air Force procurement funds. In the case of JSOW, however, the conferees on the FY2000 defense appropriations bill (H.R. 2561, enacted as P.L. 106-79, October 28, 1999) agreed in H.Rept. 106-371 to less than the amounts requested and authorized in Navy and Air Force procurement funds, providing $115.6 million for procurement of 518 Navy JSOWs and $40.7 million for procurement of 74 Air Force JSOWs (instead of the requested and authorized $154.9 million for 615 Navy JSOWs and the requested and authorized $79.9 million for 193 Air Force JSOWs) and providing $30.6 million in Navy R&D and $10.3 million in Air Force R&D funds as requested and authorized. Table 4 below depicts FY2000 funding for these programs.

In 2000, FY2001 funding was requested for JASSM ($122.3 million, including $2 million in Navy R&D funds), SLAM-ER ($27.9 million for procurement of 30 missiles), and JSOW ($284.7 million), as shown in Table 5 below. Other air-launched munitions may also be funded in the course of congressional action on the FY2001 defense budget. For example, the Air Force requested $178 million in supplemental FY2001 funds for conversion of 322 CALCMs, and Air Force officials have also indicated a desire to start a new CALCM-like program in FY2001, as noted above (p. 13). The Navy's Unfunded Requirements List of February 9, 2000, included an additional $30 million for 60 more SLAM-ERs and an additional $36 million for

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[57] National Defense Authorization Act FY1998; Conference Report to accompany H.R. 1119. H. Rept. 105-340, October 23, 1997: 632-633.

accelerated procurement of JSOW-As to replace missiles used during the 1999 Kosovo campaign, as noted above (pp. 9 and 11).

Appropriations conferees met the administration's FY2001 request for SLAM-ER funding. Conferees recommended increasing the administration's overall request for JSOW funding by $6.4 million. Appropriators agreed with House recommendations to reduce the JSOW-B anti-armor variant, although their recommended $35.2 million cut was less than the House proposal. This reduction was offset by the conferees' $41.6 increase in the baseline JSOW-A variant. Appropriation conferees recommended a $4 million reduction in the JASSM program.

Table 1. FY1997 Funding for Air-to-Surface Missiles
($ Millions)

System	Requested	Authorized	Appropriated
JASSM	198.6	198.6	168.6
SLAM-ER*	45.2	65.2	75.3
JSOW**	182.3	182.3	197.9
CALCM***	0	15.0	(100) 18.0
AGM-130***	0	40.0	(100) 35.0
AGM-142***	0	39.0	(50) 34.9

Note: Quantities funded, if specified, are in parentheses.

* SLAM-ER request comprised $22.9 M in Navy procurement funds for "Harpoon modifications" and $22.3 M in Navy R&D funds for "unguided conventional air-launched weapons;" authorizations and appropriations conferees added funding to retro-fit additional SLAM-ER missiles.

** JSOW request comprised $109.9 M in R&D funds (Navy, $86.3 M; Air Force, $23.6 M); and $72.4 M in procurement funds (Navy, $64.4 M; Air Force, $8.0 M); appropriations conferees added $15.6 M in Navy procurement funds.

*** As in prior and later years, Congress funded procurements of these currently in-production missiles that were not requested by the Defense Department.

Table 2. FY1998 Funding for Air-to-Surface Missiles
($ Millions)

System	Requested	Authorized	Appropriated
JASSM	203.3	128.0*	128.0*
SLAM-ER**	50.6	50.6	50.6
JSOW***	156.0	189.0	(150)
CALCM	0	0	0
AGM-130	1.5	25.0	25.0
AGM-142	0	25.0	25.0

Note: Quantities funded, if specified, are in parentheses.

* An additional $40.3 M of the $43 M provided for JSLAM, a House-proposed program to develop a joint SLAM variant for both Navy and Air Force instead of developing JASSM, became available for JASSM when this issue was resolved in April, 1998. See p. 7 above.

** SLAM-ER request comprised $21.7 M in Navy procurement funds for "Harpoon modifications" and $28.9 M in Navy R&D funds for "unguided conventional air-launched weapons." Congress also provided $43 million in Air Force R&D funds for a House-proposed JSLAM program, but most of this amount went to JASSM, as noted in the footnote above.

*** JSOW request comprised $96.2 M in R&D funds (Navy, $71.5 M; Air Force, $24.7 M); and $59.8 M in procurement funds for 113 missiles (Navy, $58.7 M; Air Force, $1.1 M). Congress provided $105.2 M in R&D funds (Navy, $80.5 M; Air Force, $24.7 M); and $83.8 M in procurement funds for 150 missiles (Navy, $63.7 M; Air Force, $20.1 M).

Table 3. FY1999 Funding for Air-to-Surface Missiles

($ Millions)

System	Requested	Authorized	Appropriated
JASSM*	135.0	135.0	132.0
SLAM-ER**	46.7	46.7	46.7
JSOW***	265.4	265.4	232.9
CALCM	10.0	10.0	10.0
AGM-130	0.3	0.3	0.3

*Amount requested and authorized includes $132.9 M in Air Force R&D funds for JASSM and $2.1 M in Navy R&D funds requested for TSSAM but available for JASSM; amount appropriated includes $129.9 M in Air Force funding and $2.1M in Navy funding for JASSM.

** SLAM-ER funding ($46.7 M) comprises $39.5 M in Navy procurement funds and almost $2 million in Navy R&D funds for "Harpoon mods" and some $5.2 M in Navy R&D funds for "unguided conventional air-launched weapons."

*** JSOW funding ($232.9 M) comprises $117.7 M in Navy and $52.1 M in Air Force procurement funds and $48 M in Navy and $15.1 M in Air Force R&D funds. Congress appropriated $7.5 M less than was requested in Navy procurement and $25 M less than requested in Navy R&D funds.

Table 4. FY2000 Funding for Air-to-Surface Missiles

($ Millions)

System	Requested	Authorized	Appropriated
JASSM	168.4	168.4	168.4
SLAM-ER	39.7	39.7	(56) 39.7
JSOW	275.7	275.7	(592) 197.2
AGM-130	0.2	0.2	0.2

Note: Quantities funded, if specified, are in parentheses.

Table 5. FY2001 Requests for Air-to-Surface Missiles
($ Millions)

System	Requested	Authorized	Appropriated
JASSM	122.3	116.2	118.3
SLAM-ER	(30) 27.9	27.9	27.9
JSOW	(810) 284.7	(864) 269	291.1

Note: Quantities requested, if specified, are in parentheses.

Congressional Issues

The quest for capable and affordable standoff air-to-surface missiles poses a number of interrelated issues for Congress in evaluating the proposed alternatives: (1) the advantages of an entirely new design versus a derivative of currently operational munitions or designs in full-scale development; (2) acceptable tradeoffs between perceived performance requirements in regard to range, payload, accuracy, and stealth; (3) projected inventory requirements for future combat scenarios; (4) the development and production costs and the delivery schedules of proposed alternatives; and (5) reliance on interim standoff munitions pending development of new systems.

Perceptions of threat situations that might require standoff munitions affect considerations of these issues. It can be argued that near-term threats require large inventories of affordable and readily available munitions with acceptable degrees of standoff capability, precision guidance, and warhead lethality. It can also be argued that it is necessary to invest in the development and acquisition of more advanced weaponry that may be needed over the longer term, which would include standoff munitions able to resist jamming and electronic interference and with stealth features to reduce detection by radar as well as greater range and speed capabilities than are currently available.

In addition to defense needs, other considerations will be the budgetary impact and the effects of proposed alternatives on the U.S. industrial base. In some cases, the selection among competing proposals and the awarding of development and production contracts may involve regional economic effects as well as transatlantic economic interests. Each of these proposals will need to be evaluated in light of the best "guestimates" about future threat environments, combat requirements, and budgetary priorities.

In evaluating contractor proposals and service plans for standoff munitions, Congress may consider some of the following lines of inquiry:

- When and in what threat scenarios and combat conditions would the proposed standoff munitions be needed by U.S. military forces?

- What kinds of targets could be most cost-effectively destroyed by the proposed munitions?

- What types of U.S. aircraft could deliver these munitions and with what payloads?

- What countermeasures to prevent accurate guidance of these munitions to their targets could potential enemies take and how could such countermeasures be frustrated?

- What are the estimated costs of developing and producing the proposed standoff munitions (total acquisition costs and unit production costs)?

- When would these munitions be available in sufficient quantities for use in a major regional conflict?

- What types and inventories of standoff munitions would be needed for specific conflict scenarios?

- How would the development cost and delivery schedule of a standoff attack missile that could be used by both Air Force and Navy planes compare with that of one to be used by only one of these services?

- What standoff munitions now in production could be relied on while something better is being developed and produced in quantities that might be needed?

- What would be the regional economic implications of developing and producing the proposed munitions in regard to employment and the defense industrial base?

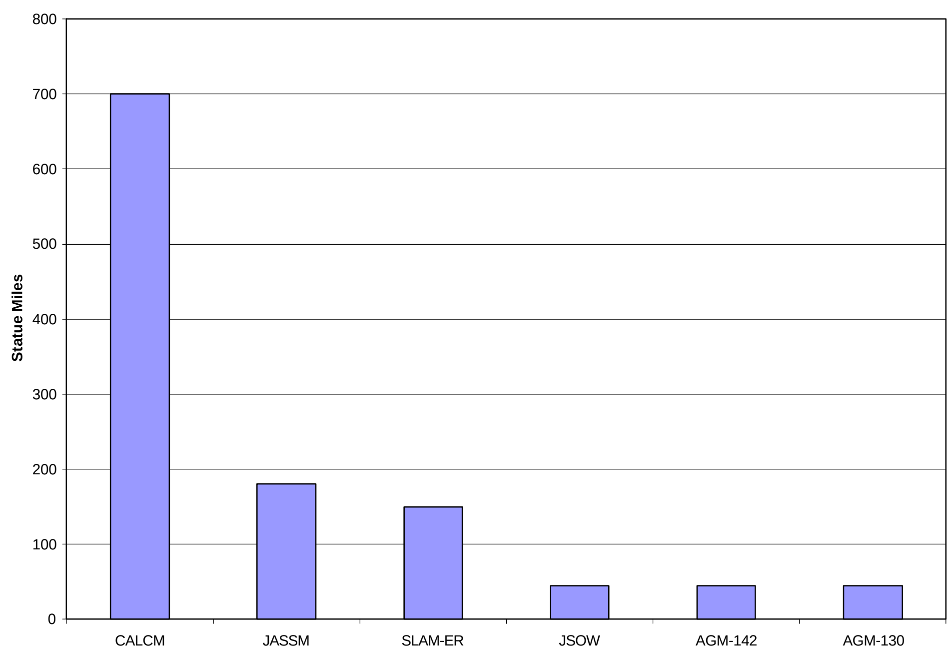
- What would be the most cost-effective mix of air-, land-, and sea-based platforms for the delivery of standoff munitions in various combat scenarios? Navy ships and submarines can launch both the SLAM and TLAM missiles, which are applicable to the same target sets as air-launched weapons. These launch platforms enjoy some advantages over land-based aircraft but have negative aspects as well. What is the best overall mix of weapons?

Comparing Standoff Munitions

Every standoff missile program, whether a new start or an upgrade of a current model, faces an array of conflicting forces; e.g., competing contractor interests, different service priorities, divergent perceptions of military threats and combat requirements, and conflicting predictions of costs and capabilities. Much of the technical information and data needed for objective and meaningful comparisons of performance capabilities and program costs are classified or proprietary – restricted for security reasons or regarded by contractors as confidential for competitive reasons. Moreover, the data available in open sources are generally based on information provided by proponents or opponents of particular missile systems, which may preclude or impair objective analysis of the relative capabilities and costs of these missiles.

Given such problems, this report does not attempt to provide a rigorous comparison of specific performance and cost differences among the missiles discussed, although some performance features are compared in general terms. All of these munitions are subsonic – traveling at less than the speed of sound, Mach 1, which varies with altitude; e.g., 762 miles per hour (mph) at sea level and 664 mph at 35,000 feet. Range is obviously a critical performance factor in comparing standoff munitions. Effective range varies, however, with the altitude of the launch aircraft. Depending on launch altitudes, the stated ranges of the systems discussed here would be as follows: some 700 miles for CALCM, up to 180 miles as projected for JASSM, up to about 150 miles for SLAM-ER, and about 40 or 50 miles for JSOW, AGM-142, and AGM-130. Depending on available basing options for launch aircraft as well as specific combat scenarios and targets, each of these standoff munitions could be used effectively, with longer range being better in regard to flexibility and targeting.

Figure 1. Estimated Range of Standoff Weapons



The combat effectiveness of standoff munitions is largely dependent on such performance factors as the lethality of the warhead and the probability of target penetration. Although numerous factors can contribute to lethality and the ability of a missile to reach its target, two simple formulas might serve as useful ways of comparing standoff munitions.

Lethality may be measured by the following formula: Payload/CEP (Circular Error Probability) = Lethality. In general, the most lethal missile, for instance, would be one with a very small CEP and a large payload. A formula for measuring the probability of target penetration would be: Flight Profile/RCS (Radar Cross Section)

= Penetration Probability. The flight profile refers to the altitude and speed of the missile and the altitude, speed, and maneuverability of the launch aircraft. A missile with a large flight profile, for instance would be able to fly at a variety of altitudes, be maneuverable, and able to fly very fast.

Given the rising cost of munitions and aircraft and prevailing budgetary constraints, cost has now become as critical a factor as performance. Reflecting this view, the concept of cost as an "independent variable" equates cost with performance as a criterion in the choice of a missile system or its launch platform. Thus, tolerable cost is comparable to the price that the market will bear, and the greater the perception of threat requirements, the higher the tolerance of cost.

Conclusions

There are several interim solutions to requirements for air-launched standoff munitions that can be delivered by U.S. fighter/attack planes and longer-range bombers. In the short term, some of these munitions could be funded while the services are developing more advanced precision-guided standoff missiles that may be needed in post-2010 conflict scenarios. If such future munitions can be developed and procured at affordable prices, there may be less need to buy as many combat aircraft as currently projected. Thus, there may be tradeoffs between funding requirements and perceptions of the cost-effectiveness of various aircraft/munition combinations.

Whether U.S. strike capabilities from the air should be based on cheaper platforms with more expensive missiles than are now available or on some combination of each has been posed by some as a basic issue. For instance, following the effective use of the B-2 during the Kosovo conflict, many in Congress and elsewhere are wondering which combination of aircraft and weapons would be most cost effective against the preponderance of targets U.S. warfighters are likely to face: a relatively expensive, penetrating bomber like B-2 armed with relatively inexpensive weapons like JDAM (Joint Direct Attack Munition)or a relatively inexpensive, stand-off bomber like the B-52 armed with relatively expensive weapons like the CALCM. For now, the DoD procurement and R&D programs described above seem to provide U.S. warfighters with some flexibility of choice in launching precision strikes from manned aircraft.

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