Military Suppression of Enemy Air Defenses (SEAD): Assessing Future Needs

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Summary

Suppressing enemy air defenses (SEAD) has been a central element of projecting military air power for over 50 years. However, several developments suggest that this mission is of growing importance to the Department of Defense (DOD). Some say that the emergence of new technologies and air defenses will increasingly challenge U.S. SEAD efforts. Making budgetary judgments on SEAD programs and processes requires the assessment of complex factors. This report will be updated.

Introduction

Suppression of enemy air defenses (SEAD) is defined by the Department of Defense (DOD) as “That activity that neutralizes, destroys, or temporarily degrades surface-based enemy air defenses by destructive and/or disruptive means.”1 By this definition, many military platforms, munitions, and processes contribute to SEAD, including reconnaissance and surveillance, stand-off jamming, employment of air-to-surface munitions, and electronic and infrared (IR) countermeasures.2

A variety of weapons platforms and munitions can and have been used to attack enemy air defenses, including long range bombers, helicopters, surface-to-surface missiles, precision guided munitions (PGMs), rockets, and “dumb bombs.” However, some combat aircraft have been designed or modified to increase their effectiveness against enemy air defenses and are typically thought of as SEAD assets. These include the F-16, EA-6B, F/A-18 and F-15E. These aircraft carry a number of munitions useful against surface-to-air missiles (SAMs). Some carry the AGM-88 High Speed Anti Radiation Missile (HARM) which is designed to lock-on to and destroy the ground-based radars used by some SAMs and anti-aircraft artillery (AAA). Also, the HARM Targeting System (HTS) and the Tactical Electronic Reconnaissance Processing and Evaluation

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2 For discussion of stand-off jamming and electronic warfare, see CRS Report RL30639.
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Historically, the percentage of U.S. combat losses due to aerial combat has steadily declined and the percentage of losses due to enemy air defenses has steadily risen. In World War II, U.S. air combat losses were split almost evenly between aerial combat (46%) and air defenses (54%). By the Korean and Vietnam wars however, combat losses due to enemy air defenses had risen to approximately 90% and aerial combat losses had dropped to approximately 10 percent.

Suppressing enemy air defenses has always been an important means of protecting U.S. aircraft, and enabling effective air operations. However, SEAD may be of growing importance to DOD and Congress for at least three reasons.

- While combat aircraft have played an important role in most U.S. conflicts since World War I, the last several conflicts (Bosnia in 1995, Kosovo in 1999, Iraq 1996-present, and Afghanistan in 2001) have emphasized the use of military aviation, suggesting that defense planners are finding airpower an increasingly practicable military tool.
- There appear to be very few countries capable of seriously challenging U.S. air forces in air-to-air combat. Since Operation Desert Storm, 100 percent of all U.S. combat aircraft losses have been due to enemy air defenses. No U.S. aircraft has been lost to an enemy aircraft since 1991. Most countries will challenge U.S. airpower primarily with surface-based air defenses.3
- DOD finds some air defenses difficult to suppress or destroy. Many analysts say that emerging air defense technologies and tactics will prove more threatening and more difficult to counter than current systems.

**Issues of Concern**

The Pentagon frequently expresses concern over several interrelated developments in enemy air defenses: the emergence and proliferation of a new generation of Russian SAMs, and the application of new technologies, either in conjunction with these or with other air defense elements. Shoulder-fired missiles continue to pose a problem for today’s SEAD forces. Observers are also concerned about the effect of strict rules of engagement on SEAD effectiveness.

Russian SA-10 and SA-12 SAMs have been operational since the 1980s, but currently are in the inventory or possession of only a handful of countries (e.g., Russia, China, Cyprus, The Czech Republic, and Germany).4 These “double digit” SAMs are a concern for military planners due to their mobility, long range, high altitude, advanced missile guidance, and sensitive radars. The Russian SA-20, still under development, has been likened to the U.S. Patriot PAC-2 missile, but with an even longer range and a radar capable of detecting stealthy aircraft. Military planners are concerned that a country with only a handful of these SAMs could effectively challenge U.S. military air operations by threatening aircraft and disrupting operations from great distances.

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4 *World Missiles Briefing*, Teal Group, Inc., Feb. 2001. India, Iran, Syria and Vietnam are known to have negotiated with Russia for these systems, but acquisition has not been confirmed.
A variety of new technologies and military systems could exacerbate the “double
digit” SAM challenge. First, commercial information and communications technologies
are enabling adversaries to better network the elements of their air defense systems. This
allows them to disperse radars, SAM launchers and other associated platforms throughout
the battlespace, and to share targeting information between launchers. This, in turn,
suggests that radars may be used less frequently and for shorter periods of time,
complicating U.S. SEAD efforts. Second, terminal defenses are being marketed by a
number of international defense companies. These radar-guided Gatling guns are
designed to protect “double digit” SAMs or other high value air defense assets by
shooting 3,000 to 4,500 rounds per minute into the sky. These systems could prove quite
effective in shooting down HARM or other missiles aimed at enemy air defenses. Third,
Russia and other countries have developed and are selling GPS jammers. Over varying
distances, these low-watt jammers degrade or totally disrupt the GPS guidance signals
used by many U.S. PGMs to augment inertial guidance systems, reducing their accuracy.

U.S. military planners must also grapple with today’s pernicious air defense threats,
such as shoulder-fired missiles. Unlike “double digit” SAMs, MANPADs (e.g., the U.S.
Stinger, Russian SA-7, and French Mistral) are widely proliferated, and found in the
inventories of scores of countries. These missiles are difficult to suppress due to their
small size, high mobility and IR guidance. Unlike radar guidance, IR guidance — which
MANPADs tend to use — does not emit energy that U.S. self-defense systems can detect.
Thus, the launch of an IR-guided missile often comes as a surprise to the targeted aircraft,
reducing the time for evasive maneuvers or deployment of self protection
countermeasures. This increases MANPADs effectiveness. IR guided SAMs were the
primary source of air combat losses in Operation Desert Storm, and since 1973, nearly
half of all air losses in combat have been attributed to IR-guided SAMs, many of them
launched from MANPADs. Others estimate that MANPADs caused 90% of worldwide
combat aircraft losses from 1984-2001.6

Shoulder-fired missiles also pose a terrorist threat to civilian aircraft. RAND
estimates that at least 20 and as many as 40 civilian airliners were shot down by terrorists
using MANPADs between 1975 and 1992.7 (CRS estimates six of these aircraft were
actually airliners, the others were smaller than most commercial aircraft.)8 The threat to
civilian airliners posed by terrorists with shoulder-fired missiles appears to be an issue of
increasing congressional concern. At least three bills introduced during the FY2005
budget cycle addressed methods for mitigating the threat of shoulder-fired missiles to
commercial aviation.9

Rules of engagement (ROE) are designed by military planners to reduce the
likelihood of fratricide (shooting down friendly aircraft), to minimize unintended civilian
casualties, and in some cases, for political feasibility (e.g., operating in ways palatable to

5 Steven Zaloga, “The Evolving SAM Threat: Kosovo and Beyond,” Journal of Electronic
7 Marvin B. Shaffer, Concerns about Terrorists with Manportable SAMs (RAND, 1993), p. 3.
9 Ibid., p 20.
coalition partners). Some have asserted that ROE in recent conflicts have been “draconian” and tied the hands of SEAD pilots; reducing their effectiveness. DOD may seek congressional support for more lenient ROE in future wars.

Assessing Future SEAD Needs

There are many factors that can be weighed, when attempting to measure the success of DOD SEAD efforts, and determining what future needs (e.g., new aircraft, upgrades to self-protection capabilities, better munitions) may be. DOD has had considerable experience suppressing enemy air defenses over the last 50 years. A survey of this experience provides some insight into SEAD success and challenges, and helps provide a context in which Congressional oversight decisions can be made. The following section describes three “measures of effectiveness” (MOEs) that can be used to focus Congressional inquiry into future SEAD needs.

MOE 1: Combat Attrition. The first area that merits examination is combat attrition. How many U.S. combat aircraft have been shot down in recent conflicts? How many have been shot down by ground-based air defenses? Because SEAD missions are designed ultimately to protect U.S. aircraft, combat attrition provides some insight into the effectiveness of SEAD efforts. As indicated in Table 1 below, from World War II to the present, the loss of U.S. combat aircraft has steadily declined, both in absolute terms, and relative to the number of combat sorties flown. While these numbers do not prove that SEAD is solely responsible for this very favorable trend, it is clear that SEAD is an important contributor to aircraft survivability.

<table>
<thead>
<tr>
<th>Conflict</th>
<th>Combat Sorties</th>
<th>Total Combat Losses</th>
<th>Attrition Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>World War II(^b)</td>
<td>2,498,283</td>
<td>19,030</td>
<td>0.76%</td>
</tr>
<tr>
<td>Korea(^c)</td>
<td>591,693</td>
<td>1,253</td>
<td>0.2%</td>
</tr>
<tr>
<td>Vietnam(^d) (AF data only)</td>
<td>219,407</td>
<td>1,437</td>
<td>0.65%</td>
</tr>
<tr>
<td>Desert Storm (Iraq)(^e)</td>
<td>68,150</td>
<td>33</td>
<td>0.04%</td>
</tr>
<tr>
<td>Bosnia(^f)</td>
<td>30,000</td>
<td>3</td>
<td>0.01%</td>
</tr>
<tr>
<td>Kosovo(^g)</td>
<td>21,111</td>
<td>2</td>
<td>0.009%</td>
</tr>
<tr>
<td>Northern/Southern Watch(^h)</td>
<td>268,000</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Iraqi Freedom(^i)</td>
<td>20,733</td>
<td>1</td>
<td>0.004%</td>
</tr>
</tbody>
</table>

Notes:
\(^a\) Other losses, either due to pilot error, accident, or unknown enemy action not included.

10 Benjamin Lambeth, NATO’s Air War for Kosovo (RAND, 2001), p. 142.
MOE 2: Effort Expended. Another factor that can be considered when assessing U.S. SEAD capabilities is the amount of effort that is expended to protect U.S. aircraft. How onerous a mission is SEAD? As Table 2 below suggests, twenty-to-thirty percent of all combat sorties in recent conflicts were devoted to SEAD, while historically, this ratio is much lower. While this increase in SEAD sorties could be attributable to a number of factors, it appears that SEAD is a growing mission area.

Table 2. Estimates of SEAD sorties and Total Combat Sorties

<table>
<thead>
<tr>
<th>Conflict</th>
<th>Combat Sorties</th>
<th>SEAD Sorties</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vietnam</td>
<td>219,407</td>
<td>11,389</td>
<td>5.2</td>
</tr>
<tr>
<td>Desert Storm (Iraq)</td>
<td>68,150</td>
<td>4,326</td>
<td>6.3</td>
</tr>
<tr>
<td>Bosnia</td>
<td>2,451</td>
<td>785</td>
<td>32.0</td>
</tr>
<tr>
<td>Kosovo</td>
<td>21,111</td>
<td>4,538</td>
<td>21.5</td>
</tr>
<tr>
<td>Northern/Southern Watch</td>
<td>268,000</td>
<td>67,000</td>
<td>25.0</td>
</tr>
</tbody>
</table>

Notes:
- Conversation with Dr. Wayne Thompson, Center for Air Force History, Bolling AFB, Aug. 9, 2001. Figure includes 8,669 F-105 Wild Weasel sorties, and 2,720 "Flack Suppression sorties. Figures include USAF sorties only. Does not include 24,278 EB-66 or 11,732 misc. EW sorties.
- Fulford, Mulhollan correspondence, op. cit.

MOE 3: Efficiency. By some measures, U.S. SEAD efforts have been effective. However, other observations suggest that efficiency could be improved. For example, one MOE pertains to the destruction of enemy air defenses (DEAD). While suppressing enemy air defenses through electronic warfare (EW) or intimidation can effectively
protect U.S. aircraft, the effect is ephemeral. Destroying enemy air defenses is generally preferred to suppressing them, because of the enduring effect that destruction has on military capabilities. As Table 3 suggests, U.S. air forces have had mixed results in recent conflicts destroying enemy air defenses. In some cases, such as in Iraq, U.S. destructive SEAD efforts have been somewhat successful. In other cases, such as Kosovo — where the Serbs employed a variety of challenging tactics — efforts were less successful.

Table 3. Destructive SEAD: Some Estimated Results

<table>
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<tr>
<th>Conflict</th>
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<tr>
<td>Desert Storma</td>
<td>35 of 120 fixed SAM batteries destroyed</td>
</tr>
<tr>
<td>Bosniab</td>
<td>52 of 70 air defense targets destroyed</td>
</tr>
<tr>
<td>Kosovo c</td>
<td>3 of 25 SA-6 batteries destroyed, 10 of 41 SAM radars destroyed</td>
</tr>
<tr>
<td>N./S. Watchd</td>
<td>33 of 35 air defense targets damaged, but many rebuilt and improved</td>
</tr>
</tbody>
</table>

Notes:


Another measure of efficiency pertains to tactics. One SEAD tactic to fire numerous HARM missiles preemptively — that is, in the direction of a SAM that is suspected to exist, but which hasn’t turned on its radar. Thirty three of 56 HARMs used in Operation Deliberate Force were fired preemptively. Over 1,000 HARMs in Operation Allied Force were fired at only a handful of SAMs, suggesting many preemptive shots. While using HARMs in this way may effectively deter adversaries from shooting at U.S. aircraft, it also poses two problem areas. First, preemptive HARM use can be expensive since HARMs cost approximately $250,000 per missile. Second, preemptively fired HARMs present a fratricide risk. If there are no enemy radar emissions for the HARM to guide on, the missile could lock-on to friendly emissions and destroy the wrong target. At least six HARMs shot during Kosovo ended up by accident in Bulgaria. While launching HARMs preemptively may be effective and necessary, it is not efficient. The Navy’s Advanced Anti-Radiation Guided Missile (AARGM) program, may reduce the need for or the potentially negative effects of preemptive missile launches ($75M requested in FY2006). The AARGM program is pursuing a number of improvements to HARM, including adding a radar that can detect enemy radars after they have turned off, and hardware and software improvements that limit the areas in which the missile can fly when searching for a target.