REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
04-05-2018	FINAL	

4. TITLE AND SUBTITLE

Defending the Nest: Updating Joint Doctrine to Mitigate the Threat of Ballistic and Cruise Missiles to Air Bases

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Maj J. Paul Conner, USAF

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Joint Military
Operations Department
Naval War College
686 Cushing Road
Newport, RI 02841-1207

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Joint Military
Operations Department
Naval War College
686 Cushing Road
Newport, RI 02841-1207

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Distribution Statement A: Approved for public release; Distribution is unlimited.
Reference: DOD Directive 5230.24

13. SUPPLEMENTARY NOTES A paper submitted to the Naval War College faculty in partial satisfaction of the requirements of the Joint Military Operations Department. The contents of this paper reflect my own personal views and are not necessarily endorsed by the NWC or the Department of the Navy.

14. ABSTRACT

The increasing proliferation of long-range, highly accurate, ballistic and cruise missile technology is threatening to end the era of sanctuary for U.S. bases around the world. Because potential adversaries continue to advance their missile technology, the U.S. must improve missile defenses at forward U.S. air bases. Investment will follow joint doctrine, but the current categorization of countermeasures into active and passive defense is insufficient. Doctrine must be updated to group countermeasures by their role prior to, during, and following missile-delivered warheads impacting an installation. Moreover, the characteristics of defenses and nature of the threat dictates that the U.S. cannot mitigate risk by using a single type of countermeasure. Instead, investment should utilize a portfolio approach to missile defense that integrates three types of defenses to prevent, protect, and recover damage caused by attacking warheads. Additional research using the proposed joint doctrine framework is needed to determine the best mix of countermeasures for future investment.

15. SUBJECT TERMS

Joint Doctrine, Missile Defense, Ballistic Missile, Cruise Missile, Hardening

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Chairman, JMO Dept
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UU	30	**19b. TELEPHONE NUMBER** *(include area code)* 401-841-3556

Standard Form 298 (Rev. 8-98)

NAVAL WAR COLLEGE
Newport, R.I.

Defending the Nest: Updating Joint Doctrine to Mitigate the Threat of Ballistic and Cruise Missiles to Air Bases

John Paul Conner

A paper submitted to the Panel of the Naval War College Essay Competition for AY 2017-2018 for consideration for the George C. Kenney Prize.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

04 May 2018

Contents

List of Illustrations

Abstract

The increasing proliferation of long-range, highly accurate, ballistic and cruise missile technology is threatening to end the era of sanctuary for U.S. bases around the world. Because potential adversaries continue to advance their missile technology, the U.S. must improve missile defenses at forward U.S. air bases. Investment will follow joint doctrine, but the current categorization of countermeasures into active and passive defense is insufficient. Doctrine must be updated to group countermeasures by their role prior to, during, and following missile-delivered warheads impacting an installation. Moreover, the characteristics of defenses and nature of the threat dictates that the U.S. cannot mitigate risk by using a single type of countermeasure. Instead, investment should utilize a portfolio approach to missile defense that integrates three types of defenses to prevent, protect, and recover damage caused by attacking warheads. Additional research using the proposed joint doctrine framework is needed to determine the best mix of countermeasures for future investment.

Introduction

> Bases in forward areas are usually within operational reach of the potential opponents. Hence, such areas should have an infrastructure in place that can support the operational and sustaining requirements of deployed forces. The infrastructure should also provide some degree of protection from attack.
>
> Dr. Milan Vego
> *Joint Operational Warfare*

Japan's December 7, 1941 surprise attack on Pearl Harbor is infamous for the damage inflicted on the battleships of the United States (U.S.) Pacific Fleet, but the raid also targeted American air power. Of the 291,500 lbs of ordnance delivered by 353 Japanese planes, 90,400 lbs targeted airfields dispersed across the island of Oahu. Japan sunk or critically damaged 18 ships, but it also destroyed or damaged 347 of 394 U.S. aircraft on the island, hit several key aviation support facilities, and crippled U.S. air power projection capabilities from Hawaii.[1]

After World War II, and especially since the end of the Cold War, U.S. air superiority has enabled allied air forces to operate from relative sanctuary, free from enemy attacks like the one on Pearl Harbor. However, the increasing proliferation of long-range, highly accurate, ballistic and cruise missile technology is threatening to end the era of sanctuary for U.S. air bases around the world.[2] Potential adversaries are following the words of early air power theorist Giulio Douhet by recognizing that "it is easier and more effective to destroy the enemy's aerial power by destroying his nests and eggs on the ground than to hunt his flying birds in the air."[3]

One potential U.S. adversary, North Korea, continues to heavily invest in advanced missile technology.[4] Due to the growing threat to air bases in South Korea, United States Forces Korea (USFK) must invest in countermeasures that guarantee the ability to generate combat sorties while under missile attack. According to joint doctrine, USFK planners should employ active and passive defenses to protect allied forces.[5] Active defense is "direct,

defensive action taken to destroy, nullify, or reduce the effectiveness of air and ballistic missile threats against friendly forces."[6] Passive defenses include "measures, other than active air and missile defense, taken to minimize, mitigate, or recover from the consequences of attack aircraft and missiles."[7] Both types of defenses include a wide range of countermeasures.

Upon assessment, the doctrinal categorization of air and missile defenses is insufficient because it does not highlight the need for different countermeasures before, during, and after missile-delivered warheads strike an air base. To ensure the U.S. retains the capability to project air power against potential adversaries such as North Korea, joint doctrine needs a framework that classifies countermeasures into three types of defenses which enable air bases to prevent, protect, and recover from missile attacks. Moreover, doctrine needs to specify a portfolio approach for U.S. forward bases which includes all three of the proposed types of defenses.

Overview of Missile Threat to Air Bases

Every branch of the U.S. military is heavily reliant on pre-existing forward airfields, bases, and ports postured around the globe. In peacetime, these installations serve the dual purpose of deterring potential adversaries as well as providing assurance to key allies and friends. During a crisis, in-place forces at forward bases provide the initial response capability to counter aggression, prevent defeat, and enable the arrival of reinforcements.[8] In most cases, follow-on forces will also arrive at forward bases to take advantage of pre-existing infrastructure, protection, and sustainment resources.

Land-based air forces are primarily dependent on forward air bases located close to the joint operational area. Due to a combination of factors such as aircraft capability, aircrew fatigue, and availability of aerial refueling, fighters require airfields within approximately 1,000 to 1,500 miles of the enemy for effective combat operations.[9] Basing aircraft farther

away requires tradeoffs between distance and sortie rates.[10] Through using forward airfields, planners reduce the factor of space by enabling aircraft to maximize the application of force over a given operational period.

Due to the possibility of air base attacks in wartime, air base protection is an important function for any Joint Force Air Component Commander. One recent study noted at least 26 conflicts in which air bases came under assault between 1919 and 2014.[11] In most cases, attackers sought to reduce their enemy's air power by destroying aircraft on the ground or disrupting the ability to generate sorties.[12] In the past, even U.S. air bases were not immune to attack. During the Vietnam War, Vietcong and North Vietnamese forces used rockets and mortars to damage or destroy over 1,600 aircraft at multiple U.S. bases in South Vietnam.[13]

Today, joint doctrine identifies ballistic and guided cruise missiles as among the threats to U.S. air bases.[14] This threat first originated in World War II with V-1 and V-2 rockets, though the Germans primarily targeted cities instead of allied air bases in England.[15] More recently, the National Defense Panel of 1997 recognized the increasing vulnerability of U.S. forward bases to ballistic and cruise missiles armed with conventional, chemical, biological, or nuclear warheads. This rising awareness contributed to the 2001 Quadrennial Defense Review labeling missiles as the greatest anti-access and area-denial threats to U.S. overseas airfields.[16] The 2018 National Defense Strategy acknowledged that the era of sanctuary is ending. As such, it prioritized investment in active and passive defenses that enable bases to "survive, operate, maneuver, and regenerate in all domains while under attack."[17] Hence, ballistic and cruise missiles are not a new threat, and the U.S. military has recognized this risk for several decades.

While the U.S. has long recognized missiles as a threat to its bases, the danger is increasing. As militaries continue to invest in advanced technologies, missiles are becoming

less expensive, easier to operate, and more lethal.[18] The proliferation of mobile launchers also makes them harder to locate and destroy before launch.[19] Moreover, potential adversaries have increased access to satellite services which improve the ability to accurately target U.S. facilities.[20] The cumulative effects of improving technology significantly reduces the number of ballistic and cruise missiles necessary to inflict damage on U.S. airfields.

A weapon is categorized as a ballistic missile if it is powered by rockets to reach high altitudes, followed by an unpowered trajectory that descends to its target.[21] There are two main offensive advantages for ballistic missiles. First, the speed and trajectory of ballistic missiles make them very difficult to shoot down. This advantage is compounded if each missile deploys multiple warheads, or by simultaneously launching several missiles. Second, the relatively short flight time minimizes the warning for a defender to attempt an already-difficult intercept. With accuracies now approaching 500 feet, ballistic missiles are steadily becoming the "weapon of choice for airfield attack."[22]

In contrast, cruise missiles are powered by jet engines and are launched from air, sea, or ground platforms. These missiles remain within the atmosphere like aircraft as they self-guide to their targets. The primary advantage of a cruise missile is the difficulty of detecting it, especially when flying within a few feet of the ground.[23] When launched in large numbers and in concert with a barrage of ballistic missiles, cruise missiles can create immense difficulties for missile defenses.[24]

The primary purpose of any ballistic or cruise missile is delivery of a warhead onto a designated target. Both ballistic and cruise missiles possess the capability to carry high explosive, chemical, biological and nuclear weapons. Additionally, these weapons can be delivered via unitary warheads or submunitions. Unitary warheads consist of a single high explosive, chemical, biological or nuclear weapon that is designed to strike a point target. In

contrast, submunitions contain dozens to hundreds of small high explosive, biological, or chemical warheads that are dispersed over large areas. Lethality varies by the size, number, and type of munition used, but the broader coverage area of submunitions generally inflicts greater damage than unitary warheads against unprotected targets.[25]

Warheads delivered via ballistic and cruise missiles can devastate a wide variety of targets across an air base. While less effective against hardened facilities, high explosive unitary warheads and submunitions are effective against runways and taxiways, aircraft parked on open parking ramps, personnel, fuel facilities, power and water supplies, munitions storage areas, and aircraft hangars. A recent study, as illustrated by Figure 1, found that a single medium-range ballistic missile "using modern guidance techniques (but not a guided warhead) equipped with submunitions had a high probability of destroying almost four squadrons of fighters (96 aircraft) parked in the open using standard spacing."[26]

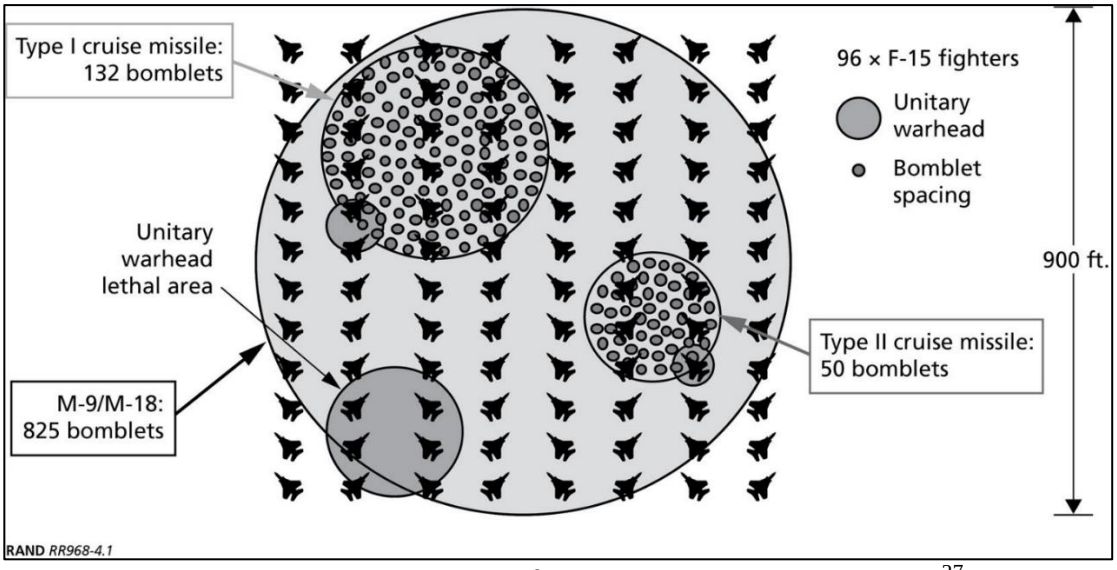

Figure 1. Warhead Lethality for Ballistic and Cruise Missiles[27]

A separate study found that "a relatively small number" of ballistic missiles could halt flying operations at the U.S. Air Force (USAF)'s Kadena Air Base in Okinawa for several days.[28] A determined adversary could launch additional attacks that would close the airfield

for several weeks, with one model predicting a closure of 43 days.[29] This level of damage to a critical forward air base would have significant impacts on the Joint Force Air Component Commander's ability to contribute to the overall war effort.

North Korea is a rogue regime that presents one of the greatest threats to U.S. forces.[30] It is armed with a substantial number of ballistic and cruise missiles spread across multiple launch locations. The arsenal includes an estimated 700 medium-range missiles capable of reaching any target in South Korea, dozens of mobile intercontinental ballistic missiles (ICBMs), and about 24 submarine-launched ballistic missiles. North Korea also possesses around 100 KN-02 missiles which can reliably and accurately hit specific point targets at a range of 90-120 km.[31] It is important to note that Pyongyang owns an ample supply of high explosive unitary, submunition, chemical, and potentially nuclear warheads. Furthermore, North Korea continues to develop and acquire higher numbers of increasingly accurate missiles. If China decided to participate in a future conflict on the Korean Peninsula, U.S. air bases across the Pacific would also be within the range of thousands of even more sophisticated missiles.[32] Ultimately, the number of available weapons and their proximity to allied airfields significantly increases the vulnerability of each base to repeated and complex attacks by both ballistic and cruise missiles.

Missile Defense in Joint Doctrine

Joint Publication 3-01 (JP 3-01) provides broad guidance to counter missile threats. The goal of missile defenses is to reduce weapon effectiveness and ease of use.[33] As opposed to the rapid advances in missile technology, missile countermeasures largely use the same techniques first identified for air base defense in World War I. Active defense, camouflage, concealment, deception (CCD), hardening, dispersal, and post-attack recovery are all enduring countermeasures still employed by today's planners against missile attacks.[34] Ideally, a

defensive strategy should include sufficient defenses to offset the enemy's finite supply of ballistic and cruise missiles.

Active defenses include a combination of weapon systems. Cruise missile can be defended by fighter interceptors, early warning radars, electronic jamming, anti-aircraft artillery, Patriot surface to air missiles (SAMs), and ship-based Aegis SM-2 and SM-6. Ballistic missile defense systems include AN/TPY-2 radars, Terminal High Altitude Air Defense (THAAD) and Patriot-3 (PAC-3) missiles, and Aegis SM-3.[35] In effect, active defenses aim to knock enemy warheads out of the sky before reaching their intended targets.

Passive defense is represented by multiple categories. The first is detection, warning systems and associated procedures. The second category is reducing enemy targeting effectiveness. It is accomplished through mobility, deception, electronic warfare (EW) and operational security (OPSEC). The first two categories are most effective prior to an attack. The third category includes passive defenses that protect capability during an attack through hardening, redundancy, dispersal. Hardening minimizes the destructive radius of attacking warheads, redundancy seeks to duplicate critical infrastructure nodes, and dispersal reduces the concentration of assets. This category also includes chemical, biological, radiological, and nuclear (CBRN) defense. Finally, a fourth category of post-attack recovery and reconstitution capabilities restore the installation to a requisite level of combat effectiveness.[36]

Doctrine recognizes that both active and passive countermeasures can reduce the effectiveness of incoming missiles, but "focused attacks by adversary air and missile threats may overwhelm defense designs."[37] Therefore, JP 3-01 recommends employing some passive defense countermeasures at every air base, including airfields already under the protection of active defenses.[38] Figure 2 provides a graphical representation of how joint doctrine suggests an air base should plan for integrated missile defense.

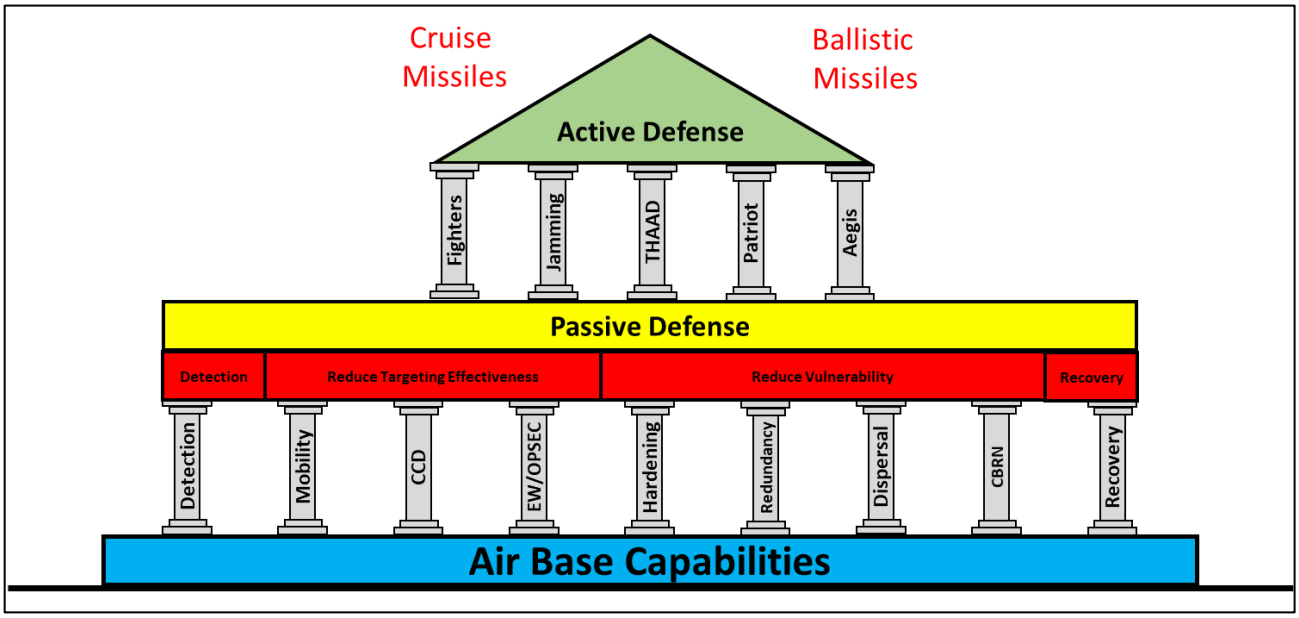

Figure 2. Joint Doctrine Missile Defense Framework

Both active and passive defenses are employed at U.S. installations around the world, including those on the Korean Peninsula. USFK provides the forward-based presence of over 23,000 U.S. military forces tasked with deterring North Korea and assuring the U.S. ally South Korea.[39] It oversees two main operating bases (MOBs) at Osan and Kunsan which house permanently assigned fighter aircraft and support units.[40] USFK also retains the use of five collocated operating bases (COBs) at Kwangju, Gimhae, Suwon, Taegu, and Chungju Air Bases. The COBs are shared with the Republic of Korea Air Force (ROKAF) and contain small areas reserved for the exclusive use of USAF forces that are designed to receive and beddown forces from outside units in the event of a crisis.[41] Overall, Figure 2 shows that there are 23 strategic and tactical military airfields in South Korea, including the two USAF MOBs and five COBs.

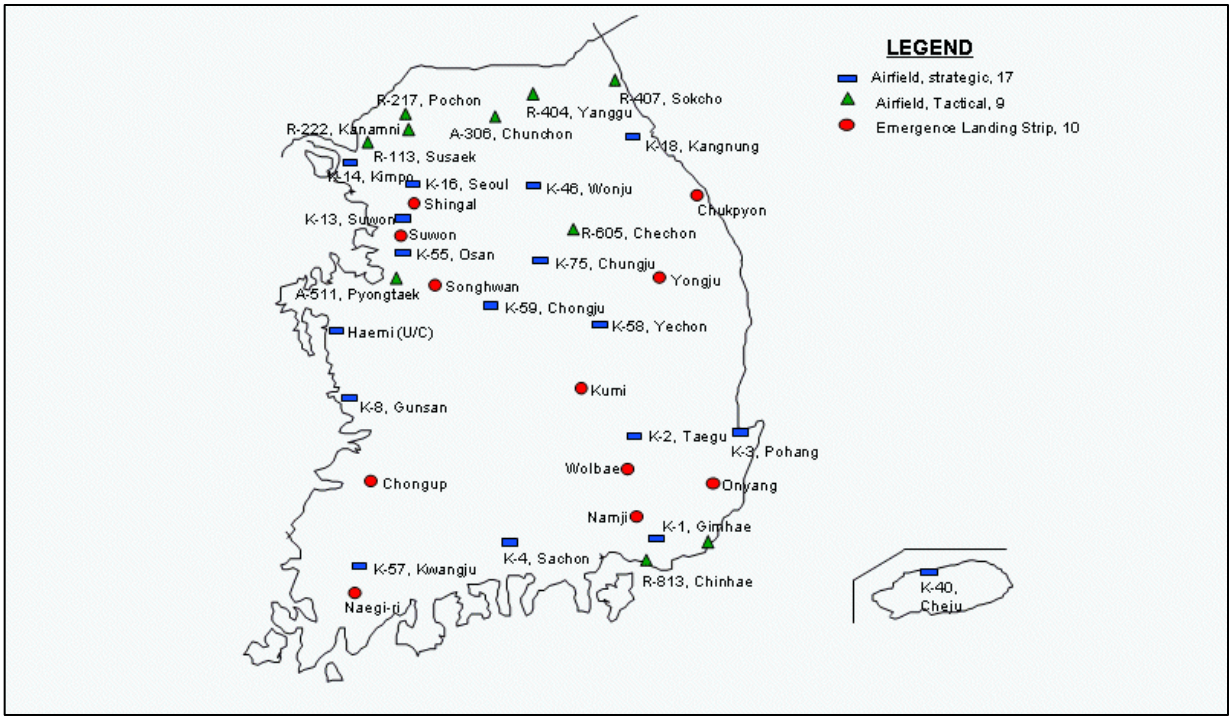

Figure 2. Military Airfields in the Republic of Korea[42]

USFK planners are responsible for ensuring the implementation of joint doctrine for missile defense at the seven U.S. bases while also advising the ROKAF for the remaining 17 airfields. As potential adversaries such as North Korea increase the number and capabilities of their arsenal, defenses must be improved. Because future investment in missile countermeasures will follow joint doctrine, it is critical that JP 3-01 presents an effective framework for planning missile defenses.

The Need for Three Types of Missile Defenses

JP 3-01 separates missile countermeasures into active and passive defenses based on whether they actively engage or passively receive incoming missile threats. While doctrine specifies the use of passive defense at each base, the classification is too broad because passive defense includes countermeasures used in the pre-impact, impact, and post-impact phases of a missile attack. In practice, each of the three phases of an attack requires separate countermeasures. Arguably, U.S. planners can comply with joint doctrine by employing a

single passive defense countermeasure at an air base. However, this strategy would fail to include the multiple other countermeasures needed before, during or after a missile strike.

In 2017, the USAF released the Engineering Functional Concept for Basing Resilience (EFC-BR) to address the rising threat to air bases. This document identified three tactics as fundamental for Air Force Civil Engineers sustaining the projection of combat air power against mission-degrading attacks. These tactics are distinguished by their employment before a disruptive event, during an attack to minimize the loss of capability, or recovery of capability after the event.[43] JP 3-01 should adopt the EFC-BR approach by integrating all joint-force defensive countermeasures into three distinct types of defenses that prevent missiles from impacting air bases, protect capability during attacks, or recover capability after attacks.

The first proposed type of defense is countermeasures that prevent missile warheads from reaching U.S. airfields. A joint solution is needed which includes fighter aircraft, U.S. Navy Aegis-equipped ships, and U.S. Army air defenses such as Patriot and THAAD. Sequencing and synchronizing each of these platforms provides maximum protection. Fighter aircraft can perform longer-range intercepts against cruise missiles, followed by sea-based missiles in intermediate ranges and then a two-tier land-based system as the last line of defense.[44] The first tier should consist of THAAD batteries to intercept ballistic missile targets above 50 km and a second tier of PAC-3s to take out both cruise missiles and ballistic missiles that reach lower altitudes.[45] This type of defense also increases the difficulty of targeting through jamming, detection systems, mobility, OPSEC, EW, and CCD such as placing assets under trees, inflatable decoy aircraft, paint schemes, and camouflage netting.[46] Ideally, U.S. planners should include as many defense layers as possible to create multiple opportunities to intercept waves of missiles before they arrive at their targets.

Because missiles may penetrate prevention defenses, joint doctrine also needs to

classify a second type of defense that protects the effectiveness and survivability of air base capabilities during attacks. Four categories of protection countermeasures merit consideration. First, hardening protects assets from near misses and drives up the cost to the attacker by requiring at least one precision weapon for each target.[47] Second, dispersal of aircraft, pavement, fuel tanks and munitions storage reduces the amount of capability lost in each successful strike and increases the number of missiles an enemy must dedicate to each airfield. Third, redundancy of critical infrastructure provides back-up capability and creates the necessity to strike additional targets.[48] Finally, CBRN defense measures such as detection systems and shielding improve the ability of personnel to survive and sustain operations in a CBRN environment.[49] Cumulatively, the four categories of protection countermeasures mitigate the damage of successful strikes to air base power projection capability.

A third type of defense, recovery forces, is required to repair and reconstitute the base from any damage inflicted by warheads that overwhelm prevention and protection defenses. Recovery requires an ample supply of engineer personnel, pre-positioned equipment, and war reserve material (WRM). Key recovery capabilities include Rapid Airfield Damage Repair (RADR), base recovery after attack (BRAAT), firefighting, and Explosive Ordinance Disposal (EOD). BRAAT focuses on recovery of facilities supporting flying operations, but it may also include repairs to facilities across the installation.[50] A 1980s USAF live-fire exercise validated that augmenting bases with additional engineers and repair equipment increases sortie generation while under attack.[51] The primary weakness of recovery defenses is the inability to prevent the destruction of critical assets. However, recovery forces contribute significantly to air base defense by decreasing the time to resume air operations and increasing the number of missiles required to close an airfield.[52]

The proposed framework for joint doctrine missile defense is graphically illustrated in

Figure 4. If conceptualized as a structure, attacking ballistic and cruise missiles must first penetrate through a roof of prevention defenses. Missiles then need to overcome protection defenses to impact air base capability. Recovery defenses represent the foundation of the structure. As long as recovery defenses survive an attack, and the foundation remains, the air base can be restored to a minimum level of mission capability. To maximize air base defense within this framework, JP 3-01 must also specify a portfolio approach for each base that includes countermeasures from each of the three types of defenses.

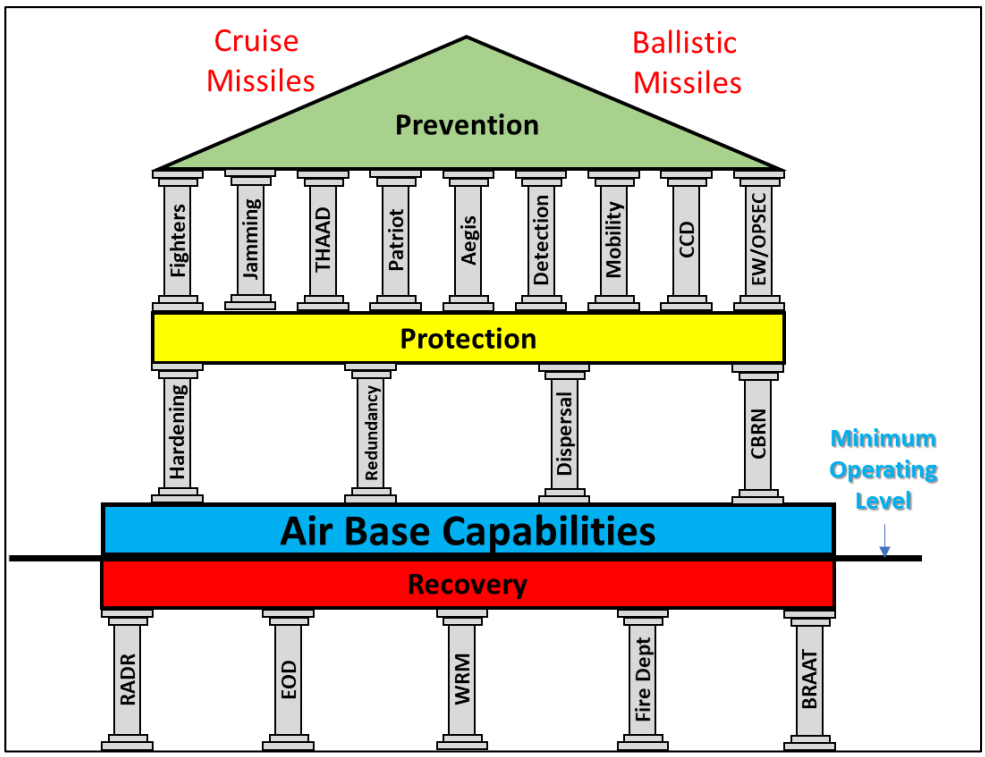

Figure 4. Proposed Missile Defense Framework

The Case Against Specifying Three Types of Defenses in Doctrine

As the enemy possesses a finite supply of weapons, a single type of countermeasure may raise the cost of attack to the point that the enemy is deterred from striking.[53] For example, North Korea has several hundred missiles, but it would also likely need to target several hundred USAF, U.S. Army and South Korean positions across the peninsula. North Korean missiles are generally assumed to suffer from "fair" to "very poor" accuracies due to

their reliance on antiquated Soviet guidance technology. According to one study, North Korea's entire missile force carrying unitary high explosive warheads could only damage 1-5% of targets across all 23 military airfields in South Korea. As a result, the study suggested that North Korea is more likely to use submunitions or chemical weapons which at most could cover 40% and 1,010% of their targets, respectively.[54] Given the inherent weaknesses in North Korean capabilities, USFK might achieve sufficient protection for its seven air bases by only implementing passive countermeasures which harden against submunitions and defend against chemical weapons. Therefore, joint doctrine could recommend selecting just the one type of defense that best reduces the effectiveness of missile attacks at an acceptable risk.

Another justification for not specifying all three types of countermeasures is cost. Most missile defense countermeasures are expensive. For example, a THAAD battery costs $800M, small hardened aircraft shelters can cost as much as $20M, and each additional engineer assigned to a recovery force costs upwards of $200K per year.[55] Recent studies concur, noting that some active and passive defenses such as ballistic missile defense, hardening, and dispersal "may be imperfect and possibly unaffordable solutions."[56] To limit demands on military budgets, JP 3-01 might suggest risk acceptance instead of implementing a portfolio approach of three defenses to preserve air base capability.

The Case for Specifying All Three Types of Defenses in Doctrine

A portfolio approach that combines to prevent, protect, and recover from attacks can mitigate the weaknesses inherent to each type of countermeasure. While prevention defense technology is continually improving, it has not reached the point of guaranteed success against incoming missiles. Intercepting ballistic missiles is particularly problematic for several reasons. First, their high-speed limits the time available for tracking and engagement, often to ten minutes or less. Second, defenders must remain on alert for 24 hours a day and seven days

a week, placing an immense strain on the forces responsible for managing intercepts.[57] Third, missile-defense designers can only reach a single-shot probability of kill of 80 to 90 percent, so each incoming missile requires two interceptors. With THAAD batteries only holding 48 to 96 ready-to-launch interceptors, each system can only defend against roughly 20 to 50 ballistic missiles. Finally, the THAAD fire control radar can only detect and track a limited number of objects. The exact capabilities are classified, but one expert speculated that North Korea could saturate the radar by launching more than 20 missiles simultaneously.[58] An observer noted how these challenges and limitations create "uncertainty…whether US missile defense systems, once fielded and deployed, can reliably defeat enemy ballistic missiles."[59]

Cruise missile defense is also problematic. Land-based air-defense systems such as the Patriot can engage cruise missiles, but they are not optimized for the task.[60] Additionally, detection and tracking suffer from the same radar limitations and strain on alert forces as ballistic missile defense. Fighter aircraft can target cruise missiles, but this prevents them from performing their primary offensive mission against enemy ground targets.[61] In the end, the effectiveness of cruise missile defenses is heavily dependent on the number of interceptors available compared to the number of inbound warheads.

All types of prevention defenses are most effective when deployed before the outbreak of hostilities.[62] Furthermore, defenses that reduce targeting effectiveness are increasingly less effective as detection sensors are becoming more sophisticated. Additionally, potential adversaries often have had years to develop targeting lists on air bases. Any reinforcements would have to arrive and setup under the threat of the missiles they are designed to counter. Sea-based Aegis ships can provide some responsive capabilities for air bases near the littorals, but this also requires sea control. Overall, prevention defenses are vulnerable to massed salvos and are mostly limited to the number of interceptors in place before a crisis.

Enemy missiles that penetrate past prevention defenses could then be countered by protective defenses, but these countermeasures also have exploitable weaknesses. Hardening provides a known target location to the enemy. Moreover, Operation Desert Storm showed that advanced hardened aircraft shelters are susceptible to repeat attacks with concrete-piercing warheads.[63] Dispersal and redundancy are restricted by the space available on an installation, and place additional burdens on support personnel for operations and maintenance.[64] Significantly, protection defenses take time to construct and are most effective when completed well in advance of hostilities.

Prevention and protection defenses are not a panacea, but the U.S. also cannot rely only on recovery forces to repair any damage. Post-attack recovery is a complex operation with multiple emergencies such as fires, collapsed buildings, wounded personnel, and unexploded ordinance.[65] Available recovery forces must be prioritized between sortie generation and reconstitution of facilities. Even with a substantial number of engineers, it can take over 10 hours to repair a damaged runway to a minimum operating capability.[66] Ultimately, even the most robust recovery force cannot replace destroyed personnel and equipment.

In the end, the selection of individual countermeasures is difficult because each has weaknesses and strengths. For example, hardened aircraft shelters "offer the smallest degree of sortie protection per investment dollar", but they may also "prove to be a relatively inexpensive insurance policy for aircraft that can be quite expensive and of high value in the conflict."[67] Choosing countermeasures also relies on accurate estimates of adversary capability and their strategy for employing ballistic and cruise missiles. USFK likely anticipates that North Korea will use submunitions and chemical warheads due to perceived issues with missile accuracy. However, recent reports also speculate that North Korea is now using Global Position System (GPS) guidance to significantly improve targeting precision.[68]

Given this uncertainty, planners need a defensive strategy "that is as resilient as possible against a range of attacks."[69] Applied to Osan or Kunsan Air Bases, an updated JP 3-01 would suggest investment in all three types of countermeasures. First, an extra THAAD battery and CCD increases prevention capabilities against a higher number of ballistic missiles. Second, strengthening hardening and chemical defenses increases protection against expected submunitions and chemical warheads. Finally, additional engineers can expedite the recovery of airfields damaged by submunitions and hardened facilities hit by GPS-guided unitary warheads. This approach minimizes risk to Douhet's "nest and eggs on the ground," while maximizing the ability to generate sorties for power projection.

Conclusion

While U.S. air power is accustomed to operating from sanctuary, a future conflict against an enemy such as North Korea would represent a competition between offensive and defensive capabilities. U.S. air bases will receive repeated attacks from ballistic and cruise missiles, and "the outcome of the battle of the airfields might be uncertain until the very end of the conflict."[70] The USAF operates most U.S. forward air bases, but missile defense is an issue for the joint force commander because it requires synchronization of capabilities from all services. Fortunately, numerous joint force countermeasures are available, and many are already in-place. Unfortunately, existing defenses are often not sufficient against modern threats, and improvements require substantial time and resources to implement.

Future investment must follow joint doctrine, but the current categorization of countermeasures into active and passive defense is insufficient. JP 3-01 requires an updated framework that classifies countermeasures by their employment prior to, during, or following missile-delivered warheads impacting an installation. Moreover, the characteristics of countermeasures and nature of the threat dictates that the U.S. cannot mitigate risk by using

only one or two types of defense. Instead, investment should utilize a portfolio approach to missile defense that simultaneously prevents missiles from reaching U.S. forward air bases, protects from warheads that impact the installation, and recovers from any damage.

Recommendations

Every forward U.S. air base faces unique threats and already possesses different existing countermeasures. Therefore, there is no set listing of countermeasures that should be applied at every base. Additional study is needed to determine the right mix within the three types for each installation. This can only be accomplished through increased research and development of countermeasure technologies in conjunction with modeling and simulation.[71] According to the EFC-BR, analytic studies require a functional concept to determine the most effective and cost-efficient courses of action.[72] The joint doctrine missile defense framework proposed in this paper can provide utility in future studies at any forward air base in the world.

Finally, any detailed analysis on required countermeasures will likely result in a costly investment strategy. Fortunately, the U.S. already receives significant financial support for infrastructure improvements from several host nations such as South Korea and Japan. This funding is an area of continual bilateral military and diplomatic engagement.[73] The Department of Defense could offset the cost of implementing new missile defense countermeasures by seeking additional contributions from nations that host U.S. air bases. Any attack on U.S. forward air bases will likely be part of a full-fledged offensive against the host nation military and its civilian population. By underwriting part of its defense budget to improve missile defenses at U.S. installations, host nations increase the protection they receive from U.S. forces operating from airfields within their borders. Therefore, defending U.S. air bases is mutually beneficial and worthy of increased investment in the three types of defenses for collective defense against ballistic and cruise missiles.

Endnotes

1. Halliday, John M. *Tactical Dispersal of Fighter Aircraft: Risk, Uncertainty, and Policy Recommendations.* Report. Accessed April 13, 2018. https://www.rand.org/pubs/notes/N2443.html, 12.

2. Vick, Alan J. *Air Base Attacks and Defensive Counters: Historical Lessons and Future Challenges.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR968.html, xi.

3. Douhet, Giulio. *The Command of the Air*. Washington, DC: Air Force History and Museum Program, 1998, 53-54.

4. U.S. Department of Defense, *Military and Security Developments Involving the Democratic People's Republic of Korea* (Washington, DC: Office of the Secretary of Defense, 2015), 1.

5. U.S. Office of the Chairman of the Joint Chiefs of Staff: Countering Air and Missile Threats. Joint Publication (JP) 3-01, Washington D.C.: CJCS, April 2017, I-04.

6. Ibid, V-7.

7. Ibid, V-15.

8. Lostumbo, Michael J., et al. "Overseas Basing of U.S. Military Forces." Accessed April 13, 2018. https://www.rand.org/content/dam/rand/pubs/research_reports/RR200/RR201/RAND_RR201.pdf, xx-xxi.

9. Bowie, Christopher J. *The Anti-Access Threat and Theater Air Bases.* Report. September 24, 2002. Accessed March 5, 2018. http://csbaonline.org/research/publications/the-anti-access-threat-and-theater-air-bases, 11.

10. Krepinevich, Andrew, Barry Watts, and Robert Work. *Meeting the Anti-Access and Area-Denial Challenge.* Report. May 20, 2003. Accessed March 5, 2018. http://csbaonline.org/research/publications/a2ad-anti-access-area-denial, 15-16.

11. Vick, Alan J. *Air Base Attacks and Defensive Counters: Historical Lessons and Future Challenges.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR968.html, 5.

12. Halliday, John M. *Tactical Dispersal of Fighter Aircraft: Risk, Uncertainty, and Policy Recommendations.* Report. Accessed April 13, 2018. https://www.rand.org/pubs/notes/N2443.html, 10.

13. Vick, Alan J. *Air Base Attacks and Defensive Counters: Historical Lessons and Future Challenges.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR968.html, 61.

14. U.S. Office of the Chairman of the Joint Chiefs of Staff: Countering Air and Missile Threats. Joint Publication (JP) 3-01, Washington D.C.: CJCS, April 2017, V-5-V-6.

15. Vick, Alan J. *Air Base Attacks and Defensive Counters: Historical Lessons and Future Challenges.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR968.html, 19.

16. Cliff, Roger, et al. *Entering the Dragon's Lair.* Report. Accessed April 13, 2018. https://www.rand.org/content/dam/rand/pubs/monographs/2007/RAND_MG524.pdf, 4.

17. U.S. Department of Defense, *The National Defense Strategy of the United States of America* (Washington, DC: OSD), 2018, 6.

18. Vick, Alan J. *Air Base Attacks and Defensive Counters: Historical Lessons and Future Challenges.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR968.html, 24.

19. Bowie, Christopher J. *The Anti-Access Threat and Theater Air Bases.* Report. September 24, 2002. Accessed March 5, 2018. http://csbaonline.org/research/publications/the-anti-access-threat-and-theater-air-bases, 41.

20. Krepinevich, Andrew, Barry Watts, and Robert Work. *Meeting the Anti-Access and Area-Denial Challenge.* Report. May 20, 2003. Accessed March 5, 2018. http://csbaonline.org/research/publications/a2ad-anti-access-area-denial, 4.

21. "Ballistic vs. Cruise Missiles." Accessed April 13, 2018. https://armscontrolcenter.org/wp-content/uploads/2017/04/Ballistic-vs.-Cruise-Missiles-Fact-Sheet.pdf.

22. Vick, Alan J. *Air Base Attacks and Defensive Counters: Historical Lessons and Future Challenges.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR968.html, 20.

23. "Ballistic vs. Cruise Missiles." Accessed April 13, 2018. https://armscontrolcenter.org/wp-content/uploads/2017/04/Ballistic-vs.-Cruise-Missiles-Fact-Sheet.pdf.

24. Vick, Alan J. *Air Base Attacks and Defensive Counters: Historical Lessons and Future Challenges.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR968.html, 22-23.

25. Bennett, Bruce. "The Emerging Ballistic Missile Threat: Global and Regional Ramifications." In *Emerging Threats, Force Structures, and the Role of Air Power in Korea*, edited by Natalie W. Crawford and Chung-in Moon, Project Air Force Conference Proceedings, 181-217. Santa Monica, CA: RAND, 2000, 190-198.

26. Bowie, Christopher J. *The Anti-Access Threat and Theater Air Bases.* Report. September 24, 2002. Accessed March 5, 2018. http://csbaonline.org/research/publications/the-anti-access-threat-and-theater-air-bases, 42.

27. Vick, Alan J. *Air Base Attacks and Defensive Counters: Historical Lessons and Future Challenges.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR968.html, 21.

28. Heginbotham, Eric. *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017.* Report. RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR392.html, xxiii.

29. Ibid, 60.

30. U.S. Department of Defense, *The National Defense Strategy of the United States of America* (Washington, DC: OSD), 2018, 1.

31. Bermudez, Joseph S., Jr., and Michael Elleman. "THAAD: What It Can and Can't Do." 38 North. February 09, 2018. Accessed March 14, 2018. https://www.38north.org/reports/2016/03/thaad-what-it-can-and-cant-do/.

32. Lostumbo, Michael J., et al. "Overseas Basing of U.S. Military Forces." Accessed April 13, 2018. https://www.rand.org/content/dam/rand/pubs/research_reports/RR200/RR201/RAND_RR201.pdf, xxiv.

33. Lostumbo, Michael J., et al. "Overseas Basing of U.S. Military Forces." Accessed April 13, 2018. https://www.rand.org/content/dam/rand/pubs/research_reports/RR200/RR201/RAND_RR201.pdf, xxiv.

34. Vick, Alan J. *Air Base Attacks and Defensive Counters: Historical Lessons and Future Challenges.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR968.html, xii.

35. U.S. Office of the Chairman of the Joint Chiefs of Staff: Countering Air and Missile Threats. Joint Publication (JP) 3-01, Washington D.C.: CJCS, April 2017, V-7-V-V-21.

36. Ibid, V-15-V-18.

37. Ibid, V-15.

38. Ibid, V-15.

39. "About United States Forces Korea." United States Forces Korea. Accessed April 13, 2018. http://www.usfk.mil/About/.

40. "7th Air Force." Pacific Air Forces. Accessed April 13, 2018. http://www.pacaf.af.mil/Info/Fact-Sheets/Display/Article/909893/7th-air-force/.

41. U.S. Department of State to Republic of Korea Air Force. Memorandum of understanding, 26 July 2007. Accessed April 13, 2018. https://www.state.gov/documents/organization/105777.pdf.

42. "Republic of Korea Airfields." Globalsecurity.org. Accessed April 24, 2018. https://www.globalsecurity.org/jhtml/jframe.html#https://www.globalsecurity.org/military/facility/images/rok-airfields.gif

43. U.S. Air Force, *Engineering Functional Concept for Basing Resilience*. Tyndall AFB, FL: Air Force Civil Engineer Center, September 2017, 2-3.

44. Thomas, Brent, et al. *Project AIR FORCE Modeling Capabilities for Support of Combat Operations in Denied Environments.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR427.html, 31-32.

45. Bermudez, Joseph S., Jr., and Michael Elleman. "THAAD: What It Can and Can't Do." 38 North. February 09, 2018. Accessed March 14, 2018. https://www.38north.org/reports/2016/03/thaad-what-it-can-and-cant-do/.

46. Vick, Alan J. *Air Base Attacks and Defensive Counters: Historical Lessons and Future Challenges.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR968.html, 40-43.

47. Bowie, Christopher J. *The Anti-Access Threat and Theater Air Bases.* Report. September 24, 2002. Accessed March 5, 2018. http://csbaonline.org/research/publications/the-anti-access-threat-and-theater-air-bases, 45-46.

48. Thomas, Brent, et al. *Project AIR FORCE Modeling Capabilities for Support of Combat Operations in Denied Environments.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR427.html, 36.

49. U.S. Air Force, *Civil Engineer Disaster and Attack Preparations*. Air Force Pamphlet 10-219, Volume 2. Tyndall AFB, FL: Air Force Civil Engineer Center, 9 June 2008, 54-56.

50. U.S. Air Force, *Airfield Damage Repair Operations*. Air Force Pamphlet 10-219, Volume 4. Tyndall AFB, FL: Air Force Civil Engineer Center, 28 May 2008, 151.

51. Bowie, Christopher J. *The Anti-Access Threat and Theater Air Bases.* Report. September 24, 2002. Accessed March 5, 2018. http://csbaonline.org/research/publications/the-anti-access-threat-and-theater-air-bases, 46-47.

52. Cliff, Roger, et al. *Entering the Dragon's Lair.* Report. Accessed April 13, 2018. https://www.rand.org/content/dam/rand/pubs/monographs/2007/RAND_MG524.pdf, 96.

53. Halliday, John M. *Tactical Dispersal of Fighter Aircraft: Risk, Uncertainty, and Policy Recommendations.* Report. Accessed April 13, 2018. https://www.rand.org/pubs/notes/N2443.html, 15.

54. Bennett, Bruce. "The Emerging Ballistic Missile Threat: Global and Regional Ramifications." In *Emerging Threats, Force Structures, and the Role of Air Power in Korea*, edited by Natalie W. Crawford and Chung-in Moon, Project Air Force Conference Proceedings, 181-217. Santa Monica, CA: RAND, 2000, 204-205.

55. Sisk, Richard. "Amid Tough Talk on North Korea, US Wants More THAAD Interceptors." Military.com. March 18, 2017. Accessed April 13, 2018. https://www.military.com/defensetech/2017/03/18/thaad-interceptors-added-defense-budget.; Thomas, Brent, et al. *Project AIR FORCE Modeling Capabilities for Support of Combat Operations in Denied Environments.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR427.html, 53; Dahlman, Carl J. *The Cost of a Military Person-Year.* Report. Accessed April 13, 2018. https://www.rand.org/pubs/monographs/MG598.html, 5-17.

56. Bowie, Christopher J. *The Anti-Access Threat and Theater Air Bases.* Report. September 24, 2002. Accessed March 5, 2018. http://csbaonline.org/research/publications/the-anti-access-threat-and-theater-air-bases, 65.

57. Ibid, 62.

58. Bermudez, Joseph S., Jr., and Michael Elleman. "THAAD: What It Can and Can't Do." 38 North. February 09, 2018. Accessed March 14, 2018. https://www.38north.org/reports/2016/03/thaad-what-it-can-and-cant-do/.

59. Bowie, Christopher J. *The Anti-Access Threat and Theater Air Bases.* Report. September 24, 2002. Accessed March 5, 2018. http://csbaonline.org/research/publications/the-anti-access-threat-and-theater-air-bases, 62.

60. Cliff, Roger, et al. *Entering the Dragon's Lair.* Report. Accessed April 13, 2018. https://www.rand.org/content/dam/rand/pubs/monographs/2007/RAND_MG524.pdf, 105-106.

61. Bowie, Christopher J. *The Anti-Access Threat and Theater Air Bases.* Report. September 24, 2002. Accessed March 5, 2018. http://csbaonline.org/research/publications/the-anti-access-threat-and-theater-air-bases, 62.

62. Cliff, Roger, et al. *Entering the Dragon's Lair.* Report. Accessed April 13, 2018. https://www.rand.org/content/dam/rand/pubs/monographs/2007/RAND_MG524.pdf, 98.

63. Halliday, John M. *Tactical Dispersal of Fighter Aircraft: Risk, Uncertainty, and Policy Recommendations.* Report. Accessed April 13, 2018. https://www.rand.org/pubs/notes/N2443.html.; Kopp, Carlo. "Airbase hardening in the Western Pacific." *Air Power Australia*, March 2012, 12-15.

64. Vick, Alan J. *Air Base Attacks and Defensive Counters: Historical Lessons and Future Challenges.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR968.html, 53-54.

65. Halliday, John M. *Tactical Dispersal of Fighter Aircraft: Risk, Uncertainty, and Policy Recommendations.* Report. Accessed April 13, 2018. https://www.rand.org/pubs/notes/N2443.html, 26-27.

66. Thomas, Brent, et al. *Project AIR FORCE Modeling Capabilities for Support of Combat Operations in Denied Environments.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR427.html, 32-34.

67. Ibid, 68.

68. Albert, Eleanor. "What's the Status of North Korea's Nuclear Program?" Council on Foreign Relations. January 3, 2018. Accessed April 25, 2018. https://www.cfr.org/backgrounder/north-koreas-military-capabilities.

69. Ibid.

70. Vick, Alan J. *Air Base Attacks and Defensive Counters: Historical Lessons and Future Challenges.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR968.html, 23-24.

71. Ibid, 52.

72. U.S. Air Force, *Engineering Functional Concept for Basing Resilience*. Tyndall AFB, FL: Air Force Civil Engineer Center, September 2017, iii.

73. Facilities Investment & Management. Accessed April 15, 2018. https://www.acq.osd.mil/eie/fim/FIM_Program_Areas.html.

Bibliography

"7th Air Force." Pacific Air Forces. Accessed April 13, 2018. http://www.pacaf.af.mil/Info/Fact-Sheets/Display/Article/909893/7th-air-force/.

"About United States Forces Korea." United States Forces Korea. Accessed April 13, 2018. http://www.usfk.mil/About/.

"Ballistic vs. Cruise Missiles." Accessed April 13, 2018. https://armscontrolcenter.org/wp-content/uploads/2017/04/Ballistic-vs.-Cruise-Missiles-Fact-Sheet.pdf.

"Republic of Korea Airfields." Globalsecurity.org. Accessed April 24, 2018. https://www.globalsecurity.org/jhtml/jframe.html#https://www.globalsecurity.org/military/facility/images/rok-airfields.gif

Albert, Eleanor. "What's the Status of North Korea's Nuclear Program?" Council on Foreign Relations. January 3, 2018. Accessed April 25, 2018. https://www.cfr.org/backgrounder/north-koreas-military-capabilities.

Bennett, Bruce. "The Emerging Ballistic Missile Threat: Global and Regional Ramifications." In *Emerging Threats, Force Structures, and the Role of Air Power in Korea*, edited by Natalie W. Crawford and Chung-in Moon, Project Air Force Conference Proceedings, 181-217. Santa Monica, CA: RAND, 2000.

Bermudez, Joseph S., Jr., and Michael Elleman. "THAAD: What It Can and Can't Do." 38 North. February 09, 2018. Accessed March 14, 2018. https://www.38north.org/reports/2016/03/thaad-what-it-can-and-cant-do/.

Bowie, Christopher J. *The Anti-Access Threat and Theater Air Bases.* Report. September 24, 2002. Accessed March 5, 2018. http://csbaonline.org/research/publications/the-anti-access-threat-and-theater-air-bases.

Cliff, Roger, et al. *Entering the Dragon's Lair.* Report. Accessed April 13, 2018. https://www.rand.org/content/dam/rand/pubs/monographs/2007/RAND_MG524.pdf.

Dahlman, Carl J. *The Cost of a Military Person-Year.* Report. Accessed April 13, 2018. https://www.rand.org/pubs/monographs/MG598.html.

Douhet, Giulio. *The Command of the Air*. Reprint, Air Force History and Museum Program, Washington, DC: 1998.

Facilities Investment & Management. Accessed April 15, 2018. https://www.acq.osd.mil/eie/fim/FIM_Program_Areas.html.

Halliday, John M. *Tactical Dispersal of Fighter Aircraft: Risk, Uncertainty, and Policy Recommendations.* Report. Accessed April 13, 2018. https://www.rand.org/pubs/notes/N2443.html.

Heginbotham, Eric. *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017.* Report. RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR392.html.

Kopp, Carlo. "Airbase hardening in the Western Pacific." *Air Power Australia*, (March 2012): 12-15.

Krepinevich, Andrew, Barry Watts, and Robert Work. *Meeting the Anti-Access and Area-Denial Challenge.* Report. May 20, 2003. Accessed March 5, 2018. http://csbaonline.org/research/publications/a2ad-anti-access-area-denial.

Lostumbo, Michael J., et al. "Overseas Basing of U.S. Military Forces." Accessed April 13, 2018. https://www.rand.org/content/dam/rand/pubs/research_reports/RR200/RR201/RAND_RR201.pdf.

Schanz, Marc V. "The New Limits to Hardening." *Air Force Magazine* (December 2015): 28-33.

Sisk, Richard. "Amid Tough Talk on North Korea, US Wants More THAAD Interceptors." Military.com. March 18, 2017. Accessed April 13, 2018. https://www.military.com/defensetech/2017/03/18/thaad-interceptors-added-defense-budget.

Thomas, Brent, et al. *Project AIR FORCE Modeling Capabilities for Support of Combat Operations in Denied Environments.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR427.html.

U.S. Air Force, *Engineering Functional Concept for Basing Resilience*. Tyndall AFB, FL: Air Force Civil Engineer Center, September 2017.

U.S. Air Force, *Airfield Damage Repair Operations*. Air Force Pamphlet 10-219, Volume 4. Tyndall AFB, FL: Air Force Civil Engineer Center, 28 May 2008.

U.S. Air Force, *Civil Engineer Disaster and Attack Preparations*. Air Force Pamphlet 10-219, Volume 2. Tyndall AFB, FL: Air Force Civil Engineer Center, 9 June 2008.

U.S. Department of Defense, *Military and Security Developments Involving the Democratic People's Republic of Korea* (Washington, DC: Office of the Secretary of Defense, 2015), 1.

U.S. Department of Defense, *The National Defense Strategy of the United States of America* (Washington, DC: OSD), 2018.

U.S. Department of State to Republic of Korea Air Force. Memorandum of understanding, 26 July 2007. Accessed April 13, 2018. https://www.state.gov/documents/organization/105777.pdf.

U.S. Office of the Chairman of the Joint Chiefs of Staff. Countering Air and Missile Threats. *Joint Publication (JP) 3-01*, Washington DC: CJCS, 21 April 2017.

Vego, Milan. *Joint Operational Warfare*: Theory and Practice. Reprint, Naval War College, Newport, RI: 2009.

Vick, Alan J. *Air Base Attacks and Defensive Counters: Historical Lessons and Future Challenges.* Report. Project Air Force, RAND Corporation. 2015. Accessed March 5, 2018. https://www.rand.org/pubs/research_reports/RR968.html.

.