Risk and Resiliency:
China's Emerging Air Base Strike Threat

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and

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Cover Image: YJ-12 supersonic anti-ship missiles in their first public debut for the "70th Victory Day Parade" in front of the Forbidden City in Beijing, China. Credit: Weibo @Antithesis, via Popular Science

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Introduction

The Asia-Pacific region is the center of gravity for U.S. strategic interests. Home to major and rising powers such as Japan and China, the region increasingly represents the primary hub of human activity by any measure. Some of the regional developments that occupy American strategic planners and decision makers include China's rapid military modernization, weapons proliferation, arms racing, and lack of military transparency. These issues promote insecurity among regional actors that rely on the United States for strategic assurance, and that count on its uncontested military strength to foster peace and stability.

In particular, China's investments in anti-access/area denial (A2/AD) systems are undermining the United States' ability to live up to regional expectations. Given the centrality of air power for U.S. power projection in the Western Pacific, the Chinese People's Liberation Army (PLA) has focused on prioritizing the development of asymmetric capabilities to target American air superiority where it is weakest—on the ground. China's military modernization program is closely associated with a number of maturing precision strike capabilities designed for attacking air bases. Referred to as "airfield runway blockades" by the PLA, such operations intend to overcome traditional Chinese weaknesses in the air by negating enemy air power on the surface. This strategy benefits from both the limited number and the relative fragility of America's forward-deployed air bases. For example, the U.S. Air Force's principal front-line facility in Asia, Kadena Air Base, Okinawa, is remarkably vulnerable to missile attack due to its lack of active and passive defenses, which includes hardening.[1] Other U.S. and allied air bases are similarly unprepared for surviving, defending, mitigating, or recovering from missile attacks. China's strategy further benefits from the technical sophistication of the PLA's strategic missile forces.

While air superiority alone does not ensure success in deterring aggression or winning a military campaign, it is often decisive in military operations.[2] Furthermore, crisis stability depends on eliminating any incentives for preemptive or first strikes, and base resiliency is crucial to this deterrent message. As the United States evaluates future force postures during a period of continued fiscal uncertainty, China's defense establishment is making significant advances in developing a force capable of dominating the air environment around its periphery. In light of these trends, what is Chinese strategic thinking on adversary air base vulnerability, and how well positioned is the PLA to exploit U.S. weaknesses? What steps has the United States taken to improve its air bases' resiliency, defined as the capacity to withstand attack, adapt, and generate sufficient combat power to achieve campaign objectives in the face of continued enemy action? What more can be done?

This paper seeks to provide an overview of the evolving airpower challenge that the United States faces in the Western Pacific and beyond. We will begin by exploring Chinese military writings on air base strike operations, and then evaluate the current trajectory of the PLA's precision strike capabilities for conducting such operations. Following this, we will describe how the U.S. military is seeking to respond to the threat to its air bases. Finally, we will assess the future implications of this evolving situation, and conclude with recommendations for how American airpower in Asia can be more resilient against threats.

PLA Threat to Regional Air Bases: Strategy, Capacity, and Trajectory[3]

Given the need for air superiority to support regional contingency operations such as maritime control, air strikes, and landing operations, U.S. air bases are a logical target for Chinese thinkers and planners. In this regard, Taiwan scenarios drive much of the PLA's thinking on air base attacks. For the PLA, obtaining the ability to rapidly and decisively defeat Taiwan, while at the same time complicating American intervention, is the principal driver of its modernization program. Not surprisingly, countering the defense of Taiwan factors heavily in Chinese thinking on airfield attacks, and this mission shapes the PLA's development of strategies to exploit perceived U.S. base vulnerabilities.

Strategy

Chinese strategists emphasize the employment of air and missile strikes as a means of leveraging the PLA's advantages over its opponents. Illustrating the importance the PLA places on air superiority, the *Science of Military Strategy* argues that strategic air raids "may replace ground operations as the main operations to attain strategic aims. Success or failure...has direct bearing and constraint on the course and outcome of war."[4] In describing the selection of targets for such strikes, the authors of the *Science of Military Strategy* state that "fighter forces are to destroy or contain threatening enemy planes through...blocking enemy airfields."[5] Missile forces, referred to as "striking fire" in PLA materials, would likely play the most critical role in an air raid. The *Science of Military Strategy* describes the use of missiles to attack enemy airpower in the following terms, "In terms of striking fire...guided and precision-guided missiles are to be used to destroy and suppress the enemy's radar stations, ground air defense weapons, and airfields."[6]

Chinese strategists indicate that in the event of conflict, the PLA would consider air bases to be the principal targets of its land-based missile units and air force assets. For example, the PLA's *Second Artillery Force Science of Campaigns* lists the primary mission of the conventionally armed missile units of the newly renamed Strategic Rocket Force (PLARF) as "suppressing enemy air force air bases, airfields, and missile defense (air defense) systems."[7] Such operations would be conducted in coordination with air units in order to achieve air superiority. PLARF strategists write that:

> *To achieve air superiority, long distance firepower must be applied to 'control the air through the ground.' Enemy combat aircraft would be suppressed or destroyed on the ground, and/or blockaded inside their bunkers; thus making it difficult for their air combat forces to play an effective role.*[8]

The PLA Air Force (PLAAF) appears to have started developing doctrine for conducting air and missile strikes on air bases prior to the 1995–1996 Taiwan Strait Crisis. In 1995, the PLAAF Command Academy published a book that included a section on air base strike operations. In the book, *The Application of Air Force Operations*, the authors referred to air base strikes as "airfield runway blockades"—terminology that is widely used by writers across the PLA today. The authors defined an airfield runway blockade in following terms:

> *The standard of a blockade is measured according to the loss of the smallest area required for taking off. Once runways have been attacked, the enemy's planes should be unable to find an area sufficient to satisfy the minimum runway length and width requirements for taking off. This is the standard by which to measure the success or failure of a blockade.*[9]

Based on the *Second Artillery Force Science of Campaigns*, a notional operation against an enemy's air defenses would proceed as follows:

> *First, anti-radiation unmanned aerial vehicles would engage in anti-radiation attacks [on radars]. Either at the same time or following this, conventionally armed missiles carrying penetrating submunitions would carry out firepower strikes to cut apart important enemy airfield targets; thereby causing enemy planes to be unable to take off or land…Afterwards, our aviation forces would engage in gap-filling bombing to destroy enemy air combat forces' ground infrastructure, and take air superiority.*[10]

Numerous research articles, technical studies, and simulation reports further indicate that the main focus of air base strike operations would likely be runways. PLARF researchers writing in 2009 argued that "combat aircraft rely on runways for taking off and landing. Once runways have been destroyed, airfields are unable to provide combat aircraft with fuel, munitions, maintenance, and other support. As such, when executing strikes on airfields, runways will be the principal targets."[11] Likewise, a team of Chinese missile designers wrote in a 2013 textbook that the main target of air base missile strikes is runways.[12] Another more detailed PLA study assessed that runways, parking ramps, and taxiways would be the highest value targets at any air base.[13]

Early PLA writings emphasize the importance of attacking runways to gain air superiority over an otherwise stronger opponent. Ballistic missiles and cruise missiles are viewed as optimal means of delivering such strikes due to their ability to penetrate enemy air defenses through the use of speed and surprise.[14] One study argued that having capabilities that could effectively penetrate air defenses to strike enemy air bases would be "an extremely important question in actual combat operations."[15] These researchers assumed that if initial barrages of conventional theater missiles could not effectively close enemy air bases, more vulnerable bomber fleets and their fighter escorts would be ordered to conduct follow-on surprise attacks. The results of their simulations, while not publically available, led the authors to conclude that more emphasis needed to be placed on theater missile strikes if air attacks were to have an acceptably high chance of success.[16] The implications of these studies are clear: PLA researchers do not have confidence in their aging bomber fleet's ability to survive missions inside denied airspace. If bombers and fighters were going to be successful, the enemy's air force would have to be first knocked out on the ground by missile strikes.

More recent Chinese studies indicate that a significant amount of simulation and planning has been devoted to exploring how the PLA's missile units could engage in strikes on air bases. Using a campaign against the Republic of China (Taiwan) as an illustrative example, one recent PLA study simulated strikes on air bases using surface-to-surface missiles. The study, noting the PLA's "limited" inventory of missiles and inability to launch a simultaneous attack against all of Taiwan's air bases at once, assessed the respective threat posed by each air base. The authors then proposed a targeting sequence whereby each base's runways would be attacked in order of priority to optimize overall campaign effects.[17] Based upon their findings, the study's authors recommended striking Pingtung Air Base first in order to ground Taiwan's fleet of E-2 "Hawkeye" airborne early warning and control (AEW&C) aircraft and C-130 "Hercules" military transport and electronic warfare aircraft.[18] Based upon this assessment, it is logical to assume that the PLA would view Kadena Air Base, the home of the United States Air Force (USAF)'s forward-deployed AEW&C aircraft, to be a priority target in a conflict with the United States or Japan. The PLA's emphasis on striking air bases supporting adversary airborne reconnaissance and strategic lift platforms might cause it to see U.S. air bases at Misawa and Yokota in Japan as high-priority targets as well.

Capacity

To meet operational requirements for a contingency that could involve the United States, the PLARF and PLAAF have been investing heavily into developing and testing a number of specialized weapons for air base attacks. These weapons include both ground and air-launched missile variants that are armed with runway penetrating submunitions. Most notably, the PLARF appears to have developed the world's first conventionally armed ballistic missile warhead capable of conducting strikes on air base runways. Chinese military-technical writings indicate that preliminary research in support of this program began in the wake of the 1995–1996 Taiwan Strait Crisis.[19]

In 1997, researchers affiliated with the PLA's Beijing Artillery Research Institute and the Beijing Institute of Technology drafted a detailed technical study on runway attacks. The study modeled airfield strikes aimed at damaging or "cutting" a 3,000-meter long runway at its mid-point with fifteen terminally guided submunitions delivered by a ballistic missile.[20] Shortly thereafter, researchers at the PLARF (then-Second Artillery) Engineering Academy in Xi'an published a computer simulation designed to assess the number of missiles required to successfully blockade an enemy runway.[21] While their results were not made publically available, this study appears to have ignited a heated internal debate on the number of missiles required to blockade an airfield runway.[22]

The majority of available PLARF research focuses on statistically modeling ballistic missile attacks on a single runway with penetrating submunitions.[23] As early as 2000, however, studies also began on the impact of striking large air bases that had two or more runways.[24] In particular, research focused on optimizing the process whereby aim-points would be selected for maximizing the effects of dispersed submunitions over multiple runways.[25] Reflecting the technological and budgetary constraints facing the PLA from the late 1990s and into the 2000s, early studies assumed for imprecise missile targeting capabilities and emphasized the need to maximize the effects of a small number of relatively expensive ballistic missiles. For example, researchers assumed that even under the most optimal conditions, submunitions would impact the surface up to 187 meters off target.[26] They also assumed that cutting runways in half would be the only mission assigned, due to the limited number of ballistic missiles available.[27]

It was not long before some researchers began to evince greater confidence in their research assumptions. For example, improvements in Chinese satellite imagery and sensor capabilities in the early 2000s appear to have led researchers at the Second Artillery Engineering Academy's Information Engineering Institute to claim that it was "extremely easy to satisfy" requirements for target guidance such that air base runways, and even individual warships docked in military ports, could be targeted.[28] The results of their simulations showed that a payload of submunitions dispersed over a target under favorable conditions could achieve a 3.7 percent probability of destroying an enemy warship and a 5.2 percent probability of destroying targets of importance elsewhere ashore. Though not particularly impressive, the results were considered an improvement over previous simulations on strikes against targets such as runways.[29]

As the anti-air base program advanced, the pace of runway-penetrating warhead development appears to have slowed due to challenges associated with developing an entirely new class of weapons. For example, in 2007, operations research analysts affiliated with the Chinese aerospace industry published a study cautioning that ballistic missile-delivered submunitions would be subject to a number of complicating factors during operations. These factors included wind direction and speed, guidance sensor and engine ignition-related positioning errors, guidance sensor errors, internal electrical system and engine timing errors, engine power errors, and warhead spin speed errors.[30] Further highlighting the technical challenges designers faced, they emphasized that problems could occur during the flight of the supersonic delivery vehicle when the "mother" warhead released and dispersed submunitions over target, when the submunitions' parachutes deployed, and when they impacted the surface.[31]

Many PLARF-affiliated studies have discussed warhead design requirements for runway-penetrating submunitions in great detail.[32] Chinese technical studies have also emphasized the need to strike the same runway with penetrating submunitions on multiple occasions. Indeed, rather than assume for a "one-and-done" strategy, these studies emphasize the need to keep air bases blockaded over time in the face of skillful enemy rapid runway repair teams. In what appears to be a reference to a Taiwan scenario, one study in 2007 noted "an enemy's very strong [runway] repair capabilities" and expressed concern that "comprehensive killing bombs"[33] may not be available for use against rapid runway repair teams.[34] As an alternative, the study suggests using multiple salvos of conventional ballistic missiles to disrupt air base engineering teams and slow the pace of repair work. The most effective way to keep a notional air base runway closed for two hours, the researchers argued, would be to fire 18 ballistic missiles in three salvos spaced out in forty-minute increments.[35] According to data from the study, the first salvo would optimally be comprised of twelve missiles, and the next two salvos would have three missiles apiece.[36] Using this technique, the researchers estimated that the PLA could expect an 87 percent chance of success.[37] Undoubtedly, technological advances made by PLARF and PLAAF weapons designers since the production of these studies have significantly improved missile payloads. In the event of war, these new weapons will elevate the threat posed to American, allied, and partner nation air bases.

Trajectory

China already has significant capability to deliver strikes against U.S. air bases in the region. The range of the aerial refueling–capable SU-30MKK fighters deployed in the Eastern Theater Command and Southern Theater Command is sufficient to hold Okinawa at risk. PLAAF's H-6K bombers armed with air-launched cruise missiles can even strike as far out as Guam.[38] Once operational, the J-20 stealth fighter will also increase China's ability to strike regional air bases, logistical facilities, and other ground-based infrastructure. The PLA Navy (PLAN) also fields a growing inventory of conventional and nuclear-powered attack submarines that may soon become capable of launching land attack cruise missiles. PLAN surface combatants, such as guided-missile destroyers equipped with long-range cruise missiles and surface-to-air missile (SAM) systems, could also allow China to hold U.S. air operations at risk far from its shores.

(Left: PLA SU-30MKK fighter jet with missiles. *Source:* Sino-Defense. Right*:* PLAAF H-6K bomber. *Source:* Medium*)*

(PLA Chengdu J-20 stealth fighter jet. *Source:* Global Times*)*

More importantly, China has the world's most active land-based ballistic and cruise missile program, providing Beijing with a real capacity for conventional precision strikes at significant ranges. Given the right coordination and surveillance networks, China could now strike air base targets well beyond the first island chain, reaching the second island chain, a line that runs in a north-south line from the Kuriles through Japan, the Bonins, the Marianas, the Carolines, and Indonesia. According to publicly available analyses, the PLA has approximately twenty liquid-fueled limited range CSS-3 intercontinental ballistic missiles (ICBMs), between fifteen and twenty liquid-fueled CSS-2 intermediate range ballistic missiles (IRBMs), and about fifty CSS-5 road-mobile, solid-fueled medium-range ballistic missiles (MRBMs), all of which are highly relevant for regional deterrence missions.[39]

(Map of the First and Second Island Chains. *Source: CIMSEC)*

In addition to these nuclear capabilities, reports indicate that the PLA has been testing a number of conventional missile warheads capable of attacking air base runways. Perhaps the first reported instance came in September 2005, when analysts discovered that the PLA had constructed a mock air base on Daluo Island off the Guangdong coastline for target practice.[40] This model air base reportedly included a fuel storage facility, two mock F-16 fighters, aircraft hangars, and an alert station at the end of the runway. Soon thereafter, satellite imagery revealed that the entire base was destroyed with munitions that created large craters. According to reports, two months later the PLARF (then-Second Artillery) conducted what appeared to be a cruise missile strike on a hardened aircraft shelter (HAS) target in Xinjiang, hitting it three times.[41]

In 2006, it was reported that the PLA had built a mock air base in the desert of Gansu Province. Based on satellite imagery of the mock-up, which is modeled after Taiwan's Ching Chuan Kang (CCK) Air Base, this site is primarily used to practice air raids.[42] Built near the PLAAF's Dingxin Air Force Test and Training Base (also known as Shuangchengzi Air Base), this area is also used for missile testing.[43] Other mock air base targets, including one resembling Kadena Air Force Base, have also been constructed in the deserts of Western China.[44]

One report in the PLA's *Liberation Army Daily* indicates that the Chinese rocket forces began experimenting with cluster munitions capable of spreading proximity mines around test ranges by the mid-2000s.[45] While speculative, these weapons could have been early versions of those being developed for slowing rapid runway repair crews.[46] Whatever the case, the first confirmed live-fire test of a ballistic missile warhead designed to disperse runway-penetrating submunitions occurred more recently. In April 2010, a warhead design team from the PLARF/Second Artillery Equipment Academy published a report that revealed the live-fire testing of this weapon on a runway target to confirm optimal warhead design parameters.[47] Beyond ballistic missile warheads developed for the PLARF, China's defense industry has also produced standoff weapon systems for the PLAAF, as well as for export customers. Two examples include the stealthy air-launched *Tianlei* "Sky Thunder" and CS/BCC5 cruise missiles, which are designed to deliver penetrating submunitions through adversary air defense systems. While current ranges are unknown, in 2012 these air-launched missiles were believed to have ranges up to 60 kilometers and have the capacity to carry 500-kilogram warheads designed for runway strike missions.[48]

Implications for a Regional Contingency

The intent and capabilities of the PLA have made the protection of forward U.S. Air Force bases within the U.S. Pacific Command (PACOM) Area of Responsibility a growing concern. The capabilities of China's missile force are qualitatively different from anything the United States has faced in the past. Chinese CSS-5 and CSS-6 missiles both have longer range, greater ease of operation, higher reliability and accuracy, and warhead options that make them more destructive than previous generations of missiles.[49] According to the Air Force Scientific Advisory Board, current missile defense systems may not be adequate to defend against advanced land-attack cruise missiles and theater-range ballistic missiles. By some estimates, missile and air attacks could disable up to 70 percent of the aircraft at U.S. overseas bases in the opening minutes of a conflict. This is largely because only four of the eight USAF bases in the region currently have hardened aircraft shelters, and none are designed to protect against Chinese missile strikes.[50] But even if hardened shelters prove capable of protecting the aircraft, planes and their crews could still become trapped due to massive debris piles on operating surfaces, rendering them inoperable and leaving them vulnerable targets for any follow-on attacks by cruise missiles. According to one study, only 82 out of 268 aircraft deployed to Kadena would be available for operations after an initial attack by only 34 Chinese warheads.[51]

The USAF has dealt with challenges of defending its overseas bases in the past, in particular during the Cold War. NATO military commanders worried about the possibility that massed Soviet forces could launch a successful strike on NATO airfields that could undermine U.S. control of the air, something that was critical to the strategic deterrence mission and to executing ground missions against hypothetical invading Warsaw Pact armies. As a result, NATO embarked on numerous initiatives designed to improve the resiliency of its bases. For example, the Collocated Operating Base (COB) program allowed the U.S. to increase dispersal to around sixty COBs in Europe by 1984. In addition, due to an extensive hardening program, one quarter of NATO fighter-capable airfields featured some hardening, such as protective shelters for aircraft and maintenance gear. The United States also strengthened its air defenses on vulnerable bases in the form of advanced fighters, SAMs, better radar, and stronger defensive coordination.[52]

In 1985, the USAF conducted a multi-week airpower exercise, *Salty Demo*, designed to assess whether these efforts were sufficient to ensure a modern air base could survive a heavy and sustained attack. During this exercise, the USAF learned that the most critical resources for sustaining its operations at a base under attack were personnel and heavy equipment—the latter to move debris and begin reconstruction. After the exercise, the USAF proposed committing more resources to a number of resiliency measures. However, it was ultimately unable to execute the full range of initiatives envisioned in the air base operability program. Some of these unfulfilled requirements are still relevant to the challenges of today, including the use of camouflage, concealment and deception, increasing operating surfaces and taxiways, and stockpiling runway repair equipment and supplies.[53]

Thirty years later, the USAF still suffers from significant gaps in air base defense. In light of growing threats, the *Quadrennial Defense Review Report* (QDR) called for increasing the resiliency of U.S. forward base infrastructure as early as 2006, arguing that "in the absence of dominant U.S. power projection capabilities, the integrity of U.S. alliances and security partnerships could be called into question, reducing U.S. security and influence, and increasing the possibility of conflict."[54] The latest QDR, released in March 2014, commits the Department of Defense (DOD) to improving the resilience of air, naval, ground, space, and missile-defense capabilities in the face of large-scale coordinated attacks.

Base Resiliency Initiatives

China has developed capabilities designed to target vulnerabilities in air base defenses. Moreover, Chinese writings and activities suggest that PLA strategists are thinking about employing these capabilities to undermine the ability of the U.S. to sustain airpower during a conflict. This section describes how the United States and the services have responded to this challenge with a focus on indications and warning (I&W), dispersal, selective hardening, and both active and passive defenses. Base resiliency is not only an operational issue; enhancing base defenses creates crisis stability by reducing the benefits of a quick surprise attack and significantly shifting China's strategic calculus in order to deter war. While U.S. initiatives are a step in the right direction, U.S. partners and allies, in particular Japan, also need to undertake such efforts to ensure they, too, can sustain operations in a contingency.

Indications and Warning

Providing advanced warning of Chinese preparations for an attack, and warning that an attack may be underway, are almost certainly the highest priority for all U.S. allied and partner nations' information collection platforms. I&W is essential during peacetime to prevent China from obtaining the advantage of surprise. As has been demonstrated repeatedly over the past two decades, I&W is especially critical during periods of crisis or limited conflict to provide strategic warning of the imminence of attack or the escalation of armed hostilities. Timely and reliable I&W greatly contributes to good decision-making, allowing leaders to take appropriate steps ranging from increasing the readiness levels of forces to activating contingency plans. Information about Chinese activities collected by a variety of sources is a basis for action by United States and allied decision-makers.

In particular, several capabilities fielded by Taiwan, such as its land, air, and sea-based listening posts, have the potential to contribute important I&W information on China.[55] Taiwan's close cultural, linguistic, and geographic proximity to China give Taiwan significant advantages in collecting signals intelligence (SIGINT).[56] Taiwan works closely with the United States to provide SIGINT on the intentions, activities, and capabilities of China's military and security forces.[57] Taiwan's ability to penetrate PLA systems benefits from its well-regarded computer hacking and cybersecurity communities, as well as its commanding position on the supply chains that support China's electronics and computer technology industries.[58] While direct comparative analysis is unavailable due to the opaque nature of the subject, anecdotal evidence suggests that Taiwan's computer and software engineering talent continues to outpace competition in China.[59]

Active Defense

If the United States receives indications and warnings of an imminent attack, active defense becomes critical for reducing the effectiveness of any military action against the base. Active defense refers to the employment of limited offensive action and counterattacks to protect a friendly air, land, sea, or space platform, or to deny the enemy a contested area or position. Active defenses can include electronic warfare, antiaircraft weapons, and other means of reducing the effectiveness of incoming attacks. There are two types of active defense against air and missile attacks: air defenses and ballistic missile defenses (BMD). Air defenses are defensive measures designed to destroy attacking aircraft or cruise missiles, or to nullify or reduce the effectiveness of such attacks. Ballistic missile defense (BMD) is a system, weapon, or technology involved in the detection, tracking, interception, and destruction of incoming ballistic missiles in their boost, mid-course, and/or terminal phases. U.S. Patriot Advanced Capability-3 (PAC-3) missiles—which have been deployed to Okinawa, Japan, and Osan AFB, South Korea—and Terminal High-Altitude Area Defense (THAAD) missiles—which have been deployed to Andersen Air Force Base on Guam and Osan AFB as well—are examples of such systems. Aegis ships with SPY-1 radars and SM-3s are also designed to counter ballistic missiles, with the bigger and better SM-3 IIA interceptor due for delivery in 2018.[60]

In a conflict, active defenses buy time for the United States to decide how to most effectively use its airpower. They also allow the National Command Authority to determine the most effective course of war fighting when an adversary is willing to strike American or allied forces and territory with missiles.[61] Lastly, increasing active defenses decreases the likelihood an adversary will use force at lower levels of conflict. It decreases the effectiveness of such moves and thus acts as a deterrent. In this way, the improvement of active defenses is inherently stabilizing.

(Left: Launch of a U.S. Patriot Advanced Capability-3 (PAC-3) missile. *Source:* Military.com. Right: Launch of a U.S. Terminal High-Altitude Area Defense (THAAD) missile. *Source:* Missile Defense Agency*)*

*(*Launch of SM-3 missile on U.S. Aegis ship. *Source: Missile Defense Agency)*

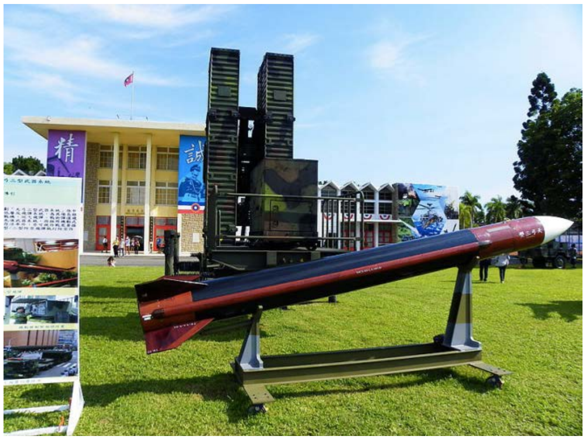
However, U.S. air bases are still not adequately protected. Even those bases that have significant active defenses are still vulnerable to saturation attacks. Andersen Air Force Base, with its long runways, large parking ramps, and vulnerable fuel storage areas, desperately needs hardening. For example, the THAAD and PAC-3 systems do little to protect Guam against potential Chinese missiles with supersonic and maneuverable warhead capabilities, such as the 1,500 km–range CJ-20 LACM, supersonic YJ-12, and the YJ-18 ASCM.[62] THAAD and PAC-3 units are insufficient because any Chinese attack could overwhelm the small number of available interceptors. To remedy this discrepancy, the Department of Defense (DoD) could consider a mix of medium-range kinetic and non-kinetic defenses, adding Indirect Fire Protection Capability (IFPC) Increment 2-1, 400 kW lasers, Surface Electronic Warfare Improvement Programs (SEWIP) Block 3, and HPM broadband systems to strengthen Guam's intercept capabilities.[63] The IFPC Increment Block 2 protects against unmanned aerial vehicles (UAVs) and cruise missiles, and it blocks against smaller and faster threats through its counter-rocket and counter-mortar capabilities.[64] Therefore, active defense efforts should be coupled with passive defenses, such as the dispersal of combat aircraft across a larger number of bases, and other steps such as burying fuel lines, training in rapid runway repair, and deception and camouflage.

(Left: Chinese Changjian-20 (CJ-20) Land-Attack Cruise Missiles (LACM). *Source:* Missile Defense Advocacy Alliance. Right: PLAN Yingji-12A (YJ-12A) supersonic anti-ship missile unveiled during victory day parade in 2015. *Source:* Navy Recognition*)*

*(*Chinese Yingji-18 (YJ-18) anti-ship cruise missile. *Source:* Missile Defense Advocacy*)*

For its part, the Republic of China Air Force (ROCAF) in Taiwan has sought to balance its active and passive defenses against a Chinese missile attack—an upgrade to the U.S. approach that emphasizes active defenses over passive.[65] In terms of active defense, Taiwan has been investing heavily in BMD, as well as defense systems for "air-breathing" targets such as cruise missiles, fighters, bombers, and UAVs to diminish the coercive utility of China's military buildup. Taiwan currently has three Patriot missile batteries (or fire units) deployed around its capital, Taipei, and six more batteries for overlapping coverage over central and southern Taiwan. Taiwan has also acquired a tenth Patriot battery to be kept on training and reserve status. All of these systems will be PAC-3 capable systems, with PAC-2 missiles integrated into firing units for defense against both ballistic missiles and air breathing targets.[66] According to one PLA assessment, Taiwan's Patriot missile batteries could each intercept twenty-four targets at a time, with an expected success rate of over 90 percent per missile.[67]

Taiwan has also developed a capable indigenous SAM system that uses the *Tien Kung* (TK) "Sky Bow" missile. Benefiting from U.S. technical assistance, Taiwan's TK SAMs are reportedly comparable to Patriot systems in most respects. TK-1s are fielded in both static and mobile variants, with a range of 100 kilometers, and TK-2s are deployed in hardened silo facilities, with engagement ranges up to 200 kilometers. Currently, Taiwan is replacing its older units with six batteries of mobile TK-3 SAMs that are roughly comparable to PAC-3s. At least two TK SAM batteries are deployed on the outer islands of Penghu and Tungyin, giving Taiwan the ability to engage frontline PLAAF fighters as soon as they take off from their air bases in Fujian Province, assuming they are not themselves first targeted by PLARF fire.[68] Aside from its BMD capable systems, Taiwan is believed to have some thirteen MIM-23 HAWK missile batteries deployed. This air defense system was the predecessor to the Patriot and would be most useful for defending against aircraft and cruise missile targets.



(Taiwan's Tien-Kung III (Sky Bow III) Surface-to-Air Missile System. *Source: Army-Technology.com*)

(MIM-23 Hawk medium-range surface-to-air missile on display. *Source:* CopyBook*)*

Passive Defense

Balancing its aforementioned investments in the area of active defense, Taiwan has done more to develop passive defenses against Chinese air and missile attacks than any other country in Asia.[69] This has included significant investments into air base hardening and dispersal. Hardening involves building or improving structures to protect personnel, equipment, or infrastructure against enemy attack, which can be done with permanent structures or deployable shelters. Dispersal refers to the spreading or separating of troops, material, establishments, or activities, which are usually concentrated in limited areas, to reduce vulnerabilities. The scale and sophistication of Taiwan's engineering and training efforts in these areas are remarkable.

In terms of hardening, Taiwan has constructed underground tunnel complexes, bunkers, and hardened aircraft hangars. Many of the most notable projects to harden critical facilities in Taiwan and on its outer islands began in the wake of the shock that followed the U.S. decision to switch diplomatic recognition from the Republic of China (ROC) to the People's Republic of China (PRC) government. For example, in 1979, Taiwan began building a massive tunnel complex inside Chiashan, or "Optimal Mountain," near the city of Hualien. This mountain base is intended to serve as a "last line of defense" for the ROCAF's air superiority fighters. Completed in 1993, this base includes an air defense missile site, an air base runway, two hardened tunnels large enough for securely operating over 200 fighter aircrafts, and ten blast doors for aircraft entering or exiting the underground tunnel network.[70] This facility also includes underground infrastructure for storing water, food, munitions, spare parts, and jet fuel. Furthermore, it features a national command center, a hospital, a large power generator, aircraft repair facilities, and living quarters.[71]

As a further means of protecting its forces from Chinese air and missile attacks, Taiwan constructed a second tunnel complex, dubbed Shizishan, or "Stone Mountain", near Taitung Air Force Base on its southeast coast. This facility is somewhat smaller than Chiashan but is still believed to be able to securely house sixty to eighty ROCAF fighters.[72] In tandem with these efforts, Taiwan has hardened all of its primary air bases and several reserve airfields. One study assessed that by 2008, ROCAF had completed 252 hardened aircraft shelters and 178 revetments.[73] These numbers have continued to grow. Taiwan is currently expanding its parking ramp space, building new taxiways, and constructing "super-hard" aircraft hangars that can surpass the ability of its tunnel complexes to resist direct hits by penetrating warheads.[74]

To increase its rapid runway repair capabilities, ROCAF has acquired a large fleet of armored repair vehicles and other advanced equipment from the United States. These have been deployed to all of Taiwan's main air bases.[75] Frequent drills and exercises have helped Taiwan enhance the capabilities of its rapid runway repair teams. Recently, one team at CCK Air Base demonstrated the ability to repair seven large craters in ninety minutes.[76] Taiwan has also benefited from U.S. Air Force combat engineering team visits to Taiwan, and ROCAF has participated in the premier Silver Flag exercises with their American counterparts on Okinawa and Guam.[77] American training teams have also been working with their Taiwanese counterparts to improve the ROCAF's ability to rapidly clear unexploded ordinance from runways.[78] Taiwan regularly practices the rapid dispersal of its aircraft operations to move key units, which are usually concentrated in limited areas, to reduce vulnerabilities. Moreover, Taiwan uses the employment of airfield camouflage and deception techniques to confuse the PLA's reconnaissance and operational planning communities. However, the ROCAF still lacks sufficient capability to protect Taiwan against PLA fighters. For example, some ROCAF fighters, such as the F-CK and Mirage 2000, can only engage one PLA fighter at a time, so the PLA's numerical superiority is a concern for ROCAF loss rates.[79]

(Three F-CK Ching-Kuo Indigenous Defense Fighters (IDF). *Source:* Airforce-Technology.com*)*

(A Taiwanese Mirage 2000-5Di fighter. *Source:* TaiwanAirPower.org*)*

For its part, the U.S. Air Force is pursuing a more modest and selective effort to harden its bases and increase its airfield damage repair capabilities in Asia. This includes a number of efforts in concert with the other services to ensure continuous and credible forward operations. The QDR calls for the capability to disperse land-based forces to other bases and operating sites, and for the ability to operate and maintain frontline combat aircraft from austere bases with only a small amount of logistical and support personnel and equipment.[80] A key initiative of the former Pacific Air Forces (PACAF) Commander General Herbert J. Carlisle was to find ways to disperse aircraft and to land aircraft, in the enormous distances of the Pacific theater, on airfields from which they did not take off. The current PACAF Commander General Terrence O'Shaughnessy has developed a new operational maneuver built upon this Rapid Raptor concept called Agile Combat Employment, or ACE. ACE focuses on "quickly deploying small contingents of F-22s to smaller, sometimes austere, bases along with a much smaller logistics package."[81] Dispersal of high-value targets like the F-22 to non-traditional bases would hopefully keep the adversary from guessing their location, complicating enemy targeting.[82]

PACAF is also working with allies and partners throughout the region to provide logistical support and coordinate capabilities to create more "places not bases" from which the U.S. can project airpower.[83] However, dispersal also comes with an operational cost. In a hypothetical conflict over the Taiwan Strait, sortie rates would be 40 percent less from air bases 1,600 miles from the Strait, such as those on Guam and Northern Japan, compared to operations out of Kadena.[84]

The U.S. Defense Department has promised to invest in airfield repair capabilities, as well as to procure fuel bladders to ensure survivability of supplies necessary to sustain operations.[85] PACAF was also honing its resiliency strategy as part of the Pacific Airpower Resiliency Initiative. This plan envisions improvements such as bolstered defensive systems and the presence of Rapid Engineer Deployable Heavy Operation Repair Squadron Engineers (RED HORSE) Airfield Operations at theater bases.[86] Planned hardened facilities on Guam, including select hangars, are also part of this initiative. Furthermore, Congress has allocated funds to hardening facilities that are critical to maintaining stability and executing the rebalance to Asia.

Major resiliency initiatives, including the Hardened Installation Protection for Persistent Operations (HIPPO) and Critical Runway Assessment and Repair (CRATR) efforts, will enhance USAF rapid repair, which is the capability to quickly return an airfield to a condition in which it can continue air operations following an attack. Rapid Airfield Damage Repair (RADR) modernization and CRATR provide methods to counter emerging threats, reduce re-repairs, support mixed aircraft inventory, and provide long-term sustainment. The RADR modernization process first assesses the runway damage and presence of unexploded ordnance (UXO). Computer software identifies the minimum crater repair required, the UXO is then rendered safe, and the craters on the runway can be repaired. This allows the airfield to be operational again within eight hours. The fielding of these new capabilities is expected to begin soon, though problems with funding persist.

HIPPO aims to ensure the survivability of operational activities and critical infrastructure against newer threat weapons. The purpose of HIPPO is to apply cost-effective application of hardening and resiliency methods to protect aircraft, fuel and water supply, and storage, as well as munitions, C3I, and other systems. For the first time since the Cold War, the services, including the Army Corps of Engineers and the Air Force Civil Engineer Center, are doing research on hardened structures, specifically permanent protective shelters designed to withstand large blasts. This is distinct from the current technology deployed in theater, the Modular Protective System, which is a lightweight space frame and composite armor panels that are rapidly deployable and recoverable.[87] Because personnel are the critical assets in any fight, these efforts also focus on enhancing the protection for critical rooms to protect them from quasi-static pressure, shock, and fragmentation. The program includes the testing and evaluation of the proposed technologies against munitions of interest. While this is a joint effort, USAF has taken the lead, with most efforts focused on PACOM's AOR. Given the growing Chinese air and missile threats, such programs are needed to enhance the resiliency of U.S. bases currently in South Korea, Japan, Guam, and Australia, as well as in any potential future bases in Southeast Asia.

Recommendations

U.S. aircraft deployed in Asia currently face a substantial risk of damage or destruction. One potential countermeasure, to operate from bases farther from the fight, raises serious questions about the United States' ability to fight an effective and efficient air campaign. For example, in a Taiwan contingency, the loss of one or two bases could severely degrade the USAF ability to generate and sustain combat air power. In Asia the threat is large, but the United States has few bases, and political access to current bases could be limited or constrained.[88] The current initiatives to improve active and passive defense are still insufficient to guarantee that the USAF will be able to exercise its capabilities of global strike, rapid global mobility, and air superiority, given China's increasing capabilities. Research should focus on driving down the cost of future interceptors and improving attack operations to strike Chinese air and missile bases.[89]

In terms of passive defenses, the U.S. should prioritize the extension of hardening to additional bases, and to include the protection of large support aircraft (tankers, AWACS, Global Hawk, etc.) on the four U.S. bases in the region that have hardened aircraft shelters.[90] Hardening is admittedly expensive; estimated costs of building shelters to protect about $10 billion worth of USAF assets from ballistic to cruise missiles is $700 million. The United States needs to invest resources into breaking the code on how to protect all aircraft cheaply, but, in the short-term, expensive efforts may be necessary given the drastic operational advantages of resiliency. In 1967, the Israel Air Force (IAF) was able to destroy 400 unprotected aircraft. Six years later, after Syrian and Egyptian hardening efforts, the IAF was only able to destroy twenty-two enemy aircraft.[91]

If the United States is serious about its security and partners and allies in the Asia-Pacific, it must look critically at passive defenses on Okinawa, Guam, and beyond. The Air Force is working with its joint and coalition partners to improve its multi- and cross-domain capabilities to ensure that adequate I&W and tracking are available to enhance protective postures, and to provide warfighters with the ability to survive and operate from forward bases. But more political engagement is needed to ensure the United States can rely on allies to help it sustain operations while under attack. For example, several allies are building more robust tanker fleets, access to which could impact the course of a conflict. Resiliency generally, and greater base hardening in particular, is a crucial element to operations, but it is also crucial to the U.S. goal of maintaining peace and stability in the region. Given their experience and requirements in this area, U.S. defense planners should work more closely with Taiwan to mutually improve capabilities. Moreover, there clearly needs to be a greater sense of urgency—not only plans or proposed programs that are partially funded, but the actual implementation of programs that reach the unit level with new technology, new CONOPS, and new organizational constructs that are actually exercised regularly with results accountable to senior leadership of the Services, Joint Staff, and OSD.

The strength of U.S. peacetime operations and deterrence are determined by the opponent's perceptions of the capabilities and resolve of the United States and its allies and partners. The joint force needs to take substantive steps in base and port resiliency, continue the primacy of partnered air and naval forces (e.g., the Joint Concept for Access and Maneuver in the Global Commons (JAM-GC)), and stress the need for services, allies, and partners to embrace new priorities, roles, and missions in the Asia-Pacific. In addition, there should be a continued evaluation of the USAF's modernization, force structure capability, and capacity, along with its forward presence and posture. Peacetime USAF engagement must take into account the factors that impact Chinese behavior, and, consequently, regional stability. By strengthening U.S. air base hardening and resiliency, and by engaging with partners and allies, the USAF will be able to play a strong, positive role in shaping regional security and in keeping the peace in Asia.

ENDNOTES

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[5] Ibid., 327.

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[7] Yu Jixun, ed., *Dier Paobing Zhanyi Xue* [Second Artillery Force Science of Campaigns] (Beijing: Liberation Army Press, 2004), 392.

[8] Ibid., 398.

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[17] Tao Guiming, et al. "Didi Daodan Daji Jichang Paixu Moxing [Modeling the Order of Surface to Surface Missile Strikes on Airfields]," *Diannao Yu Xinxi Jishu* [Computer and Information Technology], (February 2013): 12-14. Note that the authors are affiliated with the Ordnance Engineering Academy's Forth Department in Shijiazhuang, Hebei; the Institute of Electronics in Changsha, Hunan; and the General Armaments Department's Office in the Changsha area, respectively.

[18] The study did not explicitly reference place names, instead it referred to a certain island region's airfields. The location of each Taiwan air base is based on the author's assessment of the data provided (for example of 60 IDFs at an air base 150 km from China). Open source reporting on where the ROC Air Force deploys its aircraft, and Google Earth measurements of the distance of each air base from the PRC coast helped to further narrow the range of possibilities. Nonetheless, it is not certain that the author's assessment is correct in every case. See tables three and four on page 14 of Tao Guiming, et al.

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[29] Note that the senior researcher involved in this project had previously conducted the computer modeling of conventional ballistic missiles strikes on runways. See Song Guangming and Song Jianshe, "Changgui Daodan Daji Jichang Paodao de Jisuan Moni [Computer Simulation of Conventional Missile Strikes on Airfield Runway]," *Huoli Yu Zhihui Kongzhi* [Fire Control and Command Control] Vol. 26, No. 4, (2001).

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[32] Yin Zhihong, et al., "Kongdi Daodan dui Jichang Fengsuo Zhan Jianmo yu Fangzhen [Model and Simulation of Air-to-Surface Missile for Airfield Blockade Operations]," *Xitong Fangzhen Xuebao* [Journal of System Simulation], (February 2008): 583-585; Wang Xiaomei, et al.,1859-1861; and Lei Yuli and Tang Xuemei, "Qinqie Zimudan dui Jichang Paodao Fengsuo Suanfa Jilu Yanjiu [Research on Algorithm for Calculating Probability of Penetrating Submunition Used Against Airfield Runway]," *Xitong Fangzhen Xuebao* [Journal of System Simulation] Vol. 16, No. 9 (2004): 2030-2032.

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[38] *Military and Security Developments Involving the People's Republic of China* (Arlington, VA: Office of the Secretary of Defense, 2014), 9, 31, accessible online at <http://www.defense.gov/pubs/2014_DoD_China_Report.pdf>.

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[40] Gao Zhiyang, "Qiangxiu Paodao Zhiwai Jichang Beidong Fengyu de Xin Siwei [Beyond Runway Recovery – the New Thinking on Passive Airfield Defense]," *Quanqiu Fangwei Zazhi* [Defence International], (May 2006), accessible online at <http://www.diic.com.tw/mag/mag261/261-38.htm>.

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