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CAN'T GET THERE FROM HERE: OVERCOMING THE ANTI-ACCESS THREAT IN 2035

By

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Biography

Lieutenant Colonel Adderley is a 1990 graduate of Western Maryland College and was commissioned through the Air Force ROTC program at the University of Maryland. After Commissioning, Lt Col Adderley served as a Minuteman III ICBM crewmember before attending Undergraduate Pilot Training. He served as a B-52H co-pilot, aircraft commander, instructor pilot, Wing Weapons Officer and Director of Operations. Lt Col Adderley deployed in support of various contingencies including Operation ALLIED FORCE in 1999, Operation ENDURING FREEDOM in 2002 and Operation IRAQI FREEDOM in 2003. In July 2003, Lt Col Adderley was assigned to the Checkmate Division on the Air Staff at the Pentagon, Washington D.C. where he served as an Aerospace Strategist in the PACOM/NORTHCOM branch. He also served as a Strategic/Theater War Planner at HQ USCENTCOM J5 Strategy, Policy and Plans Directorate, MacDill Air Force Base, Florida. Lt Col Adderley previously served as Commander, 5th Operations Support Squadron, Minot Air Force Base, North Dakota. Lt Col Adderley is a command pilot with more than 3,300 hours in the B-52H and more than 500 combat hours.

Abstract

This paper examines the Anti-access threat the United States may face in 2035 and the challenges this threat poses to U.S. military operations. As potential enemies in the Pacific and Middle East expand more and more resources developing increasingly accurate and longer range ballistic and cruise missiles the viability of sustaining U.S. operations at bases within short striking distance of these potential enemies becomes more difficult, if not impossible. The situation is most acute in the Pacific where vast areas of open-ocean provide few basing options and both China and the Democratic People's Republic of Korea are leaders in ballistic missile development. Defending close forward bases either passively or actively may not be possible either due to cost or practicality. With U.S. forces, including naval forces, pushed further from potential enemy targets the need for air refueling capability will become even more critical than it is today. However, in 2035 U.S. air refueling capability may be less than it is today. Increasing flight distances and decreasing air refueling capability means that any Global Strike aircraft will need to have sufficient range to strike targets from distant bases without requiring any of the precious airborne fuel that will be critical to getting fighter type aircraft to their targets. The next air-breathing global strike platform will need an unrefueled combat range of *at least* 3000 nautical miles to overcome the growing Anti-access threat. Without a platform with sufficient range, the U.S. risks allowing sanctuary areas for enemies to place their highest value assets.

Introduction

"The LRS family must possess enough range and payload to overcome tough anti-access environments."
-- Lt. Gen. Christopher D. Miller, speech in Shreveport, LA, Nov 2010[1]

"Will we ever fight China? It doesn't really matter. Hopefully not. We pray that we won't. But we'll probably fight their stuff."
-- Lt. Gen. Herbert J. "Hawk" Carlisle, 29 Sep 2011[2]

"You Can't Get There From Here"
Marshall Dodge and Robert Bryan, *Which Way to Millinocket?*, 1958

The United States faces myriad threats in the 21st Century, but none more vexing than the expanding threat from systems, primarily ballistic missiles, which could deny the U.S. access to forward basing in potential regions of conflict. The term "anti-access" has become common in the Pentagon, mostly in discussions about the Peoples Republic of China. While China certainly leads anti-access development, they are hardly alone. Potential adversaries like North Korea, Iran and Syria, are all spending on systems to deny U.S. air and naval force operations from bases or locations within reach of their landmass. In 2035, in order to overcome the growing ballistic missile threat that is pushing U.S. forces farther from potential adversaries, the next air-breathing global strike platform will need an unrefueled combat range of *at least* 3000 nautical miles. Without a platform with sufficient range, the U.S. risks allowing sanctuary areas for enemies to place their highest value assets.

2035 Anti-access Threats in the Pacific

The most obvious threat to U.S. access in the western Pacific comes from China who, according to a Department of Defense 2009 report, has the "most active land-based ballistic and cruise missile program in the world."[3] China is increasing both the quantity and accuracy of its medium-range ballistic missiles (MRBM). The accuracy improvement of these systems is the bigger anti-access challenge.

China's CSS-5 MRBM with a circular error probable (CEP) of 700 meters is useful in attacking larger areas but not for targeting specific targets.[4] Their upgraded versions increase accuracy to 10 meters, sufficient to target runways and parking aprons.[5] Additionally, the conventional warhead on the latest version of the CSS-5, the mod 3, contains steerable surfaces that allow it to maneuver, complicating U.S. anti-ballistic missile targeting.[6] The range of the CSS-5 is sufficient to hit all U.S. bases in Japan and South Korea and leaves Andersen AFB, Guam as the only airfield safe from a CSS-5 strike.

The CSS-5 represents the Pacific-based threat with the longest range but may not be the most problematic anti-access threat in that region. The Chinese CSS-6 is a road-mobile short-range ballistic missile (SRBM) which China is upgrading to improve accuracy to less than 50 meters.[7] The extended range CSS-6 will be capable of hitting airfields as far as Kadena Air Base on Okinawa. China has hundreds of these in its inventory, and could render Kadena Air Base unusable in the event of conflict.

Ballistic missiles aren't the only anti-access systems that China will employ in 2035. The Chinese Land-Attack Cruise Missile (LACM) DH-10 will be able to deliver a 1,000 pound warhead with a CEP of 15-20 meters.[8] The DH-10 has GLONASS-aided Inertial Navigation System (INS) and Terrain Contour and Mapping (TERCOM).[9] DH-10s deployed to Manchuria will hold all airfields in Japan at risk, and China is "acquiring large numbers" of these missiles and launchers annually.[10]

In the past, the threat to U.S. land-based forces has been offset by carrier-based aviation, but even this at risk in 2035. The U.S. Navy trumpets its carriers as 4.5 acres of sovereign territory; however this territory will not be immune to anti-access threats. While China has some technical obstacles to overcome, such as over-the-horizon radar targeting, they are developing the CSS-5 mod 4 Anti-ship Ballistic Missile (ASBM).[11] Using guidance advances made in the CSS-5 mod 3, the ASBM variant will have a terminal seeker head that can target carrier-sized ships. The mod 4 will have the same range as the mod 3, pushing Carrier Strike Group operations out of the South China Sea and the southern portions of the Sea of Japan. China is looking to force the U.S. Navy even further away with phased upgrades to the CSS-5 mod 4. They seek to extend the mod 4's range to 1,620 nm by 2015 and to 4,320 nm by 2020.[12] Even assuming there are delays, it's likely that by 2020 U.S. Navy carriers will be operating with impunity only *east* of Guam!

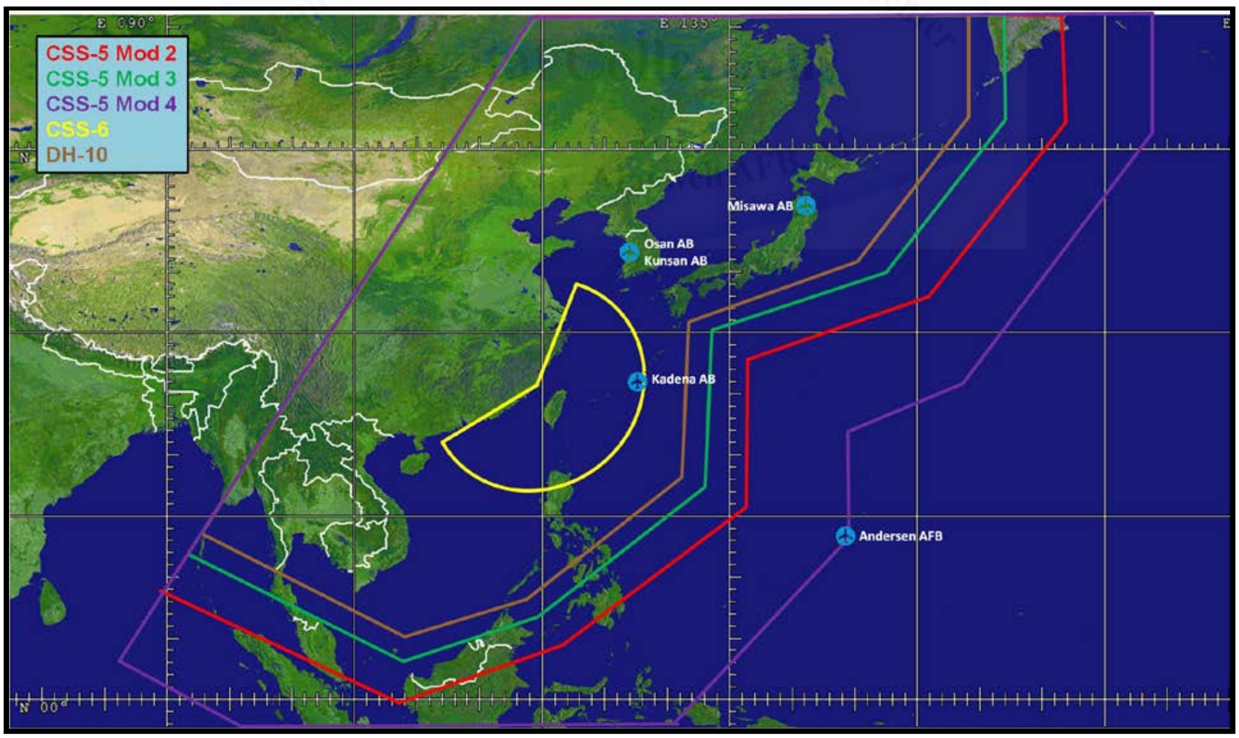

Figure 1 - Chinese Anti-access Picture in 2035

Chinese Short & Medium Range Missiles			
Weapon	**Max Range (nm)**	**2010 Inventory (launchers/missiles)**	**Estimated 2035 Inventory (launchers/missiles)**
CSS-5 mod 2	1130[13]	75-85/85-95[14]	No change. Production ceased in 1998[15]
CSS-5 mod 3	920[16]		
CSS-5 mod 4	810/1620[17]	0	~80 /~80[18]
CSS-6	325/430[19]	90-110/350-400[20]	~100 /~1500[21]
DH-10	810[22]	45-55/200-500[23]	"well over 1,000" systems[24]

Table 1 - Chinese Short & Medium Range Missiles

While armed conflict with China by 2035 seems unlikely, the same cannot be said for the Democratic People's Republic of Korea (DPRK) which is also developing anti-access capabilities. The DPRK spends approximately 40 percent of its GDP on the military "primarily in their nuclear, biological, chemical and missile programs."[25] The DPRK has hundreds of SRBMs and while the Scud-C does not have the accuracy (700 m)[26] to directly target U.S. aircraft on the ground, they may still disrupt airbase operations and overwhelm U.S. anti-ballistic missile systems, allowing more accurate missiles to "leak" through. The road-mobile, No Dong 1 can reach all of Japan, including Okinawa, and reports indicate that North Korea has augmented this system with GPS, greatly improving-accuracy.[27] Despite their potential inaccuracy, particularly with the Scud C, these systems introduce the problem of political anti-access versus physical anti-access.

With political anti-access, missile accuracy is irrelevant; the threat of missile strikes on a nation's homeland is sufficient for the host nation to deny the U.S. use of its facilities. While political anti-access is a factor for every nation, it is particularly acute for Japan in a conflict with the DPRK. Every conflict over the last 20 years has examples of host-nation refusal or conditional acceptance of U.S. forces on foreign territory. There are no indications this will change by 2035.

The No Dong 2 is an improved, longer range, version of the No Dong 1, and reports indicate that the DPRK is working on extending its range further, leaving only Andersen AFB immune from DPRK attacks. While the current 250-500 meter CEP[28] is not sufficient to target aircraft, if augmented with GPS, it will become a formidable political and physical anti-access threat.

The DPRK's most capable anti-access threat may be a land-based variant of a Russian Sea-Launched Ballistic Missile (SLBM). U.S. intelligence believes the DPRK, in the 1990s, acquired an SS-N-6 SLBM from Russia, reverse-engineered it, and has been producing them indigenously.[29] This missile, designated the Musudan, could hold Guam at risk at its maximum range, and if combined with GPS augmentation, provide a substantial anti-access threat.

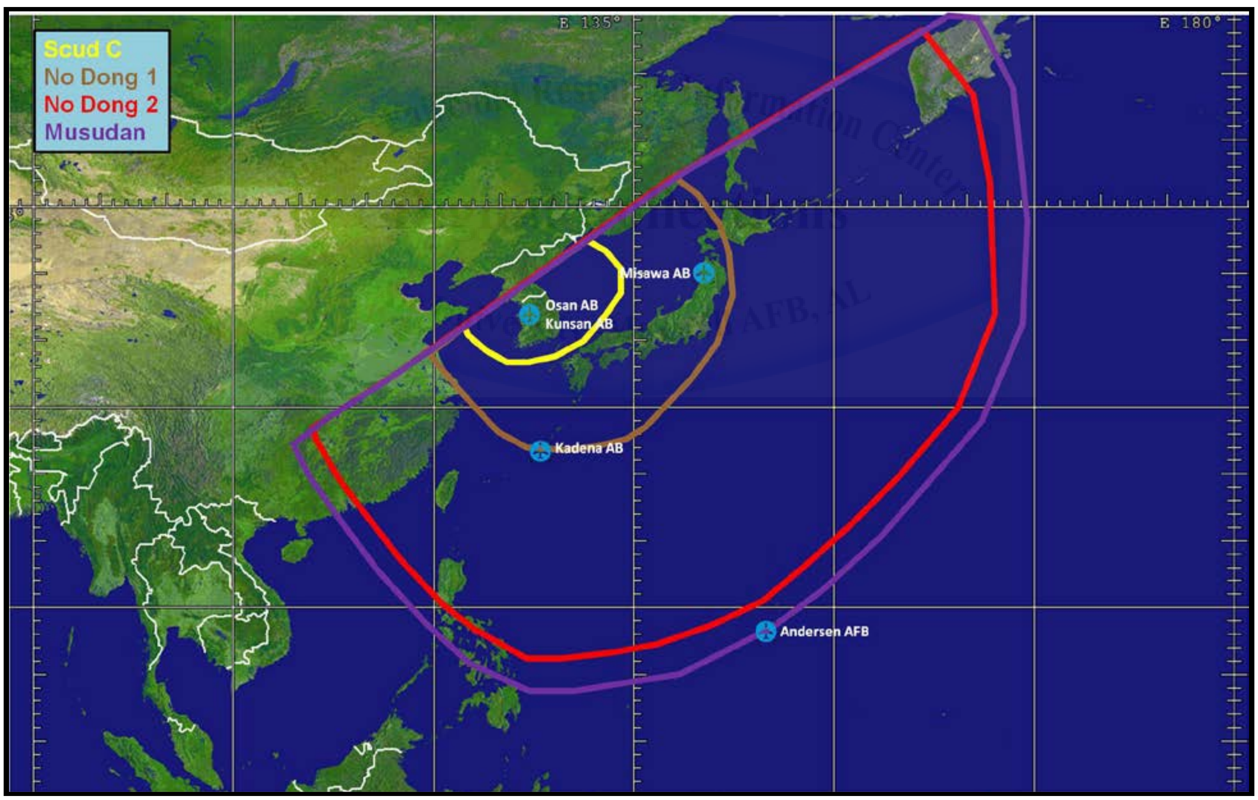

Figure 2 - North Korean Anti-access Picture in 2035

North Korean Short & Medium Range Ballistic Missiles			
Weapon	**Max Range (nm)**	**2010 Inventory (launchers/missiles)**	**Estimated 2035 Inventory (launchers/missiles)**
Scud C	324[30]	30-70/300-700[31]	Estimated annual production of 50–100 missiles per year[32]
No Dong 1	700[33]	unknown[34]/200-450[35]	Un-estimated/ Estimated annual production one to three missiles per month[36]
No Dong 2	810-1620[37]	Unknown	Un-estimated/ Estimated annual production one to three missiles per month
Musudan	1725[38]	Unknown	Un-estimated

Table 2 - North Korean Short & Medium Range Ballistic Missiles

2035 Anti-access Threats in the Middle East

Iran's missile programs, combined with its well-established anti-ship capability, make it a formidable anti-access threat. Iran has purchased hundreds of SRBM systems from China and the DPRK that can reach airfields on the Arabian Peninsula. The CSS-8, M-11, Scud B and Scud C can range airfields as far away from Iran's coast as Masirah Air Base, Oman. Despite its short range, making it useful only in the vicinity of the Strait of Hormuz, the sheer number of CSS-8 systems can overwhelm U.S. and Gulf Cooperation Council (GCC) missile defense systems. The road-mobile M-11 and Scud B complicate the defense picture further, as they can hold at risk all airfields in the Persian Gulf.

Much more troubling for U.S. planners than Iran's huge arsenal of SRBMs is their growing inventory of MRBMs. There are two variants of the Shahab-3 with ranges up to 1080 nm. Once integrated with GPS, both variants will be able to hold every Arabian Peninsula airfield at risk, with the longer variant being able to reach Turkey and Cairo.[39] Iran has also acquired 18 Musudan missiles from the DPRK.[40] To date Iran has not tested a Musudan (designated BM-25 by Iran) so it's possible this system was acquired so that its guidance technology could be used in Iran's home-grown missile programs.

"Well-substantiated reports indicate that the Iranians managed to steal and smuggle out of Ukraine several strategic cruise missiles, probably not to be deployed but to be emulated and copied".[41] These missiles, the Kh55, are equivalent to the U.S. Tomahawk LACM and as accurate as China's DH-10 at a range of 1890 nm.[42] Should Iran reproduce their own version of the Kh55, almost all of Europe will be vulnerable to attack.

These missiles are not the only anti-access threat that Iran could have by 2035. Iran is not simply importing foreign missiles and reproducing them, they are developing more advanced missiles indigenously. There is confusion on exact details of Iranian developed ballistic missiles but it appears they have produced, tested and have begun fielding three new MRBM systems that bear no resemblance to DPRK, Russian, Chinese or Pakistani missiles.[43] The Ghadr-110, Sajjil and Sajjil-2 and the Ashura missile systems may allow Iran to bring much of southern Europe within missile range. These systems have been observed in testing and military parades and while it's uncertain if these systems will augment Iran's existing force or replace older systems, what is certain is that Iran is dedicating time and money developing new MRBM systems. Despite the uncertainty in Iran's ballistic missile programs, it is clear that by 2035, minus drastic political changes in Iran, they will have formidable anti-access systems that will impede U.S. operations from bases within short striking distance of Iran.

Iran also possesses a significant anti-ship capability in the Persian Gulf. Iran's most evolved anti-ship threat is their tactic of arming small patrol craft with anti-ship cruise missiles including the C-701, C-802[44], and the indigenously produced Qader. With ranges from 13 nm on the C-701[45] to 108 nm on the Qader[46], Iran can push the U.S. Navy as far south and east as the Indian Ocean. Iran also has hundreds of land-based Silkworm and SS-N-22 Sunburn anti-ship missiles in its inventory.

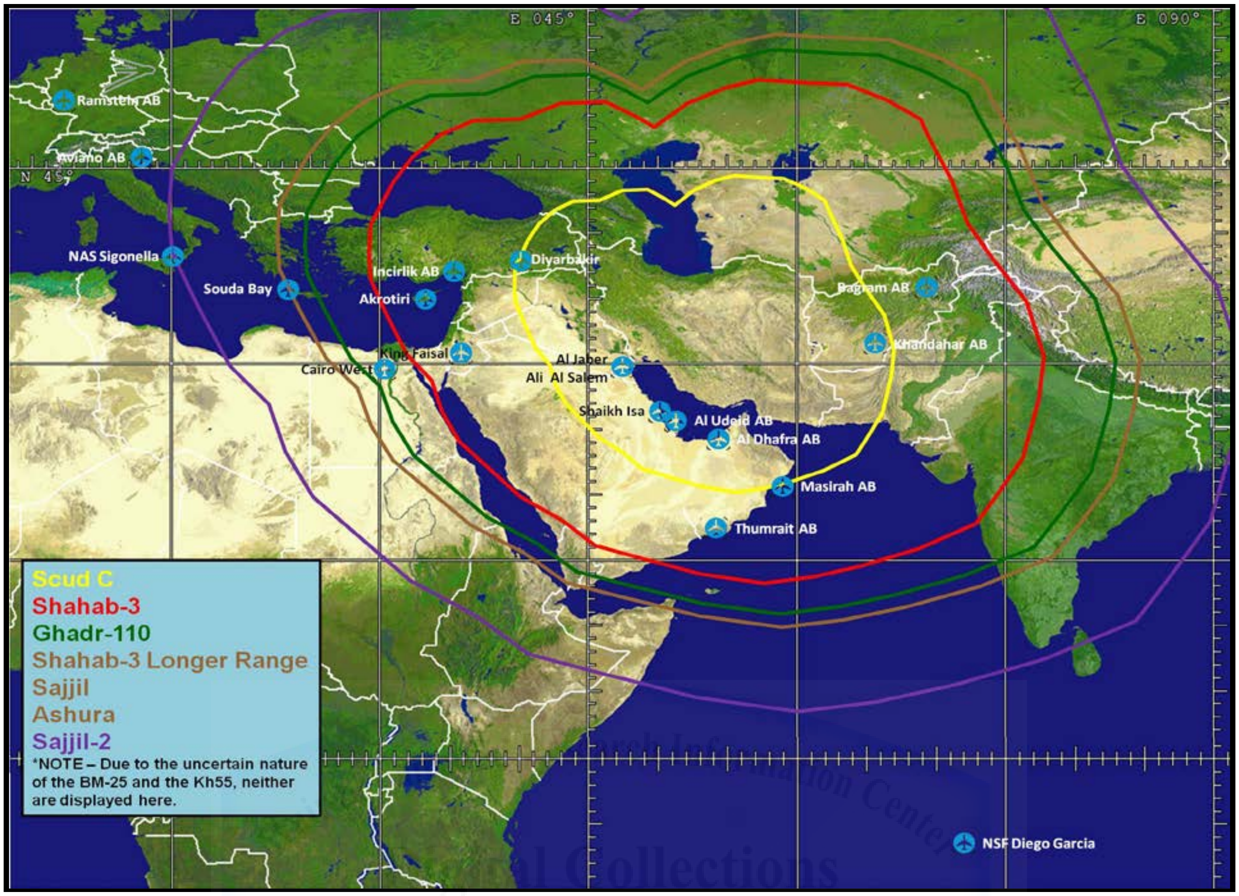

Figure 3 - Iran Anti-access Picture in 2035

Iranian Short & Medium Range Ballistic Missiles			
Weapon	**Max Range (nm)**	**2010 Inventory (launchers/missiles)**	**Estimated 2035 Inventory (launchers/missiles)**
CSS-8	80[47]	35/~200[48]	35/200
Scud B	160[49]	15/up to 300[50]	15/up to 350
M-11	215[51]	80/80[52]	80/80
Scud C	324[53]	150-220/150-220[54]	150-220/150-220
Shahab-3	700[55]	Unknown launchers/25-100[56]	20 missiles per year up to 150[57]
Ghadr-110	970[58]	Unknown	Un-estimated
Shahab-3LR	1080[59]	0	Un-estimated
Sajjil	1080[60]	0	Un-estimated
Ashura	1080[61]	0	Un-estimated
Sajjil-2	1296[62]	0	Un-estimated

Table 3 - Iranian Short & Medium Range Ballistic Missiles

Syria's significant anti-access capability is a study on rampant ballistic missile proliferation. Syria received hundreds of Scud C missiles and dozens of launchers from the DPRK in the early 1990s. Since then, Syria has worked with both the DPRK and China to develop indigenous production capability, resulting in an estimated production rate of 30 Scud C missiles annually. [63] As late as 2001 Syria, again working with the DPRK, developed the domestic capacity to build Scud D MRBMs.[64] The Scud D may be the export variant of the No Dong system and while range estimates vary, the Scud D could hold airfields as far away as Al Udeid at risk. Syria is producing an estimated 15-30 Scud D missiles annually[65] and extensive testing of the Scud D suggests Syria is planning on making the Scud D their primary ballistic missile. Most troubling is the improved accuracy this system provides with a CEP of 50 meters.[66]

Like Iran and China, albeit with a reduced capability, Syria possesses significant challenges for U.S. Navy operations in the Eastern Mediterranean. As late as 2007, Syria purchased an estimated 70 SS-N-26 anti-ship missiles from Russia.[67] With a 160 nm range[68], land-based SS-N-26s could push carrier operations west of Cyprus and, potentially, even further should Syria successfully arm their fast patrol boats with these new missiles. In addition to its newly acquired system, Syria has dozens of older C-802 anti-ship missiles, best known for its use by Hezballah against an Israeli frigate during the 2006 Israel-Hezballah conflict in Lebanon.[69]

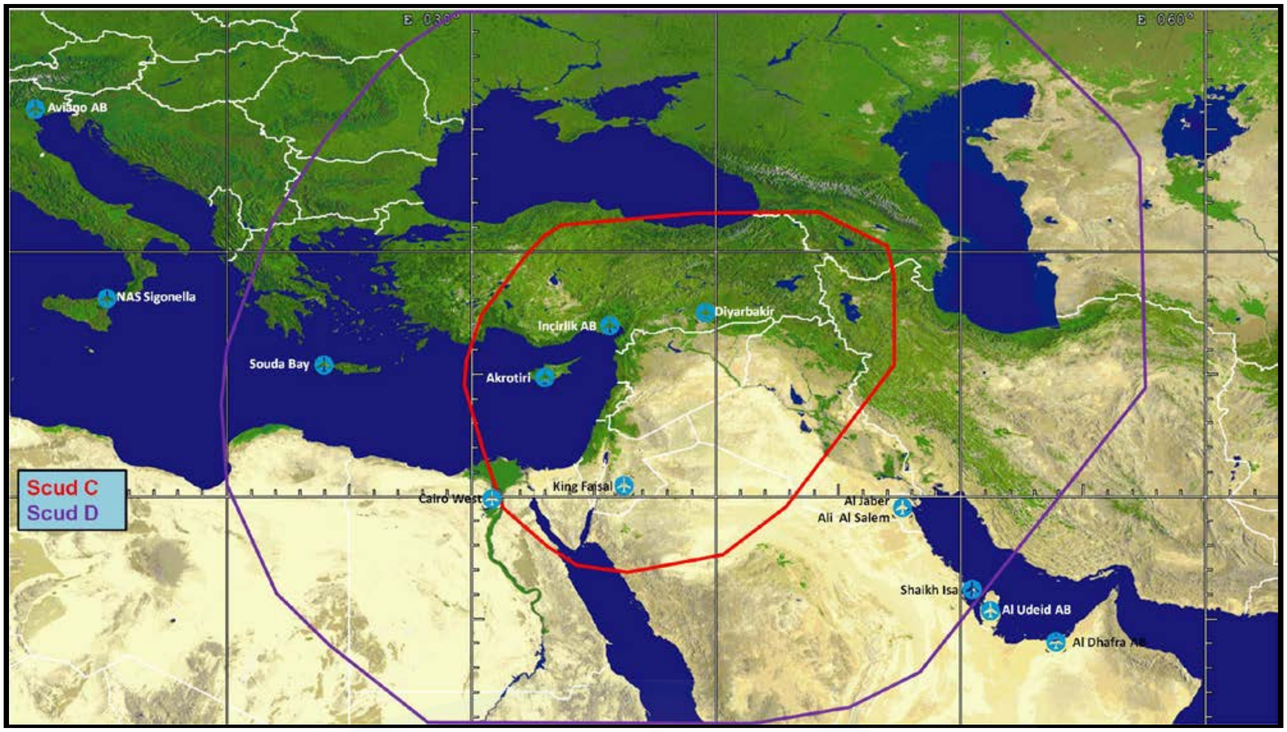

Figure 4 - Syrian Anti-access Picture in 2035

Syrian Short & Medium Range Ballistic Missiles			
Weapon	**Max Range (nm)**	**2010 Inventory (launchers/missiles)**	**Estimated 2035 Inventory (launchers/missiles)**
Scud C	324[70]	18-26/ "up to 150"[71]	Un-estimated/up to 30 missiles per year.
Scud D	728-863[72]	Unknown	Producing 15-30 per year

Table 4 - Syrian Short & Medium Range Ballistic Missiles

Anti-access Defense

With nearly all current U.S.-operated bases in the Pacific and Middle East under threat from ballistic and cruise missiles and with the U.S. Navy under similar threat; what are passive and active measures needed to protect these bases? From the perspective of passive defense, U.S. forces in the Pacific are woefully unprepared. The region lacks hardened shelters for anything larger than fighter-sized aircraft. Kadena AB, likely the main base for operations near the Taiwan Strait or on the Korean peninsula, has only 15 hardened shelters.[73] Osan Air Base and Kunsan Air Base in the Republic of Korea and Misawa AB, Japan have just enough for their assigned aircraft. There are no others in the Pacific theater available to the USAF. In the Middle East, most bases have hardened shelters but, like the Pacific bases, none for aircraft larger than a fighter.

Over the last 20 years, U.S. forces have utilized European bases for Middle Eastern conflicts. The two main air bases in Turkey that U.S. forces have used, Diyarbakir and Incirlik Air Bases have a total of 65 fighter-sized, hardened shelters. Additionally, six other bases in Turkey provide another 131 fighter-sized hardened shelters however; most are being used by the Turkish Air Force. Outside of Turkey the situation is bleak. RAF Akrotiri in Cyprus, Souda Bay, Crete, and NAS Sigonella, Italy, have no hardened shelters.

Current US Operating Bases/Hardening		
Base	**Fighter-sized Hardened Shelters**	**Large Aircraft Hardened Facilities**
Kadena AB, JA	15	0
Misawa AB, JA	28	0
Osan AB, KS	22	0
Kunsan AB, KS	19	0
Andersen AFB, GU	0	0
Al Jaber AB, KU	18	0
Ali Al Salem, KU	19	0
Sheik Isa, BA	9	0
Al Udeid AB, QA	6	0
Al Dhafra AB, AE	24	0
Masirah, MU	6	0
Thumrait AB, MU	10	0
Diyarbakir AB, TU	26	0
Incirlik AB, TU	39	0
Batman AB, TU	30	0
Erzurm AB, TU	13	0
Erhac AB, TU	20	0
Merzifon, TU	30	0
Akinci AB, TU	13	0
Konya AB, TU	25	0
RAF Akrotiri, CY	0	0
Souda Bay, GR	0	0
NAS Sigonella, IT	0	0

Table 5 - Current U.S. Bases/Hardening

Even if the aircraft at a forward base are protected there remain serious vulnerabilities to base operations under a ballistic or cruise missile attack. Runways are very resilient targets and repaired in a short amount of time *if* the repair equipment is prepositioned and protected. During exercise Salty Demo in 1985, USAFE bases exercised operating under the expected threat from Soviet missile attacks. The lesson learned from Salty Demo was that repair equipment was as critical as the aircraft and had to be sheltered too.[74]

USAFE's vulnerability to attacks on its fuel storage was so well established that they were immune from attack during Salty Demo, "no simulated attacks were conducted on the above-ground fuel storage area because it would have shut down the wing".[75] Building hardened shelters for repair equipment and hardening fuel storage is extremely expensive and may even be ineffective depending on the weapon used to strike it.

The cost of a modern, fighter sized, hardened shelter is expensive. "A shelter large enough for a single fighter-size aircraft…costs approximately $5.64 million. Enough hardened shelters to protect the aircraft of five 72-aircraft fighter wings would cost over $2.03 billion."[76] A shelter large enough for 12 bomber, tanker or reconnaissance aircraft may be as high as $700 million.[77]

Hardening fuel supply systems is possible and was done at select European airbases during the Cold War, but it is a complex and expensive undertaking. Fuel storage and distribution can be buried and reinforced with steel and concrete. A 2008 Australian Air Force study estimated it would cost approximately $14 million per airfield to build hardened fuel storage and supply systems.[78] If passive measures are inadequate or too expensive, then the U.S. must rely on active defense measures to protect its air bases.

Since Operation DESERT STORM, and the perceived success of the Patriot Anti-ballistic Missile (ABM) system, the U.S. has spent billions of dollars on theater-level ABM systems, but unless there is a sharp increase in the number of these systems, by 2035, they may be overwhelmed. The U.S. Army has 15 deployed or deployable Patriot equipped Air Defense Artillery battalions[79] consisting of five Patriot batteries with each battery having one launcher[80]. In addition to U.S. operated systems, nations such as the Netherlands, Germany, Japan, Israel, Saudi Arabia, Kuwait, Taiwan, Greece, Spain, South Korea and the United Arab Emirates have been sold at least one Patriot battery.[81] There is no plan for future Patriot systems to be built as the U.S. Army moves to deploy the Terminal High Altitude Area Defense (THAAD) system.

A THAAD battery consists of a radar system, a Command and Control Battle Manager and Communications system, three launchers, and 24 missiles.[82] Current plans are for the U.S. Army to have nine deployable THAAD batteries with 503 missiles in two Air Defense Artillery battalions by 2015.[83] THAAD will also be sold internationally with U.A.E. as the first customer with two batteries and 96 missiles by 2013.[84]

The U.S. Navy currently has 23 AEGIS ships capable of conducing air defense missions with possibly as many as 41 by Fiscal Year 2016.[85] These ships will be armed with up to 416 missiles.[86]

On paper, this ABM force seems substantial; however looking at the numbers tells a different story. The first problem, particularly in the Pacific, is that the U.S. Navy may need their AEGIS ships and their allotment of 225 missiles for self defense (assuming a 66 percent allocation of AEGIS ships for USPACOM). Assuming that two missiles are launched at an incoming ASBM and that China has as many as 80 CSS-5 mod 4s, the Navy will only have 65 missiles left to intercept up to 33 missiles bound for U.S. airfields, and this assumes no ships (with their missiles aboard) are lost during these exchanges. In the Middle East, where there is no ASBM threat, the problem of defending land-based airfields may be one of proximity. The range of the SM-3 is

270 nm[87] with the SM-2 Block IV only capable of hitting targets 130 nm[88] from the launching ship. If the Iranians make naval operations in the Persian Gulf too risky, Persian Gulf bases west of Oman will be beyond reach of Navy missile defense.

The U.S. Army and its international partners would appear to be in better shape than the U.S. Navy but this is misleading as well. Assuming that each AOR would have up 75 percent of available Patriot battalions apportioned for their conflict (up to 4,000 PAC-3/ PAC-2 missiles and 377 THAAD missiles, with 515 additional THAAD and Patriot missiles from U.A.E., Saudi Arabia and Kuwait in a Middle East conflict[89]) this gives the U.S. Army the ability to *attempt* to intercept 2,188 warheads (2,446 in the Middle East). By 2035 China could have several thousand CSS-5s and CSS-6s and nearly 800 DH-10s. The Korean peninsula is defended much easier but the DPRK may still have well over 2,000 missiles by 2035. In the Middle East, Iran could have thousands of their shorter range Scud Bs and CSS-8s by 2035. In Syria exact numbers are not known but, if Scud C assessed indigenous production capability is accurate, Syria could have over 600 of this type alone by 2035.

Alternate Basing Options

If current U.S. occupied bases become untenable as a result of an increased anti-access threat, then we must look further afield. Iwo Jima Airfield is located 652 nm south of Tokyo. Iwo Jima is within Chinese CSS-5 mod 2 range making it useless for a conflict with China; however, even though it lies within range of DPRK No Dong 2 range, it may be useful in a Korean Peninsula conflict if provided with Patriot and AEGIS protection. Perhaps the biggest limiting factor preventing U.S. operations from Iwo Jima in a conflict with the DPRK is that Iwo Jima is a

Japanese island and Japan could potentially be coerced by the DPRK to prohibit U.S. deployment to the island.

Another airfield possibly useable against the DPRK is Mactan International located on the Philippine island of Cebu. Like Iwo Jima, Mactan may be potentially useful in a Korean conflict with proper active missile defense; however, there may be political restraints on the U.S. use of Mactan as the Philippine capital of Manila lies within range of DPRK No Dong 2 missiles. While not at risk to the same extent as Japan, whose main islands lie within range of hundreds of DPRK missiles, the Philippians may be dissuaded from providing the U.S. access due to the threat to its capital from No Dong 2s.

The best alternate basing solution in the Pacific appears to come from airfields outside the range of all potential enemy nations. With the exception of Darwin International in Australia, new bilateral agreements will be needed to secure these bases for U.S. operations. Tengah and Paya Lebar airfields in Singapore; Adi Surnarmo International, Iswahyudi Airfield and Juanda International in Indonesia; Darwin International in Australia and the U.S. bases of Wake Island Army Airfield and Eareckson Air Station are all beyond the reach of Chinese and DPRK missiles and may provide the best bases to operate from in a Pacific conflict. The most attractive, from a political constraint perspective, are Wake Island AAF on Wake Island and Eareckson AS on the Alaskan Island of Shemya.

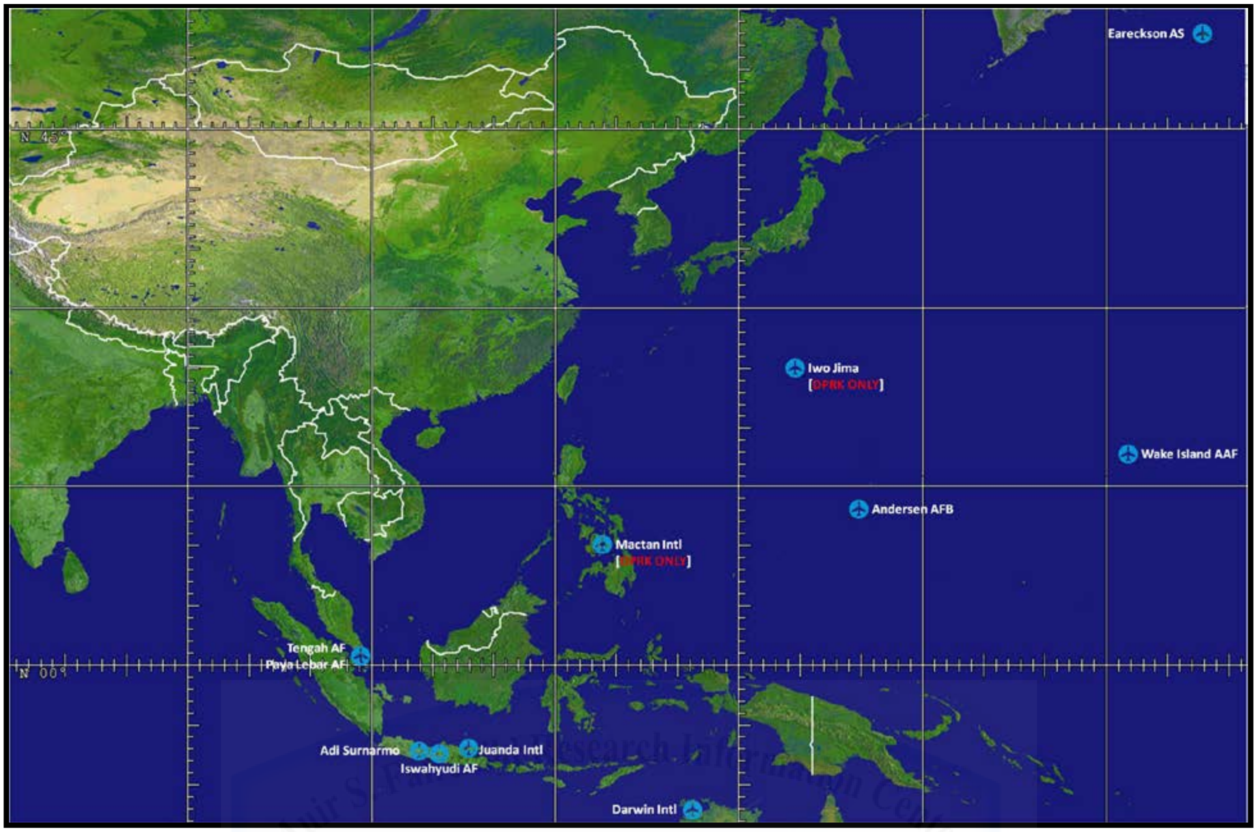

Figure 5 – U.S. Pacific Basing Options in 2035

U.S. Alternate Basing Options in the Pacific					
Base	**Runway Stats**	**Hardened Shelters**	**In-range Threat(s)**	**Distance to Taiwan Straits**	**Distance to Pyongyang**
Iwo Jima Airfield, JP	8700’ x 200’	None	CSS-5 mod 2 (PRC)	N/A	1200 nm
Mactan Airfield, RP	10,826’ x 148’	None	CSS-5 mod 2 & 3 (PRC) Musudan (DPRK)	N/A	1700 nm
Andersen AFB, GU	11,185’ x 200’/ 10,558’ x 200’	None	Musudan (DPRK)	1630 nm	1840 nm
U.S. Navy Carrier	N/A	None	None	1650 nm	300 nm
Tengah Airfield, SN	(Duel) 8,999’ x 148’	None	None	1655 nm	2550 nm
Paya Lebar, SN	12,401’ x 200’	None	None	1655 nm	2550 nm
Adi Surnarmo Intl, ID	8,530’ x 148’	None	None	1950 nm	2900 nm
Iswahyudi Airfield, ID	10,030’ x 186’	None	None	1950 nm	2900 nm
Juanda Intl, ID	9,843’ x 148’	None	None	1925 nm	2875 nm
Darwin Intl, AS	11,004’ x 200’	None	None	2320 nm	3100 nm
Wake Island AAF, US	9,859’ x 150’	None	None	2700 nm	2425 nm
Eareckson AS, US	10,006’ x 150’	None	None	3000 nm	2135 nm
Avg Flight Distance for Fighter Sized Aircraft				2044 nm	2206 nm[#] 2252 nm[$] 2297 nm[@] 2357 nm[&]
# - Iwo Jima and Mactan available (used in average flight distance calculation) $ - Iwo Jima available, Mactan NOT available (not used in average flight distance calculation) @ - Iwo Jima NOT available (not used in average flight distance calculation), Mactan available & - NIETHER Iwo Jima nor Mactan available (neither used in average flight distance calculation)					

Table 6 - U.S. Alternate Basing Options in the Pacific[90]

Due to the nature and geographic location of potential Middle East enemies, the alternate operating bases for a Middle East conflict are more plentiful than the Pacific and much closer to the combat area. None of the current bases that house USAFCENT forces will be tenable in a conflict with Iran and only Al Udeid AB, Qatar; Al Dhafra AB, U.A.E. and Masirah AB and Thumrait AB, Oman will be useable in a conflict with Syria. Djibouti Ambouli in Djibouti is within range of Iran’s Sajjil-2, but that risk may be mitigated with land and sea based air defense. In a conflict with Syria, no active defense would be required.

In a conflict with Iran, there are four bases in western Greece beyond range of all but Iran's Sajjil-2 that could be used with, like Djibouti Ambouli, active defense emplaced. Additionally, Andravida AB, Araxos AB and Aktion Airport have fighter-size hardened shelters. Available ramp and shelter space may be a factor in the use of three of these Greek bases as they currently are used by the Greek Air Force.[91] Unfortunately, Syria's more western geographic location and its arsenal of Scud Ds render none of these Greek Airfields useable in a conflict with Syria.

The Balkans provide some useable airfields that lay beyond all Syrian ballistic missile range and only reachable by Iranian Sajjil-2 missiles. Traian Vuia International in Romania and Kucova Airport and Tirana Rinas International in Albania are possibilities but may require significant U.S. investment particularly for the Albanian airfields. The fuel status at Kucova is currently listed as "unknown fuel type or whether there is any fuel".[92] Tirana Rinas International also presents challenges. Despite being categorized as a joint use airfield, Tirana Rinas International is the main airport serving Albania and has restrictions on takeoff and landing direction which could severely hamper military air operations.[93]

There are three bases in southern Italy that are beyond Syria Scud D range and within only Iranian Sajjil-2 range. Brindisi-Casale AB is a joint-use base while Gioia Del Colle AB and Foggia-Amendola AB are Italian Air Force Bases. All three bases have Italian Air Force aircraft stationed there.[94]

By 2035 there are, potentially, four airfields in Libya beyond Syrian Scud D and Iranian Sajjil-2 missile range that could be useable for U.S. operations. Ghardabiya Air Base near Sirte, Misurata Air Base, Mitiga International Airport, a joint military-civilian airport just north of Tripoli (formerly known as Wheelus Air Base) and Okba Ibn Nafa Air Base were all active Libyan Air Force bases in 2011 but sustained damage during the Libyan uprising and subsequent

NATO bombing.[95] Obviously the availability of these bases in Libya is dependent upon repairs and the relationship that the U.S. develops with the new Libyan government between now and 2035.

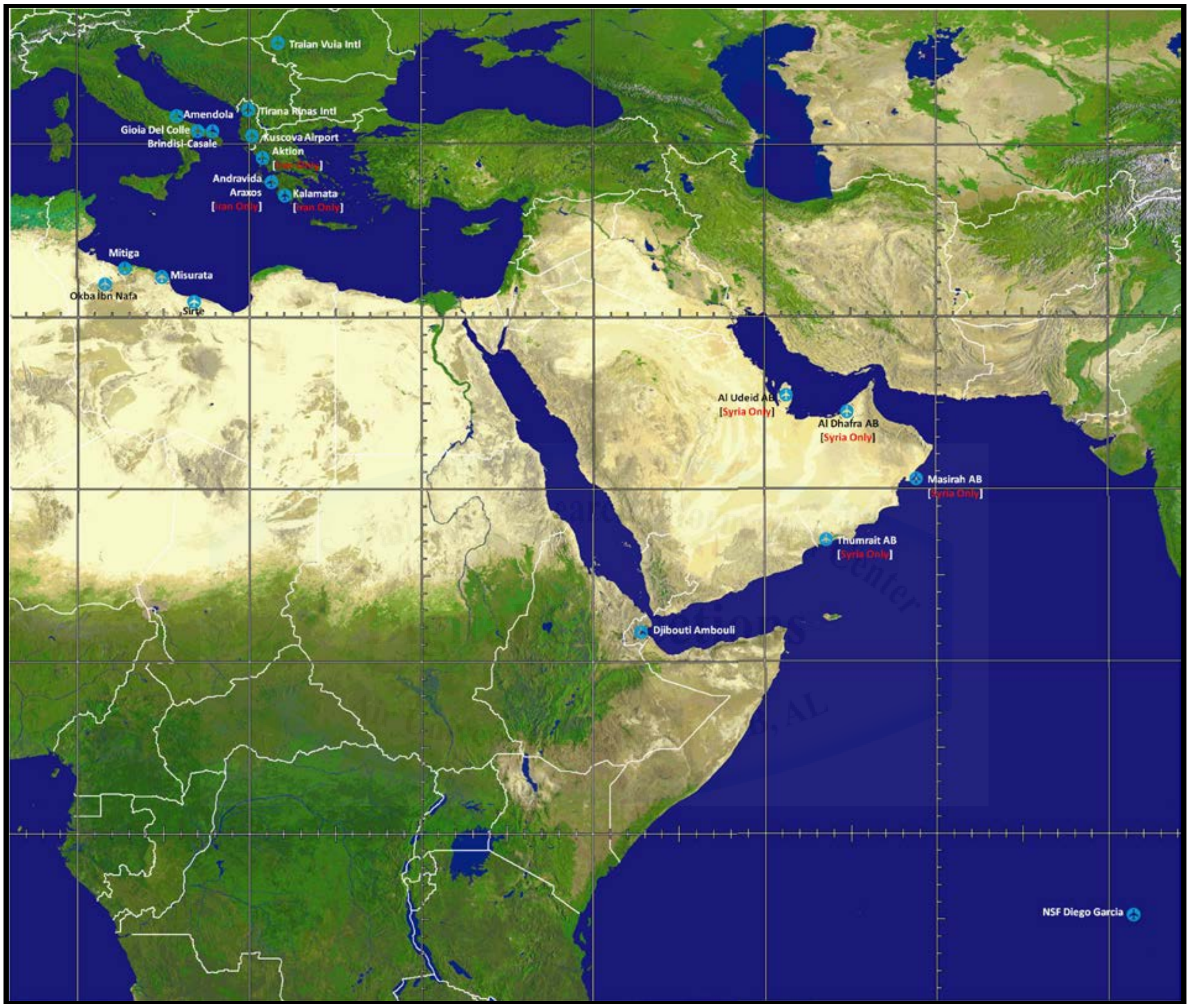

Figure 6 - U.S. Basing Options for Middle East Conflict in 2035

U.S. Alternate Basing Options in the Middle East/Europe					
Base	Runway Stats	Hardened Shelters	In-range Threat(s)	Distance to Tehran	Distance to Damascus
Al Udeid AB, QT	12,303' x 148'	6	None	N/A	932 nm
Al Dhafra AB, AE	(Duel) 12,012' x 150'	24	None	N/A	1108 nm
Masirah AB, MU	8,446' x 148' 10,005' x 148'	6	None	N/A	1428 nm
Thumrait AB, MU	13,123' x 148'	10	None	N/A	1347 nm
U.S. Navy Carrier	N/A	None	None	950 nm	250 nm
Djibouti Ambouli, DJ	10,035' x 148'	None	Sajjil-2 (IR)	1500 nm	1375 nm
Kalamata AB, GR	8,944' x 148	None	Sajjil-2 (IR), Scud D (SY)	1415 nm	745 nm
Andravida AB, GR	10,299' x 148'	25	Sajjil-2 (IR), Scud D (SY)	1445 nm	780 nm
Araxos AB, GR	10,997' x 148'	21	Sajjil-2 (IR), Scud D (SY)	1445 nm	780 nm
Aktion Airport, GR	9,410' x 148'	13	Sajjil-2 (IR), Scud D (SY)	1465 nm	825 nm
Traian Vuia Intl, RO	11483' x 148'	None	Sajjil-2 (IR)	1480 nm	1020 nm
Kucova Airport, AL	9318' x 220'	None	Sajjil-2 (IR)	1500 nm	900 nm
Tirana Rinas Intl, AL	8971' x 148'	None	Sajjil-2 (IR)	1510 nm	930 nm
Brindisi-Casale, IT	8,309' x 148'	9	Sajjil-2 (IR)	1600 nm	980 nm
Gioia Del Colle AB, IT	9,846' x 148'	20	Sajjil-2 (IR)	1630 nm	1030 nm
Foggia-Amendola AB, IT	9,121' x 148'	None	Sajjil-2 (IR)	1700 nm	1100 nm
Ghardabiya AB, LY	(Duel) 11,807' x 148'	90[#]	None	1750 nm	1000 nm
Misurata AB, LY	11,140' x 150'	None	None	1800 nm	1080 nm
Mitiga Intl, LY	11,076' x 148'	None	None	1880 nm	1150 nm
Okba Ibn Nafa AB, LY	(Duel) 10,500' x 150'	None	None	1900 nm	1200 nm
NSF Diego Garcia, UK*	12003' x 200'	None	None	2825 nm	3200 nm
Avg Flight Distance for Fighter Sized Aircraft				1538 nm[@] 1560 nm	998 nm
# - All 90 Hardened Shelters were damaged during the 2011 Libyan uprising * - Only used by Global Strike Platform @ - Okba Ibn Nafa AB NOT used (not used in average flight distance calculation)					

Table 7 - U.S. Alternate Basing Options in the Middle East/Europe[96]

The 2035 Fuel-Range Problem

The future force structure of the U.S. Air Force Air Refueling fleet is uncertain at this time but there is a strong possibility that the USAF *may* have a reduced air refueling capability than it has in 2011. A reduction in air refueling capability, as our potential enemies push us further away, is severely problematic and will require that the air breathing global strike platform can strike distant targets without the requirement for air refueling. The current USAF tanker fleet consists of 417 KC-135s and 59 KC-10As.[97] By 2035; the picture will be different with the introduction of the KC-46 tanker. The KC-46 will be able to operate off of shorter airfields than a KC-135R but will have nearly identical offload capability.[98] The USAF plans to retire 290 KC-135Rs and replace them with 179 KC-46s.[99] Assuming a higher mission capability rate of 90 percent and similar depot numbers to the early years of the KC-10 program (5 percent)[100], this provides for a maximum off load of 27.6 million pounds for the entire 2035 tanker force.

Calculating the deployed tanker requirement with such different assets as the KC-10 and the similar KC-135 and KC-46 introduces many variables and for ease of calculation it will be assumed that out of the 56 available KC-10As, all but 10 are performing support to Strategic Airlift missions to support the Pacific operations while 50 percent of the remaining tankers (53 KC-135Rs and 85 KC-46s) are supporting continuing world-wide mobility missions and training. Deploying 50 percent of the tankers force is not in compliance with the latest AEF plan but it can be assumed that a national security crisis as severe as a war with China or the DPRK would require the USAF to break the new AEF construct.

The average combat range of U.S. fighters is 1,300 nm. With an average flight *radius* in a combat sortie to the Taiwan Straits of 4,088 nm (using the alternate basing from tables 6 and 7), each fighter type aircraft would require 2.15 air refuelings taking on an average of 19,540 pounds of fuel per air refueling for a total of 42,011 pounds per strike sortie. For a Korean Peninsula conflict, with the use of Iwo Jima and Mactan, this increases to 2.66 air refuelings and a total of 51,976 pounds per strike sortie. With both Iwo Jima and Mactan denied, fighter type aircraft will require 2.97 air refuelings per sortie and a total of 58,033 pounds per strike sortie.

Defensive Counter Air (DCA) sorties will be required to protect the ISR and Command and Control platforms. The DCA profile will be similar to the strike aircraft except they will require three hours of orbit time costing 8,000 pounds per hour for a total of an additional 24,000 pounds. These DCA sorties would require 66,011 pounds for China, 75,976 for a Korean Peninsula conflict with Iwo Jima and Mactan available and 82,033 for a Korean Peninsula conflict without Iwo Jima and Mactan available.

DCA aircraft will be refueled by tankers flying up to five hours, reducing offload further and limiting 32 tankers, dedicated to DCA, to a 1.0 utilization rate while the remaining tankers fly a 1.5 utilization rate. With our force of 10 KC-10s, 53 KC-135Rs and 85 KC-46s there is a maximum offload capability of 14.865 million pounds per day. A modest force of 216 fighter type aircraft averaging an 85 percent MC rate requires 11.67 million pounds per day for China, 14.28 million pounds per day for a Korean Peninsula conflict with Iwo Jima and Mactan available and 15.85 million pounds per day for a Korean Peninsula conflict without use of either Iwo Jima or Mactan. This airborne fuel consumption leaves 3.195 million pounds per day for China, 585,000 pounds per day for Korea with Iwo and Mactan available and a *deficit* of 985,000 pounds per day for Korea without Iwo and Mactan available and this does not include the ISR and C3 aircraft. The E-3C, E-8 and RC-135V/W, assuming 24-hour coverage near the battle area, could require up to an additional 986,504 pounds of airborne fuel per day creating *deficits* (or *larger deficits*) for all but conflict with China that will have only 2.2 million pound per day available for a Global Strike platform. In order to get enough airborne fuel for fighters, ISR and C3 aircraft for a Korean conflict, up to an additional 10 KC-135R or KC-46 will be required.

With an average flight *radius* in a combat sortie to Tehran of 3,120 nm, each fighter type aircraft would require 1.4 air refuelings for a total of 27,356 pounds per strike sortie and 51,356 pounds per DCA sortie. In a Syrian conflict the average flight *radius* would be only 1,996 nm and require .53 air refuelings for a total of 10,356 pounds per strike sortie and 34,356 pounds per DCA sortie. With an attack plan and tanker force structure identical to the Pacific for a conflict with Iran; fighter type, DCA, ISR and C3 aircraft will require 8.15 million pounds leaving an excess of 6.715 million pounds of fuel. For Syria, the picture is even better. Total daily airborne fuel requirements for Syria will be 3.45 million pounds leaving 11.415 million pounds. Excess fuel can be used to extend combat range to strike more distant targets or support a Global Strike platform.

Recommendation

The anti-access threats, primarily in the Pacific, are going to require fighter-sized aircraft and air refueling assets to be based much further from the combat zone than at any time in history and an air-breathing Global Strike platform will require an unrefueled combat range of *at least* 3,000 nm (6,000 nm combat radius) in order to allow the shorter ranged assets to operate from such distances. A 2008 study by Northrop-Grumman recommended that the 2018 bomber "have a combat radius of 2,000 miles or greater."[101] In early 2011, General William Fraser, discussing the next generation bomber stated, "previous ACC analysis shows a combat radius of between 2,000 and 2,500 nautical miles is sufficient, which equals a 4,000- to 5,000-nautical-mile range."[102] All signs point to the next generation bomber having a 2,500 nm unrefueled combat range, but it isn't long enough.

As has been shown, a conflict in the Middle East does not present the anti-access challenges that the Pacific does. Barring an unforeseen and rapid development in ballistic missile development and production in the Middle East, the 2035 tanker force is more than capable of meeting the needs of short range fighters and any Global Strike platform, but the problem in the

Pacific is acute now, and worse in 2035. The idea that the Global Strike platform will also need to be refueled makes the Pacific airborne fuel shortage even more untenable. A 2,500 nm range bomber that can fly high subsonic cruise speeds means it carries enough fuel for approximately five hours plus reserve. If jet engine advances like ADVENT (Adaptive Versatile Engine Technology) and HEETE (Highly Efficient Embedded Turbofan Engine) can provide engines that burn a total of 10,000 pounds per hour at cruise, than in order to stretch its range an additional 500 nm, 20,000 pounds per sortie will be required.

Based on analysis of fuel requirements, a bomber with a 2,500 nm combat range will tax an already stretched air refueling situation in a conflict in the Pacific. A 2,500 nm range bomber, operating from Eareckson AS, will leave everything west of the most eastern portion of Beijing Military Region immune from attack (see figure 7) including Beijing itself unless provided airborne fuel. Stationing the bomber at Wake Island AAF is worse as only a small portion of Nanjing Military Region is within unrefueled range and this does not include the city of Nanjing itself or the Straits of Taiwan. A 2,500 nm bomber stationed at Darwin International can range only the most southern parts of Guangzhou Military Region and Nanjing Military Region; however this does include the Taiwan Straits, but no part of the DPRK. Because there is over two million pounds of fuel available in a conflict with China, a 2,500 nm bomber could be extended to a 3,000 nm range by taking on fuel. The excess fuel in a China conflict would allow up to 100 Global Strike sorties however; this is not an option against North Korea where a fuel deficit already exists. In a situation where the Global Strike platform requires support assets (see detailed explanation below), the 2,500 nm bomber becomes even more of a burden. In order to strike targets within the Chinese sanctuary area of the 3,000 nm bomber, the shorter range version will require 40,000 pounds of fuel for itself and over 400,000 pounds for the support assets. The excess fuel in a China scenario would disappear with only five 2,500 nm range bomber sorties against these targets with required support assets. Also not taken into account for China is a probable larger ASETF which will have more than 216 fighter type aircraft. The scenario in this paper provided 228 fighter strike sorties per day; but during Operation DESERT STORM, coalition aircraft flew in excess of 1,000 strike sorties per day![103] Operation IRAQI FREEDOM's Major Combat Operations phase saw the coalition fly over 600 strike sorties per day.[104] Operation ALLIED FORCE saw NATO aircraft fly only 135 strike sorties per day.[105] Depending on the goals of the operation, it can be assumed that a conflict on the Korean Peninsula or with China will require more strike sorties than were required against Serbia (a country slightly smaller than Kentucky[106]) and perhaps as much as were required during DESERT STORM. The additional two million pounds of excess fuel in a China conflict disappear with an additional 56 fighter strike sorties or a combination of 10 DCA sorties and 40 strike sorties.

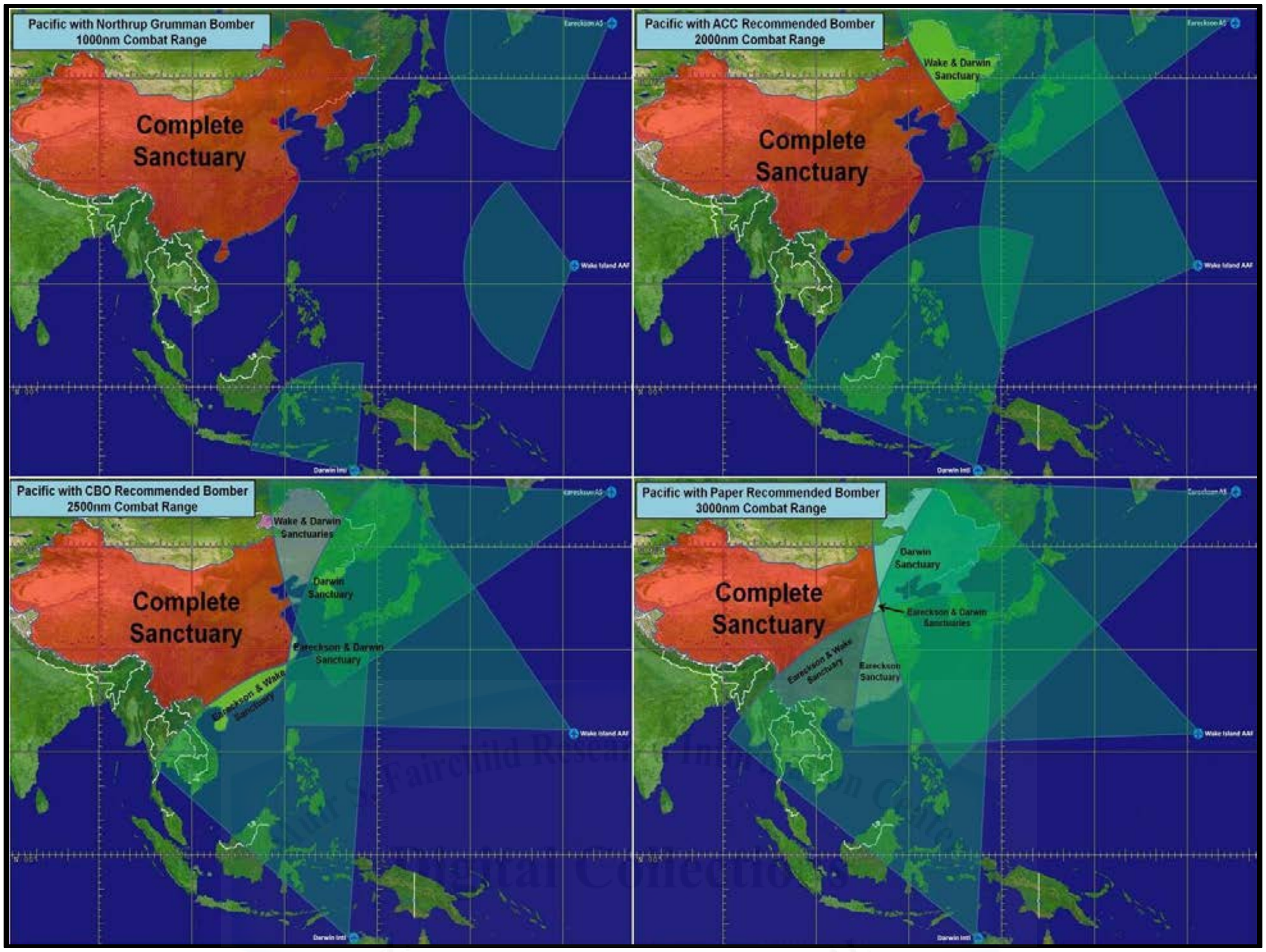

Figure 7 - Pacific Global Strike Range and Sanctuary Areas

Even a 3,000 nm bomber, without air refueling, allows China and, in some basing scenarios, North Korea, sanctuary areas but these can be broached with the available excess fuel. In the case of North Korea, with no fuel available for a Global Strike platform, difficult choices would need to be made in order to strike there. Another problem is penetrating beyond the Taiwan Straits. Unless the Global Strike platform is immune from Chinese area denial threats it will require support aircraft. If the Global Strike platform cannot self defend or is not immune from Chinese area denial systems, how many assets will need to accompany the Global Strike platform to its max range and beyond? An average of 7,006 pounds per sortie will be required to extend fighter type aircraft and additional 500 nm. A 3,000 nm range bomber will be capable of flying an average of 600 nm west of the Taiwan Straits. If this bomber requires a four-ship of OCA fighters, a four-ship of SEAD fighters and a four-ship of EA aircraft, it will require that an additional 201,772 pounds are made available. A 3,000 nm range bomber, ordered to strike targets 500 nm inside China's sanctuary, will require only 20,000 pounds to get to the target but supporting assets will require over 400,000 pounds, fortunately in a China conflict, this fuel is available.

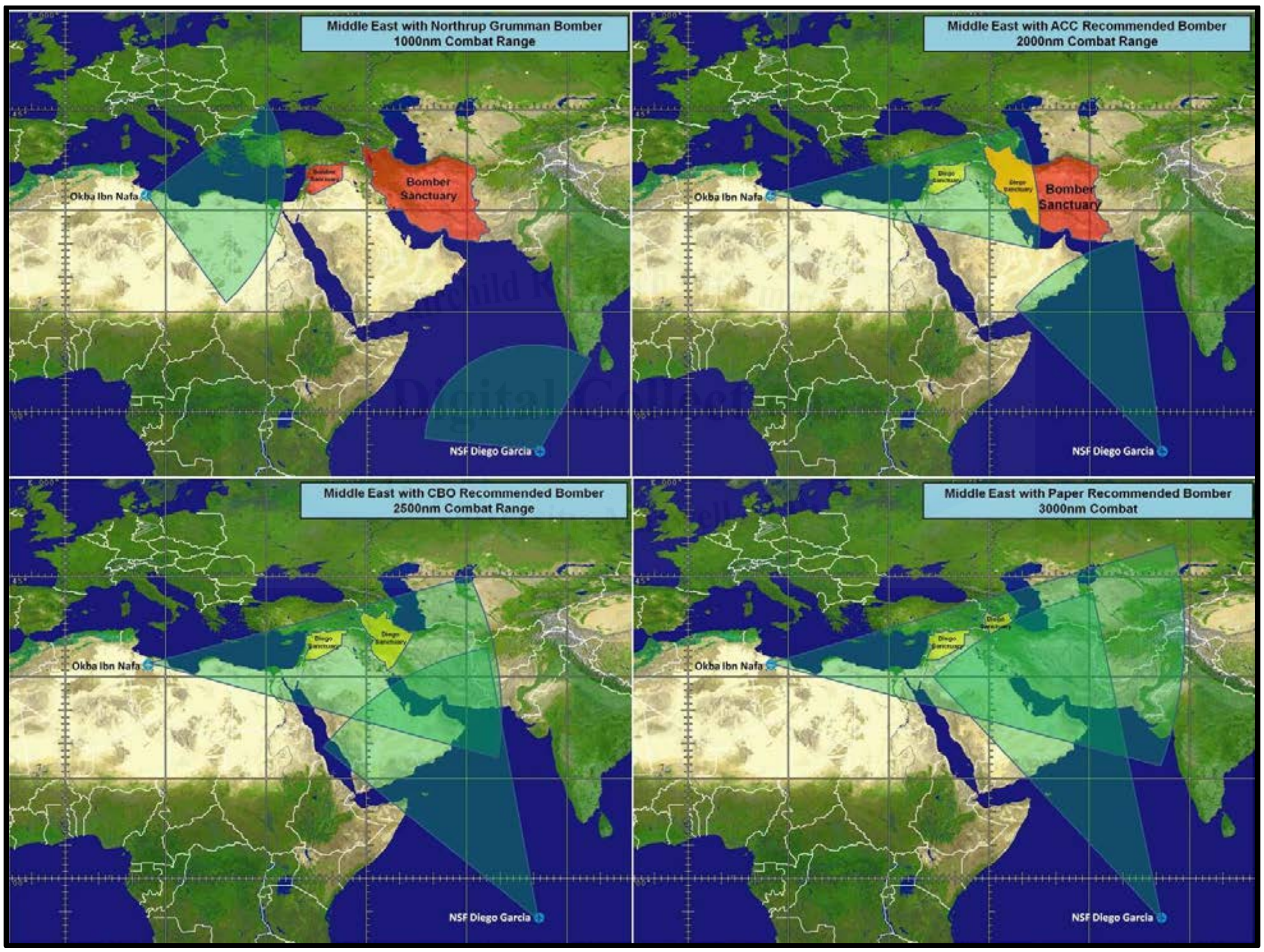

Figure 8 - Middle East Global Strike Range and Sanctuary

Conclusion

As the United States Air Force develops its next long-range strike platform it cannot afford to develop a system that will be a drain on an airborne refueling architecture that, at least in a conflict in the Pacific, will be taxed in 2035. A bomber with less than a 3,000 nm unrefueled range will leave vast areas of China and, basing dependant, parts of North Korea with areas unreachable by USAF aircraft. While carrier-based aviation may be able to hold all targets in the DPRK at risk, the U.S. cannot afford to be so limited in a conflict with an unstable nuclear capable foe.

Over-flight rights were not addressed in this paper but they could potentially make a conflict in the Pacific or Middle East even more challenging. If average flight distance is increased just 10 percent the costs will leave even greater areas of China and North Korea immune from USAF attack. Orbiting for time sensitive targeting and mobile target hunting adds another fuel burden neither of which can be complicated further by a new platform that requires more of the precious airborne fuel. A Global Strike platform with an unrefueled range of *at least* 3,000 nm is the only way for the USAF to support the evolving Air-Sea Battle concept.

Appendix

2035 Fuel-Range Problem Calculations

Total Tanker Offload Capability 2035

127 KC-135 – 20 depot possessed[107] = 107 x 75% MC Rate = 80.25 (rounded up to 81) x Max Offload of 82,500 pounds = 6,682,500 pounds

179 KC-46 – 9 depot possessed (using early KC-10 depot possessed percentage)[108] = 170 x 90% MC Rate = 153 x Max Offload of 82,500 pounds = 12,622,500

59 KC-10 – 3 depot possessed = 56 x 80% MC Rate = 44.8 (rounded up to 45) x Max Offload of 185,000 pounds = 8,325,000

6,682,500 + 12,622,500 + 8,325,000 = 27,630,000

U.S. fighters fuel to range calculations/sources

EA-6B – Fuel Capacity (including 1 external fuel tank) = 17,373 lbs[109]
Combat Range = 1,447 nm[110]

F-15E – Fuel Capacity (including 2 CFTs and 2 external fuel tanks) = 30,518 lbs[111]
Combat Range = 2,200 nm[derived from 112]

F-16 – Fuel Capacity (including 2 external fuel tanks) = 12,000 lbs[113]
Combat Range = 852 nm[114]

F/A-18 E/F – Fuel Capacity (including 2 external fuel tanks) = 20,640 lbs(E)/19,790 lbs(F)[115]
Combat Range = 1,275 nm[116]

F-22 – Fuel Capacity = 18,000 lbs[117]
Combat Range = 820 nm[118]

F-35A – Fuel Capacity = 18,250 lbs[119]
Combat Range = 1,180 nm[120]

F-35C – Fuel Capacity = 19,750 lbs[121]
Combat Range – 1,200 nm[122]

Average Combat Range = 1,282 nm
Average Fuel Capacity = 19,540 lbs

2035 Deployed Tanker Offload Capability

53 KC-135 x 75% MC Rate = 39.75 (rounded up to 40) – 16 dedicated for DCA = 24 x 1.5 UTE = 36 sorties for strike support x 82,500 lbs offload = 2.97 million pounds per day + 16 DCA sorties x 82,500 lbs offload = 1.32 million pounds = 4.29 million pounds/day KC-135 offload

85 KC-46 x 90% MC Rate = 76.5 (rounded up to 77) – 16 dedicated for DCA = 61 x 1.5 UTE = 91.5 (rounded up to 92) sorties for strike support x 82,500 lbs offload = 7.59 million pounds per day + 16 DCA sorties x 82,500 lbs offload = 1.32 million pounds = 8.91 million pounds/day KC-46 offload

10 x KC-10 x 80% MC Rate = 8 – 6 dedicated for DCA = 2 x 1.5 UTE = 3 sorties for strike support x 185,000 lbs offload = .555 million pounds per day + 6 DCA sorties x 185,000 lbs offload = 1.11 million pounds = 1.665 million pounds/day KC-10 offload

4,290,000 + 8,910,000 + 1,665,000 = 14,865,000

Number of Air Refuelings Calculation

Avg Flight Radius to mission area – Avg combat range of 1300 nm to account for ground fuel load/Avg combat range of 1300 nm for refuelings
Ex. 4088 nm to Taiwan Straits – 1300 nm to account for ground load = 2788 nm/1300 nm avg combat range = 2.1446 (rounded up to 2.15)

2035 Deployed Fighter Type Strike/DCA Fuel Requirement (PACOM)

216 deployed fighter type aircraft x 85% MC rate = 183.6 (rounded up to 184) operational aircraft

152 fighter type aircraft for strike x 1.5 UTE rate = 228 strike sorties/day x :
42,011 lbs China sortie = 9.57 million lbs/day
51,976 lbs Korea (with Iwo & Mactan available) sortie = 11.85 million lbs/day
58,033 lbs Korea (without Iwo or Mactan available) sortie = 13.23 million lbs/day

32 fighter aircraft for DCA x 1.0 UTE rate = 32 DCA sorties/day x :
66,011 lbs China sortie = 2.1 million lbs/day
75,976 lbs Korea (with Iwo & Mactan available) sortie = 2.43 million lbs/day
82,033 lbs Korea (without Iwo or Mactan available) sortie = 2.62 million lbs/day

U.S. ISR and C3 fuel to range calculations/sources (PACOM)

E-3C[123] – Fuel Capacity = 149,500 lbs

Combat Range at 310 knots = 5,000nm = 16 hours/149,500 lbs = 9,343 lbs/hour
Avg Distance to Mission Area = 2100nm/310 knots = 6.8 hours x 9,343 = 63,532 lbs
Fuel burned on mission orbit = 6 hours x 9,343 = 56,058 lbs
Return to Base = 6.8 hours x 9,343 = 63,532 lbs
Total = 183,122 lbs/sortie – 149,500 ground load = 33,622 lbs from air refueling x 4 sorties/day = 134,488 lbs

E-8[124] – Fuel Capacity = 155,000 lbs

Combat Range in time at 450 knots = 9 hours/155,000 lbs = 17,222 lbs/hour
Avg Distance to Mission Area = 2100nm/450 knots = 4.7 hours x 17,222 = 80,943 lbs
Fuel burned on mission orbit = 6 hours x 17,222 = 103,332 lbs
Return to Base = 4.7 hours x 17,222 = 80,943 lbs
Total = 265,218 lbs/sortie – 155,000 lbs ground load = 110,218 from air refueling x 4 sorties/day = 440,872 lbs

RC-135V/W[125] – Fuel Capacity = 130,000 lbs

Combat Range at 450 knots = 3900nm/450 knot = 8.6 hours/130,000 lbs = 15,116 lbs/hour
Avg Distance to Mission Area = 2100nm/450 knots = 4.7 hours x 15,116 = 71,045 lbs
Fuel burned on mission orbit = 6 hours x 15,116 = 90,696 lbs
Return to Base = 4.7 hours x 15,116 = 71,045 lbs
Total = 232,786 lbs/sortie – 130,000 ground load = 102,786 from air refueling x 4 sorties/day = 411,144 lbs

2035 Deployed Fighter Type Strike/DCA Fuel Requirement (CENTCOM)

216 deployed fighter type aircraft x 85% MC rate = 183.6 (rounded up to 184) operational aircraft

152 fighter type aircraft for strike x 1.5 UTE rate = 228 strike sorties/day x :
27,356 lbs Iran sortie = 6.15 million lbs/day
10,356 lbs Syria sortie = 2.36 million lbs/day

32 fighter aircraft for DCA x 1.0 UTE rate = 32 DCA sorties/day x :
51,356 lbs Iran sortie = 1.64 million lbs/day
34,356 lbs Syria sortie = 1.09 million lbs/day

U.S. ISR and C3 fuel to range calculations/sources (CENTCOM)

E-3C – Fuel Capacity = 149,500 lbs

Combat Range at 310 knots = 5,000nm = 16 hours/149,500 lbs = 9,343 lbs/hour
Avg Distance to Mission Area = 1300nm/310 knots = 4.2 hours x 9,343 = 39,240 lbs
Fuel burned on mission orbit = 6 hours x 9,343 = 56,058 lbs
Return to Base = 4.2 hours x 9,343 = 39,240 lbs
Total = 134,538 lbs/sortie – 149,500 ground load= -14,962 lbs x 4 sorties/day = Excess of 59,848 lbs = No Air Refueling required

E-8 – Fuel Capacity = 155,000 lbs

Combat Range in time at 450 knots = 9 hours/155,000 lbs = 17,222 lbs/hour
Avg Distance to Mission Area = 1300nm/450 knots = 2.8 hours x 17,222 = 48,221 lbs
Fuel burned on mission orbit = 6 hours x 17,222 = 103,332 lbs
Return to Base = 2.8 hours x 17,222 = 48,221 lbs
Total = 199,774 lbs/sortie – 155,000 lbs ground load = 44,774 lbs x 4 sorties/day = 179,096 lbs

RC-135V/W – Fuel Capacity = 130,000 lbs

Combat Range at 450 knots = 3900nm/450 knot = 8.6 hours/130,000 lbs = 15,116 lbs/hour
Avg Distance to Mission Area = 1300nm/450 knots = 2.8 hours x 15,116 = 42,324 lbs
Fuel burned on mission orbit = 6 hours x 15,116 = 90,696 lbs
Return to Base = 2.8 hours x 15,116 = 42,324 lbs
Total = 175,344 lbs/sortie – 130,000 ground load = 45,344 x 4 sorties/day = 181,376 lbs

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