BIOCRUISE: A CONTEMPORARY THREAT

by
Michael E. Dickey, Lt Col, USAF

The Counterproliferation Papers
Future Warfare Series No. 7
USAF Counterproliferation Center
Air War College

Air University
Maxwell Air Force Base, Alabama

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
SEP 2000		**00-00-2000 to 00-00-2000**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Biocruise: A Contemporary Threat	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **USAF Counterproliferation Center,Air University,325 Chennault Circle,Maxwell AFB,AL,36112-6427**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**		**46**	

Biocruise: A Contemporary Threat

Michael E. Dickey, Lt Col, USAF

September 2000

The Counterproliferation Papers Series was established by the USAF Counterproliferation Center to provide information and analysis to assist the understanding of the U.S. national security policy-makers and USAF officers to help them better prepare to counter the threat from weapons of mass destruction. Copies of No. 7 and previous papers in this series are available from the USAF Counterproliferation Center, 325 Chennault Circle, Maxwell AFB AL 36112-6427. The fax number is (334) 953-7530; phone (334) 953-7538.

Counterproliferation Paper No. 7

USAF Counterproliferation Center

Air War College

Air University

Maxwell Air Force Base, Alabama 36112-6427

The internet address for the USAF Counterproliferation Center is:

http://www.au.af.mil/au/awc/awcgate/awc-cps.htm

Contents:

Disclaimer

The views expressed in this publication are those of the author and do not reflect the official policy or position of the Department of Defense, the U.S. Government, or the USAF Counterproliferation Center.

The Author

Lt Col Mike Dickey commands the 421st Ground Combat Readiness Squadron at the Air Mobility Warfare Center (AMC), Fort Dix NJ. He served six years as a security specialist before being commissioned through Officer Training School. Past assignments include a variety of security and force protection assignments, from nuclear security flight commander to MAJCOM staff in USAFE and ACC, command of security squadrons in Europe and Saudi Arabia, contingency deployments to Cuba, deputy commander of the 820th Security Forces Group, and site commander at Doha, Qatar for operation Desert Fox. A graduate of the Air War College Class of 2000, he is an AETC Master Instructor and a specialist in antiterrorism and force protection operations.

Acknowledgments

I gratefully acknowledge the wise counsel and encouragement of Dr. Barry Schneider, whose challenging course first sparked my interest in this subject. I also need to thank my classmates and friends who listened to my musings and ramblings and helped me keep focused, and my brother Dr. Robert Dickey for his counsel and concern about the alarming proliferation of open-source information on the subject. Finally, to MSgt Greg Rhoades of the 820 SFG intelligence shop, for his review and "sanity check" of my writing, and Ms. JoAnn Eddy of the CPC, for her help and eternal patience as I labored with this effort, many thanks!

Illustrations

Page

Tables

Page

Abstract

The specter of intermediate and short-range missile proliferation and their employment by rogue regimes to deliver weapons of mass destruction munitions has troubled the international community and particularly the United States for some time. The prospect of an "irrational actor," either state or non-state, in possession of such a missile, coupled with current proliferation in nuclear, chemical, and biological weapons opens up frightening scenarios for future attempts at U.S. and international community intervention or involvement in regional conflicts. Recent innovations in cruise missile technology pose a new, and potentially greater problem than that posed by ballistic missiles. Cruise missiles are far easier to obtain, maintain, weaponize, and employ than ballistic missiles. Given the greater ease of production of biological weapons compared to nuclear or chemical weapons and the ease of acquisition of a cruise missile delivery system compared to ballistic missiles, several operational scenarios may prove inviting to states or non-state actors intent on influencing the United States or attacking its forces. This paper reviews proliferation and ease of weaponization of biological agents, as well as the extent of proliferation of cruise missiles, along with their general capabilities. Finally, it reviews constraints, which may be inhibiting the use of biological weapons, and poses plausible employment scenarios that could have significant impact on United States decision-makers as well as on USAF Air Expeditionary Forces. This paper seeks to raise the level of awareness of a threat, which is not "emerging" as much as it is already a clear and present danger to the United States and USAF expeditionary operations.

Biocruise: A Contemporary Threat

Michael E. Dickey

I. Introduction

Emerging from the Cold War as the sole remaining superpower, the United States faces regional stability challenges in several places around the world. The loss of a bi-polar superpower world has led to the emergence or resurgence of numerous regional conflicts, which threaten regional stability and potentially impact global economic stability. In order to meet those challenges the U.S. military has become more expeditionary in nature than ever before. As the world's predominant military power, both in nuclear and conventional terms, state and non-state actors have abundant reasons to avoid meeting the U.S. military in a "head to head" action in order to achieve their goals. The 1990-91 Gulf War efficiently highlighted the conventional warfare capabilities of the U.S. military and the foolishness of attempting to prevail against it in open conventional combat. The result of that preeminence in U.S. conventional power, however, has been the emergence among potential adversaries of a distinct asymmetric threat, which could have major adverse impacts on deployed U.S. military forces as well as on the U.S. homeland unless adequate steps are taken to counter this threat.

Not new to the world's conflict stage, the ongoing proliferation of both biological weapons and cruise missiles is alarming. While it appears that biological weapons have not been employed against an opposing armed force since World War II (North Korean assertions that the United States employed biological weapons during the Korean Conflict were proven in 1998 to be a fabrication,[1] and United States' claims that the Soviet Union employed a "yellow rain" biological or chemical agent in Cambodia were never proven), they have been used in numerous small-scale criminal acts, and recent improvements in biotechnology have made them both easier and cheaper to produce than any other weapons of mass destruction (WMD). Although prohibited from manufacture, stockpiling, or use by the Biological Weapons Convention (BWC), numerous nations are known to have biological weapons programs and others are strongly suspected of having them. Further, the relative ease of manufacture and

weaponization of biological agents (compared to other WMD) makes them a threat-in-being as opposed to one that may emerge in the future.

Closely coupled to the proliferation of biological WMD is the proliferation of modern delivery systems, which could enable a state or non-state actor to attack the U.S., or deployed U.S. forces with potentially devastating results. While the proliferation of ballistic missiles has drawn much public attention over the last several years, the ongoing proliferation of cruise missiles, unmanned aerial vehicles (UAV), and remotely piloted vehicles (RPV) presents an even greater threat. These delivery systems have enjoyed several successful engagements in the anti-ship mode, notably by Argentine forces against the British during the Falklands/Malvinas conflict, as well as their more recent land attack variant successes in the Gulf War. Their capabilities and ease of acquisition or manufacture make them an ideal attack platform for rogue states, emerging nations, or non-state actors. Additionally, UAVs and RPVs have several salient characteristics that make them a much better delivery system for biological agents than any other.

Although biological agents have not been employed militarily in recent times, there are indications that they may well be the next of the three WMD (nuclear, chemical, and biological) to be used. The wide availability of cruise missiles, UAVs and RPVs, along with breakthroughs in navigational and propulsion systems make them an ideal delivery system. Additional factors in the nature of sub-state conflict, emerging non-state actors, and transnational terrorists only enhance the possibility that these two systems will be mated and employed against the United States.

II. Biological Weapons

The use of biological warfare to prevail in combat is not new. Early recorded uses include the hurling of plague-infested bodies over the walls of the besieged city of Kaffa (modern-day Feodosia in the Crimea) to subvert its defenders in the year 1346 AD. The tactic not only worked, but is suspected of having contributed to or possibly begun the bubonic plague epidemic that swept through medieval Europe during the "dark ages" of the 1300's, killing an estimated 25 million people.[2] Often confused or lumped together with chemical weapons, biologicals are, in fact, easier to acquire and employ and can be many times more deadly. Labeled the "poor man's atomic bomb" because of their relatively low cost and ease of manufacture, a report by the Congressional Office of Technology Assessment (OTA) estimated the cost of a large biological arsenal at as low as $10 million. Compared to a conservative estimate of the cost to develop a single nuclear weapon at $200 million, the BW option can look very cost effective to rogue states, emerging states, or non-state actors.[3] The United States unilaterally abandoned its offensive BW program by Presidential Order in 1969, and was fully disarmed of BW weapons by 1972. This led to wide acceptance by the world community of the Biological and Toxin Weapons Convention (BWC), which commits signatories to "…never in any circumstances develop, produce, stockpile, or otherwise acquire or retain any biological weapons."[4] While some key officials have disagreed as to the actual ease of manufacture and weaponization, evidence exists that several nations, notably Iraq, Iran, Libya, North Korea, Israel, Egypt, Cuba, Taiwan, China, Romania, Bulgaria, Pakistan, India, South Africa, Syria, as well as Russia, are either known or suspected of having pursued BW development and stockpiling efforts.[5]

Proliferation

The relative ease with which biological weapons can be acquired has been identified by multiple sources. A 1993 report by the Congressional Office of Technology Assessment (OTA) states:

> "*Biological warfare agents are easier to produce than either nuclear materials or chemical warfare agents*

> *because they require a much smaller and cheaper industrial infrastructure and because the necessary technology and know how is widely available.*"[6]

More recently, in the Spring 1998 issue of the *Journal of Counterterrorism & Security International*, a former FBI Chief of Counter-Terrorism stated:

> *"Biological and chemical weapons are certainly available to sophisticated terrorist organizations, especially those, like many of the Middle East groups, that operate with the support of governments. These weapons are both relatively easy to acquire and lethal in their application."*[7]

Those desiring to acquire a biological agent can pursue them by several routes. They could acquire it from a pharmaceutical supply house, steal it from a laboratory, or if sufficiently trained, skilled and equipped, they could grow the agent themselves. While this might prove difficult for most it is not beyond the capability of any nation or group with access to a pharmaceutical laboratory.

It has been confirmed that several rogue states, notably Iraq, Iran, and Syria, as well as known terrorist groups such as the German Red Army Faction (RAF) and Aum Shinrikyo cult in Japan, have possessed biological warfare capabilities. Several other terrorist organizations have expressed interest in acquiring biological agent as far back as a reported attempt by the radical underground Weathermen organization in 1970.[8]

Post-Gulf War United Nations inspectors from 1991 to 1995 were able to identify a biological weapon production capability in Iraq, but they were never able to definitively link it to a biological warfare program. Iraq repeatedly denied any BW capabilities, and then suddenly recanted. In 1995, following the defection of Lieutenant General Hussein Kamel Majeed, the Iraqi General who ran their WMD program, Iraqi officials admitted that they had a biological research and development program, but claimed that all biological weapons had been destroyed. [9]

Subsequent investigation revealed enormous production of biological agents. Iraq had produced 19,000 liters of botulinum toxin, 8,500 liters of anthrax and 2,400 liters of aflatoxin. They had also produced quantities of other less well-known but still deadly agents, and had conducted field trials employing anthrax and botulinum toxin together in aerial bombs.[10]

Clearly, Iraq had a well developed, aggressive program, but one which could not be detected or verified through outside means. It took a defector or Iraq's fear of what the defector would reveal for the world to have definitive evidence.

While it appears that the German RAF group never attempted to employ the Clostridium botulinum they had acquired,[11] and the Aum Shinrikyo organization had difficulty with the potency and delivery methods of their biological assets, it was likely a matter only of time before the latter group solved their challenges had they not been stopped in 1995. Aum Shinrikyo was later found to have possessed both anthrax and Clostridium botulinum. More disturbing is Aum's was attempt to operationalize an anthrax capability—a biological agent with a near 100 percent fatality rate.[12] Their 1995 chemical attack on the subways of Tokyo using nerve agent Sarin followed nine separate attempts to employ aerosolized bacteriological agents between 1990 and 1995, including one attack using botulinum toxin against the city of Yokohama and the U.S. Navy's Yokosuka Naval Base. While the biological attacks were unsuccessful, the subway chemical attack killed 12 people and injured over 5,500 others.[13]

Advances in medical technology, which have benefited mankind in many ways, have also complicated the BW environment. The same technologies have made the production of BW agents much simpler. A nation with a "modest pharmaceutical expertise can develop BW for terrorist or military use."[14] The Federation of American Scientists has reported that:

> *"Any country having pharmaceutical, cosmetic, or advanced food storage industries will have stabilization facilities similar to those that could be used for biological weapons. The ability to disseminate the biological agent over a wide area would be limited to those countries having cruise missiles or advanced aircraft. Even the smallest country or a terrorist group, however, has the capability to deliver small quantities of BW agent to a specific target."*[15]

Numerous nations have taken up the mantle. Open-source estimates indicate that between 10 and 20 countries have, want, or are considering a BW capability.[16] Disturbing among these figures is that of seven countries identified by the U.S. Department of State as supporters of terrorism, five

(Iran, Iraq, Libya, North Korea, and Syria) are reported by the U.S. Arms Control and Disarmament Agency to possess biological warfare programs. The remaining two (Sudan and Cuba) are reported by other sources, including British Intelligence, to have biological warfare programs.[17] A U.S. intelligence source indicates the belief that Osama bin Laden funded a research institute for chemical and biological warfare for the Sudanese government. This led to the United States' conventional cruise missile strikes against a pharmaceutical facility in Khartoum, Sudan in August of 1998.[18] The prospect of a non-state actor such as Osama bin Laden acquiring a biological weapon is distinctly unsettling.

Weaponization

The actual weaponization of biological agents is undoubtedly the most challenging phase in the development of a biological weapon. Developing or growing a biological agent is only the first step, and is the relatively easiest part. However, weaponizing it, producing sufficient quantities, achieving the correct "formulation" of the agent, milling it to properly sized spores of agent, and microencapsulizing it in the correct storage or transport medium or mixture is extremely complicated. Although a biological agent is potent once developed or grown, unless it is properly weaponized, it will not be useful as a weapon. Weaponization is necessary if it is to be able to incapacitate or kill on a large scale.

Formulation

Once produced, the biological microorganisms or toxins must be milled to between 1 and 5 microns in size, stabilized and packaged until dispersed. Failure to achieve the correct formulation will cause the agent to lose its toxicity in storage, to clog sprayer nozzles during dispersal, or to fail to be absorbed properly into the human body. Agent spores smaller than 1 micron are too small to lodge in the lungs of the human target and will be exhaled. Conversely, if larger than 5 microns they become too heavy to achieve a good aerosol cloud and tend to fall to the ground before they can be inhaled.[19] If not properly stabilized the microorganisms will deteriorate quickly in the atmosphere. Each microorganism will deteriorate at a different rate, making some more valuable in weapons. Reportedly, Q-fever agent will decay at a rate of 10 percent per minute; yellow fever at approximately 30 percent per minute. Disturbingly, the

decay rate for the plague and tularemia agents is only 2 percent per minute, and anthrax decays at only 0.1 percent per minute.[20] Although obviously highly technical, and requiring special milling equipment and refrigeration systems, the procedures and equipment to perform these tasks are the same that are required for commercial pharmaceutical manufacturing, and are easily within the reach of most states.

Dispersal

Dispersal of biological weapons via aerosolization of the agent using spray devices is the delivery method of choice. While the agent could also be sprayed from a motor vehicle or boat, such sprayers may not achieve the optimal downwind results or cover as wide an area.[21] On the other hand, a crop duster type dispenser on an RPV or cruise missile/UAV carrying BW munitions, gravity bombs or spray attachments might be other methods of dispersal. Delivery using explosives is probably the least efficient of all options, since heat and blast effects may "inactivate the biological agent."[22] Also, delivery via ballistic missile may be ineffective since the speed and heat generated by the reentry vehicle or warhead could render biological weapons harmless. Effective use of ballistic missiles with BW warheads is a technical challenge, difficult to engineer. Interestingly, Iraq reportedly experimented in December 1990 and January 1991 on an unmanned aircraft, which could deliver biological agent via spray nozzles, and with a biological weapons spray tank developed from an aircraft "drop tank." Iraqi officials claimed to United Nations inspectors that the experiment did not work; however, UN inspectors found evidence the Iraqis had subsequently modified and stored three additional drop tanks.[23] Under favorable weather conditions, with a properly sized aerosol dispersal system, an aircraft, cruise missile, or UAV could deliver BW weapons and cause mass casualties in densely populated areas. For example, it has been calculated that 100kg of anthrax sprayed over a 300 square kilometer area, theoretically could cause up to 3 million deaths if the targeted population density is 3,000 to 10,000 per square kilometer.[24] The effects of each biological agent will be different, however, depending upon its resiliency to the environment. An additional consideration in the type of agent employed is persistency. While most biological agents are sensitive to heat, oxidation, and desiccation, once stabilized through the freeze-drying process for effective weaponization,

their persistency is increased dramatically. Notably, live anthrax can be persistent on the ground for up to 40 years.[25] Obviously, weaponization is entirely feasible.

Given that anthrax or a botulinum toxin is openly available, and the physical infrastructure needed to weaponize involves available "dual-use" technology also employed for legitimate pharmaceutical production, it is understandable that the proliferation and weaponization of biological agents is difficult to detect or halt. All that remains is a reliable means of delivery and the will to employ this means of creating mass casualties.

III. Cruise Missiles

Much attention has been given in the international and national press about the scourge of the proliferation of short and intermediate range ballistic missiles (BMs). However, in spite of the apparent capabilities and threat posed by ballistic missile proliferation, the greater threat to the United States, and specifically to USAF assets may be the proliferation of cruise missiles (CMs).

The technological complexity, cost, challenges in development, and complexity of employment of ballistic missiles make them harder to acquire and use. Conversely, the relative ease of acquisition, operation, and employment of simple and even some relatively advanced cruise missiles makes a much more attractive option. Cruise missiles are essentially small, lightweight, unmanned aircraft. They are much less expensive and easier to acquire than ballistic missiles, either by purchase from another country, through independent development, or by acquiring and modifying an existing UAV or RPV.[26] Cruise missiles are much easier to weaponize, test, and employ. The successes and worldwide publicity of U.S. cruise missiles during the Gulf War (admittedly at the "high end" of the cruise missile family) illustrated their capabilities and utility. Future opposing forces could well look to a cruise missile capability as a better way to challenge U.S. interests rather than the more costly, harder-to-produce, more-difficult-to-operate ballistic missiles.

Argument Against Ballistic Missiles

As the proliferation of ballistic missiles continues, several factors make the acquisition of ballistic missiles a significant challenge to developing nations and sub-state actors. Ballistic missiles, while capable, are increasingly difficult to buy outright due to the Missile Technology Control Regime (MTCR) efforts to limit their proliferation. They require an enormous effort to develop autonomously due to controls placed on the transfer of critical technology by the MTCR. Further, BMs require extensive testing to perfect the propulsion and guidance systems and can be difficult to weaponize due to the challenges involved in developing an effective warhead.

MTCR Restrictions

Established in 1987, the MTCR is not a formal treaty, but is a voluntary organization of 29 member states that prohibits the sale and export of certain missiles and missile technologies to other states. While the provisions of the MTCR apply to both ballistic and cruise missiles, the main emphasis of the Regime has been to restrict ballistic missile proliferation. The effect of the MTCR has been the significant reduction in export of ballistic missiles and critical ballistic missile technology. However, proliferation of missile technology continues. Both Russia and China continue to contribute technical assistance to some countries, and the Democratic People's Republic of Korea (North Korea) continues to market its missiles and related technologies.[27] Additionally, Iran (also not a member of the MTCR) is reported to have recently sold or transferred an undetermined number of Scud-B IRBM systems to the Democratic Republic of the Congo.[28]

Table 1. Ballistic Missile Categories

Type Missile	Maximum Range
Short-Range Ballistic Missile (SRBM)	<1,000 km (621 mi)
Medium-Range Ballistic Missile (MRBM)	1,000 – 3,000 km (621 – 1,864 mi)
Intermediate-Range Ballistic Missile (IRBM)	3,000 – 5,500 km (1,864 – 3,418 mi)
Intercontinental Ballistic Missile (ICBM)	>5,500 km (3,418 mi)
Submarine-Launched Ballistic Missile (SLBM)	Any ballistic missile launched from a submarine regardless of maximum range

Source: Federation of American Scientists, "Ballistic and Cruise Missile Threat National Air Intelligence Center NAIC-1031-0985-98," National Air Intelligence Center, 1998, n.p.; on-line, Internet, 5 October 1999, available from http://www.fas.org/irp/threat/missile/nie99msl.htm.

Challenges to Developmental Programs

In spite of challenges involved in purchasing or creating a ballistic missile program, the prestige involved in owning such a "high-tech" weapon system seems to be a continual lure to developing nations. Several are pursuing their own indigenous developmental programs. By

limiting the ability to buy systems outright, the MTCR has forced nations desiring ballistic missiles to create their own developmental programs. These programs have multiple impacts themselves. First, they are expensive and technologically complex. In addition to the costs involved in developing an adequate rocket motor and airframe and guidance system, the ballistic missile is a challenge to weaponize. Developmental programs themselves tend to telegraph a nation's intent to those other nations who may be observing. Static (ground) test firing of a rocket motor to ensure its ability and reliability can be monitored by U.S. national technical intelligence means.[29] Satellites orbiting overhead can, for example, detect and measure the "thermal bloom" or heat signature of the rocket test or of a test flight. Additional technical systems can intercept and monitor telemetry data from the test rocket. The effect of testing is to telegraph a nation's ballistic missile development intentions, giving the international community the warning and time to either persuade the developing country to curtail development or prepare to meet the challenge militarily.

Developing the reentry vehicle and warhead alone has been estimated by some experts as one of the major challenges to emerging ballistic missile programs, particularly when dealing with more exotic weaponization such as chemical or biological warheads. The payload or warhead must be stressed to survive the high "G," or force of gravity loading on launch, as well as survive the extremely high speeds and resultant heat caused by air friction during the warhead's flight. Additionally, the timing of detonation or agent release in order to achieve efficient agent dispersal is critical to a successful program.

Finally, even once a nation develops or otherwise acquires a ballistic missile capability, the system is vulnerable. Requiring fixed launch sites, or large trucks for mobility the ballistic missiles of a nation will be targeted by an opponent's aircraft and special operations forces throughout a period of conflict. The Coalition Forces' "Scud hunt" during the 1990-91 Gulf War is an example of such "seek and destroy" operations which would increase the vulnerability of ballistic missile assets. On launch, a ballistic missile is visible to national technical intelligence, its flight can be predicted and warning can be provided to its intended target area, making it less effective through loss of surprise. Finally, the direction the ballistic missiles will come from is somewhat predictable, and as more effective tactical ballistic missile defensive systems, such as the Patriot

PAC-3, come on line the ballistic missile is increasingly vulnerable to in-flight interception.[30]

The Case for Cruise Missiles

Cruise missiles are defined as "an unmanned self-propelled guided vehicle that sustains flight through aerodynamic lift for most of its flight path and whose primary mission is to place an ordnance or special payload on a target." While most often associated with the jet-powered cruise weapons of Desert Storm fame, this definition also includes unmanned air vehicles (UAVs) and remotely piloted helicopters or aircraft (RPVs).[31]

Cruise missiles are generally categorized into three types: strategic cruise, anti-ship cruise, and tactical land attack missiles based upon range capabilities.

Table 2. Cruise Missiles Categories

Mission	TYPE MISSILE	RANGE
Land Attack	Strategic Cruise	2,000-3,000km
Land Attack	Tactical Land Attack Missile (TLAM)	180-600km
Anti-Ship	Anti-Ship Cruise Missile (ASCM)	50-500km

Source: Tara Kartha, "The Rationale of Cruise Missiles-I," Institute for Defence Studies and Analyses, New Delhi, India, 1998, n.p.; on-line, Internet, 29 September 1999, available from http://www.idsa-india.org/an-aug8-9.html.

The National Air Intelligence Center (NAIC) refers specifically to two "types" of cruise missiles: anti-ship cruise and land attack, using their intended mission instead of their range or capabilities. For the purpose of this paper we will acknowledge the "mission" categorization, with the land attack divided into strategic (range up to 3,000km) and tactical (maximum range of 180-600km). Strategic land attack missiles, in the Tomahawk (U.S.) class, are expensive and complicated for the developing world, employing larger, more complicated engines as well as more complex guidance systems such as the U.S. terrain contour matching or TERCOM system. Anti-ship cruise missiles in general are shorter-range and normally carry a lighter payload than the land attack missiles. There is general agreement that the tactical land attack cruise missiles are the "ones to watch out for" in the area of future proliferation. (Note: A

TLAM could easily be used to strike a strategic target and a strategic land attack could be targeted against a tactical objective, hence the designators are purely reflective of their relative range capabilities.) While the TLAM is the apparent focus of research and development for both producers and aspirants alike, conversion and upgrade of anti-ship cruise missiles or UAV/RPV is entirely feasible.[32] The TLAM, if not purchased from an exporting country, may be an indigenous development item (difficult in the near term – 5 to 10 years), a modified anti-ship missile, or it may be a modified UAV or RPV. The NAIC, in a 1998 assessment reported that:

> *"The majority of new LACMs will be very accurate, conventionally armed, and available for export. The high accuracy of many LACMs will allow them to inflict serious damage on important targets, even when the missiles are armed only with conventional warheads. U.S. defense systems could be severely stressed by low-flying stealthy cruise missiles that can simultaneously attack a target from several directions."*[33]

There are reportedly some 130 cruise missile types in the world, spread among 75 different nations. Of those 75 nations possessing cruise missiles 19 were "producers" and of those 19 only six (India, Japan, Taiwan, South Africa, Iran, and Syria) were non-exporters.[34] Lieutenant General Jay M. Garner, former commander of the U.S. Army Space and Strategic Defense Command, summed up the cruise missile proliferation problem when he stated:

> *"Interestingly enough, cruise missiles are cheaper to buy or produce than ballistic missiles. Improving cruise missiles' accuracy (e.g. by adding precision navigation devices) is not nearly as expensive or technologically challenging as improving ballistic missile accuracy.*
>
> *Visit any international air show to see how a number of nations aggressively market cruise missiles and UAVs. We are convinced that our soldiers will face this very real threat in the near future."*[35]

Purchase

While cruise missiles capable of carrying 500kg payloads to ranges of 300km or more are subject to MTCR restrictions, several nations are producing cruise missiles which fall just below the parameters and others have modified missiles to produce a "less capable" variant of a proscribed missile.[36] In fact, the United States is one of the world's largest proliferators of cruise missiles, having sold the Harpoon ASCM to some 23 nations. The Harpoon has already been reverse-engineered by Taiwan and is reportedly for sale as the Hsiung Feng-2 or HF-2. Significantly, the Harpoon has a land-attack variant known as the SLAM, in service with the U.S. Navy.[37]

In an effort to circumvent MTCR restrictions, presumably to generate hard currency income, Russia, at the 1992 Moscow Air Show, offered a modified, shorter range version of their 3,000km-range AS-15 cruise missile for sale, advertising it as a 410kg payload with just over 500km range. Disturbingly, the missile reportedly was equipped with the Russian equivalent of the terrain contour matching (TERCOM) guidance system supplemented by the Russian Global Navigation Satellite System (GLONASS), an equivalent to the U.S. global positioning system (GPS).[38] While technically meeting the restrictions of the MTCR, the fact is that "upgrading" a proven missile airframe to extend its range and payload is not considered an insurmountable or even major technical challenge. Virtually any country with an active aircraft production or major aircraft maintenance capability could accomplish the modifications.

The French also are marketing a disturbing product in the form of their *Apache* stealth cruise missile.[39] The *Apache* is being developed in several variants, some for export and some for domestic-only use. Displayed at the Paris Air Show in June 1993 and in Singapore in February 1994, the export variant *Apache* is reported to have terrain following millimeter wave radar for guidance, with a GPS option, and capable of a payload of 400-500kg and range of 150km.[40] The prospect of marketing the advanced stealth and guidance technology is of concern due to the high probability of follow-on reverse-engineering and further proliferation.

Figure 1. French *Apache – Storm Shadow variant*

Indigenous Development or Conversion

Alternatively, any nation with at least a fledgling aircraft manufacturing or enhanced maintenance capability can either build from scratch, or modify an existing UAV or RPV. In the past, availability of effective guidance systems and engines has stymied indigenous development of cruise missiles. However, with the current level of development and proliferation of the U.S. GPS and the Russian GLONASS equivalent, the navigation challenge is solvable. A significant impediment was the small, lightweight jet engine requirement, but this can be offset by acquiring the engine through normal aircraft manufacturing channels. Russia, China, France, and the UK all produce and market suitable turbojet engines, and the U.S. has sold turbofan engines to China for use in jet trainer aircraft.[41] Alternatively, an engine could be acquired by stripping it from an anti-ship missile or modifying an anti-ship missile for a land attack mission. Iraq appears, for example, to have used the Italian turbojet-powered *Mirach 600* RPV to develop its 450km-range

Ababil land attack cruise missile, which reportedly possesses a 250kg payload capability.[42] The *Mirach 100*, also turbojet-powered, has been exported to Iraq, Libya, and Argentina, and is capable of transporting 70kg up to 900km. The United States has also contributed to the proliferation challenge, having sold the Teledyne Ryan *Scarab* RPV to Egypt. The *Scarab* boasts a turbojet capability of transporting a 100kg payload over 2500km.[43] Should this system, which includes an inertial navigation system and GPS capability, be further proliferated the potential adverse impact could be tremendous.

Critical capabilities that cruise missiles possess are that they are accurate, survivable, difficult to detect, and relatively inexpensive. The emergence of low-cost GPS systems in the 1980's has greatly improved cruise accuracy. With widely available satellite imagery and computer graphics, terrain mapping, previously reserved for "high end" U.S. and Russian cruise missiles, is now available to the Third World. Cruise missiles can be launched from aircraft, from shipboard or from land with minimal ancillary equipment. Capable of being stored or transported in metal "Sea-Land" type containers to both protect them from the elements and reduce their visibility, cruise missiles are highly mobile and thus very survivable. With their ability to fly a pre-determined circuitous route to target they are less predictable, can attack from any direction (unlike ballistic missiles) and their small size and low radar cross section make them a challenge to air defenses. Finally, their relatively low cost not only makes them affordable to an emerging nation, but for a given amount, that nation may be able to buy many more cruise than ballistic systems. The advantage is that even if detected by an air defense system they may be able to attack in numbers and so saturate defenses that at least some of them get through.[44]

Having reviewed the prolific spread of these weapons and their capabilities, of significant concern, is the final capability that makes them attractive to a rogue state or non-state actor. The inherently stable, aircraft-like performance envelope of the cruise missile, with its relatively low G-loads (force of gravity), and low operating speeds (especially when compared to an SRBM or IRBM warhead) makes it an easier and cheaper delivery system for chemical and biological weapons.[45]

IV. Employment Considerations

Biological weapons and cruise missiles have been around for several years now—why haven't they been employed together yet? What is constraining states that have this dual capability? And how long will these constraints last? How and when might these weapons be employed against U.S. military personnel, the U.S. homeland, and military expeditionary forces?

Constraints

Since Iraq possessed BW during the 1990-91 Gulf War, why did they not employ them? While the Coalition Forces feared and prepared for a chemical or biological attack by Saddam Hussein, none ever materialized. The Aum Shinrikyo cult obviously had no qualms about employing their BW capability—they failed only because of technical shortfalls. Given Iraq's significant stockpiles of BW, such weapons could have had a major impact on the course of the Gulf War, yet they were withheld.

Just prior to the Gulf War, Saddam Hussein received two very similar and very stern warnings about the implications of employing BW should the pending crisis result in armed conflict. Secretary of Defense Dick Cheney, during a 23 December 1990 news conference, cautioned publicly that should Iraq employ weapons of mass destruction the "U.S. response would be absolutely overwhelming and it would be devastating." Not three weeks later, President George Bush reinforced Cheney's statement in a letter to Hussein, warning that the American people would "…demand the strongest possible response" and warning that Iraq would pay a "terrible price" if chemical or biological weapons were employed.[46] Presumably, this implied threat of a nuclear retaliation in exchange for Iraq's use of chemical or biological weapons kept Saddam Hussein from ordering their use.

Jeffrey D. Simon, in a 1989 RAND report on "Terrorists and the Potential Use of Biological Weapons, A Discussion of Possibilities" put forward several plausible reasons which may help explain why neither Saddam Hussein nor any other state actor has employed biological weapons. Mr. Simon submits that terrorists have had several reasons to defer using biological weapons:

- To avoid a backlash or loss of support from their supporters
- To avoid an overwhelming or devastating response from the target of the attack
- To avoid the personal risk inherent in biological weapons
- Due to reluctance to work with "unfamiliar" weapons
- Due to a belief that conventional attacks are meeting their needs.[47]

While each of these is a valid reason, he goes on to state in his paper that these constraints may be weakening as religion-based terrorism grows and as terrorist groups acquire support elements which may be able to justify to themselves the magnitude of the horror of biological warfare. He further warns that once there is a first-use, others will follow (the "copycat" phenomenon).[48] Mr. Simon's report written over 10 years ago in 1989, presents an ominous prediction for the future, having had a terrorist "first-use" in 1995. With the current state of proliferation of biological weapons and the publicity surrounding Aum Shinrikyo's difficulties with their delivery systems, the inhibitions against using biological weapons may indeed be down. There are several scenarios where terrorist groups might use BW weapons. One is if a group felt that conventional attacks were not getting their message across. If they felt their supporters would accept the magnitude of the attack (or decided that the opinion of their supporters didn't matter). Also, they might act if they believed they could safely execute a biological attack and do so anonymously, so as to avoid retaliation. Might a group or state attempt a biological attack? Possibly only two things are deterring governments and non-state actors: the lack of an effective delivery system and plausible deniability.

Effective delivery systems are available now. We have already examined the huge proliferation of cruise missiles and their related UAV and RPV cousins that could be easily modified to deliver BW. Their low signature means that a nation or sub-state actor could be carrying out experimentation and proof of concept testing in some remote region of the world today and we might have no way of knowing, making clandestine attacks possible, coupled with plausible deniability.

Presuming a nation wanted to inflict major damage upon the United States or U.S. forces and escape a retaliatory attack, they would need to find a way to deliver the attack without leaving "proof-positive" evidence of from whence it came. For while the threat has been made and is ever-

present, it is very doubtful the United States could or would execute a retaliatory nuclear strike even when faced with "smoking gun" evidence to present to the rest of the world community. While some type of advanced retaliatory strike would no doubt be called for, the use of a nuclear weapon with its resultant collateral damage to infrastructure and noncombatants, even in response to a biological WMD strike against the United States or U.S. forces would bring a huge outcry of world opinion against the United States. In order to maintain influence in the community of nations, the United States would likely feel inhibited in the use of nuclear weapons, but undoubtedly a hue and cry would come from the American people, demanding justice against so heinous a sneak attack. The full conventional weight of the U.S. Armed Forces would no doubt be brought to bear. So the question is how to use BW weapons without being blamed for it!

Several terrorist groups have the funding, worldwide contacts, and anti-American zealotry to take on the task. The Osama bin Laden organization has a following that appears to support all methods of attacks against the United States. With a history of U.S. cruise missile attacks being used against his organization, the opportunity to reply in kind could seem very attractive.

Possible Employment Scenarios

Two possible employment scenarios present themselves: one against the United States homeland and the other against USAF expeditionary forces. The first objective would be for a hostile nation to locate a trans-national terrorist group, such as Osama bin Laden's organization, willing to carry out the attack. With a state sponsor to provide the delivery system (cruise missile, UAV/RPV), the biological weapon(s), and necessary training, all that would be needed would be the logistics support and training in use of the system.

One employment scenario could be to acquire three to four merchant freighters to transport containerized cruise missiles to waters off the U.S. coastline. Freighters are often hijacked by pirates in the South China Sea and adjacent waters, and not located for months, if then. The ships with their containerized cargo of cruise missiles in the short range category—150 to 300km—could be sailed to within 50km or closer to the U.S. coastline, just off shore from major cities or desired military locations,

such as Norfolk, VA. Released in the early evening and programmed to disperse their cargo while the sea breeze is blowing towards shore and the crowds are still out, with a persistent form of anthrax or other bio-toxin, these missiles could cause a major catastrophe. If flown at low-level to the target areas, and programmed to dispense the agent, then to turn back to sea, the missiles could conceivably disperse their agent without notice and cause a biohazard with no apparent explanation of its origin.

A second scenario would be a similar attack, but against an airfield and surrounding town or city designated to receive a deploying Air Expeditionary Force (AEF) in the event of an increase in regional tensions. Since the USAF AEFs routinely deploy to the same locations in Southwest Asia due to equipment prepositioning and good relations with host nations, anticipating which airfields to attack should not be difficult. By attacking the installation before tensions increase and the USAF AEF responds, the biological weapon would have time to incubate and breakout. While this could trigger supporter backlash because of collateral Islamic civilian casualties, an organization such as bin Laden's might feel the public relations storm worth weathering if the attack sufficiently halted United States deployment or degraded their ability to launch combat aircraft. If executed carefully, as in the continental United States attack scenario, identifying the responsible organization or nation could prove extremely difficult, thus avoiding both public and United States backlash. The idea of deploying troops from the United States into an airfield known to be contaminated with biological weapons could cause the U.S. National Command Authority to reconsider the value of the mission. At the very least, such an attack would massively complicate and slow the U.S. response.

The worrisome aspect of these scenarios is that biological agents and weapons are available now. The cruise missile/UAV/RPV technologies are available now. The hostile feelings and intent towards the United States and U.S. forces are there now. The only missing element is an organization or state willing to fuse and employ them.

V. Conclusions

> *It is a doctrine of war not to assume the enemy will not come, but rather to rely on one's readiness to meet him; not to presume that he will not attack, but rather to make one's self invincible.*
>
> --Sun Tzu

The information on cruise missile proliferation and capabilities is overwhelming. The Internet itself is almost a cookbook on what kind of missile to go shopping for, and what or whom one would need in their program to ensure it works. Likewise, the Internet is replete with information on the proliferation of biological weapons, their ease of manufacture and weaponization, and their enormous ability to take lives if surprise can be achieved.

Given that some terrorists will seek a "bigger bang" than the last event perpetrated, in order to maintain shock effect and adequate publicity, a cruise/biological attack may well be the next step up the ladder of escalation.

In light of all this however, several key people or agencies continue to acknowledge the threat is out there, but they "feel" it is not "probable." What is certain is that:

- Acquisition of cruise missiles is spreading, making standoff CM attack feasible for more nations and substate actors
- Biological weapons are relatively inexpensive WMD and are within the technical capability of Third World States and possibly by sophisticated and well-funded sub-state groups.
- The potential for an attack employing a land attack cruise missile armed with biological weapons increases each year.

What has not been examined and discussed in this paper, i.e., the next logical step, is to review current and planned capabilities to stop an inbound cruise missile at a safe distance. And failing that, it will be imperative to review preparedness to survive an attack on the air base—or the nation—by biological weapons.

If the USAF is to continue to project power forward it will need safe and secure operating locations, both abroad and in CONUS. The threats

posed by cruise missiles armed with biological weapons must first be acknowledged as a present day threat. They are not a "sometime in the future" threat but are a current "clear and present danger." The threat posed by CMs carrying biological weapons needs to be dissected and analyzed country by country and group by group. Adequate defenses and/or recovery methods must be developed and promulgated. To do otherwise exposes the United States, its forces, and its allies to a terrible new threat without an adequate response.

Appendix A:

Past and Present Biological Weapons Programs

The table below describes the various past and present biological weapon programs, as well as the countries' status as a supporter or sponsor of terrorism, according to the Monterey Institute of International Studies, Center for Nonproliferation Studies and the U.S. Department of State "Patterns of Global Terrorism: 1998." While by no means all-inclusive, the table serves to illustrate the wide proliferation of past and current biological programs and correlates the states currently labeled by the Department of State as sponsors of terrorism.

COUNTRY	PROGRAM STATUS	POSSIBLE AGENTS	SPONSOR OF TERRORISM
Algeria	Research effort, but no evidence of production	Unknown	No
Canada	Former program	-anthrax -rinderpest virus -botulinum toxin -Rocky Mountain spotted fever -plague -tularemia -ricin	No
China	Likely maintains an offensive program	Unknown	No
Cuba	None/Unknown	None/Unknown	**YES**
Egypt	Research program	-anthrax -botulinum toxin -plague -cholera -tularemia -glanders -brucellosis -melioidosis -psittacosis	No

		-Q-fever -Japanese B encephalitis -Eastern equine encephalitis -influenza -smallpox -mycotixins	
France	Former program	Unknown	No
Germany	Former program	-plague -cholera -yellow fever -typhus	No
India	Defensive research program	Unknown	No
Iran	Research with possible production of agents	Unknown	**YES**
Iraq	Previously active research and production program; under UN inspection; retains elements of its program	-anthrax -botulinum toxin -gas gangrene -aflatoxin -trichothecene mycotoxins -wheat cover smut -ricin -hemorrhagic conjuctivitis virus -rotavirus -camel pox	**YES**
Israel	Research program, but no evidence of a production effort	Unknown	No
Japan	Former program	-anthrax -tularemia -plague -botulinum toxin -small pox -glanders	No

		-typhoid -typhus	
Libya	Research program	Unknown	**YES**
North Korea	Research program	-anthrax -cholera -plague -small pox -botulinum toxin -hemorrhagic fever -typhoid -yellow fever	**YES**
Russia	Defensive research program; some work beyond legitimate defense activities may continue	-anthrax -tularemia -brucellosis -plague -Venezuelan equine encephalitis -typhus -Q-fever -botulinum toxin -small pox -glanders -Marburg infection -Ebola -Machupo virus -Argentinian hemorrhagic fever -yellow fever -Lassa fever -Venezuelan equine encephalomyelitis -Japanese encephalitis -Russian spring-summer encephalitis -psittacosis	No

		-ornithosis -rinderpest virus -African swine fever virus -wheat stem rust -rice blast	
South Africa	Former program	-anthrax -cholera -botulinum toxin -salmonella	No
Sudan	None/Unknown	None/Unknown	**YES**
Syria	Research program	-anthrax -botulinum toxin	**YES**
Taiwan	Possible research program	Unknown	No
United Kingdom	Former program	-anthrax	No
United States	Defensive research program	-anthrax -brucellosis -botulinum toxin -Eastern and Western equine encephalitis -Venezuelan equine encephalomyelitis -Argentinian hemorrhagic fever -Korean hemorrhagic fever -tularemia -Q-fever -Lassa fever	No

		-glanders -melioidosis -plague -yellow fever -psittacosis -typhus -dengue fever -Rift Valley fever -Chikungunya disease virus -ricin -rice blast -rice brown spot disease -late blight of potato -stem rust of cereal -rinderpest virus -Newcastle disease virus -fowl plague virus	

Sources: Center for Nonproliferation Studies, "Chemical and Biological Weapons: Possession and Programs Past and Present," Monterey Institute of International Studies, n.p., on-line, Internet, 1 January 2000, available at: http://www.cns.miis.edu/research/cbw/possess.htm; and U.S. Department of State, "Patterns of Global Terrorism: 1998," n.p., on-line, Internet, 3 February 2000, available at http://www.usis.usemb.se/terror/rpt1998/sponsor.html.

Appendix B:

Cruise Missile Proliferation/Possession

The table below depicts the wide possession of cruise missiles among selected nations. It is not intended to be an all-inclusive list, but illustrates the wide variety of cruise missiles available from various nations, as well as domestic development programs.

Country/ System	Origin country	Type system	Launch method	Max range (km)	Payload (kg)	Status
ARGENTINA						
Exocet MM-38	France	AS	Gnd/ship	42	165	In service
Exocet AM-39	France	AS	Air	50	165	In service
Exocet SM-39	France	AS	Submarine	50	165	In service
Exocet MM-40	France	AS	Gnd/ship	70	165	In service
MQ-2 Figua	Domestic	Lnd Atk	Air/gnd	900	70	Development
CHINA						
SY-1/HY-1	Domestic	AS	Gnd/ship	50	513	In service
HY-2 Silkworm	Domestic	AS	Gnd/Ship	95	513	In service
HY-3/C-301	Domestic	AS	Gnd/Ship	100	500	Development
HY-4/C-201	Domestic	AS	A/G/S	150	500	In service
FL-1	Domestic	AS	Gnd/ship	40	513	In service
FL-2/SY-2	Domestic	AS	A/G/S	50	365	In service
C-101	Domestic	AS	A/G/S	50	400	In service
C-601	Domestic	AS	Air	95	500	In service
YJ-1/C-801	Domestic	AS	A/G/S	40	165	In service
YJ-2/C-802	Domestic	AS	A/G/S	95	165	In service
C-802 (modified)	Domestic	AS/Lnd Atk	A/G/S	180	Unknown	Development
INDIA						
Exocet AM-	France	AS	Air	50	165	In service

39						
SS-N-2c Styx	Russia	AS	Air	85	513	In service
SS-N-2d Styx	Russia	AS	Air	100	513	In service
SS-N-7 Starbright	Russia	AS	Submarine	65	500	In service
SS-N-22 KORAL	Domestic /Russia	AS	Ship/ Submarine	110	500	Development
SEA EAGLE	United Kingdom	AS	Air/Ship	110	230	In service
LAKSHYA	Dom	Lnd Atk	Ground	500	200	In service
IRAN						
AS-11 KILTER	Russia	AS/Lnd Atk	Air	50	130	In service
AS-9 KYLE	Russia	AS/Lnd Atk	Air	90	200	In service
YJ-2/C-802	China	AS	A/G/S	95	165	In service
HY-2 SILKWORM	China	AS	Gnd/ship	95	513	In service
SS-N-22 SUNBURN	Ukraine	AS	Gnd/ship	110	500	In service
RGM-84A HARPOON	USA	AS	Ship	120	220	In service
HY-4/C201	China	AS	A/G/S	150	500	In service
SILKWORM (modified)	Domestic /North Korea	AS	Gnd/Ship	450	500	Development
IRAQ						
YJ-1/C-801	China	AS	A/G/S	40	165	In service
AS-11 KILTER	Russia	Lnd Atk/AS	Air	50	130	In service
EXOCET AM-39	France	AS	Air	50	165	In service
FAW 70	Domestic	AS	Gnd/Ship	70	500	In service
ARMAT	France	AS	Air	90	160	In service
HY-2 SILKWORM	China	AS	Gnd/Ship	95	513	In service
C-601 (Nisan 28)	China	AS	Air	95	500	In service
FAW 150	Domestic	AS	Gnd/Ship	150	500	In service
AS-6 KINGFISH	Russia	Lnd Atk/ AS	Air	180	1,000	In service
FAW 200	Domestic	AS	Gnd/Ship	200	500	In service

AS-4 KITCHEN	Russia	Lnd Atk/ AS	Air	400	1,000	In service
AS-5 KELT	Russia	Lnd Atk/ AS	Air	400	1,000	In service
ABABIL	Domestic	Lnd Atk	Air	500	250	Development
ISRAEL						
GABRIEL II	Domestic	AS	Ship	36	100	In service
GABRIEL III	Domestic	AS	Air/Ship	36	150	In service
POPEYE	Domestic	Lnd Atk	Air	100	395	In service
AGM-84A HARPOON	USA	AS	Air	120	220	In service
RGM-84A HARPOON	USA	AS	Ship	120	220	In service
UGM-84A HARPOON	USA	AS	Submarine	120	220	In service
GABRIEL IV	Domestic	AS	Air/Ship	200	240	In service
DELILAH	Domestic	Drone	Air/ Ground	400	54	In service
DELILAH (modified)	Domestic	Lnd Atk	Air/ Ground	400	450	Development
JAPAN						
ASM-1	Domestic	AS	Air	50	150	In service
ASM-2	Domestic	AS	Air	150	150	Development
AGM-84A HARPOON	USA	AS	Air	120	220	In service
RGM-84A HARPOON	USA	AS	Ship	120	220	In service
UGM-84A HARPOON	USA	AS	Submarine	120	220	In service
SSM-1	Domestic	AS	Gnd/Ship/ Submarine	150	250	In service
NORTH KOREA						
S-N-2a STYX	Domestic	AS	Ship	43	513	In service
HY-1/SY-2 SILKWORM	Domestic	AS	Gnd/Ship	95	513	In service
SILKWORM (modified	Domestic	AS	Gnd/Ship	160+	Unknown	Development

SOUTH AFRICA						
SKORPIOEN	Domestic	AS	Ship	36	100	In service
EXOCET AM-39	France	AS	Air	50	165	In service
SKORPIOEN II	Domestic	AS	Ship	Unknown	Unknown	Development
SKUA	Domestic	Lnd Atk	Gnd/Ship	800	100	Development
TAIWAN						
HSUING-FENG1	Domestic	AS	Air	36	100	In service
HSUING-FENG 2	Domestic	Lnd Atk/AS	Air	170	75	In service
HSUING-FENG 3	Domestic	Lnd Atk/AS	Air/Ship	300	Unknown	Development

Source: Centre for Defense and International Security Studies (CDISS), "Capabilities & Suppliers," January 2000, n.p.; on-line, Internet, 2 January 2000, available from http://www.cdiss.org/tabanaly.htm

Notes

1. Regis, *The Biology of Doom; The History of America's Secret Germ Warfare Project,* (New York, NY; Henry Holt and Company, 1999), 143, 144, 228.

2. Terry N. Meyer, Lt Col, "The Biological Weapon: A Poor Nations Weapon of Mass Destruction," *Battlefield of the Future, 21st Century Warfare Issues*, edited by Barry R. Schneider and Lawrence E. Grinter, (Maxwell AFB, AL: Air University Press, Revised Edition No. 3, September 1998), 207.

3. Robert P. Kadlec, Lt Col, "Biological Weapons for Waging Economic Warfare," *Battlefield of the Future, 21st Century Warfare Issues*, edited by Barry R. Schneider and Lawrence E. Grinter, (Maxwell AFB, AL: Air University Press, Revised Edition No. 3, September 1998), 255.

4. Terry N. Meyer, Lt Col, Op. Cit., 208.

5. Ibid., 215.

6. U.S. Congress, Office of Technology Assessment (OTA), *Proliferation of Weapons of Mass Destruction: Assessing the Risks* (Washington, D.C.: GPO, 1993), 38.

7. W. Seth Carus. *Bioterrorism and Biocrimes, The Illicit Use of Biological Agents in the 20th Century*, (Washington, D.C.: Center for Counterproliferation Research, National Defense University, August 1998 [March 1999 Revision]), 30.

8. Ibid, 157, 161-168.

9. Schneider, Barry R., *Future War and Counterproliferation, U.S. Military Responses to NBC Proliferation Threats,* (Westport, Connecticut: Praeger Publishers, 1999), 14-15.

10. Ibid.

11. W. Seth Carus, *Bioterrorism and Biocrimes, The Illicit Use of Biological Agents in the 20th Century,* Op. Cit., 157.

12. U.S. Army Medical Research Institute of Infectious Diseases, *Medical Management of Biological Casualties Handbook, Third Edition,* (Fort Detrick, Frederick, Maryland, July 1998), 17.

13. W. Seth Carus, *Bioterrorism and Biocrimes, The Illicit Use of Biological Agents in the 20th Century,* Op. Cit., 56.

14. Robert P. Kadlec, Lt Col., Op. Cit., 227.

15. Federation of American Scientists (FAS), "Biological Weapons Delivery," September 1999, n.p.; on-line, Internet, 29 September 1999, available from http://www.fas.org/ nuke/intro/cm/index.html.

16. Terry N. Meyer, Lt Col, Op. Cit., 215.

17. W. Seth Carus, *Bioterrorism and Biocrimes, The Illicit Use of Biological Agents in the 20th Century* Op. Cit., 31-33.

18. Ibid, 163-164.

19. Raymond Zilinskas, "Assessing the Threat of Bioterrorism: Congressional Testimony by Raymond Zilinskas," Monterey Institute of International Studies, October 1999.

20. W. Seth Carus, "Biological Weapons: The Threat Posed by Terrorists," testimony at the Joint Hearing Before the Senate Select Committee on Intelligence and the Senate Judiciary Subcommittee on Technology, Terrorism and Government Information, 4 March 1998, n.p., on-line, Internet, 3 February 2000, available from http://www.senate.gov/~judiciary/wlterm4.htm.

21. OTA, *Proliferation of Weapons of Mas Destruction: Assessing the Risks,* Op. Cit., 40.

22. FAS, "Biological Weapons Delivery," Op. Cit.

23. Kalpana Chittaranjan, "Iraq's BW Programme: UNSCOM Stays On," Institute for Defence Studies and Analyses, New Delhi, India, 1998, n.p.; on-line, Internet, 6 February 2000, available from http://www.idsa-india.org/an-jul8-9.html.

24. Congress, Office of Technology Assessment, *Proliferation of Weapons of Mass Destruction: Assessing the Risks,* 54.

25. U.S. Army Medical Research Institute of Infectious Diseases, *Medical Management of Biological Casualties Handbook, Third Edition,* (Fort Detrick, Frederick, Maryland, July 1998), Appendix H.

26. Tara Kartha, "The Rationale of Cruise Missiles-I," Institute for Defence Studies and Analyses, New Delhi, India, 1998, n.p.; on-line, Internet, 29 September 1999, available from http://www.idsa-india.org/an-aug8-9.html.

27. Bob Walpole, "Foreign Missile Developments and the Ballistic Missile Threat to the United States through 2015," *National Intelligence Council Paper,* September 1999, n.p.; on-line, Internet, 1 December 1999, available from http://www.fas.org/irp/threat/missile/nie99msl.htm.

28. Bill Gertz, "Iran Sold Scud Missiles to Congolese," *The Washington Times,* November 1999.

29. K. Scott McMahon and Dennis M. Gormley, *Controlling the Spread of Land-Attack Cruise Missiles,* The AISC Papers, No. 7, (Marina del Rey, California: American Institute for Strategic Studies, January 1995), 59.

30. Ibid, 17.

31. Federation of American Scientists, "Cruise Missiles," September 1999, n.p.; on-line, Internet, 29 September 1999, available from http: //www. fas.org/ nuke/ intro/ cm/ index.html.

32. Tara Kartha, Op. Cit.

33. Federation of American Scientists, "Ballistic and Cruise Missile Threat National Air Intelligence Center NAIC-1031-0985-98," National Air Intelligence Center, 1998, n.p.; on-line, Internet, 5 October 1999. available from http://www.fas.org/irp/threat/missile/nie99msl.htm.

34. Tara Kartha, Op. Cit.

35. Robin Ranger, et al. "Cruise Missiles: New Threats, New Thinking," *Comparative Strategy*, Vol 14, pp 255-275, 1995, 256.

36. Dennis M. Gormley, "Hedging Against the Cruise-Missile Threat," Carnegie Endowment for International Peace, Non-Proliferation, n.p. On-line Internet, 5 October 1999. Available from http://www.ceip.org/programs/npp/gormley%20survival.htm.

37. K. Scott McMahon and Dennis M. Gormley, Op.Cit., 12-13.

38. Dennis M. Gormley, Op. Cit.

39. K. Scott McMahon and Dennis M. Gormley, Op. Cit., 14.

40. K. Scott McMahon and Dennis M. Gormley, Op. Cit., 51.

41. Ibid, 18, 25.

42. Dennis M. Gormley, Op. Cit.

43. K. Scott McMahon and Dennis M. Gormley, Op. Cit., 48.

44. Ibid, 15-17.

45. Congress, Office of Technology Assessment (OTA), *Technologies Underlying Weapons of Mass Destruction*, (Washington, D.C.: GPO, 1993), 244.

46. Terry N. Meyer, Lt Col, Op. Cit., 214.

47. Jeffery D. Simon, *Terrorists and the Potential Use of Biological Weapons*, A RAND Report (Santa Monica, CA:The RAND Corporation, December 1989), 11.

48. Ibid, 20.

USAF Counterproliferation Center

The USAF Counterproliferation Center was established in 1999 to provide education and research to the present and future leaders of the USAF, to assist them in their activities to counter the threats posed by adversaries equipped with weapons of mass destruction.

Barry R. Schneider, Director
USAF Counterprofliferation Center
325 Chennault Circle
Maxwell AFB AL 36112-6427

Email: Barry.Schneider@maxwell.af.mil

Jo Ann Eddy, Associate Editor
The Counterproliferation Papers

Email: JoAnn.Eddy@maxwell.af.mil

(334) 953-7538 (DSN 493-7538)