March 11, 1988

MORE TASKS FOR U.S. CRUISE MISSILES

INTRODUCTION

Cruise missiles are becoming the utility fielder of the United States arsenal, capable of performing a wide variety of tasks. These relatively low cost and highly accurate weapons, fired from ships or aircraft, were first developed in the mid-1970s. It is their ability to maneuver and to fly at low altitudes and subsonic speeds that earned them the name "cruise."

Recent technological advances could enable cruise missiles to carry non-nuclear warheads great distances to destroy such classes of targets as bridges and industrial plants that previously could be knocked out only with nuclear weapons. The pending U.S.-Soviet Intermediate-range Nuclear Force (INF) Treaty, moreover, may make it necessary for the U.S. to deploy more accurate and longer range conventional cruise missiles to strengthen NATO's conventional forces. And the precarious status of U.S. military bases overseas, typified by the scheduled expulsion of 72 U.S. F-16 fighters from Spain, suggests that the U.S. must rely more on long-range conventional cruise missiles placed on strategic bombers stationed in the U.S.

Increased Potency. Their near pinpoint accuracy, enormous range, and ability to evade enemy air defenses by flying close to the ground make cruise missiles formidable weapons. If deployed more cheaply in larger numbers and given better accuracy, greater range, and mission planning support, cruise missile potency could be increased enormously. They could be armed with conventional warheads to slow down the Soviet reinforcement of troops in Europe in wartime, to allow U.S. Navy carrier battle groups to defend themselves better against enemy ships, to bombard coastal targets at longer range and with greater accuracy in a major conventional conflict with the Soviet Union, and to knock out more effectively than bombers can terrorist hide-outs and command posts in limited conflicts in the Third World.

So far, the military potential of cruise missiles has been exploited only partially. To take advantage of these weapons, the U.S. should:

♦ ♦ **Draw up a formal military requirement** for a long-range air-launched cruise missile armed with conventionally armed warheads to be carried by B-52 and other bombers. If the Joint Chiefs of Staff were to prepare such a requirement, it would push the development of long-range conventional cruise missiles through the Pentagon's bureaucracy and slow down the rush to bargain them away for nuclear arms control. NATO and the U.S. Air Force already plan to develop an air-launched cruise missile with a range of 60-130 miles for conventional warfare missions. A conventional cruise missile capable of hitting targets at least 1,000 miles away would enable NATO forces to strike at Soviet forces deep in East European territory without NATO planes becoming overly vulnerable to Soviet defenses.

♦ ♦ **Improve the performance** of long-range cruise missiles. This entails improving accuracy, extending range and enhancing their capability to evade Warsaw Pact radar by using "stealth" technologies and techniques.

♦ ♦ **Improve the mission planning process** for using conventional cruise missiles in combat. This will require much more detailed knowledge of the location and characteristics of such potential targets as bridges, command and control posts, troop mobilization centers, and industrial plants.[1]

♦ ♦ **Set up a cruise missile office** in the Pentagon to coordinate and oversee all the cruise missile related programs. This will spur development of new conventional cruise missiles that are cheaper, more accurate, and have longer range than current missiles.

♦ ♦ **Study new ways to employ cruise missiles** on ships and planes, with different types of munitions and in combination with such other types of weapons as fighter aircraft and artillery. Example: Longer-range conventional air-launched cruise missiles — known as ALCMs (pronounced *al-comes*) — with great accuracy and thorough mission planning could be used in a first wave air attack on Soviet coastal air defenses, opening up the way for safer and more effective strikes by piloted U.S. fighter bombers.

♦ ♦ **Avoid compromising conventional cruise missiles** in an arms control treaty. Conventional sea-launched cruise missiles, for example, should not be banned or their total numbers limited by a U.S.-Soviet Strategic Arms Reduction Talks (START) agreement; the U.S. Navy needs these weapons for defense against Soviet and other surface ships. Moreover, ground-launched strategic conventional cruise missiles with a range greater than 3,437 miles (5,500 kilometers), the upper range limit of ground-launched cruise missiles banned by the U.S.-Soviet INF Treaty, should not be banned or their total numbers limited by the START agreement. Nor should the U.S. conclude an arms control agreement which prevents the full exploitation of cruise missile technology for long-range conventional

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1 Industrial plants cannot now be shut down by a single long-range conventional cruise missile because they are too large and complex to be incapacitated with the single shot of a relatively small, non-nuclear warhead. Hence the need for a very destructive nuclear armed cruise missile. But if a conventional cruise missile were accurate enough, it could be targeted, for example, on an industrial plant's generator, effectively shutting down operations, at least temporarily, without the use of nuclear weapons.

ALCMs. Finally, the number of strategic bombers should not be reduced to low levels; they will be needed to carry long-range conventional ALCMs.

♦♦ **Develop new types** of warheads and munitions for conventional cruise missiles that will improve their capability to destroy airfields, bridges, command and control posts, railroad depots, and other critical military targets behind enemy lines.

THE ROLE OF CRUISE MISSILES IN U.S. STRATEGY

The long-range cruise missile is a small, unmanned projectile propelled by an air-breathing engine and capable of sustained flight very close to the ground. It can fly over relatively short distances, making it useful as a tactical arm on the battlefield or at sea. When armed with a nuclear warhead and flown over very long distances, it is used as a strategic weapon.

Cruise missiles can be launched from aircraft, ships, submarines, or ground launchers and can be armed with either nuclear or conventional warheads. Because they fly only at subsonic speeds, U.S. cruise missiles are not considered to be "first strike" weapons; they cannot surprise an enemy with quick, massive nuclear strikes as ballistic missiles can. The nuclear versions of the cruise missile can be either a "strategic" weapon launched from an aircraft or a naval vessel for long-range attacks on the Soviet homeland or, as in the case of the ground-launched cruise missile (GLCM — pronounced *glick-um*) covered by the INF Treaty with the Soviet Union, a "theater" nuclear weapon intended for launching retaliatory nuclear strikes against the Soviet Union from European territory.

Targetting Bridges and Depots. The long-range ALCMs are deployed on B-52 bombers as a strategic weapon. They would be used in time of war as an airborne force for launching retaliatory attacks on the Soviet Union. Cruise missiles placed on ships and submarines are intended for use against enemy ships or military facilities and forces on land. These sea-launched cruise missiles — known as SLCMs (pronounced *slick-ums*) essentially serve the same military purposes as any naval anti-ship or land attack sea-based weapon; they attack an opponent at sea and project naval power against enemy forces on land. They have, however, greater range and accuracy than any other non-ballistic missile in the Navy's inventory.

Cruise missiles can be deployed on land. The missile banned by the INF Treaty is an intermediate-range version of the GLCM. Shorter-range, ground-launched cruise missiles armed with conventional warheads, sometimes called tactical cruise missiles, could be used by ground forces for attacks on enemy forces 60 to 130 miles away. Very long range conventional GLCMs, with ranges exceeding 3,500 miles, could be used to destroy air defense missile sites, bridges, railroad stations, arms depots, and command, control and communication sites deep in the rear of enemy land forces.[2] The U.S. arsenal contains neither short-range nor very long range strategic GLCMs.

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2 GLCMs with a range in excess of 3,440 miles and less than 312 miles are not banned by the INF Treaty.

THE AIR-LAUNCHED CRUISE MISSILE

The ALCM-B (designated AGM-86B by the Air Force) is a subsonic, low-flying missile capable of landing within 100 feet of a target at a maximum range of 1,550 miles from the point of launch.[3] This ALCM is carried by a strategic bomber and, once fired, travels at a speed of 500 miles per hour and carries a W-80 nuclear warhead that packs 200 kilotons of explosive power, or the equivalent to 200,000 tons of TNT. Its high degree of accuracy is a result of a "tercom" (for "terrain contour matching") radar guidance system that steers the missile by comparing periodic readings of altitude measurements with a digitalized map of the terrain stored in a computer on board the missile. Thus far around 1,600 of the planned 1,700 ALCM-Bs are now operational. The total program cost will be $4.7 billion.[4]

ALCMS are deployed on the aging B-52 strategic bombers. A B-52G bomber can carry up to twelve ALCMs under its wings; the B-52H bomber, an upgraded model, can carry twelve under its wings and another eight on an internal rotary launcher. The B-1B bomber may carry up to 20 air-launched cruise missiles per plane. ALCMs will be placed on B-1B bombers in about a decade as the mission of dropping gravity bombs on the Soviet Union is taken over by the Advanced Technology "Stealth" Bomber, designated the B-2. The U.S. Strategic Air Command has based ALCM-armed bombers in Texas, New York, Washington state, Michigan, Arkansas, and Louisiana.

Roles and Missions of the Air-Launched Cruise Missile

The nuclear armed ALCMs are intended to deter or retaliate against a Soviet attack on NATO. Strategic bombers responding to a Soviet nuclear attack first would fire their ALCMs at air defense sites as they approached Soviet coastal regions. Then the bombers would attempt to fly over Soviet territory to drop gravity bombs on such "strategically re-locatable targets" as SS-25 mobile missiles, command centers, and air defense batteries whose exact location cannot be determined with confidence prior to hostilities. ALCMs also could be used against Soviet airfields, railroad stations, and some strategic command and control bunkers.

The Advanced Cruise Missile

The Pentagon is developing a new air-launched cruise missile to replace the ALCM-B. The Advanced Cruise Missile, or ACM (designated AGM-129 by the Air Force), is the next generation of nuclear armed, long-range air-launched cruise missiles. The Air Force plans to deploy 1,500 ACMs, which will comprise about half of the total air-launched cruise

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3 Charles A. Sorrels, *U.S. Cruise Missile Programs: Development, Deployment and Implications for Arms Control* (New York: McGraw Hill, 1983).

4 Information provided by the U.S. Air Force.

missile force of 3,200 missiles by the early 1990s.[5] ACMs will be carried first by B-52 bombers. As B-52s are retired and replaced by B-1B bombers in the 1990s, ACMs will be deployed on B-1Bs.[6]

The ACM will have a range of about 2,300 miles and will be larger than the ALCM-B. It will employ very advanced "stealth" techniques, such as radar absorbing materials, a streamline design, and a propulsion system that cuts down on the emission of heat to avoid detection by enemy radars and heat-seeking missiles. It will not have pop-out wings, as the ALCM-B does, but will have an aerodynamically shaped body. As a highly secret or "black" program, the ACM's cost and delivery schedule have not been provided to Congress by the Pentagon.[7]

The ACMs' mission would be no different than that of the ALCM-Bs: As a long-range strategic weapon placed on strategic bombers for use in retaliatory attacks against the Soviet Union. Yet, because of its longer range and capability to foil enemy air defense systems, the ACM could be fired at greater distances from the intended target than can the ALCM-B. Thus the pilot of the bomber carrying the ACMs need not expose himself to the dangers of flying close to Soviet targets heavily defended by fighter aircraft or air defense missiles. He can launch the ACM far outside the perimeter of air defenses and then proceed to drop gravity bombs against enemy targets less heavily defended by anti-aircraft missiles.

Short-Range Tactical Air-Launched Cruise Missiles

The Pentagon is developing shorter-range, air-launched cruise missiles for conventional air strikes behind enemy lines. These "tactical" cruise missiles will have a range of only between 60 and 100 miles. Two such missiles are the Israeli *Popeye* air-launched cruise missile, which the U.S. Air Force may deploy on B-52 bombers, and a modified version of the Navy's *Harpoon* missile, which the Air Force may put on strategic bombers and tactical aircraft. Another is the Navy/Air Force *Tacit Rainbow,* a longer-range cruise missile that can seek out and destroy enemy air defense radars. *Tacit Rainbow* will carry a non-nuclear warhead, and can be fired from a B-52 bomber or a U.S. Navy A-6E carrier-based attack bomber.[8] It can hover around over enemy air defense installations for as long as 30 minutes, find the radar emitters when they are turned on, and then destroy them.

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5 Congressional Budget Office, *Modernizing U.S. Strategic Offensive Forces: Costs, Effects, and Alternatives*, 1987, p. x.

6 Howard Silber, "SAC Preparing for Advanced Cruise Missile," *Omaha World Herald*, 13 September 1987, p. 9-B.

7 "What's Ahead in Aerospace," *Aerospace Daily*, September 18, 1987.

8 "Navy, AF Said to be Planning RFP for Tacit Rainbow Vehicles," *Aerospace Daily*, August 26, 1987, p. 314.

THE SEA-LAUNCHED CRUISE MISSILE

The Navy deploys three types of long-range SLCM for nuclear and conventional missions. The first is a land-attack, nuclear-armed cruise missile (designated BGM-109A) with a 200 to 250 kiloton nuclear warhead (W-80) and a range of 1,550 miles.[9] This can be used to attack sea ports and other coastal targets. The second SLCM is a land-attack, conventionally armed missile (BGM-109C) with a 1,000 pound warhead and a range of 800 miles. This also is used to attack coastal targets. The third is an anti-ship missile (BGM-109B) with a 1000 pound conventional warhead and a range of 290 miles.

As with the ALCM, these missiles use the "tercom" guidance system. They also employ a radar seeker system to identify ships after they have flown to the target area on inertial guidance.[10] These guidance systems enable the SLCM to strike within 25 or 30 feet of an intended target.[11] About 1,000 SLCMs are now operational. The Navy plans to buy 3,994 SLCMs for a total program cost of $12 billion. Of these, 758 will be deployed with nuclear warheads.[12]

Putting Sea-Launched Cruise Missiles on Ships and Submarines

The Navy is putting SLCMs on *Los Angeles* class submarines, *Sturgeon* class attack submarines, *Spruance* class destroyers, *Virginia* class cruisers, *Long Beach* class cruisers, *Ticonderoga* class cruisers and *Iowa* class battleships. In submarines, the SLCMs are placed either in torpedo tubes or in vertical launch tubes. In the new *Seawolf* class sub currently under development, all SLCMs will be carried in the torpedo room, which has twice the capacity as the now operating *Los Angeles* attack submarine. The *Ohio* class ballistic missile submarine may be outfitted with a half-dozen SLCMs in its 24 ballistic missile tubes.[13]

The Roles and Missions of the Sea-Launched Cruise Missile

Because of their potential high degree of accuracy, long range, and ability to deliver different munitions, SLCMs could be used for a variety of tasks: alone or with fighter bombers to attack air defense radar installations and surface-to-air missile sites, airfields, naval port facilities, bridges, weapons depots, command and control centers, and terrorist hideouts.

Land-attack conventional SLCMs provide a naval commander with many options. Example: SLCMs could soften up coastal air defenses for follow-on carrier aircraft attacks or, used in conjunction with naval artillery bombardments, to knock out command and control posts which battleship guns are not accurate enough to hit. Land-attack SLCMs can

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9 Sorrels, *op.cit.*

10 Rose E. Gottemoeller, *Land-Attack Cruise Missiles*, Adelphi Paper No. 226 (London: IISS, 1987/8), p. 8.

11 Richard Halloran, "Navy giving Submarines a New Missile Role," *The New York Times,* October 25, 1987, p. 9.

12 "Soviet Said to Harden Stance on Missiles," *The New York Times*, February 14, 1988.

13 Halloran, *op. cit.*

now strike at greater distances than carrier-borne attack bombers. The U.S. Navy's F/A-18 attack aircraft, for example, can destroy coastal targets at a range of only 660 miles, while the land-attack SLCM can do so at a range of 800 miles.

Nuclear versions of the SLCM could retaliate after a Soviet attack. They could be used against some ballistic missile sites and launch control complexes in Soviet coastal regions, or against Soviet ballistic missile submarines bases.

The anti-ship SLCM can protect U.S. aircraft carriers from enemy naval vessels. For example, the U.S. Navy's *Harpoon* anti-ship missile has a range of only 56 miles; the long-range anti-ship SLCM *Tomahawk* can destroy ships at a range of 290 miles. As the range of Soviet anti-ship cruise missiles increases, however, the range of the currently deployed class of U.S. anti-ship SLCMs may not be long enough to handle threats in the near future.

GROUND-LAUNCHED CRUISE MISSILES

A GLCM, officially designated as BGM-109G, is currently deployed in Western Europe as part of NATO's intermediate-range nuclear force. The GLCM is a nuclear armed (with warhead W-84) cruise missile with a range of 1,350 miles and capable of landing within 500 feet of an intended target. There are currently 309 GLCMs deployed in Western Europe. If the U.S.-Soviet INF Treaty is ratified by the Senate, the deployment, production, and flight testing of these missiles will be banned. Before the INF Treaty was signed; the U.S. had intended to deploy a total of 464 GLCMs in Western Europe.

The INF Treaty does not ban ground-launched cruise missiles with a range less than 312 miles or in excess of 3,440 miles. Thus the treaty would allow the deployment in Europe or elsewhere of either very long range "strategic" or shorter-range "tactical" GLCMs armed with conventional or nuclear warheads. A short-range "tactical" GLCM armed with a conventional warhead could be deployed to bolster NATO's capability to strike at Warsaw Pact mobilization centers and airfields in Eastern Europe, far back from the front field of battle. The INF Treaty ban of the current class of GLCM will restrict NATO's ability to interdict Soviet forces deep in East European territory. While a treaty-compliant, very long range GLCM could be deployed in Europe if its tested range exceeded 3,440 miles, such a missile may not be developed because of political opposition in Western Europe and the U.S. Congress.

PROMISING CRUISE MISSILE TECHNOLOGIES

The key technological breakthrough that made the cruise missile possible in the 1970s was the "tercom" guidance system. This radar steers the missile over great distances by

matching periodic measurements of the missile's altitude with a digitalized map of the terrain stored inside the cruise missile's computer. Technology now has advanced far beyond "tercom."[14]

Among the most promising technologies are:

Laser Radars. Particularly promising is the "ladar," a carbon dioxide laser that can guide a cruise missile to the general vicinity of a target by matching data from a laser surveillance of the terrain below with a digitalized map stored in the missile computer's memory. Although it employs the same terrain contour matching technique as "tercom," the ladar is much more effective. The laser radar, for example, scans forward of the missile, not merely downward, as is the case with the radar of the "tercom" system. By scanning forward, the "ladar" enables cruise missile to fly lower and thus more safely out of sight of enemy anti-aircraft radars than current cruise missiles. Ladar also can operate day or night in adverse weather, giving a military commander a great deal of flexibility in planning combat operations.

Improved Accuracy. "Ladar" could be combined with other guidance systems to improve further the accuracy of cruise missiles. Cameras in the nose of a cruise missile could provide pinpoint guidance against specific types of targets. Heat-seeking sensors could be used against targets that emit heat. Satellites may be used to relay the changing locations of such moving targets as ships, tanks and trains to the cruise missile as it flies toward its target.[15] Very accurate cruise missiles armed with more than one warhead could destroy many targets on a single run, dropping, for example, a small bomb on an airplane on the ground, then attacking air defense missiles and radars miles away, and finally crashing into a tank or a truck.

The Navstar/Global Positioning System (GPS). A new U.S. Navy space-based communication and navigation system could improve the accuracy of very long range conventional SLCMs. When completed, the Global Positioning System will consist of 28 satellites capable of communicating the geographical coordinates and speed of enemy ships to U.S. naval commanders. This information could be relayed to SLCMs while in flight to guide them to enemy ships that otherwise could be difficult to track. Although vulnerable to electronic jamming and anti-satellite weapons, the GPS could be used very effectively in Third World conflicts where U.S. foes will not have jamming capabilities.

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14 A tireless supporter of these new guidance technologies and other cruise missile upgrades has been Senator Dan Quayle from Indiana. See his "Upgrading Our Cruise Missiles: Imperative for the 1980s," *Armed Forces Journal International*, August 1987, pp. 76-80.

15 Developing a guidance system capable of targeting moving objects would be extremely difficult and costly. Much research and development remains to be done before this kind of capability could be developed for long-range cruise missiles.

NEW MISSIONS FOR CRUISE MISSILES

New technologies promise to increase cruise missile nuclear warhead potency against concrete and steel protected missile silos and command and control bunkers buried deep underground. Developments in optical sensors, infrared or "heat-seeking" imaging, and laser radar could allow cruise missiles with conventional or very low yield nuclear weapons to destroy enemy facilities up to now targeted by cruise missiles carrying enormously powerful nuclear warheads.

Nuclear Retaliation. Greater accuracy for cruise missiles has significant implications for nuclear strategic missions. A more accurate nuclear armed ALCM, for example, could be far more effective than the ALCM-B and ACM against the "hardest" of Soviet command and control bunkers buried deep underground and protected by concrete and steel walls. Some of these Soviet bunkers currently are impervious to ballistic missiles. These super-accurate cruise missiles, if outfitted with a super-hard, heavy nose cone for burrowing underground upon impact, could threaten the Soviets' nuclear war-fighting capability better than can the current arsenal of U.S. ballistic missiles.

NATO Defense. The conventionally armed long-range cruise missile, whether fired from the air or the ground, would be ideal for air attacks against targets far behind Warsaw Pact lines in Eastern Europe. The new guidance technologies, along with improvements in propulsion technologies providing greater range and radar-evading "stealth" systems, promise to make ALCMs and SLCMs deadly against bridges, command, control and communication centers, weapons and supply dumps, air defense sites, aircraft on runways, airport runways, air traffic control towers, and train stations deep in Warsaw Pact territory.

Destroying such targets would delay reinforcement and resupply of Soviet troops at the front, hurt Warsaw Pact troop morale, and give NATO time to mobilize its troops up to full strength. Cruise missiles also would enable NATO to strike very early in a war against Soviet aircraft while they are still on the ground, reducing Soviet air attacks on NATO airfields. Since NATO commanders will be reluctant to risk the Alliance's fighter jets for deep air strikes very early in a war, the cruise missile could be the most available weapon for interdicting Soviet airfields in Eastern Europe.

Conventional cruise missiles also could be extremely useful on NATO's flanks. From the Black Sea or Turkey, cruise missiles could threaten Soviet military staging areas in the Transcaucasus, which could be used to prepare for an invasion of Turkey or Iran. Soviet ships passing through the Bosphorus likewise could be stopped by U.S. cruise missiles. On NATO's northern flank, cruise missiles could help block Soviet invasion routes into northern Norway.

Against Terrorists. Air and sea-launched cruise missiles could be effective against terrorists. If accurate enough and with sufficient range, a conventional, land-attack cruise missile fired from a ship in the eastern Mediterranean Sea could destroy terrorist hide-outs, command posts, gun emplacements, supply depots and buildings in training camps deep inside Lebanon. A squadron of five B-52s, moreover, could take off from the United States, bombard a terrorist hide-out of Muammar Qadhafi with 100 long-range cruise

missiles armed with a total of 100,000 pounds of explosives and return to the U.S. without the need to land in or fly over any country's territory. Such attacks would reduce the risks of losing pilots and combat aircraft in anti-terrorist operations.[16]

GAPS AND PROGRAM PROBLEMS

Cruise missiles have tremendous military potential. This will go unfulfilled unless changes are made in current U.S. cruise missile programs. The U.S. should:

Improve accuracy. If cruise missiles are to slow a Soviet invasion of Western Europe or destroy a terrorist hide-out in the Middle East, they must be more accurate than they now are. To destroy a bridge or blow up terrorist command post, a cruise missile must strike within a few feet of the target. Yet the accuracy of today's cruise missiles are measured in tens of feet.

To improve cruise missile accuracy, the Pentagon should accelerate the Cruise Missile Advance Guidance (CMAG) program. The Office of the Secretary of Defense and the Navy support efforts to improve cruise missile accuracy, but more needs to be done to involve the other services, particularly the Air Force. Space-based communication and navigation systems, such as the Global Positioning System, which could be used to guide cruise missiles to their targets, must be developed at a rapid pace.

Improve Range. The Air Force and Navy need conventional cruise missiles with longer range. The Navy needs a cruise missile to engage enemy surface vessels out of range of those ships' anti-ship missiles. The Navy also could benefit from very long range cruise missile attacks on coastal air defenses, which pose an enormous threat to naval aircraft on bombing runs against land targets. The Air Force needs a conventional cruise missile with a range of around 1,000 miles to support tactical air strikes well out of range of enemy fighter aircraft and to strike at land targets deep in Warsaw Pact territory. Adding a turboprop engine and extra fuel capacity to existing cruise missiles would give them greater range at relatively low cost.

Develop long-range conventional air-launched cruise missiles for B-52 bombers. NATO and the Air Force already plan to develop a shorter-range air-launched cruise missile for non-nuclear missions. A longer-range conventional cruise missile is needed as well to give the B-52s greater reach against targets deep behind enemy lines. This new missile should be very accurate and capable of carrying a variety of warheads and munitions. The Joint Chiefs of Staff should set a formal military requirement for this very accurate long-range conventional cruise missile. Such a formal requirement would push long-range conventional ALCMs through the Pentagon's research and development process and reduce the chances of their being negotiated away in a nuclear arms control agreement.

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16 On two occasions in recent years, in U.S. Navy air attacks on Lebanon in 1983 and in U.S. Air Force fighter bomber attacks on Libya, the U.S. has lost aircraft, and in the Libyan operation, pilots as well in surgical, anti-terrorist strikes in the Third World.

This new missile need not be as advanced or expensive as the Advanced Cruise Missile. But it could use some of the advanced guidance and "stealth" techniques currently under development. It could employ new carbon dioxide laser radars combined with optical or heat-seeking image processing to enable the missile to fly very low over longer ranges out of sight of enemy air defense radars. Greater accuracy is necessary for conventional warheads because they lack the overcompensating, massive explosive power of a nuclear weapon. Low-cost "stealth" techniques could be used to make the missile more difficult to detect by enemy surveillance and air defense systems. Attack from heat-seeking missiles could be thwarted, for example, by limiting the hot gases emitted from the cruise missile's engine. The cruise missile's radar cross-section, or its profile on an enemy's radar screen, could be reduced and thus made more difficult to detect by using streamlined design features to deflect radar signals. Finally, the cruise missile could be outfitted with electronic countermeasure devices to jam the enemy's radars.

Develop adequate mission planning backup. For a cruise missile to be effective, cruise missile mission planners must have very precise maps, photos of routes to the target, and other information on the terrain and the target readily available. Neither U.S. Navy nor Air Force intelligence data are sufficient to provide the precise location and characteristics of potential conventional cruise missile targets. U.S. military computers and programming software are not capable of processing targeting and flight navigation data quickly to enable the cruise missiles to be reprogrammed and fired toward new targets of opportunity. Data processing shortcomings also make it difficult to coordinate cruise missile strikes with those of fighter aircraft.

The Pentagon needs to improve the mission planning process for use of cruise missiles in combat. It needs to gather more and better intelligence on the terrain and array of likely targets in potential areas of conflict. Computers on board ships and aircraft should be modernized with new program software to process very quickly the navigational and targeting information needed for effective and timely cruise missile strikes.

The Pentagon also should study how best to use cruise missiles in combat. Some of the questions to consider are: What kinds of ships and aircraft should be used in particular situations? What are the best kinds of munitions for use against airfields, train depots, bridges, and terrorist command posts? How can the services cooperate more closely during combat in so-called combined arms operations, where firepower from aircraft, missiles and artillery is coordinated closely with devastating effect on an enemy? And how can new ideas, such as super-fast cruise missiles flying the speed of a ballistic missile inside the atmosphere, change the way cruise missiles are used in battle?

Increase deployment plans. The U.S. needs many more long-range conventional cruise missiles than it now has or plans to have. The Pentagon thus must not develop a new generation of gold-plated cruise missiles that are too expensive to deploy in large numbers. The key in the short run is to add modest yet cost-effective improvements based on proven current or near-term technology. The first priority should be to develop conventional cruise missiles with longer range. The next priority should be to modify existing cruise missile frames using "stealth" technologies to make them more elusive to air defense radars. Improved accuracy will be the most expensive task. Nevertheless, the cost of advanced

guidance systems, such as "ladar," will come down as research and development are accelerated.

Open a central development office. While the Air Force and the Army have their own cruise missile programs, the Pentagon does not have a central office to coordinate the many development programs related to these weapons. Making matters worse, there is poor communication between offices responsible for super-secret "stealth" cruise missile projects and other, not so secretive, non-stealth cruise missile programs. The officials in charge of the services cruise missile development plans have no real authority over advanced guidance systems programs, for example, or vice versa.

To coordinate the cruise missile programs, the Pentagon should create a joint cruise missile office. The Navy has already begun consolidating its cruise missile programs. The Office of the Secretary of Defense supports the idea of consolidation, but the Air Force in particular has not. Press reports that the Joint Chiefs of Staff soon will establish a military requirement for new conventional cruise missiles, if correct, are encouraging and could lay the groundwork for a joint cruise missile office.[17]

Develop new warheads and munitions. Cruise missiles can only be as effective as their warhead. The Pentagon should accelerate development of new types of warheads and munitions for use against airfields, railroad depots, command and control posts, bridges and other targets far behind enemy lines. Fuel air explosive, for example, is a non-nuclear munition made up of a highly flammable fuel dispersed in an aerosol cloud that explodes with tremendous force when ignited. In some cases it can inflict nearly as much damage as a small nuclear explosion. This can be very effective against reinforced concrete bunkers, mine fields, and fighter airplanes sitting on the ground. An earth penetrating device is another potential new weapon. This is a hardened nose cone on a nuclear cruise missile that enables it to burrow into the earth upon impact and to destroy command and control bunkers buried underground. Another example is small bomblets, which create craters on airfield runways preventing takeoff and landing of enemy airplanes.

All of these improvements could be for naught if conventional cruise missiles are compromised for the sake of nuclear arms control. The U.S.-Soviet INF agreement, if ratified by the Senate, will ban all ground-launched cruise missiles with a range of more than 312 miles and less than 3,440 miles, whether armed with conventional or nuclear warheads. Strategic arms proposals by the U.S., moreover, would limit the number of deployed air-launched cruise missiles. Both the U.S. and the Soviet Union have agreed to work toward a common numerical ceiling on sea-launched cruise missiles. The Soviet Union has proposed a limit of 400 on nuclear-armed sea-launched cruise missiles with a separate limit of 600 on conventional SLCMs, for a total limit of 1,000 long-range sea-launched cruise missiles.[18]

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17 Tim Carrington, "Pentagon Planning New Cruise Missiles That Are Non-Nuclear, Very Accurate," *The Wall Street Journal*, February 26, 1988.

18 "Soviet Said to Harden Stance on Missiles," *op. cit.*

From these proposals and the INF Treaty, it is clear that the nuclear arms control process is interfering unwisely with such non-nuclear weapons as conventional cruise missiles. It also is creating an arms control verification nightmare by trying to limit weapons that cannot be distinguished in their nuclear and conventional versions.

The U.S. should not accept an arms control agreement that bans or limits numerically conventional sea-launched cruise missiles. Nor should a START agreement ban or limit the total number of conventional ground-launched cruise missiles with a range greater than 3,440 miles, the upper limit of cruise missiles banned by the INF Treaty. And the total number of strategic bombers should not be limited at very low levels because they will be needed to carry conventional air-launched cruise missiles.

CONCLUSION

Cruise missiles have a tremendous military potential. They can help NATO repel a conventional attack by the Warsaw Pact, protect U.S. aircraft carriers and other ships from enemy anti-ship missiles, provide extra air support for naval bomber attacks against land forces, and strike back at terrorists hiding deep inside such hostile territory as Lebanon, Libya, and Iran. Conventional cruise missiles attack without risking the life of a pilot or loss of a multimillion dollar fighter airplane. They can be very accurate and have a good chance of reaching and destroying their intended targets.

Competitive Edge. As important as anything else, cruise missiles give the U.S. a competitive edge over the Soviet Union. Taking advantage of America's technological superiority, cruise missiles will force the Soviets to spend billions of rubles on ways to stop them — money that otherwise could be spent on nuclear weapons, tanks, tactical fighter aircraft, and other offensive forces.

While cruise missiles are formidable weapons, the U.S. cruise missile program is not living up to its potential. U.S. conventional cruise missiles will have to be more accurate, given longer range, made less vulnerable to Soviet air defenses and electronic jamming, produced more cheaply in greater numbers, supported by better mission planning, and released from arms control constraints.

Flexible Arsenal. Conventional long-range cruise missiles will be needed to support future U.S. strategy. As the INF Treaty and possibly other arms control agreements decrease reliance on nuclear weapons for deterrence, the U.S. will have to exploit such advanced technology weapons as cruise missiles to bolster its conventional defenses. The U.S. conventional arsenal must become more varied and flexible, depending more on weapons like conventional cruise missiles that multiply the combat force of the aircraft, ships, submarines, and ground forces with which they are used. As enemy air defenses become more dangerous to U.S. fighters and bombers, and as U.S. access to overseas air bases becomes more uncertain, the capability to strike from the air with cruise missiles at very great distances will become more important to U.S. strategy.

Long-range conventional cruise missiles thus are no mere luxury for the U.S. They may prove critical to the U.S. capability to defend itself not only today but well into the next century.

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