The Neglected Dimension: Controlling Cruise Missile Proliferation

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The renowned American strategist Albert Wohlstetter often analyzed neglected issues in strategic affairs, termed "lesser-included cases." His intention, of course, was to elevate such cases to a higher level of strategic consciousness, deserving of separate attention. In late 1994, in a foreword to a monograph about controlling the spread of land-attack cruise missiles, Wohlstetter wryly warned of the tendency of decisionmakers to regard so-called "lesser-included cases"—in this case, the emerging spread of cruise missiles—as problems that could readily be taken care of by larger policy thrusts. As he put it: "the dog that could deal with the cat could easily handle the kitten."[1]

Eight years later, Wohlstetter's prescient admonition is finally beginning to register in appropriate places. On February 12, 2002, the Subcommittee on International Security, Proliferation, and Federal Services of the U.S. Senate Committee on Governmental Affairs held the first of several planned hearings probing the effectiveness of existing multilateral nonproliferation regimes, including the Missile Technology Control Regime (MTCR), in stemming the spread of weapons of mass destruction (WMD) and their delivery means to terrorist groups.[2] In a second hearing by the same committee on March 12, 2002, a CIA official drew additional attention to the need for a more balanced intelligence appraisal of missile threats. Robert Walpole, national intelligence officer for strategic and nuclear programs, indicated that the next National Intelligence Estimate (NIE) on the ballistic missile threat is expected to include more infomation about threats from land-attack cruise missiles and unmanned arial vehicles (UAVs). In questioning, Walpole observed that the reason for scant past public attention to cruise missiles and UAVs had less to do with their lack of importance than with the fact that they merit a separate esimate, which has not been given the degree of public exposure that the ballistic missile threat to the United States has attracted. The events of September 11, 2001, appear to have changed such separate treatment of missile threats, however. Future NIEs, according to Walpole, will connect all the estimates to give appropriate attention to the full range of missile threats to the United States.[3] In addition, the subcommitttee conducted a third hearing on "Cruise Missile and UAV Threats to the United States," in which government and outside experts addressed both the impact of the threat and ways to improve existing nonproliferation mechanisms to deal with it.[4] Optimistically speaking, the era of viewing cruise missiles and UAVs as merely a lesser-included case may be coming to a close. Acting on the matter to improve export controls, however, remains a more difficult challenge.

THE EMERGING CRUISE MISSILE THREAT

Concern about the spread of land-attack cruise missiles is driven by two realities: first, the quantum leap in dual-use technologies supporting cruise missile development (including satellite navigation and guidance, high-resolution satellite imagery from commercial vendors, unregulated flight management systems for converting aircraft into UAVs, and digital mapping technologies for mission planning); and second, the fact that the 33-nation MTCR is much less effective at controlling the spread of cruise missiles and UAVs than ballistic missiles.

The two primary barriers to developing land-attack cruise missiles are access to navigational guidance and propulsion systems. In the former regard, as long as highly sophisticated guidance and control technology—such as terrain contour matching (TERCOM) and digital scene matching area correlation (DSMAC) systems—represented the state of the art, there were three important barriers to proliferation. First, the functionality of these technologies depended on maps derived from highly classified overhead reconnaissance satellites. Second, developing a dedicated mapping infrastructure was prohibitively expensive. Third (and perhaps most important), TERCOM and DSMAC were subject to strong export controls. The advent of the global positioning system (GPS) has had the most profound impact on cruise missile proliferation by essentially obviating the need for such advanced navigational guidance systems. Consider that an accurate stand-alone inertial navigation system (INS) for commercial aircraft costs roughly $150,000. Less accurate stand-alone INS cost a third of this price, but adding embedded GPS receivers makes them far more accurate than the most expensive stand-alone INS. Thus, for a fraction of the cost, GPS integrated with cheap INS permits the acquiring state to leap ahead 15 years in navigational guidance systems.

As for propulsion requirements, advanced highly efficient propulsion systems, such as turbofan engines, still remain tightly controlled. But there are ways to work around such controls by using unrestricted turbojet engines available from around ten manufacturers in industrial nations. Moreover, some countries may wish to convert unarmed UAVs into armed cruise missiles. Such UAVs do not require anything like an advanced gas-turbine engine. With simple reciprocating engines, many of these systems are capable of one-way ranges of over 1,000 kilometers (km).

The second reality driving the spread of cruise missiles is the weakness of export controls on the necessary equipment and technology. Founded in 1987 by the United States and its Group of Seven (G-7) partners, the MTCR is a politically rather than legally binding agreement among member states aimed at restricting the proliferation of rockets, UAVs, and related technologies capable of carrying a payload of at least 500 kilograms (kg) for at least 300 km. In 1993, the MTCR guidelines were expanded to include all missile delivery systems capable of carrying biological and chemical warheads regardless of payload.

The MTCR is much more effective in controlling ballistic than cruise missiles for several reasons. First, there is a reasonably solid consensus among members for restricting ballistic missiles, while the same does not yet hold for cruise missiles and other UAVs. Second, loopholes created by systematic exemptions for all civilian and military aircraft can be used to circumvent many of the MTCR restrictions on UAVs. Third, the inherent modularity of cruise missiles makes determining their true range and payload, and trade-offs between the two, difficult (though by no means impossible). In particular, variations in cruise missile flight profiles—especially those taking advantage of more fuel-efficient flight at higher altitudes—can lead to substantially longer ranges than manufacturers and exporting countries advertise. Finally, and perhaps more important, the provisions of the MTCR equipment and technology annex—particularly as it applies to cruise missiles and UAVs—simply have not kept pace with the extraordinarily rapid expansion in commercially available technology facilitated by the contemporary globalized economy. To take the most egregious example: small aerospace companies are now being formed specifically to provide fully integrated flight management systems, along with an array of support services, which can enable the transformation of manned aircraft into entirely autonomous UAVs.[5]

A variety of sources thus exist to acquire land-attack cruise missiles:

- **Direct purchase from industrial suppliers.** In some ways this avenue is the easiest, and certainly the most worrisome, way to acquire highly sophisticated land-attack cruise missiles from a growing list of industrial-world suppliers, now numbering at least nine. This area is where the ground rules for determining the true range and payload of cruise missiles are so essential.

• **Conversion of short-range anti-ship cruise missiles into land-attack missiles.** Frequently cited as a major concern because of the huge worldwide inventory of roughly 75,000 anti-ship cruise missiles, this avenue may have much lower potential than first meets the eye. Only a small fraction of these missiles—foremost the Chinese Silkworm and its derivatives—may have the potential for transformation into land-attack cruise missiles with ranges over 300 km.

• **Conversion of unarmed UAVs, target and reconnaissance drones into land-attack cruise missiles.** These are increasingly being used not only in tactical military systems but also in non-military commercial, civic, and scientific applications. Of the 40 nations indigenously producing UAVs today, only 22 are members of the MTCR.

• **Conversion of small manned kit airplanes into weapons-carrying, fully autonomous cruise missiles.** There is a dizzying array of kit airplanes in today's marketplace (by one recent count, nearly 100,000 copies of 425 systems produced by worldwide manufacturers).[6] On average, the characteristics of this sample include a cruising speed of around 75 knots, a range of 500 km, a maximum weight of just less than 900 pounds (400 kg), fuel and payload capacity of 450 pounds (200 kg), a very short takeoff distance of 75 meters, and a beginner build time of around 260 hours. The biggest challenge to converting such manned airplanes into autonomous unmanned systems is flight navigation, but, as noted above, fully autonomous flight management systems are now available to convert manned aircraft into UAVs. But what makes this option most attractive are the low cost (perhaps no more than $50,000 for acquisition of the kit airplane, reciprocating engine, and autonomous flight controls) to achieve such a capability, and the difficulty of detecting such slow-flying planes. The sophisticated look-down radars of modern air defense systems eliminate slow-moving targets on or near the ground to prevent their data processing and display systems from being overtaxed. This means that large numbers of propeller-driven kit airplanes flying at under 80 knots would be ignored as potential targets. Thus, the small airplane avenue may well represent the "poor man's cruise missile arsenal" of the future.

• **Indigenous cruise missile development.** Indigenous development is not only the longest route to acquiring militarily significant cruise missile capabilities; it is also unlikely to lead developing states to true autarky or anything beyond low-tech designs. Foreign assistance is a critical variable affecting the pace and quality of indigenous development.[7]

UNCERTAINTY ABOUT THE EMERGENCE OF THE CRUISE MISSILE THREAT

Complicating predictions about the evolution of the cruise missile threat is a diverse set of crosscutting motivations and constraints facing proliferating states. Perhaps the strongest motivating factor is the decided advantage of land-attack cruise missiles over ballistic missiles and even manned aircraft in achieving military objectives. Indeed, their capacity for precise delivery makes them the weapon of choice not only for biological and chemical attacks, but also for conventional ones. Regional states facing any U.S.-led coalition cannot expect to see their aircraft survive much beyond the first blow of any campaign. Yet cruise missiles launched from a variety of survivable platforms would enable such a state to mount a strategic air campaign with cruise (and ballistic) missiles without achieving air superiority. In this connection, military effectiveness interacts closely with the growing vulnerability of Western-style force projection, especially its dependence on short-range aircraft operating out of a few forward bases. The fact that the cost of even advanced cruise missiles is less than that of ballistic missiles, and that large numbers of converted kit airplanes and UAVs could conceivably become affordable for proliferating states, adds to their attraction.

Third world motivations for acquiring large inventories of anti-ship cruise missiles, beginning in the 1960s, may shed light on what may occur in the future with their land-attack brethren. Despite their significant expense (typically around $800,000), about 40 developing nations came to see such missiles as yielding a high payoff in the absence of the prestige and operational utility of large military establishments. One accurately placed anti-ship cruise missile potentially could achieve strategic results even against a major industrial power. The use by Argentina of only a few French Exocet cruise missiles against the British Royal Navy during the Falklands War furnishes but one example.

But these strong motivations must be tempered by an equally compelling set of constraints. However much the prestige value of cruise missiles may have risen since the 1991 Gulf War, acquisition of ballistic missiles starts a proliferating state down the path toward possessing an intercontinental-range missile. Although a regional adversary of the United States could, without detection, use cruise missiles earmarked for regional warfighting to attack U.S. territory from an offshore vessel, the deterrent value of such an option pales in comparison to possession of an intercontinental ballistic missile (ICBM). Another possible constraining factor is the doctrinal and bureaucratic difficulty of fully integrating cruise missiles into third world force structures dominated by aircraft, tanks, and ships. Moreover, the underlying dual-use technologies supporting either indigenous or conversion programs are relatively new: cheap and widely available GPS/INS systems are less than a decade old; the commercial market for high-resolution satellite imagery is just beginning to mature; and subsidiary aerospace industries specializing in autonomous flight management systems for manned aircraft are a recent phenomenon. But perhaps the most important reason why cruise missiles have yet to spread widely is the absence of effective layered defenses, including counterforce capabilities, against ballistic missiles. Not until after 2007 will the United States begin to deploy such defenses effectively.

How might the cruise missile threat change or evolve over the next five to 10 years? Conventional wisdom would suggest that the cruise missile threat will evolve over time, from relatively few highly observable missiles in the near-term (one to five years), via higher numbers of lower observable, terrain-hugging missiles in the mid- term (five to 15 years), to larger numbers of stealthy missiles with endgame countermeasures in the long-term (more than 15 years). But major features of the long-term threat could materialize much sooner if MTCR handling of cruise missile transfers does not improve, or if U.S.-Russian and U.S.-Chinese relations worsen. In either case, it is conceivable that modest numbers of stealthy cruise missiles with countermeasures, accompanied by large numbers of cheap, slow-flying UAVs or converted kit planes, could emerge in five to 10 years.

THREAT IMPACT

On its own, the emergence of the cruise missile threat confronts American military forces with enormous challenges. The effectiveness of both airborne and ground-based surveillance radars is being undermined by missile designs that are increasingly sleek and aerodynamic, and have lower radar cross-sections. Reduced radar observability means that the defense has less time to react. Also, many missiles have very low flight profiles and employ terrain features to avoid detection. Low flight impedes airborne surveillance, owing to radar “clutter” from ground objects other than the target, which makes a land-attack cruise missile difficult to detect.

Some existing air defenses—consisting of fighter-based air-to-air missiles, airborne surveillance aircraft, surface-to-air missiles and battle-management command, control and communications—have substantial capability against large land-attack cruise missiles flying relatively high flight profiles. But once cruise missiles fly low or, worse, add stealth features or employ endgame countermeasures (decoys or jammers), severe difficulties arise. Indeed, even defending against easily observable cruise missiles flying relatively high is problematic. Radars could mistake friendly aircraft returning to their bases for these targets and inadvertently shoot them down. The emergence of large numbers of weapons-carrying UAVs or converted airplanes flying at very slow speeds also threatens the utility of modern air-defense systems because, as noted above, they eliminate slow-flying objects from radar processing.

Significant numbers of land-attack cruise missiles in the hands of state adversaries would have profound implications for U.S. interests and regional security balances. The emergence of land-attack cruise missiles to complement ballistic missile strike systems could conceivably bolster an adversary’s willingness to oppose U.S.-led interventions in strategically important ways. Adding cruise missiles to the threat picture gives states that wish to deter or affect the outcome of such interventions not just political but also important new military leverage. Not the least of the military advantages is the capacity of cruise missiles to greatly enlarge the effective lethal area of chemical and biological attacks compared to ballistic missiles. Moreover, the potentially high accuracy of land-attack cruise missiles means that even conventionally armed systems may be able to achieve significant damage against exposed area targets. Finally, the low cost of cruise missiles, most notably modified airplanes, makes the cost-per-kill arithmetic of cruise missile defense stark. Whether a Patriot (PAC-3) missile costs $5,000,000 or the desired $2,000,000 per copy, the figure compares unfavorably with either a $200,000-per-copy cruise missile or large saturation attacks of $50,000-per-copy modified kit airplanes. Quite simply, because ballistic and cruise missile defenses depend largely on the same high-cost air-defense interceptors, complementary cruise and ballistic missile attacks, especially saturation ones and those delivering WMD payloads, will present enormous challenges for any defense.

Several features of cruise missiles, not least their compact size and ease of maintenance, have suggested to some analysts that they may become an attractive alternative for states or terrorist groups lacking the resources or technical skills to build and deploy ICBMs. Various NIEs have drawn attention to the covert conversion of a commercial container ship as a launching platform for a cruise missile. There are thousands of commercial container ships in the international fleet, and U.S. ports alone handle over 13 million containers annually. Even a large, bulky cruise missile like the Silkworm—converted for land attack—could readily fit inside a standard 12-meter shipping container equipped with a small internal erector for launching. Such a ship-launched cruise missile could be positioned just outside territorial waters to strike virtually any important capital or large industrial area anywhere on the globe. And, because a cruise missile is an ideal means for efficiently delivering small but highly lethal quantities of biological agent, a state or terrorist group could forgo acquiring or building a nuclear weapon without sacrificing the ability to cause catastrophic damage.

Indeed, the latest NIE—no doubt influenced by the events of September 11—argues that among several other attack options cruise missile attacks on the United States are more likely than attacks with long-range ballistic missiles.[8] The NIE reaches this conclusion because such alternatives are less costly, easier to acquire, and more reliable than using an ICBM. While this scenario and other non-ICBM threats deserve close scrutiny, the conversion of small manned airplanes into weapons-carrying, fully autonomous cruise missiles ought to equally concern us. Terrorist use of large commercial airliners on September 11 came as a complete shock to American planners. To be sure, September 11 prompted a whole rash of reforms to cope with a repeat of just such an attack. But these reforms deal largely with commercial aircraft security rather than private aviation. Small converted aircraft cannot begin to approach the carrying capacity of a jumbo jet, which holds 60 metric tons of fuel. Still, because gasoline, when mixed with air, releases 15 times more energy than an equal weight of TNT, even relatively small aircraft converted to cruise missiles could do significant damage to certain civilian and industrial targets.[9] Such platforms would also be an effective means of delivering biological weapons.

As Bush administration officials contemplate significant investments in modest defenses against the familiar scenario of attacks involving a few ICBMs, they should consider four examples of small *manned* aircraft that successfully managed to reach critical political or military targets either undetected or without interference. In 1987, a 19 year-old German boy, Mathias Rust, flew his Cessna aircraft undetected from Hamburg, Germany to the heart of Red Square in Moscow, notwithstanding the Soviet Union's enormous investment in a multi-layered national air defense system.[10] In September 1994, a deranged pilot flew his commandeered Cessna onto the White House grounds, eventually crashing just below the President's bedroom. Although the Cessna was picked up on radar at Washington National Airport, Secret Service agents were not warned of the approach of the aircraft.[11] In early January 2002, a 15-year-old student pilot flying a stolen Cessna flew undetected over MacDill Air Force Base—home of the U.S. Central Command fighting the war against terrorism in Afghanistan—before slamming his aircraft into a downtown Tampa, Florida office building. Reportedly, Central Command authorities at MacDill did not learn of the flight until after the plane crashed. Most recently, a light single-engine Cessna, innocently flying off course, entered restricted airspace over Washington, D.C., close enough to the White House to hit the building had the pilot wished to do so. The incident occurred before two F-16 fighters arrived on the scene from nearby Andrews Air Force Base.[12]

These incidents should not be taken to suggest that transforming a kit or small private aircraft into a weapons-carrying autonomous attack system is technically simple. Certainly, states of concern are fully capable of such transformations. Iraq has demonstrated that with the conversion of a number of Czech L-29 manned trainer aircraft into UAVs capable of delivering a payload of nearly 500 pounds (225 kg) to a range of over 600 km. The most challenging feature of such a transformation is developing and integrating a fully autonomous flight management system into the aircraft. However, now that small aerospace companies have begun to sell fully autonomous flight management systems, along with all necessary support services to help with system integration, to enable the transformation of manned aircraft into entirely autonomous UAVs, the most difficult transformation roadblock has been eliminated. Existing loopholes in the MTCR technical annex mean that there are no restrictions (for example, even case-by-case review of transfers) constraining foreign acquisition of these flight-control systems. Such an autonomous delivery system in the hands of a terrorist means that launches could take place from hidden locations in close proximity to their intended targets.

Decisions could be made to erect some level of modest defenses against off-shore cruise missile launches. The North American Aerospace Defense Command (NORAD) is currently studying the idea of an unmanned airship operating at 70,000 feet altitude and carrying sensors to monitor low-flying cruise missiles and aircraft. Several airships would be needed together with quick-reacting interceptors to react to perceived threats. Alternatively, perhaps on the order of 100 aerostats flying at an altitude of 10-15,000 feet could act as a system of surveillance and fire control for quick-reacting interceptors. Still, numerous challenges exist, including the problem of furnishing warning information on potentially hostile ships embarking from ports of concern (to make the Coast Guard's monitoring function feasible), as well as developing the very high quality combat identification information needed to justify shooting down an air vehicle. It is safe to say that even a limited defense of the entire U.S. homeland against off-shore cruise missiles would cost at least $30-40 billion—an unspoken fact when the cost of national missile defense is discussed publicly. Moreover, any effort to construct a homeland defense against cruise missiles hinges on progress in programs of the individual U.S. military services. But such programs lack the necessary funding and face enormous service interoperability, doctrinal, and organizational challenges that stand in the way of truly joint cruise missile defenses. In addition, defending against converted aircraft originating from within the United States and aiming at nearby targets represents a wholly different national missile defense challenge, dictating difficult technical and political choices. In sum, missile defense options alone are likely to be financially taxing, operationally challenging, and too late in coming to cope with the emerging threat.

IMPROVING CONTROLS ON LAND-ATTACK CRUISE MISSILES AND UAVS

Certainly, these proliferation challenges demand a variety of different nonproliferation and counterproliferation responses. Nonproliferation policy is the first line of defense. At present, however, it is perhaps the least effective one. Missile nonproliferation policy focuses almost entirely on controlling the spread of ballistic missiles. The best evidence of a continuing failure on the part of the MTCR partnership, including the Bush administration, to address the cruise missile threat lies in the time and effort spent on developing an international code of conduct against ballistic missile proliferation. The code is the latest manifestation of the longstanding quest by various states to establish a universal, legally binding treaty covering missile proliferation.[13] Beginning in 1999, the MTCR membership undertook the drafting of a politically (though not legally) binding code that calls upon signatories to declare their ballistic missile programs annually and alert all signatories before conducting all ballistic missile tests. After the MTCR membership approved a draft text in September 2001, more than 80 nations, including the 33 MTCR member states, met in Paris in early February 2002 to review and approve a draft document outlining the provisions of the code.[14] Putting aside concerns about the nature of the technology carrots needed to lure states like Iran and North Korea into code membership, the most egregious shortcoming in the draft code is the absence of any mention of cruise missiles and UAVs, in spite of the fact that the MTCR—at least nominally—covers both classes of missiles. However noble such a code of conduct might be, its neglect of cruise missiles will reinforce their status as a second-class threat at exactly the wrong time—before such systems have spread widely to affect regional and international security.

To be sure, ballistic missiles receive top priority because they are already widely proliferated, while land-attack cruise missiles have only begun to emerge as a threat. But that is precisely the reason why improved controls on cruise missiles are so crucial now. However imperfect it has proven, the MTCR has still achieved notable success in controlling the spread of advanced ballistic missiles. It has blocked the export of hundreds of components, technologies, and production capabilities, and succeeded in dismantling the Condor missile program sought by Argentina, Iraq, and Egypt—a missile that reportedly included sophisticated technology on the level of the U.S. Pershing II missile. As a result of the success of the MTCR, the ballistic missile technology that has spread thus far is largely derived from 50-year-old Scud technology, a derivative itself of the German V-2 missile program of World War II. Missile defenses can exploit many of the weaknesses of this technology. Yet, perhaps because they fear undermining their position, few strong supporters of ballistic missile defense are willing to admit that missile proliferation can be effectively controlled. This tendency to view the MTCR glass as half empty has fostered a reluctance to adapt the regime to cope with its major shortcomings in addressing cruise missile proliferation.

Were the gaping deficiencies in the way current MTCR provisions handle cruise missile transfers eliminated, the MTCR could conceivably do as well with cruise missiles as it has with controlling the spread of highly sophisticated ballistic missiles. Effective controls on the spread of cruise missiles and related technologies that greatly improve performance would make the threat more predictable and slow its emergence. Such controls would also greatly reduce the cost of missile defenses—against both cruise and ballistic missiles. Ultimately, letting cruise missiles proliferate will not only present its own set of unique demands, but will make effective ballistic missile defenses more costly and demanding, too.

To have any positive effect on controlling the spread of land-attack cruise missiles, the MTCR membership should, without delay, strengthen the provisions of the regime in the following areas:

- **Uniform standards for determining cruise missile range and payload.** If consistent national implementation of MTCR controls is to occur, the most urgent priority is for MTCR members to strengthen the ground rules determining cruise missile range and payload. As to range, the existing rules were written primarily with ballistic missiles in mind. They involve a straightforward calculation of the maximum range trajectory of a ballistic missile. Cruise missile manufacturers frequently state the range of their products using low flight profiles. But the truth is that cruise missiles need not fly their entire distance using such low flight profiles. They can be launched at or reach a range-maximizing altitude and then drop to a terrain-hugging profile when they become more susceptible to detection. There are several other factors that contribute to determining the true range and payload capability of cruise missiles and other UAVs. However complex these factors may appear individually and in combination, they comprise a workable set of inputs for consistent implementation of MTCR controls on cruise missiles and UAVs. The MTCR membership has examined the issue in the past, particularly in the aftermath of the Anglo-French decision to transfer the Black Shaheen cruise missile to the United Arab Emirates. Thus far, however, it has failed to arrive at a consensus on appropriate ground rules. Without uniform standards, the danger is that others might decide to take advantage of the current confusion to consummate unwanted transfers of similarly sophisticated cruise missiles.
- **Tighter controls on stealthy cruise missiles.** The application of stealth technology to cruise missiles gives them the same characteristics of ballistic missiles that inspired the MTCR: difficulty of defense, short-warning time, and shock effect. Calls for tighter controls on stealthy cruise missiles are longstanding, but the membership has struggled to reach consensus on precisely what level of control to impose. Because of their inherent risk, Category I systems are automatically subject to a strong presumption of denial. The best approach to controlling stealthy cruise missiles would be to subject those missiles with greater than 300 km range, which are presently covered by Category II controls, to the same presumption of denial as Category I missiles. Cruise missiles capable of such ranges need not carry 500 kg payloads to represent an extremely dangerous proliferation threat. Indeed, they are significantly more effective in delivering small biological payloads than even Category I ballistic missiles. Coverage should be tightened on such stealthy cruise missiles.
- **Controls on UAV flight management systems.** There are no controls governing the transfer of very light, manned kit aircraft. This gap is all the more reason for the MTCR membership to consider how to bring commercially available UAV flight-management systems under case-by-case review. The MTCR coverage of flight-control systems and technology is pro-

vided under Item 10 of its equipment and technology annex, but it constrains only those systems "designed or modified for the systems in Item 1" (meaning complete rockets and UAVs capable of delivering at least a 500 kg payload to a range of at least 300 km). The original 1987 version of Item 10 applied the more liberal language—"usable in the systems in Item 1"—that would likely capture such systems for case-by-case review. Reverting back to the 1987 language would make good sense.

- **Controls on specially designed countermeasure equipment.** The addition of end-game countermeasure equipment, such as towed decoys or terrain bounce jammers, can greatly complicate cruise missile defenses. Since the effectiveness of countermeasures increases as missile radar signature diminishes, incentives for using countermeasures will rise as radar cross-section values for cruise missiles fall lower and lower. Because such countermeasure equipment is used to enhance manned aircraft survivability, at first glance it would appear that such items might be exportable under Category II controls as part of manned aircraft. But to achieve their intended synergistic effect with stealthy cruise missiles, countermeasure devices must be specially designed or modified to fit their companion vehicle. This requirement suggests that such devices could perhaps be captured under the existing MTCR framework, and that the member states should investigate precisely how the regime might be modified to bring them under control.
- **Broadened parameters covering jet engines.** The capability of a jet engine is the most critical variable in determining the range of a cruise missile. Commercial and military engines with slightly above 2,000 pounds of thrust are fully usable in cruise missile development or conversion programs. Yet the MTCR currently does not subject them even to minimal control. Broadening the current MTCR parameters covering jet engine thrust under Category II would impose only a slight administrative burden on export control organizations to review licensing applications that are commonly used in manned aircraft. Such case-by-case review would greatly enhance the capacity of MTCR members to monitor the diversion of jet engines to cruise missile applications with Category I capabilities.

During the Cold War, arms control and military deployments played complementary roles in maintaining nuclear stability. Today the two policy domains also have useful and mutually reinforcing roles to play. Without reform of the MTCR, cruise missile threats are certain to spread and inevitably make missile defenses more expensive and problematic. To borrow Albert Wohlstetter's metaphor, the current provisions of the MTCR dealing with cruise missiles and UAVs show that this particular dog cannot even begin to handle the kitten. But if the MTCR can become as effective in limiting the spread of cruise missiles as it has been with ballistic missiles, missile defenses can conceivably keep pace with evolutionary improvements in both missile categories. The necessary reform of the MTCR will not happen, however, without the committed leadership of both the U.S. Congress and executive branch. It will also require increases in the resources and personnel within the State Department, Pentagon, and intelligence agencies charged with responsibility for missile nonproliferation policy. No more effective allocation of resources could be made to complement the huge but nonetheless essential investments in missile defense that will be made to protect the future security of the United States.

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[1] K. Scott McMahon and Dennis M. Gormley, with a Foreword by Albert Wohlstetter, *Controlling the Spread of Land-Attack Cruise Missiles* (Marina del Rey, CA: American Institute for Strategic Cooperation, 1995), p. v.

[2] David Ruppe, "U.S. Response I: Shore Up Multilateral Regimes, Experts Testify," Global Security Newswire, February 13, 2001, <http://www.nti.org/d_newswire/issues/newswires/2002_2_12>; U.S. Senate, 107th Congress, 1st Session, Hearing of the Subcommittee on International Security, Proliferation, and Federal Services of the Committee on Governmental Affairs, February 12, 2002, <http://www.senate.gov/~gov_affairs/021202witness.htm>.

[3] For press coverage of Robert Walpole's testimony see Greg Siegle, "Threat Assessment I: Cruise Missiles Getting Attention, CIA Official Says," Global Security Newswire, March 13, 2001, <http://www.nti.org/d_newswire/issues/thisweek/2002_3_13_misp.html>. U.S. Senate, 107th Congress, 1st Session, Testimony of Robert Walpole before the Subcommittee on International Security, Proliferation, and Federal Services of the Committee on Governmental Affairs, March 12, 2002, <http://www.senate.gov/~gov_affairs/031102walpole.pdf>.

[4] U.S. Senate, 107th Congress, 1st Session, Hearing of the Subcommittee on International Security, Proliferation, and Federal Services of the Committee on Governmental Affairs, <http://www.senate.gov/'gov_affairs/061102witness.htm>.

[5] For a detailed elaboration of these points, see Dennis M. Gormley, *Dealing with the Threat of Cruise Missiles*, *Adelphi Paper 339* (Oxford: Oxford University Press and IISS, 2001).

[6] This accounting was accomplished by Dr. Gregory DeSantis, a private consultant, using Internet searches of the kit airplane literature, primarily *Kitplanes Magazine* monthly issues from January 2001 to January 2002.

[7] For an elaboration on these alternative courses of cruise missile acquisition, see Gormley, *Dealing with the Threat of Cruise Missiles*, Chapter 2.

[8] For an assessment of the impact of the events of September 11, 2001, on

missile defenses, see Dennis M. Gormley, “Enriching Expectations: 11 September’s Lessons for Missile Defence,” *Survival* 44, (Summer 2002), pp. 19-35.

[9]Richard A. Muller, “The Cropdusting Terrorist,” *Technology Review*, March 2002, <http://www.technologyreview.com/articles/wo_muller031102.asp>.

[10] For more details on the Rust incident, see <http://www.csmonitor.com/durable/2000/07/06/p23s3.htm>.

[11] Ruben Castaneda and Pierre Thomas, “Radar Detected Airplane before White House Crash,” *Washington Post*, <http://www-tech.mit.edu/V114/N40/crash.40w.html>.

[12] Steve Vogel and Allan Lengel, “Plane Flew Close to the White House,” *Washington Post*, June 21, 2002, p. B1.

[13] The most persuasive case against such formal treaty approaches is made by Richard Speier, “Can the Missile Technology Control Regime Be Repaired?” in Joseph Cirincione, ed., *Repairing the Regime* (Washington, DC: Routledge, 2000).

[14] For an analysis of the draft code of conduct, see Dennis M. Gormley, “A Ballistic Missile Code of Conduct: Just How Valuable?” *IISS Strategic Pointers*, <http://www.iiss.org/pub/sp/sp02002.asp>.