UAV EXPORT CONTROLS AND REGULATORY CHALLENGES

Working Group Report

STIMSON

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INTRODUCTION AND SUMMARY

The Export Controls Working Group[I] evaluated whether current U.S. and international export controls on unmanned aerial vehicles (UAVs) best promote the national security interests of the United States. This evaluation produced a series of possible recommendations for policy changes and initiatives for the U.S. government.

These recommendations fall into four main areas:

1. Enhanced Background Analysis of UAV Industry and Security Issues

a. Review economic trends in U.S. and non-U.S. UAV markets, the size of those markets, and commercial availability, through a Commerce Department defense industrial base study;

b. Clearly identify current/expected security concerns so that the full range of international and U.S. controls can be focused and appropriate. This should include analyzing:

   I. the impact of the Missile Technology Control Regime (MTCR) presumption of denial relating to Category I UAVs on identified U.S. security interests, including the presumption's nonproliferation benefits and the extent to which the presumption may foster the growth of foreign UAV providers, reducing U.S. government influence and the qualitative U.S. technological edge,

   II. and the potential security concerns posed by exports of UAVs, whether or not covered by Cate gory I criteria, to identify characteristics that pose particular concerns (e.g. speed, radar cross-section, swarming capability, surveillance payload, low observable features, armor, anti-aircraft countermeasures).[II]

c. As a follow-up to the Defense Science Board's (DSB) 2012 report on autonomous defense systems, initiate a DSB study that examines how best to leverage commercial UAV research and development to enhance military UAV capabilities.

2. Technology Release Licensing Policies of the United States and its Allies Should Be Consistent with UAV Industry and Security Analysis

a. Engage in outreach to industry regarding internal U.S. government licensing guidance that appropriately takes into account the above analysis of (1) industry trends, (2) the MTCR presumption of denial and its potential impacts, and (3) differences among UAVs (both Category I as well as Category II UAVs that pose particular concerns);

b. Engage with U.S. allies and partners with significant UAV capabilities in order to promote a convergence of licensing policies with respect to Category I UAVs and other UAVs that pose particular security concerns;

c. For both commercial and military UAV exports, encourage the export of "UAV services" that would mitigate the impact of MTCR restrictions by allowing recipients to receive the benefits of Category I UAVs without the transfer of U.S. "jurisdiction or control" and, for Category II UAVs, mitigate the impact of strict controls on the export of UAVs posing particular concerns.

[I] The report was produced by the Working Group Chair and Stimson staff based on input from group members, but the report does not reflect every individual view and was not "endorsed" by group members. This report is based on work undertaken by the working group during 2013-2015.

[II] Under the MTCR, UAVs are divided into two categories. Category I UAVs constitute complete systems of great sensitivity capable of carrying a payload of at least 500 kilograms to a distance of at least 300 kilometers. Category II UAVs include less sensitive systems capable of flying at least 300 kilometers regardless of payload. For additional details, see Missile Technology Control Regime. *Equipment, Software and Technology Annex*. April 2014. Accessed October 6, 2014. http://www.mtcr.info/english/MTCR%20TEM%20Technical%20Annex%20as%20of%202014-04-25.pdf.

3. U.S. Export Control (ITAR/EAR) Reforms

a. Provide greater clarity regarding the distinction between "unarmed military UAVs," which are controlled as defense articles under the International Traffic in Arms Regulations (ITAR), and commercial UAVs, which are controlled under the Export Administration Regulations (EAR). Specifically, establish technical criteria based on current military technology that will subject UAV technology to ITAR control (e.g., resolution capability of surveillance payload, low observable features, armor, anti-aircraft countermeasures), and continually update these criteria to keep up with technological change. Other UAV technology — whether meant for military or civilian use — should be controlled under the less restrictive EAR;

b. Review use of "anti-tamper" (anti-repurposing) conditions that are applied to U.S. export licenses to ensure that they are applied to sensitive UAV technologies in a consistent and transparent fashion that takes into account cost-effectiveness and focuses less on hardware conditions and more on software conditions where possible.

4. Defense Department UAV Acquisition and Operation Policy

a. Promote use of the Defense Exportability Features (DEF) program in the UAV context to encourage integration of adequate protections on sensitive technology earlier in the design and development process;

b. Consider government encouragement of co-development/co-production with industry in allied or partner nations to share costs, promote interoperability, and mitigate impacts on the defense industrial base from export restrictions;

c. In view of the potential loss of a U.S. governmental UAV in inhospitable territory, ensure a reasonable across-the-board anti-tamper requirement for sensitive UAV technology;

d. To ensure that export controls are not undermined, encourage greater protections against unauthorized dissemination of UAV technical data from the U.S. government inventory.

SCOPE AND ASSUMPTIONS

To produce the recommendations described above, the working group reviewed the civilian and military markets for UAVs and the trends in the development and proliferation of those systems. The working group examined how existing multilateral export control regimes and U.S. export control regulations advance national and international security interests, account for potential benefits to the United States of exporting UAVs to trusted U.S. partners and allies, and address concerns regarding UAV technology proliferation.

The working group applied both descriptive and prescriptive approaches to its work. The *descriptive* framework reviewed what security and industry developments will impact UAV export control policies at the national and international level. The *prescriptive* framework reviewed what changes, if any, should be made at the international agreement level — to U.S. export regulations and policies, and to U.S. Department of Defense acquisitions and operations policies — to account for international security developments, technological advances in UAV systems, and the evolving ways — both military and civilian — in which UAV systems are being used.

To focus our work, the working group agreed on three main assumptions that would form the basis for our analysis and recommendations:

- National and international security must remain at the forefront of U.S. UAV policy.
- Policymakers should continually ensure international and U.S. controls are appropriately focused on achieving clearly articulated security objectives as UAV technology evolves.
- Conversely, policymakers should seek to avoid unnecessary restrictions on UAV exports, which could undermine U.S./allied security by suppressing UAV research and development and promoting sales of UAVs by countries that are not close U.S. allies.

THEMATIC ISSUES AND BACKGROUND INFORMATION

The goal of export controls on any defense item is to strike a proper balance between directly suppressing the harmful proliferation of U.S. defense technology on one hand and encouraging the global competitiveness and technological edge of the U.S. defense industrial base on the other. Export control agreements and regulations that place too much emphasis on one side of the ledger do not optimally preserve U.S. national security. For example, a theoretical blanket ban on the export of U.S. defense items would, to a great extent, ensure that U.S. weaponry does not fall into the wrong hands. However, such a ban would severely undercut the ability of U.S. defense firms to invest in research and development while driving defense sales to and improving the innovation capacities of other nations, some unfriendly. On the other extreme, a policy of unrestricted defense exports might increase the revenue and resources of U.S. defense firms in the near term, but other nations gaining both weaponry and technological know-how would both threaten U.S. national security directly and undermine the United States' ability to shape international defense transfers in the long term.

The question of how to strike the right balance in the UAV context is challenging. UAV technology and its military and civilian applications have greatly evolved in recent years and will continue to do so, perhaps dramatically. The changes taking place in the UAV market makes it necessary for U.S. policymakers to continually evaluate international agreements and U.S. export controls applicable to UAVs to ensure that U.S. and international controls best protect U.S. national security interests.

BACKGROUND ON UAV INDUSTRY & MARKETS

UAVs are a lucrative technology with a growing international and domestic market in both the military and civilian sectors. Analysts believe that the global UAV market will more than double in the next ten years, from the current $6.4 billion to around $11.5 billion a year.[1] The United States is a global leader in the production of UAVs, and exports them around the world. However, other countries have growing UAV production capabilities and are increasing their market share globally.

U.S. Industry Capabilities

The United States has an established UAV manufacturing infrastructure. Today, the United States maintains a dominant position in UAV production and operation, particularly in military applications. A lack of consistent data on individual UAV exports, however, makes it difficult to ascertain the total value of U.S. UAV exports. Data from the Stockholm International Peace Research Institute (SIPRI) database indicates that the United States has authorized the export of at least $3 billion in UAV items over the span of 20 years (1994–2014),[2] but that data is incomplete and industry experts have estimated that U.S. UAV export authorizations from 2005-2012 alone were between $2 and $3 billion.[3]

A majority of UAVs produced in the United States are considered "mini-UAVs" and used for intelligence, surveillance, and reconnaissance (ISR) missions. The United States currently exports UAVs to 21 countries, including Italy and the United Kingdom. These two countries are the predominant recipients of Category I UAVs from the United States, according to SIPRI.[4]

The United States does not yet have a robust domestic commercial market for UAVs, as regulations currently limit UAV flights in national airspace. The Federal Aviation Administration (FAA) originally stat-

ed that UAVs would be integrated into the national airspace no later than September 30, 2015.[5] After missing this deadline, the FAA has stated that it expects rules to be in place by June 2016.[6] Given previous delays in the agency's rulemaking process, it is uncertain that the FAA will meet that deadline. Nonetheless, once U.S. civilian airspace is opened to UAVs, the market for commercial UAVs is expected to grow rapidly and considerably.

Non-U.S. Industry Capabilities

A number of countries export UAV platforms and technology. According to the SIPRI Arms Transfer Database, fifteen countries, including the United States, have exported whole UAV platforms.[7] Israel is the largest UAV exporter, with UAVs exported to 30 different countries, including to the United States. Industry experts have estimated that Israel exported $4.62 billion in UAV technology from 2005 to 2012.[8] China is also an emerging UAV exporter.

Unlike the United States, other countries — such as Israel and South Africa — have incorporated UAVs into their national airspace.[9] As a result, international production of UAVs for civilian commercial use production will outstrip U.S. production of such platforms over the next ten years.[10]

Defense Markets for UAVs

The defense market for UAVs was estimated to be approximately $6 billion annually worldwide. UAVs purchased in the defense market generally are for ISR missions, but also may feature technologies necessary for targeted strikes, among other military applications. While the defense market — and the UAV market more broadly — predominately involves the transfer of the less-sensitive MTCR Category II technologies, the more-sensitive Category I technologies have been exported on a smaller scale. For example, the United States has sold Category I platforms to France, Germany, Italy, NATO, and the United Kingdom, and sales of these platforms have been approved for Australia, Japan, the Netherlands, and South Korea, though they have not yet been delivered. Additionally, a Category I lease was approved for Switzerland.

Defense market analysts believe that growth in UAVs for cargo delivery and in Unmanned Combat Air Vehicles (UCAVs) will likely grow as the market for this technology expands. UAVs have already been employed for delivering cargo in Afghanistan. However, there is some skepticism that UAVs can be used for cargo delivery outside of Afghanistan and similar conflict environments.[12] Several European air forces have expressed interest in acquiring UCAVs, but little development has been seen in this area as of yet.[13]

It is projected that mini-UAVs will be the fastest growing portion of the defense UAV market.[14]

Civil Government and Commercial Markets for UAVs

Industry analysts have identified two markets for significant UAV sales growth: the civil (non-defense) government market and the commercial market. According to estimates, the civil government market will experience the most growth, with applications for law enforcement and public safety the first to develop. However, these estimates remain subject to changes in U.S. federal aviation regulation. Reports note that the civilian UAV market will remain small over the next ten years if regulatory changes to grant UAVs access to national airspace occur more slowly than projected.[15]

As the civil government market for UAVs expands, analysts project that paramilitary applications will see the most growth initially. These applications include coast guard and border patrol-monitoring opera-

tions.[16] Following the paramilitary market, public safety and precision agriculture markets are expected to develop exponentially. The Association for Unmanned Vehicle Systems International (AUVSI) projects that these markets will eventually comprise approximately 90 percent of future UAV sales, with agriculture being the larger of the two.[17] AUVSI forecasts that 100,000 UAV units will be sold per year from 2015 to 2025.[18]

In total, AUVSI predicts UAV integration into the U.S. national airspace will contribute $82.1 billion to the U.S. economy, with agriculture applications comprising $75.6 billion of that total, public safety $3.2 billion, and all other uses comprising $3.2 billion.[19]

BACKGROUND ON INTERNATIONAL CONTROL REGIMES APPLICABLE TO UAVS

Two multilateral regimes lay the groundwork for export controls on UAV technology: the Missile Technology Control Regime and the Wassenaar Arrangement. The MTCR controls exports of missile technology, a category that covers UAVs due to their potential utility as a platform for WMD delivery. The Wassenaar Arrangement establishes procedures to promote transparency in the transfer of conventional weapons and dual-use items, including UAVs.

Background on Missile Technology Control Regime

The MTCR arose from National Security Decision Directive 70 (1982), in which President Reagan ordered the negotiation of a new international export control policy to prevent the proliferation of nuclear-capable missiles able to strike from a significant distance. Thirty-four governments formally adhere to the MTCR, agreeing to "coordinate national export licensing efforts" to prevent the proliferation of "unmanned delivery systems capable of delivering weapons of mass destruction."[20] Other nations, such as Israel and China, claim to adhere to the MTCR but are not official signatories.[21] These non-members implement national export control regulations consistent with the agreement and adopt a process of information exchanges and demarches among its signatories in order to enforce accountability.

The MTCR governs the export of UAVs and separates the technology into Category I and Category II systems. The U.S. and six other close allies crafted the specific 300km/500kg definition for Category I UAVS to tightly control unmanned systems capable of delivering relatively unsophisticated nuclear weapons. This definition has been the centerpiece of the MTCR for more than 26 years. At the time of the MTCR's negotiation, there were no non-cruise missiles capable of reaching the 300km/500kg Category I threshold, but manufacturers soon built up to that definition and then exceeded it, such as with the well-known Reaper and the Global Hawk models. As a result of this rapidly evolving technology, in the late 2000s, the MTCR members considered making exceptions to the Category I export rules for certain UAVs that exceeded the 300km/500kg threshold, but determined not to do so.

The MTCR requires that Category I items be subject to a strong presumption of denial for export licensing. As a result, Category I exports are rare and only occur if a "government (a) obtains binding government-to-government undertakings embodying the assurances from the recipient government [and]…(b) assumes responsibility for taking all steps necessary to ensure that the item is put only to its stated end-use."[22] The transfer of Category I production facilities is prohibited.[23] For items that fall under Category I and II, the following factors must be taken into consideration before exporting:

- Concerns about WMD proliferation;
- The current capabilities and potential objectives of the recipient state's missile programs;

- How the transfer might impact potential development of unmanned delivery systems for WMD;
- The assessment of end-use transfers, including assurances from the recipient state;
- The applicability of other relevant multilateral agreements; and
- The risk that missiles might fall into the hands of terrorists or individuals.[24]

Category II includes: (i) complete UAV systems that do not fall under Category I and that have a range equal to or greater than 300 km; and (ii) UAVs that have an autonomous flight control and navigation capability or the capability of controlled flight out of the direct visual range of a human and incorporate an aerosol dispensing system with a capacity greater than 20 liters.[25]

Category II items were initially subcomponents of Category I systems. However, in 1993, Category II controls on rockets and UAVs were broadened to cover complete systems capable of flying 300 km range with any payload. This change was designed to cover systems capable of delivering chemical and biological payloads, which could be far lighter than nuclear payloads.

Category II technology is permitted for export, but requires a governmental review and licensing process.

For both Category I and II items, the MTCR imposes a "no-undercut rule" prohibiting an exporter from undercutting another member's export denial unless the two exporters first consult one another.

Wassenaar Arrangement

The Wassenaar Arrangement is a voluntary international agreement established to promote greater transparency and accountability for international arms transfers, and to protect against "destabilizing accumulations" of certain conventional weapons and dual-use technologies. The Arrangement is currently comprised of 41 member countries, including the United States. Wassenaar members agree to institute national policies, derived from Wassenaar-adopted best practices for export and transfer that ensure the responsible transfer of conventional weapons and dual-use items. Members are encouraged to report on arms transfers and export denials of controlled items to "countries of concern" that are not part of the regime.[26] With these provisions, Wassenaar seeks to prevent unauthorized transfers or re-transfers of items contained within two control lists — one for munitions and the other for dual-use goods and technologies.

UAVs and corresponding systems are controlled under category 9 of the Arrangement's Dual-Use List. This includes:

- UAVs that can be flown out of the direct visual range of the human operator, or which have an autonomous flight control and navigation capability;
- Equipment designed to control UAVs;
- Systems of navigation, attitude, guidance or control which are specifically designed for UAVs;
- Equipment and components designed to convert a manned aircraft to a UAV;
- Engines specifically designed or modified to propel UAVs to altitudes above 50,000 feet;
- Equipment specifically designed for production of UAVs and associated systems and equipment; and
- Software specifically designed or modified for use in UAVs.[27]

The Wassenaar Munitions List controls Remote Piloted Air Vehicles (RPVs), UAVs, autonomous programmable vehicles, as well as accompanying launch and recovery equipment, ground support equipment, and equipment for command or control. The Munitions List also limits reciprocating engines designed for UAVs.[28]

The United States has previously made a number of proposals to expand the range of UAV technology covered by the Arrangement. Specifically, the United States proposed the addition of equipment and components designed to convert a manned aircraft to a UAV, of engines specifically designed or modified to propel UAVs to altitudes above 50,000 feet, and further refinement of navigation, attitude, guidance and control systems.[29] These proposals were subsequently adopted and are reflected in the dual-use control list.

Arms Trade Treaty and United Nations Register of Conventional Arms

The Arms Trade Treaty (ATT), which was adopted by the UN General Assembly in April 2013, will have some impact on UAV exports. Although not listed specifically in the scope of the Treaty, the categories of conventional arms included in the United Nations Register of Conventional Arms are referenced in the text of the ATT. During the UN Register's most recent review, the Panel of Governmental Experts concluded that UAVs are included within the fourth and fifth categories of the Register (combat aircraft and attack helicopters, respectively). Thus, States that are party to the ATT will be required to apply the Treaty's prohibitions and export assessment obligations to transfers of UAVs. In other words, the ATT widens the controls on UAVs from the more limited membership of the MTCR and Wassenaar Arrangement and requires certain States to undertake a more rigorous level of control on UAV exports than existed previously.

Criticisms of MTCR and Wassenaar

While the MTCR and Wassenaar Arrangement are intended to limit the proliferation of missile technology, many have questioned their efficacy in achieving this aim. While the two agreements differ in scope, it is useful to consider these criticisms together.

First, there are parallel concerns with the member-nation structure of the MTCR and Wassenaar. There is a concern that some of the major producing nations of UAV technology — including Israel, China and Iran — are not members of Wassenaar or the MTCR and therefore could become key proliferators of UAV technology. Israel is currently the largest exporter of UAV technology by unit, and China and Iran are increasing their capacity to produce advanced UAVs and have already begun to export ISR UAVs.[30] Some observers are concerned that the criteria for entry into the MTCR and Wassenaar regimes — which exclude certain countries that have engaged in past proliferation activities — hinder effective anti-proliferation controls. Analysts argue that the barriers create a club mentality — "one group of states with control and access, and another group of states disenfranchised from power"[31] — that could prove counterproductive to the goals of standardizing technology export controls.

Second, a recent GAO report has expressed concern that the Wassenaar lists do not contain certain dual-use technologies which "are critical to the development of UAV programs in certain countries of concern; however, they are difficult to control because they have other commercial applications."[32]

BACKGROUND ON CURRENT U.S. EXPORT CONTROLS AND POLICIES

The United States Government announced a classified new U.S. Export Policy for Unmanned Aerial Systems, with an unclassified summary, in February 2015. The policy reinforced that the United States implements MTCR and Wassenaar obligations through two export control regulatory frameworks: the International Traffic in Arms Regulations (ITAR) and the Export Administration Regulations (EAR). The

ITAR, administered by the U.S. Department of State's Directorate of Defense Trade Controls (DDTC), regulates the export and reexport of a broad range of military items. The EAR, administered by the U.S. Department of Commerce's Bureau of Industry and Security (BIS), regulates the export and reexport of less militarily-sensitive, civilian, or dual-use items. Both classes of items are subject to different export licensing requirements and policies.

ITAR and EAR Control Lists

The ITAR and EAR contain lists of articles, services, and technical data to identify those categories of items that fall under their respective jurisdiction. The ITAR contains the U.S. Munitions List (USML, 22 C.F.R. § 121.1). Category VIII of the USML, titled "Aircraft and Related Articles," lists, among other items, certain unmanned aerial vehicles, component parts, and the technical data necessary to design and manufacture those vehicles and parts. The Category VIII listings indicate which items are also subject to MTCR restrictions. The USML also contains the MTCR Annex, and identifies specific categories cross-referenced to the corresponding USML listing, although the MTCR Annex has not been updated in many years and therefore is not current in various areas.

Items related to UAVs listed on the USML include:

- Unarmed military unmanned aerial vehicles;
- Armed unmanned aerial vehicles;
- Military intelligence, surveillance, and reconnaissance aircraft;
- Target drones;
- Optionally piloted vehicles;
- UAV flight control systems and vehicle management systems with swarming capability;
- Ship-based launching and recovery equipment specially designed for UAVs controlled under the USML and land-based variants thereof;
- Inertial navigation systems, aided or hybrid inertial navigation systems, Inertial Measurement Units, and Altitude and Heading Reference Systems specially designed for UAVs controlled under the USML aircraft controlled in this category;
- Bomb racks, missile launchers, missile rails, weapon pylons, pylon-to-launcher adapters, UAV launching systems, and external stores support systems for UAVs, drones, or missiles;
- Radar altimeters with output power management or signal modulation low probability of intercept capabilities for UAVs, drones, or missiles; and
- Electronic assemblies and components capable of operation above 257 degrees Fahrenheit that are specially designed for UAVs.

The EAR contains the Commerce Control List (CCL, 15 C.F.R. § 774, Supp. 1), which covers certain categories of non-military and dual-use UAV items as well as UAV parts and components that are "specially designed" — a functional phrase with a technical meaning that captures certain parts not specifically listed — for a military UAV other than those parts specifically identified on the USML. The CCL also covers technology required for the development, production, operation, installation, maintenance, repair, overhaul, or refurbishing of certain listed items.

ITAR and EAR Licensing Policies

Compared to other technologies, UAVs are subject to highly restrictive U.S. licensing requirements and procedures that greatly limit the ability of manufacturers to export UAV items, particularly of a military nature. U.S.-origin Category I UAV transfers generally must be Foreign Military Sales administered through the U.S. government (although exceptions are possible).

All UAV items listed on the ITAR's USML are subject to strict export licensing requirements. This means that these items may not be exported to certain nations subject to U.S. arms embargoes and that exports to any other nation require DDTC review and licensing. The standard of licensing review that the DDTC will apply depends on which MTCR category a USML-listed UAV item falls under. If a UAV item is a MTCR Category I item (i.e., capable of delivering a payload of at least 500 kilograms to a range of at least 300 kilometers), it faces a presumption of license denial. If it is a MTCR Category II item, it is reviewed on a case-by-case basis. According to a February 2015 State Department Fact Sheet entitled "U.S. Export Policy for Unmanned Aerial Systems," this case-by-case review will now consider several criteria, as follows:

- Sales and transfers of sensitive systems to be made through the government-to-government Foreign Military Sales program;
- Review of potential transfers to be made through the Department of Defense Technology Security and Foreign Disclosure processes;
- Each recipient nation to be required to agree to end-use assurances as a condition of sale or transfer;
- End-use monitoring and potential additional security conditions to be required; and
- All sales and transfers to include agreement to principles for proper use.[33]

The EAR's CCL controls UAV items for missile technology, national security, and/or anti-terrorism reasons, meaning that exports of such items to any country other than Canada require a license. The BIS reviews each license on a case-by-case basis, weighing the characteristics of the UAV item, its destination, proposed end-use and end-user, among other factors. For any items controlled for missile technology reasons (potential WMD delivery systems), the Departments of Defense, State, Energy, and Commerce review the license application. The agencies apply MTCR guidelines and additional factors, consider intelligence information, and determine if the transaction would pose an unacceptable risk or provide material assistance to a missile program of concern.

The EAR also contains a "catch-all" provision that requires exporters to obtain a license for the transfer of any item — even if non-controlled — if they know or are informed that the item will be used in the design, development, or production of UAVs with a range equal to or greater than 300 kilometers.

Licensing Provisos & Manufacturer Modification Practices

The Departments of State and Commerce normally issue export licenses with certain provisos that place conditions on exports. With regard to missile technology and UAVs, this has taken the form of "anti-tamper" provisos that require technological features that prevent the militarization, weaponization, or changes to controlled exports.

In light of proliferation concerns and past agency licensing practices, exporters also at times modify their UAV technologies in order to obtain a lower standard of scrutiny in export license applications and increase their chances of gaining license approval. For instance, in 2010, General Atomics modified its Predator UAV model so that it could not be fitted with weapons, creating a new UAV model that fell into MTCR Category

II instead of Category I. By virtue of this change and the resulting lower threshold of export license review, General Atomics was able to obtain an export license for sales of the Predator XP to certain foreign nations.

BACKGROUND ON THE U.S. NATIONAL SECURITY CONCERNS AND BENEFITS RELATED TO UAV EXPORTS

Security Concerns Presented by Proliferation of UAV Technology

The threat of weapons of mass destruction ("WMD") has dominated not just U.S. national security policy-making, but also has been a central security concern of America's partners and allies. Because of this central concern, the MTCR has focused on limiting the proliferation of missiles capable of delivering WMD — from 1987 to 1993 only nuclear weapons, and from 1993 to the present on nuclear, biological, and chemical weapons. Large UAVs present the threat of nuclear weapons delivery, while smaller UAVs are capable of delivering biological and chemical weapons. These threats are exacerbated by certain advantages that UAVs have over manned aircraft and ballistic missiles — namely, potentially lower costs for the platforms, lower risks to human personnel, ease of concealment, and endurance capability.[III]

Small UAVs are an acute chemical and biological WMD threat due to their ability to release weaponized aerosols in a patterned manner that is more efficient than delivery by ballistic missiles. As the technical and cost barriers for creating chemical and biological agents continue to decline[34], and as the cost of UAVs continues to fall, the proliferation risk of UAV-delivered chemical and biological WMD increases. As stated in the 2008 report of the Congressionally-mandated Commission on the Prevention of WMD Proliferation and Terrorism, "[t]errorists are more likely to be able to obtain and use a biological weapon than a nuclear weapon."[35] That report urged governmental efforts to "aggressively limit the proliferation of biological weapons and reduce the prospect of a bioterror attack." That conclusion supports strong international controls on one of the most effective means of delivery: UAVs.

UAVs may also present a destabilizing force between nations should their use become more widespread. Because UAVs are remotely piloted and do not transport individual persons, nations may be more willing to use them to violate the sovereign airspace of other nations. And nations whose sovereignty is violated may be more willing to use force against UAVs. The frequency of military incidents between nations may increase with the spread of UAV technology, which could in turn raise the risk of miscalculation and escalation of hostilities.

Security Benefits of Export of UAV Technology

While the export of UAV technology raises proliferation concerns, certain benefits may arise for both international and U.S. national security if UAVs are exported under appropriate safeguards.

First, the export of U.S.-produced UAVs to allied and partner military customers enhances U.S. military cooperation with those nations. The use of similar UAVs by the U.S. and partner nations could promote interoperability and improve the effectiveness of joint operations. Also, in certain situations, the United States may wish to enhance ISR capabilities of partner nations so they can effectively carry out missions that advance U.S. interests in areas and conflicts in which the U.S. military is not deployed. Additionally, broader use of U.S.-produced technology encourages foreign militaries to consult with and rely on U.S. military counterparts and manufacturers, thereby helping expand U.S. influence worldwide.

[III] While UAVs are widely presumed to be less expensive than manned aircraft, cost assessments can vary significantly depending on the methods used to define "costs" of operation and use. Moreover, costs alone are not a sufficient measure for assessing the cost-effectiveness of a given platform, as seemingly expensive aircraft may be more cost-effective than less expensive platforms depending on the mission.

Second, although overall security concerns should trump the individual economic interests of specific industrial firms, UAV exports strengthen the UAV capabilities of the U.S. defense and aerospace industrial base as a whole. Access to foreign markets diversifies and broadens the customer base of U.S. manufacturers, better insulating them from downturns in the U.S. economy, changes and delays in FAA regulations to integrate UAVs into domestic airspace, and in cuts to U.S. defense spending budgets. This results in certain security benefits for the U.S. For example, more predictable cash flows and profits will encourage the industry to make deeper investments in research and development, enabling the U.S. to maintain a military technological edge. And greater sales abroad may reduce the per unit cost of UAVs to the U.S. Department of Defense, leading to budget efficiencies that can be invested in other parts of the armed forces.

Third, wider U.S. dominance of the world market discourages other nations from producing and perhaps proliferating their own indigenous UAV capabilities. Strict U.S. export controls on commercial satellite technology over the past 15 years spurred other nations to produce their own capabilities, undermining the main security objective of the export controls.[36] Under this view, the United States risks making the same mistake with current controls on UAV technology and instead should opt for a measured strategy that promotes U.S. technology internationally but allows the United States to maintain better control over which nations receive U.S.-origin UAV technology.

In discussing the security benefits of UAV exports, it is important to recognize that this rationale may be affected by the export controls other nations place on their own UAV technology. If other nations place strict controls on such technology, the risk that their technologies will proliferate is lessened. And if other nations' defense and aerospace companies are highly constrained, that decreases the urgency of lifting U.S. UAV export controls out of fear that other nations will claim the benefits of greater military cooperation and international market share. In such a scenario, the United States may decide that its defense spending budget for UAVs will continue to be larger than foreign budgets — even amidst defense spending reductions — and that such defense spending will allow the United States to maintain a qualitative edge in UAV capabilities.

It is also important to consider whether expanded exports of UAVs are the only path to realizing the security benefits outlined above. One alternate path may be the sale of UAV services to other nations for both military and civilian commercial use, rather than the sale of complete systems. If such a business model is feasible, the United States might be able to secure the benefits of interoperability, greater influence, enhanced allied battlefield capabilities, and suppression of foreign indigenous UAV capability development without having to transfer ownership of technology to foreign entities. Additionally, a more open and accessible U.S. UAV market could potentially experience dramatic growth and help provide adequate defense industrial base stability and lower per unit costs for the Department of Defense.

RECOMMENDATIONS & ANALYSIS

1. Enhanced Background Analysis of UAV Industry and Security Issues

The working group has three specific recommendations to foster enhanced background analysis by the U.S. government of developments in the UAV industry and the national and international security concerns related to UAVs.

A. Review economic trends in U.S. and non-U.S. UAV markets, the size of those markets, and commercial viability, through a Commerce Department defense industrial base study.

The working group recommends that the Commerce Department conduct a defense industrial base study of the UAV industry. This study would be similar in nature and scope to the industrial base studies done for the imaging satellite and night vision industries.[37] Like those past studies, a comprehensive evaluation of the UAV industry and its likely growth will provide the U.S. inter-agency policy officials with an understanding of the economic and security dynamics that should inform U.S. export control policy on UAVs. Current estimates of the domestic and global UAV markets are generally based on studies conducted by industry entities. The lack of reliable U.S. governmental reports has led to wide gaps in the knowledge of policymakers regarding research, development, and production capabilities of U.S. UAV manufacturers, foreign availability of UAV technology, and future trends in the industry's development. A UAV industrial base study should analyze both domestic and foreign markets, and gauge the level of foreign availability of UAV technology.

B. Clearly identify current/expected security concerns so that the full range of international and U.S. controls can be focused and appropriate.

The potential adverse effects on U.S. national security as well as the potential benefits to U.S. national security of UAV exports are straightforward. As explained previously, the traditional concern of UAV export controls has been the potential of UAVs to act as WMD delivery systems and to destabilize relations between nations by encouraging more cross-border incursions and related retaliations. The traditional benefits of greater UAV exports are boosting the capability of allied nations, enhancing allied interoperability, strengthening the U.S. defense industrial base's innovation capacity, and discouraging indigenous weapons development by other nations.

However, as a matter of U.S. policy, it is unclear how the U.S. government assesses and prioritizes these concerns and benefits. It is also unclear whether the U.S. government has adequately forecasted future security concerns posed by UAV technology apart from the traditional focus on WMD delivery potential.

To the extent the U.S. government has not conducted a full analysis of security concerns, security benefits, and future developments, it should do so and clearly establish security priorities against which U.S. export control regulations and U.S. participation in multilateral control regimes can be properly calibrated. A full analysis should include the following three elements:

i. Analyze the impact of the MTCR presumption of denial relating to Category I UAVs on identified U.S. security interests, including the presumption's nonproliferation benefits and the extent to which the presumption may foster the growth of foreign UAV providers, reducing U.S. government influence and the qualitative U.S. technological edge.

The working group recommends that the U.S. government analyze whether the Category I presumption of denial will have a significant negative impact on the ability of U.S. industry to participate in foreign military or commercial markets to the detriment of maintaining a sufficiently robust defense industrial base and a qualitative U.S. military technological edge.

The result of this analysis will inform whether possible changes to how the U.S. government implements the MTCR Category I presumption of denial are necessary. The working group recommends some possible changes to policy in the additional recommendations of this section.

The working group recommends that the U.S. government take into account the following considerations as it studies the effect of the Category I presumption of denial on U.S. industry.

First, the MTCR limits do not affect the UAV industry's access to the domestic U.S. market, which itself is a large fraction of the world market. Second, foreign UAV manufacturers are generally regulated by governments that are MTCR members or that claim to observe MTCR restrictions, and are therefore subject to the same market access disadvantages as the United States, and also do not have wide access to the large U.S. market. Third, only two U.S. firms (General Atomics and Northrop Grumman) currently export Category I UAVs, and they are military systems. Three more — Boeing, L3, and Lockheed Martin — are in various stages of marketing their military systems. Another, Aurora, has leased its Centaur Category I UAV to Switzerland. Fourth, the FAA is expected to initially limit commercial UAVs to a takeoff weight of 55 pounds and to expand the limits in a "staged" manner as the FAA gains experience in UAV regulation and collects data. This means that substantial use of commercial UAVs will be delayed for about a decade within the United States. Fifth, most of the commercial UAV applications currently predicted — observation, agricultural spraying, small package delivery — involve small payloads and would not approach MTCR limits. Finally, large UAVs that exceed the 300 km/500 kg threshold are expensive and U.S. defense programs are already exhibiting a greater preference for cheaper, lighter systems that take advantage of ever-lighter electronic payloads. These factors make it unclear that the 300km/500kg threshold for presumption of export denial will hamper U.S. exports significantly in the next several years.

Moreover, a revision of Category I UAV controls could encourage the liberalization of other missile non-proliferation restrictions. As stated above, the quarter-century-old 300km/500kg rule is the centerpiece of the MTCR. If it is liberalized, this could spur other MTCR liberalization initiatives beyond UAVs. It took one and-a-half years of difficult negotiations to extend Category I coverage to space launch vehicles ("SLVs"), the technology that is most interchangeable with that of ballistic missiles. However, some have proposed liberalizing the SLV controls. Similarly, manufacturers of large missile defense interceptors — which, like SLVs, contain ballistic missile technology — have advocated for liberalized controls. Starting in 2003, the U.S. government itself joined in calling for such reforms. Before making reforms to MTCR Category I definitions, the prudence of liberalizing other parts of the nonproliferation regime should be considered.

ii. Analyze the potential security concerns posed by exports of UAVs, whether or not covered by Category I criteria, to identify characteristics that pose particular concerns (e.g., speed, radar cross-section, swarming capability, surveillance payload, low observable features, armor, anti-aircraft countermeasures);

As explained in the background section, the MTCR Category I / Category II distinction is largely aimed at preventing the proliferation of WMD delivery vehicles. However, UAVs — depending on how they are designed and equipped — may present a multitude of security concerns beyond WMD delivery. For example, a fleet of small UAVs (that would fall outside of Category I) may have a highly lethal and highly evasive "swarming" capability. Other characteristics that might present concerns could include: high rates of speed, robust surveillance payloads, low observable features, and anti-aircraft countermeasures.

In light of the overall lack of transparency and specificity regarding current U.S. concerns about UAV exports, the U.S. government should analyze the particular characteristics of UAV technology currently available and that may be available in the future to determine which pose serious security risks. The U.S. Government should then articulate the current and future security concerns of UAV exports, subject to restrictions on transparency in classified areas such as Low Observable-Counter Low Observable ("LO/CLO") and anti-tamper technology.

A deeper and more clearly articulated analysis of UAV capabilities will better inform U.S. export control policy to ensure that it is focusing on UAV technology of true security concern, versus relying on a dated MTCR category distinction.

C. As a follow-up to the DSB 2012 report on autonomous defense systems, initiate a DSB study that examines how best to leverage commercial UAV R&D to enhance military UAV capabilities.

In July 2012, the DSB published a study of the role of autonomous/unmanned technology in military systems currently and in the future.[38] It examined current and future battlefield applications for unmanned systems, current military research in such systems, and constraints on such systems presented by military doctrine and personnel capabilities. This study, initiated in 2010, is valuable for examining how to optimize UAV technology to enhance U.S. military capabilities. However, in light of current fiscal constraints on the Department of Defense budget, the more pressing goal for U.S. policy makers is how to optimize military capabilities *in a constrained defense budget environment*.

In light of that goal, a new DSB study should be initiated that explores: (i) how best to prioritize UAV technology, (ii) how to leverage UAV R&D that is occurring in the commercial space toward military applications, (iii) the mission impact of reducing military R&D and relying on commercial R&D, and (iv) the fiscal impact of relying on commercial rather than military R&D projects.

2. Technology Release Licensing Policies of the United States and its Allies Should Be Consistent with UAV Industry and Security Analysis

The working group has three specific recommendations to encourage the development of better policy guidance regarding U.S. security concerns related to UAVs.

A. Develop internal U.S. government licensing guidance that appropriately takes into account (1) industry trends, (2) the MTCR presumption of denial and its potential impacts, and (2) differences among UAVs (both Category I as well as Category II UAVs that pose particular concerns).

Upon completing the analyses suggested in recommendation 1(B), the United States should update its internal licensing guidance that accounts for the findings regarding the impact of the MTCR Category I presumption of denial on U.S. industry and regarding the specific capabilities of UAVs that pose security concerns.

First, while still preserving the presumption of denial, the U.S. government should consider developing guidance that allows licensing officers to factor into their decisions any benefits that would accrue to the U.S. defense industrial base and U.S. national security should a particular export license be granted. This guidance should not be aimed at merely benefiting a particular firm's bottom line. Instead, the guidance should focus on national security needs and directly extend from the U.S. government's assessment of how the MTCR Category I presumption of denial is impacting the overall technological edge of the nation in the UAV arena.

Second, the U.S. government should consider developing licensing guidance that focuses greater scrutiny on those UAV characteristics that pose security concerns. Such guidance can take one of two forms.

First, the new guidance could make it easier for some UAV systems that lack certain characteristics to overcome the MTCR Category I presumption of denial. For example, UAVs controlled under Category I but that cannot reach a certain speed or exhibit a certain radar cross-section could be deemed reduced threats as WMD delivery vehicles, such that licensing for export could be appropriate.

Before proceeding with such changes to its application of the Category I presumption of denial, the U.S. government should consider whether any liberalization of its export control and policies implementing the MTCR may destabilize an international consensus. The United States sets the standard of restraint among MTCR members, and looser U.S. restraint could lead to even less restraint by other exporters. It should be recognized that the current U.S. policy of "rare" and tightly controlled exceptions to the 300km/500kg presumption of denial has offered some flexibility for more than 26 years. Careful consideration is required before disturbing that longstanding rule.

Further, technical questions will arise as to whether new guidance or a definition can be crafted to adequately distinguish between those UAVs that pose a WMD risk and those that pose little to no WMD risk despite exceeding the 300km/500kg threshold. Taking the example of slow speed and large cross section criteria, it may appear at first that such lumbering UAV systems would be easy to shoot down and therefore pose little WMD risk. On the other hand, UAVs flying slowly at low altitude are difficult for ground-based air defenses to find because of the curvature and irregularity of the earth's surface. Slow-flying UAVs are also difficult to find from overhead because of the clutter of slow-moving ground vehicles. Second, most of the world's current conflicts involve targets without significant air defenses. Third, UAVs delivering WMD can operate in a standoff mode, releasing aerosols or powered munitions outside the defended area against targets within the defended area. Fourth, UAVs can be (and currently are being) equipped with light-weight penetration aids such as jammers, spoofers, infrared countermeasures, chaff, flares, and decoys. In sum, a technical definition of a "less sensitive" Category I UAV may be difficult to craft.

The second type of licensing guidance could make it more difficult to export certain Category II UAV systems. This guidance would counsel against the licensing of Category II UAV systems where they exhibit certain characteristics that pose security concerns. Using the "swarming" capability discussed earlier as an example, the U.S. government could mandate that any UAV system — whether Category I or Category II — that exhibits a certain level of swarming capability must overcome a presumption of license denial similar to the Category I presumption of denial.

B. Engage with U.S. allies and partners with significant UAV capabilities in order to promote a convergence of licensing policies with respect to Category I UAVs and other UAVs that pose particular security concerns.

The U.S. government should share with MTCR and Wassenaar partners any findings it makes regarding particular UAV characteristics that pose security concerns. It should also engage with these partners to promote uniform licensing policies that take into account these particular characteristics. Such engagement would enhance international security by encouraging better tailored export regimes not just in the United States, but in every nation in the world that currently implement UAV export controls.

However, the United States must conduct this engagement carefully so as not to destabilize the strong international consensus underlying the MTCR regime. As noted above, an initiative to modify the MTCR or its implementation may encourage greater liberalization of the MTCR controls than is wise.

C. For both commercial and military UAV exports, encourage the export of "UAV services" that would mitigate the impact from MTCR restrictions by allowing recipients to receive the benefits of Category I UAVs without the transfer of U.S. "jurisdiction or control" and, for Category II UAVs, mitigate the impact of strict controls on the export of UAVs posing particular concerns.

The U.S. government should consider whether the export of "UAV services" or alternative approaches involving Category II UAVs would mitigate any impact from MTCR restrictions. Export of UAV services would entail U.S. persons maintaining control of UAV systems for foreign clients and implementing missions. There would be no actual sale of UAV technology to foreign persons. This business model would not be subject to the MTCR restrictions on Category I UAV systems because the MTCR applies only to transfers "beyond the Government's jurisdiction or control."

In fact, the United States and other nations have provided UAV services for many years. The United States has provided military UAV services — chiefly sharing downloads of UAV sensor systems — in Afghanistan, Iraq, Pakistan, Libya, central Africa, Turkey, and Singapore among other sites. Such services entail the major advantages of tying the UAV operations into the United States' unrivaled intelligence and communications network. Other nations offer UAV services; for example, the Israeli military contracts for UAV services to monitor the Sinai. As Thomas Cassidy, former President and CEO of General Atomics, which developed the Predator, said, "The last thing a forward commander needs is to maintain and operate airplanes. What he needs is intelligence support — somebody looking and then piping video directly to him on a little TV set that we've already made for the special forces people." [39]

In spite of the advantages of linking with the U.S.'s military capabilities, some military partners may prefer ownership of UAV hardware rather than acquiring UAV services. Although "sovereignty" considerations may be stated as the reason for such a preference, there may be a parallel desire for a strategic attack capability. Turkey and Pakistan have declared interest in such a capability. Yet as long as UAV services provide a visible presence of UAVs in the partner nation (such as is apparently the case with the current Global Hawk deal with Japan), the distinction between hardware exports and services may be a less significant concern among close allies.

Commercial UAV services are an attractive growth area. Australia already offers such services for monitoring weather in the Pacific Ocean. There are already crop-duster services, and these could seamlessly transition into "precision application" of agricultural chemicals. If heavy cargo transports become a significant UAV activity, U.S.-controlled "Fed-Ex" type UAV services would make sense on a global basis. Very few commercial customers want to bother with buying, owning, and operating their own delivery vehicles. A subset of UAV services is "fee-for-service." This is a concept in which some or all of the costs of the UAV life cycle are recovered by financial arrangements. Fee-for-service, in one form or another, is likely to be the main model for commercial UAV services, giving manufacturers of UAVs the same financial benefits over time as outright sales. Depending on international arrangements and alliances, fee-for-service is an option for military applications.

3. U.S. Export Control (ITAR/EAR Reforms)

U.S. regulations on UAV exports should be as clear and administrable as possible, consistent with the Obama administration's Export Control Reform initiative. The working group has two recommendations to improve current U.S. export control regulations.

A. Provide greater clarity regarding the distinction between "unarmed military UAVs," which are controlled as defense articles under the ITAR, and commercial UAVs, which are controlled under the EAR

The current USML lists "unarmed military unmanned aerial vehicles" as controlled under the highly restrictive ITAR. On the other hand, non-military or commercial UAVs are controlled under the less restrictive CCL of the EAR. It is unclear in these provisions how exporters are to distinguish between those unarmed UAVs that are "military," and therefore subject to the ITAR, and those that are civilian or commercial, and therefore subject to the EAR. Consistent with the aims of the U.S. government's export control reform initiatives, greater clarity could be brought to this distinction that would allow exporters to better allocate their research and development funds.

Specifically, the U.S. government could establish technical criteria based on current military technology that will subject UAV technology to ITAR control (e.g., resolution capability of surveillance payload, low observable features, armor, anti-aircraft countermeasures), and continually update these criteria to keep up with technological change. Other UAV technology — whether meant for military or civilian use — should be controlled under the less restrictive EAR.

B. Review use of "anti-tamper" (anti-repurposing) conditions that are applied to U.S. export licenses to ensure that they are applied to sensitive UAV technologies in a consistent and transparent fashion that takes into account cost-effectiveness and focuses less on hardware conditions and more on software conditions where possible.

The working group recommends that State and Commerce prudently apply anti-tamper/anti-purposing provisos to export licenses. Use of provisos requiring measures to prevent tampering or repurposing of UAV technology for military uses can be useful tools to maximize U.S. commercial interests while preserving U.S. national security. However, the working group recommends that the U.S. government be vigilant in ensuring that such provisos are applied only to those technologies and UAV categories for which they are appropriate. In some instances — particularly when requiring UAV hardware changes — these provisos may not be completely effective and also may introduce changes to the manufacturing process that are cost-prohibitive.

Further, excessive anti-tamper measures may have an undue impact on the sale of non-military UAVs to commercial customers for whom some level of customization of the UAV is valuable. Before such provisos are required, careful study of the technology must be conducted. The working group believes that more frequent consideration should be given to anti-tamper/anti-repurposing measures applied to encryption software or communications and sensor technologies rather than to hardware, as such changes are more cost-feasible and can more precisely target military capabilities.

4. Defense Department UAV Acquisition and Operation Policy

The working group recommends that the U.S. Department of Defense consider four specific initiatives to support the U.S. UAV industry and better preserve U.S. national security interests.

A. Promote use of the Defense Exportability Features (DEF) program in the UAV context to encourage integration of adequate protections on sensitive technology earlier in the design and development process.

The Defense Exportability Features program is a U.S. Department of Defense program that funds the design and development of major defense acquisition projects meant for non-U.S. use.[40] These projects incorporate exportability features from early stages to ensure suitability for export. The DEF should be specifically applied toward developing UAV technology to assist U.S. manufacturers in creating features and technical limits that enable items to be exported. DEF funds are replenished through non-recurring cost recoupment in future foreign military sales, cooperative program MOUs reached with other nations, or direct commercial sales contracts for sale or transfer of DoD systems benefiting from exportability investments.

B. Consider government encouragement of co-development/co-production with industry in allied or partner nations to share costs, promote interoperability, and mitigate impacts on the defense industrial base from export restrictions

With respect to Category II UAVs, to mitigate the importance of exports to U.S. UAV manufacturers, the U.S. government should consider ramping up efforts to develop UAV technology together with MTCR member nations whose UAV capabilities the U.S. seeks to bolster. Such co-development projects have the benefits of cost-sharing, the promotion of defense interoperability between allies, and the ability to incorporate exportability features into the design of the technology during the development stage.

As part of the more general inquiry into whether the 300 km/500 kg MTCR Category I distinction best serves national security interests, the U.S. government should consider whether limiting co-development projects with this threshold undermines mutual security needs.

C. Ensure reasonable across-the-board anti-tamper requirement for sensitive UAV technology.

The Defense Department should consider an across-the-board anti-tamper requirement for all U.S.-origin UAVs it acquires, in order to mitigate the negative effects from the potential loss of a UAV in inhospitable territory to a hostile nation. While controls on the export of UAV technology are important, regulators should keep in mind that by their nature, military UAVs will be flown across borders and frequently into nations to which the United States does not authorize sensitive defense exports. Losing a UAV to one of these nations either due to malfunction, pilot error, or hostile action would constitute a proliferation risk in much the same way that the export of UAV technology would.

Any blanket anti-tamper requirement should be focused on the mission of preventing the hostile nation from obtaining valuable information about the design and mission of the UAV, therefore mitigating the risks that the requirement would be overly broad and place undue and unnecessary costs on U.S. manufacturers.

D. Encourage greater protections against unauthorized dissemination of UAV technical data from the U.S. government inventory.

Surveys of the UAV systems of foreign nations that are not authorized to receive exported U.S. UAV defense articles reveal striking similarities with U.S. UAV technology. [41] This indicates that foreign nations may be obtaining U.S. UAV technical data through unauthorized and covert means. U.S. export controls have been generally successful at preventing the export of certain UAV systems, particularly those that fall under MTCR Category I. However, such success is not the same as preventing foreign nations from acquiring such technology by any and all means. U.S. policy should therefore broaden its focus so that non-proliferation measures account not only for the legal export market, but also address other avenues by which non-partner nations acquire U.S. UAV technology.

CONCLUSION

As the technological capabilities of UAVs become more sophisticated and both the military and commercial demand for UAVs grow, it is essential that regulators review multilateral and U.S. export controls to ensure that U.S. security interests are best preserved. In doing so, regulators must balance the security advantages of enhancing UAV capabilities of allied and partner nations and strengthening the U.S. defense industrial base against the possible pitfalls of increasing UAV use around the world and loosening long-standing multilateral and U.S. export control rules applicable to UAV technology.

Striking the right balance will require thorough research that produces reliable information on UAV market dynamics and technology. Such information will enable the U.S. government to project the impact of any change in UAV export controls. Due to time and resource constraints, the working group has limited ability to provide the range and depth of information required to make these difficult policy decisions. However, the working group has applied its collective experience to identify the key areas of research and analysis on which the government should focus its resources.

APPENDIX 1: UAV SYSTEMS AND COMPONENTS COVERED BY THE MTCR

Category	Item	Sections that Apply to UAV Exports
I	1	UAV systems (including target drones and reconnaissance drones) that are able to deliver a payload[III] of at least 500 kilograms and that are able to fly more than 300 kilometers (now termed as Category I UAV Systems) "Software[IV] which coordinates the function of more than one subsystem, specifically designed or modified for use" in Category I UAV systems "Technology…for the development, production or use of equipment or software" of Category I UAV systems
I	2	Guidance sets[V] under complete subsystems usable in Category I UAV systems, that are "capable of achieving system accuracy of 3.33% or less of the range (e.g. a circle of equal probability (CEP)[VI] of 10 km or less at a "range" of 300 km)"[VII] "Weapons or warhead safing, arming, fuzing, and firing mechanisms"[VIII]
II	3	Turboprop engine systems[IX] and components which are specifically designed for Category II UAV systems with a range of over 300 km and that have a maximum power greater than 10 kW (excluding civil certified engines) "Ramjet/scramjet/pulse jet/'combined cycle engines', including devices to regulate combustion, and specially designed components" for Category I and Category II-over 300 km UAV systems Materials that make up the interior lining and insulation of usable rocket motor cases for both Category I and Category II-over 300 km UAV systems.[X] High energy density materials used in Category I and Category II-over 300 km UAV systems including: "Mixed fuels that incorporate both solid and liquid fuels, such as boron slurry, having a mass- based energy density of 40 x 106 J/kg or greater; Other high energy density fuels and fuel additives (e.g., cubane, ionic solutions, JP-10) having a volume-based energy density of 37.5 x 109 J/m3 or greater, measured at 20oC and one atmosphere (101.325 kPa) pressure."[XI]
II	6	"Composite structures, laminates, and manufactures thereof" designed or modified for Category I and Category II-over 300 km UAV systems,[XII] as well as production materials, technology and software for producing these materials. Materials for the fabrication of missile components in Category I and Category II-over 300 km UAV systems.[XIII]
II	9	"Integrated flight instrument systems which include gyrostabilisers or automatic pilots,"[XIV] designed or modified for Category I and Category II-over 300 km UAV systems Integrated navigation systems designed or modified for Category I and Category II-over 300 km UAV systems. Integrated navigation systems includes: "an inertial measurement device (e.g. an attitude and heading reference system, inertial reference unit, or inertial navigation system); One or more external sensors used to update the position and/or velocity, either periodically or continuously throughout the flight (e.g. satellite navigation receiver, radar altimeter, and/or Doppler radar); and Integration hardware and software." Linear accelerometers, designed for use in inertial navigation systems or in guidance systems designed or modified for Category I and Category II-over 300 km UAV systems
II	10	Hydraulic, mechanical, electro-optical, or electromechanical flight control systems as well as altitude control systems designed or modified for Category I UAV systems

II	11	Radar and laser radar systems, including altimeters, and receiving equipment for Global Navigation Satellite Systems used in Category I UAV systems. This includes "passive sensors for determining bearings to specific electromagnetic sources (direction finding equipment) or terrain characteristics,"[XV] designed or modified for use in this system.
II	12	"Apparatus and devices, designed or modified for the handling, control, activation and launching of"[XVI] Category I and Category II-over 300 km UAV systems. This includes gravity meters and "vehicles designed or modified for the transport, handling, control, activation and launching of"[XVII] Category-I UAV systems "Elementary and telecontrol equipment, including ground equipment, designed or modified for systems"[XVIII] for Category I and Category II-over 300 km UAV systems. "Tracking systems which use a code translator installed on the rocket or unmanned aerial vehicle in conjunction with either surface or airborne references or navigation satellite systems to provide real-time measurements of inflight position and velocity; and Range instrumentation radars including associated optical/infrared trackers with all of the following capabilities: Angular resolution better than 1.5 mrad; Range of 30 km or greater with a range resolution better than 10 m rms; and Velocity resolution better than 3 m/s."[XIX]
II	13	Analogue computers, digital computers or digital differential analysers "which are rated for continuous operation at temperatures from below -45 C to above +55C; or Designed as ruggedised or "radiation hardened""[XX] and designed or modified for Category I UAV systems
II	15	Vibration test equipment for Category I and Category II-over 300 km UAV systems, including: vibration test systems employing feedback or closed loop techniques and incorporating a digital controller, capable of vibrating a system at an acceleration equal to or greater than 10 g rms between 20 Hz and 2 kHz while imparting forces equal to or greater than 50 kN, measured 'bare table'; Digital controllers, combined with specially designed vibration test "software", with a 'real-time control bandwidth' greater than 5 kHz and designed for use with vibration test systems."[XXI]
II	17	"Devices for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures (i.e. stealth technology)."[XXII] This also includes software and technology of these devices, as well as materials and production technology.
II	19	Complete UAV systems that do not fall under Category I that have a range equal or greater to 300 km—including target and reconnaissance drones UAVs having an a) autonomous flight control and navigation capability or b) the capability of controlled flight out of the direct vision range involving a human and that incorporate an aerosol dispensing system/mechanism with a capacity greater than 20 liters or that has been designed or modified to incorporate this feature fall under Category II (Item-19). "Software which coordinates the function of more than one subsystem, specifically designed or modified for "use" in" UAV systems (both reconnaissance and target) that extend to a range equal or greater than 300 km. Technology that can be used for the development, production or use[XXIII] in UAV systems (both reconnaissance and target) that extends to a range equal or greater than 300 km[XXIV]

APPENDIX 1 NOTES

[III] The MTCR defines payload generally as the "the total mass that can be varied or delivered by the specified rocket system of unmanned aerial vehicle (UAV) system that is not used to maintain flight. MTCR further defines payload for UAVs as: "munitions of any type; mechanisms and devices for safing, arming, fuzing or firing; countermeasures equipment that can be removed without violating the structural integrity of the vehicle. Signature alteration equipment that can be removed without violating the structural integrity of the vehicle; equipment required for a mission such as data gathering, recording or transmitting devices for mission-specific data and supporting structures that can be removed without violating the structural integrity of the vehicle; recovery equipment that can be removed without violating the structural integrity of the vehicle; munitions supporting structures and deployment mechanisms that can be removed without violating the structural integrity of the vehicle." See Missile Technology Control Regime. Equipment, Software and Technology Annex. April 25, 2014. Accessed October 1, 2014. http://www.mtcr.info/english/MTCR%20TEM%20Technical%20Annex%20as%20of%202014-04-25.pdf. 12.

[IV] The MTCR defines "Software" as: "a collection of one or more "programmes" or "micro-programmes," fixed in any tangible medium of expression." Further, it defines programmes as: "a sequence of instructions to carry out a process in, or convertible into, a form executable by an electronic computer." And defines "micro-programmges" as: "a sequence of elementary instructions maintained in a special storage, the execution of which is initiated by the introduction of its reference instruction register." Ibid., 10-12.

[V] According to the MTCR "a guidance set integrates the process of measuring and computing a vehicle's position and velocity (i.e. navigation) with that of computing and sending commands to the vehicle's' flight control systems to correct the trajectory." Ibid. 18.

[VI] MTCR defines CEP as "a measure of accuracy, defined as the radius of the circle centered at the target, at a specific range, in which 50% of the payloads impact." Ibid., 18.

[VII] MTCR, Equipment, Software and Technology Annex, 17.

[VIII] Ibid., 18.

[IX] Includes Turboshaft engine; and Power transmission system to transfer the power to a propeller.

[X] MTCR, Equipment, Software and Technology Annex, 22-23.

[XI] Ibid., 29.

[XII] Ibid., 35.

[XIII] Ibid., 38.

[XIV] Ibid., 43.

[XV] Ibid., 51.

[XVI] Ibid., 54.

[XVII] Ibid.

[XVIII] Ibid.

[XIX] Ibid.

[XX] Ibid., 57.

[XXI] Ibid., 60.

[XXII] Ibid., 66.

[XXIII] Includes: operation, installation (including on-site), maintenance, repair, overhaul, refurbishing. MTCR, Equipment, Software and Technology Annex, 14.

[XXIV] Ibid., 71.

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NOTES

1. These numbers include R&D and procurement expenditures. See: *Teal Group Predicts Worldwide UAV Market Will Total $91 Billion in its 2014 UAV Market Profile and Forecast*. Teal Group Corporation, July 17, 2014. Accessed October 5, 2014. http://www.tealgroup.com/index.php/about-teal-group-corporation/press-releases/118-2014-uav-press-release

2. Stockholm International Peace Research Institute (SIPRI). "Arms Transfers Trade Registers." Accessed April 23, 2015. http://portal.sipri.org/publications/pages/transfer/trade-register.

3. See Goldberg, Tia. "Israel leads global drone exports as demand grows." Associated Press, June 5, 2013. Accessed October 29, 2013. http://bigstory.ap.org/article/israel-leads-global-drone-exports-demand-grows; Meyer, Josh. "Why Israel dominates global drone exports." Quartz, July 10, 2013. Accessed October 29, 2013. http://qz.com/102200/why-israel-dominates-global-drone-exports/.

4. Other countries of destination for U.S. UAV exports include: Australia, Colombia, Czech Republic, France, Germany, Iraq, Japan, Lithuania, Malaysia, Netherlands, Philippines, Poland, Romania, Singapore, South Korea, Sweden, Switzerland, Turkey, and the United Arab Emirates. Italy and the United Kingdom are the most frequent recipients of Category I UAVs.

5. US Department of Transportation. Federal Aviation Administration (FAA). *Unmanned Aircraft Systems (UAS) Comprehensive Plan: A report on the nation's UAS path forward*. September 2013. Accessed November 11, 2013. http://www.faa.gov/about/office_org/headquarters_offices/agi/reports/media/UAS_Comprehensive_Plan.pdf.

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9. *World Unmanned Aerial Vehicle Systems, Market Outlook*. Fairfax, VA: Teal Group Corp., 2013. 12.

10. Ibid., 16.

11. Ibid., 7.

12. Ibid.,10.

13. Ibid., 9.

14. US Department of Transportation. Federal Aviation Administration (FAA). *Aerospace Forecast Fiscal Years 2013-2033*. March 19, 2013. Accessed October 1, 2014. http://www.faa.gov/about/office_org/headquarters_offices/apl/aviation_forecasts/aerospace_forecasts/2013-2033/media/Unmanned_Aircraft_Systems.pdf.

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16. Other areas of initial non-defense government use are likely to include forest fire patrol, as well as FBI and international police organizations, although these applications are noted as being more distant and likely on a smaller scale than other uses mentioned.

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18. Ibid., 6.

19. Ibid., 11.

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21. Members of the MTCR include: Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Korea, Russian Federation, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, and the United States.

22. MTCR, *Guidelines*.

23. Ibid.

24. Ibid.

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32. US GAO, *Nonproliferation*, 21.

33. US Department of State, Fact Sheet, "U.S. Export Policy for Military Unmanned Aerial Systems" (Feb. 2015), available at http://www.state.gov/r/pa/prs/ps/2015/02/237541.htm.

34. The bioweapons threat is likely to worsen significantly, due to the fast pace of the ongoing biotechnology revolution and its tendency to facilitate the development of bioweapons without highly skilled scientific resources. The recent H5NI bird flu experiments in Dutch and U.S. laboratories demonstrated that mutant H5NI strains can be developed that spread the disease more easily among mammals. "Black box" technology will automate many of the processes previously requiring human skills. Polymerase chain reaction ("PCR") machines are now commonly used in laboratories to easily amplify and manipulate segments of DNA, while the BioBrick project, inaugurated at MIT in 2003, not only automates gene synthesis but has established a goal to produce synthetic living organisms using standard BioBrick parts. Such a mating of engineering and synthetic biology may have a revolutionary impact on human health, but would also exacerbate the future threat of biological weapons.

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36. US Department of Commerce (DOC). Bureau of Industry and Security. *U.S. Space Industry "Deep Dive" Assessment: Impact of U.S. Export Controls on the Space Industrial Base*. February 2014. Accessed October 1, 2014. http://www.bis.doc.gov/index.php/forms-documents/doc_view/898-space-export-control-report. 15.

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UAV EXPORT CONTROLS AND REGULATORY CHALLENGES

Working Group Report

The Stimson Task Force on U.S. Drones Policy issued its report and recommendations in June 2014. The task force was supported by three expert working groups focused on different aspects of U.S. drones policy: ethics and law; export controls and regulatory challenges; and military utility, national security, and economics. The three working groups met periodically and provided detailed background, invaluable insights, and context to task force members, including key data points, topics for consideration, and potential recommendations. Each working group has produced a background report with its own recommendations, conclusions, and issues for further research.

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