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SUMMARY

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Since the dawn of military aviation, the U.S. military has been interested in remotely piloted aircraft. Present-day unmanned aircraft systems (UAS) typically consist of an unmanned aircraft vehicle (UAV) paired with a ground control station. UAS have become ubiquitous in U.S. military operations since the 1990s with the introduction of the MQ-1 Predator.

The U.S. military currently employs several different large UAS, including

- the Army's MQ-1C Gray Eagle,
- the Air Force's MQ-9 Reaper,
- the Navy's MQ-25 Stingray,
- the Air Force's RQ-4 Global Hawk,
- the Navy's MQ-4C Triton, and
- the Air Force's RQ-170 Sentinel.

In addition, several other reported programs are either in development or currently undergoing experimentation. These programs include the Air Force's B-21 Raider and the Air Force's RQ-180.

As Congress performs its oversight and authorization functions, it may consider several potential issues associated with UAS programs, including

- the cost of manned versus unmanned aircraft,
- a lack of acknowledged follow-on programs of record,
- the management of UAS acquisitions across the Department of Defense,
- the interoperation of UAS with existing force structure, and
- export controls of UAS abroad.

Contents

Figures

Tables

Contacts

In the U.S. military, remotely piloted vehicles (RPVs) are most often called unmanned aircraft vehicles (UAVs), which are described as either a single air vehicle (with associated surveillance sensors) or a UAV system (UAS), which typically consists of an air vehicle paired with a ground control station (where the pilot actually sits) and support equipment.[1] Although UAS are commonly operated as one aircraft paired with one ground system, the Department of Defense (DOD) often procures multiple aircraft with one ground control station. When combined with ground control stations and communication data links, UAVs form unmanned aircraft systems or UAS.

The Department of Defense (DOD) defines UAVs, and, by extension, UAS as powered aircraft that

- do not carry a human operator,
- use aerodynamic forces to provide vehicle lift,
- can fly autonomously or be piloted remotely,
- can be expendable or recoverable, and
- can carry a lethal or nonlethal payload.[2]

Ballistic or semiballistic vehicles, cruise missiles, and artillery projectiles are not considered UASs under the DOD definition.[3]

UAS roles and missions have evolved over time, from collecting intelligence, surveillance, and reconnaissance to performing air-to-ground attack missions. Further, some analysts predict future roles for UAS, such as air-to-air combat and combat search and rescue.[4] However, a detailed discussion of future concepts and missions for UAS are outside the scope of this report.[5]

History of Unmanned Aircraft Systems (UAS)[6]

UAS were first tested during World War I, though they were not used in combat by the United States during that war. The United States first employed UAS in a combat role in the course of the Vietnam War, including the AQM-34 Firebee, a system which exemplifies the versatility of UAS. The Firebee, for example, initially flew in the 1950s as an aerial gunnery target drone, and then in the 1960s as an intelligence-collection drone, and ultimately was modified to deliver payloads in 2002.[7]

[1] This arrangement is applicable for the larger UAS. For smaller UAS, there is typically a single aircraft with a single ground control system.

[2] Joint Publication 1-02, "DOD Dictionary of Military and Associated Terms."

[3] Ibid.

[4] Department of Defense, *Unmanned Aircraft System Roadmap 2005-2030*, Washington, DC, August 4, 2005, at https://irp.fas.org/program/collect/uav_roadmap2005.pdf.

[5] For a detailed discussion of UAS roles, missions, and future concepts see CRS Report R47188, *Unmanned Aircraft Systems: Roles, Missions, and Future Concepts*, coordinated by John R. Hoehn.

[6] This section is derived from CRS Report R42136, *U.S. Unmanned Aerial Systems*, by Jeremiah Gertler.

[7] National Museum of the Air Force, "Ryan BQM-34 Firebee," press release, at https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/198026/ryan-bqm-34-firebee/.

The U.S. military use of UAS in conflicts such as Kosovo (1999), Iraq (2003-present),[8] and Afghanistan (2001-present) illustrates the advantages and disadvantages of unmanned aircraft.[9] (The MQ-1 Predator, discussed below, further exemplifies these advantages and disadvantages). UAS regularly garner media attention when they perform tasks historically performed by manned aircraft. They also seem to offer two main advantages over manned aircraft: (1) they eliminate the risk to a pilot's life (see the discussion on MQ-4C) and (2) their aeronautical capabilities, such as endurance, are not bound by human limitations and improve low observable technology using inherently unstable designs that might be too dangerous for humans.[10] In addition, UAS can potentially protect the lives of pilots by performing "dull, dirty, or dangerous" missions that do not require a pilot in the cockpit.[11] Examples of these missions include a 30-hour long endurance sortie performed by a B-2 bomber in 1999 (dull mission)[12]; Air Force and Navy B-17s flown through nuclear clouds to collect radioactive samples (dirty mission)[13]; and, intelligence surveillance and reconnaissance sorties flown in the presence of active threats, such as man portable air defenses or integrated air defense systems (dangerous missions).[14]

Moreover, UAS may be cheaper to procure and operate than manned aircraft.[15] However, the lower procurement cost may potentially be weighed against DOD's observation that unmanned vehicles are more likely than piloted ones to be involved in a Class A mishap, which is an accident causing $2.5 million of damage, loss of life, or the destruction of the aircraft (**Table 1**).[16] When comparing mishap rates, which are reported as incidents per 100,000 hours flown to allow for comparisons across different aircraft types, unmanned aircraft are 92% more likely to be involved in a Class A mishap compared to manned aircraft;[17] when MQ-1 mishap rates are removed from the unmanned subcategory, MQ-9s and RQ-4s are 15% more likely to be involved

[8] Chad Garland, "Attack drones keep up harassment at al Asad, leading to latest shootdown," *Stars and Stripes*, January 6, 2022, at https://www.stripes.com/theaters/middle_east/2022-01-06/coalition-thwart-drone-attack-iraq-asad-iran-proxies-4200232.html.

[9] Although the United States withdrew ground forces from Afghanistan in 2021, it continues to operate UASs there as part of its "over the horizon" capability to monitor events. John Venable, *U.S. Over-the-Horizon Capability for Afghanistan*, The Heritage Foundation, FS218, Washington, DC, September 7, 2021, at https://www.heritage.org/defense/report/us-over-the-horizon-capability-afghanistan.

[10] Low observable aircraft are those designed to be difficult for an enemy to detect. This characteristic most often takes the form of reducing an aircraft's radar signature through careful shaping of the airframe, special coatings, gap sealing, and other measures. Stealth also includes reducing the aircraft's signature in other ways, as adversaries could try to detect engine heat, electromagnetic emissions from the aircraft's radars or communications gear, and other signatures. Minimizing these signatures is not without penalty. Shaping an aircraft for stealth leads to different choices than shaping for speed. Shrouding engines and/or using smaller powerplants reduces performance; reducing electromagnetic signatures may introduce compromises in design and tactics. Stealthy coatings, access port designs, and seals may require higher maintenance time and cost than more conventional aircraft.

[11] Department of Defense, *Unmanned Aircraft System Roadmap 2005-2030*, Washington, DC, August 4, 2005, at https://irp.fas.org/program/collect/uav_roadmap2005.pdf.

[12] Ibid, p. 2.

[13] Ibid, p. 2.

[14] Ibid, p. 2.

[15] Congressional Budget Office, *Usage Patterns and Costs of Unmanned Aerial Systems*, 57090, Washington, DC, June 1, 2021, at https://www.cbo.gov/system/files/2021-06/57090-UAS.pdf.

[16] DOD defines a Class A mishap as causing $2.5 million or more worth of damage to an aircraft, the total destruction of an aircraft, or an accident resulting in a fatality. Department of Defense, *Mishap Notification, Investigation, Reporting, and Record Keeping*, DoDI 6055.07, Washington, DC, June 6, 2011, at https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/605507p.pdf.

[17] The figures are CRS calculations based on data from Air Force Safety Center Data, at https://www.safety.af.mil/Divisions/Aviation-Safety-Division/Aviation-Statistics/.

in a Class A mishap compared to manned aircraft (see **Table 1**). While manned aircraft generally have more Class A mishaps in totality when compared to unmanned platforms, this outcome is potentially the result of a larger population of manned aircraft.[18]

Table 1. Aircraft Mishap and Destruction Rates Between FY1998-FY2021

Platform	Class A Mishaps	Airframes Destroyed	Total Hours Flown	Class A/ 100,000 Hrs.	Destroyed/ 100,000 Hrs.
MQ-1[a]	130	115	2,076,397	6.26	5.54
MQ-9[a]	62	43	2,673,310	2.32	1.61
RQ-4[a]	9	7	311,280	2.89	2.25
Unmanned	**201**	**165**	**5,060,987**	**3.97**	**3.26**
F-22	32	5	410,202	7.80	1.22
F-16	148	119	6,358,547	2.33	1.87
F-15	65	38	3,302,821	1.97	1.15
A-10	20	17	2,378,464	0.84	0.71
U-2	8	2	345,083	2.32	0.58
E-3	1	0	450,150	0.22	—
E-8	3	0	222,783	1.35	—
F-35[b]	3	0	96,313	3.11	—
Manned	**280**	**181**	**13,564,363**	**2.06**	**1.33**

Source: CRS Analysis of Air Force Safety Center Data, at https://www.safety.af.mil/Divisions/Aviation-Safety-Division/Aviation-Statistics/.

Note: Subtotals of unmanned and manned mishap rates are denoted in bold.

a. Denotes unmanned platforms.

b. F-35 data represents FY1998-FY2019, which is the current calculations reported by the Air Force Safety Center.

DOD has generally used three models to operate UAS: (1) government-owned–and-operated systems, (2) government-owned-but-contractor operated systems, and (3) contractor-owned-and-operated systems.[19] When UAS were first introduced to the force, DOD used the contractor-owned-and-operated model as DOD trained military personnel to operate these new types of aircraft. After sufficient personnel were trained, DOD transitioned to a government-owned-and-operated model. DOD, however, has placed restrictions on the types of missions assigned to contractor-operated aircraft (with both government and contractor-owned aircraft), limiting these types of operations to intelligence, surveillance, and reconnaissance roles.[20]

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[18] U.S. Air Force *Department of the Air Force FY2022 Budget Overview*, Washington D.C., May 28, 2021, p. 58, at https://www.saffm.hq.af.mil/Portals/84/documents/FY22/SUPPORT_/FY22%20Budget%20Overview%20Book.pdf?ver=SMbMqD0tqIJNwq2Z0Q4yzA%3d%3d.

[19] Frank Gorenc, "The Case for Medium Altitude Persistent Air Power," *Breaking Defense*, June 10, 2020, at https://breakingdefense.com/2020/06/the-case-for-medium-altitude-persistent-air-power/.

[20] This limitation was most recently demonstrated with the Marine Corps' operation of MQ-9s in Afghanistan in 2018. Joseph Trevithick, "Marines Lay Out Plans For Their Own MQ-9 Reaper Drone Force In New Budget Request," *The Warzone*, March 12, 2019, at https://www.thedrive.com/the-war-zone/26924/marines-lay-out-plans-for-their-own-mq-9-reaper-drone-force-in-new-budget-request.

MQ-1 Predator and the Introduction of UAS

One of the first UAS to enter military service was the MQ-1 Predator, when DOD in 1996 selected the Air Force to operate the Predator. According to the Air Force, the Predator was designed to "provide to the warfighter persistent intelligence, surveillance, and reconnaissance information combined with a strike capability."[21] As an advanced concept technology demonstrator under a Defense Advanced Research Projects Agency (DARPA) contract,[22] the Predator made its first operational deployment while still serving as a technical demonstrator in 1995 in support of NATO airstrikes in Serbia.[23] From March through July 1999, the Predator flew more than 600 sorties over Kosovo, performing real-time surveillance and battle damage assessments. Predators deployed to Afghanistan in September 2001 to provide long endurance intelligence, surveillance, and reconnaissance in support of Operation Enduring Freedom, following the terrorist attacks on September 11, 2001. The wide employment of the Predator by U.S. forces facilitated the development of other closely related UAS (described below) designed for various types of missions. Although the Predator was officially retired from service on March 9, 2018, much of the U.S. military's current UAS fleet is based on that same technology, including airframes derived from the Predator.[24]

Developed by General Atomics Aeronautical Systems in San Diego, CA, the Predator helped define the modern role of UAS with its integrated surveillance payload and armament capabilities.[25] The Predator's primary function was reconnaissance and target acquisition of potential ground targets. To accomplish this mission, the Predator was outfitted with a 450 pound surveillance payload, which included two electro-optical (EO) cameras and one infrared (IR) camera for use at night.[26] These cameras were housed in a ball-shaped turret beneath the vehicle's nose. The Predator was also equipped with a Multi-Spectral Targeting System (MTS) sensor ball, which added a laser designator to the EO/IR payload that allowed the Predator to track moving targets.[27] In addition, the Predator's payload included a synthetic aperture radar (SAR), which enabled the UAS to "see" through inclement weather. The Predator's satellite communications provided for beyond (ground-based) radio line-of-sight operations.

MQ-1 Predator Physical Characteristics[28]

The Predator was a medium-altitude, long-endurance UAS. At 27 feet long, 7 feet high, and with a 48-foot wingspan, it had long, thin wings and a tail like an inverted "V." The Predator typically operated at 10,000 to

[21] U.S. Air Force, "MQ-1B Predator," press release, September 2015, at https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104469/mq-1b-predator/.

[22] IHS Janes "Unmanned Aerial Vehicles – GA-ASI MQ-1B and RQ-1A Predator," February 22, 2021, at https://customer.janes.com/Janes/Display/JUAV1317-JUAV.

[23] Ibid.

[24] Stephen Losey, "Air Force announces official retirement date for iconic MQ-1 Predator drone," *Air Force Times*, February 16, 2018, at https://www.airforcetimes.com/news/your-air-force/2018/02/16/air-force-announces-official-retirement-date-for-iconic-mq-1-predator/. Richard Whittle, *Predator: The Secret Origins of the Drone Revolution* (Henry Holt and Co., 2014).

[25] U.S. Air Force, "MQ-1B Predator," press release, September 2015, at https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104469/mq-1b-predator/.

[26] IHS Janes "Unmanned Aerial Vehicles – GA-ASI MQ-1B and RQ-1A Predator," February 22, 2021, at https://customer.janes.com/Janes/Display/JUAV1317-JUAV.

[27] Ibid.

[28] U.S. Air Force, "MQ-1B Predator," press release, September 2015, at https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104469/mq-1b-predator/.

15,000 feet to obtain the best imagery from its video cameras, although it was able to reach a maximum altitude of 25,000 feet. Each vehicle could remain on station over 500 nautical miles away from its base, for 24 hours before returning home. Pilots and sensor operators for the Predator flew the aircraft from a ground control system.

In 2001, as a secondary function, the Predator was outfitted with the ability to carry two Hellfire missiles.[29] Previously, the Predator identified a target and relayed the coordinates to a manned aircraft, which then engaged the target, but the addition of antitank ordnance enabled the UAS to launch a precision attack on a time-sensitive target with a minimized "sensor-to-shoot" time cycle. Consequently, the Air Force changed the Predator's military designation from RQ-1B (reconnaissance unmanned) to the MQ-1 (multi-mission unmanned).[30]

Following the operational success of the Predator, the Army and the Air Force both developed variants, including the MQ-1C Gray Eagle and the MQ-9 Reaper (discussed below). These aircraft used the original Predator airframe, while increasing engine power and armament.[31]

Selected Current UAS Programs

The following sections provide an overview of selected current UAS programs across DOD:[32]

- the Army's MQ-1C Gray Eagle,
- the Air Force's MQ-9 Reaper,
- the Navy's MQ-25 Stingray,
- the Air Force's RQ-4 Global Hawk,
- the Navy's MQ-4C Triton, and
- the Air Force's RQ-170 Sentinel.

Other than the RQ-170 Sentinel, which is an acknowledged classified UAS program, these selected systems have Selected Acquisition Reports, published by DOD, which provide detailed information and systems characteristics. **Table 2** provides a summary of the characteristics of these selected UAS.

Table 2. Summary of Characteristics of Selected Unmanned Aircraft

System	Length	Wingspan	Gross Weight	Payload Capacity	Speed	Endurance	Maximum Altitude
MQ-1C Gray Eagle	28 ft.	56 ft.	3,600 lb.	1,075 lb.	150 knots	27 hours	25,000 ft.
MQ-9 Reaper	36 ft.	66 ft.	10,500 lb.	3,850 lb.	240 knots	24 hours	50,000 ft.
MQ-25 Stingray[a]	51 ft.	75 ft.	—	—	—	—	—
RQ-4 Global Hawk	47.6 ft.	130.9 ft.	32,250 lb.	3,000 lb.	310 knots	34+ hours	60,000 ft.
MQ-4C Triton[a]	47.6 ft.	130.9 ft.	32,250 lb.	—	320 knots	24+ hours	50,000 ft.
RQ-170 Sentinel	15 ft.	65 ft.	Classified	Classified	Classified	Classified	Classified

[29] Ibid. For more information about the Hellfire missile see CRS Report R45996, *Precision-Guided Munitions: Background and Issues for Congress*, by John R. Hoehn.

[30] Ibid.

[31] IHS Janes, "GA-ASI MQ-1C Gray Eagle", May 22, 2020, at https://customer.janes.com/Janes/Display/JUAVA150-JUAV and IHS Janes "GA-ASI Predator B/MQ-9 Reaper/MQ-9B", October 21, 2021, at https://customer.janes.com/Janes/Display/JUAV9266-JUAV.

[32] The aircraft selected are large UAS, that are operational, and with the exception of RQ-170, have an associated Selected Acquisition Report.

Source: Analysis by CRS of data derived from DOD and contractor provided aircraft fact sheets.

Notes: Aircraft order in this table corresponds to the order of programmatic overview sections in this report.

a. Some characteristics not available.

MQ-1C Gray Eagle

The MQ-1C Gray Eagle (**Figure 1**) is an Army derivative of the MQ-1 Predator. According to the Army, the MQ-1C Gray Eagle "provides the warfighter with dedicated, assured, multi-mission UAS capabilities across all 10 Army divisions to support commanders' combat operations and Army Special Forces and Intelligence and Security Command."[33] The Army states that the MQ-1C Gray Eagle is able to fly at a maximum speed of 150 knots at an altitude of 25,000 feet for at least 27 hours.[34] It can carry four Hellfire missiles, along with electro-optical sensors, synthetic aperture radars, and communications relays.[35] According to the FY2021 Selected Acquisition Report, the Army's MQ-1C Gray Eagle flew more than 494,000 hours in FY2019, achieving a 92% combat operational availability.[36]

Figure 1. MQ-1C Gray Eagle

Source: U.S. Army Acquisition Support Center, at https://asc.army.mil/web/portfolio-item/aviation_gray-eagle-uas/.

In total, the Army has procured 204 aircraft, of which 11 are training aircraft and 13 are "operational readiness float aircraft" (i.e., spares). The average procurement unit cost of the system (essentially of a fully configured end item)[37] is $92.9 million.[38] The Army finished

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[33] U.S. Army, "MQ-1C GRAY EAGLE UNMANNED AIRCRAFT SYSTEM (UAS)," press release, November 5, 2021, at https://asc.army.mil/web/portfolio-item/aviation_gray-eagle-uas/.

[34] Ibid.

[35] General Atomics Aeronautical, "Gray Eagle Extended Range (GE-ER)," press release, November 5, 2021, at https://www.ga-asi.com/remotely-piloted-aircraft/gray-eagle-extended-range.

[36] Department of Defense, *Selected Acquisition Report (SAR), MQ-1C UAS Gray Eagle*, DD-A&T(Q&A)823-420, Washington, DC, December, 2019, at https://www.esd.whs.mil/Portals/54/Documents/FOID/Reading%20Room/Selected_Acquisition_Reports/FY_2019_SARS/20-F-0568_DOC_58_MQ-1C_Gray_Eagle_SAR_Dec_2019_Full.pdf.

[37] 10 U.S.C. §4351 defines the program unit cost as "the total of all funds programmed to be available or obligated for procurement of the program divided by ... the number of fully-configured end items to be procured." In the case of the MQ-1C, the end item unit is defined as the platoon set of equipment including four aircraft, four ground stations, and a series of ground support equipment. Ibid., p. 20.

[38] The MQ-1C SAR reports the total number of end items to be procured is 43 units. Ibid., p. 40.

operational test and evaluation of the MQ-1C Gray Eagle in August 2018 and currently operates the UAS in 15 Army companies.

MQ-9 Reaper[39]

The MQ-9 Reaper (**Figure 2**)—formerly the "Predator B"—is General Atomics' replacement for the MQ-1 Predator. According to the Air Force, the MQ-9 Reaper is a medium- to high-altitude, long-endurance UAS capable of surveillance, target acquisition, and armed engagement. Although the MQ-9 Reaper borrows from the overall design of the MQ-1 Predator, the MQ-9 Reaper is 13 feet longer with a 16-foot-longer wingspan. The MQ-9 Reaper also features a 900-hp turboprop engine, which is significantly more powerful than the MQ-1 Predator's 115-hp engine. These upgrades allow the MQ-9 Reaper to reach a maximum of 50,000 feet altitude, 240 knots airspeed, 24 hours endurance, and 1,400 nautical miles range.[40] However, the feature that most differentiates the MQ-9 Reaper from its predecessor is its ordnance capacity. While the MQ-1 Predator was able to carry two 100-pound Hellfire missiles, the MQ-9 Reaper can carry as many as 16 Hellfire missiles, equivalent to the payload capacity of the Army's Apache helicopter, or a mix of 500-pound weapons and Small Diameter Bombs.[41] Over the 2018 calendar year, MQ-9 Reapers flew a total of 325,000 hours—91% of those hours, or about 296,000, were flown in support of combat operations.[42]

Figure 2. MQ-9 Reaper

Source: U.S. Air Force, "An MQ-9 Reaper flies a training mission over the Nevada Test and Training Range, July 15, 2019 (U.S. Air Force photo by Airman 1st Class William Rio Rosado)," available at https://www.af.mil/News/Photos/igphoto/2002864740/mediaid/5461089/.

[39] This section is derived from CRS Report R42136, *U.S. Unmanned Aerial Systems*, by Jeremiah Gertler.

[40] U.S. Air Force, "MQ-9 Reaper Fact Sheet," press release, March 2021, at https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104470/mq-9-reaper/.

[41] For more information on the munitions capabilities, see CRS Report R45996, *Precision-Guided Munitions: Background and Issues for Congress*, by John R. Hoehn.

[42] Department of Defense, *Selected Acquisition Report (SAR), MQ-9 UAS Reaper*, DD-A&T(Q&A)823-424, Washington, DC, March 29, 2019, at https://www.esd.whs.mil/Portals/54/Documents/FOID/Reading%20Room/Selected_Acquisition_Reports/FY_2018_SARS/19-F-1098_DOC_09_Air%20Force_MQ-9_Reaper_SAR_Dec_2018_REDACTED.pdf.

In January 2021, General Atomics revealed a new maritime anti-surface warfare variant of the MQ-9 Reaper. The MQ-9B SeaGuardian is reportedly equipped with sonobuoy dispensing (dropping sensors designed to identify submarines) and remote sensing capabilities (most likely referring to the SeaGuardian's synthetic aperture radar used to search for surface ships) and is being tested in the Pacific.[43]

According to the FY2020 Selected Acquisition Report, the Air Force has contracted with General Atomics to build 366 MQ-9 Reapers over the life of the program.[44] The average procurement unit cost is $22.3 million in 2008 dollars (or approximately $28 million in FY2022 dollars).[45] In FY2022, the Air Force did not request to procure any MQ-9 Reapers, but the House Armed Services Committee authorized an additional six aircraft for procurement in its markup.[46]

MQ-25 Stingray

The MQ-25 Stingray (**Figure 3**), made by Boeing, is intended to provide aerial refueling for the Navy's carrier air wing. According to the Navy,

> MQ-25 will pioneer the integration of manned and unmanned operations, demonstrate mature complex sea-based C4I [command, control, communications, computers, and intelligence] UAS technologies, and pave the way for future multifaceted multi-mission UAS to outpace emerging threats. MQ-25 requirements address the need for carrier-based refueling and persistent Intelligence, Surveillance, and Reconnaissance capabilities.[47]

The MQ-25 Stingray consists of both an air vehicle and a control system designed to fit onto an aircraft carrier. Its first flight was conducted in September 2019. The MQ-25 Stingray is currently in the engineering, manufacturing, and design phase of the acquisition process, and the Navy plans to begin procurement in FY2023. According to the FY2021 Selected Acquisition Report, the Navy intends to procure 76 aircraft at an average procurement unit cost of $121 million.[48] The Navy studied several unmanned combat air vehicle concepts before settling on refueling as its first carrier-based UAS mission.

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[43] IHS Janes, "MQ-9," October 21, 2021, at https://customer.janes.com/Janes/Display/JUAV9266-JUAV.

[44] Department of Defense, *Selected Acquisition Report (SAR), MQ-9 UAS Reaper*, DD-A&T(Q&A)823-424, Washington, DC, March 29, 2019, at https://www.esd.whs.mil/Portals/54/Documents/FOID/Reading%20Room/Selected_Acquisition_Reports/FY_2018_SARS/19-F-1098_DOC_09_Air%20Force_MQ-9_Reaper_SAR_Dec_2018_REDACTED.pdf.

[45] The MQ-9 Reaper SAR reports 430 end item units to be procured. Ibid., p. 35. Calculation of inflation-adjusted dollars was done using the OSD Comptroller "Department of Defense Deflators – TOA By Public Law Title" table found at https://comptroller.defense.gov/Portals/45/Documents/defbudget/FY2022/FY22_Green_Book.pdf.

[46] H.R. 4350.

[47] Department of Defense, *Selected Acquisition Report (SAR), MQ-25 Stingray*, DD-A&T(Q&A)823-462, Washington, D.C., December 31, 2019, at https://www.esd.whs.mil/Portals/54/Documents/FOID/Reading%20Room/Selected_Acquisition_Reports/FY_2019_SARS/20-F-0568_DOC_62_MQ-25_SAR_Dec_2019_Full.pdf.

[48] The MQ-25 Stingray SAR reports 69 end item units will be procured. Ibid., p. 32.

Figure 3. MQ-25 Stingray

Source: U.S. Navy, "The MQ-25 unmanned carrier-based test aircraft comes in for landing after its first flight on September 19, 2019 at MidAmerica Airport in Mascoutah, Ill (Photo provided to the Navy source courtesy of Boeing)," available at https://www.navair.navy.mil/product/MQ-25tm-Stingray.

RQ-4 Global Hawk[49]

Northrop Grumman's RQ-4 Global Hawk (**Figure 4**) is the largest and one of the most expensive UAS currently fielded by the Air Force. The RQ-4 Global Hawk incorporates a diverse surveillance payload, with performance capabilities widely seen as rivaling or exceeding most manned spy planes. At 47.6 feet long and weighing 32,250 pounds,[50] the RQ-4 Global Hawk is about as large as a medium-sized corporate jet.[51] According to the Air Force, the RQ-4 Global Hawk flies at nearly twice the altitude of commercial airliners and can stay aloft at 65,000 feet for longer than 34 hours. It can fly to a target area 5,400 nautical miles away, loiter at 60,000 feet while monitoring an area the size of the state of Illinois (almost 58,000 square miles) for 24 hours, and then return. The RQ-4 Global Hawk was originally designed to be an autonomous drone capable of taking off, flying, and landing on preprogrammed inputs to the aircraft's flight computer; however, the Air Force routinely operates these aircraft with a mission control pilot and sensor operator.[52]

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[49] This section is derived from CRS Report R42136, *U.S. Unmanned Aerial Systems*, by Jeremiah Gertler.

[50] U.S. Air Force, "RQ-4 Global Hawk Fact Sheet," press release, October 2014, at https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104516/rq-4-global-hawk/.

[51] Congressional Budget Office, *Usage Patterns and Costs of Unmanned Aerial Systems*, 57090, Washington, DC, June 1, 2021, p. 2, at https://www.cbo.gov/system/files/2021-06/57090-UAS.pdf.

[52] U.S. Air Force, "RQ-4 Global Hawk Fact Sheet," press release, October 2014, at https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104516/rq-4-global-hawk/.

Figure 4. RQ-4 Global Hawk

Source: U.S. Air Force, "An RQ-4 Global Hawk takes off on October24, 2018, at Naval Air Station Sigonella, Italy (U.S. Air Force photo by Staff Sgt. Ramon A. Adelan)," available at https://media.defense.gov/2021/Sep/29/2002864274/-1/-1/0/181024-F-HK496-9035.JPG.

The RQ-4 Global Hawk currently is deployed in three configurations: Block 20, Block 30, and Block 40:

- Block 20, called the Battlefield Airborne Communications Node (BACN; pronounced "bacon"), serves as a communications relay for troops on the ground. Four aircraft are currently in this configuration.[53]
- Block 30 uses a combination of Synthetic Aperture Radar (SAR), Electro-optical/Infrared (EO/IR) sensors, the Enhanced Integrated Sensor Suite (EISS), and Airborne Signals Intelligence Payload (ASIP).[54] The original intent of Block 30 was to replace the U-2 spy plane. Twenty Block 30 aircraft are currently in service.
- Block 40 integrates multiplatform radar technology with ground-tracking capability (radars that can track ground forces similar to the E-8C JSTARS aircraft). Ten Block 40 aircraft are in service.

As of the FY2016 Selected Acquisition Report,[55] the RQ-4 Global Hawk had flown 140,000 flight hours (100,000 hours of which supported of combat operations).[56] 79.7% of aircraft were

[53] Department of Defense, *FY2022 U.S. Aircraft Procurement Volume II, RQ-4 Mods*, pp. 425-451.

[54] Ibid., p. 425.

[55] This is the most recent Selective Acquisition Report available for the RQ-4 Global Hawk.

[56] Department of Defense, *Selected Acquisition Report (SAR), RQ-4 Global Hawk*, DD-A&T(Q&A)823-252,

available for missions in 2014. The average procurement unit cost was $122.8 million in FY2014 (or $141.1 million in FY2022-adjusted dollars).[57] The President's FY2022 budget request restated the Air Force plan to retire all Block 20 aircraft in FY2021, and to retire all Block 30 aircraft in FY2022.[58]

MQ-4C Triton[59]

The Navy's MQ-4C Triton (**Figure 5**), which is also called the Broad Area Maritime Surveillance (BAMS) system, is based on the Global Hawk Block 20 airframe but uses different sensors to support maritime patrol operations alongside the P-8 Poseidon manned aircraft.[60] According to the FY2020 Selected Acquisition Report, "The mission sensors installed on the MQ-4C Triton provide 360 degree radar and Electro-Optical/Infrared coverage."[61] The report states that the Navy intended to reach initial operational capability in October 2020 and to make a full-rate production decision in May 2021.[62] In a 2019 annual report, the Director of Operational Test and Evaluation stated that the Navy concluded its operational assessment of the aircraft, which supported an early fielding decision.[63] The MQ-4C Triton has an average procurement unit cost of $146.1 million in FY2016 dollars (or approximately $162.6 million in FY2022 dollars).[64]

Washington, DC, March 18, 2015, at https://www.esd.whs.mil/Portals/54/Documents/FOID/Reading%20Room/Selected_Acquisition_Reports/FY_2014_SARS/15-F-0540_RQ-4AB_Global_Hawk_SAR_Dec_2014.PDF.

[57] The RQ-4 SAR reports 45 end item units will be procured. Ibid., p. 36. Calculation of inflation-adjusted dollars was done using the OSD Comptroller "Department of Defense Deflators – TOA By Public Law Title" table found at https://comptroller.defense.gov/Portals/45/Documents/defbudget/FY2022/FY22_Green_Book.pdf.

[58] Department of Defense, *FY2022 U.S. Aircraft Procurement Volume II*, *RQ-4 Mods*, pp. 425.

[59] This section is derived from CRS Report R42136, *U.S. Unmanned Aerial Systems*, by Jeremiah Gertler.

[60] U.S. Navy, *FY2022 Budget Request, Aircraft Procurement, Volume 1*, p. 189, at https://www.secnav.navy.mil/fmc/fmb/Documents/22pres/APN_BA1-4_Book.pdf. The P-8 Poseidon is a manned aircraft that functions as the U.S. Navy's maritime patrol and reconnaissance aircraft. U.S. Navy, "P-8A Poseidon Multi-mission Maritime Aircraft," available at https://www.navy.mil/Resources/Fact-Files/Display-FactFiles/Article/2166300/p-8a-poseidon-multi-mission-maritime-aircraft-mma/ (last updated Apr. 23, 2021).

[61] Department of Defense, *Selected Acquisition Report (SAR), MQ-4C Triton*, DD-A&T(Q&A)823-373, Washington, DC, April 16, 2019, at https://www.esd.whs.mil/Portals/54/Documents/FOID/Reading%20Room/Selected_Acquisition_Reports/FY_2018_SARS/19-F-1098_DOC_53_MQ-4C_Triton_SAR_Dec_2018.pdf.

[62] Ibid., p. 12.

[63] Robert Behler, *DOT&E FY2019 Annual Report*, Department of Defense Director of Operational Test and Evaluation, Washington, DC, January 30, 2020, p. 149, at https://www.dote.osd.mil/Portals/97/pub/reports/FY2019/navy/2019mq4c_uas.pdf?ver=2020-01-30-115519-423.

[64] Department of Defense, *Selected Acquisition Report (SAR), MQ-4C Triton*, DD-A&T(Q&A)823-373, Washington, DC, April 16, 2019, p. 30. The MQ-4 Triton SAR reports 65 end item units will be procured. Calculation of inflation-adjusted dollars was done using the OSD Comptroller "Department of Defense Deflators – TOA By Public Law Title" table found at https://comptroller.defense.gov/Portals/45/Documents/defbudget/FY2022/FY22_Green_Book.pdf.

Figure 5. MQ-4C Triton

Source: U.S. Navy, available at https://www.navair.navy.mil/product/MQ-4C.

In June 2019, the Iranian military shot down an MQ-4C Triton, which DOD referred to as a BAMS aircraft, in the Gulf of Oman.[65] According to a Navy press briefing, the aircraft was flying in the area to monitor the Strait of Hormuz for Iranian threats to commercial shipping. DOD officials stated, "This attack is an attempt to disrupt our ability to monitor the area following recent threats to international shipping and free flow of commerce."[66] At the time, the Trump Administration seemingly contemplated retaliatory strikes on Iran for destroying a U.S. aircraft, but reportedly determined that in responding to the loss of an unmanned aircraft, the risk of escalation was not worthwhile.[67]

RQ-170 Sentinel[68]

Although the RQ-170 Sentinel (also called "the Beast of Kandahar" in the press) is publicly acknowledged to exist, most information about it is classified. First photographed in the skies over Afghanistan, but also reportedly having operated from South Korea,[69] the RQ-170 Sentinel is a tailless "flying wing" stealthier than other current U.S. UAS.[70] An RQ-170 Sentinel was reported to have performed surveillance and data relay related to the operation against Osama bin

[65] Department of Defense, "Iran Shoots Down U.S. Global Hawk Operating in International Airspace," press release, June 20, 2019, at https://www.defense.gov/News/News-Stories/Article/Article/1882497/iran-shoots-down-us-global-hawk-operating-in-international-airspace/.

[66] Ibid.

[67] Michael D. Shear et al., "Strikes on Iran Approved by Trump, Then Abruptly Pulled Back," *New York Times*, June 20, 2019, at https://www.nytimes.com/2019/06/20/world/middleeast/iran-us-drone.html.

[68] This section is derived from CRS Report R42136, *U.S. Unmanned Aerial Systems*, by Jeremiah Gertler.

[69] Bill Sweetman, "Beast Sighted In Korea," *Aviation Week/Ares blog*, February 16, 2010.

[70] U.S. Air Force, "RQ-170 Sentinel Fact Sheet," press release, at https://www.af.mil/About-Us/Fact-Sheets/Display/Article/2796993/rq-170-sentinel/.

Laden's compound on May 1, 2011. The government of Iran claimed on December 2, 2011, to be in possession of an intact RQ-170 Sentinel following its alleged incursion into Iranian airspace.[71]

Built by Lockheed Martin, the RQ-170 Sentinel has a wingspan of about 65 feet, is almost 15 feet long, and is powered by a single jet engine.[72] It appears to have two sensor bays (or satellite dish enclosures) on the upper wing surface. Although the aircraft has an inherently low-observable blended wing/fuselage design like the B-2 stealth bomber, the RQ-170 Sentinel's conventional inlet, exhaust, and landing gear doors suggest a design that may not be fully optimized for stealth.[73]

According to the Air Force, "The RQ-170 Sentinel is a low observable unmanned aircraft system (UAS) being developed, tested and fielded by the Air Force."[74] No further official status is available.

Other Reported Programs

Although other UAS programs are in development, they are largely classified, so information about them is not publicly available. These programs include the B-21 Raider (a manned bomber reportedly capable of being piloted remotely) and the RQ-180. On December 4, 2021, Secretary of the Air Force Frank Kendall revealed that the Air Force intends to start two new UAS programs in FY2023, but no additional information is available.[75]

B-21 Raider[76]

The forthcoming B-21 Raider is not a pure UAS; the long-range bomber is expected to be operated either remotely or by an onboard crew.[77] The B-21 (**Figure 6**) is intended to operate in both conventional and nuclear roles, with the capability of penetrating and surviving in advanced air defense environments.[78] It is projected to enter service in the mid-2020s, building to an initial

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[71] Scott Shane and David E. Sanger, "Drone Crash in Iran Reveals Secret U.S. Surveillance Effort," *New York Times*, December 7, 2011, at https://www.nytimes.com/2011/12/08/world/middleeast/drone-crash-in-iran-reveals-secret-us-surveillance-bid.html.

[72] U.S. Army, *Visual Aircraft Recognition*, TC 3-01.80, Washington, DC, May 5, 2017, pp. F-17, at https://irp.fas.org/doddir/army/tc3-01-80.pdf.

[73]U.S. Air Force, *Fact Sheet: RQ-170 Sentinel*, at https://www.af.mil/About-Us/Fact-Sheets/Display/Article/2796993/rq-170-sentinel/ and Joseph Trevithick and Tyler Rogoway, "Details Emerge About The Secretive RQ-170 Stealth Drone's First Trip To Korea," *The War Zone*, January 28, 2020, at https://www.thedrive.com/the-war-zone/31992/exclusive-details-on-the-secretive-rq-170-stealth-drones-first-trip-to-korea.

[74] U.S. Air Force, *Fact Sheet: RQ-170 Sentinel*, at https://www.af.mil/About-Us/Fact-Sheets/Display/Article/2796993/rq-170-sentinel/.

[75] Bryan Bender and Lee Hudson, "2 new secret combat drones are in the works, Air Force secretary says," *Politico*, December 6, 2021, at https://www.politico.com/news/2021/12/06/combat-drones-air-force-kendall-523812.

[76] This section is derived from CRS Report R44463, *Air Force B-21 Raider Long-Range Strike Bomber*, by Jeremiah Gertler.

[77] U.S. Air Force, "Fact Sheet: B-21 Raider," press release, July 6, 2021, at https://go.usa.gov/x6exF.

[78] Department of Defense, "Department of Defense Press Briefing on the Announcement of the Long Range Strike Bomber Contract Award," Washington, DC, October 27, 2015, at http://go.usa.gov/cswxQ. Advanced air defenses, or more commonly called integrated air defense systems (IADS) consist of a family of radars to track aircraft, provide targeting data, missiles to engage, and a command and control (C2) platform to manage the radars and missiles. Some analysts consider systems like the S-300, S-400, and HQ-9 as the most advanced IADS threat aircraft would potentially need to penetrate. Maj. Peter W. Mattes, "What is a Modern Integrated Air Defense System," *Air Force Magazine*, October 1, 2019, at https://www.airforcemag.com/article/what-is-a-modern-integrated-air-defense-system/.

fleet of 100 aircraft. B-21s will be based at Dyess AFB, TX; Whiteman AFB, MO; and Ellsworth AFB, SD, with Ellsworth as the training base.[79]

Figure 6. Artist Rendering of B-21

Source: U.S. Air Force.

The B-21 was designed around three specific capabilities:[80]

1. A large and flexible payload bay capable of carrying a full range of current and future armament.
2. Range (although classified).
3. Projected average procurement unit cost of $550 million per plane in FY2010 dollars, which was announced publicly to encourage competing manufacturers to constrain their designs.

Although the Air Force has released artist renderings of the bomber, the specific design remains classified.

In an effort to achieve the $550 million target, unit cost was designated as a key performance parameter in the acquisition strategy, meaning that inability to reach that price could disqualify a bid. (That price is based on acquisition of 100 aircraft; variations in quantity may affect actual unit cost.) At the award announcement, the Air Force revealed that the independent cost estimate for Northrop's winning bid would be $511 million per plane, equivalent to $564 million in FY2016 dollars.[81] The Air Force stated that the average procurement unit cost as of 2021 is $550 million in FY2010 dollars, or $670 million in 2022 dollars.[82]

RQ-180

Another UAS program reported to be in development is the RQ-180, said to be a bomber-sized UAS.[83] On June 9, 2014, Lieutenant General Robert Otto, the former Air Force Deputy Chief of

[79] Secretary of the Air Force Public Affairs, *Air Force selects locations for B-21 aircraft*, May 2, 2018, at https://go.usa.gov/xpZse and U.S. Air Force, "Fact Sheet: B-21 Raider," press release, July 6, 2021, at https://go.usa.gov/x6exF.

[80] CRS Report R44463, *Air Force B-21 Raider Long-Range Strike Bomber*, by Jeremiah Gertler.

[81] Air Force briefing to and discussion with CRS and think tank representatives, September 1, 2015.

[82] U.S. Air Force, "Fact Sheet: B-21 Raider," press release, July 6, 2021, at https://go.usa.gov/x6exF. Calculation to adjust for inflation was made by CRS using OSD Comptroller deflators.

[83] Amy Butler and Bill Sweetman, "Secret New UAS Shows Stealth, Efficiency Advances," *Aviation Week*, December

Staff for Intelligence, Surveillance and Reconnaissance, said the Air Force was "working on the RQ-180 remotely piloted aircraft to give it better access to contested airspace, where the unmanned RQ-4 Global Hawk and manned U-2S platforms are vulnerable."[84] Few other details regarding the RQ-180 have been publicly released, and the Air Force has not officially acknowledged the program.

Potential Issues for Congress

The following section discusses potential issues as Congress considers defense legislation, including cost comparisons with manned systems, lack of follow-on programs of record, organizational management, interoperability with existing force structure, and export controls.

Cost Comparison with Manned Systems

In a June 2021 report, the Congressional Budget Office (CBO) examined the cost, reliability, and sortie rates between manned and unmanned intelligence, surveillance, and reconnaissance (ISR) aircraft.[85] Of note, CBO identified that the cost per flying hour for a RQ-4 Global Hawk was approximately $18,700, or 62% of a manned P-8 Poseidon's cost, which can perform similar missions at a cost per flying hour of $29,900.[86] The report also noted that

- RQ-4 Global Hawk was projected to fly 356 more hours per year compared with the P-8,
- RQ-4 Global Hawk had a projected life span of 20 years compared with the projected 50 year life cycle of the P-8, and
- RQ-4 Global Hawk's acquisition cost of $239 million compared with the $307 million for the P-8 Poseidon (approximately 78% of the acquisition cost of the manned platform).

Similarly, other UAS aircraft offer lower acquisition costs and cost per flight hour than manned aircraft. However, UAS aircraft generally have a higher accident rate than manned aircraft.[87] Congress may consider this tradeoff—lower costs versus higher risks—when comparing aircraft systems.

Lack of Follow-On Programs of Record

During the conflicts in Iraq and Afghanistan, the U.S. military bought hundreds of UASs per year, primarily MQ-1 Predators and MQ-9 Reapers, but also RQ-4 Global Hawks and MQ-4 Tritons. When those conflicts concluded, procurement dropped abruptly. For example, the services acquired 1,211 medium or larger UASs in FY2012, but by 2014 the annual quantity had dropped to 54 UASs and that number has continued to decline. The FY2022 budget submission requested procurement of six UAS.

6, 2013.

[84] John A. Tirpak, "For Those Hard-to-Reach Areas," *Air Force Magazine*, June 10, 2014, at https://www.airforcemag.com/for-those-hard-to-reach-areas/.

[85] Congressional Budget Office, *Usage Patterns and Costs of Unmanned Aerial Systems*, 57090, Washington, DC, June 1, 2021, at https://www.cbo.gov/system/files/2021-06/57090-UAS.pdf.

[86] Ibid., p. 8.

[87] Ibid.

DOD has not formally commented on this change; however, several factors may have influenced this downward trend. One is that the many UASs acquired during the Iraq and Afghanistan conflicts shared similar technology, and the military may have not set new requirements to incorporate new technologies. Also, although those first- and second-generation UAS worked well in permissive air environments (such as those in Iraq and Afghanistan, where there was no adversary air force or air defenses), they would have faced greater challenges in the near-peer conflicts with advanced air defenses and aircraft that are increasingly a part of U.S. defense planning. DOD may also have taken a conscious strategic pause in procurement while more advanced technologies (e.g., jet-powered UAS) matured. Finally, much UAS development is believed to have moved to unacknowledged classified systems during this period. As such, DOD procurement may not have dropped so precipitously, but rather shifted from unclassified or acknowledged classified programs to unacknowledged classified programs not visible in public budget documents.

Organizational Management

Although most U.S. military UAS are based on the MQ-1 Predator airframe, UAS programs exist across the military services. In authorization and oversight, Congress may consider the following questions. Who should manage the development and procurement of DOD UAS? Should management of at least some of these programs be centralized? If so, where in DOD should the central authority reside?

Former Air Force Chief of Staff General Norton Schwartz made the case that "ideally, what you want to do is have the U.S. government together in a way that allows us to get the best capability.... An example is BAMS [MQ-4 Triton] and [RQ-4] Global Hawk. Why should the Navy and Air Force have two separate depots, ground stations and training pipelines for what is essentially the same airplane with a different sensor? I think there is lots of opportunity for both of us to make better uses of resources."[88] A 2013 study by the RAND Corporation found that, historically, joint manned aircraft programs did not result in life cycle cost savings,[89] but that managing multiple programs through a single office without fully combining those programs may be possible.

Interoperability with Existing Force Structure

UAS present a potential interoperability challenge when conducting missions with manned aircraft because the pilot is not directly onboard the aircraft but is located either on the airfield, for takeoffs and landings, or at a U.S. installation. For example, the UAS pilot relies on cameras or sensors to make visual contact with the manned aircraft in its formation. Over the past two decades, both the Army and the Air Force have demonstrated ways to integrate UAS into their operations; most recently, the Army experimented with new concepts at its FY2021 Project Convergence.[90] The Navy and Marine Corps, however,[91] have limited experience with integrating

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[88] David A. Fulghum, "USAF Chief Considers F-35 And F-22 Replacement," *Aerospace Daily*, November 25, 2010.

[89] Mark A. Lorell et al., *Do Joint Fighter Programs Save Money?*, RAND Corporation, MG1225, Santa Monica, CA, 2013, at https://www.rand.org/pubs/monographs/MG1225.html.

[90] Andrew Eversden, "Robotic vehicles, drones coordinate recon at Army's Project Convergence 21," *Breaking Defense*, November 22, 2021, at https://breakingdefense.com/2021/11/robotic-vehicles-drones-coordinate-recon-at-armys-project-convergence-21/.

[91] In 2018 the Marine Corps began experimenting with MQ-9 Reapers utilizing General Atomics owned and operated aircraft in Afghanistan. For more information see Joseph Trevithick, "It's Official, Contractor-Owned MQ-9 Reaper

UAS into their current fleets of aircraft and operations—particularly with large UAS on aircraft carriers and amphibious ships. As new UAS are developed, along with new concepts for employing these aircraft, it remains to be seen how manned aircraft and UAS will integrate. Similarly it is not clear to what extent issues related to airspace deconfliction will present challenges for DOD.

Export Controls[92]

The United States controls the export of UAS through both multilateral export control regimes and national export controls.[93]

Missile Technology Control Regime

The Missile Technology Control Regime (MTCR) "seeks to limit the risks of proliferation of" nuclear, biological, and chemical (NBC) weapons "by controlling exports of goods and technologies that could make a contribution to delivery systems (other than manned aircraft) for such weapons."[94] Established in 1987 by the United States and six other countries, the MTCR, which holds several meetings per year and currently consists of 35 partner countries, is an informal voluntary arrangement whose partners agree to apply common export policy guidelines to an annex containing two categories of controlled items. Partner countries implement these guidelines pursuant to national legislation and regularly exchange information on relevant export licensing issues, including denials of technology transfers. The MTCR guidelines apply to both armed and unarmed UAS.

Category I MTCR items are the most sensitive and include complete UAS "capable of delivering a payload of at least 500 kg to a range of at least 300 km, their major complete subsystems … and related software and technology," as well as "specially designed" production facilities for these UAS and subsystems.[95] Partner governments should have "a strong presumption to deny" such transfers, regardless of their purpose, but may transfer such items on "rare occasions."[96] The guidelines prohibit exports of production facilities for Category I items. Regime partners have greater flexibility with respect to authorizing exports of Category II items, which include less sensitive and dual-use missile related components. This category also includes complete UAS, regardless of payload, capable of ranges of at least 300 km, as well as other UAS with certain characteristics.

The MTCR guidelines state that governments should consider six factors when considering requests for the export of MTCR annex items: (1) concerns about NBC proliferation; (2) the "capabilities and objectives of the missile and space programs of the recipient state"; (3) the "significance of the transfer in terms of the potential development" of NBC delivery systems; (4) the "assessment of the end use of the transfers," including the government assurances described below; (5) the "applicability of relevant multilateral agreements"; and (6) the "risk of controlled

Drones Will Watch Over Marines in Afghanistan," *The War Zone*, June 20, 2018, at https://www.thedrive.com/the-war-zone/21663/its-official-contractor-owned-mq-9-reaper-drones-will-watch-over-marines-in-afghanistan.

[92] This section was authored by Paul K. Kerr.

[93] For more details about these regimes, see CRS Report RL33865, *Arms Control and Nonproliferation: A Catalog of Treaties and Agreements*, by Amy F. Woolf, Paul K. Kerr, and Mary Beth D. Nikitin.

[94] Fact Sheet, "Missile Technology Control Regime (MTCR) Frequently Asked Questions," Department of State.

[95] Ibid.

[96] "Guidelines For Sensitive Missile-Relevant Transfers," Missile Technology Control Regime.

items falling into the hands of terrorist groups and individuals."[97] The guidelines also stipulate that a strong presumption of denial applies to transfers of any item on the MTCR annex or any unlisted missile if the partner government "judges, on the basis of all available, persuasive information" that the items "are intended to be used for" NBC delivery.

In addition, the MTCR guidelines state that, in cases where the exporting government does not judge the proposed Category I UAS transfer as intended for NBC delivery, the government is to obtain "binding government-to-government undertakings" from the recipient state that "[n]either the items nor replicas nor derivatives thereof will be retransferred without" the exporting government's consent.[98] The exporting government must also assume "responsibility for taking all steps necessary to ensure that the item is put only to its stated end-use." Moreover, a government is only to authorize transfers of items that "could contribute to [an NBC] delivery system" if the government receives "appropriate assurances from the [recipient] government" that the recipient will use the items only for their stated purpose and will refrain from modifying, replicating, or retransferring the items without the exporting government's prior consent.[99] Partner governments' export controls must require authorization for the transfer of unlisted items in cases where the government has informed an exporter that such items "may be intended, in their entirety or part, for use in connection with [NBC] delivery systems … other than manned aircraft." These restrictions are known as "catch-all" controls.[100]

Other Multilateral Export Control Regimes

Other multilateral regimes restrict the export of technologies that could enable the development of NBC payloads for UAS. For example, the Nuclear Suppliers Group governs nuclear-related exports, and the Wassenaar Arrangement performs a similar function with respect to conventional arms and certain dual-use goods and technologies. The Australia Group is the analogous organization for technologies relevant to chemical and biological weapons.

U.S. Export Controls

Beginning in 2017, the United States has submitted a series of proposals to the MTCR partners that would relax the regime's export guidelines for certain UAS.[101] Those governments, which take decisions by consensus, have not agreed to adopt any of these proposals. On July 24, 2020, the Trump Administration announced a new UAS export policy that treats "a carefully selected subset of MTCR Category I UAS, which cannot travel faster than 800 kilometers per hour (roughly 500 miles per hour) as Category II" and thereby overcomes the MTCR's "strong presumption of denial" for these systems.[102] The United States has exported MTCR Category I UAS to France, Italy, Japan, Germany, South Korea, Spain, and the United Kingdom.

A January 12, 2021, final rule from the Department of Commerce's Bureau of Industry and Security (BIS) implements the relevant changes to U.S. dual-use licensing procedures. BIS's annual report to Congress for FY2020, noting the cancellation of all 2020 MTCR meetings, explains that the United States adopted this policy unilaterally because there were "no venues for

[97] Ibid.

[98] Ibid.

[99] Ibid.

[100] Ibid.

[101] For details, see CRS *In Focus, U.S.-Proposed Missile Technology Control Regime Changes*, by Paul K. Kerr.

[102] "Statement from the Press Secretary on Unmanned Aerial Systems Exports," July 24, 2020.

further progress in the MTCR in the foreseeable future.”[103] The proposal “remains a priority effort of ours in the MTCR, but that – like much else – has been hampered by the travel restrictions” adopted in response to risks posed by the COVID-19 virus, according to a State Department official.[104] The MTCR members held a plenary meeting in October 2021 but did not adopt the U.S. proposal.

The United States imposes a number of other restrictions on UAS exports. The State Department administers export controls on military UAS and other defense articles; the statutory basis for this system is the Arms Export Control Act (AECA; P.L. 94-329). Section 71(a) of that law requires the Secretary of State to maintain a list of all items on the MTCR annex that are not controlled pursuant to U.S. dual-use controls. The AECA also restricts the uses to which U.S.-origin defense articles may be put and prohibits transfers of such items to third parties without U.S. government permission. The Export Controls Act of 2018 (P.L. 115-232, Subtitle B, Part I) provides broad, detailed legislative authority for the President to implement controls on the export of dual-use items, including dual-use UAS and related components. U.S. regulations on dual-use exports contain catch-all controls with respect to UAS.

The U.S. government also implements regulations to ensure that recipients of U.S.-origin UAS use the items for their declared purpose. According to a May 2019 State Department fact sheet, the United States will transfer military UAS “only with appropriate technology security measures.”[105] Both the State and Commerce Departments conduct end-monitoring to determine whether recipient countries are using exported items appropriately. Some military UAS “may be subject to enhanced end-use monitoring,” as well as “additional security conditions,” the fact sheet says.[106] U.S. transfers of MTCR Category I UAS also “shall require periodic consultations with” the U.S. government with respect to the systems’ use, according to the State Department fact sheet.[107]

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[103] *Annual Report to Congress for Fiscal Year 2020*, U.S. Department of Commerce Bureau of Industry and Security (BIS).

[104] December 8, 2021, email to CRS analyst.

[105] Fact Sheet, “U.S. Policy on the Export of Unmanned Aerial Systems,” U.S. Department of State, May 21, 2019.

[106] Ibid. Articles subject to such monitoring “are accompanied by specialized physical security and accountability notes.” (“C8.4. - Enhanced EUM,” *Security Assistance Management Manual*, Defense Security Cooperation Agency.)

[107] U.S. Department of State, May 21, 2019.

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