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Bigger Is Not Always Better: The Case for Small Maritime Uncrewed Aircraft Systems

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AIM

1. The RCN's shipborne uncrewed aircraft systems (UAS) programme initiated in 2017 has focused solely on Class II Tactical UAS for major surface combatants, discounting the smaller yet similarly capable Class I Small UAS.[1] The aim of this service paper is to inform senior RCN leadership and Naval Force Development that Small UAS are more suitable than Tactical UAS to optimize a balance of platform capability, value, ship integration, and personnel requirements. The comprehensive case for maritime UAS is beyond the scope of this paper and has been thoroughly detailed in many DND and RCN publications.[2]

INTRODUCTION

2. The pace and nature of modern military operations requires that commanders maintain detailed tactical situational awareness and have quick access to relevant intelligence, surveillance, and reconnaissance (ISR). The RCN's Concept of Operations (CONOPS) for maritime vertical takeoff and landing (VTOL) capable ISR UAS operating from its major surface combatants includes:[3]

   a. Support to Anti-Surface Warfare (ASuW) in conducting ISR and battle damage assessment;

   b. Support to Anti-Submarine Warfare (ASW) through relieving maritime helicopters (MH) from their surface ISR duties;

   c. Support to search and rescue (SAR) efforts in locating and monitoring persons and vessels in distress; and

   d. Support to maritime interdiction operations (MIO) in locating and tracking vessels of interest (VOI).

3. The naval demands for VTOL UAS in the last two decades have resulted industry development of smaller yet similarly capable UAS. The evolution of VTOL UAS from large

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[1] See NATO UAS Classification table in Annex A to this paper. The category names of "Small" and "Tactical" will be used throughout this paper to represent the categories of NATO Class II Tactical and NATO Class I Small, respectively, beyond this point; NATO, *Allied Tactical Publication 3.3.8.2 - Unmanned Aircraft System Tactics, Techniques and Procedures*, Ed: A V.1 (NATO Standardization Office, 2020), 1–2.

[2] Canada. Department of National Defence, "Leadmark 2050: Canada in a New Maritime World" (Ottawa: Commander, Royal Canadian Navy, May 13, 2016), 49; Government of Canada, *Strong Secure Engaged: Canada's Defence Policy* (Ottawa: Department of National Defence, 2017), 15, 35, 64–65, 73; Canada. Department of National Defence, "Concept for Maritime Unmanned Systems (MUS)" (Ottawa: Director General Naval Force Development, RCN, November 2015), 1–4; Canada. Department of National Defence, "Business Case Analysis v1 - Royal Canadian Navy Intelligence, Surveillance, Target Acquisition and Reconnaissance Unmanned Aircraft System (RCN ISTAR UAS)" (Royal Canadian Navy, January 2018).

[3] Canada. Department of National Defence, "Business Case Analysis v2 - Royal Canadian Navy Intelligence, Surveillance, Target Acquisition and Reconnaissance Unmanned Aircraft System (RCN ISTAR UAS)" (Royal Canadian Navy, September 2021) Annexes A-F.

rotary-wing aircraft to smaller hybrid fixed-wing aircraft has reconciled the capability gaps between the Tactical and Small categories.[4] The general CONOPS above can be satisfied by UAS regardless of size, if a search sensor is collocated with a primary optical imagery sensor.[5] This paper will identify the flaws in the RCN's UAS programme in associating the required capability to the Tactical classification of UAS, draw from lessons learned from the RCN's use of ScanEagle UAS from 2012 to 2014, and demonstrate that Small UAS are more appropriately suited for the RCN's major surface combatants.

DISCUSSION

Background and State of the RCN UAS Programme

4. The publication of *Canada's Defence Policy: Strong, Secure, Engaged* (SSE) in 2017 imposed the investment and deployment of uncrewed systems on the RCN, with a focus on UAS.[6] In response to SSE, the RCN commenced an ambitious programme consisting of four UAS projects:

a. Royal Canadian Navy Intelligence, Surveillance, Target Acquisition and Reconnaissance Unmanned Aircraft System (RCN ISTAR UAS): a SSE Initiative 32 project to acquire six UAS and fit all 12 Halifax-class ships (HCS) with the required equipment to embark and operate the UAS. In 2021, the project's planned Initial Operational Capability (IOC) of March 2022 was revised to February 2027;[7]

b. CAF UAS Provision of Service (CAF UPS): a services contract shared between RCN and CANSOFCOM aimed at bridging the capability gap until IOC of acquisition projects. Through the contract life, no operational assignments were delivered by the contractor due to delays in its acquisition of UAS, lack of UAS maturity, and airworthiness issues;[8]

c. Maritime Miniature Unmanned Aircraft System (MMUAS): a project which acquired two PUMA UAS for Kingston-class minor warships. The RCN was able to rapidly achieve IOC of 2018 by exercising existing acquisition contract options; and

[4] Alysson N. Lucena and Luiz M. G. Goncalves, "Towards a Double Hybrid VTOL UAV System," in *2020 Latin American Robotics Symposium (LARS), 2020 Brazilian Symposium on Robotics (SBR) and 2020 Workshop on Robotics in Education (WRE)* (IEEE, 2020), 1–6, https://doi.org/10.1109/LARS/SBR/WRE51543.2020.9307065.
[5] Canada. Department of National Defence, "RCN ISTAR UAS Market Survey" (Naval Engineering Test Establishment, February 2021).
[6] Government of Canada, *Strong Secure Engaged*, 15, 35, 65, 73.
[7] Canada. Department of National Defence, "DND Defence Policy - Initiative Summary: Royal Canadian Navy Intelligence, Surveillance, Target Acquisition, and Reconnaissance Unmanned Aircraft System (RCN ISTAR UAS)," SSE Two-Pager, SSE Initiative 32 (Ottawa: Director General Naval Force Development, RCN, October 25, 2021), 1–2.
[8] Canada. Department of National Defence, "Info Brief - CAF UAS Provision of Service (CAF UPS) History" (Ottawa: Director Naval Requirements, Royal Canadian Navy, November 2021), 4–6.

d. A since-cancelled miniature UAS initiative for the Naval Tactical Operations Group (NTOG).

Flaws of UAS Classification

5. CAF policy limits the operation of Class III UAS to trained RCAF pilots, and as such, the RCN is limited to flying UAS with a maximum takeoff weight (MTOW) of less than 600kg.[9] CAF UPS and RCN ISTAR UAS, the two projects for integration of UAS in major surface combatants, set excessively high system requirements to maximize the capability allowed to be operated by the RCN. RCN ISTAR UAS' overly ambitious requirements have plagued the project since its inception. The RCN's High Level Mandatory Requirements (HLMR) and preferred option approved by Defence Capability Board 2 (DCB2) and the subsequent Statement of Operational Requirements (SOR) mandated that the UAS acquired be a Tactical UAS with a prescribed combination of ISTAR sensor payloads which pushed the limits of the payload capacity of such UAS.[10]

6. Although the NATO UAS classifications adopted by the CAF in 2015 state implications of capability associated with MTOW, these implied capabilities are outdated due to UAS technological advancements. [11] The implication that Tactical UAS are required for beyond visual line of sight (BVLOS) operations outside of 50km from the control station is particularly problematic.[12] Control range, for example, is primarily dependent on the antenna height and power, not the UAS' MTOW. The 150kg MTOW line separating Small and Tactical UAS is now effectively irrelevant from a capability perspective.[13] NATO and CAF UAS classifications should be understood to form a regulatory basis rather than capability. The US Department of Defence's (DoD) UAS groups are a more appropriate representation of capability tied to MTOW, particularly in their group 3: 25-600kg.[14] Use of classifications based on weight is intended to be utilized for regulatory and quantitative airworthiness risk management.[15]

Lessons Learned from Previous RCN Employment of Small UAS

7. Prior to MMUAS' IOC, the RCN's only experience employing UAS other than targets was from 2012 to 2014 when it exercised contract options for the CA's services contract for ScanEagle UAS. ScanEagle was catapult-launched, skyhook-retrieved, high-octane gasoline fueled, 26.5kg Small UAS embarked for three Op ARTEMIS deployments in HMCS

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[9] Canada. Department of National Defence, "CAF UAS Categorization Table" (Winnipeg: RCAF, 2018).
[10] Canada. Department of National Defence, "Business Case Analysis v1 - Royal Canadian Navy Intelligence, Surveillance, Target Acquisition and Reconnaissance Unmanned Aircraft System (RCN ISTAR UAS)," 10, 37; Canada. Department of National Defence, "Statement of Operational Requirements - Royal Canadian Navy Intelligence, Surveillance, Target Acquisition, and Reconnaissance Unmanned Aircraft System (RCN ISTAR UAS) Project C.003095" (Royal Canadian Navy, May 1, 2019), 17.
[11] Canada. Department of National Defence, "Implementation of NATO UAS Classification Table," CANFORGEN 80/15, April 23, 2015.
[12] NATO, *ATP 3.3.8.2*, 1–2, 1-3.
[13] Canada. Department of National Defence, "RCN ISTAR UAS Market Survey."
[14] USA. Department of Defense., "Unmanned Aircraft System Airspace Integration Plan Version 2.0," Version 2.0 (UAS Task Force, March 2011), D-2-D-3.
[15] Canada. Department of National Defence, "A-GA-005-000/AG-001 - Department of National Defence/Canadian Armed Forces Airworthiness Program" (Ottawa: Director Air Readiness, RCAF, February 5, 2020), 2-1–5.

Charlottetown and HMCS *Regina*.[16] Embarked teams consisted of five CA previously trained personnel and four contractors. Although RCN personnel never directly operated the UAS, valuable lessons learned were captured by both ships to form the basis of future procurement projects. Of the four primary lessons learned listed below from ScanEagle RCN deployments, the first three drove the RCN's UAS programme towards Tactical UAS despite no longer being valid differentiators between Tactical and Small UAS.

8. First, heavy fuel engines (HFE) are critical for sustained shipborne UAS operations. ScanEagle was powered by high octane gasoline which posed limitations on fuel quantity embarked and storage location. Gasoline cannot be stored below deck due to its high flashpoint and ship damage control (DC) considerations.[17] Limited upper deck storage for more gasoline beyond that already carried for the ships' boats severely limits the ability to sustain gasoline powered UAS operations.[18] Demand from other navies, particularly the US Navy, has driven industry to integrate HFE into Small UAS to use maritime fuel such as JP-5 already carried onboard ships.[19] Therefore, HFE are no longer a driving factor towards larger UAS.

9. Second, a search sensor collocated with the primary optical sensor is required for the cueing of contacts outside of the ship or Task Group's organic surface radar coverage. Since UAS operating at 30 to 50 nautical miles from the ship can look far beyond the surface coverage of ships' organic radars, using a UAS' primary optical sensor uncued to search for contacts is ineffective and comparable to looking and searching through a straw.[20] Since the RCN's last ScanEagle UAS employment in 2014, technological advancements in compact wide area maritime search sensors, both optical and radar, now enable UAS as small as ScanEagle to be fitted with both primary optical and search sensors to enable the Small UAS to search for, detect, classify, identify, and track contacts without external cueing.[21] Although the smaller optical search sensors draw criticism for their shortcomings in limited visibility, they generally outperform their radar counterparts in good visibility.[22] Additionally, CAF policy constrains flight of aircraft including UAS for non-instrument rated pilots to Visual Flight Rules (VFR), and maritime ISR UAS' primary function is visual observation of contacts; therefore, there is minimal benefit of radar over optical search sensors for RCN shipborne UAS.

10. Third, launch and recovery apparatus prevent UAS from being truly complementary to the embarked MH. Launch and recovery equipment fouls the flight deck preventing concurrent MH operations.[23] UAS with VTOL capability minimize launch and recovery time and keep the deck clear for the MH. Again, demand from navies has driven industry to make several Small

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[16] Canada. Department of National Defence, "Developmental Evaluation Report – HMCS Regina UAV Operational Capability and Employment" (Esquimalt: HMCS REGINA, RCN, January 2013).
[17] Canada. Department of National Defence, 5.
[18] Alternative fuel sources including electric are not viable due to being unproven for long endurance.
[19] Paul Host, "Navy League 2021: Martin UAV, USMC Working on V-Bat Hybrid-Electric, Heavy Fuel Propulsion," Janes, August 17, 2021, https://www.janes.com/defence-news/news-detail/navy-league-2021-martin-uav-usmc-working-on-v-bat-hybrid-electric-heavy-fuel-propulsion.
[20] Canada. Department of National Defence, "ScanEagle DEVAL Report - HMCS REGINA 2013," 2.
[21] Janes, "Capability Boost: Trials Demonstrate Enhanced ViDAR/ScanEagle Package," *Jane's International Defence Review* 50, no. 1 (2017), https://customer-janes-com.cfc.idm.oclc.org/Janes/Display/idr18940-idr-2017.
[22] Canada. Department of National Defence, "RCN ISTAR UAS Market Survey," 15–19.
[23] Canada. Department of National Defence, "ScanEagle DEVAL Report - HMCS REGINA 2013," 5.

VTOL-capable UAS, as seen in the US Navy's Mi2 and US Army's Future Tactical Unmanned Aircraft System (FTUAS) competitions where all finalists were Small VTOL-capable UAS.[24]

11. Finally, smaller fixed-wing UAS are excellent for covert surveillance in comparison to louder rotary-wing aircraft. All available Tactical maritime UAS are rotary-wing aircraft while the available Small VTOL UAS are hybrid fixed-wing, meaning they switch to fixed-wing flight after takeoff. The fixed-wing ScanEagle proved more effective than the rotary-wing MH in covertly shadowing contacts of interest (COI) during Op ARTEMIS, which resulted in the UAS' contribution to the interdiction of over 1,000 pounds of narcotics during *Regina*'s 2012 deployment.[25]

Advantages of Small UAS

12. Other advantages of Small UAS over Tactical UAS include their reduced shipboard footprint and associated ease of integration, ease of access between storage and flight deck, reduced personnel requirements, and cost efficiency:

a. <u>Storage space and ship integration:</u> Small UAS are more portable, easily disassembled, and can be stored in significantly smaller areas than Tactical UAS. HCS were not designed to accommodate UAS, and every space onboard has an existing designated purpose. Shipboard integration of UAS requires some reallocation of space and potential capability trade-offs. Feasibility and shipboard integration studies and designs, as well as the modification of HMCS *Toronto* in 2020 to accommodate CAF UPS, have demonstrated that the only suitable space to embark Tactical UAS in HCS is in the Starboard Torpedo Magazine.[26] This intrusive Engineering Change (EC) as was done to HMCS *Toronto* is undesirable due to the loss of half of the ship's torpedo capacity, as well as the high $1.1M cost and its 17 week duration which required the reallocation of over 3,000 Fleet Maintenance Facility (FMF) work hours away from other RCN maintenance priorities.[27] These trade-offs and costs can be substantially mitigated by Small vice Tactical UAS, although precise shipboard footprint cannot be determined until a UAS is selected.

b. <u>Access to flight deck:</u> a Tactical UAS lesson learned from the CAF UPS project is that egress from storage in the HCS Starboard Torpedo Magazine to the flight deck requires traversing the UAS through the forward door of the magazine and

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[24] Janes, "Martin UAV Wins US Navy's Mi2 Technology Demonstration Competition," Jane's International Defence Review, April 15, 2021, https://customer-janes-com.cfc.idm.oclc.org/display/FG_3944257-JNI; Janes, "US Army Picks AeroVironment's Jump 20 for FTUAS Increment 1," Jane's International Defence Review, August 22, 2022, https://customer-janes-com.cfc.idm.oclc.org/display/FG_3944257-JNI.
[25] Canada. Department of National Defence, "ScanEagle DEVAL Report - HMCS REGINA 2013," 3, 7.
[26] Canada. Department of National Defence, "Unmanned Aircraft Systems (UAS) Studies – Initial Findings Report On Post MLR Halifax-Class Frigate UAS Feasibility Study," Feasibility Study (Naval Engineering Test Establishment, July 26, 2016); Fleetway Inc, "RCN ISTAR Initial Engineering Impact Assessment for The Halifax Class Frigates," Impact Assessment (Department of National Defence, July 18, 2019); Fleetway Inc, "Access Options for The Maritime Remotely Piloted Aircraft System for Halifax Class Frigates: Options Analysis," Impact Assessment (Department of National Defence, July 20, 2021).
[27] Canada. Department of National Defence, "Info Brief - CAF UAS Provision of Service (CAF UPS) History," 6.

through the length of the hangar.[28] The issue will persist in the upcoming Canadian Surface Combatant (CSC) based on the Type 26 design, where access to the flight deck from designated storage in the mission bay is also through the hangar where there is not sufficient space to manoeuvre a Tactical UAS around the MH.[29] Consequently, egress and ingress of Tactical UAS require traversing the MH, if embarked. Traversing the MH requires a qualified pilot as Landing Safety Officer (LSO), and consequently, Tactical UAS cannot be employed during Air Detachment crew rest periods due to the inability to move the UAS to the flight deck without traversing the MH. The CH-148 Cyclone MH project achieved Full Operational Capability (FOC) in December 2022, and the RCAF is expected to embark a Cyclone MH in every operational RCN major warship.[30] Accordingly, the shipboard integration of UAS in RCN major warships must account for a MH in the hangar; therefore, UAS should be capable of egress and ingress through existing doorways and passageways without traversing the MH. As previously stated, Small UAS are generally small, portable, easily disassembled and reassembled, and can therefore mitigate the egress and ingress issues of Tactical UAS.

c. <u>Personnel requirements:</u> Small UAS present an opportunity to lower the personnel requirements from those of Tactical UAS. The RCN's UAS projects were initiated without consideration for RCN personnel requirements to operate, maintain, and administer the capability. [31] A 2019 assessment and associated demand for 90 dedicated RCN positions for the RCN ISTAR UAS capability was denied by the VCDS-chaired Defence Team Establishment Plan (DTEP) 21.[32] A 2022 revision and reduction of the personnel requirement lowered the demand to 55 positions as signalled at the RCN's Human Resources Management Board in 2022.[33] These analyses were based on UAS detachment sizes of six personnel for

[28] Canada. Department of National Defence, 6.
[29] "Type 26 Global Combat Ship Capabilities," Think Defence, July 14, 2021, https://www.thinkdefence.co.uk/type-26-global-combat-ship-capabilities/.
[30] Canada. Department of National Defence, "Https://Www.Canada.ca/En/Department-National-Defence/Services/Procurement/Ch-148-Cyclone.Html," CH-148 Cyclone procurement project, November 2021, https://www.canada.ca/en/department-national-defence/services/procurement/ch-148-cyclone.html.
[31] In establishing a UAS capability, the RCN is effectively re-establishing its Naval Air Branch for uncrewed systems for the first time since 1975, a concept which has been overlooked in planning for the acquisition of maritime UAS. The RCAF has been functionally responsible for the oversight, administration, and operation of all CAF aircraft since the 1975 establishment of Air Command, now RCAF, and its assumption of control of the Maritime Air Group from the RCN because of the 1968 CAF unification. The proliferation and technological advancements of UAS, particularly in the last 20 years, has seen an increased demand from all elements for the introduction of new UAS; however, the RCAF has not had the capacity to operate and maintain new fleets of aircraft as demanded by the CA, RCN, and CANSOFCOM. Thus, the RCAF has enabled the respective L1s to acquire, operate, and maintain UAS fleets while maintaining RCAF regulatory oversight.
[32] Canada. Department of National Defence, "Royal Canadian Navy – Defence Team Establishment Plan (DTEP) 21 – Prioritized Summary Of Demands" (Ottawa: Commander, Royal Canadian Navy, November 15, 2019), 2.
[33] Canada. Department of National Defence, "HRMB Input - RCN UAS Programme - Jun 2022" (RCN Human Resources Management Board, Ottawa, June 9, 2022), 4, 7.

Tactical UAS[34]; however, the true personnel requirements cannot be fully determined until a UAS is selected for acquisition due to varying system complexity. Industry has indicated that Small UAS can sustainably operate with as few as two to three personnel for 24/7 operations.[35] Furthermore, the lower complexity of Small UAS potentially allows the opportunity for organic UAS ship teams as a secondary duty, akin to Ship's Team Divers and Naval Boarding Parties. The operation and maintenance of the UAS by existing ship personnel would optimize bunk and personnel resources. The feasibility analysis of this concept is beyond the scope of this paper and is recommended to be led by the Directorate of Naval Personnel.

d. Value: Small UAS are significantly more cost effective than larger UAS. In addition to the cost savings of a less intrusive ship EC, Small UAS have lower acquisition costs than Tactical UAS.[36] Accordingly, the RCN ISTAR UAS project's full scope of six UAS is affordable within budget should Small UAS be acquired, vice the affordability of fewer than two Tactical UAS.[37] The cost differential is primarily in the cost of the aircraft. The lower cost also applies to sustainment in the required recapitalization of the aircraft, estimated at every 5 years, to sustain the capability long term.[38]

e. Fuel efficiency: Another minor advantage of Small UAS is their fuel economy. The larger Tactical UAS have greater fuel capacity; however, fuel capacity does not translate to increased endurance due to lower efficiency of heavier rotary-wing aircraft. In fact, available Small UAS have an average endurance of 10 hours, compared to their larger Tactical UAS counterparts' average of six hours endurance.[39]

Disadvantages of Small UAS

13. Smaller UAS have two inherent disadvantages over larger variants, however, each can be mitigated:

a. Reduced payload capacity: The major differentiator between Small and Tactical UAS capability is the sensor payload capacity, averaging 10kg and 50kg, respectively.[40] However, the standard ISR sensor payload configuration of Small and Tactical UAS is essentially the same. Although Tactical UAS are capable of fitting and operating slightly larger and marginally more capable optical sensors, sensor configurations offered by industry for Tactical UAS, including as delivered

[34] Canada. Department of National Defence, "Statement of Operational Requirements AL2 - Royal Canadian Navy Intelligence, Surveillance, Target Acquisition, and Reconnaissance Unmanned Aircraft System (RCN ISTAR UAS) Project C.003095" (Royal Canadian Navy, August 26, 2021), 13.
[35] Shield AI, *Unmanned Aircraft System - V-Bat 128* (Shield AI / Martine UAV, 2022).
[36] Canada. Department of National Defence, "Business Case Analysis v2 - Royal Canadian Navy Intelligence, Surveillance, Target Acquisition and Reconnaissance Unmanned Aircraft System (RCN ISTAR UAS)," 31.
[37] Canada. Department of National Defence, 31.
[38] Host, "Navy League 2021: Martin UAV, USMC Working on V-Bat Hybrid-Electric, Heavy Fuel Propulsion."
[39] Canada. Department of National Defence, "RCN ISTAR UAS Market Survey," 8–9.
[40] Canada. Department of National Defence, 8–9.

for the CAF UPS project, are precisely the same optical sensor available on Small UAS.[41] The true advantage of the Tactical UAS payload capacity is the added margin for potential future payload growth and implementation. A potential mitigating consideration for added sensor payloads would be to concurrently employ multiple Small UAS with different complementary sensor configurations.

b. Ongoing integration of key components: At the time that the RCN ISTAR UAS and CAF UPS projects were initiated, there were no Small maritime UAS which met the three following critical requirements: HFE, VTOL, and collocated search and optical sensor payloads. Demands from other navies have driven industry to meet all three requirements, as demonstrated by the Shield AI V-Bat 128 upgrade which will be delivered to the US Navy and US Marine Corps this year.[42]

CONCLUSION

14. Technological advancements driven by the requirements of navies has led industry to develop Small UAS which are more suitable for integration in major surface combatants than Tactical UAS. A holistic approach to UAS procurement and integration is required to optimize capability and ensure that the RCN is appropriately able to integrate and operate the systems once delivered. As such, capability aspirations, particularly in sensor payload capacity, need to be suitably managed. It should be recognized that in establishing a new naval air capability and effectively re-forming the Naval Air Branch for uncrewed systems, there is an associated personnel and organizational cost which cannot be entirely avoided regardless of UAS size.

RECOMMENDATION

15. The RCN should focus its UAS acquisition and integration on Small UAS for its major surface combatants in order to optimize the balance of capability, ship integration, personnel requirements, and value. The RCN should additionally consider investigating the feasibility of UAS detachments as secondary duties of existing ship personnel, as well as the threshold of system complexity where dedicated maritime UAS specialists become required.

ANNEX: A. NATO UAS Classification Table

[41] Canada. Department of National Defence, 14.

[42] "U.K. and U.S. Conduct SINKEX during Atlantic Thunder 22," United States Navy, September 23, 2022, https://www.navy.mil/Press-Office/News-Stories/Article/3168366/uk-and-us-conduct-sinkex-during-atlantic-thunder-22/

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United States Navy. “U.K. and U.S. Conduct SINKEX during Atlantic Thunder 22,” September 23, 2022. https://www.navy.mil/Press-Office/News-Stories/Article/3168366/uk-and-us-conduct-sinkex-during-atlantic-thunder-22

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1. The NATO UAS Classification table adopted by the CAF, categorizing UAS by maximum takeoff weight (MTOW), is depicted below:[43]

NATO UAS CLASSIFICATION						
Class	Category	Normal Employment	Normal Operating Altitude	Normal Mission Radius	Primary Supported Commander	Example Platform
Class III (> 600 kg)	Strike/ Combat *	Strategic/National	Up to 65,000 ft	Unlimited (BLOS)	Theatre	Reaper
	HALE	Strategic/National	Up to 65,000 ft	Unlimited (BLOS)	Theatre	Global Hawk
	MALE	Operational/Theatre	Up to 45,000 ft MSL	Unlimited (BLOS)	JTF	Heron
Class II (150 kg - 600 kg)	Tactical	Tactical Formation	Up to 18,000 ft AGL	200 km (LOS)	Brigade	Hermes 450
Class I (< 150 kg)	Small (>15 kg)	Tactical Unit	Up to 5,000 ft AGL	50 km (LOS)	Battalion, Regiment	Scan Eagle
	Mini (<15 kg)	Tactical Sub-unit (manual or hand launch)	Up to 3,000 ft AGL	Up to 25 km (LOS)	Company, Platoon, Squad	Skylark
	Micro ** (<66 J)	Tactical Sub-unit (manual or hand launch)	Up to 200 ft AGL	Up to 5 km (LOS)	Platoon, Squad	Black Widow

Figure 1 - NATO UAS Classification Table. NATO, Allied Tactical Publication 3.3.8.2 - *Unmanned Aircraft System Tactics, Techniques and Procedures*, Ed: A V.1 (NATO Standardization Office, 2020), 1–2 Table 1.1.

[43] Canada. Department of National Defence, “CAF UAS Categorization Table.”