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North American, Central American and Caribbean Office

INFORMATION PAPER

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Ottawa, Canada, 31 July to 2 August 2018

Agenda Item 9: ICAO 13th Air Navigation Conference (AN-Conf/13)

RECENT PROGRESS ON REMOTE PILOTED AIRCRAFT SYSTEM (RPAS) AND UNMANNED AIRCRAFT SYSTEMS (UAS)

(Presented by the Secretariat)

EXECUTIVE SUMMARY

This information paper presents the Recent Progress on RPAS and UAS as reflected in **Appendix A** (Thirteenth Air Navigation Conference AN-Conf/13-WP/5 on Very Low Altitude Operations) and **Appendix B** (Thirteenth Air Navigation Conference AN-Conf/13-WP/6 on Remotely Piloted Aircraft System (RPAS)).

The aforementioned information will be part of the discussion of the AN/Conf/13 where States will be requested to support the recommendations for a) smaller UAS on very low altitude (1000 feet above ground level and below) and b) continue development of RPAS.

Strategic Objectives:	• Safety • Air Navigation Capacity and Efficiency
Reference	Thirteenth Air Navigation Conference (AN-Conf/13), Montréal, Canada, 9 to 19 October 2018

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APPENDIX A

International Civil Aviation Organization

AN-Conf/13-WP/5
5/4/18

WORKING PAPER

THIRTEENTH AIR NAVIGATION CONFERENCE

Montréal, Canada, 9 to 19 October 2018

COMMITTEE A

Agenda Item 5: Emerging issues
5.2: Operations below 1000 feet

VERY LOW ALTITUDE OPERATIONS

(Presented by the Secretariat)

EXECUTIVE SUMMARY

This paper addresses the opportunities and challenges linked to the emergence of a range of aviation activities in very low altitude airspace, typically at 1 000 feet above ground level (AGL) and below, particularly in urban or suburban environments. These activities include the operation of small unmanned aircraft (UA), commonly referred to as "drones", as well as new developments referred to as "flying taxis". In light of the expected benefits and to ensure safe, efficient, and interoperable worldwide operational and regulatory frameworks that include existing airspace users, ICAO should continue serving as the global facilitator and forum for the coordinated development of national regulations and supporting efforts towards the conceptualization and implementation of an unmanned aircraft systems (UAS) traffic management (UTM) system.

Action: The Conference is invited to agree to Recommendation 5.2/xx — Very low altitude operations, in paragraph 3.

Strategic Objectives:	This working paper relates to the Safety and Air Navigation Capacity and Efficiency Strategic Objectives.
Financial implications:	*Impact for the aviation community:* Significant investments will be required, possibly through public-private partnerships (PPPs), for the conceptualization and implementation of a UTM system, and to ensure safe, efficient, and interoperable worldwide frameworks, both operational and regulatory. *Impact for ICAO (relative to the current Regular Programme Budget resource levels)*: Since the 39th Session of ICAO's Assembly (A39) extended the Organization's work programme to encompass UAS operations that remain outside of the international instrument flight rules (IFR) framework, additional resources are required, both financial and human, to support ICAO's efforts in the highly specialized areas associated with unmanned aviation operations.

References:	AN-Conf/13-WP/6 A39-WP/474 Doc 10019, *Manual on Remotely Piloted Aircraft Systems (RPAS)* Doc 10007, *Report of the Twelfth Air Navigation Conference (AN-Conf/12)* Doc 10075, *Assembly Resolutions in Force as of 6 October 2016* Doc 7300, *Convention on International Civil Aviation*

1. INTRODUCTION

1.1 This paper addresses the emergence of a range of new aviation activities in very low altitude airspace, typically at 1 000 feet above ground level (AGL) and below, in urban or suburban environments. Such activities include the operation of small unmanned aircraft (UA), commonly referred to as "drones", as well as new developments such as "flying taxis", operating along with existing airspace users such as manned helicopters, paragliders and other users. UA include a broad spectrum from meteorological balloons that fly freely to highly complex aircraft piloted from remote locations by licensed aviation professionals. The latter are covered in AN-Conf/13-WP/6.

2. DISCUSSION

Opportunities

2.1 Drones are expected to support the development of goods delivery business models, in particular, online sale of products such as pharmaceuticals, food, electronics and clothing as well as inspection, monitoring and even recreational activities. The competitive advantage of drones over traditional ground transportation modes is particularly strong in densely populated urban areas.

2.2 Furthermore, a network of small, electric powered-lift aircraft that take off and land vertically may enable rapid and reliable transportation between suburbs and cities and within cities. The use of such aircraft can generate significant savings in commute time and therefore positively contribute to urban mobility. From an economic perspective, urban powered-lift networks are expected to have significant cost advantages over traditional ground and air transportation which usually require heavy infrastructure such as roads, rail, bridges, tunnels or airports.

2.3 With these new technologies, tops of parking garages, existing airports and heliports, and even unused land surrounding highway interchanges could form the basis of an extensive, distributed network of dedicated operational sites. The lower cost and increased flexibility provided by these innovative approaches may substantiate strong business cases for cities and States around the world.

Challenges

2.4 **Aircraft certification** — Ongoing "flying taxi" projects are aimed at the development and introduction within five years of highly automated unmanned aircraft systems (UAS) available for use as taxis by the general public. Such new types of aircraft expected to carry passengers will require a blend of certification requirements from both manned and unmanned aircraft categories. While airworthiness certification SARPs are under development for remotely piloted aircraft (RPA), they do not allow for people being on board at this time. Advances are being made in this field, including flight demonstrations, in the United Arab Emirates, the United States and the European Union.

2.5 **Air traffic management** — The increasing numbers of aircraft, whether manned or unmanned, operating simultaneously within metropolitan areas will require new approaches to air traffic management (ATM). The UAS traffic management (UTM) concept can be defined as a system that provides traffic management through the integration of humans, information, technology, facilities and services, supported by air and ground and/or space-based communications, navigation and surveillance. A key aspect of UTM is precisely the need for it to serve in areas with high-density aircraft operations, including package delivery. It should be noted that airspace from ground-level to upwards of 1 000 feet AGL is already the operational environment of low-flying helicopters and other manned aircraft which will also need to be identified by the UTM system. At this early stage, it would be premature to define the dimensions of the UTM, including its lower and upper limits. The primary means of communication and coordination between the air navigation services providers (ANSPs), operators and other stakeholders may be through a distributed network of highly automated systems via application programming interfaces (API), rather than the traditional voice/data exchange between pilots and air traffic controllers.

2.6 **Infrastructure development** — Identifying the infrastructure requirements, followed by development and deployment, will require the proactive cooperation of States and stakeholders with the involvement of local authorities as necessary, possibly through public-private partnerships (PPPs).

Work in Progress

2.7 Given the rapid development of aviation technology planned to operate in low level airspace, the 39th Session of the ICAO Assembly, from 27 September to 6 October 2016, expressed broad support for ICAO taking a leadership role in the development of Standards and guidance material (A39-WP/474 refers) for the proper harmonization of regulations on UAS that remain outside of the international instrument flight rules (IFR) framework. In order to facilitate this expansion of ICAO's work programme, an innovative and flexible approach was recognized as being necessary, taking into account ongoing developments at national, regional and international levels.

2.8 Currently, UTM technology is advancing rapidly in a number of States and regions. For example, in Europe, the high-level conference on UAS, held in Helsinki in November 2017, called for *"*strengthened international regulatory cooperation with ICAO, JARUS and Non-EU States*"* and invited "European authorities to come forward, as a matter of urgency, with indications of future regulatory plans which […] reflect the probable roles and responsibilities of the actors involved in drone operations and U-space provision…". U-Space, in Europe, is a set of new services and specific procedures (e.g., registration, electronic identification, geofencing, flight approval, and tracking) designed to support safe, efficient and secure access to airspace for large numbers of UA. Ongoing work on UTM also includes NASA's work in the United States, as well as other projects in China, Japan, the Russian Federation and Singapore.

2.9 In this context, the DRONE ENABLE Symposium was held in Montréal from 22 to 23 September 2017. The Symposium emphasized the need for regulators to take a different, quicker path from the traditional approach of developing regulations and guidance in order to accommodate and ultimately integrate UTM solutions.

2.10 Any framework for UTM will have to include several components, three of which are fundamental and will therefore be addressed as a matter of priority as follows: i) *registration system* from which data is accessible in real time to allow remote identification and tracking of each UA, its operator/owner and location of the remote pilot/control station; ii) *communications systems* for control of the UA and for tracking all UA within the UTM area; and iii) *geofencing-like systems* that will support automatic updates by national authorities on the 28-day aeronautical information regulation and control (AIRAC) cycle to prevent UA operation in sensitive security areas and restricted or danger areas such as near aerodromes.

2.11 To further support State and industry efforts towards harmonization of the regulatory framework applicable to UAS, ICAO has developed an online toolkit (https://www.icao.int/safety/UA/UASToolkit/Pages/default.aspx) which includes guidance material to support regulators in developing and implementing UAS national regulations, best practices and examples from States that have regulations in place. The UTM framework will be added to the UAS toolkit as it is developed by ICAO.

The Way Forward

2.12 ICAO must continue supporting States and industry stakeholders to allow more complex low-altitude operations; maintain close contact with industry innovators; identify ways to balance local and international interests; improve communications with enforcement authorities; address security risks; and accelerate the approval of special authorizations that can be recognized by multiple States.

2.13 ICAO's activities to support the development of the UTM are essential to ensure compatibility and interoperability of systems and associated regulations. The Organization must therefore continue to serve as the global facilitator and forum for States, industry, academia and other interested stakeholders to collaborate on developing the UTM system.

2.14 ICAO must expedite the development and deployment of the global aircraft registry network (ARN) which will facilitate the connectivity between national aircraft registries. The ARN will apply to manned aircraft, as well as RPA and other UA. As a global network, the ARN will support ICAO in the areas of operational safety and universal safety oversight while helping States in day-to-day operations and enabling them to fulfil their obligations under Article 21 of the Chicago Convention.

2.15 States should support the development of UTM systems by ensuring the identification and availability of sufficient and adequate infrastructure, including giving consideration to and implementing financing arrangements such as PPPs.

3. CONCLUSION

3.1 In light of the above, the Conference is invited to agree to the following recommendation:

Recommendation 5.2/xx — Very low altitude operations

That the Conference:

a) urge States to collect and share information regarding very low altitude operations;
b) request ICAO to contribute to the development of operational solutions and guidance to support the safe and coordinated development of aviation activities at low altitude particularly in urban and suburban environments, including in the vicinity of, and into, airports;

c) request ICAO to continue serving as the global facilitator and forum for States, industry, academia and other interested stakeholders in the development of the UTM system, including by developing guidance for the identification, structuring and implementation of necessary financing mechanisms such as public-private partnerships (PPPs);
d) request ICAO to expedite development of a global aircraft registry network (ARN);
e) request ICAO to continue developing provisions for the proper harmonization and implementation of regulations on UAS;
f) urge States to provide ICAO with dedicated financial and personnel support to undertake the expanded work programme associated with UAS operations that remain outside of the international instrument flight rules (IFR) framework, with the development of the UTM system, and with other low altitude operations; and
g) request ICAO to continue conducting awareness and educational activities amongst users, and to facilitate the exchange of information amongst States regarding their UAS regulations.

— END —

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APPENDIX B

International Civil Aviation Organization

AN-Conf/13-WP/6
5/4/18

WORKING PAPER

THIRTEENTH AIR NAVIGATION CONFERENCE

Montréal, Canada, 9 to 19 October 2018

COMMITTEE A

Agenda Item 5: Emerging issues
5.3: Remotely piloted aircraft system (RPAS)

REMOTELY PILOTED AIRCRAFT SYSTEM (RPAS)

(Presented by the Secretariat)

EXECUTIVE SUMMARY

This paper describes opportunities and challenges presented by the operation of remotely piloted aircraft systems (RPAS). It also presents existing and future activities of ICAO for the development of the regulatory framework to support the integration of remotely piloted aircraft (RPA) into non-segregated airspace and aerodromes.

Action: The Conference is invited to agree to Recommendation 5.3/xx — Remotely piloted aircraft system (RPAS) in paragraph 3.

Strategic Objectives:	This working paper relates to the Safety and Air Navigation Capacity and Efficiency Strategic Objectives.
Financial implications:	*Impact for the aviation community:* Considerable opportunities are associated with RPAS operations, and the aviation community at large will benefit from the development of the regulatory framework to support the safe integration of remotely piloted aircraft (RPA) into non-segregated airspace and aerodromes. *Impact for ICAO (relative to the current Regular Programme Budget resource levels)*: Since ICAO's current Standards and Recommended Practices (SARPs) development and implementation roll-out will continue over the next triennia, additional resources are required, both financial and human, to support ICAO's efforts in the highly specialized areas associated with unmanned aviation operations.

References:	AN-Conf/13-WP/5 Doc 10071, *Assembly 39th Session - Technical Commission Report* Doc 10019, *Manual on Remotely Piloted Aircraft Systems (RPAS)* Doc 10007, *Report of the Twelfth Air Navigation Conference (AN-Conf/12)* Doc 7300, *Convention on International Civil Aviation* *Remotely Piloted Aircraft System (RPAS) Concept of Operations for International IFR Operations* (CONOPS)

1. INTRODUCTION

1.1 In the *Convention on International Civil Aviation* (Doc 7300), any aircraft intended to be flown without a pilot on board is referred to as a "pilotless aircraft". Today, these aircraft are called "unmanned" rather than "pilotless". Unmanned aircraft (UA) include a broad spectrum from meteorological balloons that fly freely to highly complex aircraft piloted from remote locations by licensed aviation professionals. The latter are part of the category referred to as remotely piloted aircraft (RPA) and operate as part of a remotely piloted aircraft system (RPAS). RPAS therefore consists of an RPA, a remote pilot station (RPS), a C2 Link for control and management, and any other components as specified in the type design. Smaller UA which are commonly referred to as "drones" are addressed in AN-Conf/13-WP/5.

1.2 RPAS, which offer a vast range of capabilities and sophistication, constitute a growing industry with considerable operational opportunities and economic potential. However, since their associated technologies, designs and operating concepts are evolving rapidly, States are being challenged with the safe and efficient integration of RPAS into environments shared by a highly regulated and well established manned aircraft industry. In this context, it is necessary for ICAO to prioritize development of Standards and Recommended Practices (SARPs) for RPAS.

2. DISCUSSION

Opportunities

2.1 The combination of greater flexibility and potentially lower capital investment and operating costs associated with RPAS operations allow unmanned aviation to be a truly transformative technology. RPA are, or will be, used in a variety of applications such as: wildfire mapping; agricultural monitoring; disaster management; thermal infrared power line surveys; law enforcement; telecommunication; weather monitoring; aerial imaging/mapping; television news coverage, sporting events and moviemaking; environmental monitoring; oil and gas exploration; and freight transport. RPAS also serve to provide humanitarian relief, medical assistance and response to crises and public health emergencies.

2.2 According to industry studies, the European drone market is expected to be worth over EUR 10 billion annually in 2035 and over EUR 15 billion annually in 2050. In the United States, the integration of UAS into the national airspace system is forecast to support more than USD 13.6 billion in economic activity in the first three years of integration and the creation of over 100,000 jobs by 2025.

Challenges

2.3 Article 8 of the Chicago Convention provides that: "*Each Contracting State undertakes to insure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft.*" The availability of globally harmonized provisions for RPAS is therefore essential to support the development of required technologies and certification methods to permit the operation of RPA in non-segregated airspace and at aerodromes.

2.4 According to Annex 2 — *Rules of the Air,* Appendix 4, RPA operating internationally must satisfy requirements defined under the Chicago Convention. As such, they must have a special authorization from all affected States, an operator certificate and a certificate of airworthiness. In addition, RPA must comply with communications, navigation and surveillance (CNS) requirements; remote pilots must be licensed; and flight plans must be submitted. One notable characteristic of unmanned aviation's regulatory framework is that the automatic recognition of pilot certificates and licences provided for under Article 33 of the Chicago Convention does not extend to remote pilots. To address this gap, adoption of a Standard for mutual recognition is desirable. Additionally, meeting the requirement for certificates, licences and logbooks to be carried on board pursuant to Article 29 of the Chicago Convention will require innovative solutions.

2.5 The absence of a pilot on board brings the challenge of ensuring the ability of the pilot to "see and avoid" and "remain well clear" of other traffic and dangerous situations, such as potential collisions with other airspace users or obstacles and severe weather conditions. Technical solutions have been developed to control the aircraft through data link(s) from (a) remote location(s). Key enablers for RPA integration therefore include effective detect and avoid (DAA) functionality and C2 Link, as well as mitigation of cybersecurity threats. One of the other challenges faced by regulators and the industry in the effort to develop the regulatory framework for RPAS is insufficient data, as there is limited feedback based on experience and associated data on C2 Link and DAA. Data is therefore needed from States and RPAS industry stakeholders to align SARPs development with operational needs.

2.6 Also to be taken into account is the management of frequency spectrum, a scarce natural resource, which is under the auspices of the International Telecommunications Union (ITU). During the ITU World Radiocommunication Conference (WRC) in 2015, the ITU agreed to Resolution 155 (WRC-15) which enables the use of fixed satellite service spectrum for the provision of C2 Links beyond radio line of sight. However, certain elements of the solution identified by the ITU depend on the progress of the development of SARPs and on whether any potential safety-related problems are identified with that solution during the development of the SARPs. Depending of the outcome of the ICAO work, Resolution 155 (WRC-15) will be reviewed and updated during the WRCs in 2019 and 2023.

Work in Progress

2.7 The Remotely Piloted Aircraft Systems Panel (RPASP) is tasked, inter alia, with: a) serving as the focal point and coordinator of all ICAO RPAS-related work with the aim of ensuring global interoperability and harmonization; b) developing an RPAS regulatory concept and associated guidance material to support and guide the regulatory process; and c) reviewing ICAO SARPs, proposing amendments and coordinating the development of RPAS SARPs with other ICAO expert groups.

2.8 Accordingly, provisions in Annex 2, Annex 7 — *Aircraft Nationality and Registration Marks* and Annex 13 — *Aircraft Accident and Incident Investigation* have already been developed by ICAO. Provisions on the remote pilot licence in Annex 1 — *Personnel Licensing* have been adopted by Council and are available for voluntary use. They will become applicable in November 2022. Provisions to support RPAS are necessary in virtually all ICAO Annexes. Priority is currently given to developing SARPs for Annex 6 — *Operation of Aircraft*, the planned Part IV — *International Operations — Remotely Piloted Aircraft Systems*, Annex 8 — *Airworthiness of Aircraft* and Annex 10 — *Aeronautical Telecommunications*.

2.9 ICAO guidance on technical and operational issues related to the integration of RPA in non-segregated airspace and aerodromes is contained in the *Manual on Remotely Piloted Aircraft Systems (RPAS)* (Doc 10019) and was developed by the Unmanned Aircraft Systems Study Group (UASSG), the predecessor of RPASP. Additionally, ICAO has published online the *Remotely Piloted Aircraft System (RPAS) Concept of Operations for International IFR Operations (CONOPS)*. This document[1] describes the operational environment into which unmanned aircraft are integrating, thereby ensuring a common understanding of the challenges.

2.10 The 39th Session of the Assembly (27 September to 7 October 2016) urged ICAO to develop provisions to support safe RPAS operations, including awareness and educational campaigns, and to promote exchange of information amongst States regarding their unmanned aviation regulations (*Assembly 39th Session - Technical Commission Report* (Doc 10071, A39-TE) refers). ICAO has conducted several global and regional activities to further sensitize States and industry stakeholders including an RPAS Symposium in Abuja, Nigeria (17-18 July 2017) focused on the African continent, and the second Global RPAS Symposium in Montréal (19-21 September 2017).

2.11 At least one RPAS Workshop has been conducted in each ICAO region between 2016 and 2017. Civil aviation authorities involved in the development and implementation of RPAS regulations, as well as the certification and oversight of such activities, benefit from the exchange of information. In support of the No Country Left Behind (NCLB) initiative, the ICAO Secretariat is conducting, with the African Union Commission (AUC), a study to assess the usage of RPA and drones in rural zones and agricultural activities with a view to ensuring that operations are safe, reliable, secure, efficient, environmentally friendly and cost effective.

From Accommodation to Integration

2.12 Accommodation describes the condition when an RPA can operate in airspace using some level of adaptation or support that compensates for its inability to comply within existing operational constructs. Integration refers to a future when RPA may be expected to enter the airspace system routinely, without requiring special procedures from air traffic control. Integration will require advances in RPAS technology and the development and implementation of harmonized SARPs and Procedures for Air Navigation Services (PANS).

2.13 States should support ICAO's continuing efforts for the development of SARPs, PANS and related guidance material for the integration of RPA into non-segregated airspace. Without dedicated financial or personnel support from States and industry, the pace at which ICAO is developing provisions will not be maintained. Furthermore, States are invited to provide the resources to support ICAO's awareness-raising efforts such as regional symposia and workshops dedicated to RPAS, as well as implementation roll-out activities. To address the lack of data on DAA and C2 Link, States should actively engage industry stakeholders with a view to collecting and analysing data that will support the development of SARPs that are aligned with industry needs.

[1] https://www.icao.int/safety/UA/Documents/RPAS%20CONOPS.pdf

3. CONCLUSION

3.1 In light of the above, the Conference is invited to agree to the following recommendation:

Recommendation 5.3/xx — Remotely piloted aircraft system (RPAS)

That the Conference:

a) request ICAO to prioritize development of the regulatory framework necessary to support the integration of RPA into non-segregated airspace and aerodromes;
b) urge States to provide ICAO with dedicated financial and personnel support to prioritize development of the regulatory framework necessary for the integration of RPA into non-segregated airspace and aerodromes and to facilitate related implementation roll-out activities;
c) urge States to collect and share information on RPAS operations;
d) urge States to actively engage industry stakeholders to collect and provide technical data to ICAO on RPAS operations needed to support the development of SARPs for RPAS, including for DAA and C2 Link; and
e) request ICAO to continue developing guidance material to support safe RPAS operations, to conduct awareness and educational activities amongst users, and to facilitate the collection and sharing of information amongst States regarding their RPAS regulations.

— END —