Before the

FEDERAL COMMUNICATIONS COMMISSION

Washington, DC 20554

In the Matter of	)	
	)	
Petition To Adopt Service Rules for	)	RM-_____
Unmanned Aircraft Systems ("UAS")	)	
Command and Control in the	)	
5030-5091 MHz Band	)	

PETITION FOR RULEMAKING

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SUMMARY

Since the adoption by the 2012 World Radiocommunication Conference of an allocation for terrestrial line-of-sight command and control of unmanned aviation systems, industry and government have been working diligently to develop the standards to enable such use in the national airspace. The Commission advanced this effort with the adoption of an allocation for UAS command and control links in the 5030-5091 MHz band in March 2017. Now, this Petition makes recommendations for necessary rule changes under Part 87, and asks the Commission to develop technical and operational rules relating to use of the 5030-5091 MHz band to enable secure Control and Non-Payload Communications ("CNPC") links to support safe unmanned aircraft operations in the United States.

To fulfill this important outcome, this Petition recommends an FCC licensing framework that is aligned with FAA flight certification requirements as well as with RTCA Minimum Operational Performance Standards, to ensure that pilots in command ("PICs") not only operate under a Commission license but are first properly qualified by the FAA to operate UAS in the airspace and maintain the qualification. CNPC operations in the band include transmission of control information between the UAS and the PIC, between UAS ground stations allowing indirect relayed communications between the UAS and the PIC, and between the PIC and airspace traffic control facilities in the vicinity during flight. Necessary video C2 communications should be prudently limited to specific phases of flight. All of these links should be addressed by the Commission in the regulatory framework advocated by the Petition, and communications utilizing the band should be strictly limited to command and control and safety-of-life operations, consistent with the original purposes of the allocation.

Because the subject band is shared with both Federal and non-Federal users, mechanisms to maximize spectrum efficiency and to ensure effective coordination among all stakeholders are critical. To that end, the Petition strongly advocates for the development of a dynamic frequency assignment process using one or more Frequency Assignment Managers ("FAMs") designated by the Commission to ensure efficient spectrum access and reuse of the frequencies across multiple geographic areas. Many details of the frequency assignment process system should be left to the discretion of the FAM(s) subject to certain basic guidelines and requirements.

As the aviation industry continues to develop technologies capable of more complex unmanned flight operations in a safe and reliable manner, a complete but agile regulatory framework to enable CNPC links is crucial. Part 87 rule changes are needed in several areas, including definitions of new station types, licensing of individual PICs or organizations responsible for the use of qualified PICs, frequencies, clarifying that no individual or fleet licensing of UAS stations is required, power and emissions, station identification, frequency stability and modulations, and equipment authorization, among others. The Commission should commence a rulemaking expeditiously to address these important issues in a flexible manner so as to support ongoing UAS development.

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PETITION FOR RULEMAKING

Pursuant to Section 1.401 of the Commission's Rules,[1] the Aerospace Industries Association ("AIA") hereby petitions the Commission to initiate a rulemaking proceeding leading to the adoption of licensing and service rules for Control and Non-Payload Communications ("CNPC") links in the 5030-5091 MHz band for command and control ("C2") operations to support Unmanned Aircraft Systems ("UAS") operations. For the reasons set out below, the Commission should act without delay to commence this proceeding.

I. INTRODUCTION

The Aerospace Industries Association is the nation's most authoritative and influential voice of the aerospace and defense industry. AIA represents more than 100 leading aerospace and defense manufacturers, along with a supplier base of nearly 200 associate members, representing over one million direct U.S. aerospace and defense jobs. The Association's members are directly interested in contributing their expertise to the matter raised in this proceeding, specifically the regulatory actions necessary to use internationally harmonized, aeronautical spectrum for UAS command and control. Over the past several years AIA has been

[1] 47 C.F.R. § 1.401.

the established leader in advancing UAS integration into the National Airspace System ("NAS"). Recent technological, regulatory, and policy developments make clear that the time is ripe for FCC action.

On October 25, 2017, the White House announced that "[i]t shall be the policy of the United States to promote the safe operation of unmanned aircraft systems ("UAS") and enable the development of UAS technologies for use in agriculture, commerce, emergency management, human transportation, and other sectors."[2] The President's memorandum directed the Department of Transportation and other Federal agencies to establish a UAS Integration Pilot Program to facilitate the continued integration of UAS into the NAS.[3] A statement released concurrently by the White House Office of Science and Technology Policy explained that the Pilot Program is a "critical first step towards opening up the skies for commonsense, safe commercial drone activity," particularly with respect to removing FAA restrictions on several key categories of UAS operations, namely "flights beyond visual line of sight, flights at night, and flights over people."[4]

The Presidential memorandum specifically noted the need to consider the policy objective of "using radio spectrum efficiently and competitively."[5] The issue of spectrum usage

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[2] *Unmanned Aircraft Systems Integration Pilot Program*, Presidential Memorandum for the Secretary of Transportation, The White House, Sect. 1 (Oct. 25, 2017) ("*White House Memorandum*"), *available at:* https://www.whitehouse.gov/the-press-office/2017/10/25/presidential-memorandum-secretary-transportation (*last visited:* Dec. 5, 2017).

[3] *See id.*, Section 2(a).

[4] *Integrating Unmanned Aircraft Systems into the National Airspace*, Office of Science and Technology Policy (Oct. 25, 2017), *available at:* https://www.whitehouse.gov/blog/2017/10/25/integrating-unmanned-aircraft-systems-national-airspace (*last visited:* Dec. 5, 2017).

[5] *White House Memorandum*, Section 3(b)(viii)(E).

is critical because UAS cannot function in a safe and effective manner without highly reliable command and control links that are not disrupted by radiofrequency interference.

The Commission has long recognized the importance of allocating spectrum for UAS command and control. In 2012, the Commission, as part of the U.S. Delegation to WRC-12, successfully advocated for the allocation of the frequency band 5030-5091 MHz to the aeronautical mobile (Route) Service ("AM(R)S") on a primary basis to support radio line of sight ("LOS") control links for UAS.[6] In supporting this proposal, the U.S. Delegation observed that the operation of UAS in non-segregated airspace "will require high integrity communication links between the unmanned aircraft ("UA") and remote control centers capable of relaying the necessary air traffic control ("ATC") messages and flight critical aircraft information."[7]

Following the adoption by WRC-12 of the international AM(R)S allocation, the Commission adopted a Notice of Proposed Rulemaking in 2015 proposing to mirror this allocation in the United States.[8] Commenting parties supported this proposal, with the Small UAV Coalition noting that the spectrum allocation should be sufficiently flexible to accommodate future uses of the band by UAS.[9] The Commission adopted the allocation for

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[6] *See* Amendment of Parts 1, 2, 15, 25, 27, 74, 78, 80, 87, 90, 97, and 101 of the Commission's Rules Regarding Implementation of the Final Acts of the World Radiocommunication Conference (Geneva, 2007) (WRC-07), Other Allocation Issues, and Related Rule Updates, ET Docket No. 12-338, ET Docket No. 15-99, and IB Docket 06-123, *Report and Order, Order, and Notice of Proposed Rulemaking*, 30 FCC Rcd 4183, ¶ 225 (2015) ("*UAS Allocation NPRM*").

[7] *Proposal for the Work of the Conference,* Agenda Item 1.3, United States of America, 1st Tranche (Feb. 17, 2011), *Available at:* https://transition.fcc.gov/bureaus/ib/wrc-12/us/1st_Tranche.pdf (*last visited* Dec, 5 2017).

[8] *See* Amendment of Parts 1, 2, 15, 25, 27, 74, 78, 80, 87, 90, 97, and 101 of the Commission's Rules Regarding Implementation of the Final Acts of the World Radiocommunication Conference (Geneva, 2012) (WRC-12), Other Allocation Issues, and Related Rule Updates, ET Docket No. 15-99, *Report and Order*, FCC 17-33, ¶ 229 (2015) ("*UAS Allocation Order*").

[9] *See* Comments of The Small UAV Coalition, ET Docket No. 15-99, at 3-4 (Aug. 31, 2015).

UAS command and control links in the 5030-5091 MHz band in an order released on March 29, 2017.[10] Although the Commission's order acknowledged the supportive comments that had been filed in favor of flexible rules for UAS, the Commission concluded that "[t]echnical and operational rules relating to altitude, weight, or other requirements will be addressed in the service rules for this band, which will be promulgated in a separate proceeding."[11]

Concurrently, the Commission has been actively supporting experimental operations within the aviation and other industries to advance UAS operations in the United States. Just in the past two years, the Commission has granted about two dozen experimental licenses for UAS operations involving numerous frequency bands, many issued to AIA members.[12] These experimental operations have been instrumental in furthering the safe and reliable use of UAS.

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[10] *See* Amendment of Parts 2, 15, 80, 90, 97, and 101 of the Commission's Rules Regarding Implementation of the Final Acts of the World Radiocommunication Conference (Geneva, 2012)(WRC-12), Other Allocation Issues, and Related Rule Updates, ET Docket No. 15-99, *Report and Order*, FCC 17-33 (March 29, 2017) ("*UAS Allocation Order*").

[11] *Id.*, ¶ 42.

[12] *See, e.g.,* INSITU, Call Sign WI2XYL, File No. 0456-EX-CN-2017 (UAS command and control in the 4400.00 - 4800.00 MHz band); Rockwell Collins, Inc., Call Sign WI2XZE, File No. 0451-EX-CN-2017 (UAS operations using the 800 MHz band); Virginia Tech MAAP – FAA UAS Test Site in Blacksburg, VA, Call Sign WI2XVR, File No. 0273-EX-CN-2017 (UAS test operations in the 9500.00 - 9800.00 MHz band); Aerovironment, Inc., Call Sign WI2XVI, File No. 0121-EX-CN-2017 (small UAS technology using the 2.3 GHz band); Raytheon Missile Systems, Call Sign WI2XTE, File No. 0128-EX-CN-2017 (UAS test operations at 351.00 and 362.25 MHz); Arcturas UAV, Call Sign WI2XHL, File No. 0196-EX-PL-2016 (UAS testing using the 902 - 928 MHz and 4.40 - 5.00 GHz bands); Lockheed Martin Corp., Call Sign WI2XRQ, File No. 0195-EX-CN-2016 (UAS experimental operations on select frequencies between 365.50 and 1380.00 MHz); INSITU, Call Sign WI2XHD, File No. 0186-EX-PL-2016 (UAS command and control experiments in the 5030 - 5040 MHz band); Lockheed Martin Corp., Call Sign WI2XSE, File No. 0134-EX-CN-2016 (UAS experimental operations using the 1670.00 - 2375.00 MHz band); North Dakota Department of Commerce – Northern Plains UAS Test Site, Call Sign WI2XHT, File No. 0067-EX-PL-2016 (UAS test operations in the 4400 - 4650 MHz band); University of Missouri-Kansas City, Call Sign WI2XMD, File No. 0527-EX-PL-2016 (UAS experimental operations in the 2406.50 - 2476.50 and 5725.00 - 5825.00 MHz bands); General Atomics Aeronautical Systems, Call Sign WI2XAI, File No. 0632-EX-PL-2015 (UAS aircraft training experiments using the 16.25-18.24 GHz band); Aurora Flight Sciences,

The aviation industry has been equally focused on preparing the way for UAS to conduct more complex flight operations in a safe and reliable manner. The Federal Aviation Administration ("FAA") has been studying a number of critical concepts regarding future UAS operations, including assessments of alternatives for communications architecture, and the compatibility of UAS command and control links with other avionics radio equipment.[13] The FAA has also granted numerous waivers of its rules to permit individual operators to test UAS flights in various conditions. Some of these waiver recipients are the same companies that have received experimental licenses from the Commission.[14] For example, BNSF Railway Company secured both FCC and FAA authority to test the use of UAS to inspect the safety of rail lines over relatively long distances.[15]

Call Sign WH2XDQ, File No. 0199-EX-PL-2014 (experimental UAS operations in the 4.4-4.95 GHz band); Arcturas UAV, Call Sign WH2XLB, File No. 0668-EX-PL-2014 (experimental UAS operations at 2 GHz and 4 GHz); Airscan, Inc., Call Sign WI2XLK, File No. 0471-EX-PL-2016 (experimental UAS training operations using the 2.4 GHz and 5.8 GHz bands); General Atomics Aeronautical Systems, Inc., Call Sign WI2XJL, File No. 0309-EX-PL-2016 (experimental UAS testing on several frequencies between 5260 MHz and 5850 MHz); Battelle Memorial Institute, Call Sign WI2XQS, File No. 0281-EX-CN-2016 (experimental UAS operations in the 902.00 - 928.00 MHz band); Aerovironment, Inc., Call Sign WI2XNF, File No. 0028-EX-CN-2016 (experimental UAS operations in the 2380-2385 MHz band); BNSF Railway, Co., Call Sign WI2XPN, File No. 0187-EX-CN-2016 (use of 122.90 MHz for studying the innovative use of UAV); The Boeing Company, Call Sign WI2XPD, File No. 0167-EX-CN-2016 (UAS experimental operations in the 902.00 - 928.00, 1370.00 - 1390.00, 2300.00 - 2310.00 and 2355.00 - 2482.00 MHz bands); INSITU, Call Sign WI2XFH, File No. 0119-EX-PL-2016 (UAS test operations using 1850.00 MHz); Leidos, Call Sign WI2XOR, File No. 0079-EX-CN-2016 (using of the 1775.00 - 1795.00 MHz band to test UAS); County of Oneida, Call Sign WI2XEP, File No. 0058-EX-PL-2016 (use of 1360 MHz for UAS testing).

[13] *See* https://www.faa.gov/uas/research/reports/#cc (last visited: Dec. 8, 2017).

[14] *See* https://www.faa.gov/uas/request_waiver/waivers_granted/.

[15] *See* https://www.faa.gov/uas/request_waiver/waivers_granted/media/107W-2016-00003_BNSF_ CoW.pdf.

In addition, on behalf of the FAA, RTCA Special Committee 228 ("SC-228") has been developing Minimum Operational Performance Standards ("MOPS") to support UAS operations within the NAS.[16] These MOPS include RTCA DO-362, which specifies characteristics for UAS Terrestrial CNPC links for the command and control of UAS. The CNPC specifications can support a wide range of UAS command and control architectures – from the smallest point-to-point radio LOS application to more complex multi-aircraft and networked solutions.[17] By the end of 2018, SC-228 will also issue a Minimum Aviation System Performance Standards ("MASPS") document stipulating end-to-end performance and networking requirements for UAS C2 link systems, which will include the radiofrequency CNPC links specified in DO-362.

A sufficiently agile assignment process will be necessary to ensure that the CNPC operations of a UAS in a particular geographic area do not interfere with the CNPC operations of other UAS in the same or adjacent areas. Given that UAS are highly mobile, such an assignment process will have to take many dynamic factors into account. In addition, given the significant number of UAS that are likely to operate in the near future, only a small amount of RF spectrum will be available for each CNPC link and the assignment of that spectrum to a particular UAS will need to be limited to as short a period of time as possible so that other UAS can use the same channel as soon as it is no longer needed.

SC-228 recently completed its work on Appendix I of the UAS MOPS, which addresses a potential solution for using radio communications spectrum for UAS CNPC through a dynamic

[16] RTCA published DO-362, "Command and Control (C2) Data Link Minimum Operational Performance Standards (MOPS) (Terrestrial)" in September 2016. The FAA has developed a proposed Technical Standards Order (TSO-CNPC), for which the public comment period closed on January 22, 2018.

[17] *See* Command and Control (C2) Data Link Minimum Operational Performance Standards (MOPS) (Terrestrial), RTCA, Inc., RTCA-DO-362, at i (Sept. 22, 2016) ("*UAS MOPS*").

spectrum assignment process.[18] To ensure that the factors described in the preceding paragraph are carried out in a well-defined and controlled manner, AIA proposes that non-Federal users of UAS CNPC links in the 5030-5091 MHz band be required to hold an FCC license. In addition, the actual assignment of CNPC channels for UAS operations under the UAS MOPS to authorized operators would be carried out by a Frequency Assignment Manager that would work with both Federal assignees and non-Federal licensees of UAS CNPC links.[19] As discussed below, the UAS MOPS are a good starting point for the Commission's consideration of licensing and operational rules, as being consistent with current industry expectations for future operations.

Given the importance of the President's memorandum, the rapid growth of UAS operations to support commerce and public safety in the United States, and the recent completion of RTCA's MOPS for UAS, the moment is ripe for expeditious Commission action with respect to the adoption of licensing procedures and service rules for UAS CNPC links in the 5030-5091 MHz band.[20] AIA recommends that this rulemaking address the important issues raised in the remaining sections of this Petition.

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[18] *See UAS MOPS*, Appendix I, at I-1.

[19] AIA notes that this Petition is limited to identifying the rules necessary to permit non-Federal users to conduct operations in the band as FCC licensees. Separately, NTIA will need to engage in a coordinated effort among all affected Federal stakeholders to develop a parallel and complementary structure to authorize operations to Federal users. Furthermore, as the dynamic spectrum assignment mechanism contemplated herein would necessarily account for both non-Federal and Federal operations, we will look for direction from Federal stakeholders for the best methods to ensure efficient, practicable frequency coordination among all users.

[20] As stated throughout, AIA's Petition contemplates license access only to the C-band. Additional spectrum allocations are however under consideration for CNPC links and AIA encourages FCC and other USG stakeholders to coordinate on making those resources available as expeditiously as possible. The licensing and operational framework that AIA outlines in the instant Petition could readily be applied to those allocations as they become available.

II. THE COMMISSION'S RULES FOR UAS CNPC OPERATIONS IN THE 5030-5091 MHZ BAND SHOULD REQUIRE INDIVIDUAL LICENSING FOR UAS OPERATORS

The operation of UAS – particularly over long distances – raises a number of critical public safety and security issues which are best addressed, first and foremost, through an appropriate licensing framework for command and control links. For example, UAS can create significant risks to manned aircraft and to individuals in elevated work environments, such as tall buildings, bridges, cranes, high power lines, and similar structures. UAS operating beyond LOS ("BLOS") also introduce a heightened risk of uncontrolled landings and the risks to public safety resulting from such incidents. Further, UAS may pose significant security risks to airports, defense installations, correctional facilities, public and private schools, and other locations where it is necessary to control entry solely of authorized individuals to ensure a safe and efficient environment.

Multiple UAS operating BLOS also potentially present significant risks to each other. To avoid collisions, UAS operators will invariably be required by the FAA to comply with specific operating requirements governing the use of different altitude floors and ceilings for different types of operations, such as take offs and landings versus traversing between locations. The CNPC links to control UAS could also interfere with the CNPC links of other UAS, potentially resulting in the loss of control of one or more unmanned aircraft and the significant public safety risks that would result.

To address these critical public safety and security issues, it is imperative that the licensing framework ensure that individual operators of CNPC links in the 5030-5091 MHz band be properly qualified. At the same time, it is imperative that organizations retain the flexibility to conduct UAS operations despite the variation that can result for personnel changes and

unavailability while still ensuring that all operators are qualified. Such individual operators – referred to in the RTCA MOPS as pilots in command ("PICs") – will be responsible for the control of the UAS and all radio communications with the UAS for the command and control of the aircraft, including communications transmitted directly by devices in the possession of the PIC, communications transmitted by the aircraft, and communications transmitted by other (potentially third party) ground radio facilities used to maintain C2 communications links with the UAS during distant flight. Concurrently, such operators will also be conducting operations on behalf of an organization interested in maintaining conditions allowing its qualified employees, contractors, or agents to have authority to operate and ensuring responsible, qualified UAS operations.

The qualifications for a PIC will include significant knowledge regarding UAS operations and mandatory regulatory procedures for safe operations. Given that the articulation and implementation of the vast majority of these requirements will fall with the expertise of the FAA, FCC deference to the FAA in establishing regulatory qualifications for PICs is appropriate. Such qualifications would possibly include imposing an FAA testing requirement on PICs and the FCC's licensee eligibility rules specifying only that any licensee must document either that it has secured the comparable FAA approval individually or will utilize only individuals with such qualifications for its UAS operations. We recommend that applicants for PIC authority secure a license under the FCC's Commercial Radio Operator Program, specifically Element 3, which addresses general radiotelephone electronic fundamentals and techniques[21] and that the new

[21] https://www.fcc.gov/wireless/bureau-divisions/mobility-division/commercial-radio-operator-license-program/examinations#block-menu-block-4

license category be referred to as *Unmanned Aircraft Systems Command and Non-Payload Communications Operator License.*

In order to proceed in this manner, the Commission should issue PIC licenses only to individuals or to organizations that certify that their operators will meet the qualifications established by the FAA for PICs. Further, individuals holding PIC licensees should be required to seek renewal of their licenses pursuant to time intervals that are equivalent to the period identified by the FAA for any periodic retesting that it may require of UAS operators. Similarly, while organization UAS C2 licenses may be of a longer duration, it should be the ongoing responsibility of the organizational licensee to ensure that its PICs maintain compliance with any testing requirements periodically as required by the FAA. There should be no geographic restrictions on UAS C2 licenses, allowing each licensee to operate UAS anywhere in the United States.

III. THE COMMISSION SHOULD RESTRICT THE USE OF THE UAS ALLOCATION IN THE 5030-5091 TO SAFETY-OF-LIFE COMMUNICATIONS

The operation of CNPC links for UAS will function in spectrum that has been allocated to the AM(R)S service and, as a result, must be strictly limited to "communications relating to safety and regularity of flight."[22] Accordingly, the Commission's Rules should prohibit any use of the 5030-5091 MHz band for payload communications or other non-safety or non-route services.

Even with this restriction in place, it is anticipated that the need for access to the 5030-5091 MHz band by authorized PICs will greatly exceed the capacity of this spectrum such that a dynamic method for efficiently managing spectrum access will be needed to maximize utilization

[22] 47 C.F.R. § 87.5.

by the largest number of UAS operations. During UAS flight, authorized CNPC communications will include continual data stream of information from the UAS to the PIC regarding the conditions of the UAS including its altitude, speed, direction, GPS location, fuel reserve, and system diagnostics, along with additional information regarding the conditions surrounding the UAS, including the weather, wind direction and speed, visibility, and potential obstructions, be they other flying objects or stationary obstacles. The data produced by a UAS may also include real-time video, allowing the PIC to see the airspace ahead of the aircraft.

If the UAS is manually controlled, the forward transmission path to the UAS will also require a nearly constant stream of data from the PIC as he or she pilots the UAS in the same manner as a pilot operates a manned aircraft with continual slight adjustments to the aircraft flaps to control pitch, lift, and height; to the aircraft throttle to control speed; and to the aircraft rudder to bank and turn. The PIC may also be able to adjust the direction of the video camera, enabling the PIC to visually identify objects above, below, or to the sides of the aircraft.

The authorized CNPC communications between a PIC and a UAS in the 5030-5091 MHz band will include a direct link between the aircraft and a transceiver in the PIC's possession. They may also include communications between the aircraft and other ground stations that can act as relay points between the PIC and the aircraft, including transmissions between multiple ground stations as communications are linked between a PIC and a distant UAS in flight.

The authorized CNPC communications of a PIC may also include communications between the PIC and aircraft control facilities in the vicinity. In this way, PICs can request approval from air traffic controllers prior to moving UAS into controlled airspace, and air traffic controllers can direct the operation of UAS in the airspace under their control. The simultaneous

operation of all of these communications links could easily consume significant spectrum resources.

The UAS MOPS also address the challenge that video poses, in that video links use about 100 times as much bandwidth as voice or telemetry. Unless prudently limited to specific phases of flight, video links could limit the scarce CNPC bandwidth available and thereby reduce the number of concurrent UAS operations significantly. The UAS MOPS proposed that three video channels be shared by all, but only under specific conditions. One wideband video channel (500 kHz) would be available for visually clearing an emergency landing location. Two smaller video channels (250 kHz) would be available for use by the next UAS on final approach to check "runway clear" prior to landing.[23] Owing to its urgent nature, emergency landing location video would be limited to a single UAS in any area at a given time. An underlying premise is that airports will assign the "runway clear" channels to the next UAS to land, taking it away upon touchdown and handing it to the next UAS on approach. We endorse the specific use cases and limitations as outlined in the MOPS and believe that the FCC should give particular consideration to them, as well.

It is anticipated, however, that UAS manufacturers will seek to identify ways to minimize the bandwidth and power levels required by specific models of UAS in order to make it easier for PICs to identify and secure frequency authorizations for the operation of these UAS in potentially congested environments. As discussed in the following sections, the incentive to minimize the required bandwidth and power levels for each UAS will be heightened through the

[23] *See* Environmental Conditions and Test Procedures for Airborne Equipment, RTCA, Inc., RTCA-DO-160 at §2.2.1.5.5.

proposed use of a first-come, first served assignment process for frequency channels available for each proposed flight.

IV. THE COMMISSION SHOULD ESTABLISH A FREQUENCY ASSIGNMENT MANAGEMENT SYSTEM TO DYNAMICALLY ASSIGN OPERATING FREQUENCIES TO LICENSED PICS

In order to maximize the use of the 5030-5091 MHz band, authorized PICs should have access to specific radio frequencies for as little time as possible to complete UAS flights safely. Further, PICs should have incentives to use as little bandwidth as possible to complete each UAS flight.

To accomplish these two goals, a dynamic frequency assignment process should be developed in which PICs secure access to specific frequency channels covering a limited geographic area and then release those channels as soon as their UAS flights in that area have been completed. RTCA DO-362 envisions that this can best be accomplished through the creation of a UAS Frequency Assignment Manager, which would facilitate dynamic UAS frequency assignments on a real-time basis. The UAS Frequency Assignment Manager would either be operated by the United States Government or could be a private entity that operates under the authority of the Commission and/or the FAA. It may be possible to have more than one Frequency Assignment Manager, potentially including different managers for Federal and non-Federal assignments or possibly having regional managers. The various Frequency Assignment Managers, however, would have to coordinate their operations using the same channel assignment database in any geographic region where their services overlap or abut each other. It is anticipated that the UAS Frequency Assignment Manager(s) could collect modest fees from authorized PICs for the assignment of frequencies and for maintaining the database.

Although many of the details of the frequency assignment process might be left to the discretion of each Frequency Assignment Manager, the UAS MOPS anticipates that authorized PICs would be permitted to secure CNPC frequencies on a first-come, first-served basis and would be permitted to request specific operating frequencies for a specific geographic location no more than twenty (20) minutes before the start of a proposed flight. Using Internet access (likely through a smartphone), the authorized PIC would initiate a request by specifying the proposed take off time and flight duration, along with the geographic area or path in which the flight will occur.[24] The authorized PIC will also be required to specify the bandwidth, power level, and waveform that will be needed for the UAS communications equipment that will be used for the flight, although this type of information will likely have been pre-registered into the database by the UAS CNPC licensee as a part of the initial registration process.

Based on the availability of radio frequency channels at the specific geographic location and the bandwidth of the channels needed for the identified UAS equipment, the database will either assign specific frequency channels to the authorized PIC, or indicate that no frequency channels of the type requested are currently available. The UAS MOPS anticipates that authorized PICs will be able to request both a primary and a backup frequency channel for each flight. This will allow an authorized PIC and its UAS to automatically default to the backup frequency channel in the event that harmful interference is experienced on the primary channel. The UAS MOPS also anticipates that authorized PICs will be permitted to concurrently request up to two pairs of frequency assignments, including one pair of frequencies (a primary and a

[24] Frequency Assignment Managers, by controlling the size of geographic areas over which licenses are assigned, should be encouraged to manage the size of areas to encourage more efficient use of spectrum and to maximize the number of UAS that simultaneously may be in operation to best meet demand for C2 spectrum.

backup) that can be used during the initial stage of the flight and a second pair of frequencies that may be needed in an adjacent geographic area during a later stage of the flight.

In all cases, an authorized PIC will be required to release the frequencies through the Frequency Assignment Manager's database as soon as the flight (or the current stage of the flight) has been completed. Assigned frequencies will also be automatically revoked a reasonable period after the UAS flight was scheduled to be completed. Because of this, if an authorized PIC does not initiate its UAS flight within 20 minutes after receiving a frequency assignment, the authorized PIC will be required to request a new assignment reflecting the flight delay.

As is apparent from this discussion, the Frequency Assignment Manager's duties will be very dynamic and may need to be adjusted to reflect the still-developing day-to-day realities of UAS operations, potentially diverse UAS bandwidth requirements, and the different types of UAS flights that are likely to be undertaken by PICs. Further, these characteristics may vary materially in different types of environments. For example, geographic flight areas and flight durations may be far more constrained for UAS in urban areas, while UAS in those areas may require significantly more bandwidth to accommodate increased real-time monitoring of surrounding conditions. In contrast, UAS flight areas and durations may be greater in rural areas (such as for the inspection of a rail line) yet may require less bandwidth to adequately control the UAS in flight.

Because of such variables, it is not anticipated that the details of the frequency assignment and release process should be specified in the Commission's Rules. Instead, it would be appropriate for the Commission to establish and designate one or more Frequency Assignment Managers and permit the Manager(s) – potentially through an advisory committee –

to develop and update as necessary the detailed procedures for authorized PICs to secure and release frequency assignments on a real-time basis.

V. THE TECHNICAL RULES FOR CNPC LINKS SHOULD BE FLEXIBLE TO SUPPORT ONGOING UAS DEVELOPMENT

The UAS MOPS recognizes that UAS manufacturers are continuing to develop and experiment with different radio communications technologies to maximize the range of UAS while ensuring reliable and highly efficient transmission of CNPC data between the authorized PIC and UAS in flight. Given this ongoing process, the Commission should refrain from adopting additional bandwidth, power level, modulation, wave form, or channelization requirements for CNPC links beyond those that are already applicable to Aeronautical Stations and Aircraft Stations in Part 87 of the Commission's Rules.[25] Instead, it is anticipated that within the scope of these existing requirements the UAS Frequency Assignment Manager will be able to accommodate different types of communications signals, including variations in bandwidth and power requirements between different types of UAS.

As noted above, incentives will naturally exist for UAS manufacturers and authorized PICs to minimize both the bandwidth and the power levels that they will employ for CNPC links. Incentives will exist to minimize the bandwidth in order to make it easier for the Frequency Assignment Manager to accommodate as many assignment requests as possible in the first-come, first-served assignment process. Incentives will also exist to minimize the maximum power level because the use of higher power levels will necessitate the issuance of frequency assignments covering larger geographic areas, heightening the risk for all authorized PICs that

[25] *See, e.g.,* 47 C.F.R. § 87.187(a)(2) (indicating that aircraft station transmitter power must not exceed five watts).

the requested assignment cannot be accommodated. To this end, UAS manufacturers are likely to employ transceivers with multiple power levels and bandwidth options, allowing authorized PICs to reduce one or both (perhaps by forgoing real time video monitoring) in order to secure channel assignments in highly congested areas.

It is anticipated that UAS manufacturers will have an additional incentive to design the radio systems for UAS with the capability to operate using any channel within the 5030-5091 MHz band. Such a capability will help authorized PICs to identify an available channel using the dynamic channel assignment process. Nevertheless, the Commission may want to consider adopting a requirement that the radio systems for all UAS that are designed to operate in the 5030-5091 MHz band be capable of tuning to any channel assignment within that frequency range. Such a requirement will help ensure that the 5030-5091 MHz band is used in the most efficient manner possible.

VI. THE COMMISSION SHOULD MODIFY ITS TABLE OF FREQUENCY ALLOCATIONS TO REFLECT THE USE OF THE 5030-5091 MHZ BAND FOR CNPC LINKS TO SUPPORT UAS

The Commission should make changes to the U.S. Table of Frequency Allocations to address the use of the 5030-5091 MHz band for CNPC links to support UAS. When the Commission allocated this spectrum for AM(R)S to support UAS CNPC links, the Commission added international footnote 5.443C to the band limiting its use to internationally standardized aeronautical systems and setting limits for unwanted emissions from AM(R)S stations to radionavigation-satellite service ("RNSS") downlinks in adjacent bands to an EIRP density

of -75 dBW/MHz.[26] The Commission also eliminated footnote US367, which creates a co-primary allocation to the aeronautical mobile-satellite service.[27]

International footnote 5.444 gives priority to the microwave landing system (MLS), used at some facilities for precision approach and landing, over other uses in the 5030-5091 MHz band. Footnote US444 of the U.S. Table implements the international footnote. However, in the United States there are limited locations that use the 5030-5091 MHz band for MLS. We suggest that US444 be modified to identify the locations at which MLS operations are conducted and to establish a coordination mechanism to enable UAS CNPC operations near those MLS stations.

Furthermore, we note that CNPC operations in the band should be conducted to make every practicable effort to meet the out of band emissions requirements outlined in footnote US211.

VII. UAS CNPC EQUIPMENT SHOULD BE REGULATED UNDER PART 87 OF THE COMMISSION'S RULES AND BE SUBJECT TO FCC EQUIPMENT CERTIFICATION AND RF EXPOSURE REQUIREMENTS

Based on the FAA proposed TSO for UAS CNPC, radio links must be DO-362-compliant if the 5030-5091 MHz band (which has an AM(R)S allocation) is used. Given that fact, it is appropriate to regulate CNPC links pursuant to Part 87 of the Commission's Rules. To this end,

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[26] *See UAS Allocation Order*, ¶ 41; *see also* 47 C.F.R. § 2.106, n.5.443C ("The use of the frequency band 5030-5091 MHz by the aeronautical mobile (R) service is limited to internationally standardized aeronautical systems. Unwanted emissions from the aeronautical mobile (R) service in the frequency band 5030-5091 MHz shall be limited to protect RNSS system downlinks in the adjacent 5010-5030 MHz band. Until such time that an appropriate value is established in a relevant ITU-R Recommendation, the e.i.r.p. density limit of −75 dBW/MHz in the frequency band 5010-5030 MHz for any AM(R)S station unwanted emission should be used. (WRC-12)").

[27] *See id.*, Appendix B, §4(b).

AIA has the following recommendations regarding the incorporation of UAS CNPC links into Part 87.

§ 87.5 Definitions

The Commission should add a definition to Section 87.5 of its rules indicating that an Unmanned Aircraft System is defined as an aircraft without a human pilot onboard that is operated remotely by a PIC.[28] The Commission should further conclude that the operation of CNPC links for UAS should qualify as an Aeronautical Mobile Service,[29] with the ground stations used to control UAS defined as Aeronautical Stations[30] and the transceivers on UAS defined as an Aircraft Station.[31] Consistent with this, it may also be appropriate to add a definition of an UAS Aircraft Station as an Aircraft Station on an Unmanned Aircraft, and a definition of an UAS Aeronautical Station as an Aeronautical Station used to operate an Unmanned Aircraft System.

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[28] The FAA defines UAS as follows: "An unmanned aircraft system (UAS) is an aircraft without a human pilot onboard – instead, the UAS is controlled from an operator on the ground" (https://www.faa.gov/uas/).

[29] *Aeronautical mobile service.* A mobile service between aeronautical stations and aircraft stations, or between aircraft stations, in which survival craft stations may also participate; emergency position-indicating radiobeacon stations may also participate in this service on designated distress and emergency frequencies.

[30] *Aeronautical station.* A land station in the aeronautical mobile service. In certain instances an aeronautical station may be located, for example, on board ship or on a platform at sea.

[31] *Aircraft station.* A mobile station in the aeronautical mobile service other than a survival craft station, located on board an aircraft. *See also* Section 87.185(a), providing that aircraft stations must limit their communications to the necessities of safe, efficient, and economic operation of aircraft and the protection of life and property in the air, except as otherwise specifically provided in this part. Contact with an aeronautical land station must only be attempted when the aircraft is within the service area of the land station. However, aircraft stations may transmit advisory information on air traffic control, UNICOM or aeronautical MULTICOM frequencies for the benefit and use of other stations monitoring these frequencies in accordance with FAA recommended traffic advisory practices.

§ 87.18 Station License Required

The Commission should supplement Section 87.18 of its rules to indicate that Aeronautical Stations and Aircraft Stations used with UAS are not required to be covered by either an individual or fleet license. Instead, the authorization of PICs to use UAS C2 spectrum in a manner that ensures operators hold the appropriate FAA certification and are familiar with UAS operations and related FAA requirements, e.g., through the Commission's Commercial Radio Operator Program, via a new license category Unmanned Aircraft Systems Command and Non-Payload Communications Operator License ("UAS CNPC") will be adequate to regulate UAS use of the 5030-5091 MHz band.

§ 87.39 Equipment Acceptable for Licensing

It may be appropriate to clarify in Section 87.39 of the Commission's Rules that, although Aeronautical Stations and Aircraft Stations used with UAS are not subject to individual or fleet licensing, such stations still must be certificated for a particular use by the Commission based upon Subpart D's technical requirements, including RF emissions restrictions.

§ 87.41 Frequencies

It may be appropriate for the Commission to supplement Section 87.41 of its Rules to indicate that frequencies within the 5030-5091 MHz band used for the operation of CNPC Links to support UAS operations will be assigned by the designated UAS Frequency Assignment Manager.

§ 87.89 Minimum Operator Requirements

The Commission should indicate either in the text of an order or in Section 87.89 of its rules that a PIC that seeks to operate UAS CNPC links, whether under an individual license or on

behalf of a licensed organization, must hold a UAS CNPC license issued by the Commission. As an additional condition to the issuance of a license for use as a UAS PIC, the Commission should require the applicant to demonstrate that it holds an effective UAS PIC authorization from the FAA. The license should be expressly conditioned on such authorization being renewed on a timely basis.

§ 87.107 Station Identification

The Commission should supplement Section 87.107 with a new subsection indicating that all transmissions to and from Aeronautical Stations and Aircraft Stations used for UAS C2 operations should be in a digital format and include the license call sign and tail number of the aircraft in the uplink and downlink streams at intervals of one minute or less.

§ 87.131 Power and Emissions

Transmitter power and emissions in the 5030-5091 MHz band should conform to the requirements in RTCA DO-362 § 2.2.1.6.

§ 87.133 Frequency Stability

The frequency accuracy of a 5030-5091 MHz CNPC transmitter, or of the local oscillator of a 5030-5091 MHz CNPC receiver, should not vary more than 0.2 parts per million (ppm) from the intended value, as stipulated in RTCA DO-362 § 2.2.1.4.

§ 87.137 Types of Emission

The Commission should add a footnote to the table in Section 87.137 of the Commission's Rules indicating that the assignable emissions, corresponding emission designators and authorized bandwidths indicated in the table are not applicable to Aeronautical Stations and Aircraft Stations operating in the 5030-5091 MHz band for UAS CNPC links.

§ 87.139 Emission Limitations

The Commission should indicate that the emission limits for Aeronautical Stations and Aircraft Stations indicated in Section 87.139(c) of its rules are applicable to such stations that are capable of operating in the 5030-5091 MHz band to support UAS CNPC links, in addition to the emission limits imposed by RTCA DO-362 **§** 2.2.1.6.[32]

§ 87.141 Modulation Requirements

The Commission should indicate that the modulation requirements indicated in Section 87.141 of its rules are not applicable to Aeronautical Stations and Aircraft Stations that are capable of operating in the 5030-5091 MHz band for use with UAS CNPC links.

§ 87.147 Authorization of Equipment

The Commission should indicate that the equipment authorization procedures indicated in Section 87.147 of its rules are applicable to Aeronautical Stations and Aircraft Stations that are capable of operating in the 5030-5091 MHz band for use with UAS CNPC links.[33]

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[32] The peak envelope power of any emissions must be attenuated below the peak envelope power of the transmitter (pX) as follows: (1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 150 percent of the authorized bandwidth of 3.0 kHz, the attenuation must be at least 30 dB; (2) When the frequency is removed from the assigned frequency by more than 150 percent up to and including 250 percent of the authorized bandwidth of 3.0 kHz, the attenuation must be at least 38 dB; (3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth of 3.0 kHz for aircraft transmitters the attenuation must be at least 43 dB. For aeronautical station transmitters with transmitter power up to and including 50 watts the attenuation must be at least $43 + 10 \log_{10}$ pX dB and with transmitter power more than 50 watts the attenuation must be at least 60 dB.

[33] An applicant for certification of equipment intended for transmission in any of the frequency bands listed in paragraph (d)(3) of this section [87.147] must notify the FAA of the filing of a certification application. The letter of notification must be mailed to: FAA, Office of Spectrum Policy and Management, ASR-1, 800 Independence Ave., SW., Washington, DC 20591 prior to the filing of the application with the Commission. (1) The notification must describe the equipment, give the manufacturer's identification, antenna characteristics, rated output power,

§ 87.171 Class of Station Symbols

The Commission should supplement its list of station symbol classes with the addition of the following:

UFA—UAS Aircraft Station in the Aeronautical Mobile (R) Service

UFG—UAS Aeronautical Station in the Aeronautical Mobile (R) Service

§ 87.173 Frequencies

The Commission should supplement the table in paragraph (b) of Section 87.173 to indicate that the assignable carrier frequencies or frequency bands includes the following:

Frequency or frequency band	**Subpart**	**Class of station**	**Remarks**
	* * *		
5030-5091 MHz	F	UFA, UFG	Aeronautical Mobile (R)
	* * *		
15400-15700 MHz	Q	RL, MA	Aeronautical radionavigation

§ 87.187 Frequencies

Section 87.187 of the Commission's Rules should be supplemented with a new subsection "(ii)" indicating that use of the frequency band 5030-5091 MHz is reserved exclusively for CNPC communications in the AM(R)S to support UAS operations.

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emission type and characteristics, the frequency or frequencies of operation (which must at a minimum include the entire 5030-5091 MHz band), and essential receiver characteristics if protection is required. (2) The certification application must include a copy of the notification letter to the FAA. The Commission will not act until it receives the FAA's determination regarding whether it objects to the application for equipment authorization. The FAA should mail its determination to: Office of Engineering and Technology Laboratory, Authorization and Evaluation Division, 7435 Oakland Mills Rd., Columbia, MD 21046. The Commission will consider the FAA determination before taking final action on the application.

§ 87.475 Frequencies

Section 87.187(b)(11) of the Commission's Rules, which currently states that the 5000-5250 MHz band is to be used for the operation of the international standard system (microwave landing system), should be supplemented to indicate that the 5030-5091 MHz sub-band is reserved for AM(R)S to support CNPC links for UAS operations.

VIII. THE COMMISSION SHOULD INITIATE COORDINATION OF CNPC LINKS FOR UAS WITH CANADA AND MEXICO

While the 5030-5091 MHz band has been allocated internationally to the AM(R)S service for CNPC links to support UAS, only a properly designed and implemented CNPC link frequency assignment process will prevent cross-border interference. Accordingly, the Commission should initiate a coordination process with these neighboring countries to ensure that conflicting operations do not result. Both Canada and Mexico are likely to identify numerous beneficial uses of UAS, particularly near their borders with the United States. For example, a Canadian company is already using UAS that were manufactured in the United State to inspect pipelines, wellheads and powerlines in Foremost, Alberta, Canada.[34] At the same time, the U.S. Government is already experimenting with the use of UAS for border security.[35]

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[34] *See Canadian UAVs Inspecting Beyond Line of Sight*, GPS World (March 14, 2017), *available at* http://gpsworld.com/canadian-uavs-inspecting-beyond-line-of-sight/ (*last visited* Dec. 13, 2017).

[35] *See* News Release, "*CBP to Test the Operational Use of Small Unmanned Aircraft Systems in 3 U.S. Border Patrol Sectors*," U.S. Customs and Border Protection (Sept. 14, 2017), *available at*: https://www.cbp.gov/newsroom/national-media-release/cbp-test-operational-use-small-unmanned-aircraft-systems-3-us-border (last visited: Dec. 13, 2017).

Therefore, a coordination agreement should be entered into with both Canada and Mexico regarding the operation of CNPC links within range of the respective borders. Such an outcome would appear beneficial to all involved.

IX. CONCLUSION

For the reasons set forth herein, the Aerospace Industries Association respectfully requests that the Commission initiate a proceeding to adopt licensing procedures and service rules for UAS Control and Non-Payload Communications links in the 5030-5091 MHz band.

Respectfully submitted,

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