GHANA CIVIL AVIATION
(AIR NAVIGATION SERVICES)
DIRECTIVES

INITIAL DRAFT

PART 23: SUBPART 8 –
COMMUNICATION SYSTEMS AND PROCEDURES RELATING TO REMOTELY PILOTED AIRCRAFT SYSTEMS C2 LINK

INTRODUCTION

This Part prescribes the detailed technical provisions that contain standards, procedures, instructions and information which are intended for Communication Systems and Procedures relating to Remotely Piloted Aircraft Systems C2 Link which is necessary for the operation of Remotely Piloted Aircraft Systems (RPAS) and also to ensure safety, regularity and efficiency of international air navigation within the Accra Flight Information Region.

The standards in this Part are based mainly on Standards and Recommended Practices stipulated in Annex 10 Volume VI to the Convention on International Civil Aviation (the Chicago Convention) with such modifications as may be determined by the Authority to be applicable in Ghana.

The Service providers in Ghana, including Air Navigation Services Providers (ANSP) and RPAS Operator Certificate (ROC) holders, etc., whose operations are directly or indirectly concerned with RPAS operations, are required to comply with the provisions contained in these Directives. The Service providers shall document local procedures in their own operational manuals to ensure the maintenance of and compliance with standards in this Directive. Where the Service Provider is unable to comply with any provision in these Directives, it shall inform the Authority within a reasonable period of time and in writing. The Service Provider shall explain the basis for its non-compliance and proposal for corrective action in a timely manner, and the Authority may approve the proposal, subject to such other conditions it may impose.

INITIAL DRAFT

INITIAL_DRAFT

23.8.1 PART I — C2 LINK PROCEDURES

23.8.1.1 GENERAL

23.8.1.1.1 APPLICABILITY

23.8.1.1.2 DEFINITIONS

C2 Link means the data link between the remotely piloted aircraft and the remote pilot station for the purposes of managing the flight.

C2 Link communication service provider (C2CSP) means an entity which provides a portion of, or all of, the C2 Link service for the operation of an RPAS.

Note.— An RPAS operator may also be its own C2CSP.

C2 Link coverage area means the area in which the C2 Link service can be received including the area where the QoSD does not meet the QoSR.

C2 Link interruption means any temporary situation where the C2 Link is unavailable, discontinuous, introduces too much delay, or has inadequate integrity; but where the lost C2 Link decision time has not been exceeded.

C2 Link log means a record of the activities related to the C2 Link.

C2 Link service means a communication service providing the C2 Link.

C2 Link service area means the area within the C2 Link coverage area where the C2 Link QoSD meets the QoSR.

C2 Link specification means the minimum performance to be achieved by the C2 Link equipment in conformity with the applicable airworthiness system design requirements.

Handover means the act of passing piloting control from one remote pilot station to another.

INITIAL DRAFT

Lost C2 Link decision state means the state of the RPAS in which a C2 Link interruption has occurred, but the duration of which does not exceed the lost C2 Link decision time.

Lost C2 Link decision time means the maximum length of time permitted before declaring a lost C2 Link state during which the C2 Link performance is not sufficient to allow the remote pilot to actively manage the flight in a safe and timely manner appropriate to the airspace and operational conditions.

Lost C2 Link state means the state of the RPAS in which the C2 Link performance has degraded, as a result of a C2 Link interruption that is longer than the lost C2 Link decision time, to a point where it is not sufficient to allow the remote pilot to actively manage the flight in a safe and timely manner.

Nominal C2 Link state means the state of the RPAS when the C2 Link performance is sufficient to allow the remote pilot to actively manage the flight of the RPA in a safe and timely manner appropriate to the airspace and operational conditions.

Quality of service (QoS) means the totality of the characteristics of an entity that bear on its ability to satisfy stated and implied needs.

Quality of service delivered (QoSD) means a statement of the QoS achieved or delivered to the RPAS operator by the C2CSP.

Quality of service experienced (QoSE) means a statement expressing the QoS that the remote pilot believes they have experienced.

Quality of service required (QoSR) means a statement of the QoS requirements of the RPAS operator to the C2CSP.

Note.— The QoSR may be expressed in descriptive terms (criteria) listed in the order of priority, with preferred performance value for each criterion. The C2CSP then translates these into parameters and metrics pertinent to the service.

Remote pilot station (RPS) means the component of the remotely piloted aircraft system containing the equipment used to pilot the remotely piloted aircraft.

Remotely piloted aircraft (RPA) means an unmanned aircraft which is piloted from a remote pilot station.

INITIAL DRAFT

Remotely piloted aircraft system (RPAS) means a remotely piloted aircraft, its associated remote pilot station(s), the required C2 Link(s) and any other component as specified in the type design.

Service level agreement (SLA) means the agreement between the C2CSP and the RPAS operator covering the safety, performance, service area and security of the C2 Link provision as required for the RPAS operator's intended operations.

Switchover means the act of transferring the active datalink path between the RPS and the RPA from one of the links or networks that constitutes the C2 Link to another link or network that constitutes the C2 Link.

23.8.1.2 SPECIFICATIONS

23.8.1.2.1 GENERAL

Any time reference to the C2 Link service and timestamping of the information carried by the C2 Link shall be in Coordinated Universal Time (UTC).

Note 1.— This does not apply to the timestamping internal to the network communication protocol.

Note 2.— The timestamp includes the date and time.

Note. 3— The C2 Link is the logical connection, however physically realized, used for the exchange of information between the remote pilot station (RPS) and the remotely piloted aircraft (RPA). It enables the remote pilot's manipulation of the flight controls in the RPS to be sent to the RPA and for the RPA to return its status to the remote pilot. The C2 Link also enables the remote pilot to manage the safe integration of the remotely piloted aircraft system into the global aviation, communications, navigation and surveillance operational environment.

INITIAL DRAFT

Note 4.— Guidance on the systems and procedures relating to the C2 Link is included in the Manual on Remotely Piloted Aircraft Systems (RPAS) (Doc 10019)

23.8.1.2.2 SUPPORTED FUNCTIONS

(1) The C2 Link shall only support the remote pilot tasks required for the safe and efficient operation of the RPAS.

Note.— GCAD Part 28 contains requirements for safe operation of the RPAS.

(2) When the C2 Link includes support for the remote pilot tasks required for air traffic control (ATC) purposes, such as relay of ATC communications, the C2 Link performance shall, in a secure manner, meet the performance required for those tasks appropriate to the airspace requirements.

Note 1.— Airspace requirements vary depending upon air traffic density and complexity and may be reflected in equipage or separation requirements.

Note 2.— Alternate means of communications between the remote pilot and air traffic control may obviate the need for the C2 Link to be used for ATC communications.

23.8.1.2.3 SERVICE PROVISION

(1) The C2 Link service shall only be used for the transmission of information relating to the safe and efficient operation of the RPAS and be limited to the information described in 23.8.1.2.2(1).

(2) A C2 Link communication service provider (C2CSP) having been approved or authorized, shall comply with the requirements in GCAD Part 28 on RPAS operations as published by the Authority.

(3) The duration between C2 Link initiation and C2 Link termination shall not exceed the time of flight and ground operations, plus the time necessary to perform safety and security checking before and after each flight.

INITIAL DRAFT

Note. — Efficient use of the limited frequency spectrum resource requires that a link be released and made available to other users when not in use.

(4) The C2 Link specification shall be commensurate with the C2 Link performance required for safe operations.

(5) The C2 Link's QoSR shall be commensurate with the C2 Link specification required for safe operations.

(6) The C2 Link's QoSD shall be commensurate with the C2 Link QoSR.

(7) The C2 Link service area geographical coordinates and time of provision, intended for RPAS operational use, shall be validated and verified to ensure that C2 link service area is safe for use by its intended recipients.

Note 1.— ICAO Doc 9674 contains requirements for data quality.

Note 2.— Intended recipients can be remote pilot or ATC units concerned.

(8) A pro-active process for anticipating and mitigating interrupted or lost C2 Link states shall be implemented and described by the C2CSP to the RPAS operator.

(9) The C2CSP shall notify the RPAS Operator of any scheduled outages of the C2 Link service provision.

(10) Arrangements shall be in place to ensure that the scheduled outage does not affect any RPA during any phase of flight.

(11) The C2CSP shall notify the RPAS operator of any unscheduled degradation in their service provision, the kind of degradation being experienced and an estimated duration for that degradation.

(12) Before providing any C2 Link service, the C2CSP shall demonstrate to the responsible authority initial compliance with the provisions contained in paragraphs (1) and (3) through paragraph (12).

23.8.1.2.4 C2 LINK SERVICE AREA

(1) The C2 Link service area shall be compatible with the planned (including contingency) areas of operation of the RPA and the location of all of the RPSs involved in the operation.

INITIAL DRAFT

(2) The RPA and RPS shall always remain within the C2 Link service area.

(3) To ensure the QoSR is always met, a margin to account for the expected worst-case propagation fluctuations in the received signal level shall be included while determining the C2 Link service area.

23.8.1.3 PROCEDURES

23.8.1.3.1 GENERAL

(1) Prior to the flight, the C2CSP shall provide the RPAS operator with appropriate means to establish that the C2 Link QoSD, security, and service area meet the requirements for safe operation of the planned flight (including contingency operations).

(2) In the case where the C2 Link service can be provided by more than one link, the RPAS shall use the link with the highest QoSD.

Note.— Provisions contained in GCAD Part 28 require an operator to provide, for the use and guidance of personnel concerned, an operations manual containing all the instructions and information necessary for operations personnel to perform their duties.

23.8.1.3.2 ESTABLISHMENT, ASSURANCE AND TERMINATION OF THE C2 LINK

(1) Human factors principles shall be considered in the design of the RPS, in order for the remote pilot to manage the C2 Link during the flight and prevent its unintentional termination.

Note.— Situations may occur in which the C2 Link would need to be terminated during the flight in order to increase the safety level of the flight. However, unintentional termination must be prevented.

(2) Appropriate technical and procedural means shall be provided to the remote pilot to establish and maintain the C2 Link, including the interaction with the C2CSP. These means shall be documented in the operations manual.

INITIAL DRAFT

(3) An indication shall be provided to the remote pilot when the C2 Link has been successfully established between the RPS and the RPA and when it is interrupted, lost or terminated.

(4) Information about any C2 Link-related outages that are planned to occur during the expected duration of the flight shall be provided to the remote pilot during flight planning.

(5) Means shall be provided to the remote pilot to verify that the C2 Link meets the QoSR as part of the pre-flight check of the RPAS.

(6) The procedure supporting the switchover between links or networks that comprise the entire C2 Link shall be contained in the operations manual.

(7) Before performing a switchover to another link or network, the remote pilot shall be provided with sufficient information on the QoSD of the accepting link or network to confirm that it will meet the QoSR.

(8) Switchovers between the links or networks that constitute the C2 Link during flight shall be minimized.

(9) The procedure and the phraseology supporting handover of the C2 Link provision between RPS shall be contained in the operations manual.

(10) The procedure supporting the handover shall include a report on the status of the QoSE of the C2 Link prior to initiating the handover.

(11) A handover shall only be initiated if the accepting RPS is able to confirm that its C2 Link with the RPA achieves the QoSR needed to ensure that the handover will be successful.

(12) The condition of a lost C2 Link state shall be initiated by the RPAS or through an action by the remote pilot when the performance of the C2 Link has been insufficient to enable active management of the RPA for longer than the lost C2 Link decision time.

(13) The duration of the lost C2 Link decision time shall be in accordance with the operational management and safety requirements of the airspace.

(14) Only the remote pilot shall terminate or authorize the termination of the C2 Link.

(15) The C2CSP shall not intentionally terminate a C2 Link without the explicit consent of the remote pilot.

INITIAL DRAFT

23.8.1.3.3 ESTABLISHMENT AND ASSURANCE OF ATC COMMUNICATIONS

(1) ATC communications relayed through the RPA and the C2 Link shall be consistent with those defined for manned aircraft.

Note.— ATC communication procedures contained in Part 23 Subpart 2 — Aeronautical Telecommunications — Communication Procedures including those with PANS status, and the Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM, Doc 4444).

(2) Switchovers between links and networks that make up the C2 Link shall be avoided during transfer of ATC communications.

23.8.1.3.4 CONTINGENCY AND EMERGENCY PROCEDURES

(1) The remote pilot shall be provided with all the available RPAS status information pertinent to expedite the recovery of the C2 Link.

(2) Technical and procedural means shall be provided to indicate to the remote pilot or RPS and the RPA when the C2 Link has been successfully restored after a lost C2 Link state has occurred.

(3) From the lost C2 Link decision state, the RPAS shall either return to the nominal C2 Link state or enter the lost C2 Link state once the lost C2 Link decision time has been exceeded.

(4) After being in a lost C2 Link state, a remote pilot action shall be required to return the RPAS to a nominal C2 Link state, in accordance with the procedures contained in the operations manual.

23.8.1.3.5 SECURITY

(1) Information exchange between the RPS and RPA carried on the C2 Link shall be sufficiently secure to prevent unauthorized interference with the RPAS.

INITIAL DRAFT

(2) The RPAS C2 Link design, monitoring system and operating procedures shall be such as to minimize the potential for any unauthorized control of the RPA or the RPS during any operating phases.

23.8.1.3.6 DISPLAY

(1) RPS controls and displays shall present data in a manner minimizing the potential for errors, misinterpretation or misunderstandings.

(2) The C2 Link state information shall be presented to the remote pilot.

(3) An indication of the C2 Link QoSD, in real-time, shall be provided to the remote pilot.

23.8.1.3.7 MONITORING

(1) An automatic monitoring system shall be implemented in the RPA and RPS, to provide an alert to the remote pilot if any of the following occur within the period of operation:

(a) RPA or RPS C2 Link and/or sub-system link and/or C2CSP emission has ceased;

(b) RPA or RPS C2 Link and/or sub-system link and/or C2CSP reception has ceased;

(c) transmission of the amount of information required for the safe control of the RPA has fallen below a level specified by the type certificate holder;

(d) interruption of the C2 Link has occurred; or

(e) the C2 Link QoSD has degraded below the stated QoSR.

(2) The monitoring system shall provide an alert to the remote pilot in the event of the failure of the monitoring system itself.

23.8.1.3.8 RECORDS

(1) A C2 Link log, written or electronic, shall be maintained in each RPS.

INITIAL DRAFT

(2) The record shall commence as soon as the C2 Link is established and end only after the C2 Link is terminated.

(3) Written log entries shall be made only by authorized and on-duty persons in the RPS.

Note.— Authorized on-duty persons can be remote pilots or any other person having knowledge of facts pertinent to the entries.

(4) All entries shall be complete, clear, correct and intelligible. Unnecessary marks or notations shall not be made in the log.

(5) In written logs, any correction in the log shall be made by the authorized on-duty person.

(6) Corrections shall be initialled, dated and a rationale given for traceability.

(7) The following information shall be entered in logs by the authorized on-duty person:

(a) the name of the authorized on-duty person in charge of the log;

(b) the identification of the RPS;

(c) the date;

(d) the time of opening and closing of the RPS;

(e) the time of establishment and termination of the C2CSP service;

(f) the time of establishment and termination of the C2 Link;

(g) the QoSE of the links and networks used;

(h) the reason for the switchover of links and networks that make up the C2 Link;

(i) the signature of the authorized on-duty person;

(j) all lost C2 Link and lost C2 Link decision state events, location of the RPA with time of occurrence, and probable assessed cause when practicable;

INITIAL DRAFT

(k) any detected harmful or notable radio frequency interference, with as much detail as possible; and

(l) any information relevant to C2 Link provision considered by the remote pilot as valuable.

(8) In the log, all time related information shall use a UTC reference and all geographical related information shall use a WGS-84 reference.

(9) The C2 Link messages related to the C2 Link management shall be electronically recorded in the RPA and in any RPS which is in control of the RPA.

(10) The C2 Link management message record shall be retained for at least 30 days after completion of the flight. When the record is pertinent to accident and incident investigations, it shall be retained for longer periods until it is evident that the record will no longer be required.

(11) The RPA shall maintain an electronic log, automatically recording any information described in paragraphs (1) to (10) that is available to it.

(12) The RPA shall maintain an automatically recorded electronic log of any received or transmitted ATC orremote pilot communication either voice or data, if relayed through the RPA.

(13) The RPS shall maintain an automatically recorded electronic log of any received and transmitted ATC orremote pilot communication either voice or data.

INITIAL DRAFT

23.8.2 Part II — C2 LINK SYSTEMS

23.8.2.1 GENERAL

23.8.2.2.1 SYSTEM DESCRIPTION

(1) The RPAS communication system shall comprise the following systems:

(a) A communication system supporting communications external to the RPAS dedicated to the airspace requirements functions;

(b) A C2 Link communication system supporting communications internal to the RPAS, which comprises at a minimum:

(i) an interface with the RPS;

(ii) an interface with the RPA;

(iii) a transmitter located in the RPS communicating with a receiver located in the RPA; and

(iv) a transmitter located in the RPA communicating with a receiver located in the RPS.

Note 1.— The C2 Link communication system between the RPS and the RPA may comprise one or more different communication links and may be provided by one or more C2CSPs.

Note 2.— The C2 Link communication system may comprise ground and/or airborne and/or satellite links and systems.

(2) The RPAS shall be equipped with a lost C2 Link state detection system designed with a level of assurance that is in accordance with the intended operation.

23.8.2.2 SPECTRUM

INITIAL DRAFT

(1) The RPAS C2 Link system shall be operated only in frequency bands which are appropriately allocated and protected by regulations published by the National Communications Authority.

(2) C2 Link system frequency assignment planning shall be designed to provide immunity from harmful interference and not create harmful interference.

Note.— Provision for international frequency channel assignment planning can be found in the C2 Link System Guidance Manual.

23.8.2.3 SYSTEM CHARACTERISTICS

(1) The C2 Link system shall enable the RPA to unambiguously and at any time ensure that it is controlled by an authorized RPS.

(2) The total period of radiation of the C2 Link system transmitters shall be as short as practicable, consistent with the need for avoiding saturation of the spectrum while limiting interruption of the C2 Link.

(3) The C2 Link system radio frequency transmitters shall radiate no more power than is necessary to achieve the C2 Link specification.

23.8.2.4 DATA TRANSMISSION CHARACTERISTICS

(1) The C2 Link system message sequencing shall be based on priority criteria.

(2) The C2 Link system messages sequence management shall use timestamping.

(3) The order of priority of the transmission of information between the RPS and the RPA shall be:

(a) RPA flight control and configuration messages;

(b) high priority detect and avoid (DAA) messages;

(c) air traffic control communications including distress calls and urgency messages;

INITIAL DRAFT

(d) flight safety telemetry messages including low priority DAA messages;

(e) other flight safety messages;

(f) routine telemetry messages;

(g) air traffic services other than ATC communications; and

(h) other messages.

Note 1.— The above order of priority is for the transmission of information over the C2 Link. The order of priority of messages transmitted by communication systems other than the C2 Link will remain as listed in Section 23.2.4 of Part 23.2 and Part 23.3 Table 3-1.

Note 2.— Distress and urgency messages are defined in Part 23.2.5.8.1(1).

23.8.2.5 PERFORMANCE REQUIREMENTS

The QoSD of the C2 Link system shall be sufficient to support the operational and performance requirements for ATC service in the planned and contingency areas of operation of the RPA.

Note.— These requirements include required communication performance (RCP), required surveillance performance (RSP) and required navigation performance (RNP) when appropriate.

23.8.2.6 C2 LINK COMMUNICATION SERVICE PROVIDERS (C2CSP)

(1) The RPAS operator shall establish a service level agreement (SLA) with one or more C2CSPs concerning the C2 Link service provision.

Note 1.— An SLA is required even when the operator is its own C2CSP.

Note 2.— The SLA defines the relationship and responsibilities of the two parties in accordance with the following Standards.

(2) The C2CSP shall ensure that the QoSD is at any time meeting the QoSR.

INITIAL DRAFT

(3) The C2CSP shall conduct, with RPAS operators, real-time interference monitoring, estimation and prediction of interference risks and planning solutions for potential harmful interference scenarios under the oversight of the Authority and National Communications Authority.

(4) The C2CSPs, RPAS operators and competent authorities shall act immediately when their attention is drawn to any harmful interference.

(5) The C2CSP shall have the qualified resources and adequate documentation that will allow competent authorities to perform their oversight.

23.8.2.7 TERRESTRIAL C2 COMMUNICATION SERVICE PROVIDERS

Terrestrial RPAS equipment shall operate in frequency spectrum with an allocation as described in Part 23.5.5.2(1).

23.8.2.8 SATELLITE C2 COMMUNICATION SERVICE PROVIDERS

(1) Satellite RPAS equipment shall operate in frequency spectrum with an allocation as described in Part 23.5.5.1.

(2) SLAs between satellite C2CSPs and RPAS operators shall ensure that, once a satellite network has completed successful coordination, which guarantees the level of protection necessary to ensure the overall RPAS C2 Link QoSD, the protection level is not eroded as a result of subsequent satellite coordination agreements.

(3) SLAs between satellite C2CSPs and RPAS operators shall ensure that satellite C2CSPs act immediately when their attention is drawn to any harmful interference.

(4) The satellite C2CSP shall be responsible for ensuring that once a satellite network has completed successful coordination, the C2 Link specifications continue to be met as a result of subsequent agreements between satellite operators.

INITIAL DRAFT