CHAPTER 9

Tethered Operations within 3NM of Controlled Aerodromes

- Tethered Systems
- Crew Considerations
- Equipment Required
- Pre-flight Planning
- Common Phraseology
- Limitations
- Emergency Procedures

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CHAPTER 9 – TETHERED OPERATIONS WITHIN 3NM OF CONTROLLED AERODROMES

This module discusses the current considerations and requirements for conducting tethered operations within 3nm of a controlled aerodrome.

A tether system may be used to conduct a flight in an area that would otherwise be deemed "unsafe" for normal RPA operations. By attaching the RPA to a fixed point that is anchored to the ground we can not only guarantee the operating limits (vertical and horizontal distances), but also limit the area of effect should a failure or undesired aircraft state occur.

9.1 Tethered Systems

There are many different types of tethered systems available. These may be either commercially available or custom/home-made units.

Tethered units can also be non-powered or powered:

- **Non-powered**: This is a simple retractable cable or line designed to secure the RPA to the ground anchor and limit the field of movement should an undesirable aircraft state occur. Cables/lines must be lightweight, non-stretch and sufficiently strong to secure the RPA under different conditions (see section 9.6). A braided fishing line would be a good example of a non-powered tether.

- **Powered**: This type of tether serves the same purpose as the non-powered tether whilst also allowing power to be transmitted to the RPA in flight. These ground powered tethers can remove the need for on-board flight batteries, both reducing the take-off weight of the RPA (improving efficiency) and dramatically increasing flight time. This sort of unit is mostly used for surveillance and emergency operations outside the 3nm control zone.

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Fig 9.1: A commercial powered tether system

9.2 Crew Considerations

Any certified RPA operator (RePL) is allowed to conduct tethered operations within 3nm of a controlled aerodrome in accordance with the procedures of their ReOC and the requirements of the relevant sections of CASA Part 101 MOS.

A minimum of TWO crew is required to conduct tethered operations:

- A remote pilot in command to operate the RPA, and
- A second crew member to act as the tether operator.

9.3 Equipment Required

In addition to the standard equipment requirements of any RPA operation, the additional information should be considered:

RPA Used

Just about any RPA can be used for tethered operations as long as:

a. It has sufficient performance to lift the required payload plus the weight of the tether line and attachment, with the limitation of the MTOW.
b. It has or can be fitted with a tether attachment point of sufficient strength to restrain the RPA within the limitations described in section 9.6.

Tether Unit

A tether unit may have many different components or features, but as a minimum should include:

- Weighted ground station, ground anchor or weighted plates sufficient to restrain the RPA.

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- Tether spool and cable operated either by hand or by means of an electronic winch.

9.4 Pre-flight Planning

9.4.1 Areas of Operation

Refer to Fig 9.2 and 9.3 for an illustration of aerodrome no-fly zones.

The grey shaded areas on the illustration indicate where tethered RPA operations are permitted provided that maximum length of the tether does not breach the obstacle limitation surfaces (OLS) and/or is a maximum length of 150ft (45m).

If the tethered operation is flown within the black shaded area (no-fly zone), the operation must not be within 3NM of any runway of the controlled aerodrome. Outside 3NM, and within the black area the maximum tether length is 150ft (45m).

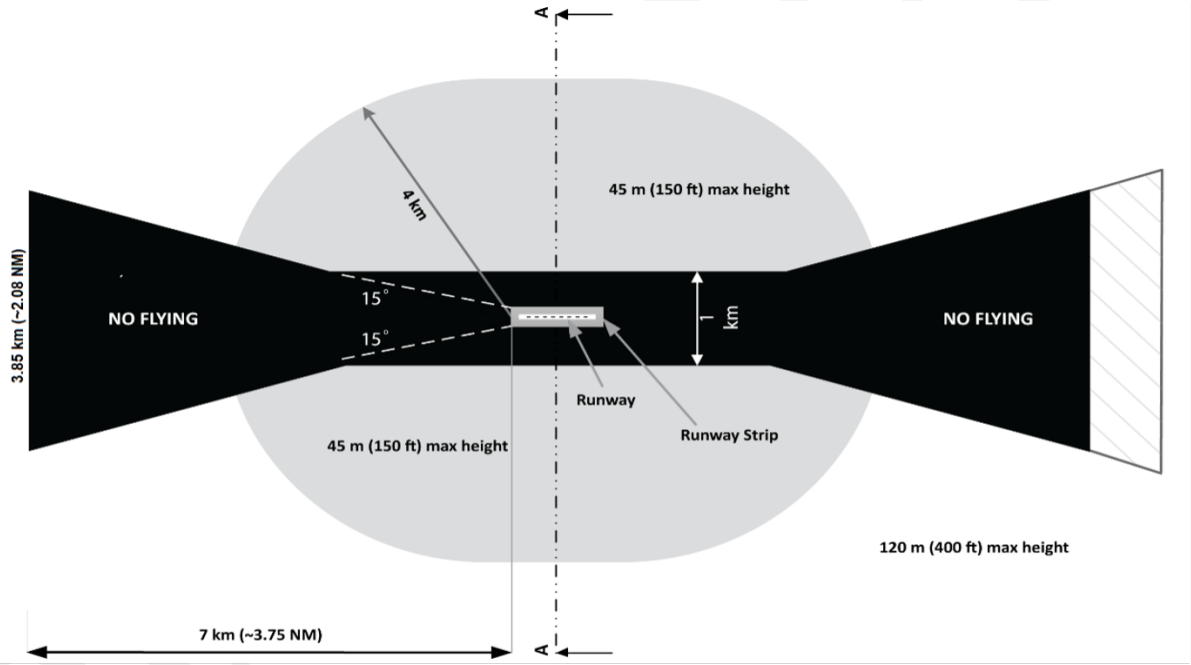

Fig 9.2: Area of operation

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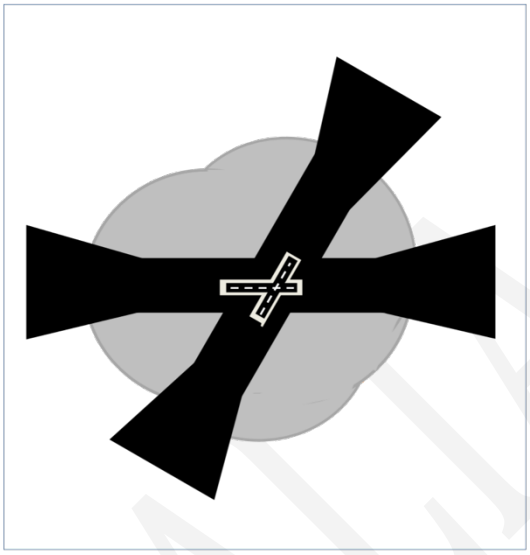

Fig 9.3: No-fly zones to be applied for multiple runways

9.4.2 Military Controlled Aerodromes

Within restricted airspace at a military controlled aerodrome, a valid letter of agreement (LOA) permitting tethered operations must be obtained from the controlling authority. At all times the operator must ensure that a clearance has been obtained from the controlling authority prior to taking off.

9.4.3 Maximum Tether Length

The maximum length of tether must be calculated to ensure that the height of the RPA does not exceed 150ft (45m) above the aerodrome elevation (as measured at the airport reference point (ARP)). If the take-off elevation of the RPA is higher than the ARP this will reduce the maximum tether length that may be used.

The method of determining maximum tether length is discussed in section 9.6.

9.4.4 Risk Assessment and Flight Authorisations

As per your standard operating conditions, any operation within 3NM of a controlled aerodrome will require an authorisation from CASA (current June 2023).

As per the current approval process (Form 101-09), the application must include a completed risk assessment for the operation that should consider the environment in which the RPA is operating.

If an approval is granted, several standard minimum requirements will apply:

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- A NOTAM must be raised for each operation and submitted as part of the application.
- A sufficiently qualified crew member should monitor an airband radio during the operation.
- Contact should be made (via telephone) with the controlling ATC Tower, 15 minutes prior to the operation to obtain clearance.

NOTE: The requirement for approval for tethered operations within 3NM of a controlled aerodrome is currently under review with the intention to remove this requirement from CASR Part 101.

9.4.5 Checklists

As part of standard operating procedures, pre/post-flight checklists for tethered operations should be reviewed and modified to include the relevant safety and operational checks for the tether system. These may be sourced from the tether manufacturer's manual and may include items such as ensuring two crew members check the attachment points for security prior to flight.

The maintenance of tether units should also be considered and incorporated into any existing routine maintenance schedule under the ReOC.

9.5 Common Phraseology

Whilst conducting tethered operations, it is strongly recommended that a list of common words and phrases be developed to ensure positive and safe communication between the remote pilot in command of the RPA and the tether operator.

Some suggested words, phrases and responses are listed below:

Remote Pilot Commands

Command	Response
"Taking off, release tether"	*"Copy, taking off"*
"Release tether"	*"Releasing tether"*
"Retract tether"	*"Retracting tether"*
"Landing, retract tether"	*"Copy landing"*
"Slow release/retract"	*"Slowing release/retract"*
"Speed up release/retract"	*"Speeding up release/retract"*

Tether Operator Commands

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Command	Response
"Stop climbing"	*"Stopped"*
"Stop descending"	*"Stopped"*
"Proceed on task"	*"Copy, climbing/descending/moving"*

Emergency Commands

Command	Response
"STOP STOP STOP"	*"Copy stop"*

9.6 Limitations

9.6.1 Limitations on flight performance

Obviously, tethering an RPA to the ground will impose several limitations on the flight of the aircraft!

The table below highlights some common considerations however, these limitations are purely subjective and may not necessarily reflect the actual limitations required for the specific RPA or tether system to be used.

Vertical Speed	3m/s – sufficiently slow enough to not damage the RPA or cause instability if the tether becomes stuck.
Horizontal Speed	5m/s – as above, slow enough to allow for the pilot to react to undesirable situations.
Lateral distance from the tether point	15 degrees from vertical (approximately 10m at 150ft).
Flight time	Less 10% from normal performance. The additional drag and resistance from the tether may reduce flight times.
MTOW	Maximum take-off weight must take into consideration the weight of the tether line as well as a safety margin to account for the effects of wind induced drag on the line.

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9.6.2 Tether/Attachment Strength

Where a tether is used to ensure the safety of an RPA in flight, the intention of the system is to restrain/contain the RPA in the event of an aircraft failure. The worst-case scenario therefore is that the RPA suffers an electronic failure and applies full throttle to all motors simultaneously.

The strength of the tether line/attachments points, as well as the weight/anchor strength of the base unit, should therefore be calculated to exceed the maximum thrust of all motors, minus the MTOW of the aircraft.

For example:

- Thrust = 5kg/motor x 4 motors = 20kg total thrust
- MTOW = 7kg
- TOTAL FORCE = 13kg

As sensible tether strength in this instance would likely double the total force for a given rating of 26kg. It may even be prudent to have a higher strength rating in order to contain an RPA that is accelerating under full throttle.

Note: Motor thrust data can normally be found in the motor/RPA manufacturer guidelines.

9.6.3 Calculating the maximum tether length.

The maximum tether length must be calculated to ensure that the RPA is not allowed to exceed a height of 150ft above the elevation of the airport reference point (ARP) as published in ERSA.

To achieve this, we use the following formula:

- Length of tether permitted (actual) = **T**
- Length of tether permitted as per MOS 101, Chapter 4 = **a**
- Elevation of tether ground attachment point = **b**
- Elevation of Aerodrome Reference Point (ARP) = **c**

Equation:

$$T = a - (b-c)$$

Note: Elevation of tether ground attachment may be measured from Google Earth, OzRunways or similar service. Elevation of ARP may be found in ERSA.

Example: Where the tether ground attachment point is 250ft AMSL; the aerodrome elevation is 200ft AMSL; and the permissible tether length (3nm from ARP) is 150ft.

- ***a** = 150, b = 250, c = 200*
- ***T** = 150 – (250-200)*

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- ***T** = 150 – 50*
- ***T – 100ft***

Therefore, the maximum length of the tether permissible is 100ft.

9.7 Emergency Procedures

As with any RPA operation, emergency procedures should be planned and discussed prior to the flight taking place. The information below highlights some of the predictable emergencies that may occur and what steps may be taken.

9.7.1 Tether retract unit inoperable

If the tether unit stops working or jams during operations:

- Tether operator announces "*STOP STOP STOP*"
- Pilot ceases any vertical or horizontal movement and keep the RPA in a stable position.
- If tether cannot be operated the tether operator will manually wind tether and control descent of RPA to landing zone.

9.7.2 RPA lost link

If the pilot loses command and control link with the RPA:

- Pilot announces, "*Lost link, hold tether*".
- Tether operator responds, "*holding tether*" and awaits further commands from pilot.
- If link cannot be re-established, tether operator will manually wind in RPA.

9.7.3 RPA flight controller failure

In the event of a flight controller failure during which the RPA remains in flight:

- Pilot announces, "*flight control failure*" and provides information regarding heading and direction of the RPA.
- If safe to do so, tether operator will manually wind in the RPA.

9.7.4 Catastrophic failure of the RPA

A catastrophic failure of one or more systems in the RPA, such as the power system/motors, will inevitably result in an uncontrolled descent and crash. This is possibly the most important function of the tether in any operation as it allows us to define the area where the RPA may impact the ground (see Fig 9.4).

For this reason, careful planning must be undertaken in the pre-flight phase of the operation to ensure that this area of effect is secure, and the boundaries delineated in

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order to control public access during the flight. Details of these procedures should be included as part of the Risk Assessment process.

The potential crash area will always cover a circular area with a radius equal to the tether length.

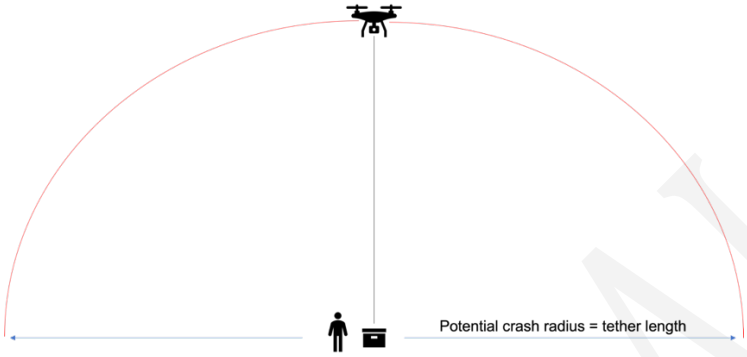

Fig 9.4: Potential crash area

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