PROBABILITY OF A UAS FLYAWAY

White paper estimating the probability of a UAS flyaway based on industry data.

REVISION 1

JANUARY 2025

Author: Pieter Franken

Co authors: Gerard Metz

Robin Zuidhof

DCRO

DUTCH ASSOCIATION OF CERTIFIED RPAS OPERATORS

EXECUTIVE SUMMARY

The Dutch Trade association for professional UAS operators (DCRO) is convinced that the SORA 2.5 assumptions for the probability of a UAS leaving the operational volume and flyaways are not in line with what is observed in the field . Discussions with operators and manufacturers strengthened DCRO in this belief. DCRO decided to collect data to see if indeed the probability was much lower in reality.

For this white paper DCRO collected data from its members as far back as 2011 from large operators/OEMs and DJI was asked to provide a statement on containment for all their enterprise models.

The data collected showed indeed that the estimation of a UAS leaving the operational area is not 1 in a 1000 flight hours as indicated in the JARUS Guidelines but around a 100 times smaller and around 1 in 100,000 flight hours. The probability of a flyaway is also a 100 times smaller and not 1 in 10,000 flight hours as assumed by Jarus but closer to 1 in 1,000,000 flight hours.

A lot can be said about the statistics and statements collected by DCRO such as that these are not specific enough or biased as operators and manufacturers would have an interest in having a lower probability.

These are however the only statistics available at present. DCRO would like to challenge anyone that does not agree with the collected data to counter the conclusions of this white paper with real data and not isolated incidents of non-professional operators.

We ask EASA and the national Civil Aviation Authorities for the following two points:

- Initiate the collection of flight safety statistics for the UAS industry in a uniform manner based on clear definitions. This should not be voluntary as a collective effort by all in the industry is needed to make the UAS industry as safe as manned aviation.
- The ground risk for the adjacent airspace should no longer be considered for the professional operators (Specific Category) as the risk of a flyaway leading to a real ground risk are negligeable.

INTRODUCTION AND DEFINITIONS

This white paper addresses the probability of a flyaway with a UAS operated by professional operators. The main reason for writing this paper is that this probability is assumed to be greater by regulators and advisory bodies than by professional operators.

In 2025, the updated SORA 2.5 will come into effect across all EASA member states. One key difference between SORA 2.0 and SORA 2.5 is that the ground risk for adjacent areas must now be considered when determining the level of containment for UAS operations. In SORA 2.5, this is listed as step #8 (previously step #9).

Debate exists regarding the pros and cons of using the new methodology to determine containment levels. However, one clear consensus from discussions with manufacturers and operators is that the current assumptions on the probability of a flyaway are not based on real data and are unrealistic.

FLYAWAY

For this white paper the term flyaway is defined as the situation in which the UAS leaves the intended operational volume due to a loss of control and the flight ends outside the operational volume.

The situation whereby the UAS exits the operational volume due to a loss of control but the operator can regain control of the UAS and can make it land in the intended operational volume is not classified as a flyaway (for this white paper), but as a loss of control only. The reason for choosing this definition is that the air risk for the adjacent area is assessed as low in the new SORA 2.5 proposal.

PROFESSIONAL OPERATORS

When assessing the probability of a flyaway it is very important to make the distinction between professional and non-professional operators. A professional operator is an operator that operates according to audited procedures from an operational manual and is trained to control a UAS under normal , abnormal and emergency conditions. In addition, the UAS flown are maintained by trained professionals. The professional operator is trained and capable of executing predefined contingency procedures in the

event of an off-nominal condition. For EASA member states we can assume these to be operators in the Specific Category and for the UK those that operate under PDRA-01.

DCRO

DCRO (Dutch Association of Certified RPAS Operators), founded in 2016, was established to serve as a knowledgeable partner for the CAA and to provide realistic figures about the actual risks of operating UASs. Since its inception, DCRO has required all members to collect and share safety statistics.

The reason why DCRO collected these statistics was that at the time it was not allowed in the Netherlands to fly closer than 150 meters from major highways as the CAA deemed the risk too high as they were afraid of a potential flyaway. Based on the safety statistics DCRO successfully demonstrated in 2016 that the probability of a flyaway was extremely low and as a result the Dutch regulators decreased the distance from 150m meters to 25 meters.

The reason for pointing out the fact that the probability of a flyaway is lower than assumed by regulators is that the operator will be forced to apply a higher level of containment as per the SORA. One of the most accepted options to comply by CAAs is adding a Flight Termination System (FTS) to a UAS. An FTS is not only costly but more important it adds a level of unsafety to the operation, the chance of the UAS terminating the flight due to a technical failure is far lower than the chance of the FTS malfunctioning. An FTS without parachute system will cause a direct crash whereas the malfunction of an FTS in combination with a parachute can lead to a UAS and payload ending in the water, an explosion proof zone or on a road.

REGULATORY AND SORA BACKGROUND

According to the JARUS guidelines for SORA (Explanatory Note for Edition 2.5, 13-05-2024), the following is assumed (A.1.2.2.b Adjacent Airspace Containment Requirements Assessment):

A flyaway occurs when a UAS leaves its operational volume, and the flight termination mechanism fails, causing the UAS to continue flight without operator intervention. For low-robustness containment, the following assumptions apply:

- There is a 10^-3 chance (0.1%) that the UAS leaves its operational volume (Pc = 0.001).

- There is a 10^-1 chance (10%) that the flight termination system fails (Pe = 0.1).

- This leads to a combined 10^-4 probability (0.0001) of prolonged, uncontrolled flight into adjacent airspace (Pec = 0.0001), equivalent to exiting the ground risk buffer.

This figure forms the basis for assessing both air and ground risk. While air risk is considered minimal, ground risk remains significant for adjacent areas.

METHODOLOGY

Several professional operators and manufacturers were approached and asked to voluntarily share data so that the probability of a flyaway could be estimated based on real data.

Two types of data were used. On one hand the data from professional operators and data submitted by manufacturer DJI.

DRONE OPERATOR DATA

Data from the operators will be presented as a single figure due to the commercial sensitivity of this data. Regulators can request this data from DCRO including the contact information of those who supplied this data.

37 members of DCOR submitted their flight safety statistics as well as 4 large foreign operators.

The total flight hours from these operators is: 1,411,183 and only 1 flyaway was reported.

The empirical probability of a flyaway all operators combined is approximately 1.4e-6 based on the data above.

DATA SUPPLIED BY DJI

DJI has released several statements as to the probability of a UAS leaving the operational volume of most of their commercial enterprise models. These are:

Model	**Probability**
DJI M300	3.2e-5
DJI M350 RTK	2.019e-5
DJI M3D	2e-5
DJI M30	1e-5
DJI Dock 1 & M30 (*)	1.579e-5
DJI FlyCart 30	0.682e-5

(*) Data based on 5.4 million flight hours.

The average probability of the UAS leaving the operational volume of all above models is approximately 1.75e-5 or 1.75 per 100,000 flight hours.

CONCLUSION

Before concluding, it is important to note that the figures from the operators relate to actual flyaways and not the instances whereby the UAS has left the operational volume. The figures from DJI indicate the probability of the UAS leaving the operational volume and not flyaways.

Jarus estimates that there is a 10% chance of a UAS ending the flight outside the operational volume after a loss of control. As DCRO we do not have the figures nor statistics of the number of times the operators experienced the UAS leaving the operational volume and were able to regain control and bring back the UAS into the operational volume.

If we would assume this assumption by Jarus to be correct then we see that the data from the operators and DJI correlates.

According to the data from DJI the chance of the UAS leaving the operational volume is 1.75e-5. If 10% of these lead to a flyaway then this would lead to the chance of a flyaway of 1.75e-06. Data from the operators show this to be 1.41e-6. These numbers are very close but the data from DJI is based on a much higher number of flight hours so we should assume this number to better express the probability.

The main conclusion that we can draw from this data for **professional operators** is that:

- The probability of a UAS leaving the operational volume is not 1e-3 but at least 1e-5
- The probability of a UAS experiencing a flyaway(and thus causing a ground risk) is at least 1e-6

DISCUSSION

A lot can be said about the data collected for this white paper. Some of the comments that were received in the past are:

- Operators and manufacturers have an interest in underreporting flyaways.
- Not enough data points
- Not specific enough per UAS type and or model
- Using same data multiple times

While these points are valid, the fact remains that these are the only statistics currently available. Not one national CAA has taken the effort to collect similar data or publish reports on the number of incidents versus the number of flights or flight hours.

NB. We challenge those who doubt the conclusions of this white paper to produce real data that indicate otherwise.

The argument that the data does not consider different types or models of UAS is not valid as the data collected by DCRO goes back to 2011! Those who have been around in the industry for 10+ years know how unreliable the UAS were that were used then. Connectors were sticking out, IP rating was unheard of, batteries were likely to fail etc. And yet not a single flyaway among the members of DCRO between 2011 and 2023 even though all experienced numerous occasions with loss of control. Why? because the pilots were trained to handle these situations and take the necessary action to ensure that a loss of control did not lead to a flyaway. Based on this fact the probability should be lower as the UAS are now better and safer than 10 years ago.

One could also argue that the conclusions are not 100% accurate as some data is used twice. While that is true this is only valid for a very small percentage of the data. For example, all the DCRO operators use mostly DJI equipment and some of them also work for Shell. However, the number of flights executed by members of DCRO are very small compared to the total number of flights on which DJII has based their data. For the Dock 1 this is based on 5.4 million flights whereas approximately several thousand flights have been executed using the Dock 1 by DCRO members. This is roughly 0.1% and the fact of using data twice can thus be ignored.

RECOMMENDATIONS

Based on the conclusions from this white paper, DCRO would recommend the following:

COLLECTION OF SAFETY STATISTICS

DCRO would like to see that safety statistics are collected across all EU member states in a uniform manner. The collection of this data should not be voluntary, Professional operators should understand the necessity to making the industry safer by adopting some good practises of manned aviation.

Statistics should also not be limited to just flyways but also include crashes, personal injury and look at the cause if this is human or a technical error.

The first step would be to harmonise the definitions behind the figures, such as the exact definition of a flyaway, a crash, an incident etc.

At DCRO we believe this the responsibility of the definitions to come from EASA and the collection of the data from the national CAAs. In this manner the submission of safety data can be made mandatory.

ADJUSTMENT OF CONTAINMENT REQUIREMENTS

At DCRO we believe that the current containment requirements for ground risk are disproportionate. The risk of a UAS experiencing a flyaway and causing a ground risk are negligible for operators in the Specific Category in our opinion. The requirements to comply with to a medium or high level of containment are excessive and only create a false sense of security since the chance of this happening is negligible.

We would even argue that adding an FTS makes the UAS less safe as the chance of these failing are far bigger than the probability of the UAS exiting the operational volume.

REFERENCES

The following members of DCRO submitted safety statistics.

Operator
AB Drone
Aerial Intelligence BV
Air Vision
Airfilms (*)
Airscope
Cloud Shots
Dedicated Drones
Delft Dynamics
Droneflight Academy
DroneView
Dutch Aerial Works
Dutch Drone Company
Eurodrone Inspections
Eye-Wings
Eyefly
Falcker
Float 360
Geo-Infra BV
Geometius
GeoZicht
Haviq Inspect

Kiwi Aerialshots
Ldewinter BV
Luchtfilmproducties
Mapture
Maritime Filming Group
Meet BV
Omnidrones Academy
Prodrone Media
RR Drone Solutions
Shipshot V.O.F.
Skeye BV
Sky Survey (*)
SkyLynx
SkyMotion
SkyVision (*)
UW Doneservices

(*) Company has terminated UAS flights or no longer active.

The data collected by DCRO was not collected by Flight Hour but by flight. In a conservative approach the number of flights was divided by 3 (assuming an average UAS flight to be 20 minutes).

APPENDICES

DJI Statements

SZ DJI TECHNOLOGY CO., LTD.
DJI SKY CITY, NO.55 XIANYUAN ROAD
NANSHAN DISTRICT
SHENZHEN, CHINA

July 19, 2024

Manufacturer Declaration

I hereby declare that the UAS listed below complies with the basic requirement as defined in point 2.5.3(b) of the AMC1 Article 11 to Regulation 2019/947 (SORA Step 9). In support of this statement I provide the probability to leave the Operational Volume (OV) due to technical reasons. The values taken into account to calculate the probability for the UAS to leave the OV are based on the flight data voluntarily shared by users:

Manufacturer	Model	MTOM (kg)	Probability to leave the OV due to technical failure
DJI	M3D/M3TD Series Dock 2	Weight: 1410 g Max Takeoff Weight: 1660 g	2e-5
DJI	M30 Series Dock	4.069kg 3.998kg (C2 class identification)	1e-5
DJI	M30	4.069kg 3.998kg (C2 class identification)	1.579e-5
DJI	M350 RTK	9.2 kg	2.019e-5
DJI	M300	9kg	3.2e-5

Name of Responsible Person: Chen Ming
Title of Signatory: Director of Technical Development
Email Address: mark.chen@dji.com
Signature:

Chen Ming
24/07/15

SZ DJI TECHNOLOGY CO., LTD.

SZ DJI TECHNOLOGY CO., LTD.
DJI SKY CITY, NO.55 XIANYUAN ROAD
NANSHAN DISTRICT
SHENZHEN, CHINA

14th October, 2024

Manufacturer Declaration

I hereby declare that the UAS listed below complies with the basic requirement as defined in point 2.5.3(b) of the AMC1 Article 11 to Regulation 2019/947 (SORA Step 9). In support of this statement I provide the probability to leave the Operational Volume (OV) due to technical reasons. The values taken into account to calculate the probability for the UAS to leave the OV are based on the flight data voluntarily shared by users:

Manufacturer	Model	MTOM (kg)	Probability to leave the OV due to technical failure
DJI	DJI FlyCart 30	95 kg	6.82×10^{-6}

Name of Responsible Person: Mark. Chen
Title of Signatory: Director of Technical Development
Email Address: mark.chen@dji.com
Signature: Chen Ming.

24/10/14

SZ DJI TECHNOLOGY CO., LTD.