

# DRONE OPERATIONS - REPORT OF THE EXPERT BOARD TO SWISS POST

January 8, 2020

## Summary

The expert board has examined the drone operations of Swiss Post and Matternet. It recognizes the numerous, significant improvements implemented by both Matternet and Swiss Post since the incidents in January and May 2019. The expert board acknowledges that Matternet and Swiss Post demonstrate a high level of safety and safety awareness and expressly supports the plans designed not only to maintain this level but also to develop it further.

Based on the information received and the analyses conducted, the expert board is confident that there are no signs of disproportionate risks, which would argue against a resumption of flight operations. Before operations can be resumed, the five conditions discussed in the report must nevertheless be satisfied.

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# 1 INTRODUCTION

## 1.1 Background

The aim of the Swiss Post drone project is to transport blood samples between hospitals and laboratories at sites throughout Switzerland. The drones are developed, manufactured and operated on behalf of Swiss Post by Matternet Inc., Mountain View, California CA 94041, USA, an American company with a Swiss subsidiary located in Dübendorf (ZH).

On both January 25 and May 9, 2019, an incident occurred in Zurich involving a Matternet M2V9 drone (cf. section 0). After the first incident, Swiss Post discontinued operations for a short time. Following the second incident, Swiss Post once again discontinued drone operations in order to identify all possible risks, assess them in full and have both the flight operations and organization analyzed. To this end, Swiss Post convened a committee of aviation and safety experts.

## 1.2 Member of the expert board

The panel of experts comprises high-ranking representatives of the civil aviation authorities, the air force, air traffic control, the world of science and customer representatives (hospitals).

- Prof. Dr. Michel Guillaume (Professor for System Integration and Structural Integrity, Head of Centre for Aviation, ZHAW)
- Luca Jelmoni (Director of the Ospedale Regionale di Lugano)
- Simon Maurer (former Chief Safety & Security Officer (CSO) Skyguide, currently CSO Swissgrid)
- Kurt Meyer (Moderator of the expert board, Senior Risk Management Expert)
- Marco Müller (airline pilot and former Head of Flight Safety SWISS International Airlines)
- Daniel Siegenthaler, (Head of Safety Management, Military Aviation Authority)

## 1.3 Contract and issues addressed

The main objective of the expert board was to analyze the flight operations of Matternet drones on behalf of Swiss Post and to make safety recommendations. Swiss Post places the utmost importance on safety when using drones to deliver blood samples. It is fully aware that even when implementing an unconditional “safety-first” approach, there is always a residual risk of unforeseen incidents.

The expert board was convened to assess whether the resumption of flight operations would be accompanied by unacceptable safety risks. With this in mind, it answered the following questions raised by Swiss Post:

- Can the expert board confirm that there are no concerns, which might prevent flight operations from being resumed (safe to operate)?
- Can the expert board confirm that flight operations can be resumed before the final report of the Swiss Transportation Safety Investigation Board (STSB) is published?

This report is intended for the Swiss Post senior management team.

## 1.4 Scope

The expert board has based its assessment on the following information and analyses conducted:

- Detailed analysis of drone operations by Matternet in Switzerland, the Matternet safety procedures, the safety management system and drone authorization.
- Assessment of the regulatory requirements:
- Swiss authorization: FOCA, “Specific Operation Risk Assessment” (SORA) with Unisphere and V2sky as third-party verification;

- US authorization part 135: the part 135 certificate comprises thousands of pages with approved manuals, exceptions and waivers;
- 44,807 requirements;
- OSR test results report.
- Other information provided:
 

<p><b>Common</b></p> <ul style="list-style-type: none"> <li>• 00_SORA_2.0_Common.Rev.1</li> <li>• 01_Annex_A_Common.Rev.6</li> <li>• 04_Safe_Recovery_From_Technical_Issues.Rev.3</li> <li>• 08_Assembly-Test-Qualify-Process</li> <li>• 15_M2V8_OVC</li> <li>• M2_Field_SOPs.Rev.13</li> <li>• Technical Harm Barrier Demonstrations.Rev.2</li> </ul> <p><b>Ticino hospital group Lugano</b></p> <ul style="list-style-type: none"> <li>• Annex A EOC Lugano.Rev.3</li> <li>• Contingency-Management-Plan EOC.Rev.2</li> <li>• Letter To Helicopter Operators - EOC</li> <li>• Lugano - EOC.kmz</li> <li>• Master Document List Lugano.Rev.1</li> <li>• Matternet Operator Certifications</li> </ul>	<p><b>University Hospital Zurich (USZ)</b></p> <ul style="list-style-type: none"> <li>• Aerial_Traffic_Deconfliction_Safety_Concept.USZ.Rev.2</li> <li>• FlightOpsChecklist USZ-UZH</li> <li>• Letter To Helicopter Operators - UZH</li> <li>• M2_Field_SOPs.Rev.13</li> <li>• Master_Data_List_USZ.Rev8</li> <li>• Removal Observer Amendment.Rev.1</li> <li>• SORA_Annex_B_V1.2_external_consultation</li> <li>• USZ Ops Annex.Rev.4</li> <li>• USZ.2018.11.08.kmz</li> </ul> <p><b>Zurich Central Laboratory (ZLZ)</b></p> <ul style="list-style-type: none"> <li>• 01_Annex_A_Specific.ZLZ.Rev.5</li> <li>• FlightOpsChecklist ZLZ</li> <li>• Letter To Helicopter Operators - ZLZ</li> <li>• Master_Data_List_Template_quer-fam</li> <li>• ZLZ_Ops_Annex.Rev.1_de_CH</li> <li>• Zürich - ZLZ.2018.11.29.kml</li> <li>• Zürich Helicopter Traffic Avoidance Concept.Rev.5</li> </ul>
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The following were specifically excluded from the analysis:

- a detailed inspection and analysis of the design and construction of the drone (already subject to a thorough inspection by Swiss and US authorities (FAA and FOCA) as part of the approval process);
- the flight control software, due to its complexity;
- a cyber-safety analysis (a safety analysis including penetration tests is carried out at Matternet on behalf of Swiss Post (CISO));
- a review of the documentation made available to FOCA by Matternet on “Specific Operation Risk Assessment” (SORA) for Swiss Post drone operations.

## 1.5 Procedure

The expert board has held six meetings to date:

- 1) 31.07.2019 (Berne) Kick-off meeting: thematic introduction, goals and familiarization
- 2) 06.09.2019 (Dübendorf/Effretikon) Site visit to Matternet: presentation of operation by Matternet and assessment of the M2V9 drones and mission control in action.

- 3) 03.10.2019 (Berne) Debriefing: general feedback from the site visit to Matternet and discussion presentation of the safety management process
- 4) 22.10.2019 (Berne) Presentation of the safety management process, detailed inspection and assessment of the safety management process implemented by Matternet
- 5) 08.11.2019 (Oerlikon) Resolution concerning resumption of flight operations, advice concerning the expert report
- 6) 13.12.2019 (Bern) Final decisions on the completion of the report; report discussion with the Swiss Post project team and representatives of Matternet

## 2 COURSE OF EVENT AND FINDINGS

### 2.1 Flight operations

As early as 2015, Swiss Post and Matternet amassed considerable experience (presented below) through the initial pilot projects.

#### **EOC hospital group, Lugano**

In Lugano, a drone connection between two locations was tested for the very first time in Switzerland in 2017. Since the start of the project, more than 2,000 flights have taken place between the EOC hospital group's two hospitals, the "Ospedale Italiano" and the "Ospedale Civico". The drones were used on a daily basis in Lugano until May 2019. The time saved with delivery drones could be as high as 45 minutes.

#### **Zurich Central Laboratory (ZLZ)**

Swiss Post began transporting lab samples for the ZLZ over the Zurich lake basin as early as June 2018. The ZLZ lab carefully evaluated the results of the tests and decided to pursue drone transport in future. This links the ZLZ emergency laboratory at Hirslanden Klinik Im Park with ZLZ's new location at Forchstrasse 454 in Zollikon. The drone needs around seven minutes to cover the route and thus delivers the goods to their destination five times faster than conventional road transport and in a more environmentally friendly manner.

#### **University Hospital Zurich (USZ)**

Swiss Post has been transporting laboratory samples by drone on behalf of USZ and the University of Zurich (UZH) since December 2018. The flight path starts from a roof terrace on the north wing of USZ, arrives at UZH Irchel at Winterthurerstrasse 190 and – where possible – flies over a forested area. Around five to ten flights take to the air on weekdays between 7.30 a.m. and 4.45 p.m.

The drone takes about four minutes to cover the two-and-a-half kilometer stretch. Compared to a courier on the road, the drone is able to travel the route twice as quickly, is more environmentally friendly and is unaffected by the traffic situation.

### 2.2 Flight operation incidents in Switzerland

On **January 25, 2019**, the drone set off from Hirslanden Klinik Im Park in Zurich. A few seconds after it had flown over the western lakeshore at 10.10 a.m. and 5 seconds, the GPS signal was lost. The drone followed the programmed flight path for five seconds. At 10.10 a.m. and 10 seconds, the drone performed a controlled emergency landing because it could no longer determine its own position. In doing so, the parachute was deployed in accordance with the internal logic of the flight termination system (FTS). Once the parachute has been deployed, the flight director no longer has any control over what happens. At this point, his screen in the mission control unit displayed the alert "FTS fuse false". The drone glided downwards on a parabolic trajectory from about 60 m above the ground, hit the surface of the water at an average vertical speed of 4 m/s and sank. The blood samples being transported remained intact and nobody was injured. In accordance with the operator's emergency plan, the flight

director immediately informed the police. On the morning of January 28, 2019, the drone was recovered from the bottom of Lake Zurich at a depth of about 20 m. (Source: STSB report)

On **May 9, 2019**, about two minutes after setting off from the University of Zurich (UZH) Irchel, the drone automatically triggered the flight termination system – FTS) and initiated a controlled emergency landing. After the parachute was deployed, the connection cord tore and the drone hit the forest floor unchecked close to a group of children who were playing nearby. The drone was destroyed on impact, although no one was injured. Neither the children nor the two nursery teachers who watched the drone crash from a distance of about 50 meters heard an acoustic warning signal. (Source: STSB report)

## 2.3 STSB investigation and measures implemented

The STSB analyzed both incidents. It concluded its investigation of the first incident with the report of April 11, 2019, which contained no specific safety recommendations.

The analysis of the second incident began immediately after the crash. On June 17, 2019, the STSB published an interim report containing two safety recommendations (strengthen the fastening of the parachute and make the acoustic warning signal louder). Both reports can be consulted on the STSB website. The investigation of the second incident is still in progress. The final recommendations and final report are not yet available.

Matternet has already implemented the recommendations published by the STSB in its interim report.

Furthermore, the FOCA decreed a Matternet drone amendment with the following four directives:

- 1) modification of the parachute system as per Matternet Safety Bulletin SB M2-001
- 2) the parachute system satisfies the directives of the ASTM F3322 standard
- 3) Repetitive inspections of the parachute system should be defined in the maintenance documents.
- 4) the flight speed should be reduced by 20% ( $V_{max}$  reduced from max. 20 m/s to 16 m/s)

Matternet has also implemented these directives.

Moreover, in addition to the recommendations indicated above, Matternet has implemented other measures designed to increase safety, as illustrated by the analysis of the data presented. Since May 2019, Matternet has completed numerous system and flight tests, both in its subsidiary in Dübendorf and in the US. The aim is to acquire yet more experience with the overall system (hardware and software) and thus increase safety even further.

Both Matternet's drone system and the operational considerations comply with the regulatory directives for warranties of "US Part 135" and "44807 Exemption". Matternet's aim in Switzerland is to have the operation of the system approved by means of an EASA light UAS operator certificate (LUC). In May 2019, the EU published the Commission Implementing Regulation (EU) 2019/947 which also governs LUC certification in part C and which must be implemented by June 2020.

The expert board established that neither the STSB nor the FOCA recommended or ordered the suspension of drone flight operations.

## 3 RESUMPTION OF FLIGHT OPERATIONS

### 3.1 Preliminary comment

The expert board recognizes the numerous, significant improvements implemented by both Matternet and Swiss Post since the incidents in January and May 2019.

The measures implemented by Matternet since May concern

- Hardware Updates of the drone M2V9,
- Flight Controller Software Updates,

- Companion Computer und Cloud Software Updates and
- Operational Updates.

The expert board certifies that Matternet and Swiss Post demonstrate a high level of safety and safety awareness. It expressly supports the plans not merely to maintain this level but to develop it further.

### 3.2 Recommendation

Based on the information received and the analyses conducted, the expert board is confident that there are no signs of disproportionate risks which would argue against a resumption of flight operations. Before operations can be resumed, the following five conditions must nevertheless be satisfied:

- 1) It is demonstrated that the recommendations of the STSB indicated in its interim report and the requirements of the amendment to the FOCA operating license have been implemented.
- 2) An independent supervisory function relating to the safety-related processes of operating in Switzerland is created by the end of March 2020.
- 3) Matternet undertakes to implement the planned measures, communicated to the expert board, in good time,
  - recruiting a Head of Safety,
  - developing a safety management system (SMS) according best practice standards of ICAO Annex no. 19
- 4) Swiss Post and Matternet guarantee, by means of a contract, that:
  - Matternet grants Swiss Post and any committees/people mandated by Swiss Post the right to information and to perform an audit
  - Matternet includes Swiss Post in relevant information flows, i.e. proactively informs Swiss Post, for example about safety-critical findings/incidents, non-conformity reporting, service bulletins, etc.
  - Matternet grants Swiss Post a seat on the safety board for Swiss operations (may be a US SMS adapted to Swiss conditions).
- 5) The FOCA maintains the operating license – which can be taken as a given from the current point in time.

The council of experts will continue to be available to Swiss Post for questions and risk assessments in connection with the drone operations after the resumption of flight operations.