



Safety recommendation no. 590

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Number of the final report	2390
Safety deficit	<p>About one minute after take-off at the University of Zurich (UZH) Irchel, the M2 V9 drone automatically triggered the flight termination system (FTS) and initiated an emergency descent with a parachute. After ejecting the parachute, the connecting rope broke and the drone hit the forest floor without deceleration and was destroyed.</p> <p>As the investigation showed, the applied firmware of the flight controller based on the software version ArduCopter 3.5.0-rc5 was only capable of using two of the three available inertial measurement units (IMU) for the flight control of the drone. As a result, the flight controller's software lacked the ability, known as resilience, not to fail completely in the event of malfunctions or the failure of individual components, but to maintain control of the drone. Only from software version 3.6.12 onwards was it possible to achieve this resilience with the corresponding configuration of the safety-critical parameter ("EK2_IMU_MASK = 7"), as published in a discussion forum of the flight controller manufacturer as Service Bulletin SB 0000002.</p> <p>In the case of the accident involving the largely identical drone SUI-9909 on 25 January 2019 (cf. summary report), the FTS was also immediately triggered due to a loss of the GPS signal. As the investigation showed, the drone's flight attitude was still stable at this time and thus a landing under engine power, either manually controlled on sight or autonomously, would not have been fundamentally impossible.</p> <p>When operating under extreme climatic conditions, corresponding flight-critical parameters such as ambient temperature and humidity are not included in practice. This would allow a flight mission to be aborted early or not carried out at all under certain conditions.</p>
Safety recommendation	<p>The Federal Office of Civil Aviation (FOCA), together with the operator or manufacturer, should take appropriate organisational or technical measures to ensure that take-off is prevented in unsuitable environmental conditions which could lead, for example, to condensation or icing.</p>
Addressees	BAZL Bundesamt für Zivilluftfahrt
Stage of the implementation	<p>Implemented – In a letter dated 29 September 2023, the Federal Office of Civil Aviation (FOCA) commented as follows:</p> <p>"The Federal Office of Civil Aviation (FOCA) is in partial agreement with Safety Recommendation (SE) No. 590.</p> <p>The FOCA's licensing practice [2] also takes into account the management of unfavourable operating conditions, among other things. In doing so, the FOCA is guided by the Operational Safety Objectives (OSO) as set out in Regulation EU 2019/947 [1] and the associated AMC.</p>

In particular, the following points should be taken into account to ensure that operation in unsuitable environmental conditions is prevented.

- OSO #21 "Operational procedures are defined, validated and adhered to",
- OSO #23 "Environmental conditions for safe operations are defined, measurable and adhered to" and
- OSO #24 "UAS is designed and qualified for adverse environmental conditions"

According to the STSB final report no. 2390, chapters 1.3 and 2.1.1, the weather conditions at the time of the accident were compatible with the applicable operating restrictions and did not influence the cause of the accident. In addition, it should be noted that the UAS model involved, Matternet "M2V9", was designed and tested beyond OSO #24 for flights in visible humidity to withstand significant weather conditions. The UAS was also subjected to more stringent tests than required by the "DO-160 Category R waterproofness testing" [3].

The FOCA hereby considers safety recommendation no. 590 to be fully implemented and completed."

[1] Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft

[2] JARUS Guidelines on Specific Operations Risk Assessment (SORA). JAR-DEL-WG6-D.04; Joint Authorities for Rulemaking of Unmanned Systems; 30 January 2019, Edition No. 2.0, http://jarus-rpas.org/wp-content/uploads/2023/07/jar_doc_06_jarus_sora_v2.0.pdf

[3] DO-160 Category R waterproofness testing, RTCA/DO-160 G Change 1, RTCA, INC., December 16, 2014, www.rtca.org

**Investigation report concerning
the safety recommendation**

Zwischenbericht
Schlussbericht
Final report
Vorbericht
