



Safety recommendation no. 587

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Safety deficit	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. After the emergency parachute was deployed, the acoustic warning signal was not heard by people not far from the crash site, which meant that the purpose of warning third parties on the ground was not fulfilled. As the investigation showed, the value of the drone's impact energy was significantly higher than the value of 80 J used in practice to date, regardless of its load.
Safety recommendation	The Federal Office of Civil Aviation (FOCA) should take appropriate measures to ensure that the impact energy of a drone descending to the ground by parachute does not pose a risk of serious injury to third parties on the ground.
Addressees	BAZL Bundesamt für Zivilluftfahrt
Stage of the implementation	Implemented – In a letter dated 29 September 2023, the Federal Office of Civil Aviation (FOCA) issued the following statement: "The Federal Office of Civil Aviation partially agrees with the issued safety recommendation no. 587. The FOCA authorises drone operations in the "special" category [4] based on a risk assessment and the documentation submitted by the applicant or operator in accordance with the Specific Operation Risk Assessment (SORA) methodology. The SORA methodology is based on the principle of a holistic or overall system-related, risk-based model, which is used to assess the risks associated with a specific application. In addition to all types of hazards associated with a particular malfunction, the model also considers the design of the unmanned aircraft and the proposed operational risk mitigation measures. The original approval for the operation of Matternet/Post (the SUI-9903 drone) was based on SORA version 1.0 (JAR-DELWG6-D.04 V1.0). Since 18.03.2022, SORA Version 2.0 [1] has formed the basis for authorisation by the FOCA. SORA follows the conservative approach, according to which any direct impact on a person is to be considered fatal ([1], §2.1 c, [5]). By applying the SORA methodology, the applicant has the possibility to claim a lower lethality. One way to reduce the risk on the ground is to take measures to reduce the impact on the ground once control of the operation of the unmanned aircraft has been lost. This is accomplished by reducing the effects of the unmanned aircraft's impact dynamics (i.e. area, energy, momentum, transfer energy, etc.). The use of parachutes (as

in Matternet/Post) is one such risk mitigation measure (known as M2 ground risk mitigation) designed to reduce the energy absorbed by people on the ground on impact.

An applicant can use M2 [6] measures to demonstrate the reduction of the effects of an impact by reducing the critical impact area and/or limiting the dynamics of the energy transfer (not the impact energy). In chapter 2.2.2 "Maximum impact energy" of the STSB final report no. 2390, 80 joules [J] is specified as the limit value for fatal injuries. This value originates from research into (point) penetrating high-velocity injuries, i.e. caused by bullets and projectiles, and is not suitable for assessing the effects of an impact caused by UAS. The 80 J refers to the maximum energy transferred to a person on impact. It does not refer to the maximum impact energy of a drone crash, regardless of whether a parachute is functioning or not. Current practice is based on the 'Abbreviated Injury Scales' [7], which originate from the automotive industry and research on the assessment of the severity of ground collisions with UAS [2, 8]. In addition, the reference to the limit of 80 J is not relevant in connection with the operation of UAS that are subject to an operating licence (special category according to (EU) 2019/947, [3]). The limit value of 80 J is relevant in the context of UAS operations in the "open" category, i.e. operations not subject to authorisation:

- Annex to (EU) 2019/947, Part 2 - Requirements for C1 UAS: 80 J is the upper limit [3]
- (EU) 2019/947 Article 14 (5) a): Operators of UAS with transmitted kinetic energy > 80 J or MTOM > 250 g (open category) [3]

On 6 July 2023, EASA published the "Means of Compliance with Light-UAS.2512 ("M2 MoC")" [2], which contains all the necessary guidelines and technical principles to fulfil "M2 Medium Robustness" and typically take a parachute system into account. The FOCA relies on this MoC when issuing operating licences for UAS if a medium robustness of M2 is required.

In the view of the FOCA, the implementation of Safety Recommendation No. 587 has already been realised at the present time due to the above-mentioned explanations. The safety recommendation and the associated safety deficit are considered in the procedure for issuing the operating licence in accordance with (EU) 2019/947 [3].

The FOCA hereby considers safety recommendation no. 587 to be closed."

[1] 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

[2] EASA Means of Compliance with Light-UAS.2512 / Means of compliance with SORA M2 (medium robustness) "M2 MoC", Doc. No. MOC Light-UAS.2512-01, Issue 1, 6 July 2023, <https://www.easa.europa.eu/en/document-library/product-certification-consultations/means-compliance-mitigation-means-m2-ref-amc>

[3] Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft and associated AMC, <https://www.easa.europa.eu/en/document-library/easy-access-rules/easy-access-rules-unmannedaircraft-systems-regulations-eu>

[4] Art. 5 of Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft

[5] The risk model on which the SORA is based always assumes a catastrophic outcome, i.e. a collision with a person always results in a fatality. All considerations regarding injuries are subjective and

subject to a risk assessment that relates to the individual case.

[6] M2 Mitigation: Systems are in place to minimise the impact of collisions on people on site.

[7] The Abbreviated Injury Scale, or AIS score for short, is an extended score for assessing the severity of trauma in patients with polytrauma. A total of 9 body regions are assessed with 6 degrees of severity. (flexikon.doccheck.com)

[8] Arterburn, D., Ewing, M., Prabhu, R., Zhu, F., & Francis, D. (2017). FAA UAS Center of Excellence task A4: UAS ground collision severity evaluation, revision 2.

(assureuas.org/wp-content/uploads/2021/06/A4-Final-Report.pdf)

**Investigation report concerning
the safety recommendation**

Zwischenbericht

Schlussbericht

Final report

Vorbericht
