# EUROCAE WG73 SG4

By Peter Cosyn and Per Osen

### The Minimal Risk UAS Initiative

On behalf of EASA, EUROCAE Working Group (WG73) is drafting a proposal for regulations for the large and heavy unmanned aircraft (UA) - with main focus on those with maximum takeoff mass (MTOM) above 150 kg. For these UA, a prescriptive certification regime will probably be implemented, along the same lines as for manned 'EASA aircraft', e.g. commercial aviation, general aviation and gliders. For light UA less than 150kg, however, regulation remains the responsibility of the national CAA.

Within EUROCAE WG73, Sub-group 4 (SG4) drafts guidelines specifically for light UAS as a common European basis for national regulation. A first document, 'UAS for Visual Line of Sight Operation' is ready for official release. SG4 has gained increasing interest from a growing base of small UAS stakeholders who acknowledge the need for a common European (and international) regulatory standard for the light UA. A considerable challenge is the fact that small UA span the mass range of 0 kg to 150 kg. One set of rules will not be suitable for all.

The heavier 'small' UA will represent a potential threat to people on the ground and to other aircraft. For these, the authorities will probably implement a similar regulatory regime as for the UA above 150 kg, maybe with less demanding requirements and potentially based on some consideration of acceptable risk level. This is similar to the classification of manned aircraft, where different certification standards apply to small single-engine aircraft and large airliners.

For small UAS at the lower end of the weight spectrum - typically 2 kg or less - the potential for causing injury to people or damaging other aircraft may become so insignificant that the need for approval or certification from a risk perspective becomes meaningless. Within SG4, a proposal has been put forward to define and classify these UAS based on a risk assessment study.

### Origin of the Concept

To provide regulators with a clear classification based on parameters such as maximum takeoff mass and terminal velocity, risk assessment studies are required that relate these parameters to a certain expected level of safety for an operating environment, which can be urban areas, rural areas, uninhabited areas etc. To reach a target level of safety that exceeds that of manned aircraft - literature typically points to a number of 10-6 to 10-7 critical events per hour - these studies should point to the required mitigating measures for a certain UAS class to be able to fly in a certain operating environment. This may include certification standards of the system, specific operating limits, specific operator qualification levels and advanced technology for sense-and-avoid.

For large and heavy UAS it all comes down to a requirement for very low failure rate of the system and a very low probability to collide with an aircraft. However, these UAS are complex systems and regulators are reluctant to believe theoretic studies. Empirical data is needed but UAS don't have the same long track record as exist for manned aircraft, hence risk assessments for UAS are based on a smaller and potentially error-prone dataset. To break through this 'chicken and egg problem' a bottom-up approach could be followed: gather data of small UAS that do not require very low failure rates to reach the target level of safety. It can be a step-wise approach that opens up larger parts of our airspace for heavier systems.

The 'inherently harmless UAS' concept fits within such an approach. These UAS are at the lowest end of the weight spectrum and have an important extra quality: an actual hit on a person or an aircraft will not be critical in almost all conditions.

The main driving force behind the concept is industry because these UAS are enabling technology for a long list of public and commercial niche applications with major benefits for society and industry. Currently a growing list of manufacturers, service providers and users depend on them but are very restricted in their operation due to the lack of rules.

### Applications and Future

Small UAS are typically not one-size-fits-all systems. A system excels in one or a few niche applications, for which it is exclusively designed. To grasp the potential, a few of these applications are listed below:

Public applications include:
- Fire monitoring
- Natural disaster monitoring and mapping
- Flood monitoring and mapping
- Contamination measurement
- Information gathering (indoor and outdoor)

Commercial activities include:
- Aerial photography for real-estate services
- Terrain mapping for local land management
- Vegetation monitoring and mapping for agro-industry
- Power-line inspection
- Asset monitoring for security and safety

In general it can be said that these system will become the work horse and surveillance platforms for local and low altitude operation. They may be small and light but they are no 'toys for boys'. They are high-tech remote sensing equipment. When designed and operated by qualified pilots according to safety guidelines, they exhibit the potential to be very safe ('harmless') as well.

To give this future a chance, transparent rules and operating procedures are needed that remove any lengthy approval procedure and avoid unnecessary restriction on flight environment and operation.

### Definition

Because nothing can be considered completely harmless, it was decided that a better name should be used for this specific

UAS group. A suggested alternative is 'Minimal Risk UAS'.

A 'Minimal Risk UAS' is defined by the fact that its operation accompanies 'acceptable risk' even if it hits a human or an aircraft. In addition, the probability for incidents shall be according to the ALARP principle (as low as reasonably practical) and may be higher for civil safety-of-life operations than for commercial operations. In general a 'Minimal Risk UAS' should never expose the innocent bystander, be it on the ground or in the air, to a critical injury risk exceeding that of manned aircraft for similar tasks.

UAS obtain their status by 'inherent' risk mitigating that may act on two levels:

1. They are too light and operate too slow to cause critical damage and (if necessary) ...
2. ... they augment their safety using passive safety enhancements such as crumple zones, frangibility and the omission of blunt front structures.

Some very light systems, typical 100 g or less, flying at moderate speed may be minimal risk UAS without any safety enhancement. Heavier and faster systems may require passive safety enhancements to reach an acceptable risk level.

### Qualification Procedure

The current suggested procedure is based on a risk assessment of collision risk and ground risk but starts from an assessment of the damage inflicting factor (in bold).

Collision Risk = $P_{\_midair\_collision} * \mathbf{P}_{\mathbf{\_damage}}$

Ground Risk = $P_{\_failure\_rate} * P_{\_hit\_on\_human} * \mathbf{P}_{\mathbf{\_injury}}$

### Collision Risk

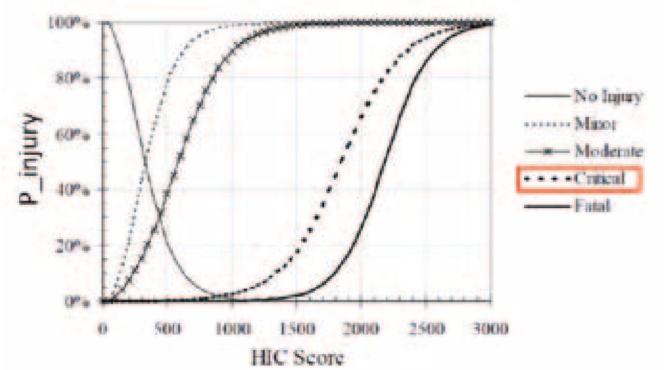
A few hundred thousand large birds with a mass ranging from 1,5 kg to 10 kg fly in UK airspace alone. Nevertheless, worldwide bird strike events resulting in damage to aircraft are limited to a few reported incidents a year with on average one fatal incident (ref: EASA safety report). It is a result of the fact that both the hit probability and the damage potential are very low. The damage potential is low because of safety regulations, such as those formulated in EASA CS23 and CS25 and their FAA counterparts:

- "The airplane must be designed to assure capability of continued safe flight and landing of the airplane after impact with a 1,8 kg bird …"
- "Several critical components are required to continue to function after collision with birds up to 3,6 kg"

Along the same line, ICAO rules Annex 2 Appendix 4 allows unmanned free balloons up to 4 kg (and a maximum package weight of 2 kg) to operate up to FL600 and beyond in non-segregated airspace. It is clear that an upper limit for 'minimal risk UAS' should be in accordance with current safety rules. The US proposes a threshold on 2 kg (ref: sUAS ARC report). A similar threshold could be adopted by EUROCAE.

### Ground Risk

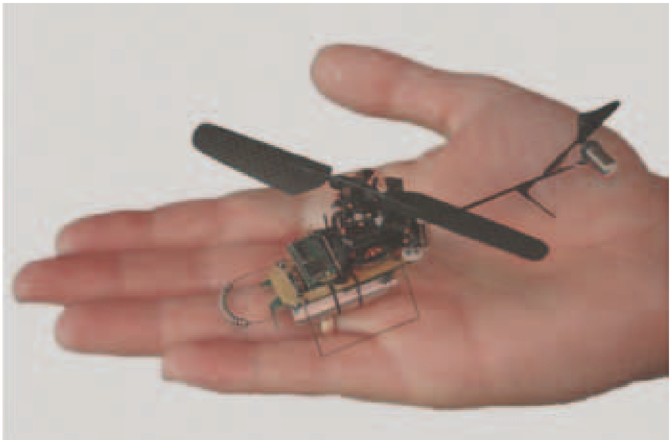
Ground risk could be assessed using common methods for impact safety. One could, for example, specifically focus on the most critical area of the human body: the head. Two critical injuries could typically arise: life threatening skull fractures due to blunt body impact and critical brain damage. By removing rigid front structures and by adding crumple zones, frangibility or shock absorbing material one can make vehicles up to 2




kg safe. A common method to assess brain damage is the Head Impact Criterion (HIC). This is a formula that relates peak acceleration of the head to critical injury.

### Examples

The figures below show a few potential Minimal Risk UAS: a 10 g nano UAS from Prox Dynamics for information gathering, a 300 g micro UAS from Skybotix for research and education, and a 1700 g micro UAS from Gatewing for terrain mapping tasks.



### Sub-group structure and purpose

The sub-group originated from a joint initiative by five European companies - ProxDynamics (Norway), Gatewing (Belgium), SenseFly (Switzerland), Skybotix (Switzerland) and MAVLAB

(Netherlands) - who addressed EUROCAE WG73 SG4 in July 2009 with a request to develop guidelines for minimal risk UAS. EUROCAE asked the sub-group to draft a proposal. The proposal was presented by Dag Henning Paulsen of ProxDynamics and Peter Cosyn of Gatewing, who leads the sub-group, in March 2010. Together with SG4 member Per Osen of Robotaviation (Norway) and Peter Cosyn were and still are actively involved in the EUROCAE WG73 SG4 meetings.

The purpose of the sub-group is three-fold:

- Support the development and use of minimal risk UAS in non-segregated airspace;
- Ensure 'minimal risk' based on objective safety criteria;
- Establish a system of approval of Minimal Risk UAS that is acceptable and practical for the national CAA, the developers and operators.

The initiative has lead to a growing group of individuals and companies that support the concept. Presently, more than 20 persons already committed to contribute their knowledge and ideas. It is an international community currently including members from Austria, Belgium, Finland, France, Germany, Norway, Spain, Sweden, Switzerland, the Czech Republic, the UK and the USA.

**Timeline and objectives**

The main objective is a clear and common sense guideline for minimal risk UAS approved by EUROCAE, supported by JARUS (Joint Authorities for Rulemaking on Unmanned Systems) and ready for adoption by national CAAs. This objective should be reached in a short time frame, counted in months instead of years.

EUROCAE WG73 SG4 is currently preparing a project plan with a timeline to progess from the current minimal risk proposal and work done by the group, to a SG4 deliverable in which a proposal for regulation will be formulated. This project plan will be reviewed during the SG4 meeting at the end of June 2010 and further actions will be addressed to SG4 and the sub-group members. Persons or companies desiring to contribute are invited to contact Peter Cosyn at pco@gatewing.com

Peter Cosyn
Initiator of the «Minimal Risk» Initiative