# APPENDIX 4-2

# Discussion of Subjects

## 1. Medical fitness

References for manned aircraft (examples)

JAR-FCL 1.035 Medical fitness
JAR-FCL 1.040 Decrease in medical fitness
JAR-FCL 1.095 Medical fitness
JAR-FCL 1.105 Medical fitness
JAR-FCL 1.145 Medical fitness
JAR-FCL 1.174 Medical Fitness
JAR-FCL 1.270 Medical fitness

Summary of referenced requirements for manned aircraft

In order to exercise the privileges of a licence, the holder shall hold a medical certificate issued in accordance with the provisions of JAR–FCL 3. For a PPL a valid Class 1 or Class 2 medical certificate shall be held, for a CPL or ATPL a valid Class 1 medical certificate. Student pilots shall not fly solo unless they hold a valid Class 1 or Class 2 medical certificate.

Holders of medical certificates shall not exercise the privileges of their licences, related ratings or authorisations when they are aware of any decrease in their medical fitness which might render them unable to safely exercise those privileges. Nor shall they take any medication or drug, or undergo any other treatment, unless they are completely sure that this will not have any adverse effect on their ability to perform safely their duties. Holders of medical certificates shall seek advice when becoming aware of:
(1) hospital or clinic admission for more than 12 hours; or
(2) surgical operation or invasive procedure; or
(3) the regular use of medication; or
(4) the need for regular use of correcting lenses.
Holders of medical certificates who are aware of
(1) any significant personal injury involving incapacity to function; or
(2) any illness involving incapacity to function throughout a period of 21 days or more; or
(3) being pregnant
shall inform the Authority and their certificate will temporarily be deemed suspended.

Discussion of the issue

*Should a medical certificate also be required for crew members of a UAV system and -if yes- which members and which level of medical certification?*

- Depending on the type of UAV system, its crewmembers may remain on the ground, be in an aircraft or on a ship. Hence there may be no need for the crew to be medically fit to sustain the forces and motions on board an aircraft while properly performing their functions.
  Also it may be possible to replace a crewmember in case of incapacitation or that the UAV temporary flies in an automatic mode.

- In manned aviation, a similar situation exists for air traffic controllers, which shall have a class 3 medical certificate, i.e. be medical fit but to a lesser extent than pilots.

Recommendations

- UAV “flight” crew member should have a medical approval, but without the physical aerial requirements if the UAV is operated from a ground-based station.

- UAV operators could have a class 3 medical certificate or equivalent, a level 2 certificate or equivalent if the control station is airborne or at sea.

## 2. Licenses and ratings

References for manned aircraft (examples)

| | |
|---|---|
| JAR-FCL 1.010 | Basic authority to act as a flight crew member |
| JAR-FCL 1.017 | Authorisations/Ratings for special purposes |
| JAR-FCL 1.025 | Validity of licences and ratings |
| JAR-FCL 1.110 | Privileges and conditions |
| JAR-FCL 1.150 | Privileges and conditions |
| JAR-FCL 1.180 | Privileges and conditions |
| JAR-FCL 1.185 | Validity, revalidation and renewal |
| JAR-FCL 1.215 | Class ratings (A) |
| JAR-FCL 1.220 | Type ratings (A) |
| JAR-FCL 1.225 | Circumstances in which type or class ratings are required |
| JAR-FCL 1.230 | Special authorisation of type or class ratings |
| JAR-FCL 1.235 | Type and class ratings – Privileges, number and variants |
| JAR-FCL 1.240 | Type and class ratings – Requirements |
| JAR-FCL 1.245 | Type and class ratings – Validity, revalidation and renewal |
| JAR-FCL 1.275 | Privileges and conditions |
| JAR-FCL 1.300 | Instruction – General |
| JAR-FCL 1.305 | Instructor ratings and authorisation – Purposes |
| JAR-FCL 1.310 | Instructor ratings – General |
| JAR-FCL 1.315 | Instructor ratings and authorisations – Period of validity |
| JAR-FCL 1.325 | FI(A) – Restricted privileges |
| JAR-FCL 1.330 | FI(A) – Privileges and requirements |
| JAR-FCL 1.355 | FI(A) – Revalidation and renewal |
| JAR-FCL 1.360 | Type rating instructor rating (multi-pilot aeroplane) (TRI(MPA)) – Privileges |
| JAR-FCL 1.365 | TRI(MPA) – Requirements |
| JAR-FCL 1.370 | TRI(MPA) – Revalidation and renewal |
| JAR-FCL 1.375 | Class rating instructor rating (single-pilot aeroplane) (CRI(SPA)) – Privileges |
| JAR-FCL 1.380 | CRI(SPA) – Requirements |
| JAR-FCL 1.385 | CRI(SPA) – Revalidation and renewal |
| JAR-FCL 1.390 | Instrument rating instructor rating (aeroplane) (IRI(A)) – Privileges |
| JAR-FCL 1.395 | IRI(A) – Requirements |
| JAR-FCL 1.400 | IRI(A) – Revalidation and renewal |
| JAR-FCL 1.405 | Synthetic flight instructor authorisation (aeroplane) (SFI(A)) – Privileges |
| JAR-FCL 1.415 | SFI(A) – Revalidation and renewal |
| JAR-FCL 1.430 | Examiners – Period of validity |
| JAR-FCL 1.435 | Flight examiner (aeroplane) (FE(A)) – Privileges/Requirements |
| JAR-FCL 1.440 | Type rating examiner (aeroplane) (TRE(A)) – Privileges/ Requirements |
| JAR-FCL 1.445 | Class rating examiner (aeroplane) (CRE(A)) – Privileges/Requirements |
| JAR-FCL 1.450 | Instrument rating examiner (aeroplane) (IRE(A)) – Privileges/ Requirements |

| | | |
|---|---|---|
| JAR-FCL | 1.455 | Synthetic flight examiner (aeroplane) (SFE(A)) – Privileges/ Requirements |
| JAR-FCL | 1.460 | Flight instructor examiner (aeroplane) (FIE(A)) – Privileges/ Requirements |
| Annex 1 | 3. | Licences for Flight Crew Members other than Licences for Pilots |
| Annex 1 | 3.1 | General rules concerning flight navigator and flight engineer licences |
| Annex 1 | 3.2 | Flight navigator licence |
| Annex 1 | 3.3 | Flight engineer licence |
| Annex 1 | 3.4 | Flight radiotelephone operator |
| Annex 1 | 4. | Licences and Ratings for Personnel other than Flight Crew Members |
| Annex 1 | 4.1 | General rules concerning licences and ratings for personnel other than flight crew members |

Summary of referenced requirements for manned aircraft

A person shall not act as a flight crew member unless (s)he holds a valid licence and rating appropriate to the duties being performed and shall not exercise privileges other than those granted by that licence or rating. An applicant for a licence or rating shall meet requirements in respect of age, knowledge, experience and where appropriate, medical fitness and skill, as are specified for that licence or rating.

In addition to pilot licences, ICAO distinguishes

- Licences for flight crew members other than licences for pilots (i.e., flight navigator, flight engineer, flight radiotelephone operator), and
- Licenses and ratings for personnel other than flight crew members (i.e., air traffic controller, flight operations officer/flight dispatcher, aeronautical station operator).

Licenses are issued by the Licensing Authority, i.e., the Authority responsible for the licensing of personnel. The Licensing Authority is deemed to have been given the following responsibilities:

1. assessment of an applicant's qualifications to hold a licence or rating;
2. issue and endorsement of licences and ratings;
3. designation and authorization of approved persons;
4. approval of training courses;
5. approval of the use of synthetic flight trainers and authorization for their use in gaining the experience or in demonstrating the skill required for the issue of a licence or rating; and
6. validation of licences issued by other Contracting States.

The JAR-FCL distinguishes student pilots, private pilots, commercial pilots and airline transport pilots. The following tables summarise their privileges:

| | | Not for remuneratio , non-revenue | | for remuneration, revenue | | | |
|---|---|---|---|---|---|---|---|
| | | | | Not commercial air ansport | | commercial air tra sport | |
| | | Pilot-in- ommand | co-pilot | Pilot-in- ommand | co-pilot | pilot-in- ommand | co-pilot |
| A | Student | Solo, if authorised by flight instructor | No | No | no | no | no |
| B | Private | Yes | Yes | No | no | no | no |
| C | Commercial | Yes | Yes | Yes | yes | single-pilot | yes |
| D | Airline trans ort (includes ins ument) | Yes | Yes | Yes | yes | yes | yes |

| Pilot's authority | required licence |
|---|---|
| 1 Under supervision of a flight instructor | A |
| 2 Pilot in command | |
| 2.1 not for remuneration/non-revenue | B, C, D |
| 2.2 for remuneration/non-revenue, single-pilot crew | C, D |
| 2.3 for remuneration/revenue, multiple-pilot crew | D |
| 3 Co-pilot | |
| 3.1 not for remuneration/non-revenue | B, C, D |
| 3.2 for remuneration/revenue | C, D |

A rating is an authorization entered on a licence and forming part thereof, stating special conditions, privileges or limitations pertaining to such licence (e.g., IMC flying, towing, aerobatics, dropping of parachutists). An Authority may establish ratings for use solely within that Member State's airspace.

The JAR-FCL specifies for which aeroplanes a type rating is required; for the establishment of type ratings for other aeroplanes, the following shall be considered:
(1) airworthiness type certificate;
(2) handling characteristics;
(3) certificated minimum flight crew complements;
(4) level of technology.
Type ratings for aeroplanes shall be established for:
(1) each type of multi-pilot aeroplane
(2) each type of single-pilot multi-engine aeroplane fitted with turbo-prop or turbojet engines
(3) each type of single-pilot single-engine aeroplane fitted with a turbojet engine
(4) any other type of aeroplane if considered necessary.

Class ratings are established for specific single-pilot aeroplanes not requiring a type rating: single-engine piston aeroplanes, touring motor gliders, single-engine turbo-prop aeroplanes, multi-engine piston aeroplanes. In order to change to another type or variant of the aeroplane within one class rating, differences or familiarisation training is required.

Instructors shall hold at least the licence, rating and qualification for which instruction is being given and shall be entitled to act as pilot-in-command of the aircraft during such training. Instructor ratings are: Flight instructor (FI), Type rating instructor (TRI), Class rating instructor (CRI), Instrument rating instructor (IRI), Synthetic flight instructor (SFI).
A person shall not carry out the flight instruction required for the issue of any pilot licence or rating unless that person has a pilot licence containing an instructor rating.

Examiners conduct skill tests and proficiency checks. Examiner ratings are: Type rating examiner (TRE), Class rating examiner (CRE), Instrument rating examiner (IRE), Synthetic flight examiner (SFE), Flight instructor examiner (FIE).
The Authority will designate and authorise as examiners suitably qualified persons of integrity to
conduct on its behalf, skill tests and proficiency checks.

Examiners shall not test applicants to whom flight instruction has been given by them for that licence or rating except with the expressed consent in writing of the Authority.

The validity of a licence is determined by the validity of the ratings, it is issued for a maximum period of 5 years. An IR is valid for one year, instructor ratings and SFI authorisations are valid for a period of 3 years, an examiner's authorisation is valid for not more than three years. Type ratings and multi-engine class ratings are valid for one year from the date of issue, or the date of expiry if revalidated within the validity period. Single-pilot single-engine class ratings have other periods of validity.

The revalidation is conducted by a skill test or proficiency check, which may be in a flight simulator, and distinguishes multi-pilot operations and single-pilot operations. Some ratings require a minimum recent experience for revalidation.

If a type or class rating has expired, the applicant shall meet refresher training and complete a proficiency check or (for a single-pilot single-engine class rating) complete a skill test.

Discussion of the issue

*Should UAV pilots be licensed?*

- For "wide" intercontinental and overseas activities, as well as for exchanging of control for a system, the JAR-FCL system for UAV must be equivalent in a reciprocal way to concerned states and their license system. (In manned aviation there is a conversion procedure of a JAA license if to be used in a FAA registered aircraft or vice verse.)

*For who in a UAV system is a license essential?*

- Operational and technical activities, checking functions.

*Should there be a similar distinction between commercial and non-commercial licenses for UAV pilots?*

- UAVs may be operated for remuneration. Hence it can be considered to require a commercial pilot's license for these. Else an equivalent of a PPL could suffice.
  Question is whether there are examples of non-commercial UAV operations, except for UAVs that fall under the EASA category of model aircraft (i.e., less than 150 kg.).
  If there would be only commercial UAV operations, is it then necessary to designate this as "commercial"? It may be that ICAO requires to make a choice between a commercial and a private license. If so, and this ICAO requirement is followed, are liability issues then covered as well, i.e., can commercial UAV operations be considered as commercial aircraft operations in terms of liability as agreed upon in ICAO?

- Type of airspace to be used may impose whether it shall be a commercial or private licence; e.g., private license for operations within restricted airspace, else a commercial license?

- Safety level chosen may require the level of the licence; e.g., a commercial license for flights over inhabited areas, else a private license?

*Should there be a similar distinction between single-pilot and multi-pilot licenses for UAV pilots?*

- UAVs may be operated by a multi-pilot crew. Multi-pilot operations, and hence the piloting of these UAVs, thus becomes a team effort; how should this be incorporated (CRM training by the operator?)

*Which ratings would be required for UAV pilots?*

- Due to general UAV set-up an Instrument Rating should be required.

- Should there be different levels of UAV license, synchronised with a UAV system classification of any kind? Similar to the definition of type ratings for manned aircraft, it may be that each type of UAV requires a different type rating and that some types of UAVs can be clustered into categories. This may depend on the outcome of the type of UAV as defined in WG II; possible criteria are:
  - the level of autonomy
  - the type of take-off, landing
  - operations within line of sight or beyond.

- The UAV's distinct feature that the crew is not onboard justifies UAVs to be an aircraft type requiring a separate type rating. What distinguishes the UAV type rating from other type ratings?

*Should there be distinct ratings for instructors and examiners?*

- Due to the small UAV community, a strict distinction between instructors and examiners may not be practical.

*Should the validity of licenses and ratings for UAV crew be arranged similarly to that of the crew of manned aircraft?*

- Which should be the requirements and procedures for the validity, revalidation and renewal of UAV licenses and ratings?

- UAV piloting may be a team effort; how should this be incorporated? This could be covered by the operator organisation.

- As a consequence of the above UAV adapted CRM (crew resource management) influence in training and operations

*Should the licensing of UAV pilots be issued by the Authority or be part of the Operator approval?*

- TBD

Recommendations

- A UAV system crewmember and technician crewmember should have a license.

- JAR-FCL should contain requirements for theoretic training and checking and procedures addressed to JAR-OPS for checking, checking functions and how to issue license and ratings.

## 3. Synthetic flight instruction

References for manned aircraft (examples)

| | |
|---|---|
| JAR-FCL 1.405 | Synthetic flight instructor authorisation (aeroplane) (SFI(A)) – Privileges |
| JAR-FCL 1.410 | SFI(A) – Requirements |
| JAR-FCL 1.455 | Synthetic flight examiner (aeroplane) (SFE(A)) – Privileges/ Requirements |

Summary of referenced requirements for manned aircraft

A synthetic flight trainer is an apparatus in which flight conditions are simulated on the ground:

- A flight simulator, which provides an accurate representation of the flight deck of a particular aircraft type to the extent that the aircraft systems control functions, the normal environment of flight crew members, and the performance and flight characteristics of that type of aircraft are realistically simulated;
- A flight procedures trainer, which provides a realistic flight deck environment, and which simulates instrument responses, simple control functions of aircraft systems, and the performance and flight characteristics of aircraft of a particular class;
- A basic instrument flight trainer, which is equipped with appropriate instruments, and which simulates the flight deck environment of an aircraft in flight in instrument flight conditions.

The holder of a Synthetic Flight Instructor (SFI) authorisation may carry out synthetic flight instruction. A Synthetic Flight Examiner (SFE) may conduct proficiency checks in a flight simulator.

JAR–FCL sets requirements for applicants for an SFI authorisation and for an SFE in terms of pilot licences held, training courses and flying experience.

Discussion of the issue

*Should synthetic flight trainers be allowed for the training and testing of UAV crewmembers and -if yes- under which conditions?*

- In manned aviation, simulators are used because they are cheaper and allow to train emergencies that may be unsafe to train in aircraft. A major disadvantage for manned aircraft may be if the simulator can not simulate the aircraft motions.
  The advantages also apply for UAVs; the disadvantage is not applicable because the motion of the operator station will never be that of the UAV.

- If the simulator has the same layout and characteristics of a real UAV control station; a UAV crew may never be able to distinguish between a real flight and a simulated flight.

Recommendations

- Simulators should be used as much as possible, for the initial training of the UAV crew as well as for the revalidation or renewal of their licenses.

- Simulators may be insufficient to train the entire crew, i.e. including personnel for launch and recovery.

- Minimum requirements for these simulators shall be established.

## 4. Age

References for manned aircraft (examples)

| | |
|---|---|
| JAR-FCL 1.060 | Curtailment of privileges of licence holders aged 60 years or more |
| JAR-FCL 1.090 | Minimum age |
| JAR-FCL 1.100 | Minimum age |
| JAR-FCL 1.140 | Minimum age |
| JAR-FCL 1.265 | Minimum age |
| JAR-FCL 1.320 | Flight Instructor rating (aeroplane) (FI(A)) – Minimum age |

Summary of referenced requirements for manned aircraft

The holder of a pilot licence who has attained the age of 60 years shall not act as a pilot of an aircraft engaged in commercial air transport operations except as a member of a multi-pilot crew and provided that (s)he is the only pilot in the flight crew who has attained age 60. The holder of a pilot licence who has attained the age of 65 years shall not act as a pilot of an aircraft engaged in commercial air transport operations. National requirements may set different age limits.

A student pilot shall be at least 16 years of age before the first solo flight. An applicant for a
- PPL shall be at least 17 years of age.
- CPL shall be at least 18 years of age.
- ATPL shall be at least 21 years of age.
- flight instructor rating shall be at least 18 years of age.

Discussion of the issue

*Which age restrictions should be applicable to the UAV crew?*

- At present, model aircraft or flight simulator are piloted by pilots who may be very young.
- Minimum age is a matter of legal responsibility
- Minimum age: may depend on the type of UAV, but based on which criteria?
- The 60$^{th}$ birthday curtailment is still subject of discussions. If UAVs are commercially operated, crewmembers are likely to retire a few years after their 60$^{th}$ birthday, so why bother?

Recommendations

- Minimum age: yes, to be determined on basis of the type of UAV and legal responsibilities.

- Maximum age: no but propose to investigate to make it dependent on medical, (operational) proficiency check and recurrent training.

## 5. Experience

References for manned aircraft (examples)

| | |
|---|---|
| JAR-OPS 1.970 | Recent experience |
| JAR-FCL 1.026 | Recent experience for pilots not operating in accordance with JAR–OPS 1 |
| JAR-FCL 1.120 | Experience and crediting |
| JAR-FCL 1.155 | Experience and crediting |
| JAR-FCL 1.190 | Experience |
| JAR-FCL 1.250 | Type rating, multi-pilot – Conditions |
| JAR-FCL 1.255 | Type rating, single-pilot – Conditions |
| JAR-FCL 1.260 | Class rating – Conditions |
| JAR-FCL 1.280 | Experience and crediting |
| JAR-FCL 1.335 | FI(A) – Pre-requisite requirements |

Summary of referenced requirements for manned aircraft

An operator shall ensure that:

- No pilot operates an aeroplane as commander unless he has carried out at least three take-offs and three landings as pilot flying in an aeroplane of the same type/class or in a Flight Simulator, of the aeroplane type to be used, in the preceding 90 days; and
- Similar requirements exist for pilots and co-pilots and holders of a valid instrument rating for flights carried out by night.

An applicant for a PPL shall have completed at least 45 hours flight time as a pilot of aeroplanes; a total of 5 hours of this 45 hours may have been completed in a FNPT or a flight simulator. Holders of pilot licences or equivalent [privileges for helicopters, microlight helicopters, gyroplanes and microlights having] fixed wings and moveable aerodynamic control surfaces acting in all three dimensions, gliders, self-sustaining gliders or self-launching gliders may be credited with 10% of their total flight time as pilot-in-command in such aircraft up to a maximum of 10 hours towards a PPL.

Applicants for a license or raring shall have completed in aeroplanes during an approved course a specific number of hours of flight time, depending on the training course (s)he has completed. From these hours of flight time, specified numbers may be flow on other categories of aircraft, but for each number there are requirements for the number of hours as pilot-in-command, of hours in multi-pilot operations, of time as pilot-in-command during specified cross-country flights, of instrument instruction time, and of night flight time.

Holders of other licences may be credited with flight time

For some training courses, the applicant shall meet specific experience requirements before being permitted to begin an approved course.

Discussion of the issue

*What experience should be required for UAV licence(s) and ratings?*

- For UAV pilots, hours in specific simulators would be very similar to "flight" hours.
- Manned aircraft pilots or ATC controllers could be retrained to become UAV pilots with a reduced theoretical training program.
- Pilots of manned aircraft may require extra attention and training for the different instrument set-up (artificial horizon behaviour) and the lack of physical sensation.

Recommendations

TBD

## 6. Training

References for manned aircraft (examples)

| | |
|---|---|
| JAR-OPS 1.943 | Initial Operator's Crew Resource Management (CRM) training] |
| JAR-OPS 1.945 | Conversion training and checking |
| JAR-OPS 1.950 | Differences training and Familiarisation training |
| JAR-OPS 1.965 | Recurrent training and checking |
| JAR-OPS 1.968 | Pilot qualification to operate in either pilot's seat |
| JAR-OPS 1.975 | Route and Aerodrome Competence qualification] |
| JAR-OPS 1.978 | Advanced Qualification Programme |
| JAR-OPS 1.985 | Training records |
| JAR-FCL 1.125 | Training course |
| JAR-FCL 1.165 | Flight instruction |
| JAR-FCL 1.205 | Flight instruction |
| JAR-FCL 1.261 | Type and class ratings – Knowledge and flight instruction |
| JAR-FCL 1.290 | Flight instruction |
| JAR-FCL 1.340 | FI(A) – Course |

Summary of referenced requirements for manned aircraft

A flight crewmember must acquire practical skills as pilot of aircraft appropriate to the privilege granted. This training must include but is not limited to the following:

- Pre-flight operations;
- Aerodrome and traffic pattern operations;
- Control of the aircraft by external visual reference;
- Flight at critically slow and high airspeeds;
- Normal and cross-wind takeoffs and landings;
- Aircraft performance;
- Flight by reference solely to instruments;
- Operational procedures, including team skills and resource management;
- Navigation using visual reference and/or radio navigation aids;
- Emergency operations;
- Compliance with air traffic services and communications procedures.

The operator shall ensure that the flight crew member completes the applicable training courses and checking, and specify when training is required. The training is conducted by qualified personnel in accordance with a detailed course syllabus.

Examples of checks are

- proficiency checks for normal, abnormal and emergency procedures; and
- a line check on the aeroplane for normal line operations described in the Operations Manual.

- training and checking for the use of all emergency and safety equipment carried.

An operator shall ensure that: a pilot who may be assigned to operate in either pilot's seat completes
appropriate training and checking.

Prior to being assigned as commander or as pilot to whom the conduct of the flight may be delegated by the commander, a pilot shall have adequate knowledge of the route to be flown and of the aerodromes, facilities and procedures to be used.

The periods of validity of checking and recent experience may be extended, where the Authority has approved an Advanced Qualification Programme that contains training and checking which establishes and maintains adequate proficiency.

An operator shall maintain records of all training, checking and qualification undertaken by a flight crew member.

Discussion of the issue

*Which flight instruction and flight-test schedules should be required for the various members of the UAV crew?*

- Should UAV crew have real "flight training" in a manned aircraft and if yes, which?
- The required level and kind of training is dependent on the function performed.
- Required training level may determine the kind of licence required (PPL, CPL, ATPL).

Recommendations

- There should be requirements for basic and type system training, recurrent training, experience and checking for UAV pilots.

## 7. Theoretical knowledge, skill and examination

References for manned aircraft (examples)

| | |
|---|---|
| JAR-FCL 1.030 | Arrangements for testing |
| JAR-FCL 1.050 | Crediting of flight time and theoretical knowledge |
| JAR-FCL 1.130 | Theoretical knowledge examination |
| JAR-FCL 1.135 | Skill |
| JAR-FCL 1.160 | Theoretical knowledge |
| JAR-FCL 1.170 | Skill |
| JAR-FCL 1.195 | Theoretical knowledge |
| JAR-FCL 1.200 | Use of English language |
| JAR-FCL 1.210 | Skill |
| JAR-FCL 1.261 | Type and class ratings – Knowledge and flight instruction |
| JAR-FCL 1.262 | Type and class ratings – Skill |
| JAR-FCL 1.285 | Theoretical knowledge |
| JAR-FCL 1.295 | Skill |
| JAR-FCL 1.345 | FI(A) – Skill |
| JAR-FCL 1.420 | Examiners – Purposes |
| JAR-FCL 1.425 | Examiners – General |
| JAR-FCL 1.465 | Requirements |
| JAR-FCL 1.470 | Contents of theoretical knowledge examinations |
| JAR-FCL 1.475 | Questions |
| JAR-FCL 1.480 | Examination procedure |
| JAR-FCL 1.485 | Responsibilities of the applicant |
| JAR-FCL 1.490 | Pass standards |
| JAR-FCL 1.495 | Acceptance period |

Summary of referenced requirements for manned aircraft

An applicant for a license or rating shall have received theoretical knowledge instruction on an approved course and shall have demonstrated to the Authority a level of knowledge appropriate to the privileges granted to the holder of that license or rating in the following subjects:

| | ATPL | CPL | IR |
|---|---|---|---|
| Air Law | X | X | X (with Operational Procedures) |
| Aircraft General Knowledge | X | X | X |
| Flight Performance and Planning | X | X | X |
| Human Performance and Limitations | X | X | X |
| Meteorology | X | X | X |
| Navigation | X | X | X |
| Operational Procedures | X | X | - |
| Principles of flight | X | X | - |

| | | | |
|---|---|---|---|
| Communications | X | X | X |

An applicant shall take the entire set of examinations in one JAA Member State.
Questions for an examination will be selected by the Authority from the Central Questions Bank (CQB) according to a common method which allows coverage of the entire syllabi in each subject. Oral examinations will not be conducted in lieu of written or computer based examinations.

A Pass in an examination paper will be awarded to an applicant achieving at least 75% of the marks allocated to that paper. An applicant who has failed to pass the examination within three attempts shall re-enter the examinations as though for an initial attempt.
An applicant shall successfully complete the theoretical knowledge examination for the appropriate pilot licence or rating within a specific period.

An applicant for a license or rating shall have demonstrated the ability to perform the degree of competency appropriate to the privileges granted to the holder of that license or rating. This skill test shall be taken within six months of completing the flight instruction.

A flight crew member must demonstrate the ability to perform as pilot of an aircraft, the procedures and manoeuvres with a degree of competence appropriate to the privileges granted, by:

- Operating the aircraft within its limitations;
- Completing all manoeuvres with smoothness and accuracy;
- Exercising good judgement and airmanship;
- Applying aeronautical knowledge; and
- Maintaining control of the aircraft at all times in a manner such that the successful outcome of a procedure or manoeuvre is never seriously in doubt.

Discussion of the issue

*Should similar theoretical knowledge be required from the UAV crew and -if yes- to which extent?*

- The required theoretical knowledge could be common for all types of UAVs, similar to the knowledge requirements for the PPL, CPL and ATPL for manned aircraft.

- While UAVs are not used for commercial transport of passengers, and while operated only by approved operators (see "operator certification"), the operator approval could cover the complex issues that are required for a CPL or an ATPL and would it suffice if the UAV crew complies with the level of PPL.

- The theoretical knowledge required for manned aircraft could be tailored to address UAV-specific issues:
  - Air law: could be limited to legislation specific to UAV operations and to the use of the airspace.
  - Aircraft General Knowledge: should also include UAV system specific issues, e.g., control station(s), data-link etc.

  - Flight Performance and Planning: as far as applicable to a UAV system.
  - Human Performance and Limitations, Meteorology, Navigation, Operational Procedures, Principles of flight, Communications: as PPL

- The required theoretical knowledge may be dependent on the function performed: pilot, navigator, commander.

- UAV systems may be operated by a crew in which each member has to perform specific tasks. Skill tests shall assess individual crewmembers as well as co-operation within the entire team.
  (Crew composition is addressed in "crew composition").

- What should a member of the UAV crew be able to demonstrate?
  Which are the success / fail criteria?
  How close to existing requirements for skills should UAV activities come?

- How to implement Human factor knowledge and principles, understanding its great importance in manned aircraft operations and all human activities, in training and operations.

Recommendations

- A basic aviation knowledge level is equal to manned aviation and should be given within the JAR-FCL framework.

- There should be requirements for basic and type system training, recurrent training, experience and checking for UAV pilots. Also how to issue a license after checking the results from theoretical and practical training.

## 8. Crew composition

References for manned aircraft (examples)

JAR-OPS 1.940 Composition of Flight Crew

Summary of referenced requirements for manned aircraft

An operator shall ensure that the flight crew is in compliance with the Aeroplane Flight Manual (AFM) and that all flight crew members hold an applicable and valid licence and are suitably qualified and competent to conduct the duties assigned to them.
Procedures shall be established to prevent the crewing together of inexperienced flight crew members.
One pilot amongst the flight crew, qualified as a pilot-in-command, is designated as the commander who may delegate the conduct of the flight to another suitably qualified pilot.

Discussion of the issue

*The flight crew for manned aircraft is well defined; UAV systems may have different crew members for the different flight phases, and crew members may perform other functions than piloting. The tasks that are necessary may be different for different UAV system. Questions to be answered are, e.g.,:*

- *Who comprises the operating crew of a UAV?*
- *Which crew members shall have a medical certificate?*
- *Which crew members shall have a license?*
- *Which other UAV personnel shall have a license and medical certificate?*

- The flight crew shall include any person who has some control over the air vehicle in-flight, directly because he can "push the buttons", or indirectly because he provides information which others use to "push the buttons". This includes the navigator, the external pilot or observer, the operator of the launch system, the operator of the arresting hooks. Because of their responsibilities, all these should have a license and a medical certificate.

- Maintenance personnel does not have control over the air vehicle in flight hence would not need a medical certificate.

- Operators of equipment that is not safety critical (e.g., operators of power generators if power failures are not safety critical).

Recommendations

TBD

## 9. Responsibilities and handover

References for manned aircraft (examples)

| | | |
|---|---|---|
| JAR-OPS | 1.955 | Nomination as commander |
| JAR-OPS | 1.960 | Commanders holding a Commercial Pilot Licence |
| Annex 1 | 1.1 | Definitions |
| Annex 2 | 2.3 | Responsibility for compliance with the rules of the air |
| Annex 2 | 2.4 | Authority of pilot-in-command of an aircraft |
| Annex 6 | 4.5 | Duties of pilot-in-command |

Summary of referenced requirements for manned aircraft

Commander: the pilot-in-command, designated by the operator for a specific flight, who may delegate responsibility to another pilot-in-command.[1]
Pilot-in-command: the pilot designated by the operator, or in the case of general aviation, the owner, as being in command and charged with the safe conduct of a flight.
Co-pilot: a licensed pilot serving in any piloting capacity other than as pilot-in-command but excluding a pilot who is on board the aircraft for the sole purpose of receiving flight instruction.
Flight crew member: a licensed crew member charged with duties essential to the operation of an aircraft during a flight duty period.

An operator shall ensure that for commanders:
(1) A minimum level of experience is specified in the Operations Manual; and
(2) For multi-crew operations, the pilot completes an appropriate command course that is specified in the Operations Manual.

The pilot-in-command is responsible for the operation of the aircraft in accordance with the rules of the air, except that (s)he may depart from these rules if necessary in the interests of safety. Before beginning a flight, the pilot-in-command shall become familiar with all available information appropriate to the intended operation.

The pilot-in-command has final authority as to the disposition of the aircraft while in command and is responsible for

- the safety of all crew members, passengers and cargo on board when the doors are closed.

[1] This would often be the same person as the Pilot-in-command, but where augmented crews were carried, the Commander might not always be physically ‘in command’. The Co-pilot can not be the Commander. Ref.: NPA 1–8; sent out for consultation between 1 December 1995 and 2 March 1996. The term commander is new, not in ICAO Annex VI; the essence is that a commander is a designated person, and always has overall responsibility, which cannot be transferred in flight.

- the operation and safety of the aeroplane from the moment the aeroplane is ready to move for the purpose of taking off until the moment it finally comes to rest at the end of the flight and the engine(s) used as primary propulsion units are shut down.
- ensuring that the check-lists are complied with in detail.
- notifying the nearest appropriate authority by the quickest available means of any accident involving the aeroplane, resulting in serious injury or death of any person or substantial damage to the aeroplane or property
- reporting all known or suspected defects in the aeroplane, to the operator, at the termination of the flight
- the journey log book or the general declaration.

Discussion of the issue

*Can a pilot-in-command control more than one air vehicle from its control station?*

*Can a UAV be operated in an unmonitored autonomous mode?*

*Is there a need to define a "commander"?*

- The pilot-in-command can be the pilot in command of a specific control station, the commander be the pilot in command of all control stations relevant to a specific flight. If 2 air vehicles are controlled from one control station and that each are handed over to a different other control stations, than at least 3 pilots-in-command are needed (i.e., one in each control station). There shall be 2 commanders, one for each air vehicle. Then the first control station (which controls 2 air vehicles) would be commanded by 2 commanders (one for each air vehicle); hence for each control station, there also shall be a "supreme" commander.
  It may not be desirable to combine command functions, especially if air vehicles are handed over from one station to another, while each station has control over multiple UAVs, the scenario may become too complex.

- If there is no upper limit of the number of air vehicles that can be controlled from one control station, then there is no upper limit of the number of air vehicles commanded by one pilot-in-command. This can be one air vehicle, but also 100. If these is an upper limit, how should it be established?

Handing over of responsibility and control (datalink/crew):
The major problems related to handing over of responsibility that should be considered from an operational point of view are the following:

- Security
  - Security of the communication in order to avoid unauthorized uplink to the UAV.
- Responsibility
  - Avoid ambiguities between stations about “who” is effectively controlling the UAV.
  - Notify to the ATC which control station is actually “responsible” of the UAV.
- Data validationn
  - Sharing of approved FPL between different control stations.

  - Sharing of vehicle status information between different control stations (e.g. transponder code, A/P mode, in voice communication frequencies).

- Security to be dealt with WG I. (?)
- Responsibility – Which source deals with assignment of control of UAV (ICAO?).
- Data validation – Which source deals with obligation to verify validation of used data.

Recommendations

TBD

## 10. Multiple type ratings

References for manned aircraft (examples)

JAR-OPS 1.980 Operation on more than one type or variant
JAR-OPS 1.981 Operation of helicopters and aeroplanes

Summary of referenced requirements for manned aircraft

An operator shall ensure that a flight crew member does not operate on more than one type or variant, unless the flight crew member is competent to do so. When considering operations of more than one type or variant, an operator shall ensure that the differences and/or similarities of the aeroplanes concerned justify such operations, taking account the level of technology, operational procedures, and handling characteristics.

An operator shall specify appropriate procedures and/or operational restrictions, approved by the Authority, in the Operations Manual, for any operation on more than one type or variant covering:
(1) The flight level crew members' minimum experience level;
(2) The minimum experience level on one type or variant before beginning training for and operation of another type or variant;
(3) The process whereby flight crew qualified on one type or variant will be trained and qualified on another type or variant; and
(4) All applicable recent experience requirements for each type or variant.

When a flight crew member operates both helicopters and aeroplanes,
- An operator shall ensure that operations of helicopter and aeroplane are limited to one type of each.
- The operator shall specify appropriate procedures and/or operational restrictions in the Operations Manual.

Discussion of the issue

*Should similar limitations apply to UAV crew members?*

Recommendations

TBD

## 11. Collision Avoidance

References for manned aircraft (examples)

| | | |
|---|---|---|
| JAR-OPS | 1.395 | Ground proximity detection |
| JAR-OPS | 1.660 | Altitude alerting system |
| JAR-OPS | 1.398 | Use of Airborne Collision Avoidance System (ACAS) |
| JAR-OPS | 1.665 | Ground proximity warning system |
| JAR-OPS | 1.668 | Airborne Collision Avoidance System |
| Annex 2 | 3.1 | Protection of persons and property. |
| Annex 2 | 3.2 | Avoidance of collisions. |

Summary of referenced requirements for manned aircraft

Aircraft shall not be operated in a negligent or reckless manner so as to endanger life or property of others. Such dangers may be collisions of aircraft (i) with the surface (and people and property thereon) or (ii) with another aircraft. The ICAO Annex 2 and the JAR-OPS provide rules, procedures and requirements for equipment to avoid such collisions.

The rules and procedures are provided by the ICAO Annex 2. Apart from exceptions,

- Aircraft shall not be flown over the congested areas of cities, towns or settlements or over an open-air assembly of persons, unless at a height that permits, in the event of an emergency arising, a landing to be made without undue hazard to persons or property on the surface.
- The cruising levels shall be in terms of:
  a) flight levels, if at or above the lowest usable flight level or the transition altitude;
  b) altitudes, if below the lowest usable flight level or the transition altitude.
- Nothing shall be dropped or sprayed from an aircraft in flight.
- No aircraft or other object shall be towed by an aircraft.
- Parachute descents, other than emergency descents, shall not be made.
- No aircraft shall be flown acrobatically.
- Aircraft shall not be flown in formation.

Aircraft shall not be flown in a prohibited area, or in a restricted area.

ICAO Annex 2 specifies under which conditions unmanned frees balloons may be operated.

ICAO notes that "It is important that vigilance for the purpose of detecting potential collisions be not relaxed on board an aircraft in flight, regardless of the type of flight or the class of airspace in which the aircraft is operating, and while operating on the movement area of an aerodrome."
The ICAO Annex 2 provides a set of rules to avoid collisions between aircraft in terms of "right of way" and evasive manoeuvring:

- An aircraft shall not be operated in such proximity to other aircraft as to create a collision hazard.

- When two aircraft are approaching head-on or approximately so and there is danger of collision, each shall alter its heading to the right.
- When two aircraft are converging at approximately the same level, the aircraft that has the other on its right shall give way, except as follows:
  a) power-driven heavier-than-air aircraft shall give way to airships, gliders and balloons;
  b) airships shall give way to gliders and balloons;
  c) gliders shall give way to balloons;
  d) power-driven aircraft shall give way to aircraft which are seen to be towing other aircraft or objects.
- An overtaking aircraft is an aircraft that approaches another from the rear on a line forming an angle of less than 70 degrees with the plane of symmetry of the latter, i.e. is in such a position with reference to the other aircraft that at night it should be unable to see either of the aircraft's left (port) or right (starboard) navigation lights. An aircraft that is being overtaken has the right-of-way and the overtaking aircraft, whether climbing, descending or in horizontal flight, shall keep out of the way of the other aircraft by altering its heading to the right, and no subsequent change in the relative positions of the two aircraft shall absolve the overtaking aircraft from this obligation until it is entirely past and clear.
- An aircraft in flight, or operating on the ground or water, shall give way to aircraft landing or in the final stages of an approach to land.
- When two or more heavier-than-air aircraft are approaching an aerodrome for the purpose of landing, aircraft at the higher level shall give way to aircraft at the lower level. Power-driven heavier-than-air aircraft shall give way to gliders.
- An aircraft that is aware that another is compelled to land shall give way to that aircraft.
- Aircraft taxiing on the manoeuvring area shall give way to aircraft taking off or about to take off.

There are additional rules for the surface movement of aircraft
The aircraft that has the right-of-way shall maintain its heading and speed, but pilot-in-command of an aircraft shall always take such action as will best avert collision. An aircraft that is obliged by the rules to keep out of the way of another shall avoid passing over, under or in front of the other, unless it passes well clear and takes into account the effect of aircraft wake turbulence.

An aircraft operated on or in the vicinity of an aerodrome shall:
(1) observe other aerodrome traffic for the purpose of avoiding collision;
(2) conform with or avoid the pattern of traffic formed by other aircraft in operation;
(3) make all turns to the left, when approaching for a landing and after taking off, unless otherwise instructed;
(4) land and take off into the wind unless safety, the runway configuration, or air traffic considerations determine that a different direction is preferable.

There are rules for water operations.

In order to enhance an aircraft's visibility, from sunset to sunrise all aircraft in flight shall display anti-collision lights. Navigation lights and other lights shall not be displayed if they may be mistaken for these lights.
Aircraft in flight and fitted with anti-collision lights shall display such lights also outside this period.

Equipment to avoid collisions include

- Altitude alerting system
- Airborne Collision Avoidance System (ACAS)
- Ground Proximity Warning System (GPWS)
- Terrain Awareness and Warning System (TAWS)

An operator may be required to equip his aircraft with an altitude alerting system capable of:
(1) Alerting the flight crew upon approaching a preselected altitude; and
(2) Alerting the flight crew by at least an aural signal, when deviating from a preselected altitude.

An operator may be required to equip his aircraft with an ACAS with a specified minimum performance. Operators of aircraft be equipped with ACAS shall establish procedures to ensure that
(1) ACAS shall be used in flight in a mode that enables Resolution Advisories (RA) to be produced
(2) When undue proximity to another aircraft is detected by ACAS, the commander or the pilot shall ensure that corrective action is initiated immediately to establish safe separation.

An operator may be required to equip his aircraft with a GPWS or a GPWS that includes a TAWS. When undue proximity to the ground is detected by a flight crew member or by a GPWS, the commander or the pilot who conducts the flight shall ensure immediately initiate corrective action to establish safe flight conditions.

Discussion of the issue

- Terrain avoidance can be regarded as:
  (1) The capability of the air-vehicle in avoiding CFIT (i.e. Controlled Flight Into Terrain) in populated areas. This supposes that the air-vehicle itself is considered expendable. Problems to be considered whether a separate terrain avoidance system is needed are:
    - A Threshold Population Density above which an area is considered as "populated".
    - Reliability of position and altitude of Air Vehicle
    - Reliability of terrain information
    - Crew alertness or if autonomous, system reliability
    - The acceptable probability of death or injury

    A distinction should be made between airworthiness considerations and operational procedures: for example, terrain avoidance capability could be assessed if the air-vehicle flies above a minimum altitude relative to the ground. (This is procedural not airworthy).
  (2) The capability of the air-vehicle in avoiding CFIT in unpopulated areas. This is relevant only if the UAV is not expendable. Then again a CFIT probability has to be established, but since this one does not combine with the population density, an attempt to increase the level of "safety" by reducing the CFIT probability (airworthiness) could cause an exponential growth in cost and complexity of the system.

- In 2001(?), an Air France Concorde crashed into a hotel located in a sparsely populated area; would this have been accepted if it had been a UAV? If no, is it useful to distinguish between "populated" and "unpopulated" areas?

- The avoidance of collisions with other aircraft is often referred to as "see and avoid". For UAVs this raises the question how they could comply with the "see" part of "see and avoid".
  Note that ICAO and JAA have no requirement for "see and avoid", but requirements to avoid collisions; "see and avoid" can be regarded as a means to avoid collisions, but there may be other means to achieve this.

- To emphasise the previous bullet, note that Article 8 in ICAO Doc. 7300 states that "No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorisation by that State and in accordance with the terms of such authorisation. Each contracting State undertakes to insure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft."
  Hence no requirement for "see and avoid" but a requirement to obviate danger. This may be more stringent than collision avoidance, e.g., the aircraft shall not be at such close range that dangerous evasive manoeuvring may be needed to avoid a collision.
  What is the meaning of "obviate"? If collision avoidance is not sufficient, should there then be a definition for a minimum distance?
  Vertical separation: equal to the accuracy of the altitude measuring equipment?
  Horizontal separation: a minimum distance depending on a specific time before impact, e.g. based on a speed is limited of 250 kts?
  And what about climbs and descents?

- Regardless the class of airspace in which an aircraft is operating, vigilance for the purpose of detecting potential collisions shall not be relaxed on board an aircraft; this could equally applies to IFR flights in airspace class A as well as VFR flights in airspace class G.

- Collision avoidance encompasses aircraft detection, conflict detection, and conflict resolution. Aircraft detection can be by "see", but ACAS, ADS-B or TIS-B could also provide the required information. Conflict detection and conflict resolution require that both aircraft are aware of each other's intentions.

- Even when pilots of different aircraft detect each other in time, they have to quickly assess the situation and correctly apply the rules for collision avoidance which -unfortunately- may be ambiguous. For example, if aircraft approach each other "head on" slightly on each other’s right side, the rules say that both shall turn right although turning left would be more efficient. A similar situation emerges if the one aircraft overtakes another aircraft and the overtaking aircraft has the other aircraft on its right-hand side. Rules for collision avoidance during vertical movements, except for landing, are entirely missing.

<u>Recommendations</u>

- Establish a threshold population density if needed.
- Establish when aircraft "obviate danger".

## 12. Recorders

References for manned aircraft (examples)

| | | |
|---|---|---|
| JAR-OPS | 1.160 | Preservation, production and use of flight recorder recordings |
| JAR-OPS | 1.700 | Cockpit voice recorders–1 |
| JAR-OPS | 1.705 | Cockpit voice recorders–2 |
| JAR-OPS | 1.710 | Cockpit voice recorders–3 |
| JAR-OPS | 1.715 | Flight data recorders–1 |
| JAR-OPS | 1.720 | Flight data recorders–2 |
| JAR-OPS | 1.725 | Flight data recorders–3 |
| JAR-OPS | 1.727 | Combination Recorder |
| Annex 6 | 6.3 | Flight recorders |
| Annex 6 | Att. D. | Flight recorders |

Summary of referenced requirements for manned aircraft

For specific passenger transport flights, aircraft shall be equipped with a cockpit voice recorder (CVR), a flight data recorder (FDR) or a combination recorder (FDR/CVR).

Following an accident, the operator of an aeroplane on which a flight recorder is carried shall, to the extent possible, preserve the original recorded data pertaining to that accident, as retained by the recorder for a period of 60 days unless otherwise directed by the investigating authority.

The cockpit voice recorder recordings may not be used for purposes other than for the investigation of an accident or incident subject to mandatory reporting except with the consent of all crew members concerned. The flight data recorder recordings may not be used for purposes other than for the investigation of an accident or incident subject to mandatory reporting except when such records are:
(1) Used by the operator for airworthiness or maintenance purposes only; or
(2) De-identified; or
(3) Disclosed under secure procedures.

Discussion of the issue

*Should recorders also be required for UAVs?*

- UAVs do not transport passengers and hence would do not need to carry onboard flight recorders as required by the JAR-OPS. However, in case of an incident there are no witnesses onboard that may provide any lessons learnt that may prevent more severe incidents.

- For UAVs, flight data may be recorded on the control station except when the UAV flies in an autonomous mode.

- Flight data to be recorded for all types of UAVs? May add a significant amount of weight!
- There shall be voice recorders on board manned aircraft because the crew may not survive an accident and explain which decisions they made.
- If flight data or voices should be recorded, preservation times shall be specified.

Recommendations

- Flight data recording: in the Control Station and in the UAV if it may fly autonomous.
- Voice recording: no.

## 13. Alternates

References for manned aircraft (examples)

| | |
|---|---|
| JAR-OPS 1.245 | Maximum distance from an adequate aerodrome for two-engined aeroplanes without an ETOPS Approval |
| JAR-OPS 1.295 | Selection of aerodromes |

Summary of referenced requirements for manned aircraft

An operator shall not operate a two-engined aeroplane over a route which contains a point further from an adequate aerodrome than the distance flown in a specific number of minutes at the one-engine-inoperative cruise speed.
An operator shall determine a speed for the calculation of the maximum distance to an adequate
aerodrome for each two-engined aeroplane type or variant operated, not exceeding V MO , based upon the true airspeed that the aeroplane can maintain with one-engine-inoperative under specific conditions.

An operator must ensure that specific aircraft performance data, specific to each type or variant, is included in the Operations Manual.

An operator shall establish procedures for the selection of destination and/or alternate aerodromes when planning a flight, and select

- a take-off alternate (within a specific range) if it would not be possible to return to the aerodrome of departure for meteorological or performance reasons.
- at least one destination alternate for each IFR flight unless the duration of the planned flight, the destination airport, and weather reports or forecasts meet specific requirements
- two destination alternates when (1) weather reports or forecasts indicate that during a period commencing 1 hour before and ending 1 hour after the estimated time of arrival, the weather conditions will be below the applicable planning minima; or (2) no meteorological information is available.

Discussion of the issue

This item may be "not applicable" because UAVs do not carry passengers on board. However, this subject triggered a discussion about alternative guidelines for gliding to alternate landing or recovery areas and guidelines for use of a Flight Termination System (FTS).

- The outcome of this discussion depends on the outcome of the airworthiness requirements for UAVs, notably the required level of safety.

- For engine failure, single-engine JAR-23 aircraft have a lower level of design safety than JAR-25 aircraft and mitigate this with operational limitation to achieve the same overall

level of safety: they shall not fly below specified minimum heights and shall not over unlandable area unless are able to glide to such an area.

- Similar requirements can apply to single engine UAVs, but only if they can glide in case of engine failure (and do not immediately use the FTS!).

- Note that this does not include engine failures that make the UAV uncontrollable.

Recommendations

- For single engine UAVs, overflight of populated areas shall only be allowed if within gliding range of landable areas and if an engine failure does not immediately activate the FTS.

- Multi-engine UAVs shall be able to reach a landable area after a single engine failure while using their operating engine.

## 14. Low visibility operations

References for manned aircraft (examples)

| | |
|---|---|
| JAR-OPS 1.297 | Planning minima for IFR flights |
| JAR-OPS 1.440 | Low visibility operations – General operating rules |
| JAR-OPS 1.445 | Low visibility operations – Aerodrome considerations |
| JAR-OPS 1.450 | Low visibility operations – Training and Qualifications |
| JAR-OPS 1.455 | Low visibility operations – Operating Procedures |
| JAR-OPS 1.460 | Low visibility operations – Minimum equipment |

Summary of referenced requirements for manned aircraft

An operator shall not select an aerodrome as a take-off alternate aerodrome unless the appropriate
weather reports or forecasts or any combination thereof indicate that, during a period commencing
1 hour before and ending 1 hour after the estimated time of arrival at the aerodrome, the weather
conditions will be at or above the applicable landing minima specified in accordance with JAR–OPS
1.225. The ceiling must be taken into account when the only approaches available are non-precision
and/or circling approaches. Any limitation related to one engine inoperative operations must be taken into account.

An operator shall only select the destination aerodrome and/or destination alternate aerodrome(s) when the appropriate weather reports or forecasts, or any combination thereof, indicate that, during a period commencing 1 hour before and ending 1 hour after the estimated time of arrival at the aerodrome, the weather conditions will be at or above the applicable planning minima.

For Category II or III operations additional requirements are provided for general operating rules, aerodrome considerations, training and qualifications, operating procedures, minimum equipment.

Discussion of the issue

*Should there be similar requirements for low visibility operations for UAVs?*

- Like the distinction between Cat I/II/III approaches for manned aircraft, it may depend on the level of autonomy of the UAV.

- Criteria in terms of ceiling, visibility and approach equipment may be different for different types of UAVs and hence difficult to express in general requirements.

- The meteorological time window of using the meteorological forecast at the estimated time of arrival ± 1 hour should be based on experience; if meteorological forecast criteria should be used for low visibility operations with UAVs, this ± 1 hour time window should be adopted.

Recommendations

TBD

## 15. Circuit protection

References for manned aircraft (examples)

JAR-OPS 1.635 Circuit protection devices

Summary of referenced requirements for manned aircraft

An operator shall not operate an aeroplane in which fuses are used unless there are spare fuses available for use in flight equal to at least 10% of the number of fuses of each rating or three of each rating whichever is the greater.

Discussion of the issue

Because onboard a UAV there is nobody to replace a broken fuse, airworthiness requirements shall address the impossibility to replace onboard fuses.

Recommendations

JAR-OPS 1.635 is only applicable to fuses in the UAV control station, no fuses onboard the UAV which may affect airworthiness.

## 16. Windshield wipers

References for manned aircraft (examples)

JAR-OPS 1.645 Windshield wipers

Summary of referenced requirements for manned aircraft

An operator shall not operate an aeroplane with a maximum certificated take-off mass of more than
5 700 kg unless it is equipped at each pilot station with a windshield wiper or equivalent means to
maintain a clear portion of the windshield during precipitation.

Discussion of the issue

- UAVs may not need a visual reference to fly, and hence there is no need to clean the window for this visual reference.

- If a window is used and protected against rain by the aircraft's contruction, then wipers may not be needed.

Recommendations

Depending on whether the UAV is flow by means of external visual reference and how this is implemented in the design, windshield or camera wipers may be required.

## 17. Equipment

References for manned aircraft (examples)

| | |
|---|---|
| JAR-OPS 1.243 | Operations in areas with specific navigation performance requirements |
| JAR-OPS 1.650 | Day VFR operations – Flight and navigational instruments and associated equipment |
| JAR-OPS 1.652 | IFR or night operations – Flight and navigational instruments and associated equipment |
| JAR-OPS 1.655 | Additional equipment for single pilot operation under IFR |
| JAR-OPS 1.670 | Airborne weather radar equipment |
| JAR-OPS 1.850 | Radio Equipment |
| JAR-OPS 1.865 | Communication and Navigation equipment for operations under IFR, or under VFR over routes not navigated by reference to visual landmarks |
| JAR-OPS 1.866 | Transponder equipment |
| Annex 6 7. | Aeroplane communication and navigation equipment |
| Annex 6 7.1 | Communication equipment |
| Annex 6 7.2 | Navigation equipment |
| Annex 6 7.3 | Installation |

In addition, the JAR–TSO contains the agreed common comprehensive and detailed aviation requirements for articles, e.g., equipment, used on civil aircraft.

Summary of referenced requirements for manned aircraft

ICAO Annex 6 and the JAR–OPS provide requirements for equipment for flight, navigation and communication during day VFR, night VFR and IFR operations.

An operator shall not operate an aeroplane by day in accordance with Visual Flight Rules (VFR) unless it is equipped with the following flight equipment:

- A magnetic compass;
- An accurate timepiece;
- A sensitive pressure altimeter, adjustable for any barometric pressure likely to be set during flight;
- An airspeed indicator;
- A vertical speed indicator;
- A turn and slip indicator, or a turn co-ordinator incorporating a slip indicator;
- An attitude indicator;
- A stabilised direction indicator;
- A means of indicating the outside air temperature; and
- A means for indicating when power is not adequately supplied to the required flight instruments.

Additional instruments are required whenever two pilots are required.

Some instruments may be replaced for others if the flight does not exceed 60 minutes duration, takes off and lands at the same aerodrome, and remains within 50 nm of that aerodrome.
For some aircraft types, each airspeed indicating system must be equipped with a heated pitot tube or equivalent means for preventing malfunction due to condensation or icing.

An operator shall not operate an aeroplane in accordance with IFR or by night unless it also has the following flight equipment:

- One additional sensitive pressure altimeter;
- A heated pitot tube or equivalent means;
- A second independent static pressure system, or (for some types) alternate source of static pressure;
- For some aircraft types: an additional standby attitude indicator that:
  (1) Is powered continuously and, after a total failure of the normal electrical generating system is powered from a source independent of the normal electrical generating system;
  (2) Provides reliable operation for a minimum of 30 minutes after total failure of the normal electrical generating system;
  (3) Operates independently of any other attitude indicating system;
  (4) Is operative automatically after total failure of the normal electrical generating system; this must be clearly evident to the flight crew; and
  (5) Is appropriately illuminated during all phases of operation.

An operator shall not conduct single pilot IFR operations unless the aeroplane is equipped with an
autopilot with at least altitude hold and heading mode.

An operator shall not operate specific types of aeroplanes unless equipped with airborne weather radar equipment whenever it is being operated at night or in instrument meteorological conditions in areas where thunderstorms or other potentially hazardous weather conditions, detectable with airborne weather radar, may be expected to exist along the route.

An operator shall not operate an aeroplane unless it is equipped with a pressure altitude reporting SSR transponder, and any other SSR transponder capability required for the route being flown.

An operator shall not operate an aeroplane under IFR, or under VFR over routes that cannot be
navigated by reference to visual landmarks, unless the aeroplane is equipped with radio communication and navigation equipment in accordance with the requirements of air traffic services in the area(s) of operation.
The radio equipment shall comprise not less than two independent radio communication systems. The navigation equipment shall comprise not less than one VOR receiving system, one ADF system and one DME and, if required, one ILS or MLS, one Marker Beacon receiving system, an Area Navigation System. There shall be an additional DME (or VOR or ADF) system if navigation is based only on DME (or VOR or ADF) signals.
The navigation equipment shall comply with the Required Navigation Performance (RNP) Type for operation in the airspace concerned. VHF communication equipment, ILS Localiser

and VOR receivers to be operated in IFR shall comply with the FM immunity performance standards
For flights in defined portions of airspace where minimum navigation performance specifications (MNPS) are prescribed or where a vertical separation minimum (VSM) of 1000 ft is applied, aeroplanes shall be appropriately equipped and authorized.

Navigation for flights under the VFR is by visual reference to landmarks.

The equipment installation shall be such that the failure of any single unit required for either communications or navigation purposes or both will not result in the failure of another unit required for communications or navigation purposes.

Discussion of the issue

*Which equipment is needed when, e.g., flying a UAV over the sea, looking for oil spills?*

- See the SSR requirement JAR-OPS 1.866: such a requirement may not be reasonable for an, e.g., 21 kg UAV?

- Specific equipment (and procedures) may be required for take-off, landing and emergency.

- Flight termination system: see "Termination and tracking".

- Equipment requirements shall be established depending on: VFR day, VFR night, IFR, and the airspace class (present, A - G, or future, Free Flight / Managed / Unmanaged).

- In general, requirements for equipment to be onboard manned aircraft is applicable to UAVs:
  - JAR-OPS requirements for navigation equipment and for navigation performance
  - JAR-TSO technical requirements for communication equipment

- For ATC the UAV should be transparent, i.e., it should communicate with the UAV as if the crew were onboard. Hence
  - There should be a communication-relay onboard the UAV, capable to handover the communication between distinct ATC centres and distinct UAV control stations (regardless whether these are in a control station in the air, on the ground, or at sea).
  - The accuracy and reliability of the UAV equipment shall meet the required standards for manned aircraft.
  - UAV pilots shall hold a license in compliance with the applicable ICAO regulations, notably “Rules of the Air” and "Air Traffic Services", including an R/T rating.

- There should be a TSO for communication relay.

Recommendations

TBD

## 18. First aid equipment

References for manned aircraft (examples)

JAR-OPS 1.745 First-Aid Kits
JAR-OPS 1.755 Emergency Medical Kit

Summary of referenced requirements for manned aircraft

An operator shall not operate an aeroplane unless it is equipped with first-aid kits, readily accessible for use, depending on the number of passengers.

An operator shall not operate an aeroplane with a maximum approved passenger seating configuration of more than 30 seats unless it is equipped with an emergency medical kit if any point on the planned route is more than 60 minutes flying time (at normal cruising speed) from an aerodrome at which qualified medical assistance could be expected to be available.

Discussion of the issue

- Not applicable for UAVs, may be in the CS.
- Probably covered by national occupational health and safety acts.

Recommendations

Not applicable on board UAVs. In the CS this should be covered by national occupational health and safety acts.

## 19. Performance

References for manned aircraft (examples)

| | |
|---|---|
| JAR-OPS 1.470 | Applicability |
| JAR-OPS 1.475 | General |
| JAR-OPS 1.480 | Terminology |
| JAR-OPS 1.485 | General |
| JAR-OPS 1.490 | Take-off |
| JAR-OPS 1.495 | Take-off obstacle clearance |
| JAR-OPS 1.500 | En-route – One Engine Inoperative |
| JAR-OPS 1.505 | En-route – Aeroplanes With Three Or More Engines, Two Engines Inoperative |
| JAR-OPS 1.510 | Landing – Destination And Alternate Aerodromes |
| JAR-OPS 1.515 | Landing – Dry Runways |
| JAR-OPS 1.520 | Landing – Wet and contaminated runways |
| JAR-OPS 1.525 | General |
| JAR-OPS 1.530 | Take-off |
| JAR-OPS 1.535 | Take-off Obstacle Clearance – Multi-Engined Aeroplanes |
| JAR-OPS 1.540 | En-Route – Multi-engined aeroplanes |
| JAR-OPS 1.542 | En-Route – Single-engine aeroplanes |
| JAR-OPS 1.545 | Landing – Destination and Alternate Aerodromes |
| JAR-OPS 1.550 | Landing – Dry runway |
| JAR-OPS 1.555 | Landing – Wet and Contaminated Runways |
| JAR-OPS 1.560 | General |
| JAR-OPS 1.565 | Take-off |
| JAR-OPS 1.570 | Take-off Obstacle Clearance |
| JAR-OPS 1.575 | En-Route – All Engines Operating |
| JAR-OPS 1.580 | En-Route – One Engine Inoperative |
| JAR-OPS 1.585 | En-Route – Aeroplanes With Three Or More Engines, Two Engines Inoperative |
| JAR-OPS 1.590 | Landing – Destination and Alternate Aerodromes |
| JAR-OPS 1.595 | Landing – Dry Runways |
| JAR-OPS 1.600 | Landing – Wet and Contaminated Runways |

Summary of referenced requirements for manned aircraft

The JAR-OPS defines three performance classes in accordance to which an operator's aircraft shall be operated, depending on the number of passengers, the maximum take-off mass, and the engine configuration. For each class the JAR-OPS provides planning guidelines for

- Take-off and Take-off Obstacle Clearance
- En-Route (Multi-engined aeroplanes, Single-engine aeroplanes, All Engines Operating, One Engine Inoperative, Aeroplanes With Three Or More Engines, Two Engines Inoperative)
- Landing (Destination And Alternate Aerodromes, Dry Runways, Wet and contaminated runways)

An operator shall not operate a single-engine aeroplane at night; or in IMC except under Special VFR. If single-engine aeroplanes are used, there shall be surfaces available which permit a safe forced
landing to be executed. An operator shall treat two-engine aeroplanes which do not meet the climb requirements of the JAR–OPS as single-engine aeroplanes.

Discussion of the issue

- A similar set of operating criteria may have to be developed for distinctive types of UAVs (which have to be defined as well).

- UAVs may have unconventional ways for take-off and landing that should be included in the performance requirements: launch-assisted take-off, rocket-assisted take-off, arresting gear cables, or an arresting net.

- If not covered by airworthiness, operational procedures shall ensure that adequate clearance from the environment is provided if the equipment does not function as designed:
  - Aborted launches if the launcher or rocket does not perform as designed.
  - Landings if the arresting gear does not perform as designed.

Recommendations

TBD

## 20. Signals

References for manned aircraft (examples)

Annex 2 3.4 Signals
Annex 2 App 1. Signals.

Summary of referenced requirements for manned aircraft

Distress signals indicate that grave and imminent danger threatens, and immediate assistance is requested: by radiotelegraphy (Morse Code or spoken word), data link, rockets or shells, or by a parachute flare showing a red light.

Urgency signals indicate that an aircraft has difficulties which compel it to land without requiring immediate assistance:
a) the repeated switching on and off of the landing lights; or
b) the repeated switching on and off of the navigation lights, distinct from flashing navigation lights.

Urgency signals may also indicate that an aircraft has a very urgent message to transmit concerning the safety of a ship, aircraft or other vehicle, or of some person on board or within sight.

Signals for use in the event of interception may be
- initiated by intercepting aircraft followed by responses by intercepted aircraft
- initiated by intercepted aircraft followed by responses by intercepting aircraft

Signals and manoeuvres may depend on whether it is day or night

Projectiles discharged from the ground at intervals of 10 seconds, each showing red and green lights or stars indicate to an unauthorized aircraft that it is flying in or about to enter a restricted, prohibited or danger area, and that the aircraft is to take such remedial action as may be necessary.

Signals for aerodrome traffic consist of light and pyrotechnic signals: green / red / white steady lights or flashes for take-off, landing or taxi clearance, or instructions to, e.g., give way to other aircraft.

Marshalling signals are from a signalman to an aircraft or from the pilot of an aircraft.

Discussion of the issue

- For UAVs it may be difficult to detect visual signals.

- Visual signals may be something of the past, it is unlikely that they would still be used to communicate with airliners at large international airports.

- If the UAV crew has an observer on the airfield, he or she would be able to see the visual signals and communicate these to the UAV pilot if (s)he is unable to, or the observer could intervene in the UAV's flight path by himself.

Recommendations

TBD

## 21. Unlawful interference

References for manned aircraft (examples)

Annex 2 3.7 Unlawful interference
Annex 2 Att. B. Unlawful interference

Summary of referenced requirements for manned aircraft

An aircraft which is being subjected to unlawful interference shall endeavour to notify the appropriate ATS unit of this fact, any significant circumstances associated therewith and any deviation from the current flight plan, in order to enable the ATS unit to give priority to the aircraft and to minimize conflict with other aircraft.
When the aircraft is unable to notify an ATS unit, the pilot-in-command should attempt to continue flying on the assigned track and at the assigned cruising level at least until able to notify an ATS unit.

When an aircraft subjected to an act of unlawful interference must depart from its assigned track or its assigned cruising level without being able to make radiotelephony contact with ATS, the pilot-in-command should, whenever possible:
a) attempt to broadcast warnings on the VHF emergency frequency and other frequencies, unless considerations aboard the aircraft dictate otherwise. Other equipment (transponders, data links) should also be used when advantageous to do so and circumstances permit; and
b) proceed in accordance with applicable special procedures (where established); or
c) if no applicable regional procedures have been established, proceed at a level which differs from the cruising levels normally used for IFR flight in the area by 1000 ft if above FL 290, else 500 ft.

ICAO Annex 11 addresses
- Responsibility of ATS units in situations of unlawful interference.
- Guidance when unlawful interference occurs and the aircraft is unable to notify an ATS unit.
- Action by SSR-equipped aircraft which are being subjected to unlawful interference.
- Action by CPDLC-equipped aircraft which are being subjected to unlawful interference.

Discussion of the issue

- It may be more difficult to protect a control station against unlawful interference than the cockpit of an aircraft. One-time screening the passengers before boarding the aircraft may be sufficient to prevent that weapons enter the cockpit, for a ground-based such screening would have to be continuous.

- The intruder of a ground based control stations runs less risks to be personally injured by his action then if he would intrude the cockpit of a flying aircraft.

- Control of aircraft from the ground and protection of this external control against unlawful interference is also being discussed for manned aircraft after the events of 9 September 2001.

Recommendations

TBD

## 22. Interception

References for manned aircraft (examples)

Annex 2 3.8 Interception
Annex 2 App 2. Interception of civil aircraft
Annex 2 Att. A. Interception of civil aircraft.

Summary of referenced requirements for manned aircraft

An aircraft which is intercepted by another aircraft shall immediately:

- follow the instructions given by the intercepting aircraft, interpreting and responding to visual signals in accordance with the specifications in Appendix 1;
- if equipped with SSR transponder, select Mode A, Code 7700, unless otherwise instructed by the appropriate air traffic services unit.

If any instructions received by radio from any sources conflict with those given by the intercepting aircraft by visual signals, the intercepted aircraft shall request immediate clarification while continuing to comply with the visual instructions given by the intercepting aircraft.

Discussion of the issue

- It may be difficult for a UAV to detect that he is intercepted and to observe the visual signals from the intercepting aircraft. The worst case is that the intercepting aircraft would shut down the UAV, hopefully over uninhabited area. This could be regarded as an acceptable risk.

Recommendations

TBD

## 23. Operator Certification

References for manned aircraft (examples)

JAR-OPS 1.175 General rules for Air Operator Certification

Summary of referenced requirements for manned aircraft

An operator shall not operate an aeroplane for the purpose of commercial air transportation otherwise than under, and in accordance with, the terms and conditions of an Air Operator Certificate (AOC). An applicant for an AOC shall allow the Authority to examine all safety aspects of the proposed operation.
An operator shall grant the Authority access to his organisation and aeroplanes and shall ensure that access is granted to any associated JAR–145 maintenance organisation.
The operator must have nominated post holders, acceptable to the Authority, who are responsible for the management and supervision of (1) flight operations, (2) the maintenance system; (3) crew training, and (4) ground operations.

The operator must

- ensure that its aeroplanes are equipped and its crews are qualified, as required for the area and type of operation.
- comply with the maintenance requirements for all aeroplanes operated under the terms of its AOC
- provide the Authority with a copy of the Operations Manual.
- maintain operational support facilities at the main operating base, appropriate for the area and type of operation.

Discussion of the issue

- UAV operators are not involved in commercial passenger transport operations but in activities that resemble "aerial work". There is no JAR-OPS (yet) for aerial work. Maybe the requirements issued by the Civil Aviation Safety Authority of Australia could be used as guidance.

Recommendations

TBD

## 24. Flight rules

References for manned aircraft (examples)

| | | |
|---|---|---|
| Annex 2 | 2. | Applicability of the rules of the air |
| Annex 2 | 2.2 | Compliance with the rules of the air |
| Annex 2 | 3. | General rules |
| Annex 2 | 3.9 | VMC visibility and distance from cloud minima. |
| Annex 2 | 4. | Visual flight rules |
| Annex 2 | 5. | Instrument flight rules. |
| Annex 2 | 5.1 | Rules applicable to all IFR flights |
| Annex 2 | 5.2 | Rules applicable to IFR flights within controlled airspace |
| Annex 2 | 5.3 | Rules applicable to IFR flights outside controlled airspace |

Summary of referenced requirements for manned aircraft

The operation of an aircraft in flight or on an aerodrome shall be in compliance with the general rules and, when in flight, also with the visual flight rules (VFR), or the instrument flight rules (IFR).

General rules address
(1) Protection of persons and property (Negligent or reckless operation of aircraft, Minimum heights, Cruising levels, Dropping or spraying, Towing, Parachute descents, Acrobatic flight, Formation flights, Unmanned free balloons, Prohibited areas and restricted areas)
(2) Avoidance of collisions (see "Collision Avoidance")
(3) Flight plans
(4) Signals (see "Signals")
(5) Time
(6) Air traffic control service (Air traffic control clearances, Adherence to flight plan, Position reports, Termination of control, Communications)
(7) Unlawful interference (see "Unlawful interference")
(8) Interception (see "Interception")
(9) VMC visibility and distance from cloud minima, depending on airspace class and the aircraft's altitude or height.

Flights under VFR shall be conducted so that the aircraft is flown in specified conditions of visibility and distance from clouds. VFR flights shall not be operated above FL 200 or at transonic and supersonic speeds. Except for take-off or landing, a VFR flight shall not be over the congested areas of cities, towns or settlements or assembly of persons below 1000 ft above the highest obstacle within 600 m from the aircraft; elsewhere the aircraft shall be at least 500 ft above the ground or water.
VFR flights in level cruising flight above 3000 ft AGL shall be conducted at a flight level appropriate to the track.

For flights under IFR, aircraft shall be equipped with instruments and navigation equipment appropriate to the route to be flown.
Except for take-off or landing, an IFR flight shall be flown above the minimum flight altitude, or, where no such minimum flight altitude has been established, over high terrain or in mountainous areas, at least 2000 ft above the highest obstacle located within 8 km of the estimated position of the aircraft; elsewhere at least 1000 ft.
An IFR flight outside controlled airspace but within designated areas or routes shall maintain an air-ground voice communication watch and establish two-way communication, as necessary, with the air traffic services unit providing flight information service.
An IFR flight operating outside controlled airspace and required to submit a flight plan and maintain an air-ground voice communication watch, shall report submit position reports.

Discussion of the issue

*To which "flight rules" would it be impossible for UAVs to comply with?*

- For UAVs it may be difficult to comply with the general rules for avoidance of collisions, signals, unlawful interference, interception; these are addressed elsewhere in this appendix.
  It may also be difficult to assess whether the visibility and distances from clouds are VMC and VFR is allowed.

- VFR and IFR only address the means for navigation; VFR is prohibited in airspace class A, all other combinations of flight rules and airspace class are allowed. If an aircraft is unable to fly VFR, it can always fly IFR, if an aircraft is unable to fly IFR, it can always fly VFR except in airspace class A.
  If UAVs are equipped with the instruments and navigation equipment appropriate to the route to be flown, then they comply with IFR.

Recommendations

TBD

## 25. Termination and tracking

References for manned aircraft (examples)

Annex 2 App 4. Unmanned free balloons

Summary of referenced requirements for manned aircraft

An unmanned free balloon shall be operated in such a manner as to minimize hazards to persons, property or other aircraft and in accordance with the conditions specified in Appendix 4 of ICAO Annex 2.

An unmanned free balloon shall
- not be operated without appropriate authorization and shall not be operated across the territory without appropriate authorization.
- not be operated such that impact of the balloon, or any part thereof, including its payload, with the surface of the earth, creates a hazard to persons or property not associated with the operation.

Operating limitations and equipment requirements address cloud coverage, horizontal visibility, minimum height over congested areas of cities, towns or settlements or an open-air assembly of persons, forwarding of position reports, operation between sunset and sunrise, and requirements for trailing antennas.

Some types of balloons are required to be equipped with
- at least two independent payload flight-termination devices or systems
- radar reflective device(s) or radar reflective material and/or with devices that permit continuous tracking by the operator beyond the range of ground-based radar.

The operator shall activate the termination devices:
(1) when it becomes known that weather conditions are less than those prescribed for the operation;
(2) if a malfunction or any other reason makes further operation hazardous to air traffic or to persons or property on the surface; or
(3) prior to unauthorized entry into the airspace over another State's territory.

Discussion of the issue

*Could the requirements for unmanned free balloons be expanded for any type of UAV?*

- Balloons are visually detectable by other aircraft because of their size; other types of UAVs may be much smaller and hence less easy to detect.

- Balloons drift with the wind, hence the maximum ground speed is limited by the maximum allowed wind. Other types of UAVs may reach higher ground speeds.

- Balloons don't have a propulsion mechanism that can physically hurt people; rotary wing and fixed wing UAVs, as well as airship UAVs have propellers and rotors that can cause injury, even at low flying speeds.

*Which shall be the requirements for termination devices?*

- If activated under any emergency, it may be activated over an populated area where gliding to an unpopulated area might be a better option.

- If a termination device should be mitigating for a less reliable system, the requirements shall limit the weight, speed and kinetic energy at ground contact and prohibit any design features that may cause severe injuries or death.

Recommendations

TBD