austro CONTROL

Failure Mode and Effect Analysis (FMEA)
for Class I Unmanned Aircraft
(courtesy translation)

The safe operation of unmanned aircraft requires high reliability of the complete system. The building codes (CS-LURS, CS-LUAS, appendix B of AON 67) only lay down basic structural, design and flight quality requirements that have to be fulfilled by the aircraft. In order to ensure an adequate overall reliability, every component itself and in interaction with other components has to be investigated systematically. In the course of this investigation it must be shown that a single failure of one component does not lead to a failure of the complete system (single failure tolerant system).

The unmanned aircraft must be designed in a way that either essential systems are duplicated and in the case of a failure the redundant system automatically/manually takes over or that an emergency mode respectively the pilot with a manual control is able to control the aircraft. In any case the pilot in command has to be informed in order to abort the manoeuvre.
Depending on the category of the unmanned aircraft (resulting from the maximum operating mass and the area of operation), support documents and assessments are required in order to attest the operational safety.

In the following table all primary common failure causes (single point failure) are listed. A single breakdown of one of the listed items must not lead to a total breakdown of the system. Compliance with this requirement must be shown. Depending on the type design of the unmanned aircraft further single point failures might exist. These have to be evaluated on a case-by-case basis.
The reaction of the complete system to a single failure has to be tested by physical examination. A theoretical contemplation or analysis is not sufficient in this regard.

The technical realisation has to be highlighted in the list below, or in a separate list. The positive result of the examination has to be confirmed by signature at the end of this sheet.

NR.	FAILURE MODE	EFFECT	TECHNICAL REALISATION
1	**Failure of the transmitter** e.g.: power supply transmitter, antenna intermitted, failure in electrical system	Connection between transmitter and receiver is jammed, pilot is not able to interfere with the flight path	
2	**Failure of the receiver** e.g.: problem with electrical system, antenna intermitted	Receiver can not process the control signals	
3	**Interrupted datalink** e.g.: radio interference, out of range, Electromagnetic Interference- EMI	Flawless control of the UA no longer possible any more	
4	**Engine failure** e.g.: malfunction of an engine, loss of propeller, loss of rotor	Uncontrolled loss of altitude and airspeed, limited manoeuvrability	
5	**Shortcut** e.g.: in the camera gimbal, sensors, operation in rain/ humidity	Derogation in the power supply of essential flight control systems	
6	**Failure of the board power system** e.g.: Faulty cables of the power system, Failure of battery	Receiver/ Servos are no longer provided with electrical power	

7	**Malfunction/Failure of the flight controller** e.g.: malfunction of the electrical flight controller	Automatic flight control system limited or not available	
8	**Malfunction/Failure of GNSS** e.g.: malfunction of satellite receiver (GNSS-Global Navigation Satellite System)	Loss of automatic angular positioning	
9	**Malfunction/Failure of the telemetry system** e.g.: Malfunction of sensors, failure in the data transmission	Loss of telemetry data that are essential for the safe operation (voltage of bus system)	
10	**Thermal overload of the battery** e.g.: internal failure of LiPo accumulators, overload through high current/ unbalance	Decrease of battery capacity, thermal overload of surroundings in the aircraft	

The applicant confirms that the conducted FMEA and the tests that were performed to investigate the operational safety of the unmanned aircraft do not show any single point failures of one component that would result in a total loss of the complete system. Any system failure is indicated to the pilot.

uLFZ/Type/Nr.   Date/Signature