All the possible security threats & risks either related to drone hardware or its control system are carefully listed along with the possible worst-case scenarios for each. All these risks are addressed during the design, selection of components, selection of software and modification of code. Moreover, all the possible security protocols shall be ensured in test flights to minimize any casualties.

Out of all these threats & risks, major ones are listed in CDR along with their severity and how we minimized them or aim to during test flights and final fly-off.

# Safety Steps in Aerodynamic Design:

# Safety Steps in Control & Computing System Design:

Since the drone is most vulnerable to any bugs or glitches in software, safer software is higher priority than performance optimized software for our Control & Computing System team. In this regard, the modifications in control loop will be used in test flight after being checked by faculty advisor and will be used in fly-off after multiple test flights without any glitch or unwanted output.

# Safety Steps in Propulsion Design:

Safer propulsion system implies safer flight. Motors & Propellers used in the drone are the highest quality ones available in market to ensure the safest propulsion system possible.

# Safety Steps in Spray System Design:

The spray tank is designed to minimized leakages in case of a crash. High quality pump is used to minimize failure probability. Pipes of good quality are used to ensure that there is no leakage of flowing pesticides.

|  |  |  |  |
| --- | --- | --- | --- |
| Probability | Severity | Risk | Mitigation |
| Improbable | Marginal | Pixhawk Processor Failure | Failsafe 32-bit co-processor |
| Remote | Minor | Control loop glitch | Frequent test-flights with deep analysis of flight data log |
| Improbable | Major | Losing connection between flight controller & flight computer | RTL or safe landing depending on GPS connection, distance from launch and remaining battery |
| Remote | Marginal | Motor Failure | Use state-of-the-art BLDC motors |
| Occasional | Major | Propeller Failure | Use Carbon Fiber Propellers |
| Remote | Major | Battery Failure | Small Failsafe battery for RTL or immediate Landing |
| Improbable | Major | Pesticides Tank Leakage | Carbon fiber as manufacture material, waterproof sheet on electrical components |
| Improbable | Minor | Pesticide not available to pump inflow | Sump in tank to ensure steady supply to pump |
| Probable | Minor | Nozzle Blockage | Filter in pump inlet |
| Improbable | Minor | Leakage from pipes | Good quality connectors & Thermal resistant pipes |
| Remote | Minor | Aircraft Stalling | Proper airfoil/angle of attack selection.  ·        Reasonable deflection of control surfaces when operated.  ·        Maintaining cruise speed greater than stalling velocity by employing rotors. |
| Remote | Marginal | Crash Landing | ·        Manual override system in place in case of emergency landing.  ·        Proper landing gear installed to bear impact.  ·        Structural reinforcement of aircraft/proper material selection. |
| Occasional | Minor | Unstable flight due to uneven weight distribution | ·        Proper component sizing.  ·        Properly assembled airframe.  ·        Adequate mechanical supports/mounts with moving components such as rotors.  ·        Drag reduction via optimization of aircraft geometry. |
| Occasional | Minor | Damage to Surfacing Material | ·        Selection of appropriate material meeting tensile strength requirement.  ·        Provision of clearance from ground in case of impact via landing gear.  ·        Selection of easily replaceable materials in case of minor damage. |
| Remote | Minor | Damage to airframe in case of impact/collapse of airframe due to load on mount plate | ·        Selection of appropriate material for airframe possessing suitable mechanical properties.  ·        Structural reinforcement of airframe.  ·        Reasonable load distribution on individual airframe members.  ·        Appropriate material selection for mount plate and reinforcement of the same.  ·        Proper mounting of components on plate and uniform load distribution across mounting plate.  ·        Structural reinforcement of mounting plate with airframe sections. |
| Occasional | Major | Propeller damage during transition phase | ·        Adequately secure fixture of propeller on shaft.  ·        Selection of appropriate time for transition to avoid unnecessary drag/abrupt flow separation across the propeller blade. |
| Occasional | Marginal | Li-Po Battery may catch fire | Charge on cement surface, Store in nonflammable container, do not charge unattended to avoid overcharging |
| Occasional | Minor | Li-Po Battery may swell | Immediately stop charging, store in fireproof container, wait for it go back to normal size, may have to replace battery |
| Remote | Major | Battery Short Circuit | Vigilant wiring and connections of battery for fly-off and charging |

To ensure the safety of the electrical motors, it is important to take the following precautions:

* Constant troubleshooting to establish whether the features in the motors are working properly.
* Conduct a proper inspection of the motor winding.
* Perform a power supply test to determine whether there is any problem by the motor.
* Do not leave a short-circuited battery for long because it would eventually explode.
* Do not power the motors beyond its voltage capacity.
* Always remember to wear goggles to ensure safety of your eyes.
* Never leave a motor to operate unattended.