13 - Multi-role VTOL Aerial Firefighting Aircraft

The need for effective aerial firefighting (AFF) is growing as the size, frequency and intensity of wild fires globally are increasing substantially. Currently, aerial firefighting is performed by two types of aircraft, namely: scoopers and tankers. However, both types of existing AFF aircraft have their limitations. Taking the most commonly used purpose built scooper, developed in 1993, the Canadair CL-415; Despite its amphibious nature, it is less versatile than repurposed helicopters such as the Firehawk. However, the Firehawk is limited by its speed, range and onboard capacity. Other repurposed aircraft such as the cruise 8 Q400 and the Boeing 747 can carry large loads of retardant and/or water but must return to base in order to refill its tank. This base may lie as far as 30 minutes away from an active fire. With response time playing a significant role in the effectiveness of a mission, speed and on site refilling is crucial to ensure mission success. Therefore, the Firefly, a tandem wing Vertical Take-off & Landing (VTOL) aircraft capable of carrying 10000 L was designed to bridge the existing performance gap between current AFF aircraft.

Mission Objective

The Firefly was designed to achieve higher speeds, a higher tank capacity and a longer range than current AFF helicopters whilst being more versatile than fixed-wing AFF aircraft. The main requirements for this design were that the aircraft shall be capable of reaching cruise speeds of at least 400 km/hr with a tank capacity of 10000 L and shall be equipped with a snorkel device capable of swiftly refilling the tank in the most inaccessible terrains. Additionally, the aircraft shall be able to be used for multi-role purposes such as search & rescue. From these requirements, the Firefly was born. Moreover, our mission is to deploy the Firefly to various locations worldwide to more efficiently and effectively fight wildfires.

System Design

The design of the Firefly came with many challenging engineering feats. The propulsion system had to be sized for VTOL and horizontal flight capabilities. Factors such as rotor sizing, required speed capabilities and internal component power loss influenced the power that could be achieved. In conclusion, four Rolls Royce AE1107F engines were chosen. Furthermore, to size the tandem wing configuration, one must take into account the effect of the wings in VTOL in addition to the dropping and cruise speeds required in horizontal mode. After a careful analysis, both wings were sized to be 38.6 m^2 with a wing span of 15.1 m. Moreover, the aircraft goes through a series of high cyclic loading due to the dropping and refilling of its tank during a mission. Therefore, the wing box and fuselage skin thicknesses were sized to withstand 20000 drops within its 10 year lifetime without maintenance. Furthermore, the aircraft was designed in accordance with our sustainability policy. As wild fires produce over 100 times the yearly CO_2 emissions compared to a firefighting fleet, the Firefly was optimised for performance. The Firefly is capable of operating on Sustainable Aviation Fuels (SAF) and aluminium alloys were chosen for the design over composite materials to increase recyclability and to reduce overall costs. With governments being the primary customer, designing a cost and mission effective aircraft is important in determining the feasibility of the Firefly. In the final weeks of the project, a financial analysis and development plan of the Firefly will be established to determine proof of concept.