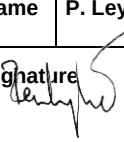
CleanLE2 Project

SUMMARY PERIOD 1

Issue : 1
Revision : 1
Date : 01/10/2015
Delivery Number : 1
WP Number : 1 MGT

CleanLE2 Project SUMMARY for Periodic Report 1

Author	
Name	P. Leyland
Signature	

1 Contents

2 Publishable Summary

CleanLE2 is part of the Cleansky FP7 European research program which develops breakthrough technologies to significantly increase the environmental performances of airplanes and air transport. Aim of the CleanLE2 project is to validate the concept of a wing leading edge cleaning device moving on the wing. The interest of such a cleaning device is to remove debris, for example insects, that accumulate on the wing during the taxi and take-off phase which can disrupt the aerodynamic flow and promote transition to turbulent flow on wings designed for low drag laminar flow. Indeed contaminants with a height as small as 0.05 mm can cause turbulent flow on wings cruising at high speed and increase total drag and thus fuel consumption.

The present project is a follow up of the first CleanLE project in which several methods for cleaning the wing have been analysed and the working principles of such a system (kinematics, cleaning methods, structure of the system) have been defined.

In period 1 of the CLEANLE2 Project the main achievements are the design of a prototype for the CleanLE system, the pre-tests of cleaning efficiency, the design of the ground testing rig that will reproduce the inflight forces on the wing to establish the forces induced and the cleaning of the device on a representative wing model, the design of the wind tunnel setup, with analyses of the pressure tap locations, and CFD/CSM simulations to help the design phase.

The system has been designed in WP2 with extensive use of numerical engineering methods: computational fluid dynamics (CFD), EM (electromagnetic), and CSM (structural mechanics) software for estimating: the aerodynamic forces encountered in flight, computational magnetostatic to size the magnets holding the cleaning devices on the wing and computational solid mechanics to size the components and estimate the loads on the structural parts. The design phase has been extended to M8 in order to integrate all conclusions from WP3.

In WP3 (Pre-tests) a method for contaminating wing surfaces with flies has been devised and built. It consists on a modified leaf-blower which « shoots » fruit flies (Drosophilae) at a speed of 130 Km/h and can thus contaminate surfaces in a representative way. Additionally a laser based sensor has been chosen to measure contaminants height before and after the tests. Cleaning tests have been performed on aluminium sheets contaminated with the aforementioned procedure. Various cleaning tools (brushes, sponges, cloths) have been used for cleaning in both dry and wet conditions using 3 different liquids. For the best combination of sponge and liquid it was possible to clean sufficiently the wing after 4 passes. Using a more abrasive sponge leads to scratches on the aluminium sheet. However it is assumed that a painted wing will be more resistant to scratches, allowing the use of more abrasive sponges and/or more pressure applied on the sponges).

This will be tested in WP6. An important result of WP3 is that dry cleaning proves ineffective, so that a cleaning liquid is necessary.

For the ground tests it has been decided to « shrink » the reference wing leading edge. 3 test zones have been selected (which correspond to wing root, mid wing and wing tip) which are connected with transition zones. The wing will be built from scratch and mounted on a structure which allows rotation of the wing to ease the contamination process and the application of weights that simulate the aerodynamic loads. Transition zones will be built with wood and covered with aluminium sheets to limit the cost. The CleanLE prototype has been updated to take into account comments of the experimental test team (ZHAW), to increase the mechanical stability of the prototype (various CSM simulation have been performed), to ease manufacturing of the parts and to limit cost by choosing as many off-the-shelf parts as possible. CleanLE prototype manufacturing is completed, manufacturing of the wing is ongoing.

The setup for the wind tunnel test bench consists in two endplates 4.7m long, 2.6m height,

placed 1.0m apart and installed in the main test section. The wing, equipped with the prototype cleaning device, is hold by the rotating guiding devices integrated in the endplates in order to vary precisely the angle of attack. To gather information about the flow 64 pressure sensors will be used whose positioning has been decided after extensive CFD simulations. Additionally oil flow visualisation will be performed in the tests. The wing has been manufactured and the mounting of the experimental setup is ongoing.
WP 5 is delayed until M17 instead of M14 due to longer than expected test bench design phase in WP4; timeline has been compressed to fit into the time line of the project (24 months). Testing (WP's 6 and 8) and Optimisation (WP7) are being now run in parallel with cross-iterations to achieve completion of the Project within 24 months.