## MAEM-RO
Methodologies and applications of emission measurements on rotorcraft

<table>
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<th>State of the art – Background</th>
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<td>Civil aviation plays a key role in economic prosperity and development all over the world: air transport industry provides 28 million jobs worldwide; aircrafts carry 40% of the value of all world trade. Direct emissions from aviation account for about 3% of the EU’s total greenhouse gas emissions. The large majority of these emissions comes from international flights. By 2020, global international aviation emissions are projected to be around 70% higher than in 2005 even if fuel efficiency improves by 2% per year. ICAO forecasts that by 2050 they could grow by a further 300-700%. The aviation industry is working hard to deliver Carbon Neutral Growth 2020 (*) , but also to reduce pollutant emissions like nitrogen oxides (NOx). (*1) For details see: <a href="http://www.iata.org/pressroom/pr/Pages/2013-06-03-05.aspx">http://www.iata.org/pressroom/pr/Pages/2013-06-03-05.aspx</a> <a href="http://www.iata.org/pressroom/pr/Documents/agm69-resolution-cng2020.pdf">http://www.iata.org/pressroom/pr/Documents/agm69-resolution-cng2020.pdf</a></td>
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### Objectives

The main target of MAEM-RO project is to develop a methodology suitable for flue gas emissions measurement during flight tests on helicopters and for test campaigns in significant flight missions, with different engine settings and environmental conditions. Some recommendations are worldwide known on how to conduct measurements of gaseous emissions on airplanes, but they do not represent a standard and are not applicable for measurements in flight. For example ICAO gaseous emission measurement requirements for aircraft gas turbines are derived from SAE Aerospace Recommended Practice 1256B, but they are not intended for flight tests. Therefore a methodology suitable for flue gas concentrations measurement during flight tests has to be designed and, of course, verified in meaningful tests. In order to develop such a methodology, the standard procedures used in the automotive and heavy duty gas turbines fields were taken into account. Moreover the recommendations suggested for on ground measurements in aviation industry have been considered as well. For example, the exhaust gas analyzer adopted is based on the FTIR (Fourier Transform Infrared Spectroscopy) operating principle, in agreement with SAE E31 Committee. The Committee recommends to implement the SAE AIR5917 Aeronautical Recommended Practice (Procedures for Measurement of Gaseous Emissions from Gas Turbine Engines Using Fourier Transform Infrared Analysis) which specifies that FTIR shall be used to measure CO, CO2, and NOx from aircraft gas turbines. |

### Description of work

In order to design a complete flue gas measurement system for flight tests, many requirements have to be taken into account:

1. the system has to be robust enough to withstand helicopter vibrations, without interfering with measurement accuracy and flight safety;
2. the system power requirements shall be compatible with the electrical power available on-board;
3. it has to be capable of automatic operation, in order to avoid expert presence during flight;
4. need for auxiliaries has to be reduced as much as possible;
5. data acquisition system has to transfer measurement signals to helicopter data acquisition system according to avionics standards.

Once a proper measuring device, able to satisfy these requirements, is found, it is necessary to proceed with the integration of the parts: gas sampling probe, sampling unit, analyzer and data acquisition system. The last step, before flight test campaign, consists in the installation of the equipment on the helicopter and in the verification of the proper operation. At the end of the flight missions a database will be prepared, containing engine conditions and gas emissions measured during flights.
Expected results

The main result, expected from the implementation of the project, is the verification of the methodology developed in flight missions on a helicopter.

a) Timeline & main milestones

The project milestones are:
MS1: the most appropriate sampling system
MS2: the most appropriate analyzer
MS3: installation on helicopter and ground test
MS4: flight tests

b) Environmental benefits

The final goal of MAEM-RO Project is to participate to reduce environmental impact from helicopters.

c) Maturity of works performed

MAEM-RO project has been successfully completed in December 2013. Numerous flight missions have been performed in different environmental conditions to verify the measurement methodology and the equipment installed on board.
At the end of the missions a database has been prepared with the gaseous emissions recorded in the different engine configurations.

Figure 1: gas analyzer and sampling unit installed on SW4 helicopter
Project Summary

Acronym : MAEM-RO
Name of proposal: Methodologies and applications of emission measurements on rotorcraft
Technical domain: Emission analysis – Tools required to perform emissions analysis and evaluation methodology; experimental support

Involved ITD: Green Rotorcraft

Grant Agreement: 267492
Instrument: Clean Sky
Total Cost: 577000€
Clean Sky contribution: 288500€

Call: JTI-CS-2009-2-GRC-05-003
Starting date: July 2010
Ending date: December 2013
Duration: 42 months

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