TEENI Publishable Summary

TEENI (Turboshaft Engine Exhaust Noise Identification) is a level 1 Project, with 11 partners (Turbomeca – Co-ordinator, ANOTEC, AVIO, Brüel & Kjaër, COMOTI, DLR, EPFL, INASCO, Microflown Technologies, ONERA, TCD), for an overall funding of 3.3M€. It has been launched on April 1st, 2008, for a 3 years duration.

TEENI deals with experimental identification of engine modules' responsibilities on exhaust Broadband Noise emission. This noise component is the second dominant noise source of a Turboshaft engine, and installing acoustic liners on the exhaust can lead to significant noise benefit on the whole helicopter levels.
Turboshaft exhaust noise is assumed to be a mix between combustion and turbine noise, with very little jet noise. It is representative of what is generally called core noise on aircraft engines. Thus, it should help to understand this difficult subject as well, thanks to its simpler geometry and absence of parasitic noise sources (as jet and fan noises).

The TEENI work programme was divided in 3 inter-dependent Work packages (WP):

- WP1: Innovative sensors development, to provide reference measurements of fluctuating quantities within the engine, under its harsh conditions
- WP2: Noise Sources Breakdown Techniques (NSBT) development, to determine the dominant emission location from external measurements. Several techniques will be evaluated, considering internal and external measurement, as well as various formalisms and approaches. Propagation through Turbine(s) and tools to help taking into account individual engine noise sources will also be developed.
- WP3: An Ardiden 1H Turboshaft engine full-scale test, to include and test developed sensors, verify (through correlation with internal sensors), assess the various NSBT pertinence and provide a first example of noise decomposition per module

In order to reduce development risks, both sensors and methods will be tested within their relative WP before the engine test.

The major deliverables of TEENI are:

- A set of sensors for measuring unsteady quantities, adequate for full-scale engine testing (650℃<T<1000℃)
- A noise breakdown technique selected out of a panel of methods thanks to an adapted treatment of engine noise database
- A thorough understanding of noise generation, propagation and radiation through the exhaust
- A comprehensive full-scale engine test database
- A ranking of exhaust noise sources, assorted with a recommendation about the noise source to be reduced in priority, through adequately tuned liners in the exhaust duct

At month 60 (end of the project) these TEENI's achievements can be listed:

- (WP1) All the sensors have been manufactured, and they all passed their designers tests successfully.
- (WP1) Quality and safety tests for these sensors have been defined, build and realised.
- Sensors for WP3 have been selected through the ad'hoc review. Unsteady pressure and unsteady temperature probes, both from DLR are the only new internal measurements that will be installed.

- WP1 is completed.
- (WP2) Noise Sources Breakdown Techniques (NSBT) have been defined, down selected where relevant and coded. They are available for testing.
- (WP2) Small scale tests for methods validation have been defined, build and realised.
- (WP2) NSBT have been successfully compared to Small scale test results
- (WP2) Numerical work (AVIO) and HELENA / SBT coupling (ANOTEC) have suffered some delays due to internal resources difficulties for the first and work re-definition for the second. Both tasks are now successfully achieved.
- WP2 is completed.
- (WP3) Internal instrumentation design on full scale engine has shown that raw material definition for the existing turbine casing was not sufficient to cover TEENI needs. Modification of existing hardware, as envisaged at the beginning of the project, was not possible. A long raw material purchase cycle has been achieved. COMOTI has realised 4 new parts and Turbomeca has modified existing parts.
- (WP3) Test matrix has been optimised to accommodate a lower number of DLR pressure sensors, enabling the simultaneous measurement of unsteady pressure and temperature and helping to keep the length of the test down
- (WP3) External instrumentation has been defined
- (WP3) Test environment modifications have been manufactured.
- (WP3) Test has been successfully performed, and test data distributed.
- (WP0B) Test analysis has been focussed on two measured shaft speeds, and completed. NSBT have been applied and show the same tendencies.
- (WP0B) Combustion Noise has been isolated and a Noise Sources Breakdown has been proposed.