(4)

SEMIANNUAL PROGRESS REPORT

on

ONR GRANT NO. N00014-89-J-1836

COMPUTATION OF BROADBAND MIXING NOISE FROM TURBOMACHINERY

Period covered by this report

March 1, 1989 to August 31, 1989

Principal Investigator:

Dr. Christopher Tam
Department of Mathematics, B-154
Florida State University
Tallahassee, FL 32306-3027

ONR Scientific Officer:

Dr. S. G. Lekoudis
Code 1132F
Office of Naval Research
800 N. Quincy Street
Arlington, VA 22217-5000

The objectives of this project are:

1. Development of a broadband mixing noise theory for turbomachinery.

2. Development of computation methods to calculate the noise generated in a ducted low Mach number environment.

Broadband mixing noise are generated by a number of sources inside a turbomachine. The most important sources are the turbulent boundary layers (on the casing walls or on the blades), the turbulent free shear layers (separated flows) and turbulent wakes (from blades). High quality noise data are currently not available. We are fortunate to obtain a set of reliable near and far field mixing noise data from the free shear layers of a low speed jet measured by Dr. Zaman of NASA Lewis Research Center. We have therefore decided to concentrate for the time being our work on broadband mixing noise theory on free shear flows. We have chosen to begin the theory by adopting the κ-ϵ turbulence modelling equations as the basis. Although at this stage the formalism is the same yet a slightly different interpretation of the physical variables is needed. The averaging process is to be a volume average. On assuming there is a distinct separation of scales between the large turbulence structures and fine scale turbulence a closed set of governing equations can be derived in the usual way by using a volume average. The volume is to be small compared with the large turbulence structures but large compared to the fine scale turbulence. The semi-empirical constants used in turbulence calculation will be adopted in our work. The next stage of work is to develop ways of solving the time dependent equations and to determine the radiated noise intensity and spectrum.

One way to solve the κ-ϵ model equations is to use numerical methods. Such computation methods are also needed in calculating the propagating of sound from inside a turbomachine to the outside world. For this type of calculation existing off-the-shelf CFD codes are generally not suitable. Most of the finite difference schemes used are subjected to effects of dispersion and damping. These effects cause acoustic signals to become greatly distorted. We are evaluating the effects aiming to minimizing them if possible. Currently we are looking at exterior problems. But we plan to study internal propagation and inflow and outflow conditions in the near future.