NASA TECH BRIEF

Study Made of Thin-Walled Pipe Response to Turbulent Fluids

A study has been conducted on the response of thin-walled pipes to turbulent fluid flows. The objectives of the study were to obtain experimental data concerning both the applied pressure field and the response it induces, and to develop an analytical approach for predicting the response of thin-walled pipes under turbulent fluid flow conditions. The report summarizes both the experimental and theoretical data on the vibrational response of pipe sections to the wall pressure field applied within them by a fully-developed turbulent fluid flow.

For the investigation, a large water flow loop was used together with miniature pressure transducers for recording wall pressure fluctuations. Statistical data on the wall pressure field were measured for a rigid thick-walled pipe. From the measurements, root mean square pressure levels, frequency power spectra, and both broadband and 1/3 octave band spacetime and spatial correlations of the wall pressure field were obtained over a range of Reynolds numbers from 5×10^5 to 2×10^6.

Using the wall pressure field data, an analytical method for predicting the response of pipes carrying turbulent fluid was developed. Based on the random vibration theory, the analysis assumes that the pressure field is homogeneous and that the response can be calculated without knowledge of the mode shapes of the many pipe resonances associated with broadband frequency excitation. The average pipe wall response can be calculated with knowledge of only the damping factor and the number of resonant modes per unit bandwidth.

The predicted pipe wall responses were in good agreement with data obtained by direct measurement at selected frequency bandwidths and several flow rates.

Notes:

1. This information should be helpful in designing fluid piping systems.
2. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B67-10518

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: J. Michael Clinch
of IITRI
under contract to
Marshall Space Flight Center
(MFS-1321)

Category 05