# DEVELOPMENT OF PROBES TO MEASURE IN-DUCT SOUND PRESSURE LEVELS OF A GAS TURBINE EXHAUST

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## 1.0 Introduction

The ability to measure in-duct sound power levels at the exhaust flange of a gas turbine would allow in situ verification of gas turbine exhaust sound power levels and, in conjunction with other measurements, verification of silencer dynamic insertion loss. The primary requirement for a measurement of sound power level is a procedure that will measure valid sound pressure levels in a high velocity, hot gas, highly turbulent turbine exhaust flow.

This paper describes the current state of development of two specialized wall mounted microphone probes: a perpendicular tube and a slit tube.

Early work established that specialized probes could be designed to desensitize microphones to turbulent pressure fluctuations [1, 2].

This type of device, called a slit tube or turbulence screen, is manufactured commercially [3]. It is utilized by an international standard, ISO 5136, to measure the sound power radiated into a duct by fans [4].

The commercially available turbulence screen is not a suitable probe for a gas turbine exhaust since the microphone would not survive the environment. Instead the probes are flush mounted and extend away from the wall similar to [5].

## 2.0 In-Duct Probe Designs

Fig. 1 shows the measuring tube arrangement. This consists of a one inch inner diameter stainless steel tube terminated by 100 feet of one inch inner diameter flexible clear plastic hose that is plugged at the far end.

The perpendicular tube probe is shown in Fig. 2. The essential features are the tip and the thermal break. The flush mounted tip is covered with three layers of glass silk cloth and wire mesh screen.

The slit tube probe is shown in Fig. 3. The essential features of this design are the 1mm wide by 635mm long slit and the thermal break. Four layers of glass silk cloth are used behind the flush mounted slit.

The two probes are calibrated for frequency response and turbulence rejection as described in reference [6].

## 3.0 In Situ Silencer Insertion Loss Measurements

Measurements were obtained for the exhaust of an operational 10 MW gas turbine. The perpendicular tube and slit tube microphone probes were attached at the end of the exhaust duct transition upstream of the silencer at the top and side walls.

The sound power at the turbine exhaust flange was calculated from the microphone probe measurements. The sound power radiated from the exhaust duct outlet was calculated from measurements obtained outside the duct in the plane of the outlet. The resulting silencer DIL is shown in Fig. 4.

For comparison a static test (i.e. zero flow) was performed using loudspeakers at the base of the exhaust duct as a sound source. The results of this test, after correcting for temperature, are also shown in Fig. 4.

Fig. 4 also shows the DIL expected from the silencer design. Note that the design DIL values assume a flanking limit of 50 dB, which, for this design, may be low by 5 dB to 10 dB based on the static test results.

There is good agreement between all three DIL curves in Fig. 4.

## 4.0 References

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4. "Acoustics - Determination of Sound Power Radiated into a Duct by Fans - In-duct Method", International Standard ISO 5136, First Edition, 1990-12-15.

5. "The Development of a Flush Mounted Microphone Turbulence Screen for Use in a Power Station Chimney Flue", J.L. Davy and I.P. Dunn, Noise Control Engineering Journal/Sep-Oct 1993, Vol. 41, No. 2, p. 313-322.

6. "Development of Probes to Measure In-duct Sound Pressure Levels of a Gas Turbine Exhaust", M.P. Sacks and S. Broughton, Twelfth Symposium on Industrial Applications of Gas Turbines, Banff, Alberta, October 15-17, 1997.

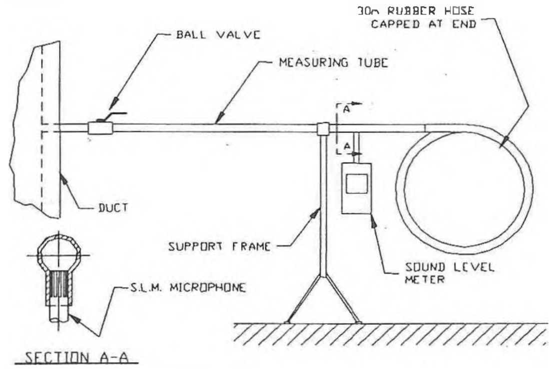


Fig 1 Measuring Tube

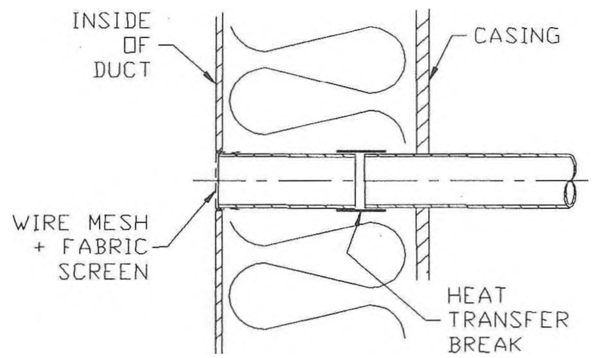


Fig 2 Perpendicular Tube Probe

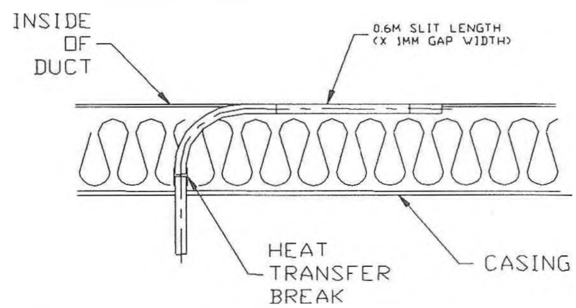


Fig 3 Slit Tube Probe

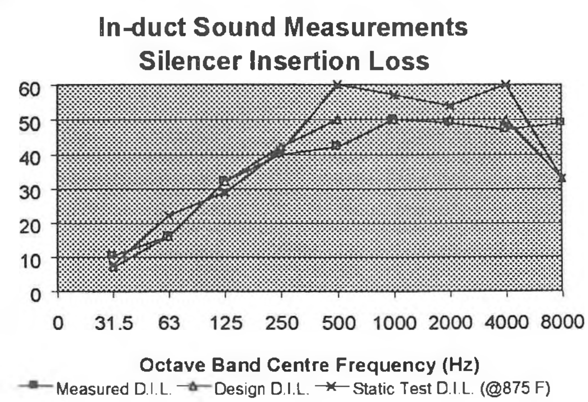


Fig 4 Insertion Loss Comparisons