# SOUND POWER DETERMINATION USING SOUND INTENSITY SCANNING TECHNIQUE

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## Introduction

Sound intensity is the primary quantity required to compute the sound power of sources, which is given by the surface integral of the product of the normal component of the sound intensity and the associated elemental area over any surface fully enclosing the source. The two methods that are currently being used to sample the sound field are based on:

a) measurements at discrete points distributed on the surface
b) sound intensity probe scan over the surface

In the discrete point method, the normal component of the sound intensity over an elemental area is independently measured on a large number of points distributed over an initial measurement surface. This method has been found to be complex and very time consuming, and particularly not well suited for large size sources operating in complex acoustic fields. In the scanning method, the probe is moved continuously along one or more prescribed paths on the surface. The surface average value of the normal component of sound intensity is obtained in a few scans, instead of independent measurements at several points. This method is relatively quick and easy to perform and gives good results for measurements requiring engineering grades of accuracies.

The measurement accuracy of the scanning technique mainly depends on the acoustic field conditions and the scanning parameters. the acoustic field condition can be expressed by the value of the indicator $F_{PI}$, based on two difference the average values of surface sound pressure level and sound intensity level. The scanning parameters include, speed of scanning, density of scanning and scanning patterns.

The study reported in this paper was undertaken to examine the range and effect of some of the major parameters associated with the scanning technique, for providing guidance to the user and to the standardization of the procedure.

## Experimental Details

Experimental sound source consisted of two 18 cm diameter loudspeakers, placed 0.5 meter apart, mounted in a 1 x 1 x 1/3 meter wooden box. The two loudspeakers were energized by white noise signals, with 6 dB difference in power levels, and 180° phase difference. This arrangement produces complex sound field with non uniform distribution of sound pressure and intensity, with recirculating regions of sound energy. Sound power levels from several horizontal surfaces directly above the source, covering an area of 1 x 1 meter, were estimated based on point measurements, and mechanical and hand scanning. The probe scanning on the measurement surface was performed on equally spaced eight horizontal lines. Both hand and mechanical scanning was done by moving the probe continuously at a constant speed along each line from one end to the other, back and forth.

## Results and Discussion

At 25 cm from the source, scanning measurements showed an accuracy, within 1 dB difference, in the frequency range 160 Hz to 3150 Hz for the scanning speeds in the range, 0.06 m/sec to 0.50 m/sec. Manual scans tended to show better results than the mechanical scans, due to extraneous noise generated by the probe traversing gear, especially at low frequencies. The sound field pressure intensity indicated values were all within 4 dB, for the point and mechanical scan measurements, both under free field and reflecting acoustic environments. Under reflecting environment, this indicator generally showed higher values.

On several measurement surfaces, it was observed that, for the measurement accuracies to be within 1 dB, the pressure intensity values are to remain less than 5 dB. In all the measurements, the dynamic capability index was higher than 10 dB. When pressure intensity index increased to 6 dB or higher, the measurement error was higher than 2 dB. This clearly demonstrated a need for another indicator in addition to the pressure intensity indicator.

## Conclusions

The experimental results show that the sound power of noise sources can be determined using sound intensity scanning technique. Both mechanical and manual scanning give good accuracy for engineering grade of measurements. The measurement distances from the source should be at distances greater than 25 cm. The pressure intensity indicator values were less than 5 dB for accuracies within 1 dB. The results also indicate a need for developing an additional indicator to assess the measurement accuracies.

## References

ISO 9614-1, *Acoustics - Determination of the Sound Power Levels of Noise Sources Using Sound Intensity - Part 1- Measurement at Discrete Points (1990).*