

## A Review of Reference Sound Sources for Sound Power Measurements

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**Why Measure Sound Power?** Sound power measurements are typically made for two reasons – the labeling of products to advise on their noisiness or their compliance with ordinance limits and to aid in the design of facilities where persons live and work. For the former, the measured sound power of the product is the final result. For the latter, architects and engineers use the measurements to predict resulting sound levels at various locations in buildings and near where noisy equipment is installed. Examples are HVAC sound calculations where the NC-levels (noise criterion levels) in occupied spaces are predicted, for estimating noise exposures at the workplace and to predict noise levels emitted into the community at specified locations of nearby residences.

**Why a Reference Sound Source (RSS)?** Howard Hardy developed the original reference sound source in 1959 because the most convenient method of obtaining sound power ratings is by comparison of the noise source to be measured to an acoustically calibrated mechanical noise source.<sup>1</sup> A relatively 'flat' octave band spectrum was achieved by running a bare forward-curved centrifugal fan wheel on a horizontal axis close to the floor.<sup>2</sup> These devices were calibrated by the Armour Research Foundation and widely used by many laboratories in the air movement industry using the substitution or 'comparison' method for determining sound power of HVAC components.

The Hardy RSS was popularized in the trade as the 'Ilg' fan, named after the fan manufacturing company that sponsored its production for engineering test purposes. Standards were then written to measure sound power by the comparison method chiefly for the HVAC industry, most notably AMCA 300.

**RSS Calibration.** The calibration environment can be hemi-anechoic (anechoic over a reflecting plane) or reverberant. Each RSS is calibrated according to ANSI 12.53 or ANSI 12.5 (ISO 6926). Calibration of Acculab RSS units, when purchased with calibrations, are performed in a hemi-anechoic environment outdoors resting on a sealed asphalt surface, where no low frequency limit exists, from 12.5 Hz to 20 kHz normalized to STP (standard conditions for atmospheric temperature and pressure).<sup>3</sup>

**Application.** A typical application is the HVAC supply fan sound power measurement in accordance with the AMCA 300 test layout (Figure 1). Here, a quiet and semireverberant corner location is found in a large plant or lab space where sound emitted from the mechanical device under test (DUT) such as a ventilation fan or the

discharge or return port of an air supply source is concentrated. Several microphone locations at various heights above the floor are designated where the sound pressure levels emitted from the DUT, and levels from a reference sound source (RSS), can be measured away from walls and objects. Comparison of these sound pressure levels yields the differences in sound power from the RSS to that of the DUT. This method is often termed the 'comparison' method.

Many U.S. and international standards exist with which sound power can be accurately measured by this comparison method. These include, but are not limited to, ANSI 12.33 (ISO3743), ANSI 12.34 (ISO 3744), ANSI 12.36 (ISO3746), AMCA 300 and ASTM F1334. Each of these standards spells out the spatial environment characteristics that are allowed for their respective sound power comparison measurement method.

An application for comparison sound power measurement according to AMCA 300 is shown in Figures 2 and 3. In the Figure 3 setup, the noise source was elevated so the RSS 101 is placed on a large horizontal surface near the DUT. Such sheet metal surfaces are prone to 'drum' when excited into vibration. All late model Acculab RSS units are equipped with spring-isolated feet to minimize coupling of RSS vibration to supporting surfaces.

**Acculab Reference Sound Sources.** Acculab reference sound sources have been developed over the past 25 years. By 1980 and under new management Ilg ceased producing the Ilg RSS. We needed an RSS for field testing in 1982, so we developed one at Acculab (Figure 4). We rotated the fan axis to vertical to achieve an omnidirectional sound field in the azimuth plane, a rugged steel bar frame, a handle to simplify shipping and field handling and a more stable low frequency output. This became the RSS 101. The octave-band sound power levels of various Acculab RSS units are shown in Figure 5.

The Ilg fan had the troubling trait that its 63 Hz octave band sound pressure level could vary unexpectedly. During an opportunity to calibrate an Ilg RSS, we found that its proximity to the floor changed the frequency of a minor tone from 43 Hz (close to the floor) to 47 Hz (3/4 inch further above the floor). This shifted that tone out of the 31 Hz band into the 63 Hz band when the fan was unwittingly situated higher from the floor.

**Specific Acculab RSS units.** The RSS 101 (Figure 6) emits a sound field of 86 dBA re 1 picowatt, which is satisfactory for relatively quiet laboratory background noise levels.

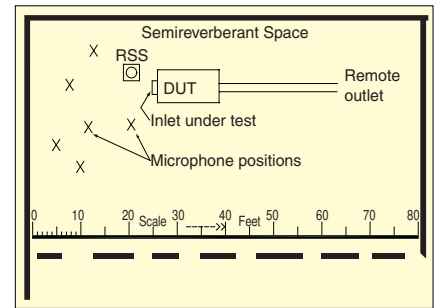


Figure 1. Typical indoor sound power measurement arrangement (AMCA 300).

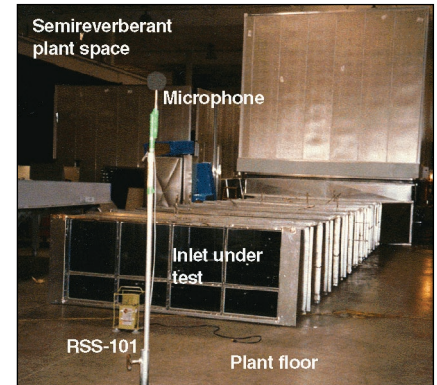


Figure 2. AMCA 300 measurement of sound power from an HVAC air inlet in a semireverberant space.

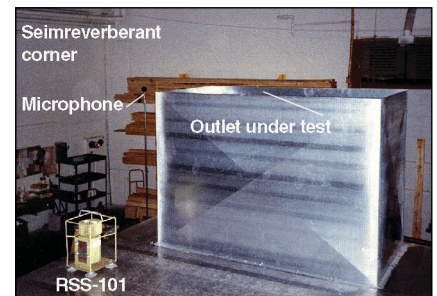


Figure 3. AMCA 300 measurement of sound power from a discharge outlet in an industrial space near a semireverberant corner.



Figure 4. Early Acculab RSS prototype (1982).

This often requires in-plant testing to be performed during quiet nighttime hours.

**RSS 400 and 300.** The RSS 400 was developed (Figure 7) for practical field testing, especially for heavy or complex equipment where the test space background noise level cannot always be kept low. It has a larger diameter fan wheel that produces 94 dBA re 1 picowatt. To satisfy international require-

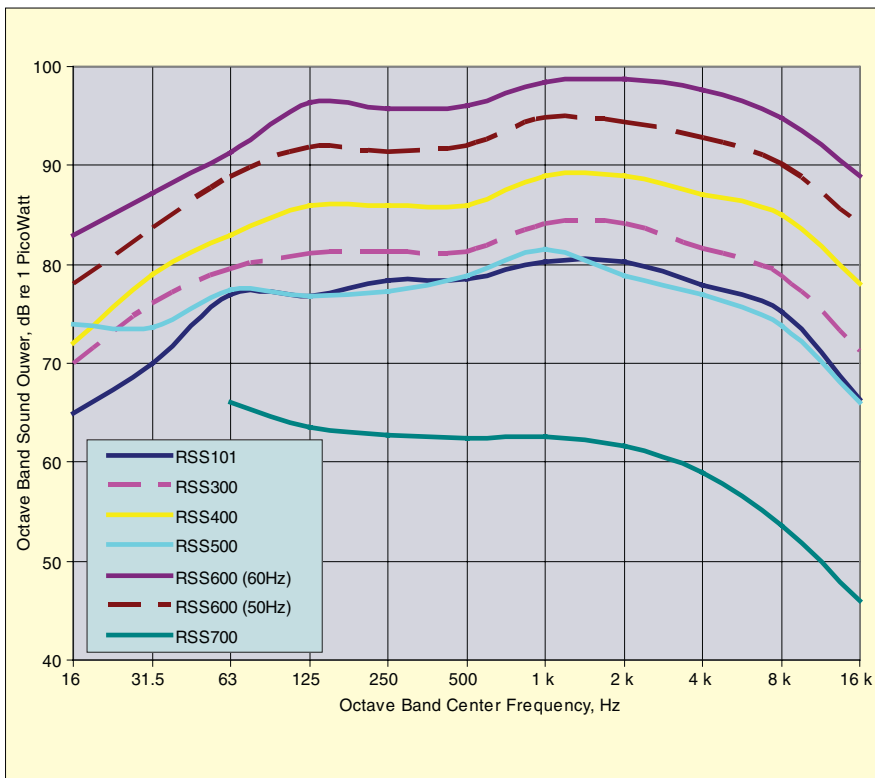


Figure 5, Octave-band sound power levels for all RSS units.



Figure 6. RSS 101.



Figure 7. RSS 400.



Figure 8. RSS 500.



Figure 9. RSS 102.

ments, the RSS 300 was developed using RSS 400 components plus a motor suited to 50-Hz operation worldwide (90 dBA re 1 picowatt).

**RSS 500.** There was a requirement to produce stable low-frequency sound, chiefly in the 63-Hz octave band, where the Ilg RSS was found to be less stable with time. To



Figure 10. RSS 600.



Figure 11. RSS 700.

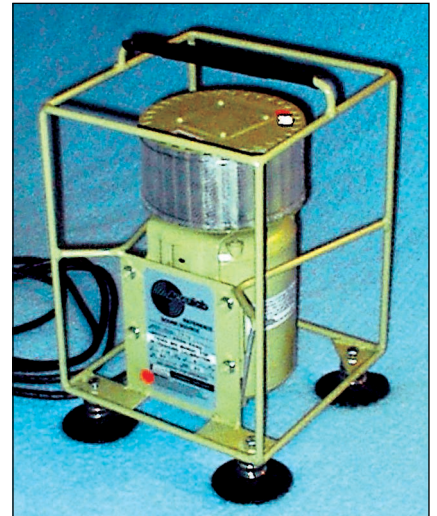


Figure 12. RSS 101U.

that end, a fan wheel twice the diameter of that of the RSS 101 and turning at half the RPM was produced. This resulted in a sound field that was again 86 dBA re 1 picowatt, but with improved and stable low-frequency content. This became the RSS 500 (Figure 8).

**RSS 102.** Several years ago, we were asked to supply a replacement for an Ilg fan, so we laid the RSS 101 on its side, added our protective frame and attached feet for stability. The result was the RSS 102 (Figure 9).

**RSS 600.** In recent years, outdoor sound

power measurements have been required for construction equipment, so still more reference sound power is required. The RSS 600 (Figure 10), producing 105 dBA (100 dBA at 50 Hz) re 1 picowatt, was accordingly developed.

**RSS 700.** A small, low-powered RSS was required for the business equipment industry, where measurements have to be taken in close quarters and on very quiet equipment. The RSS 700 (Figure 11, 68 dBA re 1 picowatt @ 60 Hz) was developed to meet this need.

**Temperature and Barometric Pressure Corrections.** Remote sites can be anywhere and at any altitude up to and above 10,000 feet. The effect of test site air temperature and pressure (site altitude) on emitted sound power must be considered. The following list of questions must be answered for any RSS/DUT combination:

- What is the sound power that the RSS produces at other standard conditions (sea level and a mandated temperature)?
- What sound power will the RSS produce in a field or lab test space (most any popu-

lated location)?

- What was the sound power that the DUT produced at that test site?
- What will be the sound power that the DUT will produce in its final operating location?
- What sound power would the DUT produce under standard conditions (STP)?

Correction methods to accommodate any of these questions are provided with each Acculab reference sound source.

**Ultrasound Reference Sound Source.** Finally, the ultrasound industry requires better and more rapid production quality control for ultrasound devices such as leak detectors and the calibration and checkout of large arrays of ultrasonic microphones to at least 100 kHz. This led to the RSS 101U (Figure 12). This is the basis for Draft ANSI 1.26 “High-Frequency Calibration of the Pressure Sensitivity of Microphones by Means of Measurements in the Free Field.”

## References

1. Hardy, Howard C., “Mechanical Noise Sources as Calibrated Noise Standards,” *J. Acoust. Soc.*

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2. Hardy, Howard C., “Standard Mechanical Noise Sources,” *Noise Control*, Vol. 5, No. 22, 1959
3. Campanella, Angelo J., “Calibration of Reference Sound Sources, a U.S. Perspective” INCE Proceedings, Noise-Con 1996, pp. 931-936.

Please visit [www.campanellaacoustics.com/rssman.html#ALTMP](http://www.campanellaacoustics.com/rssman.html#ALTMP) for a complete description and pricing of Acculab reference sound sources.

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