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THE ROLE OF NOISE EMISSION IN NOISE CONTROL

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1. INTRODUCTION

In this paper, I have chosen to discuss the roles of noise emission for several reasons:

- First, it is the first step in any noise control problem.
- Second, because there are relatively minor problems with the current international standards for determination of noise emission that should be solved in future revisions of the documents. Some suggestions for the resolution of these problems are given here.
- Third, noise *emission* has many uses for those engaged in solving noise problems; it seems worthwhile to review some of those uses to remind us of its many roles.
- Fourth, a clear distinction must be made between noise *emission*, the sound emitted by a source, and noise *immission*, the sound heard by a receiver. Although noise *emission* is usually specified by reporting the sound power level of the source, and noise immission is specified by reporting the sound pressure level at the receiver, the unit of level, the decibel is used for both quantities. This has caused a great deal of confusion. So many of our problems today involve the path between the source and receiver and the effects of noise on people that we tend to deemphasize the role of noise *emission*. For example, in a report on the INTER-NOISE 98 Congress in New Zealand last November, the keynote speaker, Birgitta Berglund from Sweden is reported[1] to have said that "health effects are related to noise *immission* and not to noise *emission*." It is, of course, true that there is a direct relationship between *immission* and health effects, but from an engineering viewpoint, determination and reduction of noise *emissions* is a key element in elimination of heath effects and annoyance due to noise.
- Fifth, a great deal of emphasis is currently being placed on sound quality rather than on noise *emission* as a physical quantity that can be measured directly. Two examples are given here; one case where sound quality led directly to an *emission* standard, and another where noise *emission* was of little value in solving a serious problem.
- Sixth, in the case of moving sources, it seems worthwhile to mention a case where control of noise *emissions* has been a partial success in controlling noise immission, and another case of partial failure.

2. CHARACTERIZATION OF SOURCES

2.1 The Source-Path-Receiver Model

In the USA, many discussions of a noise problem start with the classical noise-path-receiver model described by Bolt and Ingard in 1957.[2] In reviewing that article, I was quite surprised to find that the primary emphasis was placed on noise control for the path and noise control for the receiver: relatively little attention was paid to the characterization of the source. I believe that in today's environment, the characterization of the source noise emission would be given more attention.

2.2 Characterization of Sources

In this section, the discussion is restricted to stationary noise sources.

2.2.1 The 3740 Series

The preparation of the 3740 series[3] of international standards by the International Organization for Standardization (ISO) began in 1969, and these documents have undergone continuous improvement in the last three decades. These documents characterize the *emissions* of a source in terms of sound power level, and depend on measurements of sound pressure level to make a determination of the sound power level. The accuracy of these standards has been studied by many workers. For example, an unpublished study of the measurement uncertainty using various measurement surfaces was done within IBM in the 1980s, and, more recently, a thorough study was done here in the United Kingdom by the National Physical Laboratory.[4] The results were generally in conformity with the uncertainties specified in the standards.

There are two areas in which these documents could be improved; both relate to the qualification of the environment in which measurements are made.

ISO 3746 requires that a laboratory-quality anechoic room or hemi-anechoic room be used for the measurements. The qualification procedure involves draw-away experiments using a series of three test sources:

- Below 400 Hz, an electrodynamic speaker in a 0.02 m^3 box,
- from 400 Hz to 2000 Hz, two 10-cm diameter loudspeakers bolted together and driven as a monopole source, and,
- above 2000 Hz, a cylindrical tube with a diameter less than 15 mm.

The directivity of these sources is required to be less than 1 dB. These requirements were evidently based on a study published in 1968 that described the qualification of a fully anechoic room at the Technical University of Denmark.[5] While these sources may be very appropriate for qualification of *fully-anechoic* rooms, they are not satisfactory for the qualification of the *hemi-anechoic* rooms that are in wide use today. The main problem is the interference pattern created by the presence of the floor in the hemi-anechoic room. This qualification problem should be solved not only for facilities used for the determination of sound power, but also for qualification of hemi-anechoic rooms used for sound quality studies. The automobile industry, for example, is a major user of these rooms.

Currently, manufacturers use a variety of sources and test methods to qualify hemi-anechoic rooms. A study of a "flat" source was carried out in the late 1980s[6] at the IBM Acoustics Laboratory in Poughkeepsie, New York, USA, in connection with a laboratory certification program. The source was a 100-mm diameter loudspeaker placed in the center of a rectangular box having dimensions 60 cm x 60 cm x 9 cm high. Sound-absorptive material was placed inside the box, and a metal plate with a 12-mm hole in the center was placed on the 60x60 cm surface of the box.

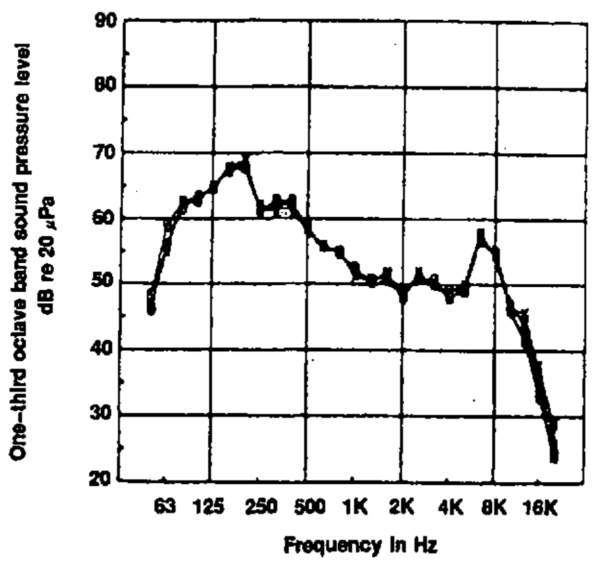

Fig. 1. Directivity of the flat test source.

Ideally, hemi-anechoic rooms should be designed with a floor such that the top of the source can be placed in the plane of the floor. Under these conditions, the directivity, as measured at a distance of 1.5 m from the source and at angles of 0, 22.5, 45, 67.5, and 90 degrees from the vertical axis, is excellent – as illustrated in Fig. 1. The five curves essentially overlap one another. When the source is placed above the plane of the floor, the directivity is not as good, but the source still functions as a wideband source for qualification of hemi-anechoic rooms.

Another problem that deserves some attention is the qualification of reverberation rooms for determination of the sound power of sources that contain discrete-frequency sources. This procedure is specified in ISO 3742 (now being combined with ISO 3741). This type of qualification procedure has a long history that has recently been summarized by Baade and Maling[7]. Currently, this procedure requires the use of a loudspeaker to excite the reverberation room sequentially by approximately 20 discrete-frequency tones in each one-third octave band. The space-averaged sound pressure level is measured, and, after a correction factor for loudspeaker response is applied, the standard deviation of the level is calculated in each one-third octave band and compared with a required value. In the mid-1970s, efforts to automate this procedure were successful,[8] but the time required to perform the testing is still unreasonably long. In 1984, Chu suggested that pseudo-random sequences could be used for reverberation room qualification.[9] The number of test frequencies used was much larger than that used in ISO 3742.

In the early 1990s, some experiments were done at the IBM Poughkeepsie Acoustics Laboratory using directly calculated multitone signals, but the results were not published until 1998[7]. The equipment used, a personal computer and one of the early "sound cards," was inferior to the equipment available today, and the rather time-consuming calculation of the multitone signals in the early 1990s is replaced by multitone generation in a few seconds using modern digital signal processing hardware and software. The key to the success of the method is to exactly match the periodicity of the test tone with the window on the Fourier analyzer used to obtain the test results. In this way, spectral leakage is eliminated, and the results are similar to the results using sequential test tones.

For the purposes of this paper, the procedure is best illustrated by an example. If a Fourier analyzer having a time window of 4 sec (1/4 Hz line spacing) is used, and one wants to generate 20 test tones spaced 1 Hz apart in the 100 Hz one-third octave band (approximately 90-110 Hz), one can calculate a waveform that consists of the 360th, 364th, 368th...harmonics of 1/4 Hz.

Then, a periodic repetition of the signal is generated to correspond to the length of time required for a moving microphone to traverse a circular path in the reverberation room. When this signal is applied to the test loudspeaker, and the spectrum is determined, discrete lines are obtained at 1 Hz intervals with essentially no spectral leakage. The standard deviation of the amplitudes can be calculated as described above. This speeds up the qualification procedure by a factor of 20.

A comparison of results obtained using single frequencies and a multi-tone signal is shown in Table 1. It can be seen that the two methods yield comparable results.

Table 1. Comparative standard deviations for a 230m[3] reverberation room.

One-third octave-band center frequency Hz	Allowed standard deviation dB	Actual standard deviation[a] dB	One-third octave-band center frequency Hz	Allowed standard deviation dB	Actual standard deviation[a] dB
100	3.0	3.225	315	2.0	1.560
		3.141			**1.907**
125	3.0	2.986	400	1.5	1.650
		2.620			**1.388**
160	3.0	2.628	500	1.5	1.410
		2.837			**1.106**
200	2.0	2.256	630	1.5	1.075
		2.237			**1.424**
250	2.0	1.618	800	1.0	1.051
		1.722			**0.876**

[a] The underlined bold values of the actual standard deviation are from multitone signals; the values not in bold type and not underlined were obtained from measurements using a series of single tones.

It appears that further studies using modern signal processing equipment would be very beneficial to those who use reverberation rooms for the determination of sound power levels. Chu has suggested other signal processing techniques that promise even more improvements to qualification methods.[10]

2.2.1 Sound Intensity Methods

Direct determination of sound intensity became practical in the mid-1970s. Later, standard methods of determining sound power via sound intensity were standardized in ISO 9614, parts 1 and 2.[11] I am sure that there have been many studies of the accuracy of these methods, so I mention only one done at the IBM Poughkeepsie Acoustics Laboratory where we used the microphone positions specified in ISO 3744 for both the sound pressure method in a hemi-anechoic chamber and the intensity method in an ordinary laboratory room.

In the computer industry, a knowledge of the noise emission of small air-moving devices (fans and blowers) is essential for the prediction of the noise emission of machines, and data is often requested from manufacturers that do not have laboratory quality facilities to make sound power determinations. In order to provide an aerodynamic load on an air-moving device, a plenum box with lightweight plastic sides was used in the laboratory. The sides of the plenum are nearly transparent to sound, and a measure of the total sound power of an air-moving device can be obtained by mounting the device on the plenum and operating it at the appropriate back pressure. The design of the plenum, originally used within IBM in the early 1960s, was refined by a committee of the Institute of Noise Control Engineering of the USA (INCE/USA), and is now an

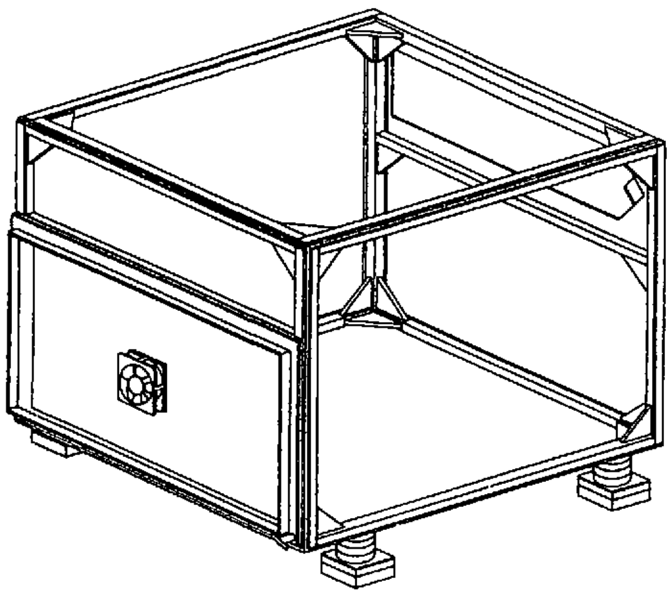

Fig. 2. Test plenum for air-moving device sound power determination.

International Standard (ISO 10302, Measurement of airborne noise emitted by small air-moving devices, 1996). The plenum is shown in Fig. 2. The fan/plenum assembly was moved from a 230 m^3 reverberation room to an ordinary laboratory room and then to a hemi-anechoic room. Comparative measurements were made.[12] Fig. 3 shows a comparison between reverberation room and anechoic room data. Fig. 4. shows a comparison between the hemi-anechoic room data and data in an ordinary room. It can be seen that all three methods are in good agreement. Several field indicators were calculated according to (then ISO **DP** 9614). One interesting result was that the calculated number of required microphone positions seemed to vary over a range between 3 and 31 whereas good results were obtained with 10 positions. I suspect that these microphone position problems have largely disappeared with the approval of the scanning method, ISO 9514—Part 2. The computer industry has also standardized a scanning method (ECMA 160[13]).

2.3 Noise Emission as a Design Tool

2.3.1 Power Flow Models

The source-path-receiver model implies attenuation (or sometimes amplification) along the path and a calculation to obtain the noise immission at the receiver. Such models are widely used in the air-conditioning industry to predict the noise levels in rooms based upon the noise emission of a fan or blower, the attenuation through ductwork, the effects of diffusers, and the properties of the room.

In simple cases, such as the one described here, the sound power of a part of a machine can be followed along internal paths[14] with the objective of estimating the sound power emitted by a multi-source machine and then sound pressure level perceived by an observer. Mainframe computers (now called servers) are generally multi-source machines and the predominant noise sources have been (and still are) air-moving devices. Sound travels through racks containing electronic circuitry that requires cooling, and in this case, one can follow the flow of power through the machine from many sources to determine the overall noise emission of the machine. In contrast to the overall sound power levels obtained by using the apparatus shown in Fig. 2, these models require a knowledge of the sound power emitted at both the inlet and outlet of the device. This information can be obtained by mounting the devices on a duct in a reverberation room and making the appropriate measurements. The two other quantities needed are estimates of the attenuation through the cards containing electronic circuits and "transmission factors" that describe the overall attenuation in noise emission that the package provides — from some location inside the machine to the radiation field.

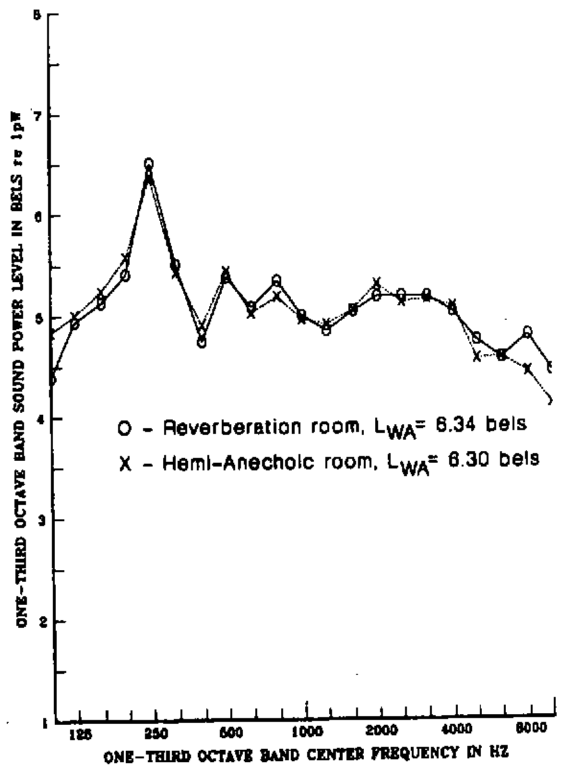

Fig. 3. Comparison of the one-third octave band sound power levels of an axial-flow fan at a back pressure of 60 Pa.

As an example, attenuation values for some cages containing cards are shown in Fig. 5. The increase in attenuation at low frequencies is probably due to end effects, and accounts for the uneven results at low frequencies that are shown in Fig. 6 — a comparison between model data and actual data for one particular configuration. A collection of data such as this allows models of machines containing many air-moving devices to be built, and predictions of the noise emission under various conditions to be made.

2.3.2 Conversion from Emission to Immission

Many methods have been devised to convert noise emission data (sound power levels) to immission data (sound pressure levels). One method used in the computer industry is described in ECMA TR27[15]. Sound pressure levels (L_p) may be calculated from sound power levels (L_W) in rooms having a variety of shapes and containing scattering objects. As an example, in a "flat room" having a length and width $>3H$ where H is the room height, L_p may be calculated from

$$L_p = L_W - 20\log(H/H_o) + \Delta L_f \qquad (1)$$

where H_o is 1 m and ΔL_f is given as a function of d/H in Fig 7. The two parameters in the figure are q, the density factor of the reflecting objects in the room (q = 0.2 in the figure), and the average absorption coefficient, α, in the room. For "flat" rooms, only the absorption coefficients of the floor and ceiling are considered. The variable q is a density factor related to scattering objects in the room, and is calculated from

$$q = (1/4S_f)\Sigma S_e \qquad (2)$$

Where S_f is the surface area of the room floor, and ΣS_e is the total area of the scatters in the room.

3. NOISE EMISSION AND SOUND QUALITY

There is a great deal of interest today in the *quality* of sound as opposed to the measures of noise emission discussed above. The automotive industry is a leader in this field — with interests in such problems as tones generated by radio antennae, the sounds of motor-actuated seat movements, the sound of motor-actuated window closures, and, of course, the sound of a door closing. Three sound quality issues in the computer industry are of interest; only one led to a standardized description of the sound in terms of noise emission.

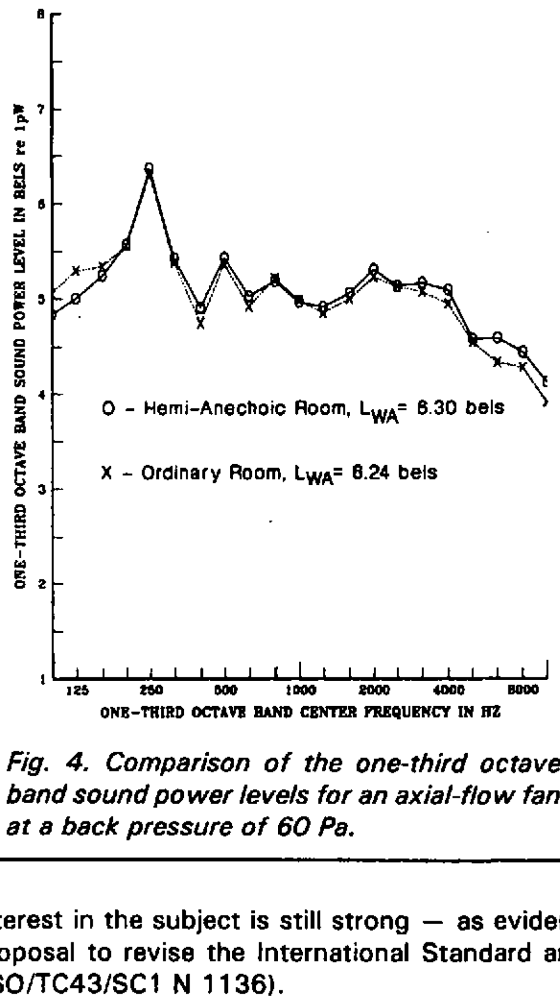

Fig. 4. Comparison of the one-third octave band sound power levels for an axial-flow fan at a back pressure of 60 Pa.

3.1. High Frequency Tones

In the early days of computer monitors, the monitors were designed much like television sets, and emitted tones having a frequency of about 15kHz. These emissions were very annoying, and received a great deal of management attention within the IBM Corporation. Because of the short wavelength and high spatial variability of the sound pressure level, an objective measure of the emission was difficult to obtain. For many years, the "standard" for the emission level was the space-averaged sound pressure level in a 230 m^3 reverberation room, but increased industry interest in the problem led to an examination of the problems involved with reverberation room determination of sound power at high frequencies. At high frequencies, air absorption is important, and reverberation times are short. However, the ability to measure short reverberation times and the use of directional microphones to separate the direct field from the reverberant field eventually led to the development of International Standard, ISO 9295, Acoustics—Measurement of the high frequency noise emitted by computer and business equipment. The problem with computer monitors was eventually solved by increases in circuit speeds and changes in technology - many noise problems, but interest in the subject is still strong — as evidenced by the formation of a new ISO work item proposal to revise the International Standard and extend it to telecommunications equipment (ISO/TC43/SC1 N 1136).

3.2. Damping of Machine Covers

The covers on mainframe computers are sometimes perceived as "tinny" when struck, and, in one case, received enough attention from management that the engineers added damping material to the interior of the covers. The effect of the damping material was, however, never quantified, and there was no firm requirement that the material be in place. Eventually cost pressures prevailed, and the material was removed — with praise for cost savings by new management.

3.3. Bearing Noise

Many earlier generations of mainframe computers were water-cooled, containing two redundant water pumps in a cooling distribution unit. Subtle sounds radiated from the bearings indicated to those charged with ensuring uninteruptible performance of the unit that the bearings were about to fail, and pumps were often replaced — some would say unnecessarily. The motor-pump

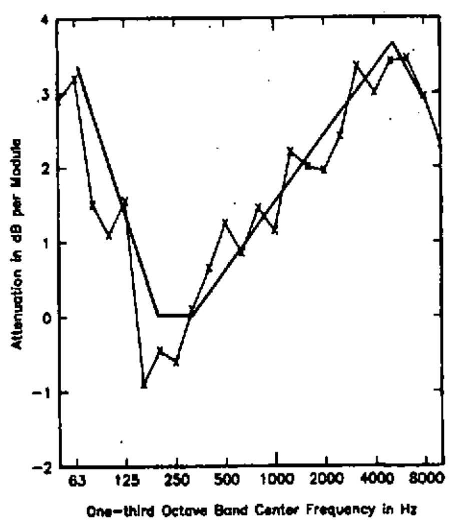

Fig. 5. Best estimate of the sound attenuation of a 25-cm high module containing electronic cards.

assembly carried a noise emission specification in terms of sound power level — set low enough to ensure that the noise specification for the unit itself was not exceeded. The warning sounds, however, were of a low level, and were difficult to quantify. The noise emission specification was not sufficient to define the subtle noise emissions. Eventually, this particular problem was also solved by a change in technology -the transition to air-cooled mainframes (servers).

4.0 VOLUNTARY LABELING

In the United States, there are a few examples of voluntary labeling of the noise emissions of machinery and equipment. The Air Refrigeration Institute has, for many years, had a program of labeling outdoor airconditioning equipment, and the data are available to consultants and others concerned with noise immission. Consumer products are rarely labeled — partly because a lack of demand, partly because of the difficulty in defining operating conditions, and partly because sound quality issues are perceived to be more important than sound power level. The situation may be quite different in Europe.

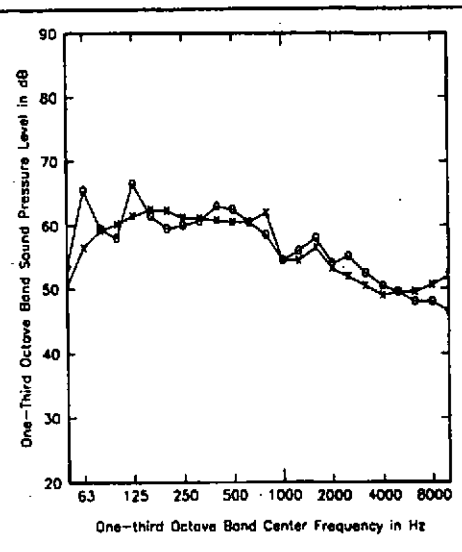

Fig. 6. An example of the measured (x—x) and calculated (o—o) sound power levels for a mid-gate blower in a machine frame. The measured A-weighted sound power level was 6.79 bels and the calculated level was 6.81 bels.

In Germany, a different approach has been tried with the environmental label "Blue Angel" being awarded. Noise emission data for a product are studied and compared with the noise emissions of similar products, and a criterion is established for the award of the label - illustrated in Fig. 8.

A description of the process for construction equipment is available.[16] The label can be applied to other products as described in the Appendix to reference 16. Further information is also on the Internet at www.blauer-engel.de. The label has had an impact on the computer industry — with levels for computer workstations set at declared sound power levels, L_{WAd}, = 4.8 B (x10 = 48 dB) when idling, and 5.5 B (x10 = 55 dB) when operating.

5.0 NOISE EMISSION FOR REGULATORY PURPOSES

In the United States, there is little interest in placing noise emission limits on stationary equipment — except when European requirements must be met. One early example of regulation in the USA from the now-failed noise program of the U.S. Environmental Protection Agency (EPA) involved portable air compressors. The agency failed to listen to prevailing opinion in Europe and

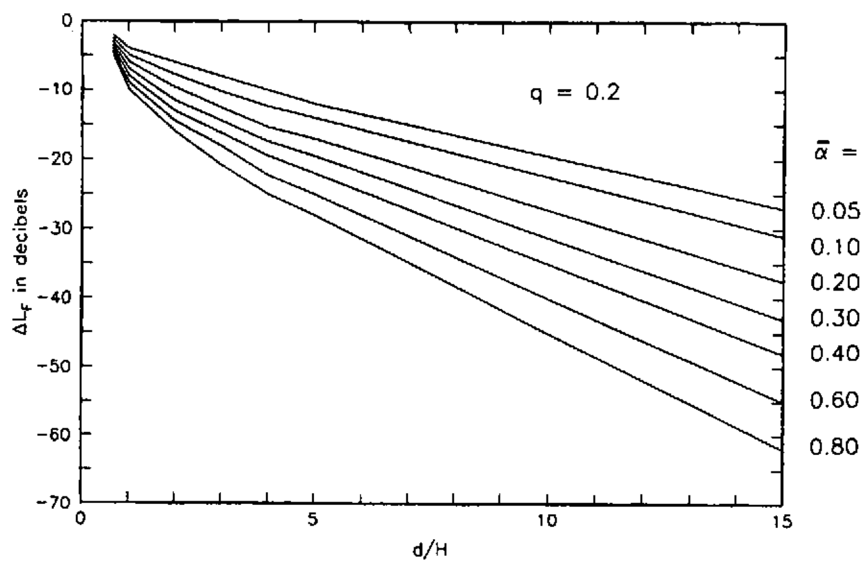

Fig. 7. Correction, ΔL_p for calculating the decrease with distance of the sound pressure level from a source for the density factor $q = 0.2$.

within the voluntary standards community in the USA that noise emissions should be specified in terms of sound power level. In regulations published in 1975 in the *Federal Register,*[17] the regulation specified A-weighted sound pressure levels 7 m from the surface of the equipment. The justifications, measurement procedures, and verification procedures required 21 pages in the *Federal Register*. Six years later, the entire program was terminated — when President Reagan' staff declared that noise was a "local problem."

Fig. 8. The German environmental label "Blue Angel."

There are others who understand the European situation better than I, but one significant development seems to me the change in directives within the European Union from product-specific noise emission standards to the "New Approach." There is now more responsibility placed on European standards bodies to develop product-specific standards. The situation as of 1994 was described by Higginson, Jacques, and Lang.[18] Additional data are provided in Annex 6 of the 1996 European Union *Green Paper,*[19] and a database of noise emission values for various types of outdoor equipment is maintained on the Internet.[20] A European Parliament resolution (A40183/97) stated that in addition to ambient noise reduction, "...attempts must be made to **reduce noise at the source,**" and further that the Commission "...looks into the prospects of an **effective control system** to reduce noise at the source." It would appear that the Working Groups involved with going beyond the *Green Paper* have only one group (VI) concerned with noise emission — railway vehicle noise emission.

In the computer industry, control of product noise emissions has been driven by Swedish noise emission requirements. These requirements are specified in terms of the sound power level in bels determined in accordance with current international standards. The key requirements are given in Table 2.

Table 2. Swedish recommended upper limits for declared sound power level values. *Statskontoret, Swedish Agency for Administrative Development,* Stockholm, Sweden. First day of validity: 1993-05-01. In case of conflict, the Swedish text prevails over the English text in the table. Amendments may be made in this table.

Product Category	Product Description	Recommended Upper Limit Sound Power Level in bels	
		L_{WAd} Operating	L_{WAd} Idling
Category I Equipment for use in dedicated rooms	A. All products	7.0 + K	7.0 + K
Category II Equipment for use in general business areas	A. Fully-formed character typewriters and printers	7.2	5.5
	B. Printers and copiers more than 4 m distance from workstations	7.0	6.5
	C. Tabletop printers and tabletop copiers	7.0	5.5
	D. Processors, controllers, disk & tape drives, etc. (more than 4 m distant from workstations)	7.0	7.0
	E. Processors, controllers, disk & tape drives, etc. (Less than 4 m from workstations)	6.8	6.6
Category III Equipment for use in quiet office areas	A. Printers, typewriters, and plotters	6.5	5.0
	B. Keyboards	6.2	N/A
	D. Floor-standing processors	6.0	5.5
	E. Tabletop processors, controllers, system units including built-in disk drives and/or tapes, display units with fans	5.8	5.0
	F. Display units (no moving parts)	4.5	4.5

Note:
$K = \lg (S/S_o)$ where S_o is equal to one square meter, and S is the footprint in square meters, i.e., the projection in square meters of the machine on the floor. If $S < 3$ square meters, use $S = 3$. The calculated value of the recommended upper limit may be rounded to the nearest upper 0.1 bel

6.0 NOISE EMISSIONS OF MOVING SOURCES

Since most of my experience is with the noise emission of stationary sources, I will make only two observations with respect to the noise emissions of moving sources.

6.1 Aircraft Noise

Requirements on the noise emissions of aircraft have been in place since 1969. Although the measurement techniques and reporting of noise emission levels must obviously be greatly different from those applicable to stationary sources, noise emission is a good measure of progress in the field. In the United States, this progress has been reported in several places, including articles by Stevens and Cazier[21] and by Willshire[22]. Fig. 9 appears in both papers. Two important points are:

- There has been a remarkable decrease in noise emission levels of aircraft in the last 45 years — driven by cooperative efforts between governments and private industry taking into account the state-of-the technology at any given time, and
- The curve is beginning to flatten - given current technology.

Although the National Aeronautics and Space Administration (NASA) in the United States has announced "stretch goals"[22] that, if met, will result in continuing reductions in noise *emission*, the *immission* situation may continue to deteriorate because of the growth of airline traffic. One small measure of the concern of citizens living near airports is the number of sites on the Internet established by citizens groups. In preparing an article related to noise and the Internet,[23] 12 such sites have been identified; more sites will probably be identified before the article is published.

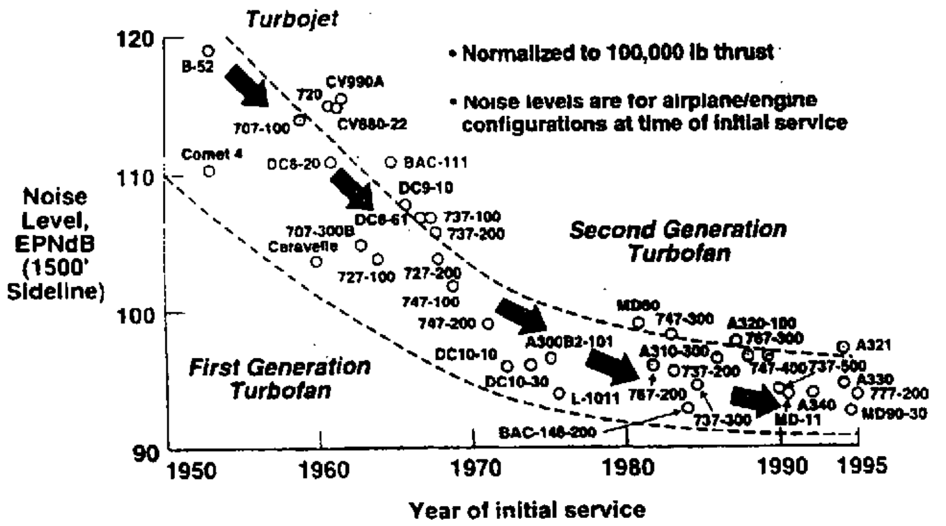

Fig. 9. Progress in noise reduction (after Willshire[22]).

6.2 Road Traffic Noise

In a draft article prepared by an international committee convened by Sandberg for the International Institute of Noise Control Engineering (I-INCE),[24] a study was made of the effects of regulations on road vehicle noise. For several reasons, it was concluded that regulations, generally written in terms of noise emission have had a limited effect on the noise immission levels perceived by those who live near roadways. Two of the key conclusions from the study were

- That noise emission from tires during "normal" running must be limited, and
- that a new measuring procedure for use during type testing of vehicles should be developed.

Similar conclusions were also published in the 1996 European Union *Green Paper*.[19] The I-INCE final report is expected to be published in 2000; the conclusions are not expected to be greatly changed. This obviously presents a major challenge to solve one of the most serious noise problems that faces the public at large.

7.0 SUMMARY

Two problems with current International Standards for determination of noise emission of sources have been identified, and two solutions have been proposed. A method used in the computer industry for conversion of noise *emission* values to noise *immission* values has been identified. Several of the roles that noise emission plays in noise control have been identified — in the design of equipment where power flow models are appropriate, one case where a sound quality problem led to a new International standard for noise emission, noise emission for regulatory purposes, and for awarding an enviromental label. A brief discussion of noise emission relative to moving sources has also been included.

8.0 THE FUTURE

To the extent that the future can be predicted from past events, it seems safe to make a few comments concerning noise control in the new millennium:

- It appears that Europe is now the driving force for reduction of noise emissions. European requirements on noise emissions are now felt worldwide as foreign manufacturers wish to export equipment to Europe. This trend will probably continue. The "New Approach" EU Machinery Noise Directive 89/392 has produced a great deal of international standards activities related to the definition of "emission sound pressure level."[25] Over time, this work should lead to better control over machinery noise emissions.

- Those industries in the United States now determining the noise emission of products will continue to do so. Absent further U.S. government regulation, there is little incentive for other industries to initiate programs related to noise emission — unless regulations are imposed by others that affect exports.

- In the United States, the automotive industry has great interest in the noise perceived by the occupants of vehicles, and the growth in test facilities and engineering positions devoted to noise and vibration control will probably continue. Absent new regulations on motor vehicle noise emissions, the very expensive program of constructing noise barriers along highways will continue as a means to protect the public from the noise of road vehicles.

- If the "stretch goals" for aircraft noise reduction announced by NASA can be met by the aircraft industry in the early years of the next millennium, progress in noise reduction can be expected, but experience has shown that significant noise reductions will be required to satisfy already-concerned citizens.

- The confusion in the minds of the public and social scientists between *emission* and *immission* will continue unless different units are used to express these quantities. For the past 20 years, the computer industry has used, and will continue to use, the bel as the unit for sound power level and the decibel as the unit of sound pressure level.

- The publication of the EU *Green Paper* has led to new noise control activities in Europe. Most of the emphasis in the *Green Paper* is on noise *immission* which, in the end, is what affects the public. Emphasis must continue to be placed on noise *emissions* as a tool for reducing noise *immissions*.

- Although the activities initiated as a result of the *Green Paper* are controversial,[26] it is very important to seek common technical solutions *vis-à-vis* noise measurement and rating, and not allow noise to be declared a"local problem" as it was in the failed EPA program in the United States.

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