TERMINAL EQUIPMENT

Control applications for the following types of terminal equipment are described in their respective chapters of the 1964 GUIDE AND DATA BOOK.

Radiant Panels—Warm Air Ceiling, Chapter 14
—Hot Water, Chapter 14
—Electric, Chapter 15
—Air Conditioning, Chapter 5
Snow Melting, Chapter 83
Induction Units, Chapter 3
Dual-Duct Mixing Units, Chapter 2
Room Fan-Coil Units, Chapter 4

Unit heaters, unit ventilators, and classroom heating-cooling units are discussed in Chapter 54 of this volume.

Radiators and Convectors

When individual room control is used, each radiator and convector is equipped with an automatic control valve. Depending upon the size of the room, one thermostat may control one valve or several valves in unison.

Volume Damper or Single-Duct Units

When individual room control is used, each volume damper is equipped with an operator. Often, several air outlets are supplied through one damper. The damper operation is usually controlled by a room-type thermostat. The volume damper is usually set to provide for minimum ventilation requirements, regardless of thermostat demand. When the air-supply system is used for heating as well as cooling, it is necessary to use a heating-cooling thermostat.

REFERENCE

[1] E. J. Brown and J. R. Fellows: Pressure losses and flow characteristics of multiple-leaf dampers (ASHAE JOURNAL SECTION, *Heating, Piping and Air Conditioning*, August 1957, p. 119).

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CHAPTER 14

SOUND CONTROL

Terminology, Sound Control Procedure, Determination of Design Criteria, Selection of Room Terminal Units, Required Duct Attenuation, Acoustical Treatment for Duct Systems, Selection of Outdoor Equipment, Isolation of Machine Vibration, Checking Completed Installation

SOUND conditioning, the creation of an acoustical environment equally as comfortable as the thermal environment, has become an accepted part of building design. The responsibility for specifying what constitutes a proper acoustic environment for various parts of the building should rest with the architect, because he alone is in a position to evaluate *all* factors involved. The air-conditioning system cannot *provide* the specified acoustic environment but must be *compatible* with it. This means that the engineer designing the air-conditioning system must establish not only heating, cooling, and air flow performance requirements, but also acoustic performance limits for the various components, and must specify pertinent installation details. The American Society of Heating, Refrigerating and Air-Conditioning Engineers has established standards[1,2,3] for acoustic performance measurement so that components can be uniformly and accurately rated

The purpose of this chapter is to provide a step-by-step procedure for the acoustic calculations for air-conditioning systems and to present the available design information in a readily usable form. The information given will include both fundamental principles and relationships derived therefrom; and also empirical data and generalized results of experience. Some of the statements and expressions given here will be qualified or presented as useful approximations or rules of thumb. This is done to make the content of this chapter rigorously correct where possible, and to provide the best available useful data in all areas, even those where convenient procedures have not been fully developed.

The basis of this chapter is a procedure for designing the acoustic performance of an air-conditioning installation. This approach creates a useful framework in which to present the fundamentals of sound control, and indicates the significance of various component parts of the installation. It is intended that much of the information given will be of value to the designer of specific air-conditioning equipment. Due to the diverse nature of such products, however, it is beyond the scope of this chapter to present specific procedures for all such design work. References 4 to 7 will be found useful in this regard.

More complete coverage of sound and sound control can be found in References 8 to 13; and information on architectural acoustics in Reference 14.

TERMINOLOGY

Levels and Decibels

In controlling sound, both the quality (or frequency spectrum) and the magnitude have to be considered. Magnitudes are expressed as *levels* above a standard reference value. The *level* is a measure of the *ratio* of sound power, or a similar quantity, to a reference value, and is expressed in decibels.

$$\text{Level, in db} = 10 \log_{10}\left(\frac{\text{Measured quantity}}{\text{Reference value}}\right) \qquad (1)$$

The reference value for a particular quantity identifies the 0 db point of the level scale of that quantity.

Fig. 1 is a graphical presentation of Equation 1. An increase in level means that the magnitude of the sound is increased in a certain ratio. For a 3 db increase, the ratio is doubled (the quantity is twice its original value). A reduction in the quantity (and the resulting ratio) to half its original value is expressed by a 3 db reduction in level.

The decibel notation simplifies the process of dealing with the tremendous range of sound magnitudes which the human ear can hear. Anywhere within this range, a change of one to two db is about the smallest change the ear can detect.

Since the decibel is a measure of ratio only, it is always necessary to specify the kind of ratio and the reference value. Two kinds of levels must be distinguished, (1) *sound pressure level* and (2) *sound power level*. The relationship between sound power and sound pressure corresponds to that between heat and temperature. The ear and instruments respond to sound pressure, but equipment sound ratings are best expressed in terms of sound power output. Like heat, sound power cannot be measured directly; it has to be computed from sound pressure measurements.[1]

Sound pressure levels are always based on the *square* of the sound pressure because the acoustical energy is proportional to the square of the sound pressure.

Sound pressure level L_p, in decibels re 0.0002 microbar, is:

$$L_p \text{ (or SPL)} = 10 \log_{10}\left(\frac{p}{0.0002}\right)^2$$

$$= 20 \log_{10}\left(\frac{p}{0.0002}\right) \qquad (2)$$

where p = sound pressure in microbars or dynes per square centimeter.

Sound power level L_W in decibels re 10^{-13} watt, is defined as:

$$L_W \text{ (or PWL)} = 10 \log_{10}\left(\frac{W}{10^{-13}}\right) \qquad (3)$$

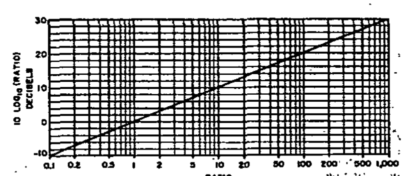

Fig. 1 .... Graph of Equation 1 for Expressing a Ratio of Sound Power in Terms of Decibels

The general responsibility for this chapter is assigned to TC 1.7, Sound and Vibration.