# E C M A

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

# PRODUCT NOISE EMISSION OF COMPUTER AND BUSINESS EQUIPMENT

ECMA TR/62

June 1993

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## Brief history

The acoustical conditions at work stations have received considerable attention as the amout of computer and business equipment installed at or in close proximity to work stations has increased. One of these influences is acoustical noise being emitted by the equipment. Depending on the level of the noise, different aspects may be of interest when rating its effects on man. At high levels, noise may cause hearing impairment, at lower levels it may be annoying, may interfere with speech communication, or may impair creativity.

To control the noise in the working environment, several countries have established regulations and standards which define maximum allowable noise levels to which an individual may be exposed during working hours.

To achieve acceptable noise levels at a work station, two factors must be considered, acoustically well-designed machines and acoustical provisions in the environment itself. This implies that both users and manufacturers are responsible for the acoustical conditions at the workplace.

To facilitate communication between different parties involved in noise control, ECMA has established standards for the measurement and declaration of product noise as well as a guideline which describes the interrelationship of product noise levels and the resulting level in an installation. This ECMA TR/ summarizes acoustical terminology and describes the International Standards and regulations with regard to computer and business equipment.

This ECMA TR/ also presents some examples of declared noise emission values of computer and business equipment.

Adopted as an ECMA Technical Report by the General Assembly of June 1993.

## Table of contents

# 1 Scope

ECMA TR/62 gives an overview of the latest developments in noise control standards and the interpretation of noise emission values of computer and business equipment. It describes the standardized quantities for the measurement and declaration of product noise emission of such equipment. This information may be useful when comparing the noise emission of equipment of the same product category as well as of different equipment used in the same environment.

A comprehensive collection of product noise emission values for various categories of computer and business equipment is provided which supports such comparisons and helps in the interpretation of product noise emission.

The applications of this Technical Report are in product design and announcement, product literature and data sheets as well as in product selection for specific user requirements.

It is not the purpose of this TR/62 to define product noise level specifications nor to establish noise exposure limits for persons working in the vicinity of computer and business equipment in a given environment.

# 2 References

| | |
|---|---|
| ECMA-74 | Measurement of Airborne Noise Emitted by Computer and Business Equipment |
| ECMA-108 | Measurement of High Frequency Noise Emitted by Computer and Business Equipment |
| ECMA-109 | Declared Noise Emission Values of Computer and Business Equipment |
| ECMA-160 | Determination of Sound Power Levels of Computer and Business Equipment |
| ECMA TR/27 | Method for the Prediction of Installation Noise Levels |
| ISO 4871 | Acoustics - Declaration and verification of noise emission values of machinery and equipment |
| 86/188/EEC | Council Directive of 12 May 1986 on the protection of workers from the risks related to exposure to noise at work |
| 89/392/EEC | Council Directive of 14 June 1989 on the approximation of the laws of the Member States relating to machinery |
| 90/270/EEC | Council Directive of 29 May 1990 on the minimum safety and health requirements for work with display screen |
| Germany | Arbeitsstättenverordnung, Par. 15 Lärm (workplace regulation, par. 15 noise) |
| Sweden | Statskontoret, The Swedish Agency for Administrative Development, Technical Standard 26:2 (1989-07-01), Noise of Computer and Business Equipment. |

*NOTE 1*

*The interrelationship of ECMA and International, regional, and national standards is given in annex B.*

# 3 Acoustical terminology

## 3.1 General

In noise control a variety of terms and definitions have been introduced during the past two decades of standardization. When dealing with acoustical values a basic understanding of the most commonly used expressions is essential. These definitions are listed in clause 4 of this ECMA TR/.

An important area of understanding relates to the distinction between the noise level emitted by an individual machine or a piece of equipment operated under well defined standard conditions in a controlled acoustical room (called EMISSION), and the noise which may occur at a receiver's location in a given environment under actual working conditions as a result of the influence of multiple noise sources, and to which individuals are exposed during their daily work (called IMMISSION). This interrelationship is explained in clause 5 of this ECMA TR/.

The following descriptions summarise some of the physical quantities which form the basis for noise measurements and noise ratings with regards to human hearing.

### 3.2 The nature of sound

Mechanically vibrating bodies put the surrounding air particles into movement which eventually reaches the human ear. For computer and business equipment typical sound sources are printing mechanisms, moving paper, cooling devices, rotating disks, and transformers, which emit sound power ranging from about $10^{-8}$ watts to $10^{-2}$ watts.

Air pressure fluctuations in the frequency range of 20 Hz to 20000 Hz are perceived as sound. The sensitivity of the human ear is strongly frequency dependent: at 1000 Hz it is sensitive to sound pressure fluctuations as low as 20 micropascals, whereas at 100 Hz its sensitivity is reduced to 10 percent. It also perceives sound pressure fluctuations at about 20 pascals and above as painful. Because of this large range of sensitivity of the human ear it is common practice to use a logarithmic scale when dealing with sound pressure fluctuations.

### 3.3 The decibel scale

The rating of sound pressure fluctuations on a logarithmic scale yields the sound pressure level in decibels, abbreviated dB, and is being a dimensionless quantity. The audible sound pressure fluctuations range from 0 dB to about 120 dB. A sound pressure level change of 1 dB may be just detected by the human ear, 3 dB are clearly perceived and 6 dB are significant. If a sound pressure level in increased by 10 dB, the ear normally perceives it as a doubling in loudness. A decrease of 10 dB is similarly perceived as a halving in loudness.

*NOTE 2*

*The decibel scale may be applied to both quantities, the total sound power emitted by a source, and the sound pressure, to which the human ear is sensitive. As this may easily lead to confusion, ECMA-109 reserves the decibel for sound pressure level measurement and declaration and uses the unit "bel" ( 1 B = 10 dB) when declaring sound power levels.*

## 4 Glossary

### 4.1 Sound pressure, $p$ , in pascals

The sound pressure, $p$ in pascals is the incremental variation in pressure above and below the static pressure at a given location in air. These variations are extremely small; e.g. for normal speech, they average about 0,1 pascals above and below atmospheric pressure at a distance of one metre from the speaker. For practical reasons the root-mean-square value (rms or effective value) of the instantaneous sound pressures averaged over a time interval is determined.

### 4.2 Sound pressure level, $L_p$, in decibels

#### 4.2.1 Single machine

The sound pressure level, $L_p$ in decibels is ten times the logarithm to the base 10 of the ratio of the square of the (rms) sound pressure, $p$, to the square of the reference sound pressure, $p_o$, of 20 micropascals ( $p_o$ = 20 µPa, the approximate threshold of hearing at 1000 Hz):

$$L_p = 10 \lg \frac{p^2}{{p_o}^2} \text{ dB}$$

#### 4.2.2 Adding sound pressure levels

In many practical situations the emitted noise of several machines may be combined to obtain a total level. A simple rule of thumb is:

- Add two equal sources: The total value is 3 dB higher
- Add ten equal sources: The total value is 10 dB higher

A more detailed explanation is given in annex A.

### 4.3 Equivalent continuous sound pressure level, $L_{peq}$, in decibels

The equivalent continuous sound pressure level, $L_{peq}$, in decibels is equal to a steady sound pressure level which would produce the same sound energy over a stated period of time as a specified time-varying sound, also known as time-averaged sound pressure level.

**4.4 A-weighted sound pressure level, $L_{pA}$, in decibels**

The A-weighted sound pressure level, $L_{pA}$, in decibels is a frequency weighted (equivalent continuous) sound pressure level, where the standardized A-weighting accounts for the frequency dependent hearing characteristics. The A-weighted sound pressure level is the commonly used value for noise measurements and noise ratings with regard to its influence on man. The correct terminology is to express the value of $L_{pA}$ in decibels (dB) re 20 μPa, although it is commonly expressed in units of dB(A) or dBA.

**4.5 C-weighted peak sound pressure level, $L_{pCpeak}$, in decibels**

The C-weighted peak sound pressure level, $L_{pCpeak}$ in decibels is the highest instantaneous value of the C-weighted sound pressure level determined over an operational cycle.

**4.6 Sound power, $W$, in watts**

The sound power, $W$, in watts is the rate per unit time at which airborne sound energy is radiated from a source into its environment. The sound power of a source is essentially independent of the environment.

**4.7 The sound power level, $L_W$ in decibels**

The sound power level, $L_W$, in decibels is a logarithmic quantity of the measured sound power of a source with reference to 1 picowatt ($W_o = 10^{-12}$ watts):

$$L_W = 10 \lg \frac{W}{W_o} \text{ dB}$$

**4.8 A-weighted sound power level, $L_{WA}$, in decibels**

The A-weighted sound power level, $L_{WA}$ in decibels is a frequency weighted sound power level, using the standardized A-weighting. The A-weighted sound power level is used to describe the total emitted sound power of a source, being independent of its environment.
The relevant standard for computer and business equipment, ECMA-109 (ISO 9296) specifies this level as the major quantity for product noise emission declaration.

**4.9 Noise emission**

For computer and business equipment the standards for determining noise emissions are ECMA-74 (ISO 7779), ECMA-108 (ISO 9295), and ECMA-160 (ISO 9614-2). They describe the acoustical noise emitted by a sound source under well defined conditions. These conditions include the installation and operation of the source (equipment), the acoustical properties of the test environment, and the measurement and evaluation method to be used. These conditions are generally specified in basic International Standards which are supplemented by test codes for specific machinery and equipment categories. A summary and interrelationship of these International Standards is given in annex B.

**4.10 Emission sound power level and sound pressure level**

The emission sound power level and sound pressure level are quantities to describe the noise emitted by a source, e.g. computer and business equipment. Major noise emission quantities are the A-weighted sound power level, $L_{WA}$ and the A-weighted sound pressure level at the operator or bystander positions, $L_{pA}$ These values are to be determined under standardized installation and operating conditions in an acoustically well defined environment. The A-weighted sound power level is the primary quantity when declaring noise emission values for computer and business equipment. The A-weighted sound pressure level is used for standard emission measurements at a defined operator position or at positions on a path around the equipment (bystander positions).

*NOTE 3*

*The C-weighted peak sound pressure level $L_{pCpeak}$, in decibels, is also a noise emission quantity, which is mainly used if its value exceeds 130 dB. For computer and business equipment, such high levels are unusual, and are not included in this Technical Report.*

**4.11 Declared noise emission values**

Declared noise emission values are emission sound power and sound pressure levels specified and/or reported for a specific piece of equipment or for a mass produced machine family. ECMA-109 (ISO 9296) defines these values.

**4.11.1 Declared sound power level, $L_{WAd}$, in bels**

The declared sound power level, $L_{WAd}$ in bels includes statistical quantities accounting for measurement uncertainties and production variability. For computer and business equipment, declared A-weighted sound power levels, expressed in bels (B), are "statistical maximum" values for a given machine family or a batch of manufactured units. The sound power emitted by a product is the same both in an acoustical laboratory as it is in the user's actual environment, if the product is operating identically in both environments.

*NOTE 4*

***Why use Bels?*** *The computer and business equipment industry has a long tradition in publishing product noise emission values. For more than 25 years the A-weighted sound pressure level in decibels has been used as the noise descriptor, whereas other industries have used the A-weighted sound power level, also in decibels, as the declaration value. When introducing the sound power level for declaring the noise emission of computer and business equipment in the early 1980's, it was not well received because of the confusion with sound pressure levels, when both were given in decibels, albeit with different reference values. A breakthrough was achieved with the publication of ECMA-109 in 1985 and the resulting ISO 9296 in 1988, which clearly separates the two quantities by declaring the A-weighted sound power level in bels (1 B = 10 dB), and no longer confuses the user between sound power and sound pressure.*

*World-wide experience gained with these standards in years since their introduction has confirmed the importance of the decision to use the bel. The computer and business equipment industry uses these standards which provide a clear basis of communication in product noise declaration.*

**4.11.2 Declared sound pressure level, $L_{pAm}$, in decibels**

Declared sound pressure level, $L_{pAm}$, in decibels are production mean values as defined in ECMA-109 (ISO 9296).

**4.12 Noise immission**

Noise immission describes the noise received by humans. Rating of immission may be performed with respect to hearing impairment, annoyance or interference with speech or work.

Immission in general depends on the noise emitted by the installed equipment in operation during the workshift as well as other influences such as the acoustical properties of the room, number of machines contributing to the total immission, and the background noise which may be due to air conditioning systems, outside traffic etc. Since in real life the noise in environments varies with time, the A-weighted equivalent continuous sound pressure level $L_{pAeq}$ is used for immission measurements.

**4.13 Rating sound level, $L_r$, in decibels**

The rating sound level, $L_r$ in decibels is used for rating noise immission of a person at a work station. The A-weighted (equivalent continuous) sound pressure level, $L_{pAeq}$ is to be determined over a typical 8-hours workshift, which is then called the rating level $L_r$; this level may include, or may be supplemented with corrections to account for the impulsive or tonal character of the rated noise.

## 5 Noise emission versus noise immission

The interrelationship of the noise emitted by an individual machine, or several machines, (Product Noise Emission) and the noise perceived by an individual person at a given location in an installation during a workshift (Noise Immission) is complex and must be determined for each situation individually.

The procedure to determine the immission consists of

a) predicting the installation noise level $L_{pAeq}$ from physical parameters such as room characteristics, declared noise emission values, etc. Declared values depend on the standard measurement procedure, standard installation conditions, standard operations, and declaration procedure which takes into account measurement variability and production variation.

b) determining actual $L_{pAeq}$ by adjusting the predicted level to account for differences in actual equipment operation and exposure duration.

c) determining the rating level $L_r$ by applying possible subjective corrections, if any, to the actual $L_{pAeq}$

These steps are shown in figure 1. ECMA TR/27 describes a method for predicting the Installation Noise level $L_{pAeq}$ at a specified work station for a given arrangement of equipment in a room with known acoustical properties. This predicted $L_{pAeq}$ may be considered "typical" for a specific location in a given installation. It considers the physical layout of the installation and assumes standard operating conditions for the installed equipment; it is free of subjective and variable parameters, but it may be used for immission predictions. These predictions are mainly useful when planning a new installation or for establishing a specification for a new product which is to be installed at work stations for which immission limits apply. The actual value of $L_{pAeq}$ may differ from the predicted installation noise level $L_{pAeq}$ if the machines operate differently from standard conditions and if the operator's exposure duration is different.

In an existing installation, a person's actual noise rating level $L_r$ can be directly determined from the equivalent continuous sound pressure level measured during a full workshift, usually using a noise dose meter which is attached to the worker's clothing. Corrections for impulsive noise and/or prominent tones may be applied.

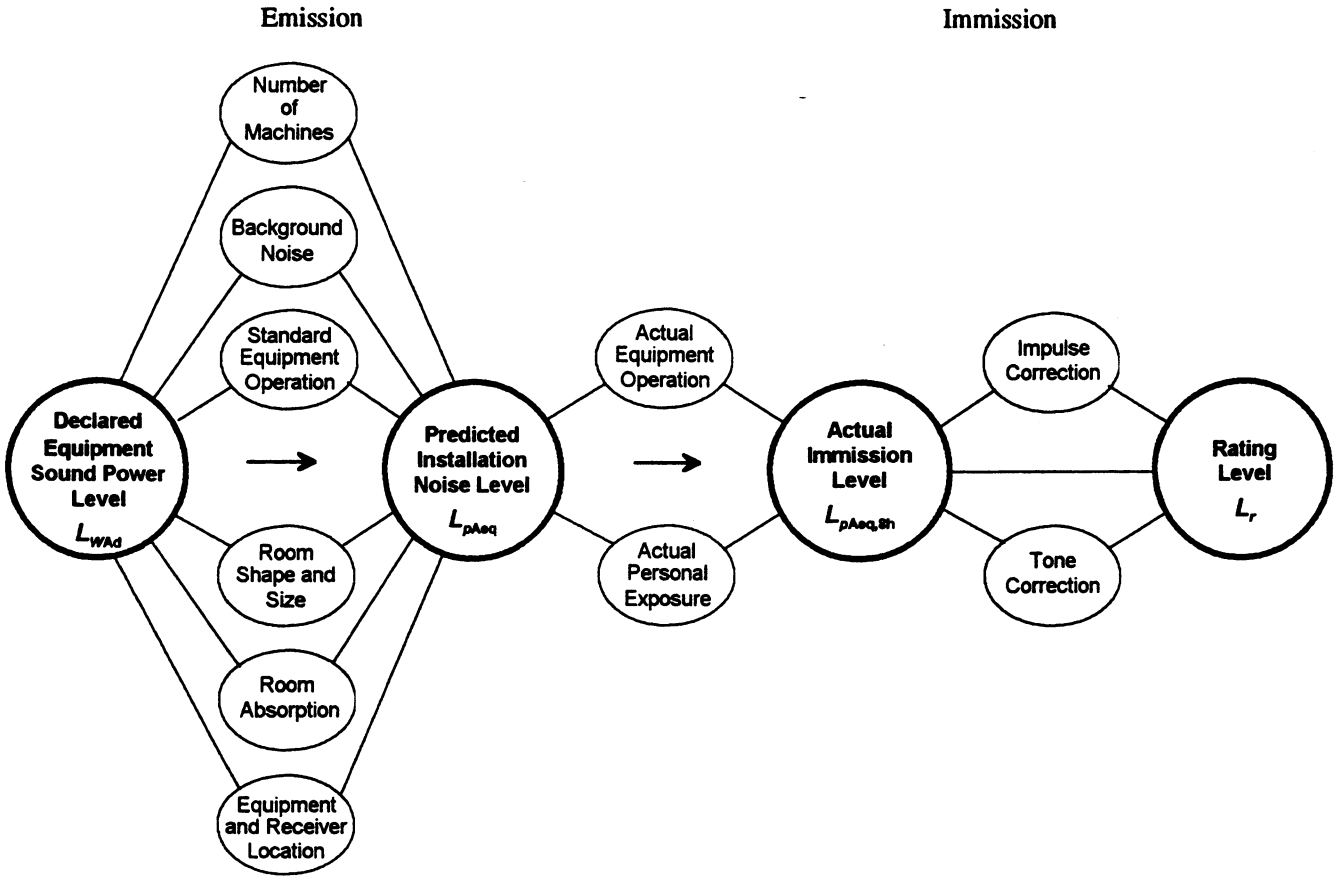



**Figure 1 - Interrelationship of noise emission and noise immission**

## 6 Product categories

### 6.1 General

The evolution in the information technology industry during the past decade has provided a large variety of computer and business equipment being used in professional and private applications.

There are product categories which are typically found in a specific type of environment, e.g. text processing equipment in offices. On the other hand the same product family may be found in different working environments, e.g. table-top printers in General Business Areas as well as in a Private office.

For the purpose of this ECMA TR/ computer and business equipment has been grouped in categories which are typical for their technical functions and operation rather than with regard to their application in a specific environment for which different noise requirements may exist.

For product noise declaration purposes, the wide range of computer and business equipment must be grouped into categories of products for which similar installation and operating conditions can be defined. Such conditions have been specified in ECMA-74 and ISO 7779 for a variety of products categories, which are listed below:

- Typewriters
- Printer *)
- Teleprinters
- Keyboards *)
- Duplicators *)
- Card readers - card punches
- Magnetic tape units *)
- Disk units *)
- Visual display units
- Electronic units *)
- Microform readers
- Facsimile machines (Telecopiers) and page scanners
- Cheque processors
- Personal computers and workstations *)
- Page printers *)
- Self-service automatic teller machines
- Enclosures or rack systems

*) Acoustical data for these categories of products are given in annex D.

## 6.2 Description of product categories

**Typewriters**
Equipment with a keyboard for manual data entry. The information is either keyed-in and immediately printed on paper character-by-character (manual typing), or keyed-in and stored for word or line editing with following automatic print-out (interactive operation).
Typewriters which are equipped with a full-page storage are considered as typewriters during manual typing and as printers during automatic print-out of a full page.

**Printers**
Electronically controlled equipment which prints stored information on paper and is not normally keyboard-operated, and the noise output is dependent on the print pattern. The output may be obtained by means of impact-printing (e.g. typebar-, train-, chain-, or band-printers, printwheel, type-element or matrix printers) or by non-impact printing (e.g. ink jet, electro-erosion, or thermal printers).

**Teleprinters**
Equipment operating as a send/receive machine basically comprising a keyboard, a printing unit, a mechanical or electronic send/receive unit (line control unit) and (integrated or optional) a memory unit (electronic, paper tape punch or reader, magnetic tape, disk or cassette).

Standard test Conditions: For keyboard operation, the operation conditions specified for typewriters apply. For automatic operation, the operating conditions specified for printers apply.

**Keyboards**
Equipment for manual data entry fixed to, or connected with, another unit, e.g. visual display unit, or a computer console.

**Duplicators**
Equipment which can produce one or more copies from a master. Such equipment can be coupled with one or more additional attachments and features. These may be in the form of input, ouput or internal devices for a variety of duplicating needs. Input devices can be in the form of master document loading, handling and registering, or special paper feeders for continuous stationery or label printing. Output devices can be in the form of copy handlers such as sorters, automatic staplers, stackers and binders. The equipment may have an internal reversing device(s) for handling two-sided originals and producing two-sided copies; i.e. automatic duplexing. The duplicator may also offer full colour duplicating from full colour masters, or highlight colour duplicating.

**Card readers - Card punches**
Equipment of this category may perform a single function, such as reading the information from, or punching it into, a punched card. The two functions may also be combined in one machine which allows the use of both functions in one process or to use them separately. The number of cards processed per unit time depends for readers mainly on the nominal processing speed; for punches it may be significantly influenced by the total number of columns to be punched per card.

**Magnetic tape units**
Equipment for writing on, and reading from, a magnetic tape wound on reels or within a cassette or a cartridge. A unit may contain one or more separately operable tape drives.

**Disk units**
Equipment for writing on, and reading from, one or more rotating magnetic or optical disks. Disks may be removable or non-removable. Magnetic disks may be flexible or rigid. A unit may contain one or more separately operable disk drives.

**Visual display units**
Equipment which displays information on a screen, and which may be equipped with a keyboard for information entry. The keyboard may be fixed to the display unit or connected to it by means of a cable.

**Electronic units**
Equipment such as processors, electronic memories and controllers, containing only electronic circuits, power supplies, but no moving mechanical parts except those associated with cooling.

**Microform readers**
Equipment to display micro-images. Microform readers may differ from each other, depending on the different types of microforms to be used, such as microfiche, aperture cards and rollfilm.

**Facsimile machines (Telecopiers) and page scanners**
Equipment operating as a send/receive machine, basically comprising a numeric keyboard, a paper feeding device, a scanner, a print unit and an electronic send/receive control unit. The telecopier is used for transmitting text, drawings and graphic information via public transmission networks.

**Cheque processors**
Equipment of this category may perform a single function such as printing (or encoding) information onto cheques, reading information from cheques, printing lists, storing/retrieving information from a flexible disk cartridge, or sorting cheques.

**Personal computers and workstations**
Small systems such as personal computers, workstations and word processors which include a keyboard, visual display unit, and a processor unit which itself may contain combinations of one or more flexible disk and/or rigid disk drives, magnetic tape units or printers.

**Page printers**
Equipment which produces printed output from computers, the noise output of which is independent of the material printed on the page. Such equipment may have peripheral equipment such as envelope feeders, sorters, and special paper feeders. It may print single-sided or two-sided.

**Self-service automatic teller machines**
Equipment of this category is mainly used in banking environments and provide various services to customers such as cash dispense, funds transfer between accounts, account balance inquiry, balance statement issuing and envelope deposit.

**Enclosures or rack systems**
Systems comprising several similar or different system sub-assemblies which are installed in a rack or enclosure. The sub-assemblies can have different configurations as required by the user to meet his specific requirements. The sub-assemblies may be self-contained with their own power supplies and cooling assemblies or may rely on power supplies and cooling assemblies installed separately in the rack or enclosure.

# 7 Product noise emission

## 7.1 Declaration of product noise emission

The general procedure for product noise emission declaration is specified in ISO 4871. Specific information for computer and business equipment is defined in ECMA-109. Declared noise emission values are the A-weighted sound power level , $L_{WAd,}$ in bels (B) and the A-weighted sound pressure level, $L_{pAm,}$ in decibels (dB).

For computer and business equipment declared sound power levels are a statistical maximum value for a large proportion of the manufactured units, typically 0,3 B higher than the production mean value. The declared sound pressure level is however a mean value for the production. The sound power level $L_{WAd}$ is a statistical maximum value (or "guaranteed value") while the sound pressure level is an average value, since the sound power level is the primary descriptor of computer and business equipment, whereas, the sound pressure level is only supplemental, although required, information.

Declared noise emission values are given in technical documents or other literature supplied to the user. An example is shown in annex C. The presentations shall contain the following information for both the operating and the idling condition of the equipment, if applicable.

a) the words "Declared Noise Emissions per ECMA-109" (resp. ISO 9296)
b) the Declared sound power level, $L_{WAd,}$ in B
c) the Declared sound pressure level, $L_{pAm,}$ in dB, and an indication of whether it applies to the operator or the bystander positions.

The value of the declared sound power level indicates the limit below which the A-weighted sound power levels of a specified large proportion of a batch of machines are stated to lie when the machines are new. The verification procedures are designed such that there is 95% probability of acceptance if no more than 6,5% of the equipment in a batch has A-weighted sound power levels greater than the declared noise emission value $L_{WAd.}$

The value of the declared sound pressure level indicates the mean value of a series of machines manufactured according to the same specification when new. This value is not part of the verification procedure.

## 7.2 European product noise emission declaration requirement

The council of the European Communities has established in Chapter 1. Article 3, of its Council Directive of 14 June 1989 on the approximation of the laws of the Member States relating to machinery (89/392/EEC), that "Machinery covered by this Directive shall satisfy the essential health and safety requirements", set out in (its) annex 1. annex A 1.7.4(f) of its, specifies the indicators which are required for machinery with regard to noise declaration, reading in part:

> The instructions must give the following information concerning airborne noise emissions by the machinery, either the actual value or a value established on the basis of measurements made on identical machinery:
>
> - equivalent continuous A-weighted sound pressure level at work stations, where this exceeds 70 dB(A); where this level does not exceed 70 dB(A), this fact must be indicated,
> - peak C-weighted instantaneous sound pressure value at work stations, where this exceeds 63 Pa (130 dB in relation to 20 µPa),
> - sound power level emitted by the machinery where the equivalent continuous A-weighted sound pressure level at work stations exceeds 85 dB(A).
>
> Sound levels must be measured using the most appropriate method for the machinery. The manufacturer must indicate the operating conditions of the equipment during measurements and what methods have been used for the measurements.

The methods for measuring sound pressure levels and for determining sound power levels for machinery and equipment have been established by ISO in ISO 11200 series and in ISO 3740 series respectively and the methods for declaring sound emissions have been established by ISO in ISO 4871. ECMA-109 (ISO 9296) and ECMA-74 (ISO 7779 and EN27779) are the machine specific test codes based on the ISO general standards (see annex B).

The member states of the European Community are about to have the requirements of the EEC Directive implemented into national legislation. As part of this legislation, the Federal Republic of Germany has included the noise emission declaration requirements in the latest revision of the Law on Machinery Safety. This law

**became effective on 1993 January 1, and is valid for all types of machinery and equipment being exhibited or offered for sale.**
The required values are to be obtained in accordance with the above mentioned ISO standards which are being implemented as EN standards.

ECMA has taken the position that declaring noise emission values per ECMA-109 (ISO 9296) satisfies the requirements of 89/392/EEC and the German equipment safety law. ECMA has endorsed the CBEMA position that the computer and business equipment industry will continue to measure and declare noise emission levels of its products according to ISO 7779 and ISO 9296.

### 7.3 European requirement for work with display screen equipment

E.C. Council Directive 90/270/EEC, of 29 May 1990, "on the minimum safety and health requirements for work with display screen" invokes the use of ISO 9241 to cover the detailed requirements of the directive (see also clause 9 of this ECMA TR/). Part 6 of ISO 9241 contains several sections on acoustical noise. Although its aim is the noise at the workplace, it also describes the requirements for noise emission from machines and equipment.

Significantly ISO 9241 Part 6 contains the following statements:

> "When replacing or purchasing equipment and machinery for workrooms, details should be given in machine documents/contracts of the noise emission from these machines and equipment."
>
> "Noise emission data consist of the noise emission values, e.g. the sound power level, the machine related workplace sound pressure level and the impulse content, as well as information on the standards used for noise emission measurements (ISO 3744, 3745, 3746, 7779) and standards for the method of declaration of the data and the verification method (ISO 4871; ISO 7574 parts 1 to 4)."

### 7.4 Product noise emission specifications

Product noise emission requirements are part of most product specifications. Such information is required if national regulations or standards exist or if the equipment is offered in a noise-sensitive market. It is important that specifications for noise emissions from computer and business equipment be according to industry standards and international standard procedures. For computer and business equipment, this requires declarations per ECMA-109 based on measurements to ECMA-74 or ECMA-160. The following values should be specified: $L_{WAd}$ and $L_{pAm}$ for both operating and idle modes according to ECMA-109.

Purchasers of computer and business equipment requesting acoustical information concerning the noise emission of the equipment, should refer to ECMA-109. "Declared noise emission values" are standardized product emission quantities and should be used in all communications between manufacturers or suppliers and users. Installation noise levels or workplace immission levels are not qualified quantities in product specifications or product sales literature of computer and business equipment.

Product noise emission requirements may be defined in procurement specifications. For instance, the Swedish Agency for Administrative Development has included such requirements in its Technical Standard 26:2, Part 3: "Recommend Highest Emission Values for Computer and Business Equipment" in accordance with ECMA-109. The table that lists these values is shown in annex E.

Many of today's regulations define requirements which limit the noise exposure of a person at a work station (Immission requirements, see clause 9 of this ECMA TR/), rather than the noise level of the product itself. Therefore, for products which are intended for use in environments for which immission limits exist, the corresponding noise emission value for the equipment must be derived from the immission requirement. This interrelationship is described in clause 5 of this ECMA TR/.

The United Kingdom Central Computer and Telecommunications Agency in its "Catalogue of standards for use in IT Procurement" refers to British Standard BS 7135 Parts 1, 2, and 3 (ISO 7779, ISO 9296, ISO 9295 respectively) for specifying the noise emission values of IT equipment.

## 8 User environments

There is a large variety of environments in which computer and business equipment is used. Accordingly, the noise immission requirements for the various types of environments may also vary greatly. To facilitate this interrelationship, the most typical types of environments may be described as follow:

### 8.1 Manufacturing/Utility Area

An area where the principal activity is manufacturing or production. The ambient noise level is usually established by the machines in the room, many of which may operate continuously.

Examples of manufacturing areas are factories, workshops, manufacturing and assembly floors.

### 8.2 Data Processing Area

An area specially designed to house large or medium size data or document processing equipment. The principal activity is routine work performed by machine operators and service personnel. The ambient noise level is usually established by the machines in the room, many of which operate continuously.

Examples of data processing areas are computer rooms with and without raised floors, print shops, duplicating rooms, and cheque reading/sorting rooms.

### 8.3 General Business Area

An area where the principal activity is routine office work or similar activity. The ambient noise level in the area may be determined by the noise of the equipment in the room, but may also be significantly influenced by speech communication. Personnel may work at individual workplaces and several workplaces may be installed in the area, which may be equipped with personal systems or host terminals. Medium size data processing equipment may also be installed in the area, but usually not in the immediate vicinity of individual work stations or desks.

Examples of general business areas are open plan areas, administrative or bookkeeping offices, word processing and typing centres, terminal printer areas, and laboratory rooms.

### 8.4 Commercial (or Special) Office Area

An area where the principal activity is office work or similar activity where the noise level may or may not depend on the equipment installed in the area. Personnel may work at individual desks and several desks may be installed in the area. These are areas where good speech communication is important with ambient noise levels significantly below those of a general business area.

Examples of Commercial Business Areas are commercial agency offices, including banks, finance and loan companies, insurance and travel agencies, hospital office areas.

### 8.5 Quiet Office/Professional Office Area

An area with low ambient noise level where activity requires a high degree of mental concentration or creativity. Both, single user offices and rooms for several persons may require such an office or space.

Examples of quiet office areas are private offices for executives, business professionals, scientists, engineers and programmers, libraries, classrooms, conference and meeting rooms, hospital operating rooms, medical treatment rooms, and private residences.

## 9 Work station requirements

Work station requirements are immission requirements to protect workers against noise which may impair hearing or human activities. Several countries have established requirements for the immission level at a work station. Such requirements may either be part of legislation setting maximum allowable limits, or be issued as guidelines or standards giving recommended noise immission values.

Several countries have established a safety noise immission limit of 85 dB(A), above which noise protection programs are required. This limit has also been specified in the EEC Council Directive of 12 May 1986 (86/188/EEC).

There are only a few countries which have specified limits below this level. The following two regulations are examples of such requirements:

**Germany:**
As part of the workplace law, published in 1975, Germany has established immission limits for the working environment. Paragraph 15 "Protection against Noise" reads in part:

> In working environments the noise level shall be as low as possible due to the type of work. The (*immission*) rating level at the workplace in a working environment, including influences which may originate outside the room, shall not exceed:

- 55 dB(A) when mainly mental activity is concerned
- 70 dB(A) when simple or mainly mechanized office work or similar activity is concerned
- 85 dB(A) for other types of activity

**Norway:**
The Norwegian regulation relating to the Working Environment Act of 1982 states the same limits for the same type of work as the German law; in addition recommended values are given which are 10 dB lower. The regulation states "Efforts shall be made to reduce the noise exposure for employees to the recommended limits, if this is technically possible and does not entail unreasonable costs".

**European Directive for work with display screen equipment 90/270/EEC and ISO 9241-6:**
E.C. Council Directive 90/270/EEC, of 29 May 1990 "on the minimum safety and health requirements for work with display screen " invokes the use of ISO 9241 to cover the detailed requirements of the directive. 90/270/EEC states:

> 2 (d) Noise, Noise emitted by equipment belonging to work station(s) shall be taken into account when a work station is being equipped, in particular so as not to distract attention or disturb speech.

ISO 9241 on "Ergonomic requirements for office work with visual display terminals" Part 6 "Environmental requirements" contains several sections on acoustical noise. In part the acoustics sections contain the following statements:

> The purpose is to optimize work stations and workrooms acoustically for activities on visual display terminals. The primary aim in this connection is to avoid interferences and harmful influences. Those effects due to noise can be classified as follows:
>
> - Hindrance of verbal and other communication
> - Reactions of the central and autonomic nervous system
> - Reduced performance
> - Annoyance
> - Impaired hearing
>
> The annoyance and harmful effects due to noise at the workplace are generally determined by the rating sound level. In order to avoid harmful effects due to noise, the rating sound level at the workplace should be as low as possible. In order to achieve this, the noise emission from work equipment must be as low as possible and the workrooms acoustically optimized. This implies protection against noise penetrating the workroom from outside as well as sound insulation within the room. Tables of the standard show values for the maximum background noise level depending on the type of activity and the type of room.
>
> Noise at the workplace:
>
> The rating sound level should not exceed $L_r$ = 55 dB(A) in the case of difficult and complex tasks.

Another section deals with noise levels which should not be exceeded if verbal communication is necessary at the workplace.

## Annex A

## Addition of noise levels

Noise from several sources combines to produce a sound level higher than that from any individual source. Two equally intense sound sources operating together produce a sound level which is 3 dB higher than one alone and 10 sources produce a 10 dB higher sound level. Note that the dB values are not added directly as they are logarithmic quantities.

A total noise level is calculated from individual levels using the following equation:

$$L_{tot} = 10 \lg \sum_{i=1}^{N} 10^{0,1 L_i}$$

Where $L_{tot}$ is the resulting noise level
$L_i$ is the noise level of the individual unit
$N$ is the number of levels to be added.

For two levels, this relationship is illustrated in figure A.1 below which may directly be used as shown in the following example.

Example: A rack system consists of three modules, a processor producing 50 dB, a channel controller 56 dB, and a rigid disk unit 59 dB; all three units were measured individually under the same conditions. The total level for the rack system can be calculated using the above equation, to be 61,1 dB, or be determined directly from the diagram below as follows:

Step 1 - Take the difference of the levels of the first two units ($L_1$ = 50 dB and $L_2$ = 56 dB) being 6 dB; enter this value into the diagram (X-axis) and read on the vertical scale the corresponding value, $\Delta L$ = 1 dB; add this value to the higher of the two equipment levels ($L_2$ = 56 dB), resulting in a sum of 57 dB;

Step 2 - The new two levels are $L_2$ = 57 dB and the level for the rigid disk unit, $L_3$ = 59 dB; the difference is 2 dB which is entered into the diagram (X-axis) and we read a corresponding value of $\Delta L$ = 2,1 dB from the vertical scale; this value is added to the higher level ($L_3$ = 59 dB), resulting in a total level of 61,1 dB for the rack system.

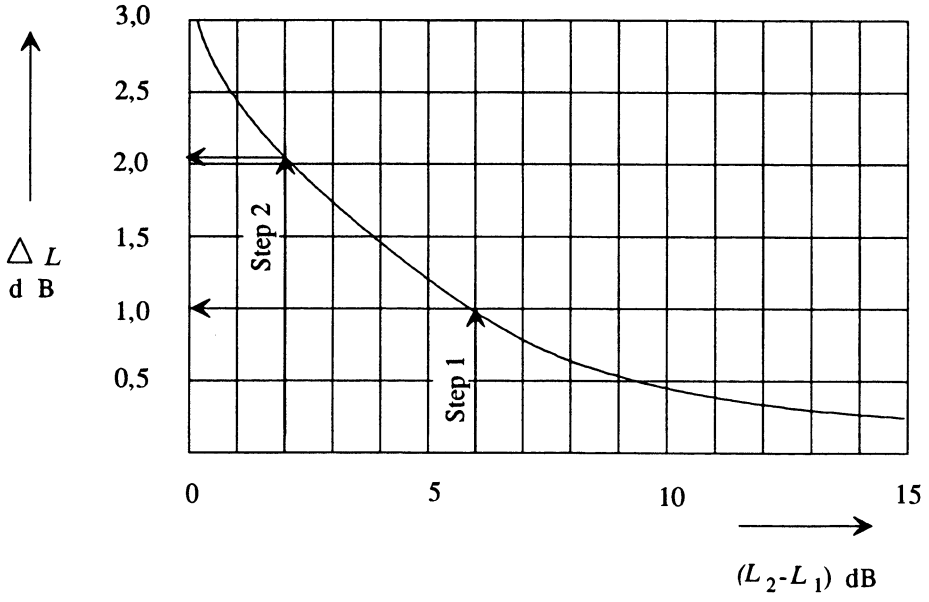
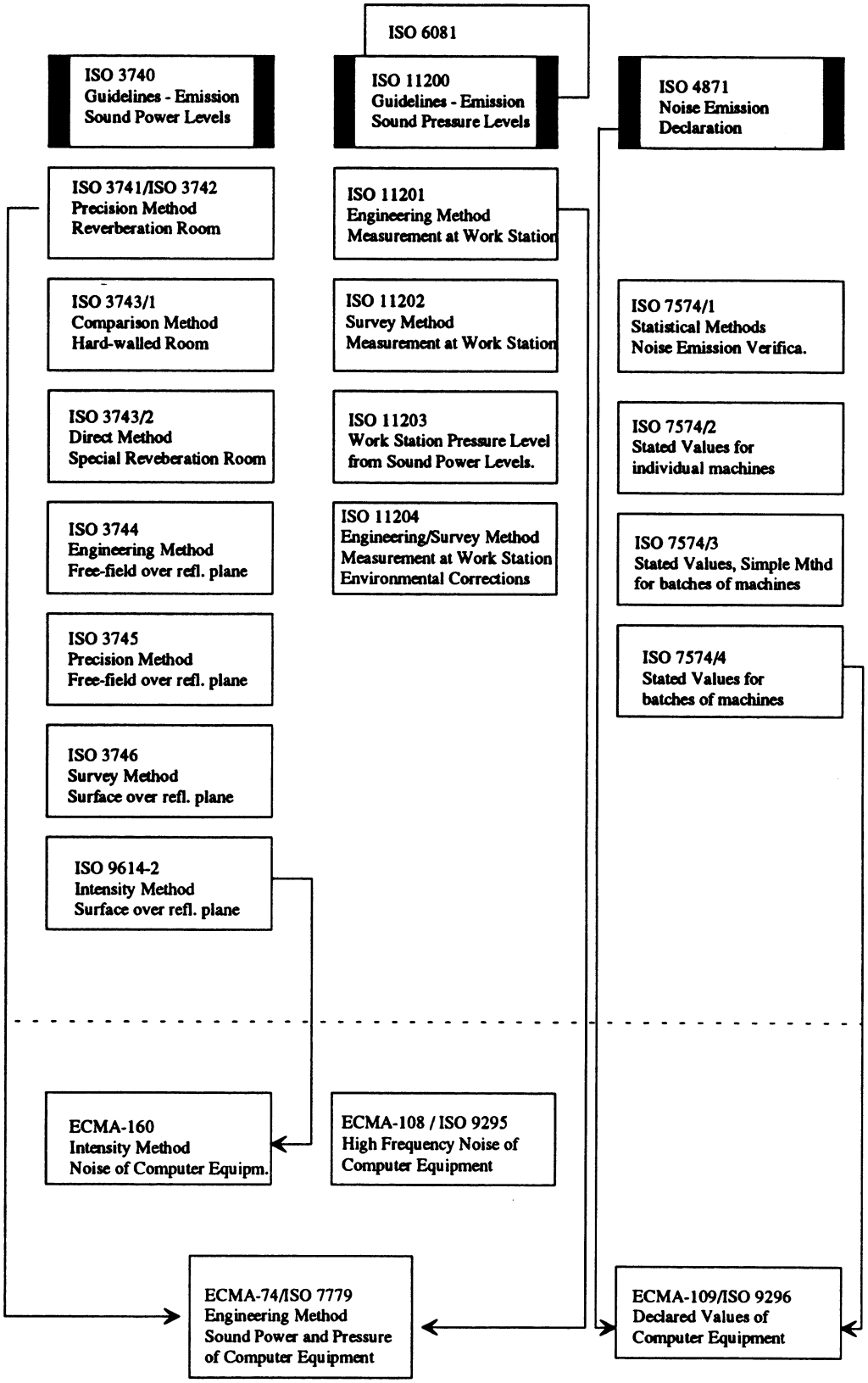



**Figure A.1 - Noise level addition chart**

# Annex B

## Interrelationship

### B.1 Interrelationship of International Standards for Noise Emission of Computer and Business Equipment



## B.2 Interrelationship of International Standards for Noise Emission - General Applicability - Sound Power Levels

| TITLE | ECMA | ISO | BS | EN | DIN | FRANCE | JAPAN | USA | Others |
|---|---|---|---|---|---|---|---|---|---|
| Determination of sound power levels of noise sources - guidelines | | 3740 | 4196 Part 0 | | 45635 PT1 | NFS 30-006 | | S1.30 | Norway NS 4816 |
| Precision methods in reverberation rooms | | 3741 | 4196 Part 1 | 23741 | 45635 PT2 | NFS 31-022 | | S1.31 | |
| Precision method for discrete frequency & narrow band sources in reverberation rooms | | 3742 | 4196 Part 2 | 23742 | 45635 PT2 | NFS 31-023 | | S1.32 | |
| Direct method in reverberation rooms | | 3743 | 4196 Part 4 | | 45635 PT3 | NFS31-024 | | S1.33 | |
| Engineering method for free fields over reflecting plane | | 3744 | 4196 Part 5 | | 45635 PT1 | NFS 31-025 | | S1.34 | |
| Precision method field over reflecting plane | | 3745 | 4196 Part 6 | | 45635 PT1 | NFS 31-026 | | S1.35 | Norway NS 4821 |
| Survey methods | | 3746 | 4196 Part 7 | | 45635 PT1 | NFS 31-027 | | S1.36 | Norway NS 4822 |
| Survey methods using a reference sound source | | 3747 | 4196 Part 7 | | | NFS 31-067 | | | |
| Determination of sound power levels using sound intensity; measurement using fixed points | | 9614-1 | | | | | | S12.12 * | |
| Determination of sound power levels using sound intensity; measurement by scanning | | 9614-2 | | | | | | S12.12 * | NS-INSTA 121 Norway |
| | | | | | | | | | |
| Test code for the measurement of airborne noise emitted by rotating electrical machinery | | | | 21680 | | | | | |
| Engineering methods for free field over reflecting plane | | 1680-1 | 7458 Part 1 | 21680-1 | | | | | AS 1081 |
| Survey methods | | 1680-2 | 7458 Part 2 | 21680-2 | | | | | |

## B.3 Interrelationship of International Standards for Noise Emission - General Applicability - Sound Pressure Levels

| TITLE | IEC | ISO | BS | EN | DIN | FRANCE | JAPAN | USA | Others |
|---|---|---|---|---|---|---|---|---|---|
| Method of preparation of test codes of engineering grade for measurement at operator or bystander positions of noise emitted by machinery | | 6081 | 7025 | | | | | | |
| Acoustics-Noise emitted by machinery and equipment-Guidelines for the use of basic standards for the determination of emission sound pressure levels at the work station and at other specified positions | | DIS11200 | | PrEN 31200 | | | | | |
| Acoustics-Noise emitted by machinery and equipment-Engineering method for the measurement of emission sound pressure levels at the work station and at other specified positions | | DIS11201 | | PrEN 31201 | | | | | |
| Acoustics-Noise emitted by machinery and equipment-survey method for the measurement of emission sound pressure levels at the work station and at other specified positions | | DIS11202 | | PrEN 31202 | | | | | |
| Acoustics-Noise emitted by machinery and equipment-Determination of emission sound pressure levels at the work station and at other specified positions from the sound power level | | DIS11203 | | PrEN 31203 | | | | | |
| Acoustics-Noise emitted by machinery and equipment-Measurement of emission sound pressure level at the work station and at other specified locations - Engineering/survey methods requiring environmental corrections | | DIS11204 | | PrEN 31204 | | | | | |

## B.4 Interrelationship of International Standards for Noise Emission - Computer and Business Equipment

| TITLE | ECMA | ISO | BS | EN | DIN | FRANCE | JAPAN | USA | Others |
|---|---|---|---|---|---|---|---|---|---|
| Measurement of airborne noise emitted by computers and business equipment | 74 | 7779 | 7135 Part 1 | 27779 | DIN EN 27779 (45.635 Part 19) | NFS 31-072 | JIS Z 8731-1983 | S12.10 | AS3755 Australia |
| Measurement of high frequency noise emitted by computers and business equipment | 108 | 9295 | 7135 Part 2 | 29295 | | NFS31.11 1 | | | AS3756 |
| Declared Noise Emission Values or computers and business equipement | 109 | 9296 | 7135 Part 3 | | 45.649 Part 1 & 2 | | | | AS3757 |
| Determination of sound power levels of computers and business equipment using sound intensity; Scanning method in controlled rooms | 160 | | | | | | | | |

## B.5 Interrelationship of International Standards for Noise Emission - Small Air Moving Devices

| TITLE | ECMA | ISO | BS | EN | DIN | FRANCE | JAPAN | USA | Others |
|---|---|---|---|---|---|---|---|---|---|
| Measurement of Noise Emitted by Small Air-moving Devices | | DIS10302 | | | | | | ANSI S12.11 | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

## Annex C

## Product noise emission declaration - Examples of noise emission declarations

### Example 1

Declared noise emission values apply to all variations of a product and no operator position is specified

| Product: Computer, Model ABC<br>Declared noise emissions in accordance with ISO 9296 | Operating | Idling |
|---|---|---|
| $L_{WAd}$ (1 B = 10 dB) | 7,1 B | 7,0 B |
| $L_{pAm}$ (bystander positions) | 57 dB | 56 dB |

### Example 2

Different declared noise emission values apply to variations of the product manufactured in different years and an operator position is specified.

| Product: Disk drive, Model DEF<br>Declared noise emissions in accordance with ISO 9296 | Operating | Idling |
|---|---|---|
| $L_{WAd}$ (1 B = 10 dB) | 5,2 B | 4,8 B |
| $L_{pAm}$ (operator position) | 41 dB | 37 dB |
| Year of manufacture: 1981-1982 | | |
| $L_{WAd}$ (1 B = 10 dB) | 5,5 B | 5,1 B |
| $L_{pAm}$ (operator position) | 44 dB | 40 dB |
| Year of manufacture. before 1981 | | |

### Example 3

Declared noise emission values apply to individual printer units, no operator position is specified and several printing speeds are available, of which 100 cps is the most frequently used.

| Product: Printer model XYZ; serial number: 123456<br>Declared noise emissions in accordance with ISO 9296 | Operating | Idling |
|---|---|---|
| $L_{WAd}$ (1 B = 10 dB) | 7,4 B | 5,2 B |
| $L_{pAm}$ (bystander positions) | 62 dB | 40 dB |

## Annex D

### Product noise emission value for categories of computer and business equipment

Members of Committee ECMA/TC26 have collected declared product noise emission values for many equipment categories during 1990/92. All data originate from products of ECMA member companies and were supplied by these companies to the ECMA secretariat for further statistical evaluations and presentations.

For the categories, for which representative statistical noise emission values were available, data are shown in this annex.

The listed values do not necessarily represent "best available noise control technology" or "a level of improved acoustical design" since they do not consider other important parameters which could affect the acoustical emissions of a product. Such other factors include: size, functionality, reliability, cost of operation, ease of use, etc.

It is planned to update this information as new data becomes available.

Detailed Noise Emission Values are presented for the following equipment categories; these are declared values in accordance with ECMA-109 (resp. ISO 9296):

- Printers: see D.1

  Impact line printers
  Impact matrix printers

- Keyboards: see D.2

- Duplicators: see D.3

- Magnetic tape units: see D.4

  Large tape units
  Medium size tape units

- Disk units: see D.5

  Disk units, floor-standing
  Disk units, table-top

- Electronic units: see D.6

  Electronic units, large processors
  Electronic units, medium size processors

- Personal computer and workstations: see D.7

  Personal computer, floor-standing
  Personal computer, table-top

- Page printers: see D.8

*NOTE D.1*

*The terms "large" and "medium size" are not uniquely defined so that for some equipment overlapping data could not be avoided.*

## D.1 Printers

Standard test conditions

Printing a specified test pattern at nominal speed on single sheet paper weighing approximately 75 g/m$^2$ or continuous folded or rolled stationery, weighing approximately 55 g/m$^2$.

### D.1.1 Impact line printers

Declared noise emission values:

| | | | |
|---|---|---|---|
| **Printing** | Sample size: | N = 17 | N = 17 |
| | Mean value: | $L_{WAd}$ = 7,5 B | $L_{pAm}$ = 58,2 dB |
| | Stand.dev.: | s = 0,31 B | s = 2,7 dB |
| **Idling** | Sample size: | N = 13 | N = 14 |
| | Mean value: | $L_{WAd}$ = 6,7 B | $L_{pAm}$ = 48,4 dB |
| | Stand.dev.: | s = 0,49 B | s = 7,2 dB |

Individual values are plotted in figures D.1 and D.2.
Statistically, 68% of the values are within the following limits:

| **Impact line printers (floor-standg.)** | $L_{WAd}$ (B) | $L_{pAm}$ (dB) |
|---|---|---|
| Printing | 7,2 - 7,8 | 56 - 61 |
| Idling | 6,2 - 7,2 | 41 - 56 |

### D.1.2 Impact matrix printers (tabletop):

Declared noise emission values:

| | | | |
|---|---|---|---|
| **Printing** | Sample size: | N = 45 | N = 41 |
| | Mean value: | $L_{WAd}$ = 7,3 B | $L_{pAm}$ = 58,3 dB |
| | Stand.dev.: | s = 0,36 B | s = 3,6 dB |

Individual values are plotted in figures D.3 and D.4.
Statistically, 68% of the values are within the following limits:

| **Impact matrix printers (tabletop)** | $L_{WAd}$ (B) | $L_{pAm}$ (dB) |
|---|---|---|
| Printing | 6,9 - 7,7 | 55 - 62 |

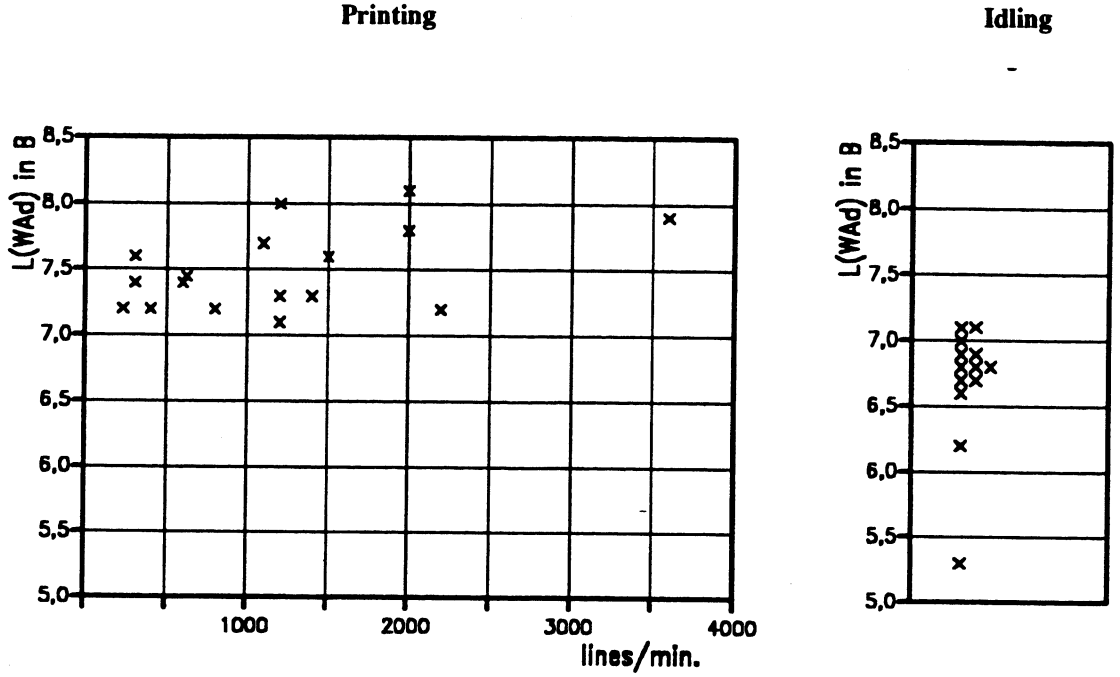



**Figure D.1 - Declared sound power levels, $L_{WAd}$ in B - Impact line printers**

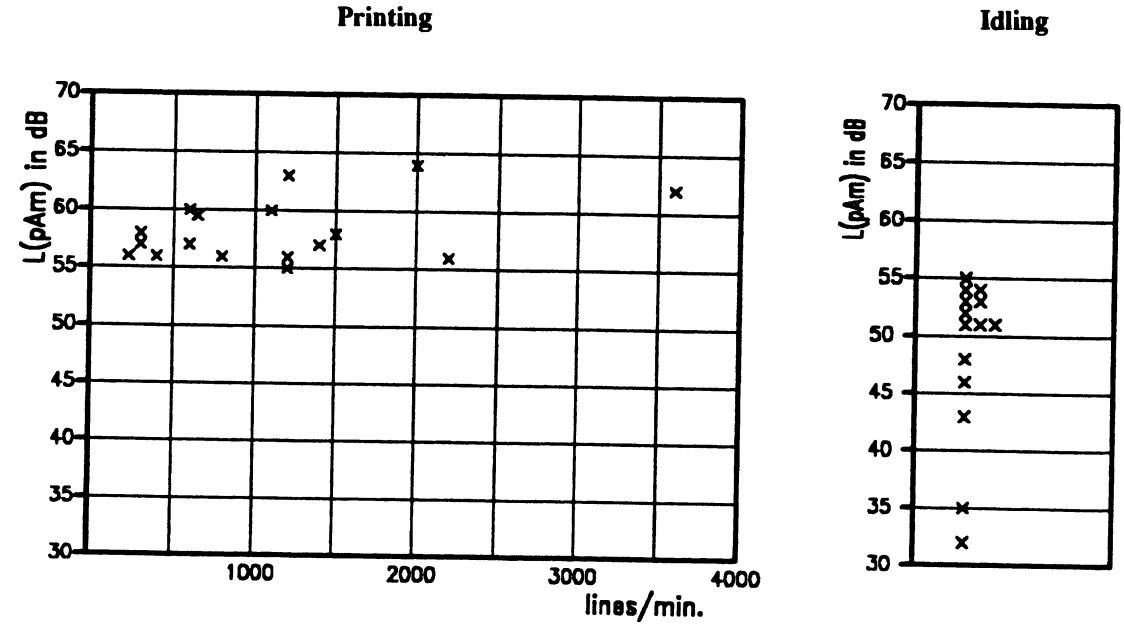



**Figure D.2 - Declared sound pressure levels, $L_{pAm}$ at the bystander positions, in dB - Impact line printers**

*NOTE D.2*

*Values for the idle mode of printers also depend on size and speed of the equipment.*

**Printing**

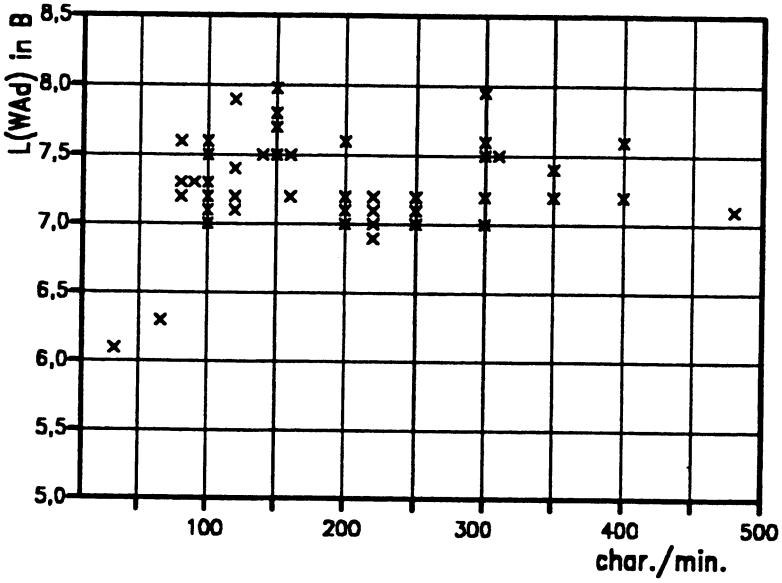



**Figure D.3 - Declared sound power levels, $L_{WAd}$ in B - Matrix printers (tabletop)**

**Printing**

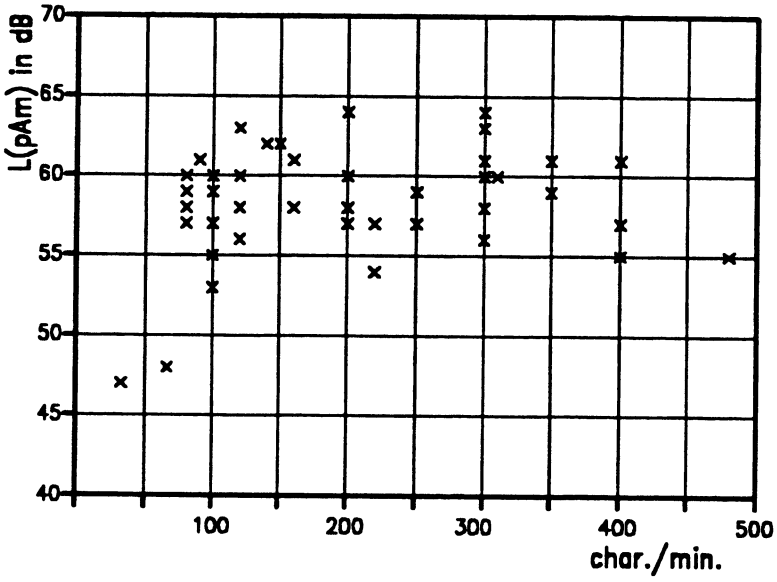



**Figure D.4 - Declared sound pressure levels, $L_{pAm,}$ at the bystander positions, in dB - Matrix printers (tabletop)**

## D.2 Keyboards

Standard test conditions

Keying-in at a rate of 5 char./s, preferable using a test robot.

Declared noise emission values for keyboards are:

| | | | |
|---|---|---|---|
| Keying-in | Sample size: | N = 22 | N = 22 |
| | Mean value: | $L_{WAd}$ = 5,7 B | $L_{pAm}$ = 49,6 dB |
| | Stand.dev.: | s = 0,44 B | s = 4,3 dB |

Individual values are plotted in figures D.5 and D.6.

Statistically, 68% of the values are within the following limits:

| **Keyboards** | $L_{WAd}$ (B) | $L_{pAm}$ (dB) |
|---|---|---|
| Typing | 5,3 - 6,1 | 45 - 54 |

*NOTE D.3*

*Variations of keyboard noise levels are mainly due to small differences in the adjustments of the keyboard robot and its interaction with the keys.*

**Operating**

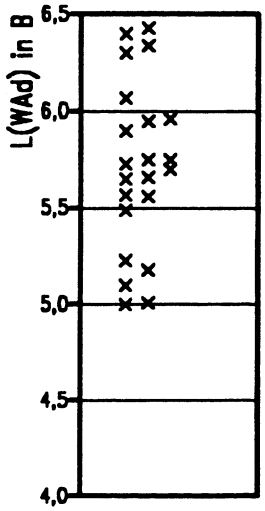



**Figure D.5 - Declared sound power levels, $L_{WAd}$ in B - Keyboards**

Operating

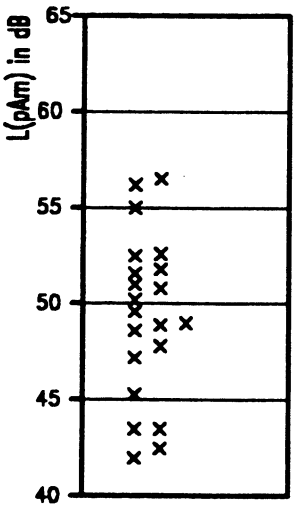



**Figure D.6 - Declared sound pressure levels, $L_{pAm}$ at the operator's positions, in dB - Keyboards**

## D.3 Duplicators

Standard test conditions

Desktop equipment is placed on the standard test table, floor-standing units are on the floor of the test room. Either single sheets of paper, weighing approximately 75 g/m2, or continuous folded or rolled stationery shall be used. Printing shall be performed at the rated speed; printing one copy from one master. Consecutive operation cycles shall be performed.

Declared noise emission values for duplicators are

| | | | |
|---|---|---|---|
| Copying | Sample size: | N = 13 | N = 10 |
| | Mean value: | $L_{WAd}$ = 7,8 B | $L_{pAm}$ = 60,7 dB |
| | Stand.dev.: | s = 0,43 B | s = 3,9 dB |
| Idling | Sample size: | N = 17 | |
| | Mean value: | $L_{WAd}$ = 6,1 B | |
| | Stand.dev.: | s = 0,51 B | |

Individual values are plotted in figures D.7 and D.8.
Statistically, 68% of the values are within the following limits:

| Duplicator (Floor-standing) | $L_{WAd}$ (B) | $L_{pAm}$ (dB) |
|---|---|---|
| Copying | 7,4 - 8,3 | 57 - 65 |
| Idling | 5,6 - 6,6 | |

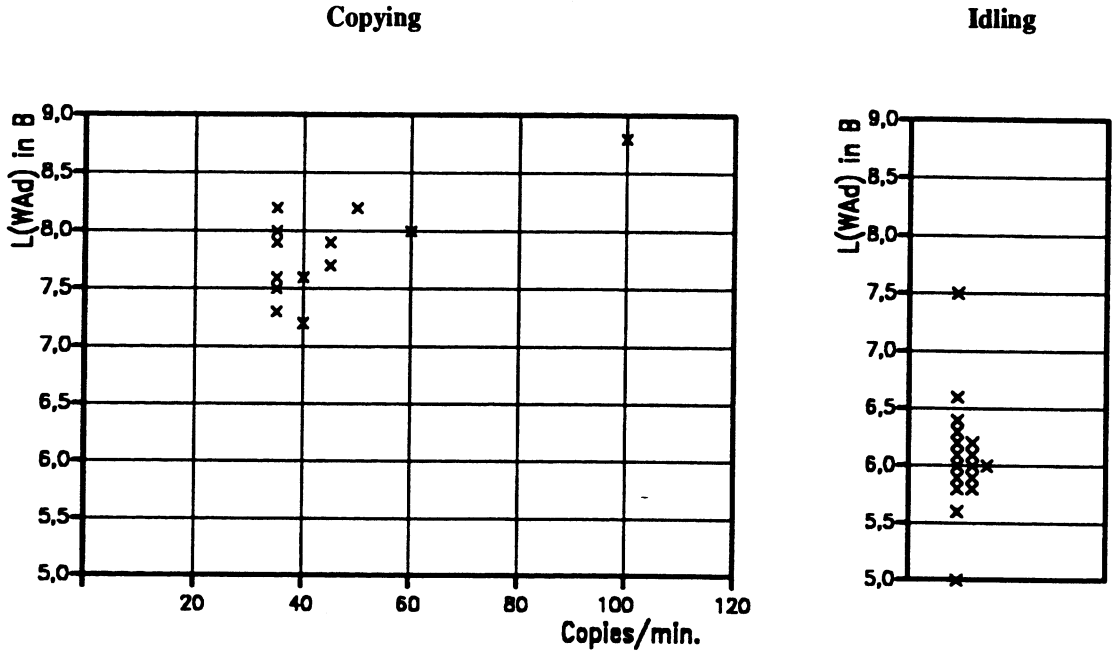



**Figure D.7 - Declared sound power levels, $L_{WAd}$ B - Duplicators (floor-standing)**

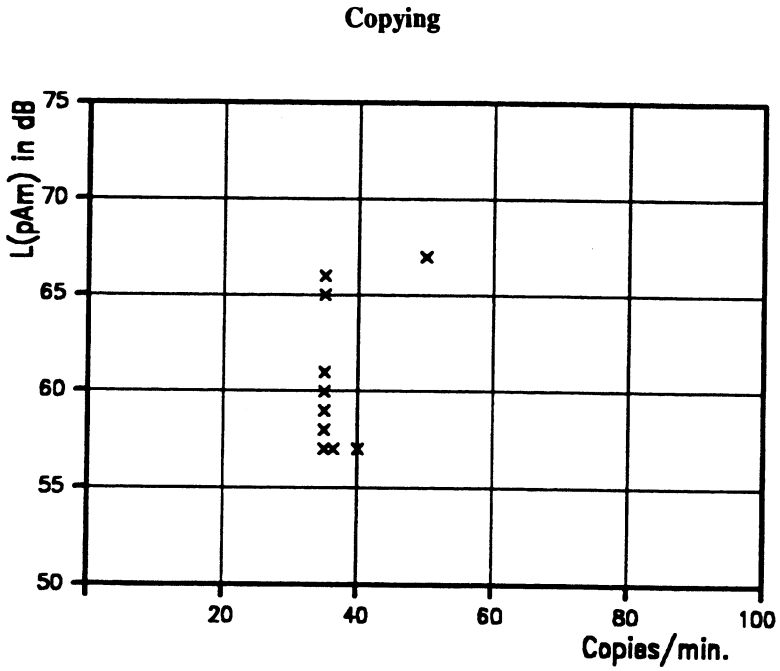



**Figure D.8 - Declared sound pressure levels, $L_{pAm}$, at the bystander positions, in dB - Duplicators (floor-standing)**

*NOTE D.4*

*Values for the idle mode of duplicators also depend on size and speed of the equipment.*

## D.4 Tape units

Standard test conditions

Different modes of operation may be chosen from the standard: Idling unloaded mode, idling loaded mode, read/write mode, streaming mode. The used mode shall be stated.

### D.4.1 Large tape units

Declared noise emission values:

| | | | |
|---|---|---|---|
| Streaming | Sample size: | N = 7 | N = 7 |
| | Mean value: | $L_{WAd}$ = 7,5 B | $L_{pAm}$ = 58,4 dB |
| | Stand.dev.: | s = 0,46 B | s = 4,7 dB |

Individual values are plotted in figures D.9 and D.10
Statistically, 68% of the values are within the following limits:

| Large tape units | $L_{WAd}$ (B) | $L_{pAm}$ (dB) |
|---|---|---|
| Streaming | 7,0 - 8,0 | 54 - 63 |

### D.4.2 Medium size tape units

Declared noise emission values:

| | | | |
|---|---|---|---|
| Streaming | Sample size: | N = 5 | N = 5 |
| | Mean value: | $L_{WAd}$ = 6,5 B | $L_{pAm}$ = 47,6 dB |
| | Stand.dev.: | s = 0,39 B | s = 5,6 dB |

Individual values are plotted in figures D.11 and D.12
Statistically, 68% of the values are within the following limits:

| Medium tape units | $L_{WAd}$ (B) | $L_{pAm}$ (dB) |
|---|---|---|
| Streaming | 6,1 - 6,9 | 42 - 53 |

**Operating**

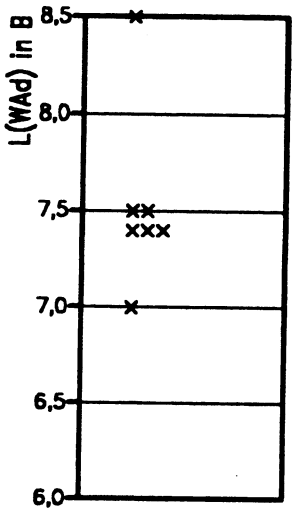



**Figure D.9 - Declared sound power levels, $L_{WAd}$ in B - Large tape units**

**Operating**

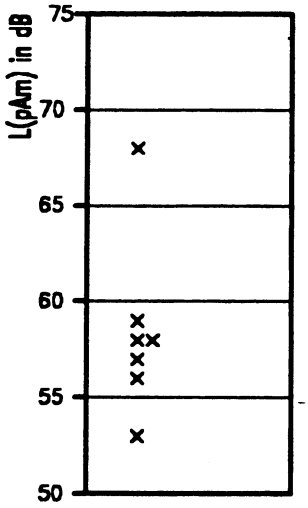



**Figure D.10 - Declared sound pressure levels, $L_{pAm}$ at the bystander positions, in dB - Large tape units**

**Operating**

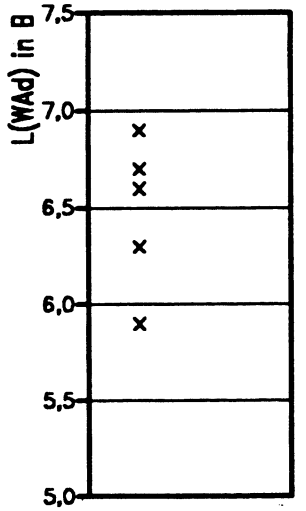



**Figure D.11 - Declared sound power levels, $L_{WAd}$ in B - Medium-size tape units**

**Operating**

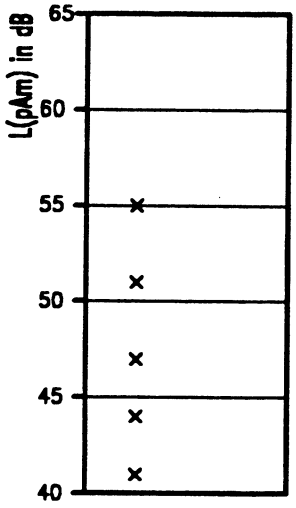



**Figure D.12 - Declared sound pressure levels, $L_{pAm}$ at the bystander positions, in dB - Medium size tape units**

## D.5 Disk units

Standard test conditions

Randomly select a cylinder and a track on this cylinder, each having an equal probability of being selected.

### D.5.1 Large disk units

Declared noise emission values:

| | | | |
|---|---|---|---|
| Accessing | Sample size: | N = 10 | N = 8 |
| | Mean value: | $L_{WAd}$ = 7,4 B | $L_{pAm}$ = 55,9 dB |
| | Stand.dev.: | s = 0,28 B | s = 2,6 dB |
| Idling | Sample size: | N = 8 | N = 8 |
| | Mean value: | $L_{WAd}$ = 7,2 B | $L_{pAm}$ = 55,1 dB |
| | Stand.dev.: | s = 0,38 B | s = 2,8 dB |

Individual values are plotted in figures D.13 and D.14
Statistically, 68% of the values are within the following limits:

| Large Disk units | $L_{WAd}$ (B) | $L_{pAm}$ (dB) |
|---|---|---|
| Streaming | 7,1 - 7,7 | 53 - 59 |
| Idling | 6,9 - 7,5 | 52 - 58 |

### D.5.2 Tabletop units

Declared noise emission values:

| | | | |
|---|---|---|---|
| Accessing | Sample size: | N = 4 | N = 4 |
| | Mean value: | $L_{WAd}$ = 5,4 B | $L_{pAm}$ = 4,8 dB |
| | Stand.dev.: | s = 0,38 B | s = 3,8 dB |
| Idling | Sample size: | N = 4 | N = 4 |
| | Mean value: | $L_{WAd}$ = 5,3 B | $L_{pAm}$ = 44,0 dB |
| | Stand.dev.: | s = 0,29 B | s = 2,5 dB |

Individual values are plotted in figures D.11 and D.12
Statistically, 68% of the values are within the following limits:

| Disk units, tabletop | $L_{WAd}$ (B) | $L_{pAm}$ (dB)*) |
|---|---|---|
| Streaming | 5,0 - 5,8 | 41 - 49 |
| Idling | 5,0 - 5,6 | 42 - 46 |

*)Measured at the operator's position

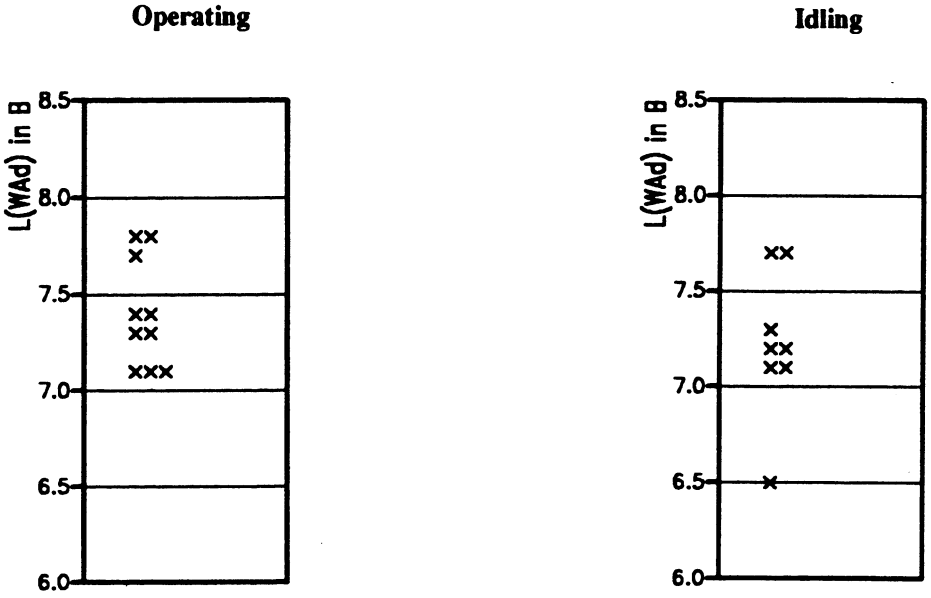



**Figure D.13 - Declared sound power levels, $L_{WAd}$ in B - Large disk units**

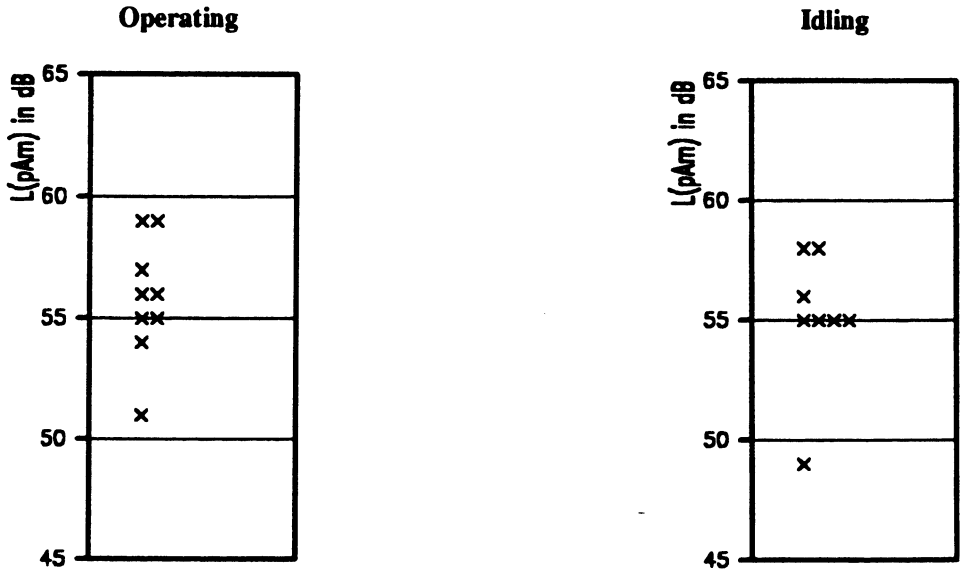



**Figure D.14 - Declared sound pressure levels, $L_{pAm}$ at the bystander positions, in dB - Large disk units**

*NOTE D.5*

*Values for the idle mode of disk units also depend on size and speed of the equipment.*

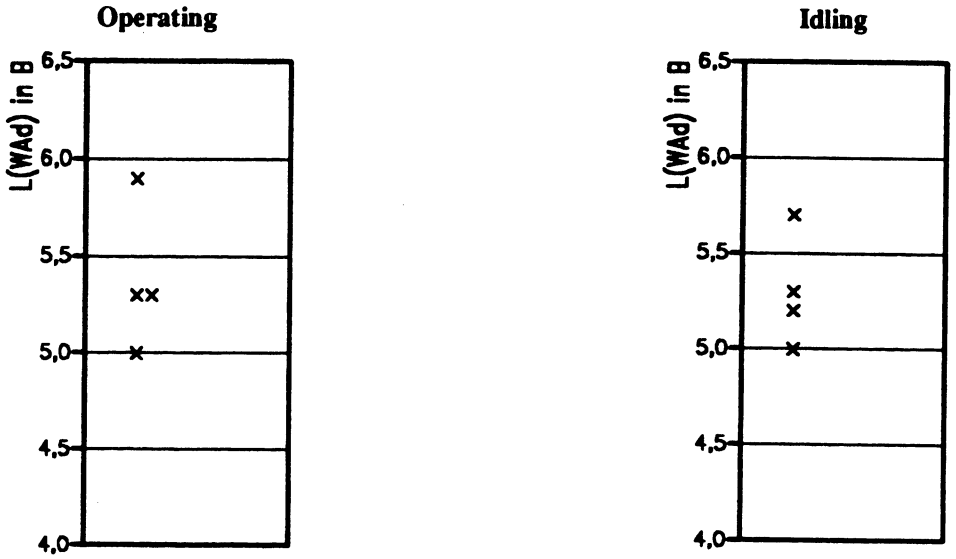



**Figure D.15 - Declared sound power levels, $L_{WAd}$ in B - Tabletop disk units**

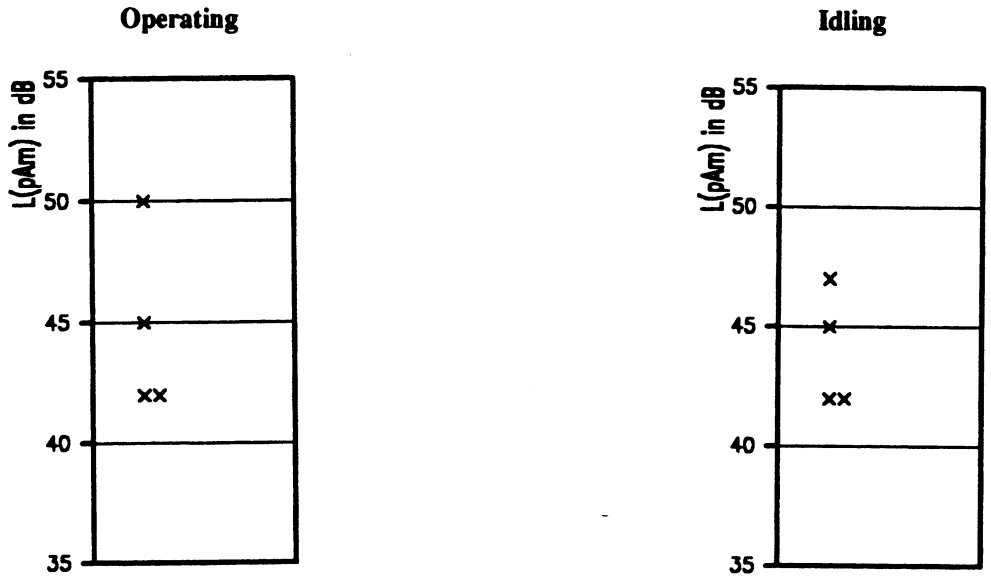



**Figure D.16 - Declared sound pressure levels, $L_{pAm}$ at the operator's position, in dB - Tabletop disk units**

## D.6 Electronic units

Standard test conditions

Steady-state operation with normal load on all cooling devices, power supplies and distributed power supply elements. Units having temperature controlled cooling devices are measured at 23°C environment conditions.

### D.6.1 Large Processors

Declared noise emission values:

| | | | |
|---|---|---|---|
| Operating | Sample size: | N = 14 | N = 12 |
| | Mean value: | $L_{WAd}$ = 7,5 B | $L_{pAm}$ = 55,5 dB |
| | Stand.dev.: | s = 0,15 B | s = 1,3 dB |

Individual values are plotted in figures D.17 and D.18
Statistically, 68% of the values are within the following limits:

| Large Processors | $L_{WAd}$ (B) | $L_{pAm}$ (dB) |
|---|---|---|
| Operating | 7,3 - 7,7 | 54 - 57 |

**D.6.2 Medium size processors**

Declared noise emission values:

| | | | |
|---|---|---|---|
| Operating | Sample size: | N = 27 | N = 22 |
| | Mean value: | $L_{WAd}$ = 6,7 B | $L_{pAm}$ = 50,2 dB |
| | Stand.dev.: | s = 0,44 B | s = 4,8 dB |

Individual values are plotted in figures D.19 and D.20
Statistically, 68% of the values are within the following limits:

| Medium size processors | $L_{WAd}$ (B) | $L_{pAm}$ (dB) |
|---|---|---|
| Operating | 6,2 - 7,3 | 45 - 55 |

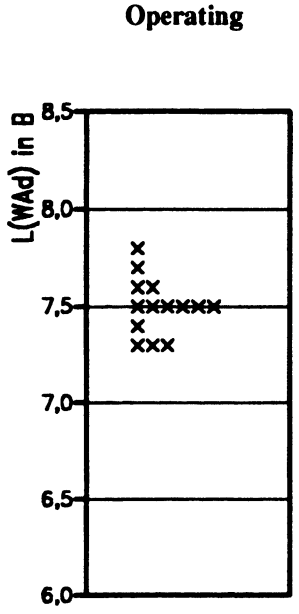



**Figure D.17 - Declared sound power levels, $L_{WAd}$ in B - Large processors**

Operating

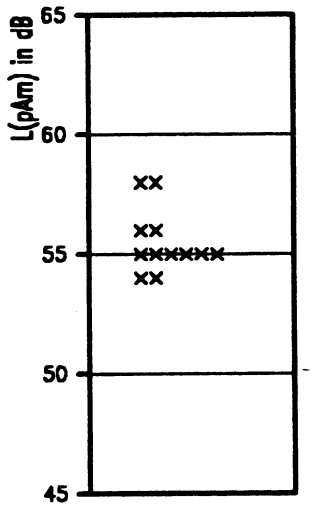



**Figure D.18 - Declared sound pressure levels, $L_{pAm}$ at the bystander positions, in dB - Large processors**

Operating

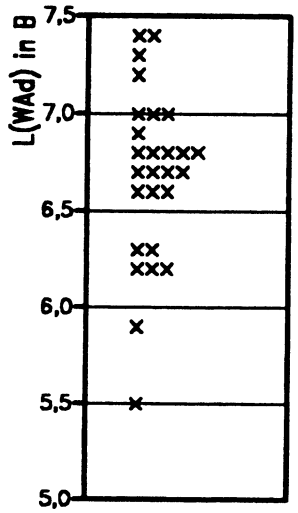



**Figure D.19 - Declared sound power levels, $L_{WAd}$ in B - Medium-size processors**

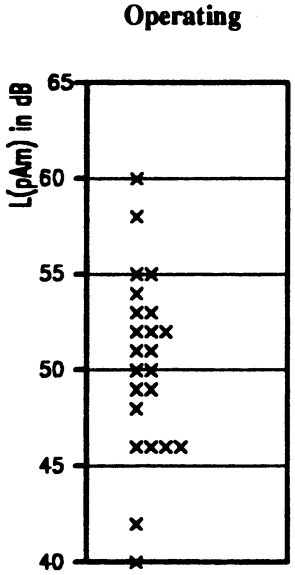



**Figure D.20 - Declared sound pressure levels, $L_{pAm}$ at the bystander positions, in dB - Medium-size processors**

## D.7 Personal computers and workstations

Standard test conditions

The constituent units of the system are tested individually, i.e. separate tests for the processor in idle state, processor with flexible disk operation, rigid disk operation, tape drive operation. The results are reported individually. If the results are combined, the weight of each operation shall be clearly stated.

Units having temperature controlled cooling devices are measured at 23°C environmental conditions.

### D.7.1 Floor-standing personal computers

Declared noise emission values:

| | | | |
|---|---|---|---|
| Operating | Sample size: | N = 10 | N = 7 |
| | Mean value: | $L_{WAd}$ = 5,5 B | $L_{pAm}$ = 38,9 dB |
| | Stand.dev.: | s = 0,38 B | s = 3,6 dB |
| Idling | Sample size: | N = 9 | N = 6 |
| | Mean value: | $L_{WAd}$ = 5,3 B | $L_{pAm}$ = 37,2 dB |
| | Stand.dev.: | s = 0,33 B | s = 3,0 dB |

Individual values are plotted in figures D.21 and D.22.
Statistically, 68% of the values are within the following limits:

| Floor-stdg. processors with disk | $L_{WAd}$ (B) | $L_{pAm}$ (dB) |
|---|---|---|
| Disk Operation | 5,1 - 5,9 | 36 - 43 |
| Idling | 5,0 - 5,6 | 34 - 40 |

### D.7.2 Tabletop personal computers

Declared noise emission values:

| | | | |
|---|---|---|---|
| Operating | Sample size: | N = 43 | N = 24 |
| | Mean value: | $L_{WAd}$ = 5,2 B | $L_{pAm}$ = 37,8 dB |
| | Stand.dev.: | s = 0,30 B | s = 3,1 dB |
| Idling | Sample size: | N = 29 | N = 25 |
| | Mean value: | $L_{WAd}$ = 4,9 B | $L_{pAm}$ = 35,8 dB |
| | Stand.dev.: | s = 0,26 B | s = 2,8 dB |

Individual values are plotted in figures D.23 and D.24.
Statistically, 68% of the values are within the following limits:

| Tabletop personal computers | $L_{WAd}$ (B) | $L_{pAm}$ (dB) |
|---|---|---|
| Disk Operation | 4,9 - 5,5 | 35 - 41 |
| Idling | 4,7 - 5,2 | 33 - 39 |

Additional values: Declared sound pressure levels for the operator's position

| | | |
|---|---|---|
| Operating | Sample size: | N = 42 |
| | Mean value: | $L_{pAm}$ = 41,0 dB |
| | Stand.dev.: | s = 1,3 dB |
| Idling | Sample size: | N = 31 |
| | Mean value: | $L_{pAm}$ = 38,2 dB |
| | Stand.dev.: | s = 2,9 dB |

Individual values are plotted in figure D.25
Statistically, 68% of the values are within the following limits:

| Tabletop personal computers | $L_{pAm}$ (dB) |
|---|---|
| Disk Operation | 38 - 44 |
| Idling | 35 - 41 |

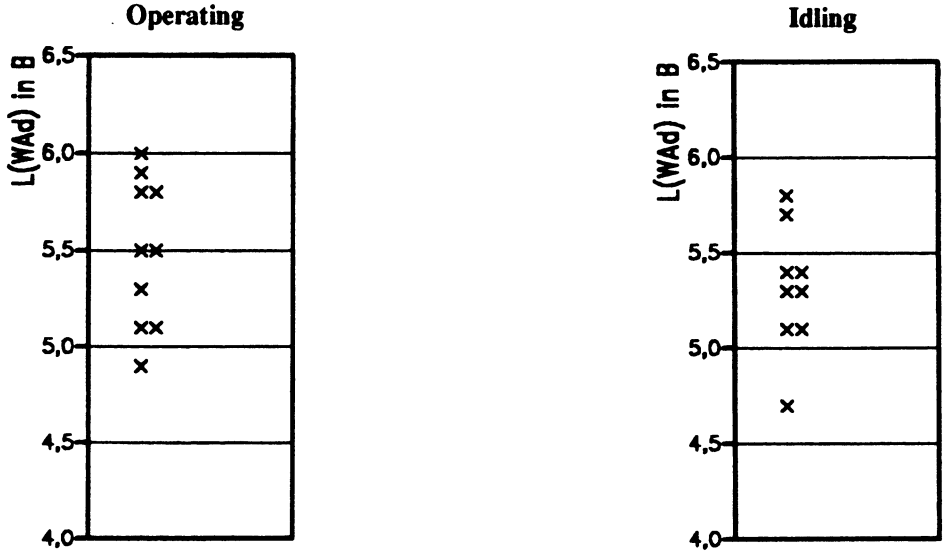



**Figure D.21 - Declared sound power levels, $L_{WAd}$ in B - Floor-standing personal computers**

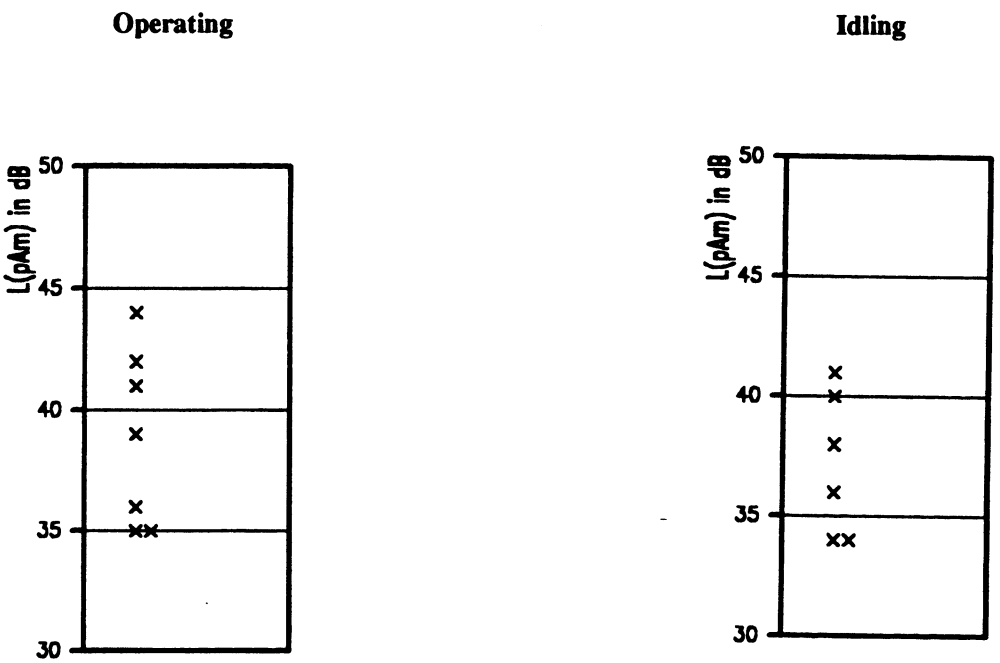



**Figure D.22 - Declared sound pressure levels, $L_{pAm}$ at the bystander positions, in dB - Floor-standing personal computers**

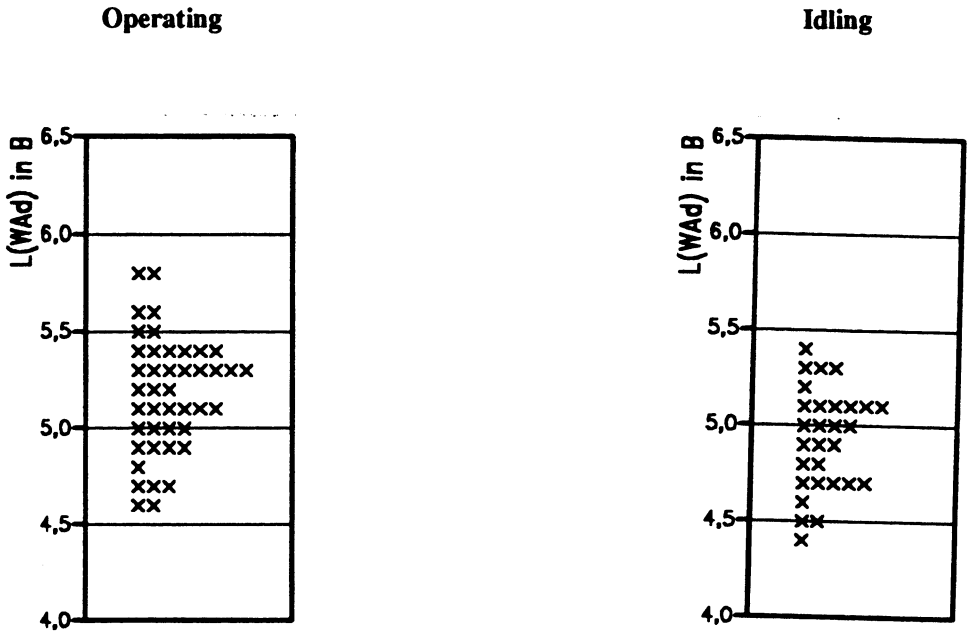



**Figure D.23 - Declared sound power levels, $L_{WAd}$ in B - Tabletop personal computers**

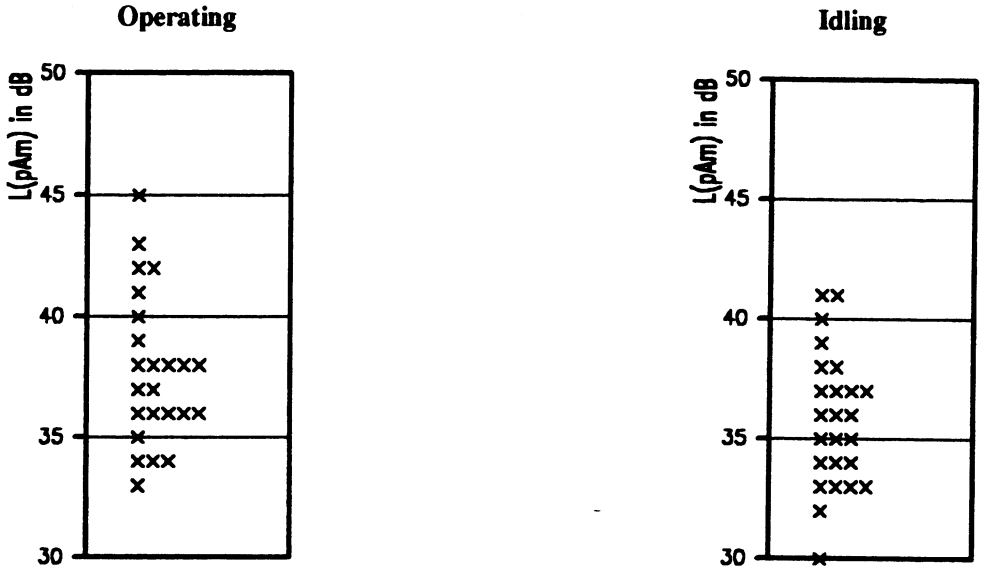



**Figure D.24 - Declared sound pressure levels, $L_{pAm}$ at the bystander positions, in dB - Tabletop personal computers**

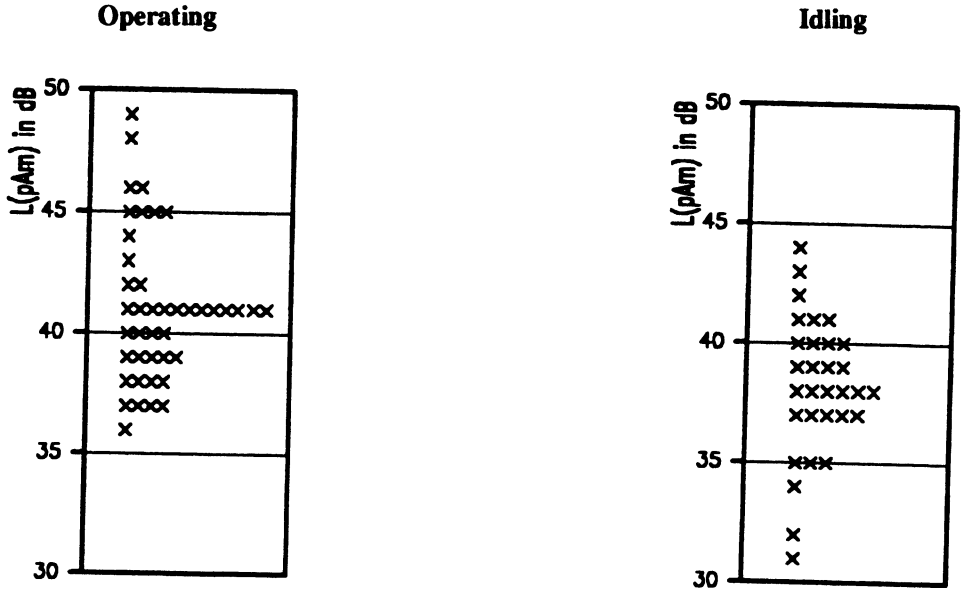



**Figure D.25 - Declared sound pressure levels, $L_{pAm}$ at the operator's position, in dB - Tabletop personal computers**

## D.8 Page printers

Standard test conditions

Printing a specified test pattern at nominal speed on single sheet paper weighing approximately 75 g/m² or continuous folded or rolled stationery, weighing approximately 55 g/m².

### D.8.1 Large laser printers

Declared noise emission values:

| | | | |
|---|---|---|---|
| Printing | Sample size: | N = 7 | N = 7 |
| | Mean value: | $L_{WAd}$ = 8,2 B | $L_{pAm}$ = 64,6 dB |
| | Stand.dev.: | s = 0,46 B | s = 3,8 dB |

Individual values are plotted in figures D.26 and D.27.
Statistically, 68% of the values are within the following limits:

| Large laser printers | $L_{WAd}$ (B) | $L_{pAm}$ (dB) |
|---|---|---|
| Printing | 7,8 - 8,7 | 61 - 68 |

### D.8.2 Tabletop laser printers

Declared noise emission values:

| | | | |
|---|---|---|---|
| Printing | Sample size: | N = 23 | N = 17 |
| | Mean value: | $L_{WAd}$ = 6,4 B | $L_{pAm}$ = 50,4 dB |
| | Stand.dev.: | s = 0,25 B | s = 2,7 dB |
| Idling | Sample size: | N = 23 | N = 22 |
| | Mean value: | $L_{WAd}$ = 5,4 B | $L_{pAm}$ = 38,5 dB |
| | Stand.dev.: | s = 0,4 B | s = 3,4 dB |

Individual values are plotted in figures D.28 and D.29.
Statistically, 68% of the values are within the following limits:

| Tabletop laser printers | $L_{WAd}$ (B) | $L_{pAm}$ (dB) |
|---|---|---|
| Printing | 6,1 - 6,7 | 47 - 53 |
| Idling | 5,0 - 5,8 | 35 - 42 |

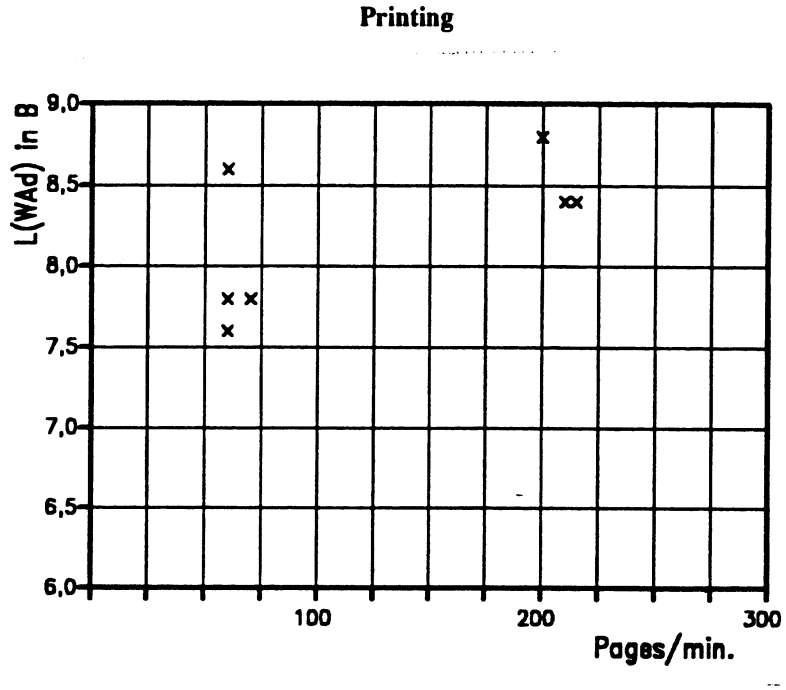



**Figure D.26 - Declared sound power levels, $L_{WAd}$ in B - Large laser printers**

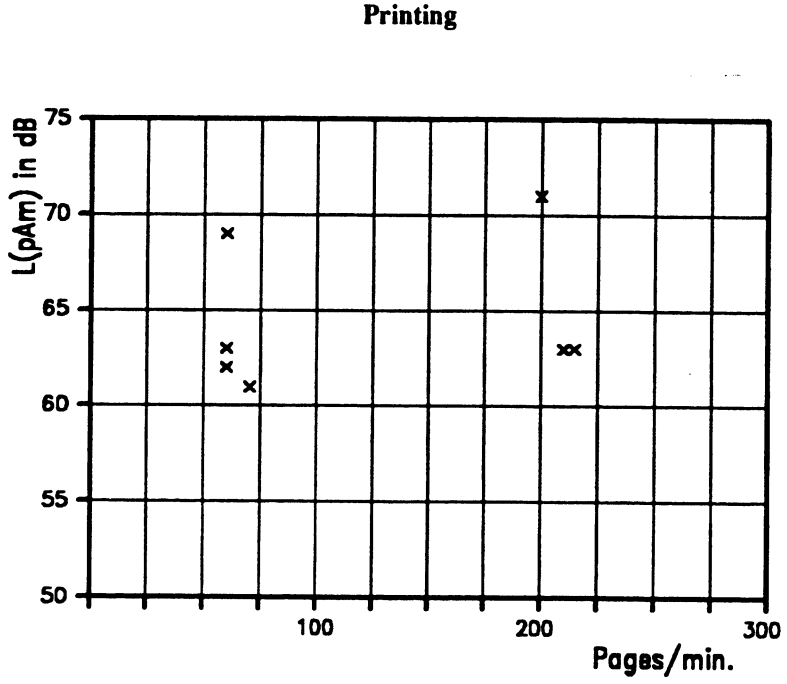



**Figure D.27 - Declared sound pressure levels, $L_{pAm}$ at the bystander positions, in dB - Large laser printers**

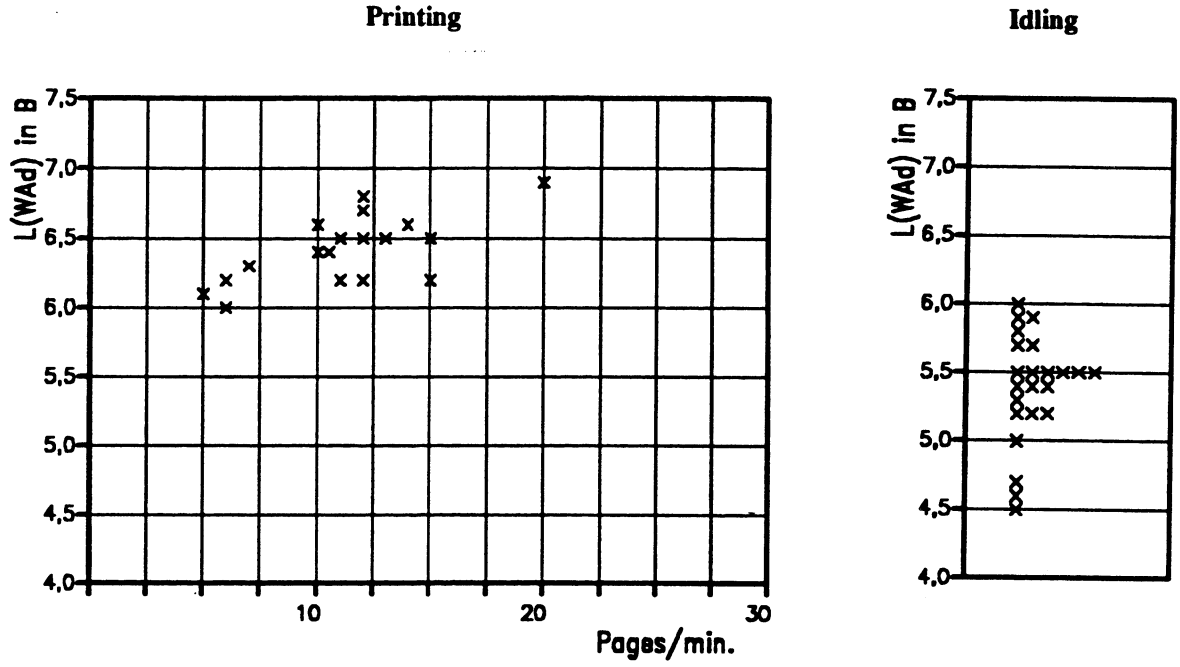



**Figure D.28 - Declared sound power levels, $L_{WAd}$ in B - Tabletop laser printers**

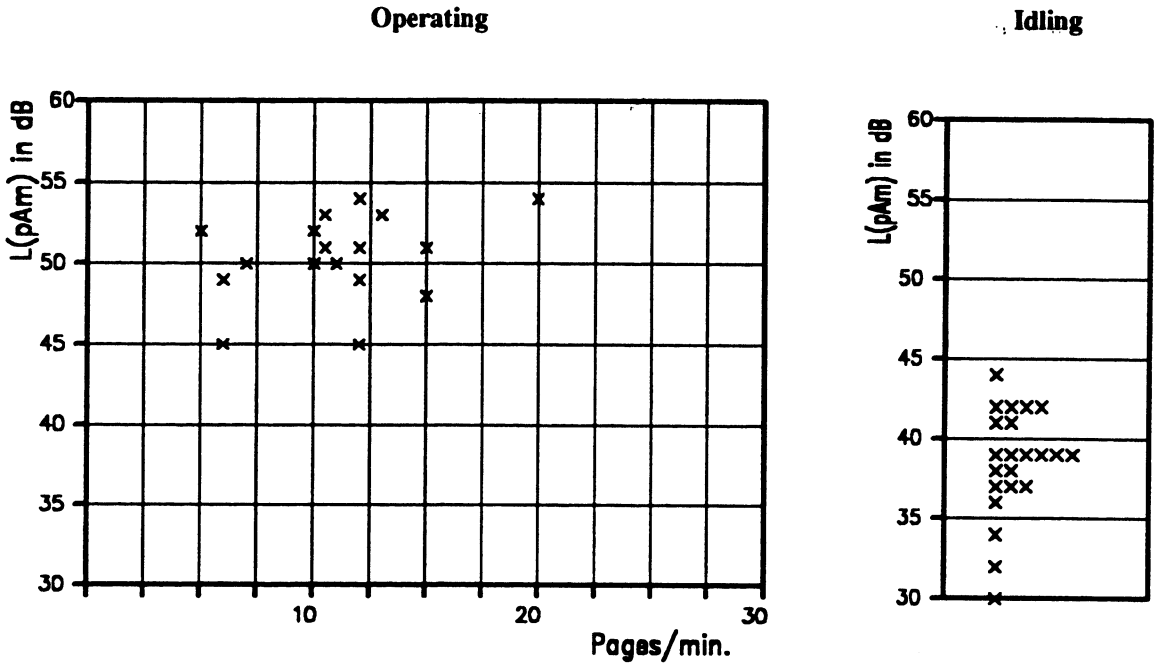



**Figure D.29 - Declared sound pressure levels, $L_{pAm}$ at the bystander positions, in dB - Tabletop laser printers**

## Annex E

### Recommended upper limits of declared sound power values

**Sweden, Statskontoret, The Swedish Agency for Administrative Development**

**Technical Standard No. 26:2, 1989-07-01, Noise of Computer and Business Equipment**

| Product Category | Product Description | Recommended Upper Limit Sound Power Level in bels $L_{WAd}$ Operating | $L_{WAd}$ Idling |
|---|---|---|---|
| Category I<br>Equipment for use in dedicated rooms | A. All products | 7,0 + *K* | 7,0 + *K* |
| Category II | A. Fully-formed character typewriters and printers | 7,2 | 5,5 |
| Equipment for Use in General Business Areas | B. Printers and copiers more than 4m distance from work stations | 7,2 | 6,5 |
| | C. Tabletop printers and tabletop copiers | 7,0 | 5,5 |
| | D. Processors, controllers disk & tape drives, etc. (More than 4m distant from work stations) | 7,0 | 7,0 |
| | E. Processors, controllers disk & tape drives, etc. (Less than 4m distant from work stations) | 6,8 | 6,6 |
| Category III | A. Printers, typewriters and plotters | 6,5 | 5,0 |
| Equipment for Use in Quiet Office Areas | B. Keyboards | 6,2 | N/A |
| | C. Floor-standing processors | 6,0 | 5,5 |
| | D. Tabletop processors, controllers, system units including built-in disk drive and/or tapes, display units with fans | 5,8 | 5,0 |
| | E. Display units (no moving parts) | 4,5 | 4,5 |

*Notes: $K = \lg (S/S_o)$ where $S_o$ is equal to one square meter and S is the footprint in square meters, i.e. the projection 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.*