NOISE TEST CODES AND NOISE CLAUSES OF MACHINERY SAFETY STANDARDS.

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1. INTRODUCTION

EEC-Directives 89/392 and 91/368 on machinery safety lay down the following major essential requirements regarding noise emission:

- noise reduction is an integral part of machinery safety.

- machinery must be so designed and constructed that risks resulting from the emission of airborne noise are reduced to the lowest level taking account of technical progress and the availability of means of reducing noise, in particular at source.

- specified quantitative information on airborne noise emitted by machinery under defined operating conditions must be made available by manufacturers (noise declaration).

The implementation of this directive implies that noise emission by machinery is dealt with in different types of standards:

a) basic noise Standards giving methods for determining the noise emission quantities called upon by the EEC-Directive (emission sound pressure level at workstations (ISO 11200 series) and sound power level (ISO 3740 series and ISO 9614)).

b) ISO 4871, specific to noise declaration and verification.

c) ISO 11688 on the recommended practice for the design of low-noise machinery.

d) ISO 11689 on the collection and representation of noise emission data.

e) standards specific to given families of machinery, called "Noise Test Codes", that prescribe the mounting and operating conditions during noise emission measurements, workstation positions, the noise emission measurement methods and the noise declaration and verification method to be used. ISO 12001 specifies the content of Noise Test Codes.

f) safety Standards specific to families of machinery. A European Standard (EN XXXX) defining the content of the noise clauses of machinery safety Standards is in progress.

This paper is based on the standardization work in progress. It describes what should be the contents of Noise Test Codes and of the noise clauses in safety Standards.

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2. NOISE CLAUSES OF SAFETY STANDARDS

Machinery safety is presently dealt with in 26 CEN Technical Committees, each of them covering a specific family of machinery, with the task to prepare safety Standards and in a few ISO or IEC Technical Committees (see Table 1). Each CEN/TC has normally several Working Groups, each of them dealing with a sub-family of machinery. About 120 machinery safety Standards are presently in progress at the European level!
As a widespread machinery hazard, noise has to be considered in most of them. In order that the noise requirements in the machinery EEC-Directives are met, noise clauses of machinery safety Standards are to be focused on the following major topics.

2.1 Noise Reduction at the Design Stage

Whenever noise is identified as a significant risk for a given family of machinery, engineering action must be undertaken to reduce the noise emitted to the lowest possible level. Machinery safety Standards are then expected, for the machinery they cover, to describe the main internal sound sources and to give a list of technical measures that are known to be efficiently applicable. Such a list is to be based on ISO 11688 that recommends technical strategies for low-noise design of machinery. Technical measures other than those listed can also be applied so that innovation is not hindered.

2.2 Noise Emission Measurement, Declaration and Verification.

The requirement that manufacturers shall give a specified information on noise emission to their potential clients implies that noise emission is measured and that this measurement is done under specified test conditions so that noise emission values are comparable. A machinery safety Standard must then refer to an appropriate Noise Test Code on which noise declarations will be based. Furthermore, the fact that quantitative information on noise emission is yielded implies that a verification must be possible. A machinery safety Standard must then refer to ISO 4871.

2.3 Achievable Noise Emission Levels (State of the Art).

In order to decide whether or not the lowest possible level of noise emission is attained for a given machinery, it is necessary to know how noisy the machines on the market are. This refers to the state of the art regarding noise emission that has then to be determined. This is to be done by stating "achievable noise emission levels" determined using ISO 11689. For a given family or sub-family of machinery, such levels can be agreed upon from the "cloud" of noise emission data yielded by noise declarations made according to ISO 4871 and the relevant Noise Test Code. The organization of data collection is a decisive step with regard to the determination of the state of the art. The feasibility of a European noise emission data base is presently considered.

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3. NOISE TEST CODES

With regard to the fulfilment of the essential requirements of the machinery EEC-Directive, Noise Test Codes are essential standards. The preparation of such codes is considered to be the task of machinery Technical Committees with the assistance of ISO/TC 43/SC1 "Noise" or CEN/TC 211 "Acoustics" depending on whether the code is made at the International level or at the European level. ISO 12001 gives the rules for preparing such codes. A typical lay-out is shown in Figure 1.

Noise Test Codes must be such that, through their use, machines in a given family or sub-family can be ranked regarding their noise emission.

Operating conditions of a machinery normally vary a lot from a user to the other and, consequently, so does noise emission. Since manufacturers cannot declare noise emissions for all possible operating conditions of a machinery once installed in a workshop, the Noise Test Code can only prescribe a limited number of operating conditions. The now accepted rule is that the operating conditions prescribed are representative of a normal and typical use of the machine. Among these operating conditions, one must yield the highest noise emission that is reproducible. Reproducibility of the measurement result is a major aspect to be considered when deciding on operating conditions to be specified in a Noise Test Code. The compromise between easiness of measurement, representativity of operating conditions and reproducibility of results is always difficult to make. A poor reproducibility means a high uncertainty in the results and forces a manufacturer to declare higher noise emission values in order to be on the safe side in case of verification. Reproducibility depends also on the grade of accuracy of the method used to measure noise emission. For declaration purposes, the recommended grade is grade 2 "engineering". Several basic noise Standards offer grade 2. These are ISO 3743, 3744, 9614 for sound power determination, ISO 11201, 11203 and 11204 for emission sound pressure level determination. A Noise Test Code can allow the use of all grade 2 of accuracy standard methods but one of them (for each basic emission quantity) can be stated as preferred, for example because its application to the family of machinery concerned is particularly easy or it is currently practiced by manufacturers.

Basic noise emission Standards give universal values of the standard deviation of reproducibility. For a given family of machinery, this standard deviation may be in fact higher and is often smaller than the universal value. It is therefore in the interest of manufacturers to know the actual value of the standard deviation of reproducibility for their machinery. This value can be obtained by carrying out joined experimental investigation (such as round robin tests) when preparing the Noise Test Code. Such investigation also provides useful information for the choice of appropriate operating and mounting conditions. It is often thought that preparing a Noise Test Code is only a matter of gathering machinery, noise, and health and safety experts around a table. It is only so if appropriate noise emission data is available. If no such data is available, some investment is to be accepted in order to create it and is always worthwhile because a poor Noise Test Code is likely to lead to a wrong ranking of the machinery on the market.

One of the basic rules when drafting a Noise Test Code is to refer only to the basic noise Standards allowed without repeating them word for word. When a basic noise Standard offers options, a choice has to be made and stated in the Noise Test Code.
Most machinery CEN and ISO TCs, see Table 1, will sooner or later prepare Noise Test Codes. Some have already started (agriculture and forestry machinery, compressors, hand-held power tools, footwear machinery, foundry machinery, paper machinery, wood-working machinery...).

4. CONCLUSION

As they provide the basic rules for measuring, declaring, verifying, presenting and reducing noise emission values, ISO Standards play a major role in the implementation of the current European strategy regarding machinery noise. These Standards will be issued word for word as European Standards. Noise Test Codes and machinery safety Standards are mostly (but not only) elaborated at the European level. Let us hope that they will spread out of Europe and become ISO Standards, so contributing to the suppression of barriers to trade and to the promotion of machinery safety not just in EEC and EFTA Countries but throughout the world.

5. BIBLIOGRAPHY

Council Directive 89/392/EEC of 14 June 1989 on the approximation of the laws of the Member States relating to machinery.

Council Directive 91/368/EEC of 20 June 1991 amending Directive 89/392.

ISO 3740 - Acoustics - Determination of sound power levels of noise sources - Guidelines for the use of basic standards.

ISO 3743 - Acoustics - Determination of sound power levels of noise sources - Engineering methods for small, movable sources in reverberant fields. Part 1: Comparison method in hard-walled test rooms. Part 2: Special test rooms.

ISO 3744 - Acoustics - Determination of sound power levels of noise sources - Engineering method employing an enveloping measurement surface in an essentially free field over a reflecting plane.

ISO 4871 - Acoustics - Declaration and verification of noise emission values of machinery and equipment.

ISO 9614 - Acoustics - Determination of sound power levels of noise sources using sound intensity.

ISO 11200 - 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.

ISO 11201 - 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.

ISO 11202 - 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.

ISO 11203 - 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.

ISO 11204 - Acoustics - Noise emitted by machinery and equipment - Determination of emission sound pressure levels at the work station and other specified positions with environmental corrections.

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ISO 11688 - Acoustics - Recommended practice for the design of low-noise machinery and equipment. Part 1: Planning. Part 2: Noise generation principles.

ISO 11689 - Acoustics - Systematic collection and comparison of noise emission data from machinery and equipment.

ISO 12001 - Acoustics - Noise emitted by machinery and equipment - Rules for the drafting and presentation of a Noise Test Code.

EN XXXX - Acoustics - Noise emitted by machinery and equipment- Rules for the drafting of the noise clauses of safety Standards.

NOTE: Standards quoted are presently in quick progress.

TITLE : NOISE TEST CODE FOR "name of machinery family" - Grade "Y" of accuracy.

1 - SCOPE

2 - NORMATIVE REFERENCES (Standards referred to in the Noise Test Code)

3 - DEFINITIONS (of key technical terms)

4 - DESCRIPTION OF MACHINERY FAMILY

5 - SOUND POWER LEVEL DETERMINATION
- Basic International Standards that may be used (from ISO 3740 series and ISO 9614).
- Measurement uncertainty.

6 - EMISSION SOUND PRESSURE LEVEL DETERMINATION
- Basic International Standards that may be used (from ISO 11200 series).
- Selection of relevant work station(s).
- Measurement uncertainty.

7 - INSTALLATION AND MOUNTING CONDITIONS

8 - OPERATING CONDITIONS

9 - MEASUREMENT UNCERTAINTIES

10 - INFORMATION TO BE RECORDED

11 - INFORMATION TO BE REPORTED

12 - DECLARATION AND VERIFICATION OF NOISE EMISSION VALUES

Fig.1 - Typical lay-out of a Noise Test Code according to ISO 12001

NOISE TEST CODES AND NOISE CLAUSES OF MACHINERY SAFETY STANDARDS.

	TC	Title
I	2	Rotating machinery
E		
C	5	Steam turbines
	23	Tractors and machinery for agriculture and forestry
	39	Machine-tools
	60	Gears
	70	Internal combustion engines
I	72	Textile machinery
	110	Industrial trucks
S	115	Pumps
O	116	Space heating appliances
	117	Industrial fans
	118	Compressors, pneumatic tools and machines
	127	Earth-moving machinery
	131	Fluid power systems
	144	Air distribution and diffusion
	184	Industrial automation systems and integration
	192	Gas turbines

	TC	Title
	10	Passengers, goods and service lifts
	98	Lifting platforms
	142	Wood-working machines
	143	Machine-tools
	144	Agricultural and forestry machines
	145	Rubber and plastic proces-sing machines
	146	Packaging machines
	147	Cranes
	148	Continuous handling machines
	149	Rail - Dependent storage and retrieval equipment
	150	Industrial trucks
C	151	Construction equipment and building material machinery
E	152	Leisure and recreational machines / equipment
N	153	Food-processing machinery
	186	Thermoprocessing technology
	196	Mining and quarrying machinery
	197	Pumps
	198	Printing and paper machinery
	200	Tannery machines and plants
	201	Leather goods and footwear machinery
	202	Foundry machinery
	213	Machinery using propulsive charges
	214	Textile machinery
	232	Compressors
	240	Thermal spraying equipement
	255	Hand-held non-electric power tools
	270	Internal combustion engines
	271	Surface treatment equipment

Table 1 - List of ISO, IEC and CEN MACHINERY TECHNICAL COMMITTEES potentially or actively acting in the field of machinery noise.