# Information on Emissions in Machinery Standards

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Verein zur Förderung der Arbeitssicherheit in Europa

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# Preface

Standardization on the safety of machinery is one of the key focuses of the work of the Commission for Occupational Health and Safety and Standardization – KAN. One of the aspects of the safety of machinery is emissions in the form of noise, vibrations, hazardous substances and radiation. Standards play a central role in this area since their purpose is to lend definite shape to the provisions of the Machinery Directive under which the manufacturer is required to minimize the emissions of his machine and inform the user of any residual risks.

This task of standardization has been the subject of discussion on the national, European and international levels for many years. Strategies to enhance the prominence given to emissions in standards have been developed and the first steps towards implementation have been taken.

To communicate the current state of the debate and make basic documents available to a broader public, e.g. manufacturers, users and supervisory authorities, the KAN Secretariat has issued this report.

This collection of material contains not only familiar documents and positions (e.g. the reasoning given in the Machinery Directive, the latter's implementation in the basic machinery standard EN 292, positions from government, industry and standards makers, development of a KAN strategy and its implementation), but also other approaches and developments (e.g. benefit of emission values for the user or pilot projects in France and Germany). This report is designed to serve as a basis for the ongoing discussion of tasks and scope for action as well as of the limits of standardization in the improvement of occupational health & safety in relation to machine emissions.

## 1.1 Introduction

Machines which people work at and with have to be safe if they are to be used in the single European market. This is the law in the European economic area.

The hazards which may impair the safety of machines, plant etc. in the work process are not confined solely to mechanical causes. Rather, they range widely, covering electrical risks, the ergonomic design of the machine and health-hazardous emissions.

Hazardous emissions - in other words, releases of energy and substances - include noise and vibrations caused by the machine as well as hazardous substances or radiation released by the machine. High emissions may have a serious effect on persons at their workplaces and result in serious illness. Examples of this are hearing loss induced by exposure to excessive noise, and bone and joint damage to the hands and arms, circulatory disturbances in the hands and damage to the lumbar region of the spine on exposure to excessive vibration.

According to the European principles of occupational health & safety (Article 95 [formerly 100a] of the EC Treaty, Machinery Directive 98/37/EC and its national implementation), such hazards must be reduced as far as possible during the design and construction of the machine in line with the current state of the art (minimization principle). Preference must be given to risk reduction at the source. If this alone is insufficient, supplementary technical precautions must be taken.

Machine users must then be informed of any residual risks (principle of informing the user) and instructed in the machine documents about further technical measures, the mode of operation to reduce the emission, and personal protective equipment for indirect protection from the residual risks.

A design engineer faced with the task of designing a machine with state-of-the-art safety needs guidance. In his central work document, i.e. the standard, he therefore requires details of the type and scale of possible hazards which the machine may pose.

Nevertheless, the state of information on the different types of hazard varies widely. Until now, far greater consideration has been given to mechanical and electrical hazards in European machinery safety standards (type C standards) than those due to emissions. As stated in a French paper in

1997[1], the C standards developed in the last few years satisfy the requirements of the Machinery Directive "in terms of the mechanical and electrical risks in general to a sufficient degree. However, as far as action to prevent noise, vibration, radiation, emissions of hazardous substances ... are concerned, they do not provide sufficient guidance to the designer of machines." In machinery standards, most progress has been made with the treatment of noise-related hazards as far as the measurement of emissions is concerned.

Furthermore, health and safety professionals and standardization experts are undecided as to how this information (e.g. specific values, emission classes) should be included in standards and how the tasks in hand are to be performed.

KAN has therefore compiled this brochure with the aim of making the existing knowledge of the hazards posed by emissions and of their determination and reduction more accessible to standards users (design engineers, supervisory authorities) and machine users. It also highlights the existing gaps in this knowledge and suggests how they can be filled. This source of information and suggestions is intended as an aid to argumentation for the tasks in hand.

The approach taken in addressing this central concern of KAN is described in Chapter 2 following an explanation of the background and concepts in Chapter 1. Chapter 3 reviews the state of the debate within and outside Germany. Chapter 4 presents examples of activities to date and the annexes document the sources of importance for the subject (in some cases in extract form).

## 1.2 Background

Over the last few years, numerous health and safety professionals and institutions have pointed out and criticized the shortcomings in the consideration given to emission hazards in machinery standards. There have been many demands to include specific emission values in product standards. For a long time, however, no progress was made in the discussion of this issue. The Commission for Occupational Health and Safety and Standardization (KAN) has now been addressing itself to the issue since 1996 and has developed a strategy aimed at improving the prominence given to emissions in the standardization process. The implementa-

[1] Jean-Paul Lacore, Recours à des valeurs indicatives (valeurs réalisables d'émission, valeurs repères ...) ou à des „classes d´émission" dans les normes C.

tion of this strategy requires deeper discussion and the development of possible solutions. For instance, KAN is investigating the central issue of which other bodies specializing in health and safety could join with the manufacturers in supporting the process. KAN has also approached safety experts and works councils to instruct them of their right to information on emission hazards when purchasing a machine.

## The Machinery Directive

The requirement of giving sufficient consideration to hazards possibly resulting from machine emissions is laid down in the Machinery Directive 98/37/EC[2]. It contains the essential safety and health requirements which a machine must satisfy. European standards are designed to make the satisfaction of these requirements easier; their purpose is to support the fundamental requirements of the Directive and provide technical solutions for practical application.

The provisions of the Machinery Directive thus appeal directly or indirectly to two groups of persons of relevance in this connection: product manufacturers and the European standardization bodies.

Product manufacturers are obligated by the Directive to minimize the health hazards posed by their products (**hazard minimization principle**) and to inform the user of any residual risks (**principle of informing the user**).

Standards can help the design engineer to technically apply the essential requirements of the Directive. The text of the Directive can be supplemented by the standards bodies in two different ways. Firstly, technical standards can specify the **means**, i.e. the manufacturer is given specific design solutions. Alternatively, the standard may specify results or protection **targets**, in which case the machine manufacturer is obliged to find his/her own solution for achieving this target.

## A balancing act for standardization

These two options give the subject a problematical aspect. On the one hand, specifications made in European standards must not be so rigid as to deprive the manufacturer of all freedom for action and thus inhibit technical progress. For this reason, the description of specific design solutions in standards is not generally considered particularly helpful. On

[2] Directive 98/37/EC of the European Parliament and of the Council of 22 June 1998 on the approximation of the laws of the Member States relating to machinery.

the other hand, the specifications in standards should provide an added value to the manufacturer in comparison with the Directive.

The inclusion of values for machinery emissions in standards which makes it easier for the manufacturer to comply with the minimization and information principles is therefore both useful and necessary. These values must not on any account be intended or interpreted as rigid limits. They must reflect the state of the art and serve the manufacturer as a practical guide. The latter can then assess the state of the art before optimizing measures to reduce risks and inform the user of any residual risks. By referring to these values, the OH&S authorities are thus able to verify compliance with the provisions of the Directive. Incidentally, the expediency of describing the state of the art concerning the minimization of emission hazards by providing emission values in standards was discussed[3] and documented[4] already at the beginning of the 90s.

## 1.3 The prominence given to emissions in the Machinery Directive and in the basic standard for the safety of machinery

The Machinery Directive 98/37/EC lays down the "Essential health and safety requirements relating to the design and construction of machinery and safety components" in its Annex I. Of special interest for this report are the requirements relating to emissions, which are quoted verbatim in Annex 1 of this report.

For the hazards of noise and vibrations, the Directive contains a fundamental **minimization principle** (i.e. hazard reduction) at the lowest level in relation to technical progress and the means available. Special attention is devoted to hazards resulting from machine mobility. For compliance with the **principle of informing the user**, the Directive specifies the duty for the operating instructions to state values on the noise or vibrations emitted by the machine. To ensure result comparability, the manufacturer must also inform the user of the measuring method employed and the operating conditions under which the measurements were carried out.

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[3] Cf. for instance "Guidance on convenient use of achievable values in C standards", CEN/TC 114/CAG N3, 29th October 1993 and 3rd February 1994.

[4] Cf. EN 414:1992 and CEN Report 1100:1994

On the subject of the hazards associated with hazardous substances and radiation, Annex I of the Directive stipulates that the risks must be eliminated; and, if this is not possible, that the hazardous substances must be "contained and/or evacuated" and the radiation limited to a safe level.

Although the statement of parameters is not explicitly demanded for these types of emission, quantification of all emissions is nonetheless interpreted by some as the logical consequence of the minimization principle (see Chapter 3.1).

The Machinery Directive formulates the most important requirements with regard to machine safety. To give design engineers, manufacturers and other interested parties more specific details and interpretative assistance, the basic standard on machinery safety EN 292 "Safety of machinery" - containing basic concepts, design principles and general aspects applicable to all machines, equipment and plant (type A standard) - was created. It can help design engineers in the application of type B standards, which deal with a safety aspect or a safety device for a whole series of machines, equipment and plant. It also serves as an aid to the creation of type C standards, which contain detailed safety requirements for a certain machine or group of machines. It is currently undergoing revision, whereby attempts are being made to give greater prominence to emissions in the standard. For further details, see Chapter 4.1 "Revision of EN 292"; quotes from the standard in its current version are contained in Annex 2 of this report.

## 1.4 Terms and Definitions

Despite the unequivocal demands of the Machinery Directive for minimization and information, the debate on the statement of emission values in product standards has yet to make satisfactory progress. One of the reasons for this is, firstly, that clearly defined concepts, e.g. emission and immission, are still being confused; and, secondly, that several terms describing the same thing are in circulation, e.g. achievable values, reference values and indicative values, and several terms are indeed (still) in need of clear definition.

In the present context

- **Emission** is defined as a machine's release or discharge of noises, vibrations, pollutants and radiation (hazard factors) into the environment, whereby the machine's installation and operating conditions are standardized and as close to the practice as possible;

- **Immission** is defined as the totality of all energy and substance shares per hazard factor which act upon an observed location (workplace); in the case of noise, for instance, this is the direct share from all more or less distant machines and that reflected by room surfaces and room installations, generally averaged over a certain period, e.g. 1 work shift.
- **Exposition** is defined as the totality of all energy or substance shares per hazard factor on the temporal average in relation to a single person.

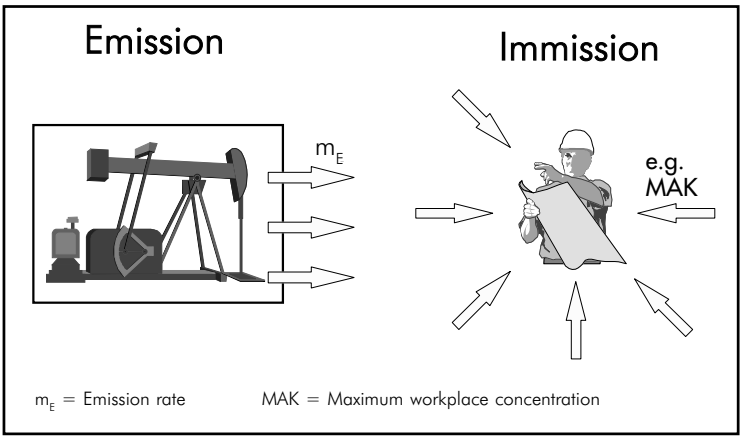
The following figure illustrates the distinction between emission and immission, taking the example of pollutants.

For each hazard factor there are usually parameters quantifying the emission, immission and exposure, e.g. the maximum workplace concentration for pollutant exposure. It is usual only to speak of emission, immission or exposure values without quoting the associated parameters if the situation described rules out the risk of misunderstandings.

### Limit values

Limit values are legally binding, maximum permitted values, which must not therefore be given in standards. The specification of immission limit values and exposure limit values relating to the health and safety of workers at the work-

Difference between emissions and immissions



place is reserved, in accordance with for example the EU Memorandum on the role of standardization[5] and CEN Resolution BT 22/1997, for the political decision-making process and law-making on the national level.

The specification of machine emission limit values, i.e. upper limits for noise, vibrations etc., is not generally considered conducive to progress in competitive low-emission product design. On the European level such limit values therefore only exist - for historical reasons - for certain types of building machines and motor vehicles.

## Emission values

The values referred to in this report are thus covered by directives subject to Article 95 (formerly 100a) of the EC Treaty and relate to product safety requirements. The hazardous emissions released by a machine in the form of noise, vibrations, radiation or hazardous substances are expressed in so-called emission values. These are designed to enable the manufacturer, by referring to the available values, to compare his product with other products in terms of emissions and to establish a competitive edge by undercutting these values. This of course presupposes that the emission values defined are interpreted as a selling point by machine users. These values are also intended to serve as an incentive to manufacturers to improve the state of the art and thus reduce the hazard level.

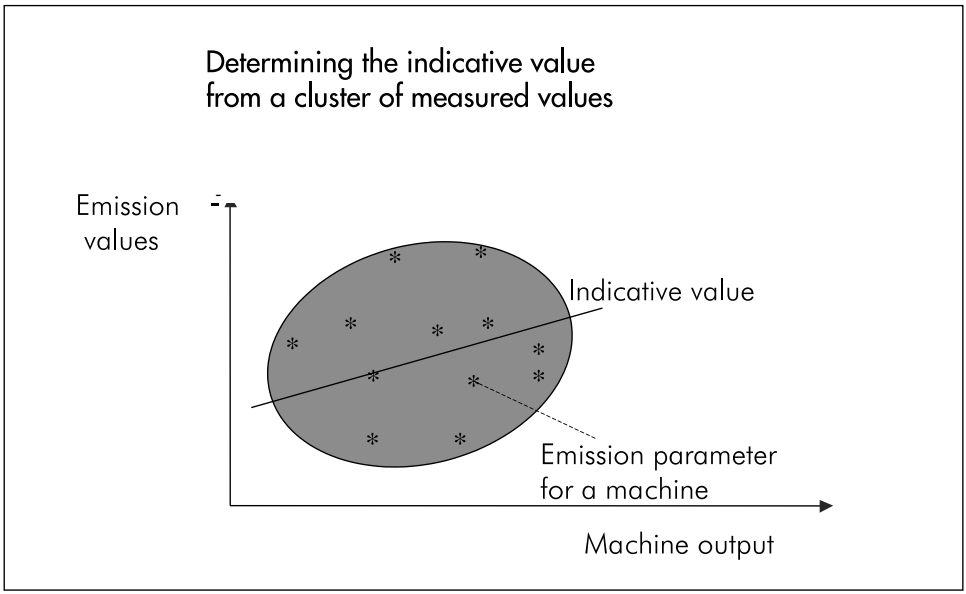
## Range of emission values (cluster of measured values), indicative values

To provide information on emission levels, the range of the emission values (cluster of measured values, see figure) of a type of machine should be summarized in a standard. The state of the art can be deduced from the range. Indicative values (guide values) represent the mean **emission values** realizable on products of the same type on the market with proven technical measures. These values should be specified in standards as technical parameters for machines in a Europe-wide consensus.

The term "achievable value" also used in this connection, which is employed inter alia in the Memorandum on health and safety standardization in support of "new

[5] EU Memorandum "The role of standardization in relation to article 118a of the EC-Treaty", in KAN Report 5 "European standardization concerning the safety and health of workers at work", ed. Verein zur Förderung der Arbeitssicherheit in Europa, Sankt Augustin 1996.

approach" directives[6] to describe a machine's emission, is not helpful. It is not obvious from this term that this value simply expresses a mean value rather than specifying a bottom limit for the emission which cannot be technically improved upon at present.




## 1.5 State of te art

Since indicative values are supposed to express the "state of the art" and should not be interpreted as limit values, it is also important to define what is meant by "state of the art". This term is also defined in different ways on the national legal level and on the European standardization level.

[6] DIN German Standards Institute (ed.): DIN Report 40, Memorandum on health and safety standardization in support of "new approach" directives; application in the field of machinery - CEN Report 1100, Berlin 1994, see also Chapter 4.1.

## National legal definition of the term "state of the art"

In regulating technical safety, German legislation frequently resorts to "indeterminate legal terms", e.g. state of the art, state of science and technology, acknowledged rules of technology. They are given clearer contours mainly in sets of technical rules. The goal of the dynamic implementation of laws is thus achieved.

The level of safety is graduated[7]:

1. **Established** ergonomic findings: "Findings which, in the opinion of the overwhelming majority of experts, fulfil the goals of occupational safety, can be realized with appropriate means, and are ascribed to the field of ergonomics ... in so far as they are concerned with the problem of human labour."
2. Acknowledged rule of technology: "A technical solution which is **proven** in practice and considered correct by the majority of experts[8]. This practice is regarded by the majority of experts as an accurate description of the state of the art at the time of publication."[9]
3. State of the art: "State of development of **progressive** processes, installations or modes of operation which **suggest** that the practical suitability of a measure for limiting emissions is established."[10]
4. State of science and technology: "State of development of **the most progressive** processes, installations or modes of operation which, in the opinion of leading experts from science and technology, is considered necessary on the basis of the latest scientific findings in relation to the goal specified in law."[11]

The above illustrates the difference in emphasis of the "indeterminate legal terms" used in legislation. Technical standards and other technical rules have

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[7] Halbach et al., Übersicht über das Arbeitsrecht, ed. Federal Ministry of Labour and Social Affairs, 6th edition, Bonn, June 1997, p. 522 f.

[8] E.g. in § 3 DruckgasV, § 6 DampfkesselV and § 3 AcetV.

[9] Definition of the term by the joint engineering committee (VDI Bulletin No. 47, 1982, p. 24); see also § 3 Gesetz über technische Arbeitsmittel (Gerätesicherheitsgesetz), BGBl. I 1998, p. 730, 734, and § 3 Allgemeine Verwaltungsvorschrift zur Durchführung des Zweiten Abschnitts des Gerätesicherheitsgesetzes.

[10] Legal definition in § 3 VI BImSchG.

[11] Commentary on § 87 Industrial Constitution Law, in: Fitting et al., Handkommentar zum Betriebsverfassungsgesetz, Verlag Franz Vahlen, Munich, 19th edition, 1998, p. 1148 f.

the purpose of supporting these legal terms and must thus describe the demanded state of development in each case.

The consideration of the current state of the art in meeting health and safety requirements is also anchored in European regulations and documents.[12] For example, the European standards bodies are requested to support the essential safety requirements contained in product-related EC directives, such as the Machinery Directive, by drafting technical specifications "with reference to the state of the art".[13]

### Definition of "state of the art" from the point of view of European standardization

The "state of the art" and "acknowledged rule of technology" are **not** interpreted in European standard DIN EN 45020[14] as embodying different states of development. Rather, an "acknowledged rule of technology" is a description of the state of the art, accurately in the opinion of the majority of experts[15, 16].

DIN EN 45020 defines these terms as follows:

- State of the art: Developed stage of technical capability at a given time as regards products, processes and services, based on the relevant consolidated findings of science, technology and experience.
- Acknowledged rule of technology: Technical provision acknowledged by a majority of representative experts as reflecting the state of the art.

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[12] Cf., for instance, recital 14 along with 1.5.8 and 1.5.9 of Annex I of the Machinery Directive 98/37/EC; Council Decision on the "New Approach in the field of technical harmonization and standardization"; CEN Report CR 1100, 1994: Memorandum on health and safety standardization in support of "new approach" directives; application in the field of machinery.

[13] Halbach et al., Übersicht über das Arbeitsrecht, ed. Federal Ministry of Labour and Social Affairs, 6th edition, Bonn, June 1997.

[14] DIN EN 45020 "General terms and their definitions concerning standardization and related activities", April 1994.

[15] Summarized from an opinion of the DIN legal department of 19.01.95 in response to an inquiry from BAGUV.

[16] At a meeting of the chairmen and convenors of the TCs in June 1994, the EU Commission and the CEN Consultant expressed the opinion that an EN describes the state of the art at the time of its publication in the Official Journal of the EU; cf. Horst Liedtke: Maschinennormung - Kurzbericht aus der Praxis, printed in KAN Report 1, Sankt Augustin 1995, p. 85-88.

## Conclusion

In European and national legislation, the terms "state of the art" and "acknowledged rule of technology" describe a high level of protection. The state of the art is described in specifications of standards developed by a rule-making standards body ("the majority of representative experts") and these can be regarded as acknowledged rules of technology.

The Machinery Directive demands that machines meet its essential health and safety requirements, which are given concrete shape in standards. Machines must be designed in fulfilment of these requirements and in accordance with the state of the art. From Article 95 (formerly 100a) of the EC Treaty, it can be compellingly concluded that the Machinery Directive assumes a high level of protection. It can be concluded that standards as a rule ensure a high level of protection.

# 2 Recommendations from OH&S on the specification of emissions

## 2.1 Strategy of German OH&S

Taking as its point of departure the unsatisfactory treatment of emission-related hazards, KAN - with the involvement of all interested parties, such as representatives of government, the statutory accident insurance institutions, standards makers and industry - has developed a strategy, the wording of which is contained in Annex 4.1. Representatives from France (Institut National de Recherche et de Sécurité - INRS) and the United Kingdom (Health & Safety Executive - HSE) have contributed towards the development of KAN's position. The goal is greater prominence given to emissions in machine safety standards and the statement of emission values particularly for mass products like hand-held power tools.

To implement this strategy, the following steps are necessary:

1. Specifying the available measuring methods for the various machine types in type C standards.
2. Defining the representative operating states for emission measurements in type C standards.
3. Carrying out measurements on this basis.
4. Collecting the measurement results.
5. Compiling the data for each machine type.
6. Deriving the state of the art for this machine type from the results and expressing it in the form of indicative values for design engineers in product standards.

The approach also turns to still unresolved issues, e.g. which other specialist OH&S bodies, along with the manufacturers, could support the gradual development process; and for which machines pilot projects should be encouraged for the gathering of experience.

## 2.2 Strategy of French OH&S

Parallel to the German resolution, the strategic steering committee on "Occupational hygiene and safety" (COS HST) of the French standardization body AFNOR has adopted a similar strategy (wording in Annex 4). Like in Germany, the Machinery Directive is seen as the basis requiring the inclusion of emission values in product standards, and the task of machine safety standards is to support this requirement. Quantitative details in standards are also seen in France as giving manufacturers an opportunity to effectively evaluate their products, minimize hazards and inform product users.

The inclusion of values is considered suitable for certain product groups, but not necessarily for all. The preconditions that have to be met are the same as those proposed by KAN:

- ☐ Test methods must be available and operating states defined.
- ☐ A method of data acquisition must be available.
- ☐ The results must express the state of the art for the particular machine type.

A pilot project for hand-held machines is being carried out as a means of obtaining information on noise and vibration hazards. Further information on its implementation can be found in Chapters 4.2 and 4.3.

# 3 State of the debate

On the basis of the strategies adopted by Germany and France, there is now a need - in addition to the national discussion - for a debate on the European and international level on such issues as how the goals can best be achieved in practice, who should be responsible for which tasks, and which policy should be adopted.

## 3.1 National level (Germany)

The principles of the KAN strategy are supported by all the interested parties.

For instance, the Zentralverband der Elektrotechnik und Elektroindustrie e.V. (ZVEI) [Central Association of the Electrical Engineering Industry][17] is of the opinion that emission values given in standards as indications of ranges and as indicative values would be a practicable aid to the manufacturer. Firstly, it would enable him to assess the state of the art in relation to the hazards posed by his product. And, secondly, it would give him the opportunity to develop technical solutions in fulfilment of the standard. As long as standards do not include design suggestions, emission values are not interpreted as limit values and a precise distinction is made between emission and immission, ZVEI is in favour of treating all significant hazards in product standards and including the statement of the relevant emission values. In describing the state of the art, these would give the manufacturer a guide to how he should design his product. Emission details in equipment documentation would also, in ZVEI's opinion, help the operator to design his operating environment and codes of practice accordingly.

In the opinion of standards makers, it is absolutely essential to investigate in detail the feasibility and financeability of the required steps.

According to the views expressed by Dr Pense of the chemical industry (Annex 5), the statement of indicative values for hazard substance emissions is also in the interests of his branch of industry. He sees benefits both for the manufacturer, e.g. incentive to conduct measurements and use of low emission values as a selling point, and for the user, e.g. source of information and aid for the decision about additional protective measures at the workplace, if indicative values are available. He also suggests considering whether the purchase of low-emission machines could be linked to exemption

[17] Source: Contribution by Mr Huhle, ZVEI, at the KAN Forum on "OH&S-related standardization as a means of effective prevention - Machine emissions" at "Arbeitsschutz Aktuell 98" in Leipzig.

from workplace measurements, e.g. for certain hazardous substances. The user's desire for information on emissions when purchasing a machine will put greater pressure on the manufacturer to measure his machine's emissions and compare them with the indicative values.

However, such an exemption linked to the machine's emissions still requires exhaustive discussion with the regulatory and supervisory authorities. As far as users are concerned there is a fundamental benefit in that the purchase of machines with low emission values may make additional protective measures superfluous at the workplace.

The German Federal Institute for Occupational Safety and Health (BAuA) is also decidedly in favour of the quantification of hazardous substance emissions in product standards . Its specific suggestion of supplementing the indicative value reflecting the state of the art with so-called emission classes modifies the emission parameter approach.

In the BAuA's opinion, three emission classes for hazardous substances should cover the range between zero emission and the indicative value as the top limit. The demarcation lines between the classes should be drawn for each type of machinery on the basis of technical aspects. Under this approach, the manufacturer assigns his machine to an emission class on the basis of the results of emission measurements during conformity testing. Machines which can be assigned to one of these classes would thus conform to the directive and be marketable.

From the BAuA's point of view, this approach would yield a whole range of advantages.

- ☐ By adopting emission classes, the risk of confusing emission values with numerically fixed limit values would be excluded.
- ☐ The ongoing technical development of machines would be rewarded by assignment to a lower emission class and thus probably encouraged.
- ☐ According to the BAuA, the advantage of emission classes over numerical emission values would be that a purchase decision would not be solely based on a numerical comparison of measurement results.
- ☐ For the purchaser of a machine assigned to a low emission class, additional OH&S measures on site could

[18] Source: BAuA contribution to the KAN meeting 04/96: "Emission classes rather than achievable values".

be superfluous, thus yielding economic advantages. Furthermore - as already stressed by the representative of the chemical industry - the purchaser would be able to estimate at the planning stage whether and on what scale extra measures would be necessary on site to achieve compliance with the applicable OH&S regulations. If machines in different emission classes were available, the purchaser could choose the most cost-effective machine for his situation and, in doing so, take account of anticipated future developments.

- Employers for their part would also be supported in their hazard assessment as knowledge of the emission classes would usually make it possible to calculate on the basis of rough estimates whether the demanded values are complied with.
- In the BAuA's opinion, supervisory services would generally find it easy to assess local conditions on the basis of the machine's emission class. Any proposals for improving the workplace situation could be formulated precisely and their implementation monitored with ease.
- Regulatory authorities whose competence lies within the scope of Article 137 (formerly 118a) of the EC Treaty would find in industry and on the market machines with specific emission classes which would facilitate precise and immediately executable measures. Depending on the circumstances, certain OH&S requirements could be assigned to a certain emission class. In the opinion of the BAuA, this would be of benefit to small and medium-size enterprises in particular.

In addition to these supplementary comments and arguments in favour of the basic position of the KAN strategy, the individual steps of the approach are also discussed.

On the issue of whether the statement of emission values by the manufacturer is only desirable for the emission of noise and vibrations, the German Federal Ministry of Labour and Social Affairs (BMA), which, along with other bodies on the national level, is responsible for interpreting the Machinery Directive, has also expressed its opinion. In this connection, the BMA emphatically opposes the position of certain Technical Committees involved in European and international standardization which reject quoting such values for hazards other than noise and vibrations. The standards makers often argue that since the Machinery Directive does not contain any statements on other hazards the standardization bodies have no mandate.

The BMA is of the view that the quantitative statement of emissions, particularly for noise and vibrations, but also for hazardous substances and radiation, in product standards is compellingly demanded by the EC directives. The necessity for the quantification of all significant emissions is derived not only from the marking requirement, but also from the minimization principle of the Machinery Directive. If hazard minimization is to be described objectively, quantification in product standards is indispensable, in the BMA's opinion. In addition, the BMA also holds that hazards posed by emissions have not so far been given sufficient prominence in standards. The BMA therefore advocates a consistent implementation of the KAN strategy outlined in Chapters 2 and 4.1 of this report and considers it feasible to import the results obtained directly into ongoing standardization processes. The first step at the present moment should be the specification of measurement methods in C standards and the definition of operating states.

According to the Federation of the Statutory Accident Insurance Institutions of the industrial sector (HVBG), the KAN strategy needs to be more precisely formulated on this point. The argument from manufacturers and standards makers that the strategy will be difficult to implement as uniform measuring methods for the specific application are not yet available or fully developed should, in the HVBG's view, be countered by defining where research is needed. In the process, KAN should firstly make use of its contacts with the relevant research institutions (BAuA, PT AuT, BIA) and secondly attempt to develop suitable solutions with its European partners.

### 3.2 European and international level

In France, the Institut National de Recherche et de Sécurité (INRS) has been engaged for some time now in promoting the specification of emission values in product standards. It also chaired the working group CEN/BT 60 in the preparation of the Memorandum on health and safety standardization in support of "new approach" directives (see DIN Report 40, Chapter 4.1).

The INRS's position endorses the strategy of the German OH&S institutions (Chapter 2.1 and Annex 4.1) and is reflected in the resolution of the strategic steering committee on "Occupation hygiene and safety" of the French standardization body AFNOR (Chapter 2.2 and Annex 4.2). The resolution, mirroring the proposal of the German BAuA, demands

"the inclusion of emission classes in certain C standards".

In a general report of 1997, the INRS attempts to find explanations for the hitherto vain efforts to have emission values specified in product standards. It highlights, inter alia, the lack of continuity and resolution on the part of design engineers and OH&S professionals in terms of joint action, the unfortunate choice of terminology ("achievable values"), the confusion over emission and immission values, and the lack of practical experience. The INRS attempts to overcome these deficiencies with its own activities and by cooperating with KAN and other relevant institutions.

In the meantime, a steering group has been convened by the interested groups on the French level as a means of implementing this general report. The steps planned initially for noise hazards are presented in Chapter 4.2.1.

On the CEN level, the standards committee CEN/TC 114 "Safety of machinery", which is of great relevance for machine safety, has taken a further important step. In its Business Plan it has set itself the goal - in response to KAN's suggestion - of giving greater prominence to emissions in machine standards. From now on, design engineers are to be provided with tools which make better use of the growing knowledge of the quantification and minimization of health-hazardous emissions which are to be used more intensively in machine standardization.

With his adivsory nucleus, the CEN Rapporteur for machine safety has investigated the question of who can collect the emission data necessary for the definition of indicative values and who can also conduct the measurements. Collecting data, he claims, is not the task of industry and lies outside the possibilities of CEN and its standardization bodies. In addition, he adds, owing to the large number of machine configurations, the nature of the market and limited output figures, suitable noise abatement technology is not usually available. This gives rise to the efforts to state indicative values. However, these, if available at all, are difficult to compare.

On the international standardization level, the IEC subcommittee 61F "Safety of hand-held motor-operated electric tools" has decided that "requirements in connection with specifications for noise measurement, vibration measurement and dust measurement" will not be included in standards. The reason given is that the European approach which focuses on directives has little impact

world-wide and thus that European views, which are strongly influenced by the Machinery Directive, would in some respects be unenforceable. Clearly in evidence at this meeting were the efforts "to leave more responsibility and greater freedom in the hands of manufacturers, whilst at the same time stressing the responsibility of governments and public authorities."

This lack of understanding of international standards makers for the European safety concept of the Machinery Directive and the implementation in standards is by no means confined to the field of hand-held power tools, but also applies to the same extent to numerous other fields. This position overlooks the benefits of this safety philosophy and the regularities of the European market. For this reason it is necessary to convince international standards makers of the fact that, in the long term, their standards and thus also international products can only be adopted unchanged in Europe if they are compatible with the European conception of machine safety.

# 4 Implementation

In Chapter 3, emissions were not dealt with individually but as "the emissions of a machine". However, in the implementation of the KAN strategy, a distinction has indeed to be made between noise, vibrations, hazardous substances and radiation. Different sources on the machine, transmission routes, effects, measuring methods and also differences in the state of knowledge make it necessary to individually study the hazards, their treatment in standardization and the manufacturers' information on emissions and investigate ways of overcoming the shortcomings.

One way of improving the situation is to give greater prominence to emissions in the basic standard EN 292, which is currently undergoing revision (Chapter 4.1).

We also wish to present investigations by KAN and various other projects on individual emissions (Chapters 4.2 to 4.5). The individual approaches underline that considerable difficulties will have to be overcome for all hazards before satisfactory quantification will be possible. Nevertheless, there are a number of approaches which are worthy of further consideration, e.g.

- ☐ Surveying manufacturers to obtain a reliable picture of the state of the art.
- ☐ Specifying emission classes rather than individual emission values.
- ☐ Examining manufacturers' information in the search for shortcomings in the implementation of the machinery safety standards.
- ☐ Using indicative values to check hazard minimization efforts.

Projects which attend to the collection of data required for implementation are presented in Chapter 4.6.

## 4.1 Revision of EN 292

As explained, objections have been raised to the quantification of emission values in product standards for a variety of reasons. According to one line of argument frequently put forward in this connection, the Machinery Directive explicitly demands quantification only for hazards posed by noise and vibrations if these are significant and therefore that the standards makers have no mandate. With clear statements in terms of the quantification of the other health-impairing emissions in the Machinery Directive, it would be possible to enhance the acceptance of the KAN resolution (Annex 4), particularly among the other CEN members.

The current revision of the basic machine safety standard EN 292 "Safety of machin-

ery", Parts 1 and 2, also represents an opportunity to give greater prominence to emissions. KAN has therefore joined forces with representatives of horizontal CEN/TCs on noise, vibrations, hazardous substances and radiation in advocating additions to the standard in this direction.

The result so far is that the most recent version of Part 1 of July 1999 (Rev. 16) adopts the terms "emission (section 3.28)" and "emission control performance (section 3.29)", which result from the emission values of machines of the same design. In the strategy of risk reduction, reference is also made to emissions (section 5.0.3). The design engineer must estimate the risk, e.g. on the basis of emission values, for each identified hazard and hazardous situation.

In the present version of the revision of Part 2 of July 1999, major additions relating to emissions have been included:

- In "taking into account the general technical knowledge regarding machine design and construction", emission values for noise, vibrations, hazardous substances and radiation are to be collected and compared (section 3.3c).
- In "the enclosure of control stations and intervention zones, combined protection from several risks is to be provided and emission hazards, e.g. noise, vibration, radiation, hazardous substances" are to be included (section 4.1.1).
- Section 4.4 covers additional protective measures reducing emission if the reduction of emissions at source is not achieved to a sufficient extent. Examples are listed for noise (enclosures; screens fitted to the machinery; silencers), vibrations (vibration isolators, additional mass, vibration absorbers, resilient mounting, suspended seat) and hazardous substances (use of dust-reducing procedures, machine encapsulation, local exhaustion with filtration, wetting with liquids, special ventilation in the area of the machine). Useful standards, e.g. for the measurement of noise emissions or for the isolation of a vibration source, are also listed.

Greater prominence given to emissions in the basic standard will provide the basis for the inclusion of indicative values in C standards.

## 4.2 Noise

### Results of the KAN Study "Noise protection for machinery and workplace - status of and need for occupational health and safety standardization"

The KAN Study "Noise protection for machinery and workplace - status of

and need for occupational health and safety standardization"[19] investigated, amongst other things, the state of standardization in terms of emissions. The study reveals a need for action to be taken to improve the consideration given to noise hazards in national and European standardization. For instance, it criticizes the insufficient implementation of type B standards for noise measurement and noise control in the safety standards for machinery. The preconditions for the determination of noise parameters still are not sufficient as not all noise sources have been encompassed under the present system or are not measured in near-authentic operating conditions.

The recommendations which KAN derives from this are aimed at improving the provision of data, experience and materials on measuring methods and uniform operating conditions, emission values and noise control measures and on their inclusion in standard drafting and revision.

The results and the resultant need for action are presented in greater detail in Annex 6 of this report.

## Prominence given to noise hazards in selected standards

The debate on the quantification of emission values in product standards was initiated at KAN in 1996. The KAN Secretariat thereupon selected seven machine standards and work items as examples and examined them for their treatment of noise emissions.

On the basis of the subsequent review, KAN firstly shows to what extent noise hazards are dealt with in the selected standards. It examines whether the hazard is mentioned at all. Furthermore, KAN analyzes whether noise control measures, measuring methods, standardized operating conditions and, finally, values for the emission are given reflecting the state of the art. Detailed analysis results from two examples are presented in Annex 7.1.

The results obtained from the examples are largely identical to those from the KAN Study "Noise protection for machinery and workplace - status of and need for occupational health and safety standardization" and the experience from KAN comments on machine standards. They show that reference is usually made to the hazard and to design measures to

[19] KAN Report 8, ed. Verein zur Förderung der Arbeitssicherheit in Europa, August 1996

reduce the hazard. The measuring methods are not yet specified in all relevant type C standards. The state of the art is rarely quantified in the form of numerical values. These are often taken from directives, national regulations or ISO standards where they serve as limit values, or are obsolete.

Table 2: Review of the prominence given to noise hazards in selected standards

| Standard / Criteria | DIN EN 774: Garden equipment - Hand held, integrally powered hedge trimmers (12/1997) | prEN 792 - 14: Hand-held non electric power tools - Safety requirements - Part 14: Assembly power tools for non-threaded mechanical fasteners (08/1995) | DIN EN 289: Rubber and plastics machinery; compression and transfer moulding presses; safety requirements for the design (01/1998) | DIN EN 791: Drill rigs - Safety (01/1996) | prEN 474-7: Earth-moving machinery - Safety - Part 7: Requirements for scrapers (05/1998) | DIN EN 692: Mechanical presses - Safety (08/1996) | DIN EN 608: Agricultural and forestry machinery - Portable chain saws (12/1994) |
|---|---|---|---|---|---|---|---|
| Noise cited as a hazard | | | | | | | |
| Reference to technical noise reduction measures | | | | | | | |
| Acoustic measuring methods given | | | | | | | |
| Operating state for acoustic measurements defined | | | | | | | |
| State of the art quantified | | | | | | | |

Yes
No
Values obtained from the "Baumaschinen-Lärm-VO" (construction machine noise ordinance) or the "Special testing principles for the assessment of the noise of chain saws at the chain saw operator's ear" (1986) of the agricultural accident insurance institutions

### Results of the project of BAuA / NRW OH&S administration / BG for the mechanical engineering and metal industry

In cooperation with the Federal Institute for Occupational Safety and Health (BAuA) and the BG for the mechanical engineering and metal industry, the Landesanstalt für Arbeitsschutz des Landes Nordrhein-Westfalen (Occupational Health & Safety Agency of North-Rhine/Westphalia) has had manufacturers' information on noise in their operating instructions checked by the OH&S authorities. Information on machines from 1411 manufacturers from 25 countries was investigated. It was discovered that the details given by manufacturers and importers were highly deficient. 43% of the documents examined contained incomplete information and 28% none at all, and 56% of the manufacturers and importers stated that they were unaware of the legal provisions and/or measurement standards.

From the data on 1054 machines from 571 manufacturers, which were compiled by the OH&S authorities in NRW, the ranges of the emission values for the individual machine types have been determined.[20]

### Results of a survey of manufacturers by the central research and testing institute of the German accident insurance institutions

In the context of the debate on the specification of emission values in C standards, manufacturers have frequently pointed out that in the vast majority of cases no information was available on the state of the art and the effort required for conducting such measurements was excessive.

Of interest in this connection are the results of an investigation by the central research and testing institute of the German accident insurance institutions (BIA) together with the Austrian and Swiss accident insurance institutions AUVA and SUVA. In a survey of manufacturers, measurement data on the noise emissions from a total of 20 different woodworking machines and hand-held tools were gathered. The BIA compared the data with existing data from the literature (VDI ETS Guidelines, BAuA research reports, information from the BG for the woodworking industry) and discussed the results for woodworking machines with the woodworking BG.

[20] Further information can be obtained on the Internet at http:// www.komnet.nrw.de or from Landesanstalt für Arbeitsschutz des Landes Nordrhein-Westfalen, Ulenbergstr. 127-131, 40225 Düsseldorf.

The noise emission values gathered in the survey of manufacturers had to be assessed differently in terms of their information value. For some of the gathered values, reliable statements were difficult to make as information on the operating state during measurement was lacking or the number of samples was too small. For 50% of the machine types covered, however, the number of samples was sufficiently large and the emission values relatively sound. The values obtained are for the most part somewhat lower than the comparison values obtained from the literature, the latter, however, were mostly gathered over ten years ago. The lower values obtained in the survey can thus be explained by noise reduction measures undertaken in the intervening period.

In spite of the reservations mentioned, the authors come to the conclusion that "it is possible to gain a fairly accurate picture of the state of the art for many machines in terms of noise emissions from this survey of manufacturers", even if the results and experience still require further discussion and development.

### Implementation of the resolution of the strategic steering committee "Occupational hygiene and safety" (COS HST) of the French standardization body AFNOR in the noise sector

At the beginning of 1999, the French Institut national de recherche et de sécurité (INRS) launched an action programme concerned with practices in the provision of information on noise from machines. This programme is aimed at ensuring that full information on noise emissions from machines, as demanded in Europe, is in fact provided. It comprises two schemes which are mutually compatible and are to be carried out in parallel.

- Scheme A: This is a **pilot project** in which the INRS will cooperate with a number of French manufacturers of selected machines. (Together with these manufacturers, the noise emissions of products will be measured at the companies and the resultant readings gathered. These will then be investigated as to whether indicative values can be derived from them for the particular machine type and possibly included in C standards for these

[21] This pilot project is a response to the request to carry out pilot projects/measures, as formulated in the resolution of the French COS "HST" of 10th March 1998 for the statement of indicative values in C standards and in the resolution of Kommission Arbeitsschutz und Normung (KAN) of 9th December 1997 on the quantification of emissions in product standards.

machines.) The project will initially focus on hand-held pneumatic screwdrivers.

- ☐ Scheme B: In this case, a **survey of manufacturers** is planned in which the companies concerned are to be approached mainly, though not exclusively, at trade fairs. The intention is to question manufacturers on the following subjects: Opinions on the statement of noise emissions, the methods employed and their practice to inform about noise emissions; knowledge of and application of standards concerned with the measurement of noise emissions from machines; possible difficulties of all kinds, particularly in terms of the availability of manpower and materials.

The resources required for carrying out the programme (manpower and materials) are being provided by the INRS, the regional centres for physical measurements, which in France belong to the social security system, and the French Ministry of Labour.

The steering group for this pilot project met for the first time on 18th February 1999. It is composed of the following interested and "involved" groups: the French Ministry of Labour, the Fédération des industries mécaniques (FIM), the Centre technique des industries mécaniques (CETIM, French research centre), the regional centres for physical measurements of the social security system, the Union de normalisation de la mécanique (UNM), Le Syndicat des industries de l'outillage (SIO), the trade unions, the "Occupational hygiene and safety" strategic steering committee (COS "HST") of the French standardization body AFNOR[22] and the INRS.

The envisaged measures are, if possible, to be combined with other measures with a similar objective, which in Germany are based on the KAN resolution. The already intensive cooperation with KAN and the Federal Institute for Occupational Safety and Health (BAuA) is to be expanded further. Moreover, the standardization section of the INRS will find out about comparable projects in other Member States of the European Union, and above all in the United Kingdom and Scandinavia.

The pilot project described in Scheme A has already started and is scheduled for conclusion by June 2000. The INRS employed a new member of staff for the

[22] At the end of the resolution of COS "HST" 10.03.98, the following is stated: "COS will follow up these actions."

varied tasks for the duration of the project. During the initial phase, contacts have been established with manufacturers of hand-held pneumatic screwdrivers, e.g. at trade fairs.

The measurement phase has also started. The measurements have to be carried out on over 60 different models so that the readings can be presented as a cluster of points, as described in EN ISO 11689. As a result of support from CRAM and the supraregional centres for physical measurements, technicians from CETIM and the INRS can use the workshops of operators of pneumatic screwdrivers for the measurements and thus keep costs low.

With the aid of the results, it is hoped to be able to provide either clusters of measuring points or, in another way, indicative values for noise in a future generation of machine safety standards for screwdrivers. These values should reflect the current state of the art and serve as an example so that the statement of values will become standard practice in other type C standards as well.

Since this goal is still far from being reached and will also be difficult to reach, the exchange of experience between Germany and France is still considered very important.

## 4.3 Vibrations

### Results of the KAN Study "Definition of the need for standardization to establish vibration parameters"

The KAN Study "Definition of the need for standardization to establish vibration parameters"[23] has investigated the state of standardization in terms of vibration emissions. The results and conclusions, extracts of which are presented in Annex 8, also reveal a need for action in the vibration sector. This concerns, firstly, the provision of further test standards particularly for whole-body vibrations, the specification of operating conditions and the description of the state of the art with the aid of collected and managed data. Secondly, the study strongly advises that C standardization be supported by vibration experts and that a stronger distinction be made between emissions and immissions in the standards.

### Prominence given to vibration hazards in selected standards

Like for noise (Chapter 4.2), the KAN Secretariat has selected representative

[23] KAN Report 3, ed. Verein zur Förderung der Arbeitssicherheit in Europa, March 1996.

machine standards and work items and investigated them for the prominence they give to vibration emissions.

The following table shows the extent to which prominence is given to vibration hazards in the selected standards. Annex 7.2 contains more detailed analysis results from two examples, one positive and the other negative.

The exemplary investigations on vibration hazards also confirm the results of the KAN Study "Definition of the need for standardization to establish vibration parameters" and the KAN comments in this emission sector. They show that, so far, the state of the art is barely quantified with indicative values at all in the machine safety standards. In some cases, the necessary measuring methods are not available and it has proven difficult to specify the operating conditions. By comparison, greater progress has been made with the quantification of noise emissions.

Table 3: Review of the prominence given to vibration hazards in selected standards

| Standard / Criteria | prEN 474-7: Earth-moving machinery - Safety - Part 7: Requirements for scrapers (05/1998) | DIN EN 774: Garden equipment - Hand held, integrally powered hedge trimmers - Safety (12/1997) | DIN EN 632: Agricultural machinery - Combine harvesters and forage harvesters - Safety (08/1995) | DIN EN 692: Mechanical presses - Safety (08/1996) | E DIN EN 1726: Safety of machinery - Industrial trucks - Self-propelled trucks up to and including 10,000 kg capacity and tractors with a drawbar pull up to and including 20,000 newtons (03/1995) | E DIN EN 792-14: Hand-held non electric power tools - Safety requirements - Part 14: Assembly power tools for non-threaded mechanical fasteners (08/1995) |
|---|---|---|---|---|---|---|
| Vibration cited as a hazard | | | | | | |
| Technical reduction measures given | | | | | | |
| Measuring methods given | | | | | | |
| Operating state for measurement defined | | | | | | |
| State of the art quantified | | | | | See footnote[24] | |

Yes
No
Value taken from ISO 7505[25]

[24] The investigated standards do not usually give any details of the state of the art, but merely - in accordance with the principle of informing the user - instructions for the manufacturer on the information on vibration to be supplied to the user (DIN EN 608 excepted).

[25] Forestry machinery - Chain saws - Measurement of hand-transmitted vibration (1986).

Table 3: Review of the prominence given to vibration hazards in selected standards (continued)

| Standard / Criteria | E DIN EN 792-15: Hand-held non electric power tools - Safety requirements - Part 15: Cutting-off and crimping power tools (12/1995) | E DIN EN 792-7: Hand-held non-electric power tools - Safety requirements - Part 7: Grinders (12/1995) | DIN EN 474-1: Earth-moving machinery - Safety - Part 1: General requirements (12/1994) | DIN EN 996: Piling equipment - Safety requirements (04/1996) | DIN EN 608: Portable chain saws (12/1994) | DIN EN 791: Drill rigs (01/1996) |
|---|---|---|---|---|---|---|
| Vibration cited as a hazard | | | | | | |
| Technical reduction measures given | | | | | | |
| Measuring methods given | | | | | | |
| Operating state for measurement defined | | | | | | |
| State of the art quantified | | See footnote[26] | See footnote[26] | See footnote[26] | | See footnote[26] |

Yes
No
Value taken from ISO 7505[27]

[26] The investigated standards do not usually give any details of the state of the art, but merely - in accordance with the principle of informing the user - instructions for the manufacturer on the information on vibration to be supplied to the user (DIN EN 608 excepted).

[27] Forestry machinery - Chain saws - Measurement of hand-transmitted vibration (1986).

## 4.4 Hazardous substances

In April 1996, KAN approved the results of a study entitled "Emission of hazardous substances by machinery" . These results include, amongst other things, the conclusion that too few type C standards quote "parameters for the assessment of the emission behaviour" of hazardous substances and that the inclusion of "indicative values" definitely makes sense under certain conditions.

### Prominence given to substance hazards in selected standards

The KAN Secretariat has again selected representative machine standards and work items for the hazardous substance sector and examined them for the prominence given to hazardous substance emissions.

The following table shows the extent to which prominence is given to hazardous substance hazards in selected standards. Annex 7.3, like for noise and vibration hazards, presents detailed analysis results from two examples, one positive and the other one negative.

### The quantification of dust emissions from hand-held power tools for woodworking

In the context of a project carried out by the BIA together with the Central Association of the Electrical Engineering Industry (ZVEI) and the accident insurance institution for the woodworking industry, hand-held power tools for woodworking with integrated dust extraction were investigated on a test bench in order to determine the state of the art in terms of dust emissions. On the basis of the results of the project, it would be possible to describe the state of the art with an indicative value reflecting the protection level provided by the equipment examined. Details of the background and investigation are presented in Annex 9.

[28] KAN Report 15, ed. Verein zur Förderung der Arbeitssicherheit in Europa, September 1997.

Table 4: Review of the prominence given to hazards from hazardous substances in selected standards

| Standard / Criteria | ISO/ DIS15012-1:Health and safety in welding and allied processes - Requirements, testing and marking of equipment for air filtration (06/99) | prEN 454:Food processing machinery - Planetary mixers - Safety and hygiene requirements (11/1994) | DIN EN 608:Portable chain saws (12/1994) | prEN 746-7:Industrial thermoprocessing equipment - Part 7: Special safety requirements for vacuum thermoprocessing equipment (06/1994) | prEN 12757-1:Mixing machinery for coating materials - Safety requirements - Part 1: Mixing machinery for use in vehicle refinishing (02/1997) | prEN 12840:Safety of machine-tools - Manually controlled turning machines (04/1997) | DIN EN 50144-1: Safety of hand-held electric motor operated tools - Part 1: General requirements (05/1998) |
|---|---|---|---|---|---|---|---|
| Hazardous substances cited as a hazard | | | | | | | |
| Technical reduction measures given | | | | | | | |
| Measuring methods given | | | | | | | |
| Operating state for measurement defined | | | | | | | |
| State of the art quantified | | | | | | | |

Yes
No

## 4.5 Radiation

The Machinery Directive demands of manufacturers that "any emission of radiation is limited to the extent necessary for its operation and that the effects on exposed persons are non-existent or reduced to non-dangerous proportions."

A European B standard prEN 12198-1 is currently being drafted to precisely define these "non-dangerous proportions". The text of a paper - printed in Annex 10 - by Dr Eggert from the Federal Institute for Occupational Safety and Health in Berlin describes these standardization activities of the working group of TC 114 "Safety of machinery" (WG 13 "Radiation of machinery"). The three-part standard specifies categories for machine emission values relating to radiation:

- ☐ Category 0 applies to machines whose emission values are beneath existing reference values (not limit values!) for exposure of the general population. There is no marking obligation or a special obligation to inform the user.
- ☐ Category 1 machines have emission values above the reference values for exposure of the general population, but beneath those for exposure at the workplace. The machine has to be marked with "1" and the user has to be informed.
- ☐ In the case of category 2 machines, the reference value for exposure at the workplace is exceeded. The machine has to be marked with "2" and the user has to be informed.

According to Dr Eggert, and as already mentioned in Chapter 3.1, the assignment of machines to one of the mentioned categories facilitates "considerably the work of the persons responsible for protection from non-ionizing radiation in the working environment and thus helps to break down trade barriers under the terms of Article 95 (formerly 100a) of the EC Treaty". This approach roughly corresponds to the fundamental position advocated by the BAuA and by the French INRS for the quantification of emissions in product standards, which involves supporting indicative values by so-called emission classes.

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[29] prEN 12198 - 1 Safety of machinery - Assessment and reduction of risks arising from radiation emitted by machinery - Part 1: General principles, Part 2: Radiation emission measurement procedure, Part 3: Reduction of radiation by attenuation or screening

## 4.6 Databases of emission values

An important point, and a central aspect of the KAN resolution of December 1997 on the quantitative statement of emission values in product standards, is the gathering of measured values.

In this connection, it has been frequently pointed out that in many sectors there are at present no suitable measuring methods. The survey of manufacturers described in Chapter 4.2.1 shows on the other hand that there are already sectors in which there are not only measuring methods available, but also the requisite measurement values. Either way, however, the data are not collected systematically. The conditions under which data could be collected (suitable institutions, funding etc.) remain to be settled as well as the updating of such databases as the state of the art progresses.

Efforts to gather data in databases have so far proven difficult for the reasons given. A move by the Directorate-General V of the European Commission to bring together the data on emissions is not being pursued further at present. Information on an existing emission database from Umeå, Sweden, is available on the Internet at http://umetech.niwl.se. This database, supported by the "Biomed 2" programme of the European Commission, brings together data on hand-arm vibrations from hand-held power tools and whole-body vibrations from earth-moving machines. In some cases, the hand-arm vibrations are accompanied by noise emission values.

Certain accident insurance institutions have data collections relating to certain machines (e.g. woodworking equipment); at the BIA, emission data are being collected in the context of investigations into proceedings for the recognition of occupational diseases.

So far, however, there has not been a controlled, interdisciplinary procedure, even though the database tools are available. Collecting the existing data is a necessary task in advancing towards the goal of quantification.

# 5 Future Tasks

The conclusion from this collection of documents is that compliance with the Machinery Directive in terms of emissions is not satisfactory. Action still needs to be taken in a number of areas. Yet to be clarified as well is who is responsible for which task.

Examples of which tasks can be handled by whom are:

- ☐ Provision of the measuring methods required for measuring emissions, definition of the operating states and inclusion of these methods in the machine safety standards by research institutions and standardization bodies.
- ☐ Measurements carried out by manufacturers, test institutes and by other OH&S institutions.
- ☐ Provision of the available data by manufacturers and accident insurance institutions.
- ☐ Collection of the data by OH&S institutions and KAN.
- ☐ Establishing pan-European contacts with manufacturers and OH&S experts by KAN.

KAN will also continue to accompany these activities, e.g. by submitting its comments on the relevant type A, B and C standards, by exchanging information with the relevant parties in Germany and the rest of Europe (particularly France) and by supporting activities to bring data together.

# 6 Literature


[1] CEN Report 1100: Memorandum on health and safety standardization in support of "new approach" directives; application in the field of machinery. DIN-Fachbericht 40, DIN Deutsches Institut für Normung (ed.), Beuth Verlag GmbH, Berlin, 1994

[2] CEN Resolution BT 22/1997 in KAN Report 11 "The standardization of OH&S management systems", Sankt Augustin, 1997, p. 75 f.

[3] DIN EN 45020: General terms and their definitions concerning standardization and related activities, April 1994

[4] EU-Memorandum "The role of standardization in relation to article 118a of the EC Treaty", in: KAN Report 5 "European standardization concerning the safety and health of workers at work", 1996

[5] Fitting et al., Handkommentar zum Betriebsverfassungsgesetz, Verlag Franz Vahlen, Munich, 19th edition, 1998, p. 1148 f.

[6] Halbach et al., Übersicht über das Arbeitsrecht, ed. German Federal Ministry of Labour and Social Affairs, 6th edition, June 1997, p. 522 f.

[7] KAN Report 3, Definition of the need for standardization to establish vibration parameters, March 1996

[8] KAN Report 8, Noise protection for machinery and workplace - status of and need for occupational health and safety standardization, August 1996

[9] KAN Report 15, Emission of hazardous substances by machinery, September 1997

[10] Lacore, Recours à des valeurs indicatives (valeurs réalisables d'émission, valeurs repères...) ou à des "classes d'émission" dans les normes C

[11] Liedtke, Maschinennormung - Kurzbericht aus der Praxis, printed in KAN Report 1, Sankt Augustin, 1995, p. 85-88

[12] prEN 12198-1, Safety of machinery - Assessment and reduction of risks arising from radiation emitted by machinery - Part 1: General principles; prEN 12198-2, Radiation emission measurement procedure; prEN 12198-3, Reduction of radiation by attenuation or screening

[13] Directive 98/37/EC of the European Parliament and of the Council of 22nd June 1998 on the approximation of the laws, regulations and administrative provisions of the Member States concerning machines (OJ EC L 207 of 23.7.1998, p. 1)

# Annex 1 The minimization and marking of emissions in Annex I of the Machinery Directive 98/37/EC

(Annex I: Essential health and safety requirements relating to the design and construction of machinery and safety components)

## A-1.1 Noise hazards

### Minimization of noise hazards

*"1.5.8 Noise*

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.

*3 Essential health and safety requirements to offset the particular hazards due to the mobility of machinery*

*3.2.1 Driving position*

... Where the machinery is fitted with a cab, this must be designed, constructed and/or equipped to ensure that the driver has good operating conditions and is protected against any hazards that might exist (for instance: inadequate heating and ventilation, inadequate visibility, excessive noise and vibration, falling objects, penetration by objects, rolling over, etc.).

### Statement of parameters for noise hazards

*1.7.4 Instructions*

d) Any literature describing the machinery must not contradict the instructions as regards safety aspects. The technical documentation describing the machinery must give information regarding the airborne noise emissions referred to in (f) ...

e) Where necessary, the instructions must give the requirements relating to installation and assembly for reducing noise or vibration (e.g. use of dampers, type and mass of foundation block, etc.).

f) 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 workstations, 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 workstations, where this exceeds 63 Pa (130 dB in relation to 20 $\mu$Pa),
- ☐ sound power level emitted by the machinery where the equivalent continuous A-weighted sound pressure level at workstations exceeds 85 dB(A).

In the case of very large machinery, instead of the sound power level, the equivalent continuous sound pressure

levels at specified positions around the machinery may be indicated.

Where the harmonised standards are not applied, sound levels must be measured using the most appropriate method for the machinery.

The manufacturer must indicate the operating conditions of the machinery during measurement and what methods have been used for the measurement.

Where the workstation(s) are undefined or cannot be defined, sound pressure levels must be measured at a distance of 1 metre from the surface of the machinery and at a height of 1,60 metres from the floor or access platform. The position and value of the maximum sound pressure must be indicated."

## A-1.2 Vibration hazards

### Minimization of vibration hazards

*1.5.9 Vibrations*

Machinery must be so designed and constructed that risks resulting from vibrations produced by the machinery are reduced to the lowest level, taking account of technical progress and the availability of means of reducing vibration, in particular at source.

*3 Essential health and safety requirements to offset the particular hazards due to the mobility of machinery*

*3.2.1 Driving position*

... Where the machinery is fitted with a cab, this must be designed, constructed and/or equipped to ensure that the driver has good operating conditions and is protected against any hazards that might exist (for instance: inadequate heating and ventilation, inadequate visibility, **excessive** noise and **vibration**, falling objects, penetration by objects, rolling over, etc.).

*3.2.2 Seating*

... The seat must be designed to reduce vibrations transmitted to the driver to the lowest level that can be reasonably achieved.

### Statement of parameters for vibration hazards

*1.7.4 Instructions*

d) Any literature describing the machinery must not contradict the instructions as regards safety aspects. The technical documentation describing the machinery must give information regarding the airborne noise emissions referred to in (f) and, in the case of hand-held and/or

hand-guided machinery, information regarding vibration as referred to in 2.2.

e) Where necessary, the instructions must give the requirements relating to installation and assembly for reducing noise or vibration (e.g. use of dampers, type and mass of foundation block, etc.).

*2 Essential health and safety requirements for certain categories of machinery*

*2.2 Portable hand-held and/or hand-guided machinery*

*Instructions*

The instructions must give the following information concerning vibrations transmitted by hand-held and hand-guided machinery:

- ☐ the weighted root mean square acceleration value to which the arms are subjected, if it exceeds 2,5 $m/s^2$ as determined by the appropriate test code. Where the acceleration does not exceed 2,5 $m/s^2$, this must be mentioned.

If there is no applicable test code, the manufacturer must indicate the measurement methods and conditions under which measurements were made.

*3 Essential health and safety requirements to offset the particular hazards due to the mobility of machinery*

*3.6.3 Instruction handbook*

Apart from the minimum requirements set out in 1.7.4, the instruction handbook must contain the following information:

(a) regarding the vibrations emitted by the machinery, either the actual value or a figure calculated from measurements performed on identical machinery:

- ☐ the weighted root mean square acceleration value to which the arms are subjected, if it exceeds 2,5 $m/s^2$, should it not exceed 2,5 $m/s^2$, this must be mentioned,
- ☐ the weighted root mean square acceleration value to which the body (feet or posterior) is subjected, if it exceeds 0,5 $m/s^2$, should it not exceed 0,5 $m/s^2$, this must be mentioned.

Where the harmonised standards are not applied, the vibration must be measured using the most appropriate method for the machinery concerned.

The manufacturer must indicate the operating conditions of the machinery during measurement and which methods were used for taking the measurements; ...

## A-1.3 Hazards from hazardous substances

### Minimization of hazards from hazardous substances

*1.5.13 Emissions of dust, gases, etc.*

Machinery must be so designed, constructed and/or equipped that risks due to gases, liquids, dust, vapours and other waste materials which it produces can be avoided.

Where a hazard exists, the machinery must be so equipped that the said substances can be contained and/or evacuated.

Where machinery is not enclosed during normal operation, the devices for containment and/or evacuation must be situated as close as possible to the source emission.

*3 Essential health and safety requirements to offset the particular hazards due to the mobility of machinery*

*3.5.3 Emissions of dust, gases, etc.*

Where such hazards exist, the containment equipment provided for in section 1.5.13 may be replaced by other means, for example precipitation by water spraying.

The second and third paragraphs of section 1.5.13 do not apply where the main function of the machinery is the spraying of products.

*5 Essential health and safety requirements for machinery intended for underground work*

*5.7 Emissions of dust, gases, etc.*

Exhaust gases from internal combustion engines must not be discharged upwards."

### Statement of parameters for hazards from hazardous substances

The Machinery Directive does not demand the statement of parameters for hazards from hazardous substances.

## A-1.4 Radiation hazards

### Minimization of radiation hazards

*1.5.10 Radiation*

Machinery must be so designed and constructed that any emission of radiation is limited to the extent necessary for its operation and that the effects on exposed persons are non-existent or reduced to non-dangerous proportions.

*1.5.12 Laser equipment*

Where laser equipment is used, the following provisions should be taken into account:

- ☐ laser equipment on machinery must be designed and constructed so as to prevent any accidental radiation,
- ☐ laser equipment on machinery must be protected so that effective radiation, radiation produced by reflection or diffusion and secondary radiation do not damage health,
- ☐ optical equipment for the observation or adjustment of laser equipment on machinery must be such that no health risk is created by the laser rays.

*1.7 Indicators*

*1.7.2 Warning of residual risks*

Where risks remain despite all the measures adopted or in the case of potential risks which are not evident (e.g. electrical cabinets, radioactive sources, bleeding of a hydraulic circuit, hazard in an unseen area, etc.), the manufacturer must provide warnings.

## Statement of parameters for radiation hazards

The Machinery Directive does not demand the statement of parameters for radiation hazards.

# Annex 2 Extracts from EN 292 "Safety of machinery - Basic concepts, general principles for design"

**Part 1: Basic terminology, methodology, November 1991**

In Part 1, section 4 of the standard, the possible emissions from machinery are listed in detail:

### 4.5 Hazards generated by noise

Noise may result in

- ☐ permanent loss of hearing acuteness,
- ☐ tinnitus,
- ☐ tiredness, stress etc.
- ☐ other effects such as loss of balance, loss of awareness etc.
- ☐ interference with speech communication, acoustic signals etc.

### 4.6 Hazards generated by vibration

Vibration may be transmitted to the whole body and particularly to hands and arms (use of hand-held machines).

The most severe vibration (or less severe vibration over a long time) may generate serious disorders (vascular disorders such as white-finger, neurological, osteo-articular disorders, lumbago and sciatica etc.).

### 4.7 Hazards generated by radiation

These hazards are produced by a variety of sources and may be generated by non-ionizing or ionizing radiation:

- ☐ low frequency,
- ☐ radio frequency and micro-waves,
- ☐ infra-red,
- ☐ visible light,
- ☐ ultra-violet,
- ☐ x and $\gamma$ rays,
- ☐ $\alpha$, $\beta$ rays, electron or ion beams,
- ☐ neutrons.

### 4.8 Hazards generated by materials and substances

Materials and substances processed, used or exhausted by machinery, and materials used to construct machinery may generate several different hazards:

- ☐ hazards resulting from contact with, or inhalation of, fluids, gases, mists, fumes and dusts, having a harmful, toxic, corrosive and/or irritant effect,
- ☐ fire and explosion hazards,
- ☐ biological (e.g. mould) and microbiological (viral or bacterial) hazards.

**Part 2: Technical principles and specifications, November 1991**

With respect to emissions, part 2 of the standard contains information on the observance of ergonomic principles, safeguarding measures and requirements concerning the accompanying documents.

### 3.6 Observing ergonomic principles

3.6.3 Avoiding as far as possible noise, vibration, thermal effects (extreme temperatures) etc..

### 4 Safeguarding

... Certain safeguards may be used to avoid exposure to more than one hazard (e.g. a fixed guard preventing access to a zone where a mechanical hazard is present being used to reduce noise level and collect toxic emissions).

#### *4.2.2 Requirements of guards*

*4.2.2.1 Guards may have to achieve following functions:*

...- containment/capture of materials, workpieces, chips, liquids, radiation, dust, fumes, gases, noise etc., which may be ejected, dropped or emitted by the machine...

### 5.5 Accompanying documents (in particular: instruction handbook)

#### *5.5.1 Contents*

c) Information relating to the machine itself

For example:

...- data[1] on noise and vibration generated by the machine, about radiations, gases, vapours, dust emitted by it, ...

Annex A of the standard contains Annex I of the Machinery Directive and thus also its wording on the hazards arising from noise, vibrations, radiation, laser equipment, emissions of dust, gases etc.

[1] With reference to the measuring method employed.

# Annex 3 Excerpt from the "Memorandum on health and safety standardization in support of 'new approach' directives"[2]

*4.1.5 Limit values of exposure - Achievable values*

As regards provisions expressed in terms of results making use of limit values, a fundamental distinction has to be made between limit values of exposure of a person to a hazard and achievable values for product-related harmful agents as, e. g., harmful emissions from a machine in operation.

*a) Limit values of exposure of a person to a hazard*

The determination of limit values of exposure of a person to a hazard is within the jurisdiction of the Public Authorities. At EEC level, the limit values of exposure are determined by directives based on Article 118a of the EEC Treaty and Article 30 of the EURATOM Treaty.

*b) Achievable values for product-related harmful agents*

Standards may set achievable values - determined by the state of the art - for definite factors generating hazards of all possible natures[9] during normal use of a product (e. g. the emission values for noise, vibration, dust or other harmful agents resulting from operation of a machine).

These achievable values do not constitute limit values of exposure for persons, but are the emission values from a machine under defined test conditions relating to the operation of the machine (for example, speed, load, material to be used.....) and to the measurement of the corresponding harmful agents.

They are not a barrier to innovation, and they should not prevent the achievement of better values. With this in view, they have to be revised when the state of the art evolves.

NOTE

As far as machinery is concerned, the framed statements should be reproduced in all C standards in which achievable values are given.

Achievable values are useful in setting levels of performance that a designer can

[2] CEN Report 1100: Memorandum on health and safety standardization in support of "new approach" directives; application in the field of machinery. DIN-Fachbericht 40, DIN Deutsches Institut für Normung (ed.), Beuth Verlag GmbH, Berlin, 1994

use to evaluate the effectiveness of the measures taken to minimize a hazard.

Similarly, they can be used to verify the application of the provisions of a standard, provided that:

- ☐ a reliable method or means of verification exists;
- ☐ operating conditions during the test simulate typical conditions of use that are reproducible;
- ☐ there is a method for data collection.

## A-4.1 KAN resolution of 9th December 1997: Quantifying emission in product standards

### I Starting point

Against the background of the requirements specified in the EC product directives and aimed at the manufacturer

- ☐ to reduce the risks to the lowest possible level (principle of risk reduction to the lowest possible level),
- ☐ to inform the user of the existing residual risk (principle of user information),

emissions which are detrimental to health need to be quantified, if possible. If the significant essential health and safety requirements of the directives are supported by product standards, the state of the art in terms of these emissions is to be quantified in the standards.

This quantification enables the manufacturer to assess the state of the art in terms of the risks generated by his product, to adopt the most suitable measures for reducing the risks (adherence to the principle of risk reduction to the lowest possible level) and to inform the user of the scale of the remaining risks (adherence to the principle of user information).

### II Strategy

KAN approves the proposal of its working group to adopt the following progressive procedure.

The aim consists in integrating exemplary construction measures to reduce emission as well as numerical emission values into standards.

In order to be able to identify and indicate emissions such as noise, vibration, hazardous substances and radiation, certain conditions have to be fulfilled.

1. The measuring procedures, which already exist to a large extent (type B-standards), are to be specified in type C-standards for the different groups of machinery.
2. Representative states of operation for measuring emission are to be defined.
3. Measurements are to be carried out on the basis of the statements made under 1 and 2.
4. Measurement data are to be collected.
5. Data are to be gathered for each type of machinery and assessed by presenting the distribution of the measured values (orbit of measured values) for example.

6. The measuring results must be integrated into the suitable product standards. They are to be considered as to reflect the state of the art for the particular type of machinery and as indicative values which support the designer in his efforts to reduce the risks.

## III Implementation

The KAN secretariat is requested to develop concepts with regard to the following questions that haven't been answered yet.

1. Which German institutions in the field of occupational health and safety beside the manufacturers will be able to participate in the procedure described in chapter II?
2. Which are the most suitable machinery to be used in pilot projects and pilot standards? Carrying out the projects should be as simple as possible so that the steps mentioned in chapter II can be accelerated and the experience made can be transferred to other areas.

KAN recommends to conduct research necessary to back the steps mentioned in chapter II and therefore invites the competent technical divisions within

- ☐ the BAuA (Federal Institute for Occupational Safety and Health)
- ☐ the BIA (central research and testing institute of the German Berufsgenossenschaften)
- ☐ the BGZ (Central Office for Health and Safety at Work of the German Berufsgenossenschaften)
- ☐ the institution funding "Arbeit und Technik"

to check their possibilities of dealing with the subject, to initiate research and to inform KAN of the ongoing activities.

At the same time KAN invites the OHS institutions (e.g. BAuA, BGs and ZLS) as well as further testing and measuring bodies to cooperate with the manufacturers to carry out measuring series and define the state of the art, if no data are available for a specific group of machinery.

In this respect KAN calls for the support of the European partners responsible for occupational health and safety issues (e.g. HSE, INRS).

In cases where measured values are available without having been analysed to define the state of the art, the KAN secretariat is requested to develop acceptable solutions. According to the re-

quirements of the machinery directive concerning noise and vibrations, the manufacturer has to indicate emission values within the product information, if a significant risk exists. These information are to be collected and evaluated. In addition, existing databases containing manufacturers' information on noise and vibrations of various machinery may be analysed and extended. In Umeå/Sweden a data base is accessible via the Internet (http://umetech.niwl.se).

The KAN secretariat is also requested to check whether KAN studies should be conducted in view of the aims mentioned in chapter II.

### A-4.2 Results of the deliberations by the French COS on 10th March 1998 relative to quantitative emission values in C-type standards[3]

At its meeting of 26 November 1997, the COS "Hygiène et Sécurité du Travail" (Health and safety at work Strategic Orientation Committee in AFNOR) has examined document N 162 concerning the use of indicative values in C-type standards.

Considering that :

- ☐ the machinery directive in its annex 1, clauses 1.1.2, 1.5.8, 1.5.9, 1.5.10, 1.5.11, 1.5.12, 1.5.13, 1.7.4 f) and 2.2 requires the designer :
  - to eliminate or reduce hazards as much as possible (principle of reduction of hazards to health to the lowest possible level);
  - to take the necessary measures with regard to hazards that cannot be eliminated (principle of reduction of hazards to health to the lowest possible level);
  - to inform users about residual hazards (principle of information);
  - to design and construct machinery so that hazards due to noise, vibrations, radiations, emissions of dusts or gases are reduced to the lowest possible level taking account of technical progress;
  - to indicate, in the instructions for use, noise and vibrations levels when certain values are exceeded.
- ☐ harmonised standards provide technical provisions allowing products that conform to the requirements of directives to be designed and manufactured (principle of the new approach);

[3] Translation by the KAN Secretariat

☐ standards can set achievable values, determined by the state of the art, for defined factors generating dangerous phenomena of any nature (E 09-000 : Memorandum on standardization in the field of health and safety intended to back "new approach" directives § 4.1.5 b).

*The COS considers that quantification, in C-type standards, of emissions of noise, vibrations, radiations, dangerous substances ... using indicative values (or reference values) allows :*

☐ the designer of a product to make, by comparison, the best possible assessment of the hazards generated by the product and, hence, take optimal prevention measures (fulfilment of the principle of reduction of hazards to the lowest possible level).

☐ the user to choose a product "with full knowledge of the facts".

*However, COS considers that such a practice should by no means be made general because it is not applicable to certain families of machinery. It considers that, in certain C-type standards, it may be useful to resort to emission classes.*

If provisions of this type are introduced in C-type standards, it is necessary that they reflect the state of the art for the category of machines considered, that a reliable method or reliable verification means exist, that operating conditions during the test simulate typical conditions of use that are reproducible and that a method for collecting the data is available (E 09-000 § 4.1.5 b[4]). These indicative values are not intended to serve as criteria for acceptation or rejection of a product.

*COS recommends that :*

☐ preferably at the European level, a research pilot-action is carried out on hand-held machines (covering noise and vibration for which numerous measurement results are available) with the purpose of validating the approach;

☐ a call for technical organizations that may take part in the pilot-action is launched.

*COS will follow up these actions.*

[4] See Annex 3 of the present report

# Annex 5 Low-emission machines – an incentive for the operator

**Contribution to the discussion from Dr Pense, chemical industry**

The chemical industry also has an interest in the specification of guide values describing the state of the art for hazardous substance emissions. As the term suggests, they give the manufacturer and user a guide to the degree to which emissions, e.g. on processing machines, can be controlled at the present time. They encourage the manufacturer to measure his product's emissions and to publicize this information as a selling point for the product. The operator has access to information on the state of the art and can specifically purchase a low-emission machine. Given precise knowledge of substance emissions, it is then easier at the planning stage to assess the additional protection, if any, that needs to be provided at the workplace.

There is currently a debate in the industry on whether the purchase of low-emission machines could be linked on the national level to exemption from workplace measurements for certain substances.

Under German law today, machines with sufficiently low emission values can be exempted from workplace measurements in a number of ways. By satisfying the criteria specified in TRGS 420 "Process- and substance-related criteria for reliable long-term compliance with air limit values (VSK)[5]", it is indeed possible to reliably ensure the long-term compliance with limit values. If the BIA/BG recommendations for the monitoring of work areas[6] are followed , compliance with a certain limit value at the workplace is assumed.

However, such an emission-linked exemption, which is beyond the scope of standardization, still requires exhaustive discussion with the regulatory bodies and supervisory authorities.

It is nevertheless worthwhile considering the basic possibility of encouraging the operator to purchase low-emission machines and thus to stimulate improvement in the state of the art. Many matters would have to be considered in this context, e.g.

- ☐ For which substances would exemptions be possible?
- ☐ What happens if an immission limit is lowered on the national level? Is it possible, for instance, to specify a

[5] Bundesarbeitsblatt, H. 9/1993, pp. 63-65.

[6] In: Messung von Gefahrstoffen, BIA Arbeitsmappe 1000 - 1025.

value for the state of the art relating to machine emissions which ensures that the limit is not exceeded?

- ☐ Does the exemption apply to all settings of machines put to their intended use?
- ☐ Can the scope of exemption be so precisely demarcated that this exemption applies to all possible set-ups in production shops, i.e. machine density, ventilation etc.? If not, how then should the scope be restricted?
- ☐ What exemption criteria for workplace measurements should be applied which can be clearly assessed, e.g. during an inspection by the accident insurance institutions or the public supervisory authorities?
- ☐ Is it possible to ensure that the limit value does not change in the course of machine use? Shouldn't routine maintenance be demanded for this?
- ☐ How is a combination of old and new machines to be treated? Does the exemption apply only to the new machine, thus necessitating transitional or exclusion arrangements for old machines? Or is exemption only possible for parks consisting solely of new machines whose emissions are known under defined conditions?

In spite of the many still outstanding issues, users do perceive the fundamental benefits resulting from the quantification of emissions to describe the state of the art. On the basis of emission values, action to reduce emissions can be taken at source, and this may reduce the scale of additional protection measures necessary at the workplace.

# Annex 6 Results of the KAN Study "Noise protection for machinery and workplace - status of and need for occupational health and safety standardization" (Extract)

## I. Introduction

The authors of the study recognize a considerable need for action in order to improve the way noise protection is dealt with in national and European standardization.

## II. The need for standardization resulting from the Machinery Directive for noise-emitting machinery

1. Basic standards (B-type standards) for measuring and reducing noise as the basis for safety standards specific to machinery (C-type standards) are largely complete or exist as working documents. Implementation of standards, however, is unsatisfactory in terms of both scope and quality:
   - In C-type standards the requirements of the basic standards are often not taken sufficiently into account and not applied uniformly. Noise is frequently not considered a significant hazard, the possible noise reduction measures are not applied to the relevant machinery category and information on measuring procedures for specific machinery is neither homogeneous nor clear.
2. With approximately 400 projects, the need for standardization and revision of relevant C-type standards is considerable and time-consuming; preparation is distributed among 50–150 standards bodies. Nevertheless, these standards should be completed quickly.
3. Better cooperation between manufacturers, operators, acoustics experts and between committees specific to machinery and acoustics at national and European level is necessary in order to eliminate standardization deficits.

## III. Standardization concept with regard to sound emission and the significance for occupational health and safety

1. The aim of the standardization concept - to establish machinery-related noise parameters as an instrument for reducing noise pollution at the workplace - should be assessed positively. However, European C-type standardization projects are yet to meet requirements for establishing clear and reproducible noise parameters (both for comparing emissions from machinery in the same performance category and for calculating noise immission and therefore assessing pollution at the workplace) satisfactorily. The following action is required:
   - Information on methods of measuring noise emissions, emission

value ranges and concrete reduction measures should be included sufficiently in standards specific to machinery.

- In addition to the emission sound pressure level at the workplace, standards should also state the machine's most important noise emission parameter - the sound power level in realistic operating conditions - even in cases in which only the sound pressure level is required by law.
- The standardization concept should include all sound sources, i. e. machinery, including noise-emitting work processes, transport systems and tools.

## IV. Analysis and assessment of the state of the art

1. The interpretation of the term "state of the art" varies considerably at both national and European level; nevertheless, EU directives and regulations still refer to this term. In standardization, sound levels are described with the help of noise parameters instead. The state of the art can generally be derived from these sound levels.
2. In order to analyze and assess the state of the art with regard to noise reduction there is a need for standardization:
   - For establishing and presenting the noise parameters of individual part areas of noise protection (source, transmission paths, immission point);
   - For determining the state of the art for noise reduction using sound level or sound quality. Sound levels contained in standards will clearly strengthen occupational health and safety.
3. There is a need for standardization for individual aspects of noise protection
   - For machinery:
     - For emission parameters for machines and large mechanical plant, but also for individual machine components,
     - For implementing the basic standard to the specific machinery in order to establish the state of the art for noise-reducing machinery technology,
     - For specific noise measuring procedures for tools[7] ,

[7] These are tools which are not covered by the Machinery Directive although they are relevant to noise pollution.

  - For specific measuring procedures for transport systems,
  - For listing sound levels in C-type standards.
- For sound-proofing products:
  - For assessing sound level reduction achieved by sound-proofing products in specific machinery categories or branches of industry;
- For buildings, rooms:
  - Standardization in this area is essentially sufficient, but model solutions (e. g. in informative annexes) for specific branches of industry are desirable;
- For workplaces:
  - For calculating noise immissions at individual points (the calculation of an average noise parameter for a whole room is regulated by standards). In order to make it easier to design low-noise workplaces, noise reduction measures, existing noise parameters and attainable values for individual part stages of noise reduction for selected machinery groups, areas of activity and branches should be combined in VDI directives.

4. Greater account must be taken of noise reduction back at the machinery design phase.

From these results of the study, KAN has derived recommendations on the subject of the quantification of noise emissions.

**KAN's recommendations**

From the results, KAN has derived recommendations which are directed at DIN, the social partners, the technical occupational health and safety bodies and the KAN Secretariat.

Summing up, it can be said that the action required from DIN essentially involves suggesting to its reflecting committees for specific machinery that an increased amount of data, experience and material on measuring procedures, emission values and noise reduction methods be collected at national and European level for the purpose of European standardization, taking account of this information when drawing up and revising standards, and making this information known throughout Europe. Preparatory work should be carried out with the aim of standardizing noise protection in type C standards, e.g. checking and modifying operating conditions, developing further measuring procedures, and standardization

on the collection and presentation of noise parameters should also be initiated.

For the social partners, the need for action is concentrated on using the available research funds and advocating and supporting the aims of this study at the European level.

The technical occupational health and safety bodies are requested to check carefully the guide values given in the working documents and draft standards and to provide technical support.

KAN and its Secretariat are called upon to make applications for standardization, encourage research, support the collection of acoustic data from series-produced machines on the European level and support standardization by providing the emission data necessary for stipulating sound levels.

# Annex 7 Detailed results of an analysis of machinery safety standards for their treatment of emission hazards

## A-7.1 Treatment of noise emissions

Table 5: DIN EN 774 (August 1996) "Hand held, integrally powered hedge trimmers"

| Question | Yes/No | Section/Quotation |
|---|---|---|
| 1. Is noise cited as a hazard? | Yes | 5.2 Instruction handbook |
| 2. Are technical noise reduction methods given? | No | |
| 3. Are acoustic measuring methods given? | No | |
| 4. Is the operating state for acoustic measurements defined? | No | |
| 5. Is the state of the art quantified? | No | |

Table 6:
DIN EN 608
(December 1994)
"Portable chain
saws"

<table>
<tr><th>Question</th><th>Yes/<br>No</th><th>Section/Quotation</th></tr>
<tr><td>1. Is noise cited as a hazard?</td><td>Yes</td><td>Section 4.9 Noise emission</td></tr>
<tr><td>2. Are technical noise reduction methods given?</td><td>No</td><td></td></tr>
<tr><td>3. Are acoustic measuring methods given?</td><td>Yes</td><td>4.9 Noise emission<br>"The time-averaged emission sound pressure levels at the operator's ear shall be measured in accordance with EN 27182. The sound power levels from the chain saw shall be measured in accordance with ISO/DIS 9207."</td></tr>
<tr><td>4. Is the operating state for acoustic measurements given?</td><td>Yes</td><td>4.9 Noise emission<br>Table 1<br>"Idling, racing, full load"</td></tr>
<tr><td>5. Is the state of the art quantified?</td><td>Yes[1]</td><td>4.9 Noise emission<br>Table 1: Achievable sound pressure values
<table>
<tr><th>Operating state</th><th>Displacement ($cm^3$)<br><40</th><th>> 40 to 80</th><th>> 80</th></tr>
<tr><td>Idling dB(A)</td><td>85</td><td>85</td><td>85</td></tr>
<tr><td>Racing dB(A)</td><td>102</td><td>105</td><td>-</td></tr>
<tr><td>Full load dB(A)</td><td>100</td><td>103</td><td>105</td></tr>
</table>
"These achievable values do not constitute personal exposure limits, but the emission values from a machine under defined test conditions (for example, speed, load, material to be used ...) and according to the measurement of the corresponding noise levels.<br>NOTE: The achievable sound pressure values given in table 1 are not a barrier to innovation, and they should not prevent the achievement of better values. With this in view, they will have to be revised when the state of the art evolves."</td></tr>
</table>

[1] Noise emission values are based on the "Special testing principles for the assessment of the noise of chain saws at the chain saw operator's ear" (1986) of the agricultural accident insurance institutions. They represent a first step towards agreement on "achievable sound pressure values" for chain saws on the European level and are considered useful guide values from the point of view of OH&S. DIN 38822 "Woodworking machines; Portable cutter bar chain sawing machines for one-man operation; Safety requirements and testing", which has been superseded by EN 608, has also been referred to in the statement of achievable sound pressure values.

## A-7.2 Treatment of vibration emissions

Table 7: E DIN EN 474 "Earth-moving machinery - Safety, Part 7: Requirements for scrapers" (May 1998)

| Question | Yes/No | Section/Quotation |
|---|---|---|
| 1. Is vibration cited as a hazard? | No | |
| 2. Are technical reduction methods given? | No | |
| 3. Are measuring methods given? | No | |
| 4. Is the operating state for measurements given? | No | |
| 5. Is the state of the art quantified? | No | |

Table 8:
DIN EN 608 (December 1994) "Portable chain saws"

<table>
<tr><th>Question</th><th>Yes/ No</th><th>Section/Quotation</th></tr>
<tr><td>1. Is vibration cited as a hazard?</td><td>Yes</td><td>Section 4.10 Vibrations</td></tr>
<tr><td>2. Are technical reduction methods given?</td><td>No</td><td></td></tr>
<tr><td>3. Are measuring methods given?</td><td>Yes</td><td>4.10 Vibration<br>"The weighted acceleration sum shall be measured and calculated in accordance with ISO 7505."</td></tr>
<tr><td>4. Is the operating state for measurements given?</td><td>Yes</td><td>4.10 Vibration<br>Table 2<br>"Idling, racing, full load"</td></tr>
<tr><td>5. Is the state of the art quantified?</td><td>Yes</td><td>4.10 Vibration<br>Table 2: Achievable vibration values
<table>
<tr><th>Engine displace-ment</th><th></th><th>Idling<br>m/s²</th><th>Racing<br>m/s²</th><th>Full load<br>m/s²</th></tr>
<tr><td rowspan="2">≤ 80 cm³</td><td>Front handle</td><td>12.5</td><td>12.5</td><td>12.5</td></tr>
<tr><td>Rear handle</td><td>-</td><td>12.5</td><td>12.5</td></tr>
<tr><td rowspan="2">> 80 cm³</td><td>Front handle</td><td>15.0</td><td>15.0</td><td>15.0</td></tr>
<tr><td>Rear handle</td><td>-</td><td>15.0</td><td>15.0</td></tr>
</table>
"These achievable values do not constitute personal exposure limits, but the emission values from a machine under defined test conditions (for example, speed, load, material to be used ...) and according to the measurement of the corresponding vibration levels.<br>NOTE: The achievable vibration values given in table 2 are not a barrier to innovation, and they should not prevent the achievement of better values. With this in view, they will have to be revised when the state of the art evolves."</td></tr>
</table>

## A-7.3 Hazards from hazardous substances

Table 9: DIN EN 608 (December 1994) "Portable chain saws"

| Question | Yes/No | Section/Quotation |
|---|---|---|
| 1. Is the emission of hazardous substances cited as a hazard? | Yes | Section 4.17 Exhaust gases |
| 2. Are technical reduction methods given? | No | |
| 3. Are measuring methods given? | No | |
| 4. Is the operating state for measurements given? | No | |
| 5. Is the state of the art quantified? | No | |

Table 10: ISO/DIS 15012-1 "Health and safety in welding and allied processes - Requirements, testing and marking of equipment for air filtration" (06/99)

| Question | Yes/ No | Section/Quotation | | |
|---|---|---|---|---|
| 1. Is the emission of hazardous substances cited as a hazard? | Yes | Section 4 Welding fume emission | | |
| 2. Are technical reduction methods given? | Yes | Section 5<br>Use of welding fume separation equipment | | |
| 3. Are measuring methods given? | Yes | Section 6 and Annexes C, D<br>Detailed measurement requirements, description of the test bench, methods of statistical evaluation etc. are given with reference to EN 1093-6/7. | | |
| 4. Is the operating state for measurements given? | Yes | Section 6 and Annexes C, D<br>Example: To determine the separation efficiency of welding fume exhaust system, the emission rate of the welding fume source and in Annex C suitable welding fume sources are given. | | |
| 5. Is the state of the art quantified? | Yes | Section 5.3<br>Air filtration equipment for welding fumes has to fulfil the requirements concerning the separation efficiency and has to be classified to one of the following welding fume classes. The welding fume classes differ in the requirements for the separation efficiency based on the state of the art. | | |
| | | Welding fume class | Separation efficiency [%] | Recommended for the treatment of: |
| | | W 1 | $\geq 95$ | Unalloyed and alloyed steel without compounds of e.g. nickel and chromium |
| | | W 2 | $\geq 99.5$ | As above and alloyed steel with compounds of e.g. nickel and chromium $\leq$ 30% |
| | | W 3 | $\geq 99.9$ | As above and high-alloy steel |

# Annex 8 Results of the KAN Study "Definition of the need for standardization to establish vibration parameters"

**Completing the machinery directive (measuring emissions)**

The standards needed to complete the machinery directive are mainly emission measuring standards aimed at establishing comparable emission parameters and testing rules. They are partly machinery safety standards (type C standards)[8] and partly vibration-specific type B standards in CEN/TC 231 (vibrations).

Information on vibrations in machinery safety standards varies considerably in terms of quality.

The rapid completion of machinery-specific vibration standards requires the presentation of superordinate type B framework standards with high priority[9]. It is desirable for vibration experts to assist those responsible for standards in the drafting of individual testing standards.

The processing status of testing standards for machinery varies considerably:

- ☐ Testing standards for hand/arm vibrations are highly advanced.
- ☐ As far as whole-body vibrations are concerned, framework and individual testing standards for mobile machines are still at an early stage.

There is a major need for the development of standardized operating and peripheral conditions for measuring emissions. It is difficult, and in some cases impossible, to establish realistic, representative conditions. Switching to substitute working procedures is only a solution in exceptional cases.

Emission parameters for estimating immissions

Since it is only practical to compare emissions from machines with equal capacity, testing methods must take greater account of the relationship between the assessed vibrational severity or the frequency-assessed effective value of the machine's vibrational acceleration and capacity-dependent duration. Methods designed to establish actual or representative exposure duration based on certain work output/ tasks must be developed.

Emission parameters alone cannot be used to describe the actual vibration levels to which workers are subjected in practice. It is often not possible to estab-

[8] Based on general standards EN 292-1 and 2 and EN 414

[9] Based on DIN 45675 and EN 28662-1ff.

lish exposure level based on emission data.

As far as the manufacturer is concerned, however, parameters provide an incentive to measure and reduce vibrations directly on machinery. They only serve as a guide to users wishing to procure new equipment if machines of equal capacity are compared.

### Description of the state of the art in standardization projects

Although it would be useful to describe the state of the art in order to estimate emission and immission values, it is not yet possible to do so to a satisfactory level. Obtainable values would first have to be updated constantly in testing standards and a central and/or several individual databases set up, maintained and constantly updated. Nevertheless, it would still be impossible to prevent a delay between the current state of the art and the point at which standards are updated.

Until the legal situation for acquiring and processing manufacturer data has been clarified and suitable test methods for determining obtainable values and statistical principles exist, manufacturers and users are recommended to use the few available data reserves as a rough guide. Appendices to standardized data acquisition are planned for key ISO standards.

# Annex 9 Dust emissions from hand-held woodworking power tools

**Paper delivered by Mr Heimann (BIA) at the congress "Arbeitsschutz aktuell 98" in Leipzig on 7th October 1998**

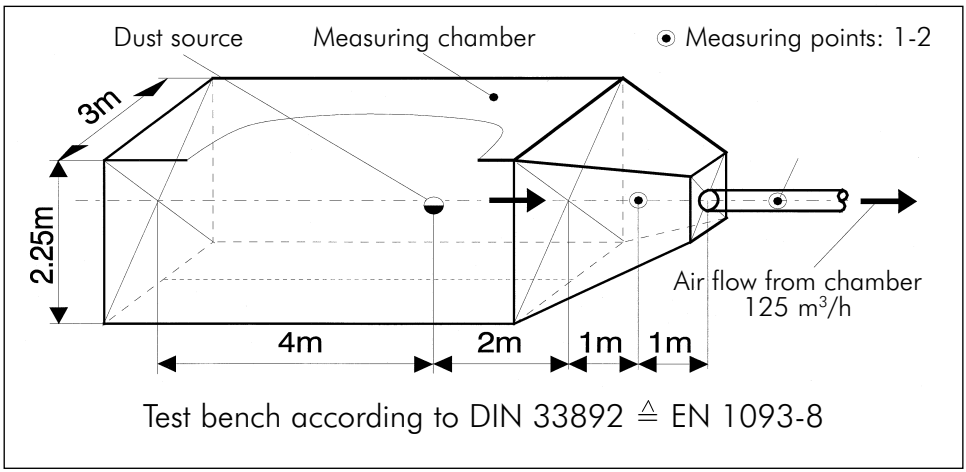
Since wood dust, and particularly that from beech and oak, can cause cancer of the nose, dust from woodworking machines usually has to be extracted. On hand-held power tools, this has been effected so far by tested mobile dust extractors which are connected by a hose to the machine - in this case a flat-bed sander.

However, many carpenters feel inhibited in their work by the hose between the machine and the dust extractor, and consequently the suction equipment is often left unused in the corner (and only employed when the labour inspectorate or accident insurance institution inspectors come round).

In recent years, a growing number of machines have become available equipped with integrated dust extraction, i.e. with built-on dust filter bags. This gives rise to the question whether this method is sufficient to limit wood dust emissions to a permissible level.

The partial vacuum required to collect the dust is generated by the tool itself or by a fan in the machine. The dust collected in this manner is deposited in a built-on paper or textile filter bag.

Figure 1: Measurement of wood dust concentrations from power tools



In the above-mentioned project by the BIA, ZVEI and woodworking BG, 18 machines were selected and made available for examination on the BIA test bench.

A diagram of the test bench conforming to DIN 33892 "Dust emission of technical equipment; determination of the dust concentration under worst-case conditions; basic methods" (E. 8/90) is shown in Figure 1. It also complies with the new European B standard EN 1093-8 "Pollutant concentration parameter, test bench method" (E. 7/95). The test bench consists essentially of a test chamber 6 m long, 3 m wide and 2.25 m high with a 2 m deep funnel, at the end of which (on the right of the diagram) 125 $m^3$ air is extracted per hour, corresponding to a 2.5-fold air turnover in the chamber.

The dust-free room air enters the test chamber through some 8,000 perforations in the windows of the four double doors. The machines are operated in the intended manner at a distance of 2 m upstream from the funnel. The uncollected dust from the machine - in this case a circular saw - is emitted into the ambient air and carried by the air current to the wood dust measuring device in the middle of the funnel.

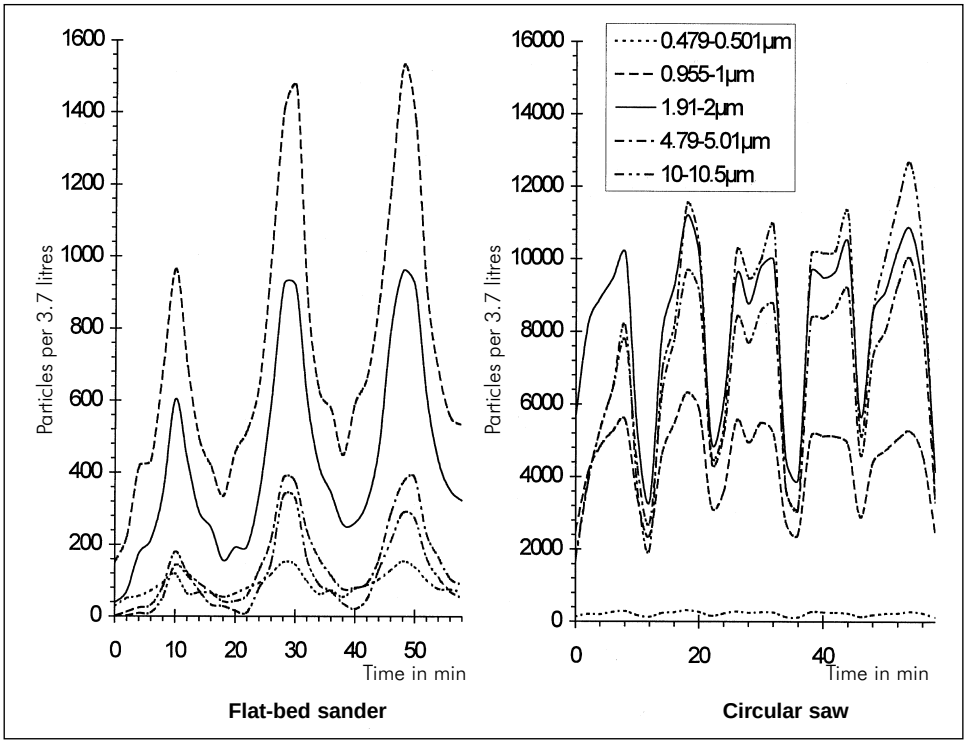
The measuring device takes in 22.5 $m^3/h$ of air through an annular gap and the respirable wood dust contained is deposited on a measurement filter and subsequently weighed.

To obtain information on the grain size distribution of the dusts generated and changes in concentration during the test, a particle counter (measurement range 0.2 - 200 $\mu$m) was additionally employed in the chamber's suction tube. Figure 2 shows the particle concentrations of two machines over the test period of 1 h.

The testing procedure for the individual machines is specified in detail for almost all machines in the international standard DIN EN 50144 "Safety of hand-held power tools - Part 1 and ff." (2/96). As the test materials, the standard calls for beech wood for sanding machines and chipboard for saws.

For flat-bed sanders (left in the diagram), three cycles of 10 minutes of sanding and a 10-minute break are envisaged. Particle concentrations rise during sanding and fall during the break. Circular saws (right in the diagram) are tested in five cycles of 10 minutes of sawing and a 2-minute break. The scale on the y axis shows that during sawing (right) far more dust particles are generated than during flat-bed sanding. Furthermore, the main peaks of particle count concentrations

Figure 2: Test performed in accordance with DIN EN 50144



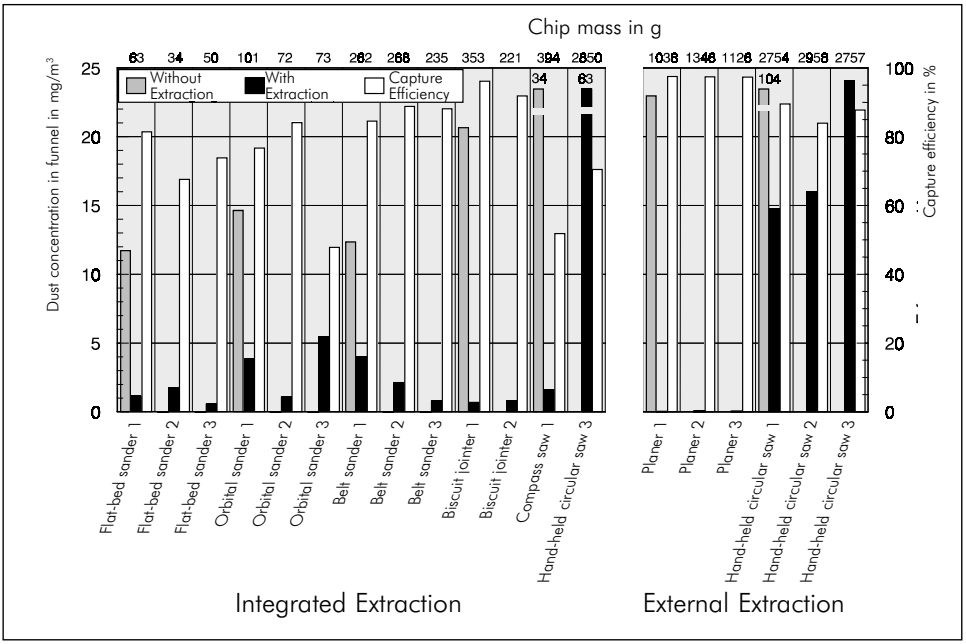

are of particle diameters of about 10 $\mu$m for the circular saw and of only 1-2 $\mu$m for the flat-bed sander. The other machines tested are situated roughly between these extremes.

Figure 3 summarizes the key results of the tests. The dust emissions of the machines are dependent essentially on three factors,

- the machine's rate of chip production,
- the type of chip production, and
- capture efficiency at the tool.

The various machine types are arranged from left to right in the order of chip production in mass (see head of graphs). The lowest chip mass during the test period, 34 g, was produced by flat-bed

Figure 3: Wood dust concentrations from power tools



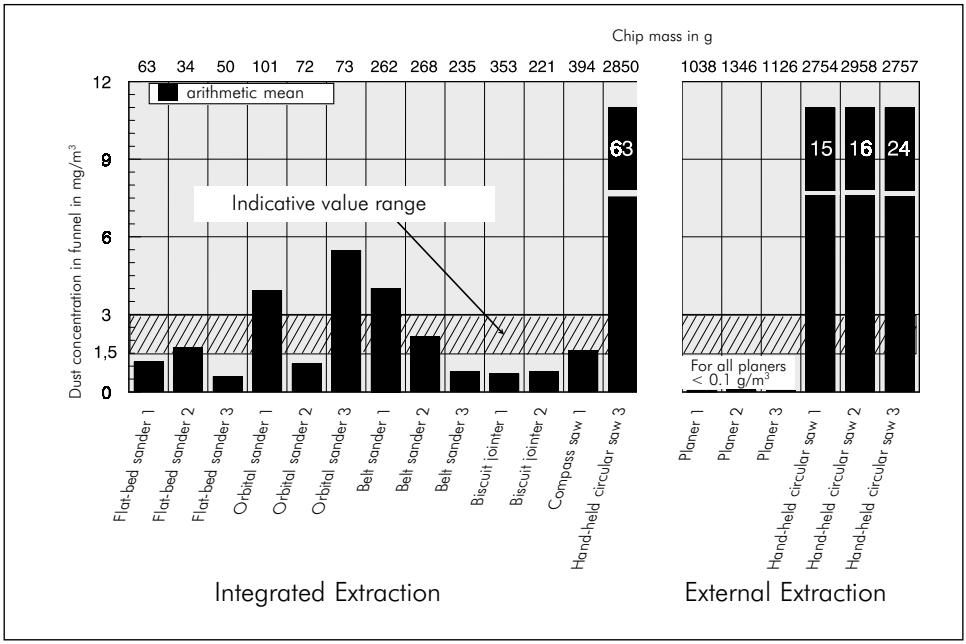

sander 2, whilst the circular saws (top right) produced about 3 kg, amounting to almost 100 times as much.

The second factor is the type of chip production, i.e. sanding or sawing. Sanding mainly generates dust, whilst planing and sawing mainly produces coarser particles.

Attempts were made to test three machines of each type. However, only two biscuit jointers and one compass saw were in fact available.

To obtain information on dust emissions without extraction, tests were carried out with one example of each machine. The results are illustrated by the grey bars. Dust emissions without dust extraction vary from about 10 on the flat-bed sander to about 100 mg/m$^3$ on the circular saw.

Figure 4: Wood dust emissions – state of the art




For an assessment of the machines, what counts however are the concentrations measured in the funnels of the test bench when integrated dust extraction is employed. These are shown in the figure by the black bars representing the mean values from three tests.

Basically, it can be said that high capture efficiencies of about 70 to 90% generally yield low concentrations. An exception to this, however, is the circular saw on which the capture rate beneath the chipboard is too low, giving rise to very high values even with external suction by means of a dust extractor.

For the compass saw, which mostly produces large particles, a capture efficiency of 50% is sufficient, whilst the same rate on orbital sander 3 results in relatively high concentrations because of high dust production. All three planers suffered from the special problem of congestion

after about 1 minute, which meant that the tests could not be completed.

Suction with the dust extractor yielded values of less than 0.1 mg/$m^3$ on the planers.

Summing up, it can be concluded that on hand-held woodworking machines with integrated dust extraction - and excepting the circular saw - the state of the art is so effective that only minimal dust emissions still occur (Figure 4). However, certain machines would have to be and could be improved.

# Anhang 10 Standardization in the field of non-ionizing radiation – implementation of the specifications of the Machinery Directive in European standards

**Paper delivered by Dr Siegfried Eggert, German Federal Institute for Occupational Safety and Health (BAuA), Berlin, at the congress "Arbeitsschutz aktuell 98" in Leipzig on 8th October 1998**

Protection from the harmful effects of electrical, magnetic and electromagnetic fields (non-ionizing radiation) at the workplace has so far been effected by the imposition of limit values/reference values to restrict exposure in provisions in accordance with Article 137 (formerly 118a) of the Treaty of Rome or similar regulations.

The implementation of such provisions is made considerably easier if, by demanding certain properties of machines and plants, which can be specified in standards in accordance with Articles 94/95 (formerly 100a) of the Treaty of Rome, the emission of radiation can be prevented or restricted or attention drawn to it by appropriate marking.

In the Council Directive of 14th June 1989 on the approximation of the laws of the Member States relating to machinery (Machinery Directive 98/37/EC), section 1.5.10 - Radiation - under "Protection from other hazards" demands: "Machinery must be so designed and constructed that any emission of radiation is limited to the extent necessary for its operation and that the effects on exposed persons are non-existent or reduced to non-dangerous proportions".

The Technical Committee TC 114 "Safety of machinery" convened in 1990 the working group WG 13 "Radiation of Machinery", whose task has been to convert the requirements of the Machinery Directive and European standard EN 292 into an equivalent type B standard.

It was obvious from the outset that the goal was not going to be achieved by drawing up a standard purely confined to limiting emissions. This would depend on there being exposure (immission) limit values accepted universally throughout Europe, which at present is not the case.

A draft standard prEN 12198-1 "Safety of Machinery - Assessment and reduction of risks arising from radiation emitted by machinery - Part 1: General principles" was completed in December 1996 and has already passed the first enquiry among CEN members. Parts 12198-2 "Radiation emission measurement procedure" and 12198-3 "Reduction of radiation by attenuation or screening" are expected to be approved in the enquiry procedure by the end of October 1998.

These standards are aimed at the manufacturers and sellers of machines. They are not sets of regulations to limit emissions in the usual sense, as the "reference values" given in Part 1 are not limit values. The reference values given, which are the same as the exposure values of the ICNIRP Guidelines of 1998/1/, state the limits for the classification of machines and plant in one of three possible categories. (The reference values for optical radiation correspond to those of international guidelines and recommendations for personal protection.)

These categories are:

Category 0: The emission values of the machine are beneath the reference values for exposure of the general population in accordance with the ICNIRP recommendations. There is no obligation to label the machine to indicate the emitted radiation or to specially inform the user.

Category 1: The emission values of the machine are above the reference values for exposure of the general population, but beneath the reference values for exposure at the workplace. The label "1" must be affixed to the machine. Sufficient information for the user must be enclosed in the documentation.

Category 2: The emission values of the machine are above the reference values for exposure at the workplace. The label "2" must be affixed to the machine. Adequate information for the user must be enclosed in the documentation.

Protection from the possible disturbance of active electronic implants by electric, magnetic and electromagnetic fields does not fall within the scope of these standards.