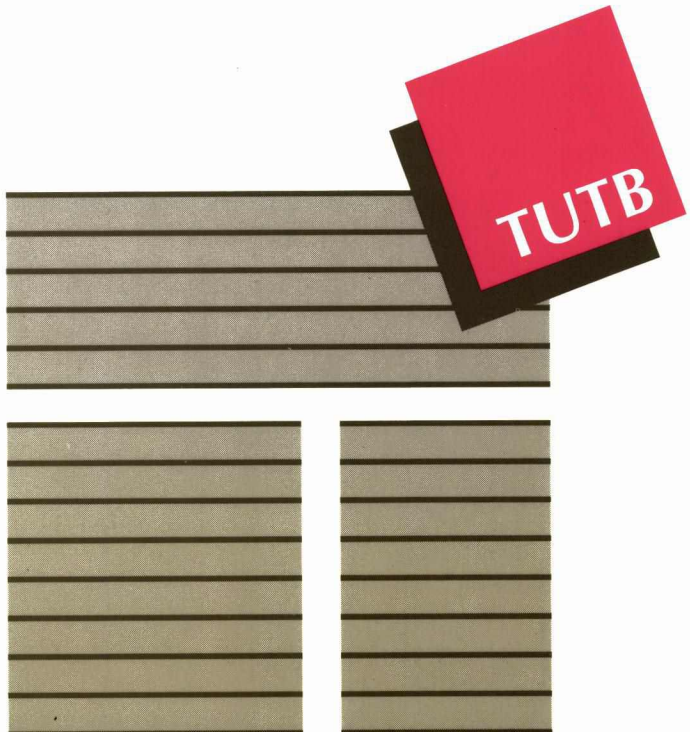
REPORT

INTEGRATING ERGONOMIC PRINCIPLES INTO C-STANDARDS FOR MACHINERY DESIGN

TUTB proposals for guidelines



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by J. A. Ringelberg and P. Voskamp

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European Trade Union Technical Bureau
for Health and Safety
June 1996

Integrating Ergonomic Principles into C-Standards for Machinery Design
TUTB Proposals for Guidelines

ISBN: 2-930003-17-0

June 1996

D/1996/6107/18

Printed in Belgium

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Foreword

The TUTB's involvement in standardization

Since its creation by the ETUC in 1989 - the same year in which the Framework Directive[1] and Machinery Directive[2] were adopted - the TUTB has been actively involved in European standardization work mandated by the European Commission. This involvement takes different forms: the TUTB has been an associate member of CEN since 1994, contributing to technical work - both at the level of the coordinating bodies (BTS) and in certain technical committees (TC) responsible for drafting harmonized standards - and preparing technical comments on draft standards at the CEN public enquiry stage. It also participates in an expert capacity in the work of the tripartite group of the Advisory Committee on Health and Safety in Luxembourg which examines the Commission's proposals for mandates to CEN and studies the comments made by the different interest groups on procedure and mandated work.

These activities are based on both the TUTB's own expertise and on that of its network of trade union experts participating in European standardization work, particularly at the level of the technical committees and working groups.

One of the key aims of the TUTB is to strengthen trade union influence on the design of work equipment by establishing common objectives and strategies for the improvement of working conditions[3].

The European directives establish the principle that the manufacturer is ultimately responsible for equipment design and they impose a range of requirements with which the manufacturer must comply before the equipment is put on the market in the Member States of the European Union and the European Economic Area. These common requirements - integrated design principles - are the only legal obligations that exist. As far as the trade unions are concerned, all these requirements must be enforced, and the fact that they have been given technical substance in the harmonized standards is an important step towards ensuring their application. Indeed, while not obligatory for designers, standardization is in fact an essential tool for requirements relating to health, safety and more specifically ergonomics at the workplace, as it is often the only reference recognized by all the interested parties.

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[1] 89/391/EEC: *O.J.* N°L183/1 of 29 June 1989.
[2] 89/392/EEC: *O.J.* N°L183/9 of 29 June 1989.
[3] See: *The trade union contribution to European standardization*, TUTB, 1991; and TUTB document: *Overview of trade union participation in CEN standardization work*, updated April 1996.

Ergonomics for machinery design as a trade union priority

Ergonomics for machinery design is a priority and a constantly reoccuring theme for the TUTB and the trade union experts who participate in the working groups drafting standards, particularly those dealing with work equipment (C-standards).

The TUTB considers it essential that there is a strong trade union presence in this work, as it provides a privileged forum at which to put across the workers' point of view concerning the design of work equipment. This is all the more relevant in the comparatively new field of ergonomics, because here technical knowledge is not sufficiently developed to meet all the needs of the users.

Drawing up standards for equipment design which incorporate users' health and safety protection measures is a complex multi-stage process, of which one of the crucial elements is the identification by the standardizers of the hazards to users and related situations. The users' experience is a key resource in this design phase and consequently, by giving support to trade union experts, the TUTB aims to ensure that this experience is taken into account.

Promoting a new approach integrating the users' experience

The users' experience forms part of an overall *operators' point of view* which can be used to identify the *critical phases in the development of a machine*. This enables designers to give the operators a sufficient degree of autonomy to reorganize their work, in particular when confronted with various types of malfunction and hazard, whatever the foreseen level of automation.

The users' point of view is in fact a new approach in the standardization process for work equipment which introduces some specific concepts:

- the *user* corresponds to the *worker/operator* considered as the *ultimate user* of a machine as distinct from a *user/employer* who chooses and *purchases* the machine;
- the *normal use of a machine* includes intended use and intended misuse which must be taken into account when performing the risk assessment;
- *experience* covers both the experience acquired by the direct users, experts in their working practice, and the knowledge of *experts* in general, including that of *trade union experts*.

In order to take the users' experience into account, two main questions must be addressed:

1. *How can the users' experience be passed on to the standardizers?*

This question ties in with another concerning the nature of trade union participation in the work of CEN. It means identifying how this experience can be collected, accumulated and formalized with a view to passing it on to the standardizers, and how trade union experts can be involved in this process.

The following methodological aspects need to be considered:

- How can the users' experience, expectations and requirements be identified when they are often so fragmented?
- Is it necessary to develop a *sectoral* approach according to the type of machine on the one hand, and on the other a *cross-sector* approach for other types of machines?
- What should be done when, despite the existence of ergonomic hazards, there are no completely measurable data with which to assess them? This is a common situation which is in theory foreseen in standardization, but the methodology to be followed is not easily applied.

2. *How is it possible to verify whether the users' experience is being taken into account effectively in C-standards*?

In line with the Machinery Directive, trade unions, labour inspectorates and other interested parties must be given the assurance that the procedure for hazard evaluation, elimination and information is being correctly carried out and that the following aspects are covered:

- an ergonomic assessment of these hazards takes into account both the actual working conditions and the experience acquired and expressed by the operators;
- the risks have been eliminated or reduced as much as possible in accordance with the state of the art;
- there is sufficient information about the residual risks and these are adapted to the users.

Consequently, when a C-standard is being drafted, three sections in particular should be examined carefully:

- the *hazards* covered, which must clearly identify the hazardous situations as they are really experienced by operators/workers;
- *safety requirements and/or measures* to reduce the effect of all hazards;
- *information for use,* which must give substance to the existing basic safety statements related to the use of the machine and to the necessary precautions, particularly in the case of unforeseen residual risks.

TUTB contribution to the CEN Ergonomics seminar

It was against this background, having identified the most crucial points of the ergonomic approach, that the TUTB actively participated at the Ergonomics seminar organized by CEN in October 1995. The TUTB's presentation entitled *A users'*

perspective[4] aimed to analyse the problems raised when incorporating ergonomics into standards, and in particular sought to show the importance of taking into account the users' point of view. The TUTB made the following proposals which were also included in the conclusions of the seminar:

- the clarification of the work programme of CEN/TC 122 (Ergonomics);
- the enlargement of the range of ergonomic topics covered by A- and B-standards (horizontal standards developing the essential safety requirements of the Machinery Directive);
- a guide to the application of A- and B-standards;
- a procedure to enable users to participate in risk assessment;
- a procedure to enable users to contribute to the drafting of safety measures, provisions or information clauses.

The common view was that an *Ergonomics guide* would be a useful means of improving the ergonomic content of standards. Up to now ergonomics has been inadequately dealt with in standardization, often because of the lack of expertise in the working groups. The TUTB therefore decided to take the initiative of compiling its own guide providing a structured summary of the information already available in order to both make this information more widely known and to highlight the gaps which exist in CEN's work programme.

This guide as a first step

This guide is the result of fruitful cooperation between the TUTB and ergonomics experts involved in CEN TC 122. It seeks to define instructions for the application of both general information and specific ergonomic principles contained in the horizontal A- and B-standards which cover such aspects as bio-mechanics, noise, lighting, accessibility etc. These are common to a large number of machines and therefore to a large number of C-standards.

The methodological approach used in the guide - based on the rules of machine safety standardization laid down in EN 414[5], while also including the distinguishing characteristics of ergonomics - has two main elements: it identifies and evaluates ergonomic risks generically (adapting the models in EN 292-1[6] and prEN 1050[7]) and also provides a model for the use of B-standards for different ergonomic subject areas.

The careful attention required to regroup all the A- and B-standards as a source of safety measures has enabled the TUTB to identify some startling gaps in European

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[4] See *TUTB Newsletter* N° 2, p.15.
[5] EN 414: 1992 *Safety of machinery - Rules for the drafting and presentation of safety standards.*
[6] EN 292-1: 1991 *Safety of machinery - Basic concepts, general principles for design - Part 1: basic terminology, methodology.*
[7] prEN 1050: 1994 *Safety of machinery - Principles for risk assessment.*

standardization. This is particularly the case for the B-standards where certain subject areas have not been well covered and others have been completely neglected.

Moreover, working on this guide has brought to our attention one particular difficulty which is not insignificant: risk estimation, the methodology for which is defined in prEN 1050, is based on quantitative elements such as the duration of exposure, the severity of potential harm, the frequency of accidents etc. These data are necessary and enlightening, but when dealing with ergonomics the difficulties of adapting these parameters to real workers must be taken into account.

These facts, the gaps in the horizontal standards and the need for specific methodologies to evaluate ergonomic risks should all serve to highlight to CEN and to the European Commission the importance of making further progress on the ergonomic aspects of standardization and the need to devote the necessary resources to this.

Future steps

Bearing this in mind, the TUTB continues to seek ways of improving the ergonomic content of machine safety standards. We are therefore planning a pilot data collection project which will combine so-called objective data (accident statistics, the impact of occupational diseases, etc) and a certain subjective element based on users' evaluations, with the aim of showing the viability and utility of such an input when carrying out risk assessment.

We are, in any case, very aware that the way in which users perceive different work situations cannot be fitted neatly into a list of *risk factors* and is not limited to hazards characterized by accidents at work. The users' experience combines physical and cognitive aspects displayed when operating machinery, as well as *subjective* and *psycho-social* aspects which are all inter-related.

The TUTB therefore gives priority to achieving greater trade union input into European standardization work, and is planning further training and another guide aimed primarily at trade union experts.

We would like to thank J. A. Ringelberg and P. Voskamp, the authors of this report, and Sven Bergström (Sweden), Enrico Gibellieri (Italy) and Hans Handler (Denmark), trade union experts, for their support and contributions to the preparatory work.

Marc Sapir
TUTB Director
June 1996

How to integrate ergonomic principles into C-standards

1. Introduction

Machinery and standardization

Machinery put on the European market has to meet the essential health and safety requirements laid down in the Machinery Directive (89/392/EEC and two later amendments[8]). The aim of this European legislation was to harmonize the health and safety regulations related to machinery in order to create an internal European market allowing the free movement and trade of machinery.

The standardization programme for machinery - to a large extent mandated by the EC - is divided up into the following different types of standard:

- A-standards cover fundamental aspects for all machinery; examples are EN 292 and EN 414;
- B1-standards deal with safety aspects concerning a range of machinery;
- B2-standards deal with components or devices which are used on a wide variety of machinery;
- C-standards are vertical standards that cover a specific type of machine (see definitions in EN 292-1).

In total around 700 machine safety standards have been or are being drawn up in the working groups of the various CEN Technical Committees. More recently, the standardization process has moved on from the production of general horizontal A- and B-standards and is now focused on C-standards. In order to produce good C-standards, it is crucial to bridge the communication gap between the TCs involved in writing A- and B-standards and those producing C-type ones. This is especially important when integrating general ergonomic principles into C-standards.

[8] 91/368/EEC: *OJ N°L198* of 22 July 1991 and 93/44/EEC: *OJ N°L175* of 19 July 1993.

Ergonomics

This guide uses the definition of the term ergonomics given in European standard EN 614-1[9]: "*a multidisciplinary field of science and its application. In applying ergonomics to the design of work systems it is important to take human capabilities, skills, limitations and needs into account when exploring the interaction between people, technology and the work environment.*"

The application of ergonomic principles to work systems is described in ENV 26385[10]. The work system is derived from a concept that combines the operators, work equipment (including machinery), work space, work processes, work tasks, their management and organization and interactions between them. It can vary in complexity from a workshop with a single operator using hand-held equipment to a processing plant and its operators.

Work equipment is only one component of the work system and should not be considered in isolation. Good ergonomic design takes the operator as its starting point and considers both how the operator is expected to interact with the work equipment and how the work equipment fits into the system as a whole.

The manufacturer's responsibility

The Essential Safety Requirements (ESR) the manufacturer has to meet before he can bring his product on the market are specified in Annex 1 of the Machinery Directive. The aim of these measures is "*to eliminate any risk of accident throughout the foreseeable lifetime of the machinery, including the phases of assembly and dismantling, even where risks of accident arise from foreseeable abnormal situations" (1.1.2.a).*

The product being designed has to be as inherently safe as possible, so the manufacturer must take into account all possible risks to health and safety at the earliest possible stage of the design process. This requirement is set out in EN 292 and EN 414.

As far as ergonomic risks are concerned, the Machinery Directive (Annex 1, clause 1.1.2.d) states that "*under the intended conditions of use, the discomfort, fatigue and psychological stress faced by the operator must be reduced to the minimum possible taking ergonomic principles into account*". These ergonomic principles can be found in EN 614-1.

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[9] EN 614-1: 1995 *Safety of machinery - Ergonomic design principles - Part 1: terminology and general principles.*
[10] ENV 26385: 1990 *Ergonomic principles of the design of work systems* (ISO 6385:1981).

When taking into account the possible risks, the manufacturer must follow the strategy defined in the Machinery Directive:

- define the limits of the machine, including intended use and foreseeable misuse of the machine;
- rough design, hazard identification and risk analysis. Any hazards should be excluded as much as possible at this stage;
- if risks still exist, then they must be reduced to an acceptable level by means of:
  - design (intrinsic measures);
  - provision of protective measures such as guards and safety devices;
  - provision of information on training, safe work systems, maintenance and PPE etc for the risks not completely dealt with by the first two steps;
- any constraints to which the operator is subjected as a result of the necessary or foreseeable use of PPE must be taken into account by the manufacturer.

Compliance with a harmonized European standard gives the manufacturer a presumption of conformity with one or more of the Essential Safety Requirements (art. 5.2 of the Machinery Directive) dealt with in the standard.

2. Scope

This guide aims to provide C-standardizers with a strategy for integrating the necessary ergonomic principles into C -standards. The approach is based on EN 292-1 and -2[11], EN 414 and prEN 1050, and uses an amended version of the step by step method set out in prEN 1050. Each step has been adapted to include ergonomic aspects, and practical guidelines are given on how to make use of all the available horizontal standards when drafting C-standards. By using this approach, the manufacturer can meet the ergonomic requirements of the Machinery Directive (Annex I, 1.1.2.d).

[11] EN 292-2: 1991 *Safety of machinery - Basic concepts, general principles for design - Part 2: technical principles and specifications.*

3. A step by step approach

This approach is based on the general procedure for dealing with safety clauses from EN 292-1 and -2, EN 414 and prEN 1050:

Step 1: Clarifying **the limits of the machine**. This is important in order to determine clearly the usability of the machine with regard to operators and exposed persons.

Step 2: Identifying the relevant ergonomic aspects by means of a hazard identification. The hazards identified will be considered as **relevant ergonomic hazards**.

Step 3: Complete risk estimation taking into account all the relevant ergonomic hazards which can occur during the life cycle of the machine in order to distinguish between those relevant ergonomic hazards which are in fact negligible and those which form **ergonomic risks** requiring further evaluation.

Step 4: Risk evaluation of the remaining relevant risks to determine a list of **significant ergonomic risks**.

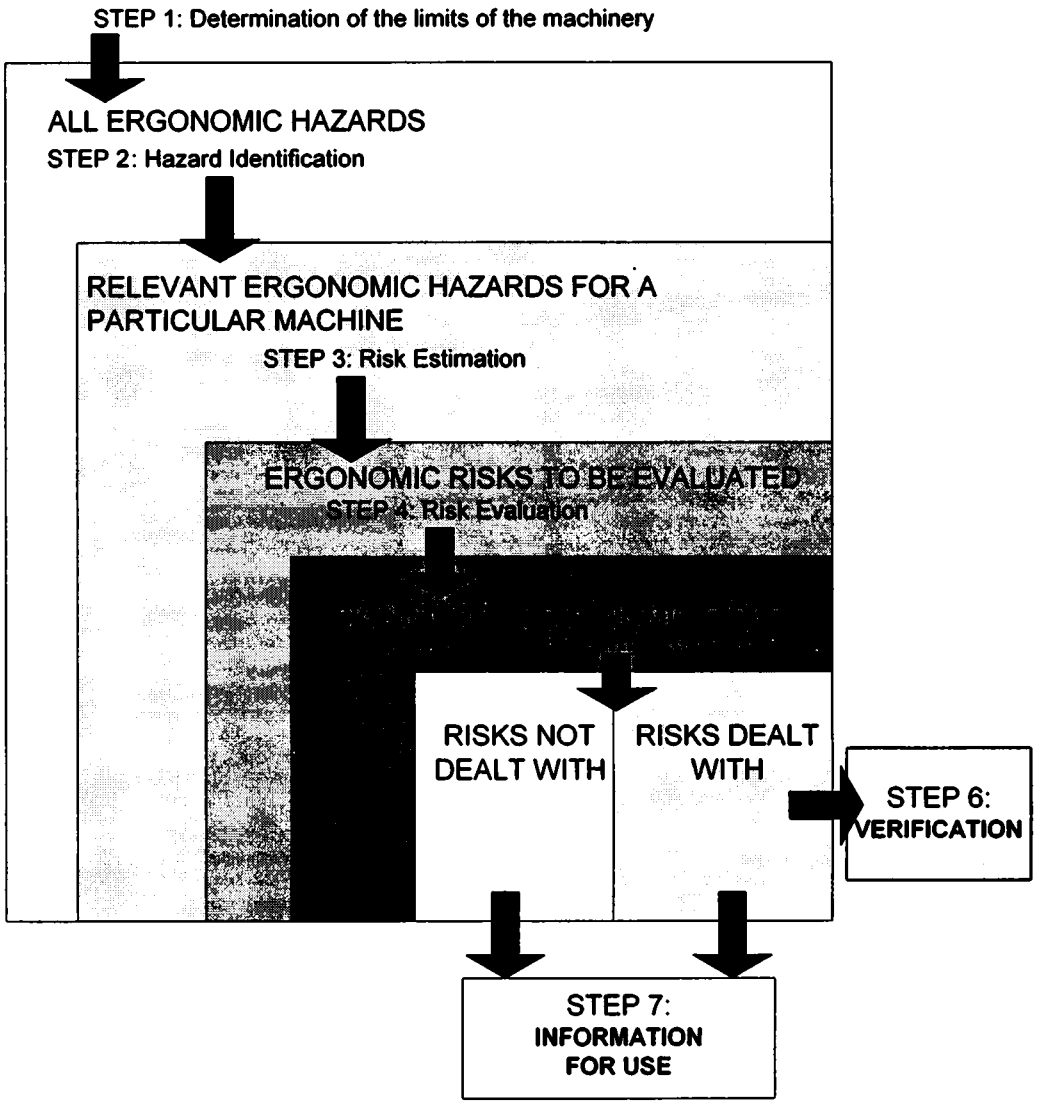
Step 5[12]: **Risk reduction** for the significant ergonomic risks which are dealt with in the standard. It is possible not to deal with one or more of the significant ergonomic risks, but if this is the case it must be mentioned in the scope of the standard and the risks must be listed.

Step 6: **Verification methods** for the risks dealt with in the standards.

Step 7: **Information for use** concerning the residual ergonomic risks that are both dealt with and not dealt with in the standard.

[12] If any risk reduction measures are performed at step 5, then the manufacturer must start again at step 1.

Step by step approach to standardization for ergonomics according to general guidelines set out in EN 414 and prEN 1050



STEP 1: DETERMINATION OF THE LIMITS OF THE MACHINERY

EN 292-1: 3.1 defines a machine as follows: *"an assembly of linked parts or components, at least one of which moves, with the appropriate machine actuators, control and power circuits, etc, joined together for a specific application, in particular for the processing, treatment, moving or packaging of a material. The term machinery also covers an assembly of machines which, in order to achieve one and the same end, are arranged and controlled so that they function as an integral whole".*

In this guide the same definition will be used. Ergonomic aspects of machinery can only be designed, evaluated and verified when all the accessories of the machinery are present. Ergonomic requirements are necessary when considering 'the operator' and 'the exposed persons'.

Data on the limits of the machine is the key element on which the C-standard will be based. The limits of the machinery should be described for all four phases of the life-cycle of the machine:

- construction and installation;
- operation;
- maintenance;
- dismantling.

The four phases, based on EN 292-1: 3.11, are presented in checklist 1. In this checklist a matrix is used to determine the intended use of the machine in which the four phases mentioned are related to the following items:

a) work tasks (types of job) for which the machine will be used:
   - production task;
   - control task;
   - general work or precision work;
   - at a fixed work station or a mobile station;
   - sitting/standing/walking work etc;
   - work with a low force exertion: head/neck/eyes;
   - work with a high force exertion: leg/foot/shoulder/arm/hand;
   - work with a high mental load;
   - industrial, non-industrial and domestic use;

b) intended user groups (the population that will use the machine), such as age-groups, level of training etc:
   - young, older persons, disabled and chronically ill persons;
   - general healthy working population;
   - skilled people and trained people;
   - industrial, non-industrial and domestic users;

c) space limits:
- for the machine itself, including for the operators;
- inside the machine (eg driving positions);
- for the operator when doing maintenance or faultfinding;
- for accessories and component parts;
- accessibility;

d) time aspects:
- determination of the foreseeable duration and frequency of use;
- life-cycle of the machine and its different component parts;
- duration of use by the operator;
- frequency of use by the operator;

e) environmental conditions of the intended worksites:
- climate;
- noise;
- lighting;

f) use of PPE if it cannot be avoided;

g) foreseeable ergonomic misuse (EN 292-1: 3.12):
- use by others than the intended user group;
- use in an incorrect working posture;
- use in unsafe and unhealthy conditions;
- use without proper training.

In checklist 1 the items for listing the limits of the machine are given. The C-standardizer should collect the information according to the boxes in the checklist.

If relevant limits are introduced into the standard by the C-standardizer, they have to be mentioned in the scope of the standard and in the clauses dealing with information for use (step 7) according to rules established in EN 414.

STEP 2: IDENTIFICATION OF HAZARDS GENERATED BY NEGLECTING ERGONOMIC PRINCIPLES

Checklist 2 consists of questions about the hazards in all the phases of a machine's life. In this step by step approach, the possible uses of the machine at each phase according to the limits determined in step 1 are considered.

The ergonomic hazards considered are those included in the hazard list in prEN 1050 based on the definition of ergonomics in EN 614-1. The *"Hazards generated by materials and substances processed, used by the machinery and by its constituent materials"* mentioned in point 7 of Annex A of prEN 1050 are not taken into account in this guide because these toxic and biological agents present another kind of specific risk.

The results of this step can be presented in the form of a matrix (checklist 2). When the answer to a question is 'yes', the stage must be marked and analysed in the next steps of the model. In case of doubt the answer should be 'yes'. The output of step 2 is a list of **Relevant Hazards**.

STEP 3: RISK ESTIMATION

A risk estimation has to be made for each relevant hazard. According to prEN 1050, the main factors to be taken into account when performing risk estimation are exposure and severity. However, when considering these two factors, it must be borne in mind that ergonomic hazards differ in nature from safety hazards and that it is particularly difficult to evaluate aspects such as severity and exposure related parameters (eg duration and frequency). Most ergonomic hazards are continuously present and may cause long term health effects, while exposure to accidents is determined by probability laws. Examples of such ergonomic hazards are a restricted working posture, working in a hot or cold climate or work that imposes a heavy mental burden.

Moreover, regarding severity, the question arises as to the varying statistical significance of different dose-effect relationships. Therefore, a system for risk estimation that is based only on probability and severity of impairments is not always applicable. Despite these difficulties however, it is still useful to gather data on accidents and occupational diseases in order to improve the assessment of ergonomic risks, especially taking into account different user groups and types of machinery.

In view of these difficulties, a questionnaire has been drawn up combining the most essential requirements of various ergonomic standards. This questionnaire for a quick risk estimation (checklist 3) contains limit values for the ergonomic hazards based on the standards mentioned in brackets. When an ergonomic hazard is below this limit value, the ergonomic risk may in general be considered as negligible.

At the end of step 3 it is possible to separate those relevant hazards which are estimated to be negligible from those which are considered to be **ergonomic risks** to be evaluated in more detail in step 4: risk evaluation.

STEP 4: RISK EVALUATION

In the Technical Committee drawing up the C-standard, an evaluation has to be made of the ergonomic risks which will occur in the general use of the machine. In order to carry out the risk evaluation, the C-standardizers have to use the strategies and values presented in the respective B-standards on general and specific ergonomic subjects. These standards are classified in checklist 4 to make it easier to find the necessary references.

Based on the risk evaluation, the C-standard committee can conclude that:

1. The risk is below the level mentioned in the B-standards and therefore does not need to be taken into account.
2. The risk is above the level mentioned in the B-standards and must therefore be taken into account.
3. There is no information available (no standard exists or there are no provisions) to make the right evaluation. The machine manufacturers using the C-standard must be aware of this and find a solution by seeking expert advice.

The output of step 4 is different evaluations for the different ergonomic risks resulting from step 3. Those requiring further action as a result of this evaluation are called **significant ergonomic risks**.

An example: after step 4 it is concluded that machine X has the following ergonomic risks:

- an unacceptable risk for the pedal force needed by the operator;
- the access openings are too small: they only allow 50% of small men and 75% of women to enter;
- the working posture during operation will be 30° bent forward because of the lack of visibility outside the machine. This forms an unacceptable ergonomic risk.

The significant risks must be reduced at stage 5.

STEP 5: RISK REDUCTION

All the significant risks require action to be taken to reduce them. However, there might be one or more reasons why some cannot be dealt with, eg there is no information available or the standard is restricted to some specific items. The significant ergonomic risks which for any reason are not dealt with in the standard must be mentioned in the scope, as is stated in EN 414.

Risk reduction can be achieved by using the provisions of the standards (checklist 4) in an iterative design process (as found in some B-standards) to apply the following possible solutions for risk reduction in C-standards:

- elimination by redesigning the machine;
- safeguarding;
- use of protective equipment[13].

STEP 6: VERIFICATION

Each C-standard must provide information on how the stated ergonomic measures can be verified by means of the information in the relevant B-standards where available. If there is no relevant B-standard, then a specific verification method should be given in the C-standard. All the parts of the relevant B-standards are given in the last column of the matrix in checklist 4.

STEP 7: INFORMATION FOR USE

Residual ergonomic risks that are not covered by the C-standard have to be taken into account by the manufacturer. If there is no way of reducing or - according to step 5 - eliminating the risk through design, the C-standard must give guidance to the manufacturer by means of clauses on information for use that must accompany the machine (EN 292-2; 5.5 and EN 414: 6.10). Any limitation in the use of the machine (steps 1-5) should be mentioned either in the scope or in the instruction handbook. In addition, safety signs or pictograms can be prescribed. Any specific requirements for the instruction handbook must be presented in the C-standard, which must also specify the minimum markings to be put on the machine (EN 414: 6.10.3). Information on specific ergonomic clauses relevant to instruction handbooks can be found in the B-standards mentioned in checklist 4.

[13] The use of PPE is always the last solution in the hierarchy of measures.

4. Conclusion

According to the Machinery Directive and the relevant horizontal standards, there is no doubt about the importance of considering ergonomic aspects in C-standards. In order to do this, better mutual cooperation between A-, B- and C-standardizers is required. But what does this mean in practical terms?

It is often the case that C-standardizers ignore ergonomic hazards because they either feel unable to assess the relevant risks (steps 1, 2, 3 and 4), or they do not know how to deal with them once the risks have been considered as significant (steps 5, 6, and 7).

Taking into account the needs of C-standardizers and the users of the machinery, we have tried to make it easier to use the rather fragmented horizontal provisions in the field of ergonomics. Therefore, the ergonomic tools provided by the horizontal standards have been summarized in a coherent structure based on a step by step methodology.

Two points stand out in conclusion to our technical overview:

1. There is a need for active users' participation when integrating ergonomics in product standards. This is not only because of their position as interested parties, but also because it is clear that ergonomics is not a purely objective issue and therefore, the provisions concerned need a systematic input from users' expertise. Checklist 3 in step 3 provides a relevant example of the specific nature of ergonomics: given the difficulty of estimating risks using an approach based on systematized conventional criteria, we have compiled our own list of relevant questions, which does not pretend to be exhaustive but aims to be helpful.

2. The summary of the available B-standards in this guide shows that certain ergonomic aspects have either not been well covered or have been completely neglected (see checklist 4).

Checklists

CHECKLIST 1: ITEMS FOR LISTING THE LIMITS OF THE MACHINERY (STEP 1)

	LIFE CYCLE PHASES			
	Construction and installation	Operation	Maintenance	Dismantling
INTENDED USE Work tasks				
User groups				
Space limits				
Time limits . duration . frequency				
Environmental . climate . noise				
Use of personal protective equipment				
Foreseeable misuse				

CHECKLIST 2: CHECKLIST FOR HAZARD IDENTIFICATION (STEP 2)

	LIFE CYCLE PHASES			
	Construction and installation	**Operation**	**Maintenance**	**Dismantling**
ERGONOMIC HAZARD				
1. Are there hot or cold surfaces on the machine that can be reached by the operator?				
2. Does the operator have to work in a hot or cold environment?				
3. Does the machine have a separated space with a particular climate for the operator (cabin, control room)?				
4. Does the machine produce a loud noise?				
5. Does the operator have to listen to another person or to acoustic signals while performing his tasks?				
6. Does the machine produce hand-arm vibrations on the operator?				
7. Does the machine produce vibrations on the whole body of the operator?				
8. Does the machine produce electromagnetic radiation?				
9. Is there a need for whole body access into the machine?				
10. Is there a need for the access of body parts (upper-body, forearm, hand, fingers, feet, toes, head etc) into the machine?				

11. Is the use of personal protective equipment necessary?				
12. Does the machine have a fixed workstation for its operation				
13. Does the operator have to lift products or machine parts?				
14. Does the operator have to exert force with his body ?				
15. Does the operator have to work in a restricted working posture?				
16. Does the operator have to read displays or objects inside or outside his work position to fulfil his tasks?				
17. Is the machine used in environments with inadequate lighting?				
18. Does the operator have a significant mental burden?				
19. Is the machine equipped with a combination of control actuators and displays?				
20. Does the operator need to see visual safety signals?				
21. Does the operator need to hear auditory safety signals?				
22. Is the machine equipped with a display or control device?				

CHECKLIST 3: QUICK-SCAN QUESTIONNAIRE FOR ERGONOMIC RISK ESTIMATION (STEP 3)

Only the questions corresponding to the hazards identified in step 2 should be considered in the risk estimation. If the answer to a question is 'yes', then the next step, Risk evaluation, must be carried out.

ERGONOMIC HAZARD	REFERENCE	YES/NO
1a. Does the machine have cold surfaces with a temperature below...° C[14] which can be reached by the operator?	WI 00122038	
1b. Does the machine have hot surfaces with a temperature above 43° C which can be reached by the operator?	EN 563	
2a. Does the operator have to work for longer than one hour in a temperature below 10°C?	ISO/TR 11079	
2b. Does the operator have to work for longer than one hour in a temperature above 25° C?	EN 27243	
3. Does the operator have to work for large parts of the day in a moderate environment with a temperature above 20° C or below 18° C?	EN ISO 7730	
4. Does the machine produce noise levels of more than 70 dB(A)?	89/392/EEC Annex 1: 1.7.5 f	
5. Does the machine produce noise levels of more than 65 dB(A)?	ISO/CD 9921-1	
6. Does the machine produce hand-arm vibrations on the operator of more than 1.0 m/s² Hz?	ENV 25349	
7. Does the machine produce vibrations on the operator's whole body above 0,5 m/s²?	CR 1031	
8. Does the machine emit electromagnetic radiation with a level above 10 kV/m (for electric fields) or 500 μT (for magnetic fields)?	ENV 50166-1/2	
9. Is the access opening for a whole body larger than 2100 mm high and 750 mm wide?	EN 547-1/3	
10. Access openings: - is there an upper-body access opening smaller than a circle diameter of 700 mm? - is there a head access opening smaller than a circle diameter of 390 mm? - is there an access opening for both arms smaller than a rectangle of 670 x 240 mm? - is there an access opening for one arm smaller than a circle-diameter of 240 mm? - is there a hand access opening smaller than a rectangle of 150 x 65 mm? - is there a finger access opening smaller than a circle-diameter of 53 mm? - is there a foot access opening smaller than a rectangle of 325 x 153 mm?	EN 547-2/3	

[14] WI 00122038 does not set any specific value.

11.	Is the use of personal protective equipment taken into account in the design of the machine?		
12.	Is the fixed work station designed for working postures other than sitting? When sitting: - is the working height for the arms higher than 505 mm above the seat? - is the working front-reach for the arms larger than 170 mm? - is the non-adjustable leg space less than 720 mm? - is the width for the foot & leg space smaller than 990 mm? - is the foot & leg space depth below the surface smaller than 955 mm? - is the space for leg movement under the seat less than 285 mm? - is the non-adjustable seat height between 340 mm and 505 mm	WI 00122045	
13.	Does the operator have to lift items of more than 3 kg?	prEN 1005-2	
14.	Does the operator have to exert: - pedal force of more than 100 N? - hand-arm force of more than 20 N?	prEN 1005-2	
15.	Does the operator have to work in forced working postures like twisting or bending when sitting or standing?	prEN 1005-4	
16a.	Are there displays or objects that the operator has to look at frequently located outside his field of vision from 0° to 30° in front of him with a viewing width of 50°?	prEN 894-2	
16b.	Is his field of vision limited by workstation structures?		
17.	Is the machine used for tasks demanding difficult or special visual requirements or is the machine used for work in environments with a lighting level below 750 lux?	ISO 8995	
18a.	Do the work tasks infringe one or more of the following: - the experience, capabilities and skills of the operators are recognised; - the work tasks are identifiable as complete and meaningful whole units of work with a clearly identifiable beginning and end, rather than as isolated fragments of such tasks; - the work tasks are identifiable as a significant contribution to the total output of the work system; - the operator is able to use an appropriate variety of skills, capabilities, activities and behaviour (skill based, rule based and knowledge based); - the operator is given an appropriate degree of freedom and autonomy; - sufficient feedback on task performance in terms meaningful to the operator is provided; - opportunities to practise and develop existing skills and capabilities as well as to acquire new one are provided.	WI 00122049 (draft proposal for prEN 614-2)	

18b. Is one of the following situations likely to arise: - both operator under- and overload which may lead to unnecessary or excessive strain, fatigue or to errors; - repetitiveness which may lead to unbalanced work strain and thus to physical disorders as well as to feelings of monotony, boredom or dissatisfaction; - the operator working alone with few or no opportunities for social and functional contacts.	WI 00122049 (draft proposal for prEN 614-2)	
19. Does the interaction between the operator and displays and controls infringe one or more of the following characteristics: - suitability for the task; - self descriptiveness; - controllability; - conformity with user expectations; - conformity with bio-mechanical requirements; - error tolerance; - suitability for individualization and learning.	pr EN 894-1	
20. Can visual safety signals be seen by all operators in all circumstances?	prEN 842	
21. Can auditory safety signals be heard by all operators in all circumstances?	EN 457	
22a. Is the machine equipped with control devices other than push button that: - have a circle diameter larger than 7 mm? - have a resistance of less than 6,9 N?	prEN 894-3	
22b. Is the machine equipped with analogue, digital, tactile or audible displays?	prEN 894 -2	

CHECKLIST 4: REFERENCE MATRIX FOR THE A- AND B-STANDARDS IN THE FIELD OF ERGONOMICS (STEP 4)

	Definition	Requirements/ design process	Measures	Verification or testing methods
1a. Hot surfaces	EN 563 cl. 3	EN 563 cl.4	EN 563 annex C	EN 563 cl.5
1b. Cold surfaces	WI 00122038	WI 00122038		WI 00122038
2a. Cold environments[15]	ISO/CD 13731	ISO/TR 11079		ISO 9920
2b. Hot environments[15]	ISO/CD 13731	EN 27243		EN 27726 ENV 27933
3. Moderate environments	ISO/CD 13731	EN ISO 7730 WI 00122056		EN 27726 EN 28996
4 Noise[16]		prEN 31690-1 ISO 1999 WI 00122056	prEN 31690-2	EN ISO 11200 EN ISO 11201 EN ISO 11202 EN ISO 11203 EN ISO 11204
5. Noise interferences		ISO/CD 9921-1/2 prEN 894-2 cl.5	ISO/CD 9921-3	ISO/CD 9921-1/2/3
6. Hand-arm vibrations[17]	ENV 25349	ENV 25349	CR 1030-1	EN 1033 ENV 25349
7. Whole body vibrations	prEN 1031	prEN 1031 WI 00122056	prEN 1299	prEN 1031 prEN 1032
8. Electromagnetic radiation		ENV 50166-1/2		ENV 50166-1/2
9. Access openings for the whole body	prEN 979	prEN 547-1/3 WI 00122056	WI 00114046 WI 00114065 WI 00114068 WI 00114069	WI 00122057
10. Access openings for body parts	prEN 979	prEN 547-2/3	prEN 547-2 annex B	WI 00122057
11. Use of PPE		prEN 547-1/2/3 WI 00122051-55[18]		
12. Work station design	prEN 979	WI 00122045 WI 00122056	WI 00122045	WI 00122057

[15] See also ISO/DIS 11399: 1995 *Ergonomics of the thermal environment; - Principles and application of international standards.*

[16] See also prEN 1746: *Safety of machinery - Guidance for the drafting of the noise clauses of safety standards.*

[17] There are several more standards for this subject giving measurement methods for specific machines and applications. See the standardization catalogues.

[18] These standards describe data for the design of PPE. Some contain useful data for machinery design.

13. Lifting	prEN 1005-1	prEN 1005-2	prEN 1005-2	prEN 1005-2
14. Force exertion	prEN 1005-1	prEN 1005-3	prEN 1005-3	prEN 1005-3
15. Working posture	prEN 1005-1	prEN 1005-4		prEN 1005-4
16. Visual field		prEN 894-2 WI 00122056		
17. Lighting	WI 00169002 ISO 8995	prEN 1837 ISO 8995 WI 00169014		ISO 8995
18. Mental load	prEN ISO 10075-1	WI 00122049	WI 00122049	
19. Interaction controls - signals	prEN 894-1 cl. 3 WI 00122060	prEN 894-1 cl.4 WI 0122061		
20. Visual safety signals	prEN 842	prEN 842		prEN 842
21. Acoustic safety signals	EN 457 cl. 3 prEN 981 cl. 3	EN 457 cl. 5 prEN 981 cl. 5		EN 457 cl. 6 prEN 981 cl. 6
22a Displays	prEN 894-2 cl.3	prEN 894-2		
22b Control actuators	prEN 894-3	prEN 894-3		prEN 894-3

Annexes

ANNEX 1: INVENTORY OF ERGONOMIC HAZARDS FROM prEN 1050 INCLUDED IN THIS ERGONOMICS GUIDE

(3) *Thermal hazards*:
- (3.1) Burns and scalds by a possible contact of persons, by flames or explosions and also by the radiation of heat sources;
- (3.2) Health damaging affects by hot or cold work environment.

(4) *Hazards generated by noise:*
- (4.1) Hearing loss (deafness), other physiological disorders;
- (4.2) Interference with speech communication, acoustic signals etc.

(5) *Hazards generated by vibrations:*
- (5.1) Use of hand-held machines resulting in a variety of neurological and vascular disorders;
- (5.2) Whole body vibration, particularly when combined with poor postures.

(6) *Hazards generated by radiation:*
- (6.1) Low frequency, radio frequency radiation, microwaves.

(8) *Hazards generated by neglecting ergonomic principles in machinery design:*
- (8.1) Unhealthy postures or excessive effort;
- (8.2) inadequate consideration of hand-arm and foot-leg anatomy;
- (8.3) Neglected use of personal protective equipment;
- (8.4) Inadequate local lighting;
- (8.5) Mental overload and underload, stress;
- (8.6) Human error, human behaviour.

(21) *Additional hazards and hazardous events due to mobility linked to the work position on the machine:*
- (21.1) Fall of persons during access to (or at/from) the work position;
- (21.5) Insufficient visibility from the work position;
- (21.6) Inadequate lighting;
- (21.7) Inadequate seating;
- (21.8) Noise at the work position;
- (21.9) Vibration at the work position.

(22) *Additional hazards and hazardous events due to the control system:*
- (22.1) Inadequate location of controls/ control devices;
- (22.2) Inadequate design of the actuation mode and/or action mode of controls.

(29) *Additional hazards and hazardous events due to lifting; hazards generated by neglecting ergonomic principles:*
- (29.1) Insufficient visibility from the driving position.

Important subjects missing in prEN 1050 are: *information displays* and *repetitive movements*. The subject *information displays* is included in the checklist in question 21 (annex 2). For *repetitive movements*, there is no available standard and no work items have been included in the work schedule of any CEN technical committee.[19] For this reason this subject is not taken into account in this guide.

[19] A guidebook on this subject containing limit values has been produced in the Netherlands: Huppes, G. et al. *Repeterende bewegingen*, SDU, The Hague, 1994.

ANNEX 2: CHECKLIST COMBINING ERGONOMIC HAZARDS IN prEN 1050 (ANNEX 1) WITH QUESTIONS FOR HAZARD IDENTIFICATION (CHECKLIST 2)

(3) Thermal hazards:

1. Are there hot or cold surfaces on the machine that can be reached by an operator?
2. Does the operator have to work in a hot or cold environment?
3. Does the machine have a separated space with a particular climate for the operator (cabin, control room)?

(4.1) Hearing loss (deafness), other physiological disorders:

4. Does the machine produce a loud noise?

(4.2) Interference with speech communication, acoustic signals etc.:

5. Does the operator have to listen to another person or to acoustic signals while performing his tasks?

(5.1) Use of hand-held machines resulting in a variety of neurological and vascular disorders:

6. Does the machine produce hand-arm vibrations on the operator?

(5.2) Whole body vibration, particularly when combined with poor postures:

7. Does the machine produce vibrations on the whole body of the operator?

(6.1) Low frequency, radio frequency radiation, micro waves[20]*:*

8. Does the machine produce electromagnetic radiation?

(8.1) Unhealthy postures or excessive effort
(8.2) Inadequate consideration of hand-arm and foot-leg anatomy
(8.3) Neglected use of personal protective equipment:

9. Is whole body access into the machine necessary?
10. Is the access of body parts (upper-body, forearm, hand, fingers, feet, toes head etc) into the machine necessary?
11. Is the use of personal protective equipment necessary?
12. Does the machine have a fixed workstation for its operation?
13. Does the operator have to lift products or machine-parts?
14. Does the operator have to exert forces with his body?
15. Does the operator have to work in a special working posture?
16. Does the operator have to look at displays or objects in- or outside his work position to fulfil his tasks?

(8.4) Inadequate local lighting:

17. Is the machine used in environments with inadequate lighting?

(8.5) Mental overload and underload, stress:

18. Does the operator have a mental load?

(8.6) Human error, human behaviour:

19. Is the machine equipped with a combination of control actuators and displays?
20. Does the operator have to look at visual safety signals?
21. Does the operator have to hear auditory safety signals?

(21.1) Fall of persons during access to (or at/from) the work position:

9. Is whole body access into the machine necessary?

[20] This hazard has been included because it is not clear whether is belongs to the field of safety or to that of ergonomics.

(21.5) Insufficient visibility from the work position:

16. Does the operator have to look at displays or objects inside or outside his work position to fulfil his tasks?

(21.6) Inadequate lighting:

17. Is the machine used in environments with inadequate lighting?

(21.7) Inadequate seating:

12. Does the machine have a fixed workstation for its operation?
15. Does the operator have to work in a specific working posture?

(21.8) Noise at the work position:

4. Does the machine produce a loud noise?

(21.9) Vibration at the work position:

6. Does the machine produce hand-arm vibrations on the operator?
8. Does the machine produce vibrations on the operator's whole body?

(22.1) Inadequate location of controls/ control devices

(22.2) Inadequate design of the actuation mode and/or action mode of controls:

22. Is the machine equipped with a display or a control device?

(29.1) Insufficient visibility from the driving position:

16. Does the operator have to look at displays or objects inside or outside his work position to fulfil his tasks?

ANNEX 3: BIBLIOGRAPHY OF ERGONOMICS STANDARDS APPLICABLE TO THE DESIGN OF MACHINE SAFETY STANDARDS

Where information is lacking because standards are not available, other sources of information in national standards and handbooks on ergonomics should be used.

A-standards

prEN 979: 1993 *Basic list of definitions of human body dimensions for technical design*

This draft standard provides a basic list of anthropometric measurements for use in the establishment of common comparative definitions of population groups. The basic list specified in this standard is intended to serve as a guide for ergonomists who are required to define population groups and apply their knowledge to the geometric design of the places where people work and live. This list is not intended to serve as a guide for how to take anthropometric measurements but it gives information to the ergonomist and designer on the anatomical and anthropometrical basis and principles of measurements which are applied in the solution of design tasks. It may be used in conjunction with national or international regulations or agreements to assure harmony in defining population groups. In its various applications, it is anticipated that the basic list will be supplemented by specific additional measurements.

ENV 26385: 1990 *Ergonomic principles of the design of work systems (ISO 6385:1981)*

The ergonomic guiding principles specified in this international standard apply to the design of optimal working conditions with regard to human well-being, safety and health, taking into account technological and economic efficiency.

EN 614-1: 1995 *Safety of machinery - Ergonomic design principles - Part 1: Terminology and general principles*

This European standard gives the ergonomics principles to be followed before and during the process of the design of work equipment, especially machinery. Although the principles in this European standard are orientated towards equipment for occupational use, they are also applicable to equipment for private use. It applies to the interactions between the operator and the work equipment when installing, operating, adjusting, maintaining, cleaning, repairing or transporting equipment and outlines the principles to be followed in taking the needs of the operator fully into account.

prEN ISO 10075-1: 1991 *Ergonomic principles related to mental workload - Part 1: general terms and definitions*

This draft standard represents an extension of ENV 26385, sub-clauses 3.7 to 3.9, describing terms and definitions in more detail. Annex A forms an integral part of this standard.

B-standards

EN 457: 1992 *Safety of machinery - Auditory danger signals - General requirements, design and testing (ISO 7731:1986, modified)*

This standard specifies the safety and ergonomic requirements and the corresponding test methods for auditory danger signals and gives guidelines for the design of the signal to be clearly perceived and differentiated as required in 5.3 of EN 292-2. It does not apply to verbal danger warnings (eg, shouts, loudspeaker announcements). Special regulations such as those for a public disaster and public transport are not affected by this standard.

prEN 547-1: 1991 *Safety of machinery - Human body measurements - Part 1: principles for determining the dimensions required for openings for whole body access into machinery*

This draft standard applies to passages for operators of machines as defined in EN 292 and for the adult population in comparable fields of application. It includes dimensions as specified in Part 3. Dimensions for passages are based on the values for the 95th and 99th percentiles of the expected user population respectively. Values for the 99th percentile apply to emergency egress routes. The anthropometric data used as a basis originate from the measurement of naked persons. In other words the data specified do not take into account clothing and equipment or machinery specific conditions (operating conditions) or environmental conditions. The dimensions given in this standard ensure passage for the user population. Where it is necessary to prevent people reaching a hazard other standards shall be used.

prEN 547-2: 1991 *Safety of machinery - Human body measurements - Part 2: principles for determining the dimensions required for access openings*

This draft standard presents dimensions for access openings that ensure the best compromise between the need for free space for movement and the compactness of equipment and installations machinery. It describes how anthropometric data (plus certain allowances) determine the minimum dimensions of access openings for different body positions. It includes dimensions as specified in Part 3. Dimensions for access openings are based on the values for the 95th percentile whereas reach distances are based on the values for the 5th percentile, in each case the least favourable body dimension of the adult population of the expected user population being used as a basis. The same considerations apply to the location of access openings. The anthropometric data used as a basis originate from static measurements of naked persons. In other words: The data specified do not take into account body movements, clothing and equipment or machinery specific operating conditions and environmental conditions. The dimensions given in this standard ensure access for the user population. Where it is necessary to prevent people reaching a hazard, other standards shall be used.

prEN 547-3: 1994 *Safety of machinery - Human body measurements - Part 3: anthropometric data required for access openings*

This draft standard presents the anthropometric data which can be used to fill in the measurements of prEN 547 parts 1, 2 and 4. Most of the data are based on the definitions given in prEN 979. The data are based on the values for the 95th percentile or on the values for the 5th percentile, in each case the least favourable body dimension of the adult population of the expected user population being used as a basis.

EN 563: 1994 *Safety of machinery - Temperatures of touchable surfaces - Ergonomics data to establish temperature limit values for hot surfaces*

This is a type B1 safety standard concerned with the risk of burns caused by contact between human skin and hot surfaces. This standard applies to hot surfaces of all products and equipment that must or can be touched during their normal use. That includes the area of safety of machinery as well as any other applications. This standard provides data concerning circumstances under which contact with a hot surface may lead to skin burns. These data allow the assessment of risks of burning. This standard also provides data to be used to establish temperature limit values for hot surfaces to protect against skin burns. These data can be used in the development of standards for specific equipment where temperature limits are required. This standard does not apply, if a large area of the skin (approximately) 10% or more of the skin of the whole body) can be in contact with the hot surface. This standard also does not apply to skin contact with more than 10% of the head or contact which could result in burns of vital areas of the face (e.g. burns resulting in the restriction of airways). In these cases severe injuries may occur, even if the surface temperature does not exceed the values specified in this standard. The data of this standard apply to surfaces of objects with relatively high thermal capacity when compared with that of the skin of the human body. This standard applies to the skin of adults. As far as there are no special data for the skin of children this standard may also be used to assess the risk of burning of children's skin in contact with hot surfaces. This standard does not provide data for the protection against pain. If the burn thresholds specified in this standard are not exceeded, there is normally no risk of burning, when the skin comes in contact with the hot surface, but pain may occur nevertheless. If there is also a need for protection against pain, surface temperature values should be taken from other suitable sources.

prEN 842: 1992 *Safety of machinery - Visual danger signals - General requirements, design and testing*

This draft standard specifies the safety and ergonomic requirements and the corresponding test methods for visual danger signals. It also provides guidance for the design of the signals to be clearly identified and distinguished as required in 5.3 of EN 292-2. It does not apply to danger indicators - presented either in written or pictorial form - transmitted by data display units. Special regulations, such as those for public disaster and public transport, are not affected by this standard.

prEN 894-1: 1993 *Safety of machinery - Ergonomic requirements for the design of displays and control actuators - Part 1: human interactions with displays and control actuators*

This draft standard applies to the design of control actuators and displays on work equipment, especially machines. It specifies the relationships that have to be maintained between the movements of control actuators, the response of any associated displays, and the human response to information given by the system, to minimise operator errors and to ensure an efficient interaction between the operator and the equipment. It is particularly important to observe these relationships when an operator error may lead to injury or damage to health.

prEN 894-2: 1993 *Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 2: displays*

This draft standard gives recommendations on the selection, design and location of information displays so that they are adapted to the requirements of the operators, and take account of the circumstances of their use. It includes visual, audible and tactile displays. It applies to displays used in equipment (e.g. machines and installations, control panels, operating and monitoring consoles) for occupational and private use. It does not apply to visual display terminals (VDTs) used for office tasks, the ergonomic requirements for which are given in the multipart standard ISO 9241.

prEN 894-3: 1993 *Safety of machinery - Ergonomic requirements for the design of displays and control actuators - Part 3: control actuators*

This draft standard gives recommendations on the selection, design and location of control actuators so that they are adapted to the requirements of the operators and take account of the circumstances of their use. It applies to manual control actuators used in equipment for occupational and private use. It is particularly important to observe its recommendations where operating a control actuator may lead to injury or damage to health, either directly or as a result of a human error.

prEN 981: 1993 *Safety of machinery - System of danger and non-danger signals with sound and light*

This draft standard is applicable to all kinds of danger signals which have to be clearly identified and distinguished as required in 5.3 of EN 292-2, and to all degrees of urgency - from an extreme urgency to an "all clear" situation. For cases when light signals are to be used complementary to sound signals, characters are stated for both. Certain fields of application covered by specific standards or other conventions in force (international or national) are excluded; in particular, fire alarms, medical alarms, alarms used in the field of public transport, navigation signals and signals for special fields of activity (e.g. military) are excluded. When new signals are being planned, however, this draft standard should be considered in order to avoid inconsistency.

prEN 1005-1: 1993 *Safety of machinery - Human physical performance - Part 1: terms and definitions*

This draft standard provides definitions on concepts and parameters used for prEN 1005-2, prEN 1005-3 and prEN 1005-4.

prEN 1005-2: 1993 *Safety of machinery - Human physical performance - Part 2: manual handling of objects associated to machinery*

This draft standard specifies ergonomic requirements for the design of machinery concerned with manual handling of objects (lifting, lowering and carrying) in industrial and professional activities. It is also relevant to employers who shall apply the information provided by machinery designers when planning, organizing and laying out the work. The draft applies to manual handling of items of 3 kilograms or more. It covers lifting, lowering and carrying concerning the construction, transport and commissioning (assembly, installation, adjustment) use (operation, cleaning, fault finding, maintenance, setting, teaching or process changeover) and decommissioning, disposal and dismantling of machinery.

prEN 1005-3: 1993 *Safety of machinery - Human physical performance - Part 3: recommended force limits for machinery operation*

This draft standard specifies force limits for pushing and pulling tasks, gripping, arm work and pedal work under the following conditions; - pushing and pulling with whole body exertion and using a two-handed symmetrical grip whilst standing and walking - manual exertion (to/from, up/down, in/out), arm work whilst sitting and standing - leg exertion, one-foot or two-feet forces pushing or pressing of pedal(s) whilst sitting and standing. It is primarily designed to provide guidance for the designer and applies above all to machines which are manufactured after the date of issue of the standard. The design of hand-held machines is not included in the scope of this standard.

prEN 1005-4: 1996 *Safety of machinery - Human physical performance - Part 4: evaluation of working postures in relation to machinery*

This draft standard presents guidance to the designer of machinery or its components parts in controlling health risks due to machine-related working postures. It specifies recommended limits for working postures with minimal external force exertion, while taking into account body angles and durations. The recommendations will give protection for nearly all healthy adults.

CR 1030-1: 1995 *Hand-arm vibration - Guidelines for vibration hazards reduction - Part 1: engineering methods by design of machinery*

These guidelines outline feasible ways in which possible hand-arm vibration hazards associated with hand-held, hand-guided and other machinery, may be reduced by machinery design in order to provide practical professional help to designers and manufacturers of machinery. The document covers five principal aspects of the reduction of the effects arising from exposure to hazardous machinery vibration: - reduction of vibration magnitude at source; - reduction of vibration transmission from the source to handles and other surfaces in contact with the hands; - minimisation of transmission from the machine to the hand-arm system by ergonomic means (minimisation of the forces received or exerted by the operator's hands); - minimisation of exposure time by increasing the performance of the machine (see note to section 3.2); - thermal design to optimise hand temperature.

prEN 1031: 1993 *Measurement and evaluation of whole-body vibration - General requirements*

This draft standard is intended to be used for defining magnitudes of whole-body vibrations transmitted from supporting surfaces to the human body in the frequency range 1 to 80 Hz. According to this standard, the magnitudes are stated as r.m.s. values of representative vibrations. The vibration is specified in terms of weighted acceleration magnituders, exposure time and the direction of vibration relative to the torso. Only rectilinear vibrations are dealt with in this standard. Although primarily written for application to vibration emission evaluation, this standard may also be applied to vibration evaluation at workplaces. It does not present any vibration limits.

prEN 1032: 1993 *Mechanical vibration - Testing of mobile machinery in order to measure the whole-body vibration emission value - General*

The purpose of this draft standard is to provide general requirements for the vibration Test Codes to be incorporated in the machinery related standards, including the conditions under which the measurements shall be made (e.g. operating and environmental conditions). It applies to sitting and standing position and is applicable to all machinery producing periodic or random vibration with or without transients. It aims to ensure consistency and compatibility of test and evaluation methods, but does not present limits or recommended vibration values.

EN 1033: 1995 Hand-arm vibration - *Laboratory measurement of vibration at the grip surface of hand-guided machinery - General*

EN 1033 describes the basic requirements for evaluating vibration at the machine-hand contact surface of hand-guided machines, e.g. lawn mowers, single axis tractors, vibratory rollers, and other types of machines which are provided with handles, guiding beams or similar means of control. Test codes are designed to give information on the vibration characteristics of a specific type of machinery, enabling comparisons to be made between similar machinery, but of different manufacturers. The standard does not yet apply to hand-held power tools and to fixed machinery in which the vibration is transmitted to the hands of the user through the workpiece, nor does it apply to the measurement of vibration to the handle of the user via steering wheels or similar controls of vehicles. This standard is not intended for assessment of human exposure to vibration. The measurement and assessment of human exposure to hand-transmitted vibration in the workplace is given in ENV 25349.

prEN 1299: 1994 *Vibration isolation of machines - Information for the application of source isolation*

prEN 1837: 1995 *Safety of machinery - Integral lighting of machinery*

This draft standard specifies the parameters of a built-in lighting system designed to provide illumination in and at machines to enable the safe and efficient visual performance of the full task to be carried out uninterrupted in the absence of normal lighting.

ENV 25349: 1992 *Mechanical vibration - Guidelines for the measurement and assessment of human exposure to hand-transmitted vibration (ISO 5349: 1986)*

This standard specifies general methods for measuring and reporting hand-transmitted vibration exposure in three orthogonal axes for the one-third octave bands, having centre frequencies from 6.3 to 1250 Hz, the octave bands, having centre frequencies from 8 to 1000 Hz and a frequency-weighted measure which covers the frequency range from 5.6 to 1400 Hz.

EN 27243: 1993 *Hot environments - Estimation of the heat stress on working man, based on the WBGT-index (wet bulb globe temperature) (ISO 7243: 1989)*

Gives a method which can easily be used in an industrial environment for evaluating the stresses on an individual. It applies to the evaluation of the mean effect of heat on man during a period representative of his activity but it does not apply to very short periods, or to zones of comfort.

EN 27726: 1993 *Thermal environments - Instruments and methods for measuring physical quantities (ISO 7726: 1985)*

Specifies the minimum characteristics. Applies to studies of hot, comfortable or cold environments at places occupied by humans. Is to be used as reference for specifying rules for manufacturers and users and contracts between parties.

EN ISO 7730: 1995 *Moderate thermal environments - Determination of the PMV and PPD indices and specification of the conditions for thermal comfort*

The purpose of this international standard is a) to present a method for predicting the thermal sensation and the degree of discomfort (thermal dissatisfaction) of people exposed to moderate thermal environments; b) to specify acceptable thermal environmental conditions for comfort. It applies to healthy men and women exposed to indoor environments where the aim is to attain thermal comfort, or indoor environments where moderate deviations from comfort occur. In extreme thermal environments, other international standards apply. The present standard may be used in the design of new environments or in assessing existing ones.

prEN 27933: 1993 *Hot environments - Analytical determination and interpretation of thermal stress using calculation of required sweat rates*

This draft standard specifies a method of analytical evaluation and interpretation of the thermal stress experienced by a subject in a hot environment. It describes a method of calculating the heat balance as well as the sweat rate that the human body should produce to maintain this balance in equilibrium: this sweat rate is called the "required sweat rate". The various terms used in the determination of the required sweat rate show the influence of the different physical parameters of the environment on the thermal stress experienced by the subject. In this way, this it makes it possible to determine which parameter or group of parameters should be modified, and to what extent, in order to reduce the risk of physiological strains. The main objectives of this draft standard are a) the evaluation of the thermal stress in conditions likely to lead to excessive core temperature increase or water loss for the standard subject; b) the determination of the modifications to be brought to the work situation in order to reduce or exclude these effects; c) the determination of the maximum allowable exposure times required to limit physiological strain to an acceptable value.

EN 28996: 1993 *Ergonomics - Determination of metabolic heat production (ISO 8996: 1990)*

This standard specifies methods for determining the metabolic rate, but can also be used for other applications, e.g. for the assessment of working practices, the cost of specific jobs or sport activities, the total cost of activity, etc. Annexes A to G contain: classification of metabolic rate for kinds of activities, classification of metabolic rate by occupation, data for standard person, metabolic rate for body posture, type of work and body motion related to work speed, metabolic rate for typical activities, example of calculation of the average metabolic rate for a work cycle, examples of calculation of the metabolic rate based on measured data.

EN ISO 11200: 1995 *Acoustics - Noise emitted by machinery and equipment - Guidelines for the use of basic standards for the determination of emission sound pressure levels at the work station and at other specified positions*

EN ISO 11201: 1995 *Acoustics - Noise emitted by machinery and equipment - Measurements of emission sound pressure levels at the work station and at other specified positions- engineering method in an essentially free field over a reflecting plane*

EN ISO 11202: 1995 *Acoustics -Noise emitted by machinery and equipment - Measurement of emission sound pressure levels at the work station and at other specified positions - survey method in situ.*

EN ISO 11203: 1995 *Acoustics - Noise emitted by machinery and equipment - Determination of emission sound pressure levels at the work station and at other specified positions from the sound power level.*

EN ISO 11204: 1995 *Acoustics - Noise emitted by machinery and equipment - Measurement of emission sound pressure levels at the work station and at other specified positions. Method requiring environmental corrections*

prEN 31957: 1995 *Acoustics - Determination of sound insulation performance of cabins - Laboratory and in situ measurements* (ISO/DIS 11957)

prEN 31690-1: 1995 *Acoustics - Noise control - Guidelines for the design of low-noise workplace - Part 1: noise control strategies (ISO/DIS 11690-1)*

prEN 31690-2: 1995 *Acoustics - Noise control - Guidelines for the design of low-noise workplaces - Part 2: noise control measures (ISO/DIS 11690-2)*

ENV 50166-1: 1995 (CENELEC) *Human exposure to electromagnetic fields - Part 1: low frequency 0-10 Hz*

ENV 50166-2: 1995 (CENELEC) *Human exposure to electromagnetic fields - Part 2: high frequency 10 khz-300 Ghz*

ISO 1999: 1991 *Acoustics - Determination of occupational noise exposure and estimation of noise-induced hearing impairment*

This international standard a practical relation for these quantities expressed as A-weighted noise level in dB and duration of exposure within a normal working week (40 hours) and the percentage of personnel that is to be expected to obtain a raised hearing threshold of 25 dB or more as a result of this exposure, averaged from 500, 1000 and 2000 Hz.

ISO 8995: 1989 *Principles of visual ergonomics - lighting of indoor work systems*

This international standard identifies the parameters that influence visual performance. It also presents the criteria that have to be satisfied in order to achieve an acceptable visual environment. It is applicable to working areas in industrial buildings, offices and hospitals, but not to those working areas of low luminance used for such activities as projection, viewing of transparencies, and handling of photosensitive materials.

ISO 9920: 1995 *Ergonomics of the thermal environment - estimation of the thermal insulation and evaporative resistance of a clothing ensemble*

ISO/DIS 9921-1: 1995 *Ergonomic assessment of speech communication - Part 1: speech interference level and communication distances for persons with normal hearing capacity in direct communication (SIL method)*

ISO/CD 9921-2: 1991 *Ergonomic assessment of speech communication - Part 2: assessment of speech communication by means of the Modified Articulation Index (MAI method)*

ISO/CD 9921-3: 1991 *Ergonomic assessment of speech communication - Part 3: speech communication with electro-acoustic systems*

ISO/TR 11079: 1993 *Evaluation of cold environments - Determination of requisite clothing insulation*

ISO/CD 13731: 1995 *Ergonomics of the thermal environment - Definitions, symbols and units*

Work items (WI)

WI 00114046 *Safety of machinery - Permanent means of access to machines and industrial plants - Part 1: choice of a fixed means of access between two levels*

WI 00114065 *Safety of machinery - Permanent means of access to machines and industrial plants - Part 2: working platforms and gangways*

WI 00114068 *Safety of machinery - Permanent means of access to machines and industrial plants - Part 3: stairways, stepladders and guard-rails*

WI 00114069 *Safety of machinery - Permanent means of access to machines and industrial plants - Part 4: fixed ladders*

WI 00122038 *Safety of machinery - Surface temperatures of touchable parts - Cold surfaces*

WI 00122045 *Safety of machinery - Anthropometric requirements for the design of workplaces at machinery*

This work item establishes principles for deriving dimensions from anthropometric measurements and applying them to the design of workplaces at non-mobile machinery. It is based on current knowledge and anthropometric measurements. It specifies the body's space requirements for equipment during normal operation in sitting and standing positions. It does not specifically include space demands for maintenance, repairing and cleaning work.

WI 00122049 *Safety of machinery - Ergonomic design principles - Part 2: Interactions between the design of machinery and work tasks*

This work item gives the ergonomic design principles to be followed before and during the process of the design of work equipment, especially machinery. It gives advice and requirements to be used for the design of work tasks for the operator based on the needs of the operator in the field of perception and processing of information, determination of strategies, decision making and communication.

WI 00122051 *Personal protective equipment - Ergonomics - Anthropometry*

WI 00122052 *Personal protective equipment - Ergonomics - Biomechanics*

WI 00122053 *Personal protective equipment - Ergonomics - Thermal characteristics*

WI 00122054 *Personal protective equipment - Ergonomics - Biological aspects*

WI 00122055 *Personal protective equipment - Ergonomics - Sensory aspects*

WI 00122056 *Ergonomic design principles for the operability of mobile machinery*

WI 00122057 *Basic principles of the ergonomic testing of anthropometric aspects of industrial products and designs*

This work item determines the procedures to be applied to the composition of groups of persons whose anthropometric characteristics are to be representative of all prospective users of any specific object under test. These procedures will be applicable to the anthropometric aspects of testing of industrial products and designs having direct or indirect contact with the human body and its functions, eg. machinery, work equipment, personal protective equipment (PPE), consumer goods, working spaces, architectural details, types of transport.

WI 00122061 *Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 4: location and arrangements of displays and control actuators*

This work item gives recommendations on the location and arrangements of combinations of displays, combinations of control actuators and combinations of both types. It is important to use these recommendations where operating a control actuator may lead to injury or damage to health, either directly or as a result of a human error.

WI 00169002 *Lighting applications - General terms and quality criteria - Definitions*

This work item defines basic terms for the use in all lighting applications; specialist terms with limited applications will be given in individual standards. It also sets out a framework for the specification of lighting requirements, giving details of aspects which should be considered when setting those requirements.

WI 00169003 *Lighting applications - Lighting of workplaces*

This work item specifies the lighting requirements for safety and good practice for work-places. Work-places include both indoor and outdoor task areas. All visual tasks are considered including VDU's.

WI 00169014 *Safety of machinery - Integral lighting of mobile machinery*

TUTB PUBLICATIONS

TUTB Newsletter

- **TUTB Newsletter.**
  3 issues a year: n° 1: October 1995, n° 2: February 1996, n° 3: June 1996 *(EN/FR)*

Books

- **Prevention at the Workplace. An initial review of how the 1989 Community Framework Directive is being implemented.** *(EN/FR/DE)*
  Laurent Vogel. 1994. 422 pages.

- **Worker representation on health and safety in Europe.** *(EN/FR/DE)*
  David Walters, Alan Dalton, David Gee. 1993. 95 pages.

- **Promoting Health and Safety in the European Community. Essential information for trade unions.** *(EN/FR/DE)*
  1991. 90 pages.

Brochures

- **A European trade union initiative to promote a high quality work environment.**
  TUTB presentation brochure. *(EN/FR/DE)*

- **Synopsis of Community Health and Safety Directives.** *(EN/FR/DE)*
  2nd edition. 1994. 118 pages.

- **Preventive services at the workplace in Denmark.** *(EN/FR/DE)*
  Per Tybjerg Aldrich. 1993. 70 pages.

Reports

- **Trade union training in health and safety. A survey of European practice in training for workers' representatives.** *(EN/FR)*
  1995. 154 pages.

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