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Ergonomics — The application of ISO/TR 12295, ISO 11226, the ISO 11228 series and ISO/TR 23476 in the construction sector (civil construction)

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National foreword

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 3, *Anthropometry and biomechanics*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Construction is one of the biggest working sectors in the world. The sector includes an immense diversity of skill sets and categories of workers. In addition, the size, structure and market of construction companies can also be extremely variable. The sector employs on average between 5 % to 10 % of the workforce in most countries, indicating that construction is a significant component of the global economy and is one of the largest employers in the world. Globally, musculoskeletal disorders are the major cause of work-related illnesses, accounting for more than 33 % of all occupational diseases, with the prevalence becoming 65 % for construction workers.[49] There are also indirect socio-economic implications due to job loss, absenteeism, health costs and even worker hospitalization.[29] There is no doubt that the prevention of work-related musculoskeletal disorders (WMSDs) can significantly contribute to reduce economic and social impact. Increasing attention is being drawn to the application of practical actions in construction settings to help reduce work-related accidents and illness and WMSDs in particular. ISO 11226, the ISO 11228 series and, more recently, ISO/TR 12295 and ISO/TR 23476 are useful for this specific scope.

Experiences in the application of these documents have been acquired in different parts of the world, but rarely in construction. This document extends the scope and methods included in existing standards to all the different construction, although the application experiences presented in this document are mainly based on the civil construction sector. Special attention is devoted to rendering this document accessible also to non-experts. Reference is made to easily applicable, non-commercial online tools (simple tools in spreadsheets) that can be useful for the purposes of this document, making possible the application of the criteria provided here and therefore the real numerical estimate of the biomechanical overload risks.

The ISO 11228 series, ISO 11226, ISO/TR 12295 and ISO/TR 23476 establish ergonomic recommendations for different manual handling tasks, repetitive movements and working postures. All their parts apply to occupational and non-occupational activities. The documents provide information for designers, employers, employees and others involved in work, job and product design, such as occupational health and safety professionals.

The ISO 11228 series consists of the following parts, under the general title *Ergonomics — Manual handling*:

— *Part 1: Lifting, lowering and carrying;*

— *Part 2: Pushing and pulling;*

— *Part 3: Handling of low loads at high frequency.*

ISO 11226 provides recommended limits for static working postures with no or minimal external force exertion, while taking into account body angles and duration.

ISO/TR 12295 serves as an application guide of the ISO 11228 series and ISO 11226. It offers a simple risk assessment methodology for small and medium enterprises and for non-professional active.

This document is intended to be used alongside ISO/TR 12295, ISO 11226, the ISO 11228 series and ISO/TR 23476, also in the construction sector, where the risk from biomechanical work overload from repetitive movements, from manual handling of loads, from towing and pushing carts and awkward postures is universally present.

The OCRA checklist method, in its multi-day cycle risk assessment version,[22] is currently the only risk assessment method available in literature capable of offering criteria and application experiences to address multitask analysis (supported by a specific simple tool in the form of free download spreadsheets for final risk calculation).

ISO/TR 12295 had already adopted this multitask method of exposure analysis.

After all, the development of a method capable of predicting the appearance of pathologies (real risk assessment method) can be optimized only after years of use and improvement. The development of

a new TR which, offering evaluation solutions for biomechanical overload study in construction, can stimulate many more valid epidemiological studies in the future, is therefore desirable. The concept of doing nothing, while waiting for sufficient and perfect published methods, means not doing prevention.

The National Institute for Occupational Safety and Health (NIOSH) itself, due to the formula for calculating the lifting index (LI), changed the maximum limit value of its first formula several times over the years, through years of application experience. Recently the NIOSH added the formula for calculating the variable lifting index (VLI) for the evaluation of manual lifting tasks of complex loads, with many different weights and geometries.[21],[67] The gained experience in this type of analysis was introduced in ISO/TR 12295 and ISO 11228-1.

For the study of working postures it is important to point out the new time-based assessment computerized strategy (TACOS)[25] for posture, which adds to all the experience gained from the RULA and REBA methods and from ISO 11226, a more adequate timing assessment (therefore not only qualitative studies of work postures, but also studies of their real duration).

The mathematical criterion for the extension of the calculation of any risk factors for the study of biomechanical overload, not only for the working day cycle but also for cycles different in duration (e.g. annual cultivation cycles), was also discussed within a specifically activated writing group of experts for the preparation of this document. The transition is indispensable for the extension of the evaluation models already present in the specific International Standards (all used in this document) to the risk evaluation in multitask exposition with annual turnover needed for risk studies in construction (see Annex B).

Any other risk assessment methods that include a multitask analysis procedure can adopt the criteria here proposed, extending multitask annual exposure risk study, for instance to:

— repetitive movements (e.g. strain index, method present in ISO 11228-3);

— manual handling of loads (NIOSH formula in ISO 11228-1);

— application of ISO 11226, the ISO 11228 series and ISO/TR 12295 in the agricultural sector (ISO/TR 23476).

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1 Scope

This document is intended to be used alongside ISO/TR 12295, ISO 11226, the ISO 11228 series and ISO/TR 23476 in the construction sector.

This document (although the examples shown refer only to the civil construction sector) gives information on how existing standards can be used in a global sector, such as construction. Where biomechanical overload is a relevant aspect, albeit with different characteristics, work-related musculoskeletal disorders (WMSDs) are common and specific preventive actions are needed.

This document is intended to:

1) define the user(s) and fields for its application (including non-experts in ergonomics);

2) provide examples of procedures for hazard identification, risk estimation or evaluation and risk reduction in different agricultural settings, through:

   — more synthetic procedural schemes (main test);

   — more analytical explanations of the procedures, through mathematical models and application examples, and with the use of specific free simple tools in Annexes A, B and C.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 General outline of work processes in an annual multi-task analysis in civil construction

4.1 General structure of a multi-task analysis

Specifically, this document provides additional information to aid the user in the selection and use of the appropriate standards. Depending upon whether specific risks are present, it is intended to help the user to decide which standards to apply. It will include three levels of approach (Figure 1):

— First level: the participatory approach for pre-mapping of danger and discomfort provides all users, particularly those who are not experts in ergonomics, with criteria and procedures to identify situations in which they can apply the ISO 11228 series, ISO 11226 and ISO/TR 12295 as well as in agricultural settings (ISO/TR 23476): key-enter and key-questions level. Only in the early analytical