BRITISH STANDARD

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Ergonomics — Manual handling —

Part 3: Handling of low loads at high frequency

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National foreword

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A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Part 3: Handling of low loads at high frequency

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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.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 11228-3 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 3, *Anthropometry and biomechanics*.

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

— *Part 1: Lifting and carrying*

— *Part 2: Pushing and pulling*

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

This corrected version of ISO 11228-3:2007 incorporates the following corrections:

— the error message substituted for Equation (C.9) has been replaced by the missing equation;

— the hyperlink previously referenced as [65] in the Bibliography, no longer active, has been deleted, together with its mention in the main body of the document, and the numbers of the other bibliographical references following it have been adjusted accordingly.

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Introduction

Handling of low loads at high frequency (repetitive work) can cause pain and fatigue, which could lead to musculoskeletal disorders, reduced productivity, and deteriorated posture and movement co-ordination. The latter can increase the risk of errors and may result in reduced quality and hazardous situations. Good ergonomic design and proper organization of work are basic requirements for the avoidance of the adverse effects mentioned.

Risk factors in repetitive work include the frequency of actions, exposure duration, postures and movement of body segments, forces associated with the work, work organization, job control, demands on work output (e.g. quality, task precision) and level of training/skill. Additional factors can include environmental factors, such as climate, noise, vibration and illumination.

The recommendations provided by this part of ISO 11228 are based on available scientific evidence concerning the physiology and epidemiology of manual work. The knowledge is, however, limited, and the suggested guidelines are subject to change according to future research.

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Ergonomics — Manual handling —

Part 3:
Handling of low loads at high frequency

1 Scope

This part of ISO 11228 establishes ergonomic recommendations for repetitive work tasks involving the manual handling of low loads at high frequency. It provides guidance on the identification and assessment of risk factors commonly associated with handling low loads at high frequency, thereby allowing evaluation of the related health risks to the working population. The recommendations apply to the adult working population and are intended to give reasonable protection for nearly all healthy adults. Those recommendations concerning health risks and control measures are mainly based on experimental studies regarding musculoskeletal loading, discomfort/pain and endurance/fatigue related to methods of working. For the evaluation of working postures, refer to ISO 11226.

This part of ISO 11228 is intended to provide information for all those involved in the design or redesign of work, jobs and products.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6385, *Ergonomic principles in the design of work systems*

ISO 11226, *Ergonomics — Evaluation of static working postures*

ISO 11228-1, *Ergonomics — Manual handling — Part 1: Lifting and carrying*

ISO 11228-2, *Ergonomics — Manual handling — Part 2: Pushing and pulling*

ISO 14738, *Safety of machinery — Anthropometric requirements for the design of workstations at machinery*

ISO 15534 (all parts), *Ergonomic design for the safety of machinery*

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3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms and definitions given in ISO 6385, ISO 11228-1, ISO 11228-2, ISO 11226 and the following terms, definitions, symbols and abbreviated terms apply.

NOTE In the definitions involving frequency, a unit of time is mentioned because more than one method is involved, each using a different unit, e.g. seconds in HAL (see Annex D), minutes in the OCRA Index (see Annex C) and Strain Index (see Annex D).

3.1 Terms and definitions

3.1.1
repetitive task
task characterized by repeated work cycles

3.1.2
work cycle
sequence of (technical) actions that are repeated always the same way

3.1.3
cycle time
t_C
time, in seconds, elapsing from the moment when one operator begins a work cycle to the moment that the same work cycle is repeated

3.1.4
technical action
elementary manual actions required to complete the operations within the cycle

EXAMPLE Holding, turning, pushing or cutting.

3.1.5
repetitiveness
characteristic of a task when a person is continuously repeating the same work cycle, technical actions and movements

3.1.6
frequency of actions
number of technical actions per unit of time

3.1.7
force
F
physical effort of the operator required to execute the task

3.1.8
postures and movements
positions and movements of body segment(s) or joint(s) required to execute the task

3.1.9
recovery time
period of rest following a period of activity which allows restoration of musculoskeletal function (in minutes)

3.1.10
additional risk factor
object and environmental factors for which there is evidence of causal or aggravating relationship with work-related musculoskeletal disorders of the upper limb

EXAMPLE Vibration, local pressure, cold environment or cold surfaces.

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3.1.11
move
transport of an object to a given destination using the upper limbs and without walking

3.1.12
reach
shift the hand towards a prefixed destination

3.1.13
carry
transport of an object to a given destination by walking

3.2 Symbols and abbreviated terms

A_M	additional multiplier
ATA	actual technical action
f	frequency of actions per minute
F	force (N)
F_B	basic force limit
F_L	force limit
F_M	force multiplier
j	generic repetitive tasks
k_f	constant of frequency of technical actions per minute
L	actual load
MODA PTS	modular analysis predetermined time system
MSD	musculoskeletal disorders
MTA	motion time analysis
MTM	methods/time measurement
MVC	maximum voluntary contraction
n_{ATA}	overall number of actual technical actions within a shift
n_{ep}	number of exposed individuals
n_{pa}	number of persons affected by one or more UL-WMSD
n_{RPA}	partial reference number of technical actions within a shift
n_{rt}	number of repetitive task(s) performed during a shift
n_{RTA}	overall number of reference technical actions within a shift

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n_{TC}	number of technical actions in a cycle
OCRA	occupational repetitive action
PA	prevalence (%) of persons affected
P_M	posture multiplier
PTS	predetermined time system
RTA	reference technical action
R_{eM}	repetitiveness multiplier
R_{cM}	recovery multiplier
SE	standard error
t	net duration of each repetitive task, in minutes
t_C	cycle time, in seconds
TA	technical action
t_M	duration multiplier
UL-WMSD	upper limb work-related musculoskeletal disorders
WF	work factor

4 Recommendations

4.1 Avoiding repetitive handling tasks

Hazardous manual handling tasks should be avoided wherever possible. This can be achieved through work enlargements, job rotation and/or mechanization/automation within the framework of a participative ergonomics approach. In the case of repetitive handling of low loads at high frequency, many tasks can be modified through the use of robotics or automated production systems.

NOTE A “participative ergonomics approach” signifies the practical involvement of workers, supported by suitable communication, in planning and managing a significant amount of their work activities, with sufficient knowledge and ability to influence both processes and outcomes in order to achieve desirable goals.

4.2 Risk assessment

4.2.1 General

When repetitive handling is unavoidable, a four-step approach in accordance with ISO Guide 51 and ISO 14121, and involving both risk assessment and risk reduction, should be adopted. The four steps are hazard identification, risk estimation, risk evaluation and risk reduction.

The procedure shown in Figure 1 should be adopted when carrying out a risk assessment of jobs involving the manual handling of low loads at high frequency.

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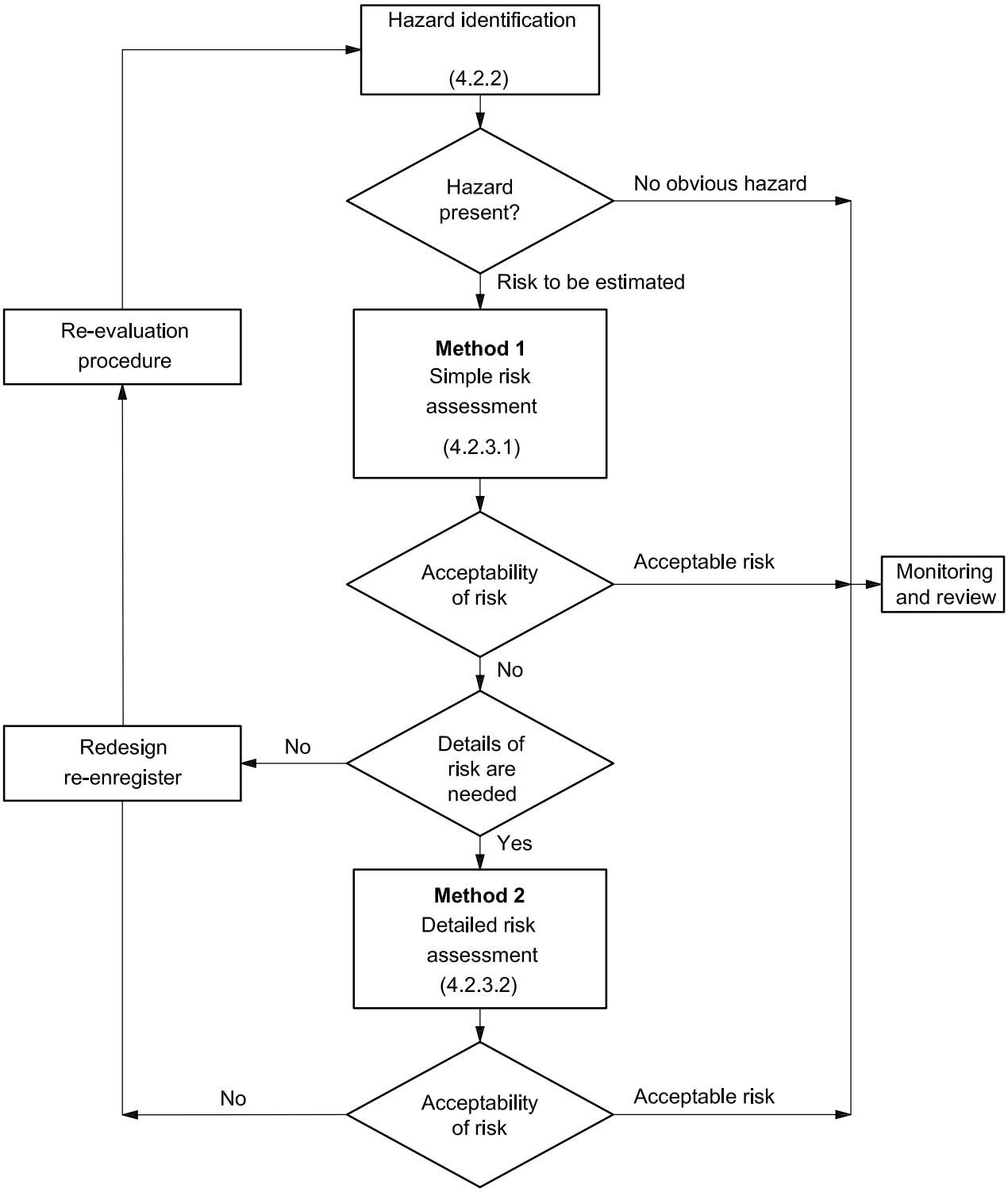

Figure 1 — Risk assessment procedure

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4.2.2 Hazard identification

4.2.2.1 General

The first step of the risk assessment is to identify whether hazards exist which may expose individuals to a risk of injury. If such hazards are present, then a more detailed risk assessment can be necessary. When determining if one or more of the following hazards is present, consideration should be given to the guidelines for avoiding them.

4.2.2.2 Repetition

Frequent repetitive movements give rise to a risk of injury that can vary depending on the context of the movement pattern and the individual. As the movement cycle increases and/or the cycle time decreases, the risk of injury increases. Repetitive movements should be avoided within a task or job.

4.2.2.3 Posture and movement

Sitting restricts overall movement of the body, particularly those of the lower leg and back. This may lead to increased and complex loading of the back and upper extremities. Standing for prolonged periods of time often results in pain/discomfort in the legs and lower back and can lead to venous pooling in the legs. Complex postures involving combined movements (e.g. flexed and twisted) can present greater risk (see ISO 11226). Whenever possible, workers should be given the option to vary between sitting and standing.

Work tasks and operations should provide variations to the working posture: both whole-body postures and movement of specific limbs. In the work tasks, extreme ranges of joint movement should be avoided; there is also need to avoid prolonged static postures.

4.2.2.4 Force

Forceful exertions can be harmful. Tasks should involve smooth force exertions, with the avoidance of sudden or jerky movements. Handling precision (accurate picking and placement), and the type and nature of the grip can introduce additional muscular activation.

4.2.2.5 Duration and insufficient recovery

Insufficient time for the body to recover between repetitive movements (i.e. lack of recovery time) increases the risk of injury. Duration can be broken down into different levels, i.e. work shift duration, job duration, task duration. The opportunity for recovery or rest may fall within each of these work periods.

4.2.2.6 Object characteristics

Inappropriately designed objects could have characteristics that can cause harm (e.g. contact forces, shape, dimensions, coupling, object temperature). Inappropriately placed handholds may lead to awkward hand/arm postures. Non-cushioned handholds and objects constructed of a smooth material increase the difficulty of grasping the object and increase force requirements. The size and shape of the object being handled and the coupling between it and the operator’s hands will determine the grip type and the force that the operator must exert.

4.2.2.7 Vibration and impact forces

Exposure to hand/arm vibration, shocks or impacts can lead to a desensitizing of the hand and increase the force necessary for gripping an object or tool. Prolonged exposure to these types of risk factors has also been linked to vascular and neurological disorders of the upper limbs.

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4.2.2.8 Environmental conditions (lighting, climate, noise, etc.)

Inappropriate lighting, hot and cold environments and high levels of noise can impose additional hazards. Wet or contaminated surfaces are likely to inhibit the ability to exert forces and increase the risk of injury. The designer of products shall consider environmental conditions only within the limits of the foreseeable use of the product.

4.2.2.9 Work organization

Work organization (e.g. task duration, job duration, recovery time, shift patterns) has an important part to play in the exposure to musculoskeletal risk factors. This should be structured to facilitate rest periods and avoid the use of similar muscle groups over the duration of the work shift. Job rotation, job diversification and job enlargement are all methods of structuring the work to facilitate variation and recovery within the work period.

4.2.2.10 Psychosocial factors (e.g. job complexity, job demands, job content)

Psychological response to work and workplace conditions has an important influence on general health and, in particular, musculoskeletal health. These factors include the design, organization and management of work, the specific impact of workplace risk factors, such as work content, and the overall social environment (i.e. the context of work). Many of the effects of these psychosocial factors occur via stress-related processes, which can have a direct effect on biochemical and physiological responses.

4.2.2.11 Individuals

Individual skills, training, age, gender, health problems and pregnancy are personal characteristics that can influence performance and should be considered in the risk assessment. Skill and experience are likely to benefit the individual when performing the task and reduce the risk of injury. Training can increase the level of skill.

Important aspects of work design include the amount of control an individual has over his/her work, the level of work demands, the variety of tasks he/she is required to perform and the level of support provided by managers, supervisors and/or co-workers. Undesirable psychosocial aspects of a job contributing to a risk of musculoskeletal disorders include the following:

— workers have little or no control over their work and work methods or organization;

— tasks require high levels of attention and concentration;

— workers are unable to make full use of their skills;

— workers have little or no involvement in decision making;

— workers are expected to carry out repetitive, monotonous tasks exclusively;

— work is machine- or system-paced;

— work demands are perceived as excessive;

— payment systems encourage working too quickly or without breaks;

— work systems limit opportunities for social interaction;

— high levels of effort are not balanced by sufficient reward (resources, remuneration, self-esteem, status, etc.).

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4.2.3 Risk estimation

4.2.3.1 Method 1 — Simple risk assessment

Risk estimation is performed by a simple risk assessment of jobs composed by a single repetitive task (monotask jobs).

The procedure and checklist model presented in Annex B is preferred for the carrying out of the simple risk assessment. There are four parts to this assessment procedure:

— preliminary information describing the job task;

— hazard identification and risk estimation procedure and checklist;

— overall evaluation of the risk;

— remedial action to be taken.

NOTE As a second choice, other simple methods and checklists given in Annex A can be used, taking into consideration the specific characteristics of the repetitive task under examination.

Risk estimation using Method 1 should allow the classification of the risk by the three-zone approach (green, yellow and red) and determine the consequent action to be taken. The three risk zones are defined as follows.

a) Green zone (acceptable risk)

The risk of disease or injury is negligible or is at an acceptably low level for the entire working population. No action is required.

b) Yellow zone (conditionally acceptable risk)

There is a risk of disease or injury that cannot be neglected for the entire working population or part of it. The risk shall be further estimated (using the more detailed assessment of Method 2), analysed together with contributory risk factors and followed as soon as possible by redesign. Where redesign is not possible, other measures to control the risk shall be taken.

c) Red zone (not acceptable)

There is a considerable risk of disease or injury that cannot be neglected for the operator population. Immediate action to reduce the risk (e.g. redesign, work organization, worker instruction and training) is necessary (see 4.3 and Annex E).

4.2.3.2 Method 2 — Detailed risk assessment

4.2.3.2.1 General criteria

If the risk estimated using Method 1 is considered to be YELLOW or RED, or if the job is composed of two or more repetitive tasks (multitask job), the performing of a more detailed risk assessment is recommended. This will also allow a better determination of the remedial measures to be taken.

For detailed risk assessment, OCRA (occupational repetitive action) is the preferred method (see 4.2.3.2.2). It is recommended for the specific purposes of this part of ISO 11228 because, given the knowledge at the time of publication, it considers all the relevant risk factors, is also applicable to “multitask jobs”, and provides criteria — based on extensive epidemiological data — for forecasting the occurrence of UL-WMSD (upper limb work-related musculoskeletal disorders) in exposed working populations.

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Other detailed risk assessment methods are available which can be used for a detailed risk assessment, depending on the kind of risk factors identified by Method 1, the nature of the job and the experience of the analyst.

Annex D gives basic information about other detailed risk assessment methods useful for the purposes of this part of ISO 11228, together with some remarks about their applicative limits at the time of publication.

Whichever method is used for detailed risk assessment, it should allow the classification of the risk by the three-zone model and determine the consequences to be acted upon in accordance with Table 1.

Table 1 — Method 2 — Final assessment criteria

Zone	Risk level	Consequences
Green	No risk	Acceptable: no consequences
Yellow	Very low risk	Improve structural risk factors (posture, force, technical actions, etc.) or take other organizational measures
Red	Risk	Redesign tasks and workplaces according to priorities

4.2.3.2.2 OCRA method for detailed risk assessment

The OCRA index is the ratio between the number of actual technical actions, ATA, carried out during a work shift and the number of reference technical actions, RTA, for each upper limb, specifically determined in the scenario under examination [11], [38].

The OCRA risk assessment procedure consists of three basic steps:

a) Step 1

Calculate the frequency of technical actions/min and the overall number of ATA carried out in the shift (by each upper limb).

b) Step 2

Calculate the overall number of RTA.

c) Step 3

Calculate the OCRA index and perform a risk evaluation.

Table 2 (ATA and RTA calculation in monotask jobs), Table 3 (ATA and RTA calculation in multitask jobs) and Table 4 (OCRA index calculation and risk evaluation) give an overview of the procedure detailed in Annex C.

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Table 2 — OCRA assessment procedure for monotask jobs — Steps 1 and 2

Step1	**Calculate the overall number of actual technical actions, n_{ATA}, carried out in a shift by each upper limb.**	
	a)	Count the number of technical actions, n_{TC}, in a cycle.
	b)	Evaluate their frequency, f, per minute, considering the cycle time, t_C, in seconds: $f = n_{TC} \times \frac{60}{t_C}$
	c)	Evaluate the net duration, t, of the repetitive task in the shift, in minutes.
	d)	Calculate the overall number of ATA carried out in the shift: $n_{ATA} = f \times t$
Step 2	**Calculate the overall number of RTA within the shift:** $n_{RTA} = k_f \times F_M \times P_M \times R_{eM} \times A_M \times t \times R_{cM} \times t_M$	
	30	Constant of frequency, k_f, of technical actions = 30/min
	×	
	F_M	Force multiplier
	×	
	P_M	Posture multiplier
	×	
	R_{eM}	Repetitiveness multiplier
	×	
	A_M	Additional multiplier
	×	
	t	Duration of the repetitive task, in minutes
	=	
	n_{RPA}	Partial reference number of technical actions in the shift
	×	
	t_M	Duration multiplier
	×	
	R_{cM}	Recovery multiplier
	=	
	n_{RTA}	Overall number of RTA
NOTE	See 3.2. for the complete list of symbols and abbreviated terms used in this part of ISO 11228.	

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Table 3 — OCRA assessment procedure for multitask jobs — Steps 1 and 2

Step1	**Calculate the overall number of actual technical actions, n_{ATA}, carried out in a shift by each upper limb, considering each repetitive task, j, in the shift.**				
	a)	Count the number of technical actions in a cycle for each repetitive task (n_{TCj}):			
		Task A	**Task B**	**Task C**	**Task n**
		n_{TC}	n_{TC}	n_{TC}	n_{TC}
	b)	Evaluate the frequency of action per minute for each repetitive task, f_j, considering the cycle time for each repetitive task, t_{Cj}, in seconds:			
		Task A	**Task B**	**Task C**	**Task n**
		f	f	f	f
	c)	Evaluate the net duration (t_j) of each repetitive task in the shift, in minutes.			
		Task A	**Task B**	**Task C**	**Task n**
		t	t	t	t
	d)	Calculate the overall number of ATA carried out in each repetitive task and, by summing them, the overall number of ATA in the shift: $n_{ATA} = \sum\left(f_j \times t_j\right)$			
		Task A	**Task B**	**Task C**	**Task n**
	n_{ATA} =	$t \times f$	$t \times f$	$t \times f$	$t \times f$
Step 2	**Calculate the overall number of RTA within the shift:** $n_{RTA} = \sum_{j=1}^{n}\left[k_f\left(F_{Mj} \times P_{Mj} \times R_{eMj} \times A_{Mj}\right) \times t_j\right] \times \left(R_{cM} \times t_M\right)$				
	30	**Task A**	**Task B**	**Task C**	**Task n**
		30	30	30	30
	×	×	×	×	×
	F_{Mj}	F_M	F_M	F_M	F_M
	×	×	×	×	×
	P_{Mj}	P_M	P_M	P_M	P_M
	×	×	×	×	×
	R_{eMj}	R_{eM}	R_{eM}	R_{eM}	R_{eM}
	×	×	×	×	×
	A_{Mj}	A_M	A_M	A_M	A_M
	×	×	×	×	×
	t	t	t	t	t
	=	=	=	=	=

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Table 3 (*continued*)

n_{RPAj}	RPA Task A	RPA Task B	RPA Task C	RPA Task n
$n_{RPA,tot}$		Total of partial reference numbers of technical actions in shift $n_{RPA,tot}$		
×		×		
t_M		Duration multiplier t_M		
×		×		
R_{cM}		Recovery multiplier R_{cM}		
=		=		
n_{RTA}		n_{RTA}		

NOTE See 3.2. for the complete list of symbols and abbreviated terms used in this part of ISO 11228.

Table 4 — OCRA index calculation and risk evaluation — Step 3

Step3	Calculate the OCRA index and carry out the risk evaluation:			
	OCRA Index = $\frac{n_{ATA}}{n_{RTA}}$	Number of actual technical actions in the shift / Number of reference technical actions in the shift		
	Risk evaluation	**Zone**	**OCRA Index value**	**Risk level**
		Green	⩽ 2,2	No risk
		Yellow	2,3–3,5	Very low risk
		Red	> 3,5	Risk

4.3 Risk reduction

A proper risk assessment is the basis for appropriate choices in risk reduction. Risk reduction can be achieved by combining, in different ways, improvements in different risk factors and should consider, among other things

— the avoidance and limitation of repetitive handling, especially for long daily durations without proper recovery periods or at high frequencies,

— proper design of the task, workplaces and work organization, also using existing International Standards and introducing adequate task variation,

— proper design of the objects, tools and materials handled,

— proper design of the work environment,

— individual workers' capacities and level of skill for the specific task.

See Annex E for more detailed information about risk reduction options.

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Annex A
(informative)

Risk assessment — General framework and information on available methods

A.1 General framework

The Consensus Document listed under Reference [10], which was prepared and published by the IEA[1)] Technical Committee, *Musculoskeletal Disorders*, with the endorsement of ICOH, defines in a general model the main risk factors to be considered and presents observational procedures that can be used in their description, classification and evaluation.

In its conclusions, the document underlines the need for an integrated evaluation by means of concise exposure indices.

The general model of description and assessment of tasks, concerning all exposed workers in a given situation, is aimed at analysing four main risk factors: repetitiveness, force, awkward postures and movements, and lack of proper recovery periods. Such factors should be assessed as functions of time (mainly considering their respective durations). In addition to these factors, others, grouped under the term “additional risk factors”, should be considered; these are mechanical factors (e.g. vibrations, localized mechanical compressions), environmental factors (e.g. exposure to cold) and organizational factors (e.g. pace determined by machinery), and for most of them there is evidence of association with UL-WMSD.

Each identified risk factor should be properly described and classified. This allows, on the one hand, identification of possible requirements and preliminary preventive interventions for each factor and, on the other hand, eventually, the consideration of all the factors contributing to the overall “exposure” within a general and mutually integrated framework. From this viewpoint “numerical” or “categorical” classifications of results may be useful to make management of results easier, even if it is important to avoid the feeling of an excessive objectiveness of methods whose classification criteria can still be empirical.

In adopting Reference [10], it should be emphasized that the OCRA method (and the OCRA index) [11], [38] represents an endeavour to organize the data obtained from the descriptive analysis of the various mechanical risk factors, as they are collected following indications contained in the Consensus Document itself.

The main advantages of the OCRA method are the following:

— it provides a detailed analysis of all the main mechanical and organizational risk factors for UL-WMSD;

— it uses a common language with respect to traditional methods of task analysis (predetermined time systems): this makes company technicians (production engineers, analysts) more familiar with the method and helps them to improve work procedures;

— it considers all the repetitive tasks involved in a complex (or rotating) job and estimates the overall worker’s risk level;

— in many epidemiological surveys it has shown itself to be well related with health effects (such as the occurrence of UL-WMSD); therefore, it is a good predictor (within definite limits) of the risk at a given OCRA level.

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As for the OCRA method's disadvantages, it should be underlined that it can be time consuming, especially for complex tasks and multitask jobs, and does not consider all psychosocial factors related to the individual sphere.

These considerations were the basis for the choice of the OCRA method in Annex C as the reference method for detailed risk assessment.

However, other methods are proposed in the literature for a detailed risk assessment; in the following paragraphs the main of those methods will be briefly presented, also taking into account their potential limits in respect to the general model here considered.

A.2 Review of other methods of risk assessment

Several other methods/procedures for the risk assessment of repetitive movements and efforts of the upper limbs which also provide synthetic exposure scores are already available in the literature.

A non-exhaustive list is given in Table A.1 (adapted from Reference [32]).

Most of them are simple (and often empiric) screening tools, not tailored for a detailed risk assessment: they could be used at an entry level (step 1) as an alternative to the recommended Method 1 presented in 4.2.3.1 and Annex B).

Other methods, such as OWAS and, in part, RULA, are primarily devoted to the study of working postures and give less consideration to the other main risk factors involved in repetitive handling at high frequency.

A special mention should be given to the tool OREGE [21], a movement identification and evaluation aid whose purpose is to quantify biomechanical stresses represented by forces, constraining postures and movement repetitiveness. Developed by France's *Institut National de Recherche et de Sécurité* (INRS), it has not been included in Table A.1 because, as proposed by INRS, it cannot stand alone and can be used only in the context of a more general and specified approach to UL-WMSD prevention. The application of the tool requires a specific ergonomic ability because it is mainly based on observation of the operator, his/her perception of constraints and on dialogue between the expert and the operator, and final assessment is based largely on expert knowledge and experience. OREGE uses other tools (i.e. visuoanalogic scales for the estimation of frequency and force, RULA for the estimation of postures) in a combined way. Notwithstanding this "mixed" approach, which makes it unsuitable for the specific scope of application of this part of ISO 11228, OREGE represents an interesting and participatory method for the prevention of UL-WMSD at the field level, justifying its mention in this short review.

Of the methods included in Table A.1, only a few allow for a detailed risk assessment in some way corresponding to the general model [10]. In addition to the OCRA index, these are, substantially, the Strain Index and the HAL/ACGIH TLV (for monotask handwork), which methods are also briefly presented in Annex D along with data presented in Reference [9].

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Table A.1 — Non-exhaustive list of main methods for risk assessment of repetitive movements/exertions at high frequency

Method		Main characteristics	Kind of output	Body part assessment
OWAS	Ref. [26]	Analysis of postures of different body segments; it also considers their frequency during a work shift.	Quantitative	Whole body
RULA	Ref. [34]	Rapid coded analysis of static and dynamic postures; it also considers force and action frequency: the result is an exposure score that drives to the kind of preventive measures to be taken.	Quantitative	Upper limbs
REBA	Ref. [18]	Similar to RULA (checklist), it considers all body segments while also taking into account manual handling of loads.	Quantitative	Whole body
PLIBEL [a]	Ref. [27]	Checklist for the identification of different risk factors for different body segments; it considers awkward postures, movements, equipment and other organizational aspects.	Quantitative	Whole body
Strain Index	Ref. [35]	Detailed method (monotask) that considers the following risk factors: intensity of exertion, duration of exertion per cycle, efforts per minute, hand/wrist posture, speed of work, and duration of task per day.	Quantitative	Distal upper limbs
QEC [a]	Ref. [31]	Quick method for estimating the exposure level; it considers different postures, force, load handled, duration of task with hypothesized scores for their interaction.	Quantitative	Whole body
OSHA checklist [a]	Ref. [45]	Checklist proposed during the development of the OSHA standard (withdrawn); it considers repetitiveness, awkward postures, force, some additional factors and some organizational aspects.	Quantitative	Upper limbs
HAL/TLV ACGIH	Ref. [1]	Detailed method (for monotask handwork lasting almost 4 h per shift) mainly based on the analysis of frequency of actions (in relation to duty cycle) and of peak force; other main factors are generically considered.	Quantitative	Upper limbs
Upper limb expert tool [a]	Ref. [28]	Screening method evaluating the “work load”, it considers repetition, force, awkward postures, task duration and some additional factors.	Semi-quantitative	Upper limbs
OCRA index	Ref. [11], [38]	Detailed method that considers the following risk factors: frequency of technical actions, repetitiveness, awkward postures, force, additional factors, lack of recovery periods, duration of repetitive task.	Quantitative	Upper limbs
OCRA checklist [a]	Ref. [11], [41]	Semi-detailed method that considers, in a simplified way, the same risk factors as the OCRA index. Exposure level is classified in the three-zone system. Applicable also to multitask repetitive jobs.	Quantitative	Upper limbs

[a] Method/tool useful for the purposes of Method 1.

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Annex B
(informative)

Method 1 — Simple risk assessment checklist

B.1 General

This annex provides checklists and the evaluation model for the simple risk assessment of Method 1 (see 4.2.3.1). The structure and content of the checklist is as follows.

— **Preliminary information describing the job task**

B.2.1 consists of general information (job description, tasks to be evaluated, etc.). Initial consideration should also be given to the prevalence of work-related health complaints and/or work changes (planned or improvised) made to the work equipment or tools.

— **Hazard identification, risk estimation procedure and checklist**

B.2.2 presents a procedure that adopts a five-step approach, taking account of the four primary physical risk factors (repetition, high force, awkward posture and movements, insufficient recovery), as well as any other additional risk factors which may be present. When hazards are identified, steps should be taken to reduce or eliminate these hazards from the task/job (see Annex E).

The characteristics of the work cycle are the primary risk factors for a job. Step 1 of the assessment is therefore the base of the risk estimation. The other risk factors that are relevant for the risk assessment are awkward or uncomfortable postures (step 2), use of force by upper limbs (step 3), lack of recovery periods (step 4) and additional risk factors (step 5).

— **Overall evaluation of the risk**

B.2.3 describes the method for the overall risk assessment and the actions to be taken in consequence. If one of the risk factors is found to be in the red zone, then the overall risk is RED; if none of the risk levels are RED, but one or more is in the yellow zone then the overall risk is YELLOW; if all risk levels are in the green zone then the overall risk level is GREEN. For additional factors, the level of risk decreases as one moves towards the green zone. In making an overall assessment, additional factors should always be taken into consideration. See 4.2.3.1 for an explanation of the risk zones and consequential action.

— **Remedial action to be taken**

See B.2.4 for the remedial action that should be formulated and carried out.

B.2 Checklist

B.2.1 Preliminary information

Complete Table B.1.

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Table B.1

Job description: Operations covered by this assessment (detailed description): Locations: Personnel involved: Date of assessment:	Diagrams (other information):

B.2.2 Hazard identification and risk evaluation

This part of the checklist is used for a specific risk evaluation if the work is repetitive. The risk should always be further analysed if the work involves nearly identical movements that are frequently repeated for a significant period of the normal workday. If the duration of the repetitive work is for less than 1 h/day or 5 h/week, the risk caused by repetition is considered negligible. In that case, no further risk evaluation of the repetitiveness is needed.

Complete Table B.2.

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Table B.2

Questions to consider (possible risk factors)	Risk evaluation (zone)		
	GREEN, if...	**YELLOW**, if...	**RED**, if...
Step 1 — Repetitive movements/duration — Does the job involve... **Yes** **No** ☐ ☐ A work cycle or a sequence of movements that is repeated more than twice per minute and for more than 50 % of the task duration? ☐ ☐ Repeating nearly identical movements of the fingers, hands or arms every few seconds? ☐ ☐ Intense use of the finger(s), hand(s) or wrist(s)? ☐ ☐ Repetitive shoulder/arm movement (regular movements with some pauses or almost continuous arm movement)? If the reply to all questions is “No”, the evaluation is GREEN and no further evaluation is needed. If the answer to one or more questions is “Yes”, the work is categorized as repetitive. Use the right-hand columns to evaluate acceptable duration if no other significant risk factors are present and proceed to a further evaluation of the combined risk factors by steps 2, 3 and 4.	Repetitive movements, but no other risk factors, for no more than 3 h total on a "normal" workday AND No more than 1 h without a break If this statement is true, then the total evaluation is GREEN and no further evaluation is needed. ☐	The conditions described in the red and green zone are not true. ☐	Repetitive movements without any other risk factors for more than 4 h total on a “normal” workday ☐

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