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Ergonomics — Manual handling —

Part 1: Lifting and carrying

Ergonomie — Manutention manuelle —

Partie 1: Manutention verticale et manutention horizontale

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 11228-1 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*

Introduction

The three parts of ISO 11228 establish ergonomic recommendations for different manual handling tasks. All the parts apply to such vocational and non-occupational activities. The standards will provide information for designers, employers, employees and others involved in work, job and product design. It is connected with ISO 11226.

This part of ISO 11228 is the first International Standard on manual handling.

Disorders of the musculoskeletal system are common worldwide and one of the most frequent disorders in occupational health.

Factors such as the size and mass of the object being handled, working posture, and the frequency and duration of manual handling can alone, or in combination, lead to a hazardous handling activity and correspond to the risk of musculoskeletal disorders.

It is desirable to specify the recommended limits for the mass of objects in combination with working postures, and frequency and duration of manual handling which persons may be reasonably expected to exert when carrying out activities associated with manual handling.

An ergonomic approach has a significant impact on reducing the risks of lifting and carrying. Of particular relevance is a good design of the work, especially the tasks and the workplace, which may include the use of appropriate aids.

This part of ISO 11228 provides a step-by-step approach to estimating the health risks of manual lifting and carrying; at each step, recommended limits are proposed. In addition, practical guidance for ergonomic organization of manual handling is given in Annexes, A, B and C.

The risk-assessment model presented allows the estimation of the risk associated with a manual material-handling task. It takes into consideration the hazards (unfavourable conditions) related to the manual lifting and the time spent with manual-handling activities. Unfavourable conditions could be high masses to be manipulated or awkward postures required during the lifting process such as twisted or bent trunks or far reaches. This part of ISO 11228 provides information on both repetitive and non-repetitive lifting.

The recommended limits provided are based on the integration of data derived from four major research approaches, namely the epidemiological, the biomechanical, the physiological and the psychophysical approach.

Ergonomics — Manual handling —

Part 1:
Lifting and carrying

1 Scope

This part of ISO 11228 specifies recommended limits for manual lifting and carrying while taking into account, respectively, the intensity, the frequency and the duration of the task. This part of ISO 11228 is designed to provide guidance on the assessment of several task variables, allowing the health risks for the working population to be evaluated.

This part of ISO 11228 applies to manual handling of objects with a mass of 3 kg or more.

This part of ISO 11228 applies to moderate walking speed, i.e. 0,5 m/s to 1,0 m/s on a horizontal level surface.

This part of ISO 11228 does not include holding of objects (without walking), pushing or pulling of objects, lifting with one hand, manual handling while seated, and lifting by two or more people. Holding, pushing and pulling of objects will be included in other parts of ISO 11228.

This part of ISO 11228 is based on an 8 h working day. It does not concern analysis of combined tasks in a shift during a day.

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/IEC Guide 51, *Safety aspects — Guidelines for their inclusion in standards*

ISO 7250:1996, *Basic human body measurements for technological design*

ISO 14121, *Safety of machinery — Principles of risk assessment*

EN 1005-2, *Safety of machinery — Human physical performance — Part 2: Manual handling of machinery and component parts of machinery*[1)]

1) To be published.

3 Terms and definitions

For the purposes of this document, the following definitions apply.

3.1
manual handling
any activity requiring the use of human force to lift, lower, carry or otherwise move or restrain an object

NOTE This also includes handling people or animals.

3.2
manual lifting
moving an object from its initial position upwards without mechanical assistance

NOTE This also includes handling people or animals.

3.3
manual lowering
moving an object from its initial position downwards without mechanical assistance

3.4
manual carrying
carrying when an object remains lifted and is moved horizontally by human force

NOTE This also includes handling people or animals.

3.5
ideal posture for manual handling
standing symmetrically and upright, keeping the horizontal distance between the centre of mass of the object being handled and the centre of mass of the worker less than 0,25 m, and the height of the grip less than 0,25 m above knuckle height

NOTE 1 The location of the centre of mass of the object is approximated by the vertical projection of the midpoint of the line between the hands at the grasping location. The location of the centre of the mass of the worker is approximated by the midpoint of the line between the inner points of the ankles.

NOTE 2 For anthropometric measurements see ISO 7250.

3.6
unfavourable environmental conditions
conditions that give an additional risk to the lifting or carrying task

EXAMPLES Hot or cold environment, slippery floor.

3.7
ideal conditions for manual handling
conditions that include ideal posture for manual handling, a firm grip on the object in neutral wrist posture, and favourable environmental conditions

3.8
repetitive handling
handling an object more than once every 5 min

3.9
mid-sagittal plane
vertical plane in the anterior-posterior direction that divides a person assuming a neutral body posture into equal left and right halves

See Figure A.2.

3.10
neutral body posture
upright standing posture with the arms hanging freely by the side of the body

3.11
plane of asymmetry
vertical plane passing through the midpoint of the line between the inner ankle bones and the vertical projection of the centre of gravity of the load when the load is at its most extreme displacement from the neutral, mid-saggittal plane

3.12
angle of asymmetry
angle formed between the lines that result from the intersections of the mid-sagittal plane and the plane of asymmetry

NOTE If the feet are repositioned during the lift/lower sequence, the referent planes must be determined at the point in the action sequence wherein the largest degree of asymmetrical twist is encountered (see Figure A.2).

3.13
reference mass
mass considered appropriate for use with an identified user population during the application of the risk-assessment method described herein

3.14
cumulative mass
product of the carried mass and the carrying frequency

NOTE The cumulative mass for carrying is separately defined in kilograms per minute which represents the risk for short term, in kilograms per hour which represents the risk for medium term and in kilograms per 8 hours representing the risk for long term.

4 Recommendation

4.1 Introduction

This clause provides information for the evaluation of manual lifting and carrying.

4.2 Ergonomic approach

In those cases where manual lifting and carrying cannot be avoided, one should make a health and safety risk assessment taking into account the mass of the object, the grip of the object, the position of the object relative to the position of the body, and the frequency and duration of a specific task.

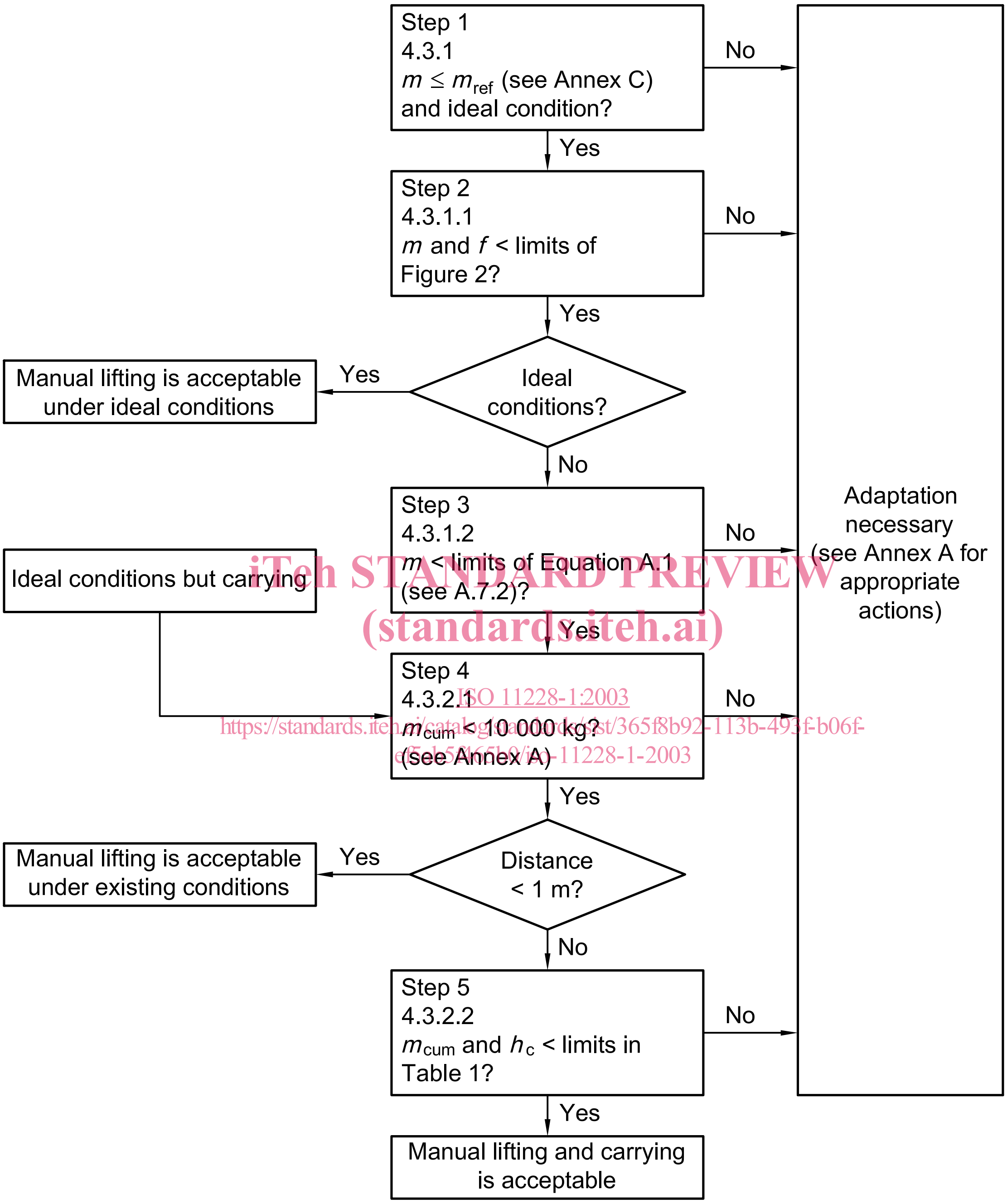
The risk assessment can be accomplished using a step by step approach (see Figure 1). With each successive step, the evaluator needs to judge the interrelated aspects of the various tasks. It is stressed that employers should provide their employees with adequate information and training for all situations addressed by this part of ISO 11228. Employees and others can lower the risk of injury by adopting safe ways of manual handling (see Annex A).

Risk assessment consists of four stages: peril recognition, hazard identification, risk estimation and risk evaluation, in accordance with ISO 14121, EN 1005-2 and ISO/IEC Guide 51. For information about hazard identification see Annex A.

If recommended limits are exceeded, measures should be taken to prevent the task from being carried out manually, or adapt the task in such a way that all questions in the step model are satisfied. The primary objective of risk reduction is to take measures to improve the design of manual-handling operations, the task, the object and the working environment relative to the characteristics of the individuals, as appropriate. It should not be assumed that the provision of information and training alone will ensure safe manual handling (see Annex A).

4.3 Risk estimation and risk evaluation

The step model illustrated in Figure 1 describes the procedures for addressing the interrelated aspects of manual lifting and carrying (4.3.1 and 4.3.2).



m mass of object to be lifted

m_{ref} reference mass for identified user population group

f frequency

m_{cum} cumulative mass

h_c distance (of carrying)

Figure 1 — Step model

4.3.1 Manual lifting

An initial screening of non-repetitive manual lifting in ideal conditions requires the determination of the object's mass (step 1). The recommended limit for the mass of the object is presented in Annex C. Step 1 gives general guidance for designers and employers. For additional information see A.7.

Screening of repetitive tasks requires determining the object mass in combination with lifting frequency (see step 2; 4.3.1.1). When limits for mass and frequency are not exceeded, continue to step 3; otherwise adaptation is necessary (see Annex A). For screening of lifting tasks in non-ideal postures, step 3; 4.3.1.2 should be used.

For screening the cumulative mass per day for manual lifting (step 4), the recommended limits in 4.3.2.1 should be applied.

4.3.1.1 Recommended limits for mass and frequency (step 2)

For repetitive manual lifting in ideal conditions, the recommended upper limit for frequency, taking into account the mass of the object, is presented in Figure 2. Figure 2 contains graphs for lifting durations of less than or equal to 1 hour per day and durations of 1 h to 2 hours per day respectively. The absolute maximal lifting frequency is 15 lifts per minute. In this case, the total duration of lifts shall not exceed 1 hour per day and the object mass shall not exceed 7 kg.

For repetitive manual lifting in ideal conditions, step 2 should be sufficient, otherwise continue to step 3.

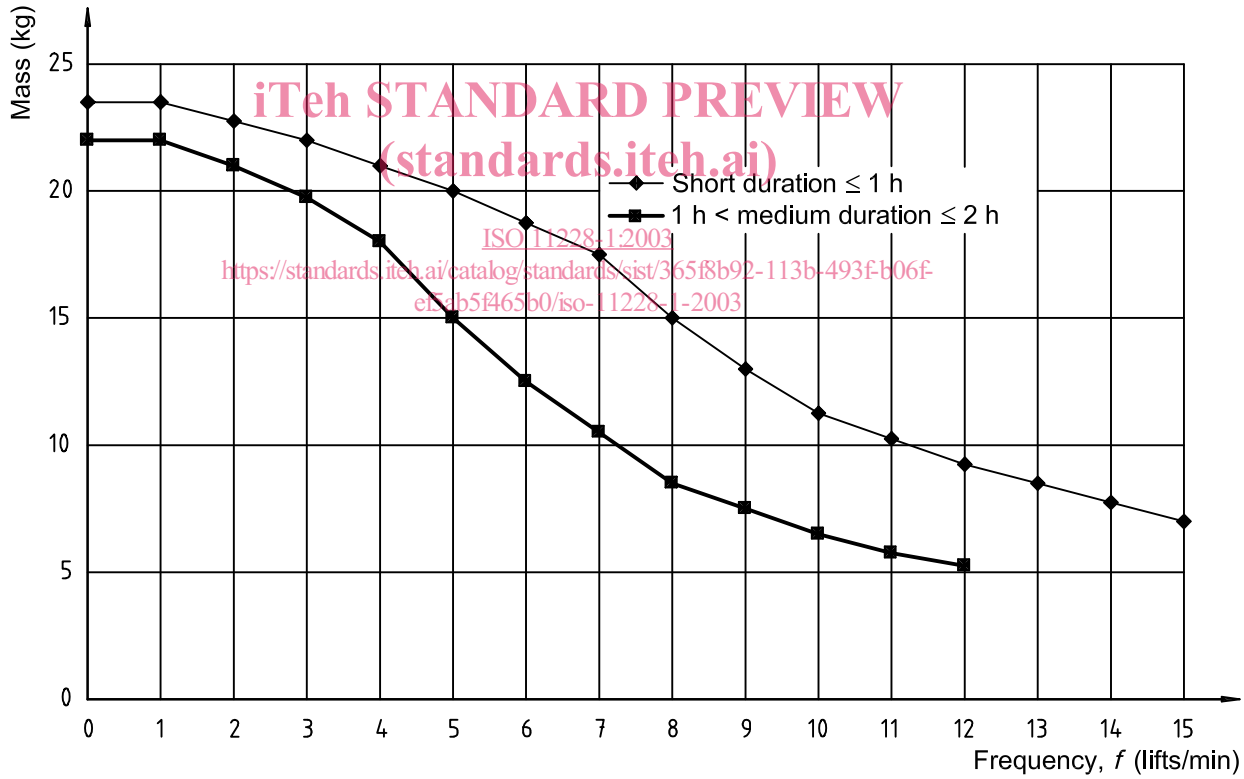


Figure 2 — Maximum frequency for manual lifting related to mass of the object in ideal conditions for two different lifting durations, corresponding to Table A.1

4.3.1.2 Recommended limits for mass frequency and object position (step 3)

For determining the recommended limits for the mass of objects relative to working posture/object position and lifting frequency and duration, the equations in A.7 should be used. In A.7, several assumptions that must be taken into account are presented. Given these variables, if the recommended limit for manual handling is exceeded, then the task should be adapted by changing the mass, the lifting frequency, the lifting duration or the object position.

4.3.2 Cumulative mass of manual lifting and carrying

For screening the cumulative mass of manual carrying and lifting per day (see step 4, 4.3.2.1), the recommended limits in 4.3.1.1 should initially be used. For determining the cumulative mass of carrying related to distance, refer to 4.3.2.2 (step 5). For an object to be carried once for a modest distance (one or two steps), the limits for lifting should be applied. In addition, there are recommended limits for the total cumulative mass given for a 1 h or 8 h workday.

4.3.2.1 Recommended limit for cumulative mass per day (step 4)

The cumulative mass is calculated as a product of mass and frequency of carrying. These two values both are limited in steps 1 and 2. In this way, the mass reference should never exceed 25 kg and frequency of carrying should never exceed 15 times/min. Under ideal conditions, the recommended limit for cumulative mass of manual carrying is 10 000 kg per 8 h. When the carrying distance is long (20 m), this limit has to be decreased to 6 000 kg per 8 h.

4.3.2.2 Recommended limit for cumulative mass related to distance (step 5)

For manual carrying in ideal conditions, the recommended limits for cumulative mass, related to the carrying distance, are presented in Table 1. This table provides the limits as follow:

— in kilograms per minute, which should protect against the excess of local load;

— in kilograms per hour, which should protect against excess of general load;

— in kilograms per 8 hours, which limits the long-term risk.

The limits are not simple multiplications, because the risks for short term, medium term and long term are qualitatively different. The last column of Table 1 shows examples of different combinations of mass and frequency. These examples show that the limits in kilograms per minute cannot always be applied because of the limits of maximal mass and frequency (5 kg × 15/min = 75 kg/min even for a distance of 1 m, and 25 kg cannot be lifted more than once per min, see Figure 2).

In the practical application this part of ISO 11228, first the limits of maximal mass and frequency have the priority; when those limits are respected, the limits to carrying have to be applied. Conversely, if the distance of carrying cannot be reduced, mass and/or frequency should be modified.

Under unfavourable environmental conditions, or when lifting from/to low levels, e.g. below knee height, or when the arms are lifted above the shoulders, the recommended limits for cumulative mass for carrying in Table 1 should be substantially reduced (at least by one-third).

4.4 Risk reduction

Risk reduction can be achieved by minimizing or excluding hazards resulting from the task, the object, the workplace, the work organization or the environmental conditions; examples of which are given in A.3 to A.6.

4.5 Additional considerations

Health surveillance should be provided by the employer with respect to work-related risks.

Technical means of reducing risk should be provided, and complemented with information and appropriate training with respect to work-related risks.