International ergonomics standards (ISO & CEN) and relevant methods for risk assessment and management in WMSDs area

by

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with input from

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List of contents

- WMSDs in Europe
- Background information on relevant CEN and ISO standards
- Applying standards at shopfloor level
- Emulating CEN & ISO standards by means of new methods (e.g. EAWS)
- Features & limitations of these new methods
- conclusions
Table 7.1: Percentage of workers reporting each individual symptom, EU27 (%)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backache</td>
<td>24.7</td>
</tr>
<tr>
<td>Muscular pain</td>
<td>22.8</td>
</tr>
<tr>
<td>Fatigue</td>
<td>22.6</td>
</tr>
<tr>
<td>Stress</td>
<td>22.3</td>
</tr>
<tr>
<td>Headaches</td>
<td>15.5</td>
</tr>
<tr>
<td>Irritability</td>
<td>10.5</td>
</tr>
<tr>
<td>Injuries</td>
<td>9.7</td>
</tr>
<tr>
<td>Sleeping problems</td>
<td>8.7</td>
</tr>
<tr>
<td>Anxiety</td>
<td>7.8</td>
</tr>
<tr>
<td>Eyesight problems</td>
<td>7.8</td>
</tr>
<tr>
<td>Hearing problems</td>
<td>7.2</td>
</tr>
<tr>
<td>Skin problems</td>
<td>6.6</td>
</tr>
<tr>
<td>Stomach ache</td>
<td>5.8</td>
</tr>
<tr>
<td>Breathing difficulties</td>
<td>4.8</td>
</tr>
<tr>
<td>Allergies</td>
<td>4.0</td>
</tr>
<tr>
<td>Heart disease</td>
<td>2.4</td>
</tr>
<tr>
<td>Other</td>
<td>1.6</td>
</tr>
</tbody>
</table>
WMSDs are caused mainly by manual handling, heavy physical work, awkward and static postures, repetition of movements and vibration.

The risk of MSDs can increase with the pace of work, low job satisfaction, high job demands and job stress.

PHYSICAL RISKS

THE SURVEY REVEALS THAT CERTAIN PHYSICAL RISKS STILL PERSIST.

THE PROPORTION OF WORKERS REPORTING REPETITIVE HAND OR ARM MOVEMENTS HAS INCREASED (BY 4%), WITH 62% OF THE WORKING POPULATION REPORTING EXPOSURE FOR 25% OR MORE OF THE TIME;

37% OF WORKERS HANDLES HEAVY LOADS FOR ALMOST 25% OF WORKING TIME

50% OF WORKERS REPORT WORKING IN PAINFUL OR TIRING POSITIONS AT LEAST 25% OF THE TIME.
WMSDs as occupational diseases

Work related musculoskeletal disorders (WMDs) represent more than 50% of all occupational diseases in Europe.
The most common musculoskeletal occupational diseases are:

tenosynovitis of the hand or wrist

epicondylitis of the elbow

and carpal tunnel syndrome.
EN 1005-2

Safety of machinery - Human physical performance - Part 2: Manual handling of machinery and component parts of machinery

This European Standard was approved by CEN on 13 February 2003.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovak Republic, Spain, Sweden, Switzerland and United Kingdom.
1 Scope

This European Standard specifies ergonomic recommendations for the design of machinery involving manual handling of machinery and component parts of machinery, including tools linked to the machine, in professional and domestic applications. This European Standard applies to the manual handling of machinery, component parts of machinery and objects processed by the machine (input/output) of 3 kg or more, for carrying less than 2 m. Objects of less than 3 kg are dealt with in prEN 1005-51. The standard provides data for ergonomic design and risk assessment concerning lifting, lowering and carrying in relation to the assembly/erection, transport and commissioning (assembly, installation, adjustment), operation, fault finding, maintenance, setting, teaching or process changeover and decommissioning, disposal and dismantling of machinery. This standard provides current data on the general population and certain sub-populations (clarified in annex A). This part of the standard does not cover the holding of objects (without walking), pushing or pulling of objects, hand-held machines, or handling while seated. This document is not applicable to specify the machinery which are manufactured before the date of publication of this document by CEN.
Method 1
Carry out a screening of the proposed design. Are the criteria satisfied?

No

No

No

Carry out a more detailed risk assessment. Are the criteria satisfied?

Measures should be taken to improve ergonomic design

Measures should be taken to improve ergonomic design

Consider additional variables. Are the criteria satisfied?

Yes

Yes

Yes

Redesign machinery. See 4.2

Assessment shows that the risk is within acceptable limits

NOTE It is recommended to consider further steps to reduce risk factors to their lowest possible level.

Figure 1 — Flowchart identifying the step-wise approach to assessment
The first method is a quick screening method. Method 2, an easy to handle method, shall be applied if the screening method indicates risks. Some additional risk factors can be taken into account in method 2. Method 3 is an extended assessment method, which assesses risks in a more thorough way and is supplemented by additional risk factors not presented in methods 1 and 2. All three methods have different levels of complexity. The most efficient approach is to begin the risk assessment by applying method 1 (the most simple one) and use methods 2 and/or 3 only if the assumptions and/or operational situations identified in method 1 are not met.
### Table 1 — Reference mass \((M_{ref})\) taking into consideration the intended user population

<table>
<thead>
<tr>
<th>Field of application</th>
<th>(M_{ref} [\text{kg}])</th>
<th>Percentage of F and M</th>
<th>Females</th>
<th>Males</th>
<th>Population group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic use(^a)</td>
<td>5</td>
<td>Data not available</td>
<td></td>
<td></td>
<td>Children and the elderly</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td>General domestic population</td>
</tr>
<tr>
<td>Professional use (\text{general})(^b)</td>
<td>15</td>
<td>95</td>
<td>90</td>
<td>99</td>
<td>General working population, including the young and old</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>85</td>
<td>70</td>
<td>90</td>
<td>Adult working population</td>
</tr>
<tr>
<td>Professional use (\text{exceptional})(^c)</td>
<td>30</td>
<td>Data not available</td>
<td></td>
<td></td>
<td>Special working population</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td>Special working population</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td>Special working population</td>
</tr>
</tbody>
</table>

\(^a\) When designing a machine for domestic use, 10 kg should be used as a general reference mass in the risk assessment. If children and elderly are included in the intended user population, the reference mass should be lowered to 5 kg.

\(^b\) When designing a machine for professional use, a reference mass of 25 kg should not be exceeded in general.

\(^c\) While every effort should be made to avoid manual handling activities or reduce the risks to the lowest possible level, there may be exceptional circumstances where the reference mass might exceed 25 kg (e.g. where technological developments or interventions are not sufficiently advanced). Under these special conditions other measures have to be taken to control the risk according to EN 614-1 (e.g. technical aids, instructions and/or special training for the intended operator group).
Figure B.3 — Example of force distribution functions of male and female subgroups

Figure B.4 — Example of weighting and combining of all subgroup distributions

Figure B.5 — Example of calculation of percentiles
EN 1005 series

Safety of machinery - Human physical performance –  
Part 1: Terms and definitions  08.09.2009

Safety of machinery - Human physical performance –  
Part 2: Manual handling of machinery and component parts of machinery  08.09.2009

Safety of machinery - Human physical performance –  
Part 3: Recommended force limits for machinery operation  08.09.2009

Safety of machinery - Human physical performance –  
Part 4: Evaluation of working postures and movements in relation to machinery  08.09.2009

CEN  EN 1005-5  
Safety of machinery - Human physical performance –  
Part 5: Risk assessment for repetitive handling at high frequency

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4.3.2.2.5 Manual carrying of loads

In general, machines should be designed so that manual carrying is avoided. Where this is not possible, the maximum manual carrying distance should be as low as possible (less than 2 m).
The Dual European System of Health & Safety at Work

Machinery-Directive
89/392/EEC

Framework-Directive
89/391/EEC

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

“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.”

Preamble:

... Whereas Article 118a of the Treaty provides that the Council shall adopt, by means of Directives, minimum requirements for encouraging improvements, especially in the working environment, to guarantee a better level of protection of the safety and health of workers; Whereas this Directive does not justify any reduction in levels of protection already achieved in individual Member States, the Member State being committed, under the Treaty, to encouraging improvements in conditions in this area and to harmonizing conditions while maintaining the improvements made ...
### Relations between CEN and ISO

<table>
<thead>
<tr>
<th>CEN (draft) standards</th>
<th>ISO (draft) standards</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EN 1005 - 4</strong> Safety of Machinery - Evaluation of working postures in relation to machinery</td>
<td><strong>ISO 11226</strong> Ergonomics - Evaluation of working postures</td>
</tr>
<tr>
<td><strong>EN 1005 - 5</strong> Safety of Machinery - Manual handling of low loads at high frequencies</td>
<td><strong>ISO 11228 - 3</strong> Ergonomics - Manual handling - low loads at high frequencies</td>
</tr>
<tr>
<td><strong>EN 1005 - ?</strong> Safety of Machinery - Pushing &amp; pulling in relation to machinery</td>
<td><strong>ISO 11228 - 2</strong> Ergonomics - Manual handling - Pushing and pulling</td>
</tr>
<tr>
<td><strong>EN 1005 - 3</strong> Safety of Machinery - Recommended force limits for machinery operation</td>
<td><strong>ISO 11228 - ?</strong> Ergonomics – Recommended force limits</td>
</tr>
<tr>
<td><strong>EN 1005 - 2</strong> Safety of Machinery - Manual handling of machinery and component parts of machinery</td>
<td><strong>ISO 11228 - 1</strong> Ergonomics - Manual handling - Lifting and Carrying</td>
</tr>
</tbody>
</table>
**Key Indicator Method on Lifting, Holding & Carrying**

**Assessment of Manual Handling Tasks Based on Key Indicators**

**Workplace Activity:**

<table>
<thead>
<tr>
<th>Lifting or displacement</th>
<th>Holding</th>
<th>Carrying</th>
</tr>
</thead>
<tbody>
<tr>
<td>(kg)</td>
<td>(kg)</td>
<td>(kg)</td>
</tr>
<tr>
<td>Number of working days</td>
<td>Time rating points</td>
<td>Duration of working day</td>
</tr>
<tr>
<td>1000 lbs (+)</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>1000 lbs (-)</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>10000 lbs (+)</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>10000 lbs (-)</td>
<td>10</td>
<td>4</td>
</tr>
</tbody>
</table>

**2nd step: Determination of rating points of load, posture and working conditions**

<table>
<thead>
<tr>
<th>Effective load</th>
<th>Load rating point</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10 kg</td>
<td>1</td>
</tr>
<tr>
<td>10 kg - 20 kg</td>
<td>2</td>
</tr>
<tr>
<td>20 kg - 30 kg</td>
<td>3</td>
</tr>
<tr>
<td>30 kg - 40 kg</td>
<td>4</td>
</tr>
<tr>
<td>40 kg - 50 kg</td>
<td>5</td>
</tr>
<tr>
<td>50 kg - 60 kg</td>
<td>6</td>
</tr>
<tr>
<td>60 kg - 70 kg</td>
<td>7</td>
</tr>
</tbody>
</table>

**Posture, position of load**

1. **Upper body upright not twisted**
   - When lifting, holding, carrying and inverting the load is closer to body

2. **Slightly bending forward or twisting the trunk**
   - When lifting, holding, carrying and inverting load is near to medium to body

3. **I am handling or for handling forward**
   - Slightly bending forward with simultaneous twisting of body

4. **Bending far forward with simultaneous twisting of trunk**
   - Load far from body or above shoulder height

**Risk score**

1. **Low load situation, physical overload is possible for less resilient persons**
2. **Increased load situation, physical overload is possible for less resilient persons**
3. **Highly increased load situation, physical overload is possible for normal persons. Redesign of the workplace is recommended**
4. **High load situation, physical overload is likely to appear. Workplace redesign is necessary**

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*Karlheinz Schaub*
Risk evaluation / basic philosophy

Stressors
simultaneous / consecutive

task / environment

Individual
characteristics, abilities
and skills

strain

limit
value

classical stress - strain concept

complex specific load
situation e.g.
manual materials handling

relevant characteristics
of the intended
user population

risk evaluation
according to
traffic light scheme

ergonomic risk assessment according to CEN / ISO

complex load
situations in various
stress situations (e.g.
manual materials handling
AND action forces)

relevant characteristics
of the intended
user population

summed
risk scores
for all modes of
stressors
per time unit

risk evaluation
according to traffic
light scheme

ergonomic risk analysis according to EAWS
### European Assembly Worksheet (Version 1.2)

#### Task Information
- **Line**: [Data]
- **Gender of operation**: [Data]
- **Task duration**: [Data]
- **Substitute**: [Data]

#### Result of Overall Evaluation
<table>
<thead>
<tr>
<th>Component</th>
<th>Score</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posture</td>
<td>0.5</td>
<td>2D / 3D working postures</td>
<td></td>
</tr>
<tr>
<td>Force</td>
<td>0.3</td>
<td>Additional loads</td>
<td></td>
</tr>
<tr>
<td>Manual Handling</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ExtraLoad</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UpperLimit</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### European Assembly Worksheet (Version 1.2)

### Basic Position as well as Postures

#### Time Aspects for Repetitive Loads
- **Type of Task**: [Data]
- **Cycle Time**: [Data]
- **Average Work Cycle Time**: [Data]

#### Comments & Proposals for Improvements
- **Additional Notes**: [Data]

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forces

extract from force atlas

manual materials handling

repetitive loads
EAWS - overview - evaluation (2)

Result of overall evaluation:

- **Whole Body**
  - Postures: 
  - Forces: +
  - Manual handling: +
  - Extra: +

- **Upper Limbs**

EAWS evaluation:
- 0-25 Points: Green
- 26-50 Points: Yellow
- >50 Points: Red

By total score from:

- **Whole Body**
- **Upper Limbs**

Derive action class:

- **Green**
  - Low risk - recommended; no action is needed

- **Yellow**
  - Possible risk - not recommended; redesign if possible, otherwise take other measures to control the risk

- **Red**
  - High risk - to be avoided; action to lower the risk is necessary

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Features & limitations of these new methods

- Screening methods (with a holistic concept) work proper in the field of short cycled work (0,5 – 5 min.)
- They are not properly applicable for longer cycle times (i.e. >10 min.)
- or non-cyclic work
- For longer cycles or non-cyclic work, holistic methods are not available (do green postures, forces and materials handlings last into overall green situations?)
conclusions

- Efforts are needed to complete the system of standards
- Efforts are needed to transform standards into easy applicable methods
- Efforts are needed to develop risk assessment tools for longer cycle times or non-cyclic work (simultaneous & successive superposition of physical workload)
- Efforts are needed to create awareness for poor ergonomics and WMSDs as a possible consequence (especially SMEs)
- Efforts are needed to show that good ergonomics & high productivity are linked to each other (and not contradictory)
Thank you for your attention!

Ciao Enrico & Dani