

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

by

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- ❑ 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

provided by Enrico Occhipinti

4° EUROPEAN SURVEY- 2005. PRELIMINARY RESULTS



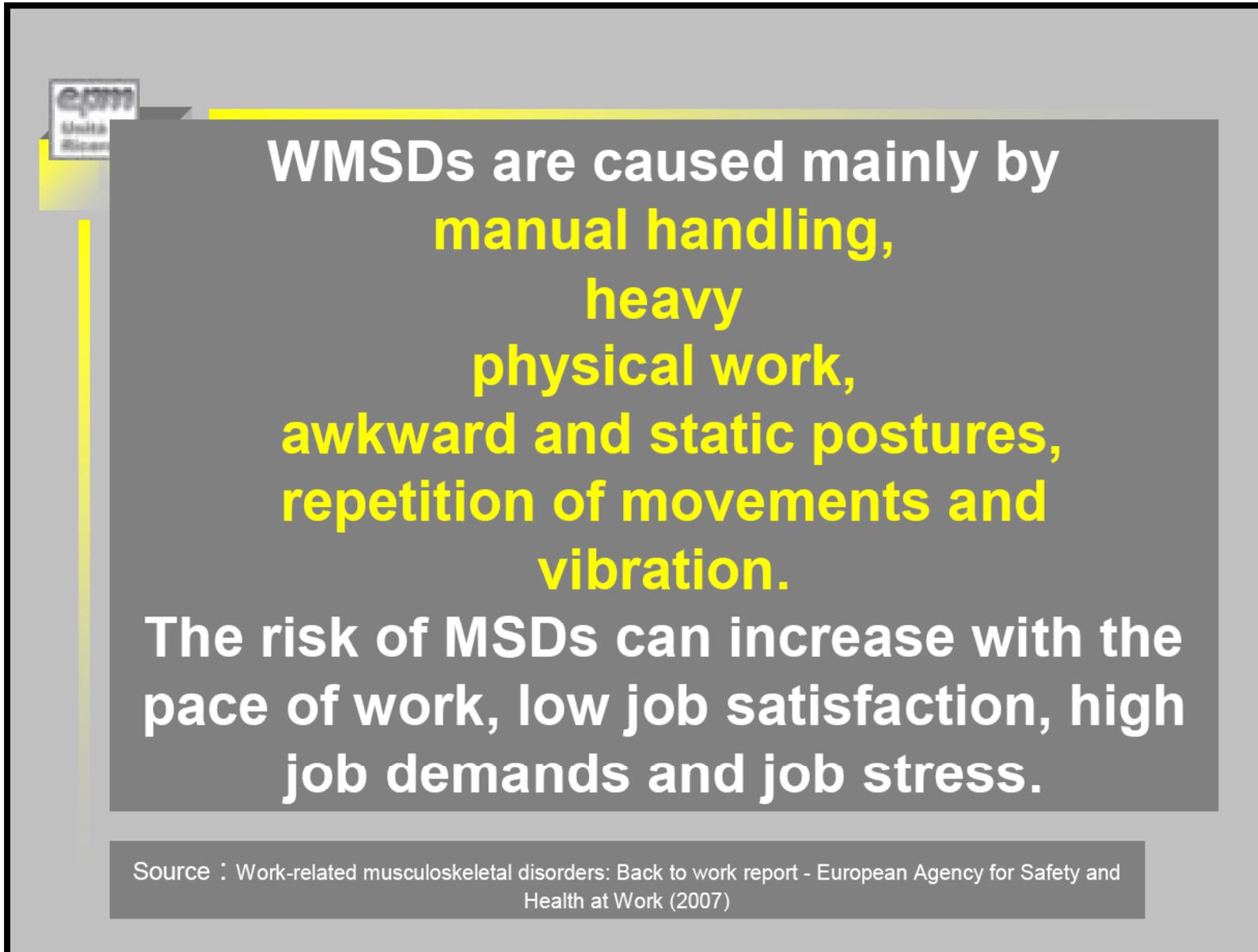
4^o SURVEY- 2005. PRELIMINARY RESULTS
PREVALENCE OF WORK RELATED HEALTH PROBLEMS
27 EU COUNTRIES

Table 7.1: Percentage of workers reporting each individual symptom, EU27 (%)

Symptom	
Backache	24.7
Muscular pain	22.8
Fatigue	22.6
Stress	22.3
Headaches	15.5
Irritability	10.5
Injuries	9.7
Sleeping problems	8.7
Anxiety	7.8
Eyesight problems	7.8
Hearing problems	7.2
Skin problems	6.6
Stomach ache	5.8
Breathing difficulties	4.8
Allergies	4.0
Heart disease	2.4
Other	1.6

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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.

Source : Work-related musculoskeletal disorders: Back to work report - European Agency for Safety and Health at Work (2007)

4° EUROPEAN SURVEY- 2005.

PRELIMINARY RESULTS

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.

provided by Enrico Occhipinti

WMSDs as occupational diseases

**WORK RELATED
MUSCULOSKELTAL DISORDERS**

WMSDs

**REPRESENT MORE THAN 50 %
OF ALL OCCUPATIONAL
DISEASES IN EUROPE**

provided by Enrico Occhipinti

**The most common
musculoskeletal occupational
diseases are:**

tenosynovitis of the hand or wrist

epicondylitis of the elbow

and carpal tunnel syndrome.

provided by Enrico Occhipinti

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1005-2

April 2003

ICS 13.110; 13.180

English version

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

Sécurité des machines - Performance physique humaine -
Partie 2: Manutention manuelle de machines et d'éléments
de machines

Sicherheit von Maschinen - Menschliche körperliche
Leistung - Teil 2: Manuelle Handhabung von Gegenständen
in Verbindung mit Maschinen und Maschinenteilen

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

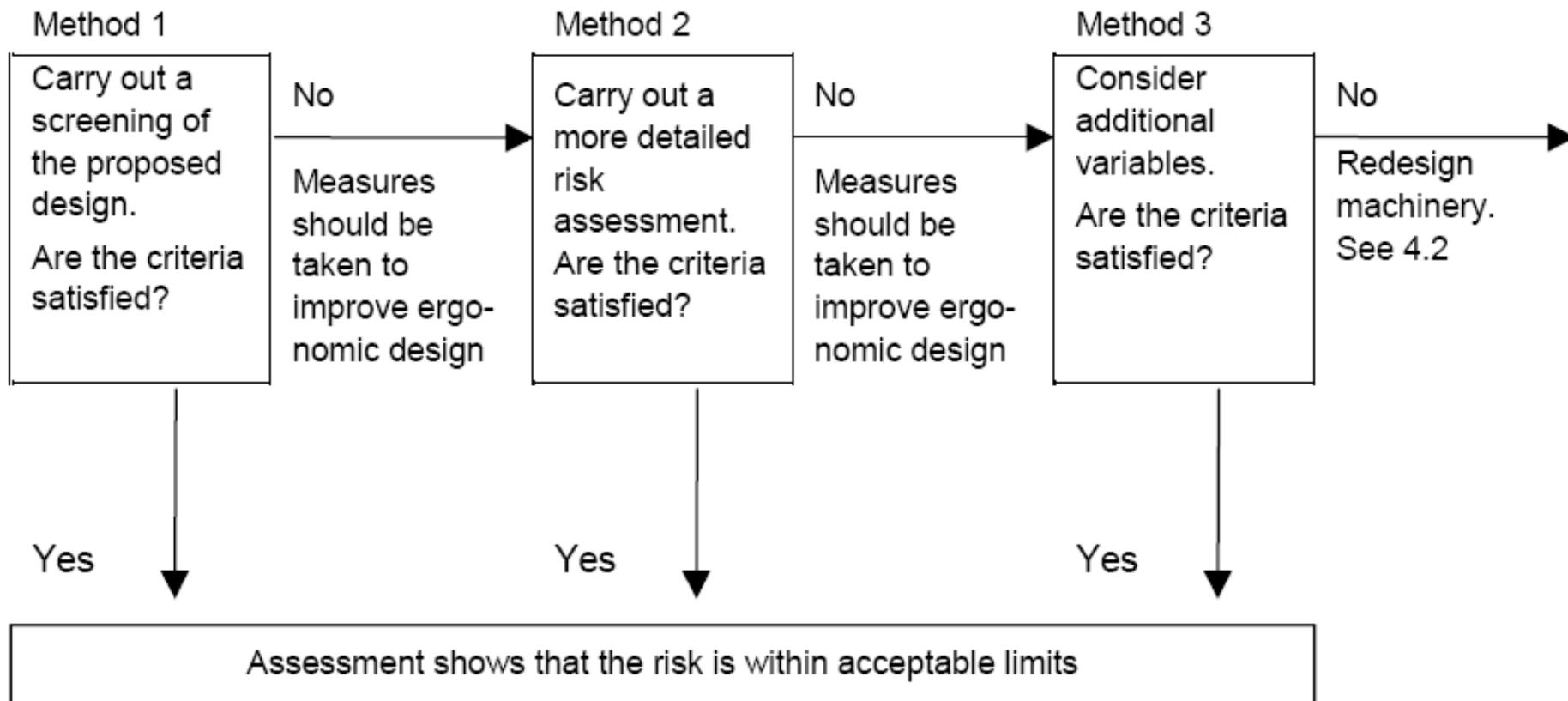
This European Standard specifies **ergonomic recommendations for the design of machinery** involving manual handling of machinery and component parts of machinery, including tools linked to the machine, in professional and domestic applications.

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.



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

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

^aWhen 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.

^bWhen designing a machine for professional use, a reference mass of 25 kg should not be exceeded in general.

^cWhile 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).

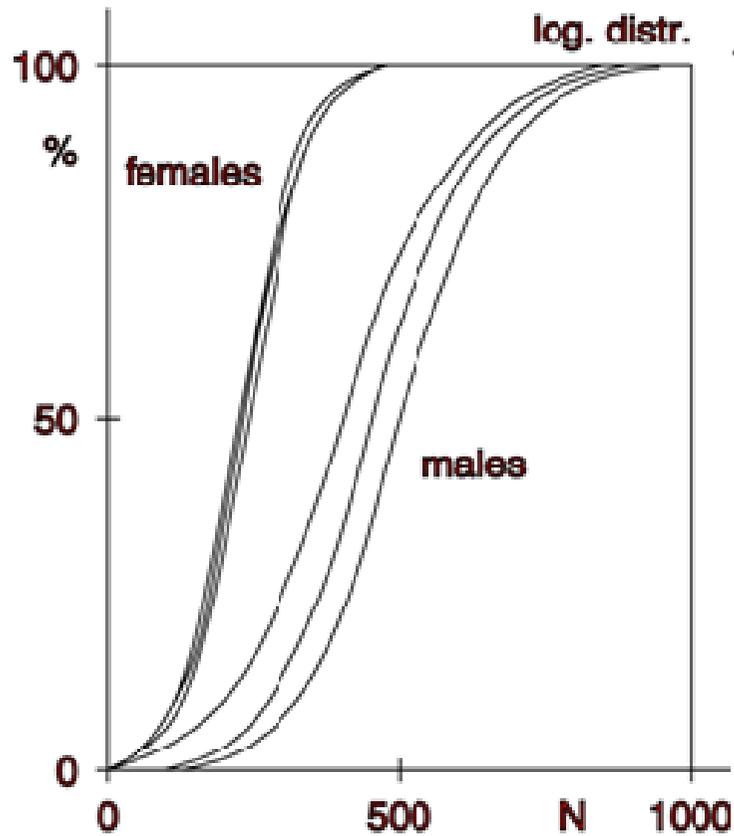


Figure B.3 — Example of force distribution functions of male and female subgroups

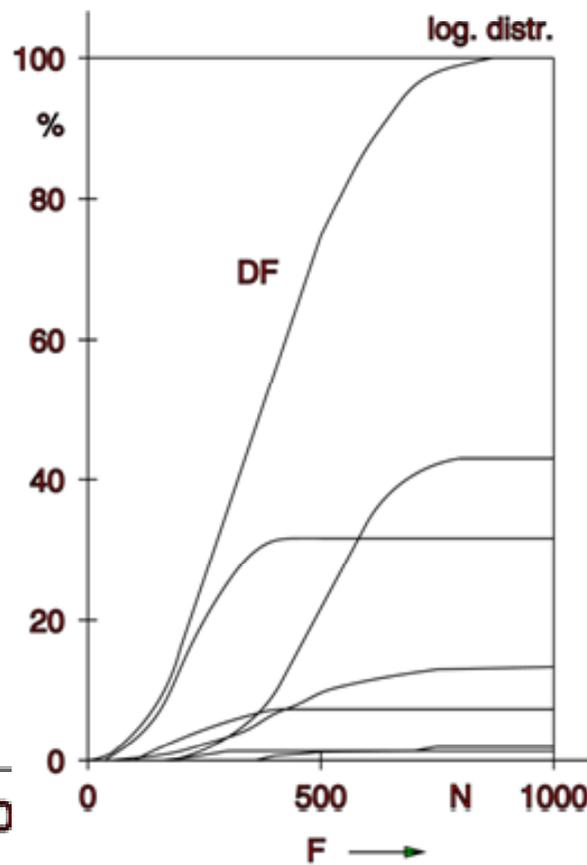


Figure B.4 — Example of weighting and combining of all subgroup distributions

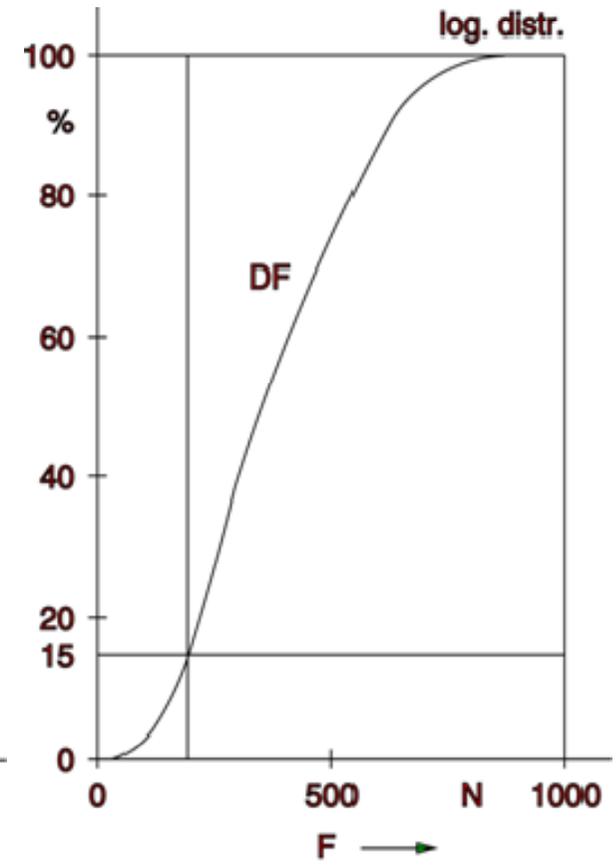


Figure B.5 — Example of calculation of percentiles

CEN EN 1005-1:2001+A1:2008

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

CEN EN 1005-2:2003+A1:2008

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

CEN EN 1005-3:2002+A1:2008

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

CEN EN 1005-4:2005+A1:2008

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

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**).

Machinery-Directive

89/392/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.”

Framework-Directive

89/391/EEC

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

...

CEN (draft) standards

EN 1005 - 5 Safety of Machinery -
Manual handling of low loads
at high frequencies

EN 1005 - 4 Safety of Machinery -
Evaluation of working postures
in relation to machinery

EN 1005 - ? Safety of Machinery -
Pushing & pulling in relation
to machinery

EN 1005 - 3 Safety of Machinery -
Recommended force limits
for machinery operation

EN 1005 - 2 Safety of Machinery -
Manual handling of machinery
and component parts of machinery

ISO (draft) standards

ISO 11228 - 3 Ergonomics - Manual
handling - low loads at high frequencies

ISO 11226 Ergonomics -
Evaluation of working postures

ISO 11228 - 2 Ergonomics - Manual
handling - Pushing and pulling

ISO 11228 - ? Ergonomics –
Recommended force limits

ISO 11228 - 1 Ergonomics - Manual
handling - Lifting and Carrying

ASSESSMENT OF MANUAL HANDLING TASKS BASED ON KEY INDICATORS Version 2001

Where there are a number of individual activities with considerable physical strains, they must be estimated separately.

Workplace/Activity:

1st step: Determination of time rating points (Select only one column !)

Lifting or displacement operations (< 5 s)		Holding (> 5 s)		Carrying (> 5 m)	
Number at working day	Time rating points	Total duration at working day	Time rating points	Overall length at working day	Time rating points
< 10	1	< 5 min	1	< 300 m	1
10 bis < 40	2	5 bis 15 min	2	300 m to < 1km	2
40 bis < 200	4	15 min to < 1 hr	4	1 km to < 4 km	4
200 bis < 500	6	1 hrs to < 2 hrs	6	4 to < 8 km	6
500 bis < 1000	8	2 hrs to < 4 hrs	8	8 to < 16 km	8
≥ 1000	10	≥ 4 hrs	10	≥ 16 km	10

Examples: • laying bricks, • placing workpieces into a machine, • taking boxes out of a container and putting them onto a conveyor belt

Examples: • holding and guiding a cast iron slug while working on a wheel stand, • operation a hand grinding machine, • operating a weed-eater

Examples: • furniture removal, • delivering scaffolding parts to a building site

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

Effective load ¹⁾ for men	Load rating point	Effective load ¹⁾ for women	Load rating point
< 10 kg	1	< 5 kg	1
10 bis < 20 kg	2	5 bis <10 kg	2
20 bis < 30 kg	4	10 bis <15 kg	4
30 bis < 40 kg	7	15 bis < 25 kg	7
≥ 40 kg	25	≥ 25 kg	25

1) „Effective load“ means in this context the real action force, which are necessary for moving load. This action force does not correspond to the load mass in each case. When tilting a carton, only 50 % of the load mass will have an effect on worker and when using a cart only 10 %.

Typical posture, position of load ²⁾	Posture, position of load	Posture rating point
	<ul style="list-style-type: none"> Upper body upright, not twisted When lifting, holding, carrying und lowering the load is close to body 	1
	<ul style="list-style-type: none"> Slightly bending forward or twisting the trunk When lifting, holding, carrying und lowering load is near to medium to body 	2
	<ul style="list-style-type: none"> Low bending or far bending forward Slightly bending forward with simultaneous twisting of trunk Load far from the body or above shoulder height 	4
	<ul style="list-style-type: none"> Bending far forward with simultaneous twisting of trunk Load far from body Restricted stability of posture when standing Crouching or kneeling 	8

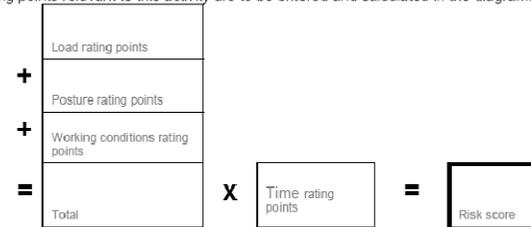
2) For determination of posture weighting the typical body posture when manual handling must be use. E.g. when there are different postures with load a mean values must be used – not occasionally extreme values.

Ed. by •Federal Institution of Occupational Safety and Health and •Regional Committee of Occupational Safety and Safety Techniques (•Bundesanstalt für Arbeitsschutz und Arbeitsmedizin - BAuA und •Länderausschuss für Arbeitsschutz und Sicherheitstechnik - LASI) 2001

Working conditions	Working conditions rating point
Good ergonomic conditions, e.g. sufficient space, no physical obstacles within the workspace, even level and solid flooring, sufficient lighting, good gripping conditions	0
Space for movement restricted and unfavourable ergonomic conditions (e.g. 1: space for movement restricted by too low high or working area less than 1,5 m ² or 2: posture stability impaired by uneven floor or soft ground)	1
Strongly restricted space of movement and/or instability of centre of gravity of load (e.g. transfer of patients)	2

3rd step: Evaluation

The rating points relevant to this activity are to be entered and calculated in the diagram.



On the basis of the rating calculated and the table below it is possible to make a rough evaluation. ³⁾ Regardless of this provisions of the Maternity Leave Act apply.

Risk range	Risk score	Description
1	< 10	Low load situation, physical overload unlikely to appear.
2	10 bis < 25	Increased load situation, physical overload is possible for less resilient persons ⁴⁾ . For that group redesign of workplace is helpful.
3	25 bis < 50	Highly increased load situation, physical overload also possible for normal persons. Redesign of the workplace is recommended.
4	≥ 50	High load situation, physical overload is likely to appear. Workplace redesign is necessary ⁵⁾ .

3) Basically it must be assumed that as the number of point rating rises, so the risk of overloading the muscular-skeletal system increases. The boundaries between the risk ranges are fluid because of the individual working techniques and performance conditions. The classification may therefore only be regarded as an orientation aid. More exact analyses require specialist ergonomic knowledge.

4) Less resilient persons in this context are persons older than 40 or younger than 21 years, newcomers in the job or people suffering from illness.

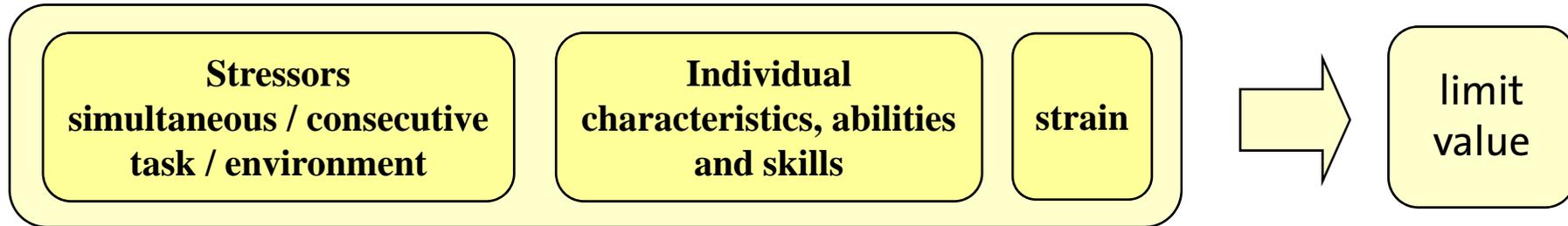
5) Design requirements can be determined with reference to the number of point in the table. By reducing the weight, improving the execution conditions or shortening the strain time, elevated stress can be avoided.

Check the workplace necessary for other reasons:

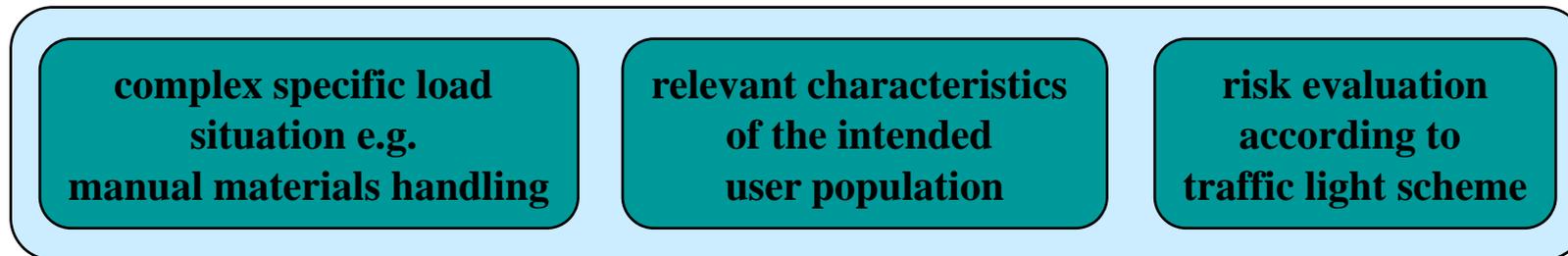
Reasons: _____

Date of assessment: _____ Assessed by: _____

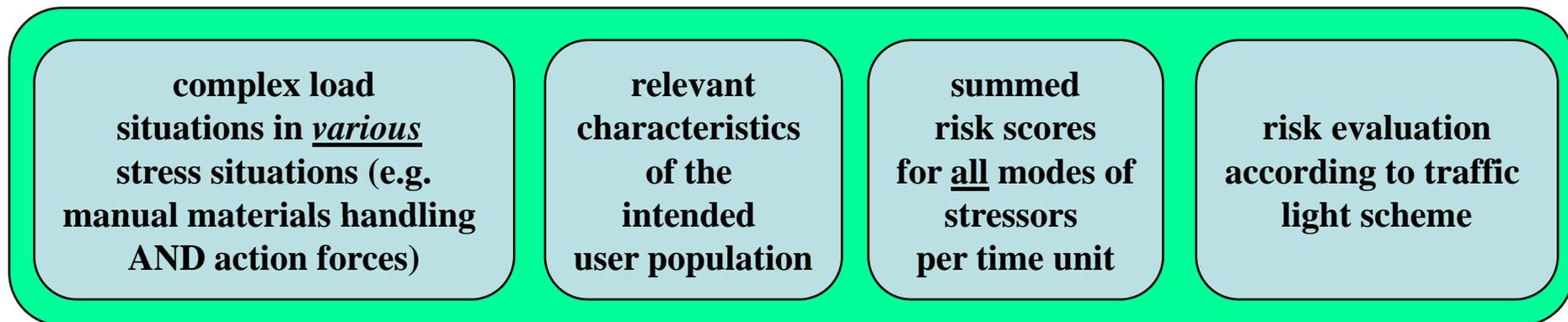
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classical stress - strain concept



ergonomic risk assessment according to CEN / ISO



ergonomic risk analysis according to EAWS

header

overall evaluation

additional loads

comments & improvements

time aspects for repetitive loads

European Assembly Worksheet (V 1.2.2)

Line: _____ Gender of operator: m f Stature: _____ [cm]
 Analyst: _____ Date: _____
 Task: _____ Task duration: _____ [sec] UAS-Analysis: _____

Result of overall evaluation:

green yellow red

WHOLE BODY = Postures + Forces + Manual handling + Extra + UPPER LIMBS

0-25 Points green Low risk - recommended; no action is needed
 26-50 Points yellow Possible risk - not recommended; redesign if possible, otherwise take other measures to control the risk
 > 50 Points red High risk - to be avoided; action to lower the risk is necessary

Extra points "Whole body" (per minute / shift) (for details see instructions for use)

0a Working on moving objects	0	3	6	15	impairment:
	none	middle	strong	very strong	
0b Accessibility (e.g. entering motor or passenger compartment)	0	2	5	10	accessibility:
	good	complicated	poor	very poor	
0c Special load situations (please describe in detail) (please see also EAWS instructions for use)	0	5	10	15	Other physical workload:
	none	low	strong	very strong	

extra = Σ lines 0a - 0c Attention: Max. score = 40 (line 0) Attention: correct evaluation if duration of evaluation = 600

Comments / proposals for improvements

For scoring of repetitive tasks only:

Unit	Description	Calculation	Result
Real shift duration [min]			
Official pauses and other pauses [min]			-
Real lunch break duration [min]			-
Real breaks (e.g. coffee, etc.) [min]			-
Net duration of repetitive task/s (a) [min]			=
no. of real units (or cycles)	(b)		
Net cycle time [sec]		(a/b x 60)=	
Observed cycle time [sec]			
Resultant score "upper limbs" (line 20)			

European Assembly Worksheet (V 1.2.2)

Basic position as well as postures of trunk / arms (incl. loads / action forces of 30-40N)

for durations of evaluation periods $\leq 60s$, the scores in lines 1-17 are corrected as follows:
 duration of evaluation period = duration of posture or movement > 60 = duration of evaluation period [sec]

Postures	duration of evaluation period for static or high frequent postures / movements of trunk / arms [% sec/min, min/8h]							Sum of lines	Trunk rotation*			Trunk lat. bending*			Far reach**		
	5	10	20	33	67	>67	1		2	4	8	13	1	2	4	8	13
Standing																	
1 Upright standing & walking	0	0	1	1	2												
2 slightly bent backward	1	2	4	8	13												
3 standing, no body support (for other restrictions see Extra Points)	0	7	12	20	40												
4 Dors. with suitable support	2	5	8	15	25												
5 Strongly bent forward = 60°	5	12	21	38	63												
6 drc. with suitable support	3	7	12	23	38												
7 upright, arms at / above shoulder level	5	12	21	38	63												
8 upright, arms above head level	8	19	33	60	100												
Sitting																	
9 upright with back support	0	0	0	1	2												
10 slightly bent forward or slightly bent backward	0	1	2	4	7												
11 upright no back support (for other restrictions see Extra Points)	1	2	4	8	13												
12 bent forward	4	10	16	30	50												
13 upright, arms at / above shoulder level	6	14	25	45	75												
14 upright, arms above head level	6	14	25	45	75												
Kneeling or crouching																	
15 upright	5	9	15	27	45												
16 bent forward	6	14	25	45	75												
17 arms at / above shoulder level	9	23	43	80	135												
Lying & climbing																	
18 (lying on back, breast or side), arms above head	9	21	37	68	113												
19 climbing	10	33	66														
20 posture = Σ lines 1 - 13																	

Attention: Max. duration of evaluation = duration of task or 100% t

Attention: correct evaluation if duration of evaluation = 600

2D / 3D working postures

forces

extract from force atlas

repetitive loads

manual materials handling

European Assembly Worksheet (V 1.2.2)

17 (per minute / shift) **Forces**

time x load level individual scores Σ

18 (per minute / shift) **Forces**

time x force level individual scores Σ

F_{max} forces of the arm and whole body

all forces recorded in Newton (N) values for F_{max} (MVC) for the usage of the "European Assembly Worksheet" (EAWS) during the planning phase (not to be used for the final evaluation)

Attention: Max. score = 70 line 17 30 line 18

Manual materials handling (per shift)

19 Weights of loads (kg) for repositioning (lifting / lowering), carrying and holding as well as pushing and pulling

reposition, carry: males 0.5th 2nd 5 10 15 20 25 30 35 40 >40
 females 0.5th 2nd 5 7 10 12 15 20 25 >25

Load points: 0.5 1 1.5 2 3 4 5.5 7 8.5 25

pushing and pulling: males <40 60 80 110 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400 2500 2600 2700 2800 2900 3000 3100 3200 3300 3400 3500 3600 3700 3800 3900 4000 4100 4200 4300 4400 4500 4600 4700 4800 4900 5000 5100 5200 5300 5400 5500 5600 5700 5800 5900 6000 6100 6200 6300 6400 6500 6600 6700 6800 6900 7000 7100 7200 7300 7400 7500 7600 7700 7800 7900 8000 8100 8200 8300 8400 8500 8600 8700 8800 8900 9000 9100 9200 9300 9400 9500 9600 9700 9800 9900 10000 11000 12000 13000 14000 15000 16000 17000 18000 19000 20000 21000 22000 23000 24000 25000 26000 27000 28000 29000 30000 31000 32000 33000 34000 35000 36000 37000 38000 39000 40000 41000 42000 43000 44000 45000 46000 47000 48000 49000 50000 51000 52000 53000 54000 55000 56000 57000 58000 59000 60000 61000 62000 63000 64000 65000 66000 67000 68000 69000 70000 71000 72000 73000 74000 75000 76000 77000 78000 79000 80000 81000 82000 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Result of overall evaluation:

<input type="checkbox"/> green <input type="checkbox"/> yellow <input type="checkbox"/> red	WHOLE BODY	=	Postures	+	Forces	+	Manual handling	+	Extra	UPPER LIMBS
		=		+		+		+		
EAWS evaluation	0-25 Points	green	Low risk: - recommended; no action is needed							
	26-50 Points	yellow	Possible risk: – not recommended; redesign if possible, otherwise take other measures to control the risk							
	>50 Points	red	High risk:– to be avoided; action to lower the risk is necessary							

By total score from:

- **WHOLE BODY**
- or
- **UPPER LIMBS**

derive action class

Green	Low risk - recommended; No action is necessary
Yellow	Possible risk - not recommended; Redesign, if possible, or take actions to control the risk
Red	High risk - to be avoided; action to lower the risk is necessary

- ❑ 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?)

- ❑ 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)

Ciao Enrico & Dani

