DGUV conference on MSD
16th / 17th of October 2009,
Institute Work and Health (BGAG)
DRESDEN

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

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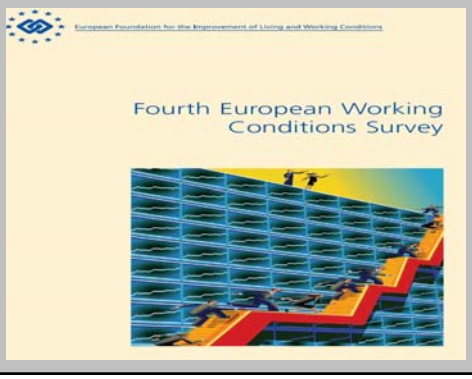
Chair IEA TC on Musculoskeletal Disorders

eurostat THEME 3 Population and social conditions

Work and health in the EU
A statistical portrait

4° EUROPEAN SURVEY- 2005.
PRELIMINARY RESULTS



4° 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

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

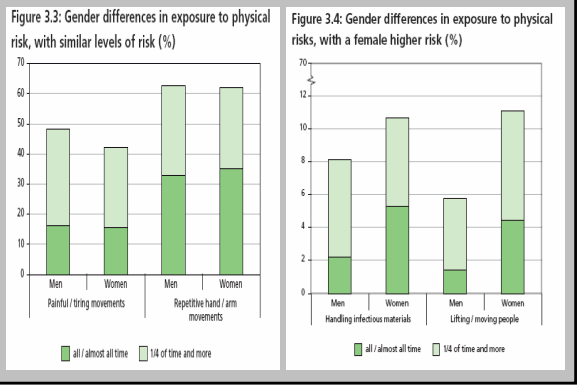
THE SURVEY REVEALS THAT CERTAIN PHYSICAL RISKS STILL PERSIST.

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.

4° SURVEY- 2005. PRELIMINARY RESULTS
EXPOSURE TO PHYSICAL RISK CONSIDERING GENDER



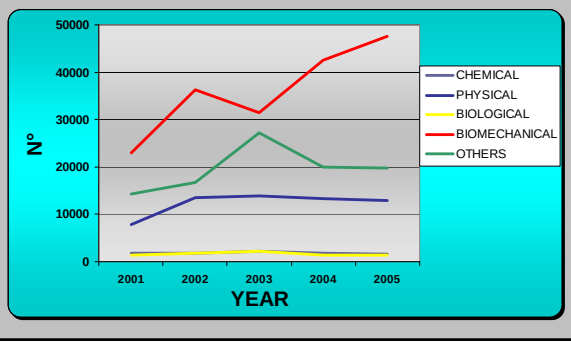
WMSDs as occupational diseases

WORK RELATED MUSCULOSKELTAL DISORDERS

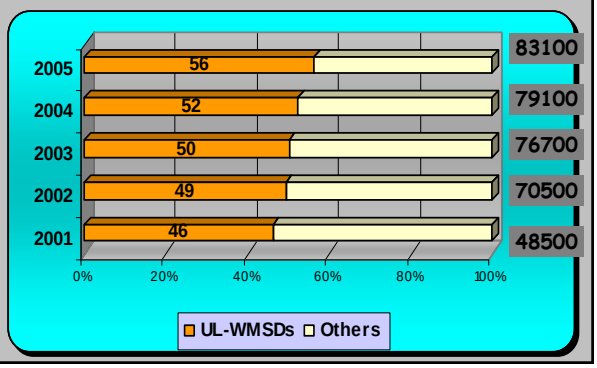
WMDSs

REPRESENT MORE THAN 50 % OF ALL OCCUPATIONAL DISEASES IN EUROPE

Biomechanical overload as a risk factor for occupational diseases in Europe



WMSDs and other occupational diseases in Europe
Eurostat 2001-2005



The most common musculoskeletal occupational diseases are:

tenosynovitis of the hand or wrist

epicondylitis of the elbow

and carpal tunnel syndrome.

Main occupational diseases in Europe - 2006

Le "top 3" des maladies professionnelles les plus fréquemment reconnues (2006)

Pays	N°1	N°2	N°3
Allemagne	Surdités	Asbestoses et plaques pleurales	Mésothéliomes
Autriche	Surdités	Maladies de la peau	Asthmes bronchiques allergiques
Belgique (2005)	Maladies ostéo-articulaires	Paralysie des nerfs due à la pression	Surdités
Danemark (2005)	Maladies de la peau	TMS	Surdités
Espagne	TMS	Maladies de la peau	Surdités
France	TMS	Maladies de l'amiante	Lombalgies
Italie	TMS	Surdités	Maladies respiratoires
Luxembourg	Maladies infectieuses	Asbestoses	Canal carpien
Portugal	TMS	Surdités	Maladies respiratoires
Suède	TMS	Surdités	Pathologies psychosociales
Suisse	Surdités	Maladies infectieuses	Maladies de la peau

Source : Eurogip 2009: Les maladies professionnelles en Europe - Statistiques 1990-2006 et actualité juridique

Main occupational diseases in Spain - 2007

Principales maladies professionnelles reconnues

Maladies	Reconnaissances	En pourcentage du total
Tendinites, ténosynovites	10 319	60,66
Syndromes de compression des nerfs périphériques dont le syndrome du canal carpien	2 189	12,87
Dermatoses par agent matériel artificiel	949	5,58
Hypoacousies ou surdité due au bruit	548	3,22
Hygromas	445	2,62
Autres	2 560	15,05
Total	17 010	100

Reconnues avec arrêt et indemnisation

Maladies	Reconnaissances	En pourcentage du total
Tendinites, ténosynovites	7 307	63,40
Syndromes de compression des nerfs périphériques dont le syndrome du canal carpien	1 504	13,05
Dermatoses par agent matériel artificiel	644	5,59
Hygromas	313	2,72
Maladie causée par un agent matériel métallique	190	1,65
Autres	1 567	13,60
Total	11 525	100

WMSDs represent 85 % of all compensated occupational diseases in Spain (2006)

WMSDs are the biggest cause of absence from work in practically all Member States. In some states, WMSDs account for 40% of the costs of workers' compensation, and cause a reduction of up to 1.6% in the gross domestic product (GDP) of the country itself.
MSDs reduce companies' profitability and add to the social costs of governments.

Source : Work-related musculoskeletal disorders:Prevention report - European Agency for Safety and Health at Work (2008)

It has been estimated that the direct cost for a company of a WMSDs (as occupational disease) is about 40000 Euros.

PREVENTION OF WMSDs : AN EUROPEAN PRIORITY

The challenge of work-related health problems, including musculoskeletal disorders, has been recognised and addressed at the European level by the adoption of a number of EU directives, technical rules, strategies and policies.

Creating more and better quality jobs is an important EU objective and was reinforced at the Lisbon Council in 2000.

Successful prevention of WMSDs would greatly contribute to achieving this objective.

Many problems can be prevented or greatly reduced through employers complying with existing safety and health law, technical standards and following good practice.

Source : Work-related musculoskeletal disorders:Prevention report - European Agency for Safety and Health at Work (2008)

ERGONOMICS

Definitions by IEA (International Ergonomics Association)

The Discipline of Ergonomics

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods *to design in order to optimize human well-being and overall system performance.*

Physical ergonomics

is concerned with human anatomical, anthropometric, physiological and biomechanical characteristics as they relate to physical activity.
(Relevant topics include working postures, materials handling, repetitive movements, work related musculoskeletal disorders, workplace layout, safety and health).

IEA TC on Musculoskeletal Disorders

Chair: Prof. Enrico Occhipinti

Objectives

To collect, review and share with all ergonomists and OSH in the world, methods, "good practices" and "best experiences" for risk assessment and management of WMSDs, including aspects related to job/task design and to workplace/work tools design.

Current Plans and Activities

- **Prevention of WMSDs in the health care sector.**
- **International Standards and guidelines relevant for WMSDs prevention.**
- **Methods and experiences of risk assessment, management and of positive ergonomic intervention for WMSDs prevention.**
- **MSD aspects in office work .**
- **Development of softwares and tools useful for the application of ergonomics methods also by non ergonomics experts**

Ergonomics standards : aims

Ergonomically designed work systems enhance safety, improve human working and living conditions and counteract adverse effects on human health.

Also they usually improve the operator-machine system performance and reliability.

Applying ergonomics to the design of work systems, ensures that human capabilities, skills, limitations and needs, as well as technological and economic effectiveness and efficiency are taken into account.

The European Council Directive 89/331/EEC

Framework Directive for health and safety at work

Requires, among others, employers to undertake a "risk assessment".

Specifically the directive states that " the employers shall… evaluate *(ALL)* the risks to the safety and health of workers….

Subsequent to this evaluation and as necessary, the preventive measures and the working and production methods implemented by the employer must assure an improvement in the level of protection…

COMMISSION ASKS WORKERS AND EMPLOYERS WHAT ACTION SHOULD BE TAKEN TO COMBAT MUSCULOSKELETAL DISORDERS

Brussels, 12 November 2004.

The European Commission is seeking the views of workers' and employers' representatives on how best to tackle the growing problem of musculoskeletal disorders (MSD). These ailments, which include back pain and repetitive strain injury, are the biggest health and safety problem facing European workers today. Studies show that they affect over 40 million workers in all sectors across the EU and account for 40 to 50 per cent of all work-related ill-health. They are costing employers across the EU billions of euros. The problem is eroding Europe's competitiveness and leading to losses of 0.5 to 2 per cent of GNP each year.

SECOND STAGE OF CONSULTATION OF THE SOCIAL PARTNERS ON WORK-RELATED MUSCULOSKELETAL DISORDERS (14 MARCH 2007)

The Commission is considering proposing **a new legislative initiative addressing all significant risk factors of work-related musculoskeletal disorders .**

This new legislative instrument would take the form of an individual directive.

The envisaged directive would cover all major work-related musculoskeletal disorders.

The envisaged directive would also incorporate the provisions of both Directive 90/269/EEC and Directive 90/270/EEC.

The envisaged directive would be supplemented by other non-regulatory initiatives.

A new EU directive regarding all WMSDs : state of affairs

The initiative is actually slowed.

The Unions want a general directive on MSDs that would give weight to the impact of work organisation and psychosocial factors.

The European employers' organisation, Businesseurope, is against it and ask for a sectorial approach and the development of non-binding schemes like awareness-building and exchanges of "good practice".

The Commission would like to favour an overall approach that combines regulatory and non-regulatory measures.

International technical standards for WMSDs prevention

Actual ergonomics standards (in physical ergonomics area) could be useful to enforce principles, requirements and criteria given by primary European social legislation.

This could happen both in relation to:

- general principles in the framework directive 89/331/EEC (i.e with reference to manual repetitive job)
- existing particular directives (i.e 90/269/EEC on manual handling of loads)

International technical standards for WMSDs prevention

EUROPEAN STANDARDS RELATED TO THE MACHINERY DIRECTIVE USEFUL FOR DESIGNING TASKS AND WORKPLACES AND FOR PREVENTING WMSDs

STANDARD	NUMBER	PHYSICAL PARAMETERS
Interaction between task and workplace design	EN 614-2	General requirements
Anthropometric requirements for the design of workstation at machinery	EN ISO 14738	Anthropometric requirements
Manual handling of objects associated with machinery	EN 1005-2	Manual handling of loads
Recommended force limits for machinery operation	EN 1005-3	Force limits
Evaluation of working postures in relation to machinery	EN 1005-4	Postures and movements
Repetitive handling at high frequency	EN 1005-5	Action frequency

Those standards specify ergonomics requirements when designing a new machinery and related tasks/workplaces. They are generally compulsory for the purposes of Machinery Directive

ISO STANDARD USEFUL FOR ASSESSING AND RE-DESIGNING EXISTING TASKS AND WORKPLACES AND FOR PREVENTING WMSDs

ISO 11226

"Ergonomics — Evaluation of static working postures" (2000)

ISO 11228

"Ergonomics - Manual handling"

Part 1: Lifting and carrying (2003).

Part 2: Pushing and pulling (2007).

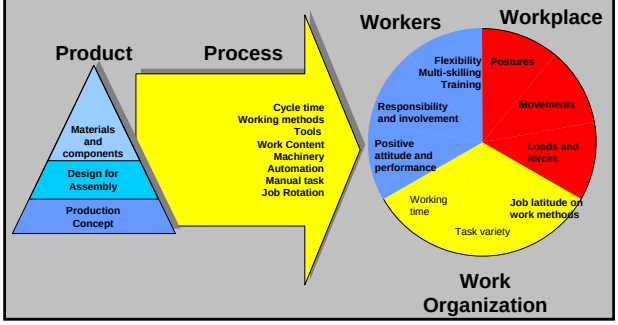
Part 3: Handling of low loads at high frequency (2007).

DETAILS ON STANDARDS

- ***Shortly on CEN standards***
  (more useful at a design stage)
- ***Something more on ISO standard and their perspectives***
  (more useful for assessing and re-designing actual tasks and workplaces)

DESIGNING TASKS AND WORKPLACES: EUROPEAN STANDARDS RELATED TO THE MACHINERY DIRECTIVE

An integrated approach to Ergonomics



EN 614-2

ERGONOMIC DESIGN PRINCIPLES: INTERACTIONS BETWEEN THE DESIGN OF MACHINERY AND WORK TASKS

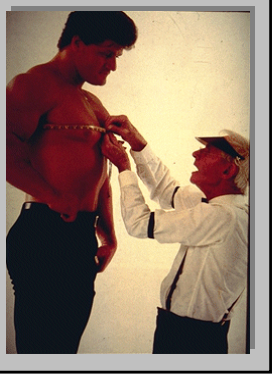
This European Standard helps the designer in applying ergonomics principles to the design of machinery, focusing especially on the interaction between the design of machinery and work tasks.

The designer shall ensure that ergonomics characteristics of well-designed work tasks are fulfillled.

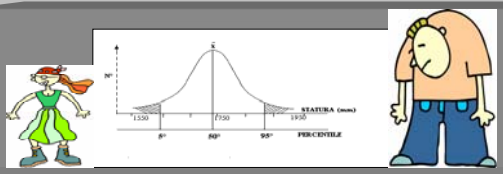
These characteristics shall be pursued by designing machinery and work tasks in interaction.

EN ISO 14738

ANTHROPOMETRIC REQUIREMENTS FOR THE DESIGN OF WORKSTATIONS AT MACHINERY



EN ISO 14738



THIS STANDARD SPECIFIES PROCEDURES AND PRINCIPLES FOR DERIVING DIMENSIONS FROM ANTHROPOMETRIC MEASUREMENTS AND APPLYING THEM TO THE DESIGN OF WORKSTATIONS AT MACHINERY (ESPECIALLY IN INDUSTRIAL SETTINGS), ALSO CONSIDERING TASK CHARACTERISTICS.

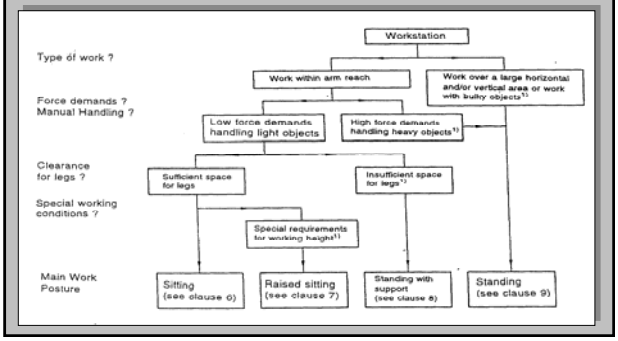
EN ISO 14738

DESIGN OF WORKSTATIONS AT MACHINERY SHALL BE BASED ON AN ANALYSIS OF TASK REQUIREMENTS INCLUDING SEVERAL ELEMENTS:

– time aspects;
– size of working are aand of objects to be handled;
– force and action demands;
– dynamic body measurements ;
– co-ordination and stability demands;
– visual demands;
– need for communication;
– frequency and duration of body, head and limb movements;
– need to move between workstations;
– the possibility for adopting different postures

EN ISO 14738

DECISION TREE FOR DETERMINATION OF MAIN WORK POSTURE



EN ISO 14738

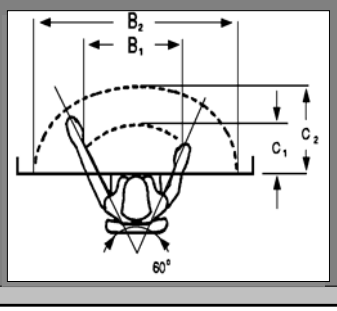
WORKING HEIGHT, WORKING SURFACE HEIGHT AND SLOPE

Task demands	Posture	Working height	Working surface height
Fine co-ordination of hand-work (arm supported) com-bined with visual monitoring in the same working area		higher than elbow height	high working surface possible
Active movements with arms, small objects		at elbow height	surface at elbow height
Handling of large, but not excessively bulky or heavy objects		variable, depen-ding on the size of the object	surface below elbow height if compatible with space for legs; a forward sloping seat can provide more space

Figure 3 - Recommendations for working heights

EN ISO 14738

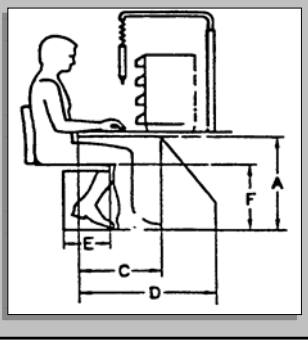
OPERATIONAL AREAS FOR UPPER LIMBS



MEASURE	VALUE (mm)
B1	480
B2	1300
C1	170
C2	415

EN ISO 14738

SITTING POSTURE: SPACE FOR LEGS



MEASURE	VALUE (mm)
A	820-495
A	720
C	520
D	855
E	285
F	370-535
G	0-165

EN 1005 -2

SAFETY OF MACHINERY –
- HUMAN PHYSICAL PERFORMANCE –

MANUAL HANDLING

OF MACHINERY AND COMPONENT PARTS OF MACHINERY

EN 1005 -2

RISK ASSESSMENT BASED ON NIOSH METHOD FOR LIFTING (RNLE)

$$\text{RISK INDEX} = \frac{\text{LOAD REALLY HANDLED}}{\text{RECOMMENDED LOAD}}$$

RI < 0,85: the risk is tolerable (green).

0,85 < RI < 1,0: significant risk exists (yellow).

RI >1,0 : a definite risk exists and redesign is necessary.

Table 1 — Reference mass (M_{ref}) taking into consideration the intended user population

Field of application	M_{ref} [kg]	Percentage of F and M	F_{emales}	M_{ales}	Population group	
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 35 40	Data not available			Special working population	Special working population

[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).

EN 1005-3

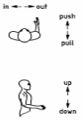
RECOMMENDED FORCE LIMITS FOR MACHINERY OPERATION

Step A : Determination of basic force

Step B : Determination of adjusted force in relation to other risk factors

Step C : Evaluation of tolerability and risk.

EN 1005-3 Step A – Basic Force Limits

Activity		Professional use F_b in N	Domestic use F_b in N
	Hand work (one hand): Power grip	250	184
	Arm work (sitting posture, one arm): - upwards - downwards - outwards - inwards - pushing - with trunk support - without trunk support - pulling - with trunk support - without trunk support	 50 75 55 75 275 62 225 55	 31 44 31 49 186 30 169 28
	Whole body work (standing posture): - pushing - pulling	 200 145	 119 96
	Pedal work (sitting posture, with trunk support): - ankle action - leg action	 250 475	 154 308

EN 1005-3

Step B – Determination of adjusted force (F_{br}) in relation to other risk factors

1. VELOCITY (FAST MOVEMENTS) (M_V)
2. FREQUENCY OF ACTION (M_F)
3. DAYLY DURATION (M_D)

$$F_{br} = F_b \times M_v \times M_f \times M_d$$

EN 1005-3

Step C – Evaluation of tolerability and risk

The previous steps concern capability, starting from maximal isometric force.
The *risk multiplier* stated below takes into consideration the tolerability of body tissues.

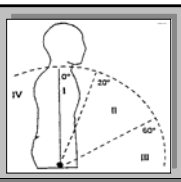
THE FORCE VALUE OBTAINED IN STEP B IS MULTIPLIED BY THE VALUES GIVEN IN THE FOLLOWING TABLE

RISK AREA	*Mr*	*RISK OF DISEASE*
RECCOMMENDED	< 0,5	NEGLIGIBLE
NOT RECCOMMENDED	0,5 - 0,7	NOT NEGLIGIBLE
TO BE AVOIDED	> 0,7	OBVIOUS AND NOT ACCEPTABLE

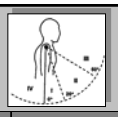
EN 1005-4

EVALUATION OF WORKING POSTURES AND MOVEMENTS IN RELATION TO MACHINERY

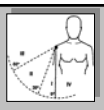
EN – 1005-4
TRUNK – FLEXION / EXTENSION



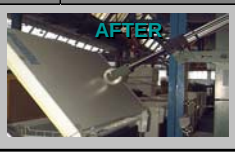
	STATIC POSTURE	MOVEMENTS	
		LOW FREQ. (<2 min.)	HIGH FREQ. (>2 min.)
I°	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE
II°	CONDIZION. ACCEPTABLE(A)	ACCEPTABLE	NOT ACCEPTABLE
III°	NOT ACCEPTABLE	CONDIZION. ACCEPTABLE(C)	NOT ACCEPTABLE
IV°	CONDIZION. ACCEPTABLE (B)	CONDIZION. ACCEPTABLE (C)	NOT ACCEPTABLE



EN – 1005-4
UPPER ARM
FLEXION / EXTENSION.
ABDUCTION



	STATIC POSTURE	MOVEMENTS	
		LOW FREQ (<2 min.)	HIGH FREQ. (>2 min.)
I°	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE
II°	CONDIZION.ACCEPTABLE (A)	ACCEPTABLE	CONDIZION.ACCEPTABLE (C)
III°	NOT ACCEPTABLE	CONDIZION. ACCEPTABLE (C)	NOT ACCEPTABLE
IV°	NOT ACCEPTABLE	CONDIZION.ACCEPTABLE (B)	NOT ACCEPTABLE



EN 1005-5

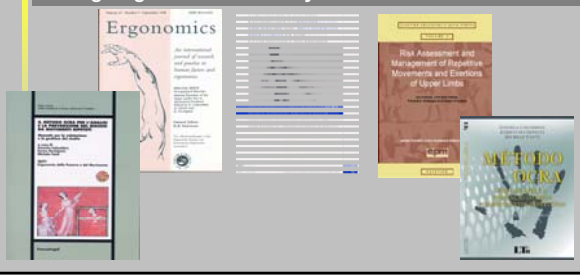
Risk assessment for repetitive handling at high frequency.

Guidance to the designer of machinery in assessing and controlling health and safety risks due to machine-related repetitive handling at high frequency. This standard presents a risk assessment method intended for risk reduction option analysis.
It is a non-harmonized standard (not compulsory)

EN 1005-5 is based on

OCRA method

that was adapted considering the perspective of designing a new machinery and related manual tasks



OCRA METHOD
FACTORS CONSIDERED IN RISK ASSESSMENT

DURATION

FREQUENCY OF ACTIONS

ADDITIONAL FACTORS

USE OF FORCE

AWKWARD POSTURES AND MOVEMENTS

LACK OF RECOVERY PERIODS

OCRA INDEX CLASSIFICATION

(EN 1005-5)

ZONE	OCRA RISK INDEX	RISK EVALUATION
GREEN	UP TO 2,2	ACCEPTABLE
YELLOW	2,3 – 3,5	CONDITIONALLY ACCEPTABLE
RED	FROM 3,6	NOT ACCEPTABLE

EN 1005 - 5 ANNEXES

Several annexes (A to H) explain how to apply the OCRA method for the purpose of the standard

ISO Standard 11228 (Parts 1-3)

ISO 11228 "Ergonomics - Manual handling"

consists of the following parts:

Part 1: Lifting and carrying (2003).

Part 2: Pushing and pulling (2007).

Part 3: Handling of low loads at high frequency (2007).

Each individual standard is a "volountary" standard and provides information for designers, employers, employees and other persons engaged in prevention and work, job and product design.

In general those standards adopt a four-step approach involving both risk assessment and risk reduction: *hazard identification, risk estimation, risk evaluation and risk reduction.*

ISO 11228-1

Manual Handling
Lifting and carrying

ISO 11228-1 : SCOPE

This part of ISO 11228 :

specifies recommended limits for manual lifting and carrying.

applies to manual handling of objects with a mass of 3 kg or more.

applies to moderate walking speed.

is based on an 8 h working day.

does not concern analysis of combined tasks.

FIVE STEP MODEL FOR EVALUATING LIFTING AND CARRYING IN ISO 11228-1

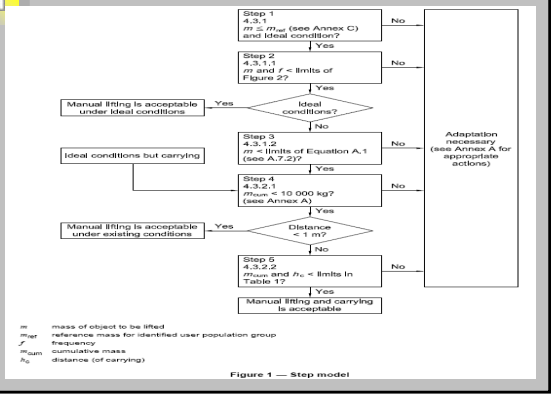


Figure 1 — Step model

AN INITIAL SCREENING OF NON-REPETITIVE (OCCASIONAL) MANUAL LIFTING IN IDEAL CONDITIONS REQUIRES THE DETERMINATION OF THE OBJECT'S MASS (STEP 1).

Table C.1 — Reference mass (m_{ref}) for different populations

Field of application	m_{ref} kg	Percentage of user population protected F and M[a]	F	M	Population group	
Non-occupational use	5	Data not available			Children and the elderly	Total population
	10	99	99	99	General domestic population	
Professional use	15					
	20	95	90	99	General working population, including the young and old	General working population
	23					
	25	85	70	95	Adult working population	
	30					
	35	See NOTE			Specialized working population	Specialized working population under special circumstances
	40					

NOTE Special circumstances. While every effort should be made to avoid manual-handling activities or reduce the risks to the lowest possible levels, there may be exceptional circumstances where the reference mass may exceed 25 kg (e.g. where technological developments or interventions are not sufficiently advanced). In these exceptional circumstances, increased attention and consideration must be given to the education and training of the individual (e.g. specialized knowledge concerning risk identification and risk reduction), the working conditions which prevail and the capabilities of the individual.

[a] F: Female, M: Male

THOSE ARE ALSO RECOMMEMDED REFERENCE MASS FOR FURTHER ASSESSMENT OF THE RECOMMENDED LOAD IN *ISO 11228-1*

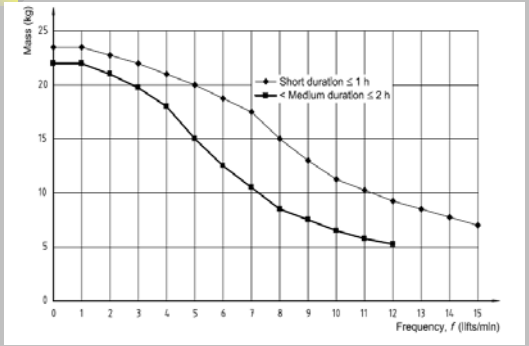
ISO 11228-1

The following specifications have been proposed considering also EN 1005-2

Working population by gender and age	*Reference mass (mref)*
Men (18-45 years old)	25 Kg
Women (18-45 years old)	20 Kg
Men (<18 o >45 years old)	20 Kg
Women (<18 o >45 years old)	15 Kg

NOTE 1: 23 kg is included in the 25 kg mass.

RECOMMEMDED REFERENCE MASS AS A FUNCTION OF FREQUENCY OF LIFTS AND DURATION (IDEAL CONDITIONS) (STEP 2).



ISO 11228-1
Manual Handling – Lifting

STEP 3:

Application of the

Revised NIOSH Lifting Equation (RNLE) for no ideal lifting conditions.

MODEL TO ASSESS LIFTING TASKS

LIFTING INDEX=

ACTUAL LOAD WEIGHT
RECOMMENDED WEIGHT LIMIT

THE RECOMMEDED WEIGHT LIMIT IS EVALUATED BY:

1. MAXIMUM RECOMMENDED WEIGHT UNDER IDEAL CONDITIONS
2. REDUCED CONSIDERING OTHER RISK FACTORS (REDUCTION FACTORS/ MULTIPLIERS)

MODEL FOR CALCULATING THE RECOMMENDED WEIGHT LIMIT

LOAD CONSTANT	KG	Maximum recommended weight under optimal lifting conditions
VERTICAL FACTOR	X	Height of hands from floor at beginning of lifting
DISPLACEMENT FACTOR	X	Vertical displacement distance from origin and destination of lifting
HORIZONTAL FACTOR	X	Maximum load distance from body during lifting
ASYMMETRY FACTOR	X	Angular load displacement from subject's sagittal plane
FREQUENCY FACTOR	X	Frequency of lifting actions per minute considering task duration
GRIP FACTOR	X	Judgement on hand/load coupling

= *RWL Recommended Weight Limit*

ISO 11228-1
Manual Handling – Carrying (ideal conditions)
Step 4 and 5

Table 1 — Recommended limits for cumulative mass related to carrying distance (for general working population)

Carrying distance	Carrying frequency	Cumulative mass			Examples of product m_f
	f_{max}		m_{max}		
m	min^{-1}	kg/min	kg/h	kg/8 h	
20	1	15	750	6 000	5 kg = 3 times/min 15 kg = 1 time/min 25 kg = 0,5 time/min
10	2	30	1 500	10 000	5 kg = 6 times/min 15 kg = 2 times/min 25 kg = 1 time/min
4	4	60	3 000	10 000	5 kg = 12 times/min 15 kg = 4 times/min 25 kg = 1 time/min
2	5	75	4 500	10 000	5 kg = 15 times/min 15 kg = 5 times/min 25 kg = 1 time/min
1	8	120	7 200	10 000	5 kg = 15 times/min 15 kg = 8 times/min 25 kg = 1 time/min

NOTE 1 In the calculation of the cumulative mass, a reference mass of 15 kg and a frequency of carrying of 15 times/min are used for the general working population.
NOTE 2 The total cumulative mass of lifting and manual carrying should never exceed 10 000 kg/day, whichever is the daily duration of work.
NOTE 3 23 kg is included in the 25 kg mass.

- When distance < 1 metre than consider only lifting;
- If lifting and/or lowering in unfavourable conditions than reduce the cumulative mass by 1/3

Risk classification and risk reduction

Risk classification is yes/not type.

At every step, if the recommended limit for manual handling is exceeded, then a risk is presumed and the task should be adapted.

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.

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.

Interpretation of Lifting Index (*mAImR*) Values (proposals)

Lifting Index Value	Exposure level	Interpretation	Consequences
LI ≤ 0,85	Acceptable; No risk	Exposure is acceptable Lifting conditions accommodate > 90% of males and females, including younger and older. (Green zone)	Acceptable: no consequences
0,85 < LI < 1,0	Borderline or very very low exposure	Exposure is acceptable for most members of reference working population but a significant part of it could be exposed to a very low risk level. (Yellow zone)	If possible, improve structural risk factors or take other organizational measures
1,0 < LI < 2,0	Risk present; low level	A significant part of adult industrial working population could be exposed to a low risk level (Red-light zone)	Redesign tasks and workplaces according to priorities
2,0 < LI < 3,0	Risk present; significant level	An increased part of adult industrial working population could be exposed to a significant risk level. (Red zone)	Redesign tasks and workplaces as soon as possible
LI > 3,0	Risk present; high level	Absolutely not suitable for most working population. (Very red - or violet - zone).	Redesign tasks and workplaces immediately

CONSIDERATIONS REGARDING ISO 11228-1

In several contexts, the standard is not "fully" applicable.

In the healthcare sector, patient' handling assessment could hardly be achieved by methods proposed in the standard.

ISO TC 159 (and CEN) recently launched the proposal of a Technical Report on "manual handling of people in the healthcare sector"

(ISO-CD 12296).

Its publication is foreseen in two years.

CONSIDERATIONS REGARDING ISO 11228-1

The standard does not concern analysis of combined tasks in a shift during a day.

With this purpose, reference should be made to updated proposals, based on NIOSH equation, that will be now referred.

DEFINITIONS OF MANUAL HANDLING TASKS

epm

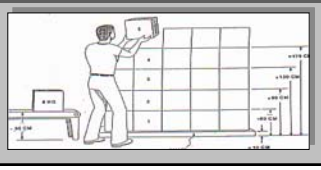
DEFINITION OF DIFFERENT MANUAL LIFTING TYPES

4 types of working tasks involving MANUAL LIFTING can be identified:

TYPE OF MANUAL LIFTING TASK	RISK INDEX
1.MONO TASK that is task involving the lifting of only one (kind of) object (with the same load) using always the same posture (body geometry) between origin and destination .	*LI*
2. COMPOSITE TASK (ex multitask) when lifting objects of one kind only according to different geometries (collection and positioning on shelves placed at several heights and/or depth levels). Practically each geometry takes the name of SUBTASK.	*CLI*
3. VARIABLE TASK when lifting several objects with different weights on shelves placed at different heights and/or depth levels. Each different weight category and each different geometry takes the name of SUBTASK.	*VLI*
4. SEQUENTIAL TASK where workers rotate between a series of single or multi- task lifting rotation slots during a work shift.	*SLI*

NIOSH Composite Lifting Index in multitask : not in the standard

- **Calculation technique used when the loads or vertical / horizontal locations (at origin or destination) vary within the task/s (no more than 10 sub-task)**
- **The Composite Lifting Index (CLI) is computed by a "difficult" formula. Normally it is determined by the most overloading LI incremented by a "quota" determined by the other LI's.**



Sequential Lifting Index in multitask

Ergonomics
Vol. 50, No. 11, November 2007, 1761–1770

Taylor & Francis

New procedure for assessing sequential manual lifting jobs using the revised NIOSH lifting equation

T. R. WATERS*†, M.-L. LU† and E. OCCHIPINTI‡

†National Institute for Occupational Safety and Health, Cincinnati, Ohio, USA
‡Director Research Unit 'Ergonomics of Posture and Movement' EPM, Milan, Italy

A sequential manual lifting job is defined as a job where workers rotate between a series of manual lifting rotation slots or elements at specified time intervals during the course of a work shift. The original NIOSH lifting equation lacked a method for assessing the physical demands of these types of jobs. This paper presents the sequential lifting index (SLI), a new conceptual method for assessing the physical demands for sequential manual lifting jobs. The new method is similar to the composite lifting index (CLI) method that was provided by NIOSH for assessing multi-task jobs. The SLI method expands upon the methods originally provided by NIOSH by providing a simple method for estimating the relative magnitude of physical stress for sequential manual lifting jobs. It should also be useful in assisting safety and health specialists to prioritize or rank hazardous jobs within a plant.

Keywords: Manual lifting; Lifting index; Job rotation; Sequential exposure

VLI

New proposal presented at IEA 2009 Conference – Beijing (August)

The Variable Lifting Index (VLI): A New Method for Evaluating Variable Lifting Tasks Using the Revised NIOSH Lifting Equation

T. Waters, E. Occhipinti, D. Colombini, E. Alvarez, A. Hernandez

Procedures for collecting and organizing data useful for the analysis of variable lifting tasks and for computing the VLI.

D. Colombini, E. Occhipinti, E. Alvarez, A. Hernandez , T.Waters

Research Unit EPM - Foundation Don Gnocchi onlus - Milano (Italy) and CEMOC- EPM - Foundation Policlinico Mangiagalli - Milano (Italy)

Center for Ergonomics and Prevention (CERPIE) - UPC - Barcelona (Spain)

National Institute for Occupational Safety and Health – Cincinnati, Ohio (USA)

A special VLI software will be freely available in EPM, CERPIE-UPC and NIOSH web sites

ISO 11228-2

Manual Handling – Pushing and pulling

ISO 11228-2

This part of ISO 11228 provides methods for identifying the potential hazards and risks associated with whole-body pushing and pulling.

Pushing and pulling, as defined in this part of ISO 11228, is restricted to the following:

- whole-body force exertions (i.e. while standing/walking);
- actions performed by one person
- forces applied by two hands;
- forces used to move or restrain an object;
- forces applied in a smooth and controlled way;
- forces applied without the use of external support(s);
- forces applied on objects located in front of the operator;
- forces applied in an upright position (not sitting).

ISO 11228-2

Method 1

Application of psycophysical criteria and tables for risk assessment of pushing and pulling tasks

Example of table for pushing at a 2 m distance (from ISO 11228-2)

Table A.5

Handle height	Two-handed *pushing* — Maximum acceptable *initial* force — 90 % of population N															
	Frequency of pushing															
	10/min		5/min		4/min		2,5/min		1/min		1/2min		1/5min		1/8h	
cm	0,1667 Hz		0,0833 Hz		0,0667 Hz		0,042 Hz		0,0167 Hz		0,0083 Hz		0,0033 Hz		$3,5 \times 10^{-5}$ Hz	
m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f
2 m pushing distance																
144	135	200	140	220	150					250	170			260	200	310	220
95	89	210	140	240	150					260	170			280	200	340	220
64	57	190	110	220	120					240	140			250	160	310	180

Table A.6

Handle height	Two-handed *pushing* — Maximum acceptable *sustained* force — 90 % of population N															
	Frequency of pushing															
	10/min		5/min		4/min		2,5/min		1/min		1/2min		1/5min		1/8h	
cm	0,1667 Hz		0,0833 Hz		0,0667 Hz		0,042 Hz		0,0167 Hz		0,0083 Hz		0,0033 Hz		$3,5 \times 10^{-5}$ Hz	
m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f
2 m pushing distance																
144	135	100	50	130	80					150	100			180	110	220	140
95	89	100	50	130	70					160	90			190	100	230	130
64	57	100	40	130	60					160	80			180	90	230	120

ISO 11228-2 Risk assessment

Method 2

If the checklist is insufficient and the situation or population is not addressable by the psychophysical tables of Method 1, then Method 2 should be used.

Method 2 adopts a procedure to determine whole-body pushing and pulling force limits according to specific characteristics of the population and the task.

Method 2 is divided into four parts :
Part A — Muscle force limits;
Part B — Skeletal force limits;
Part C — Maximum forces permitted;
Part D — Safety limits.

Method 2 adopts a three-zone approach to determine the level of risk (green, yellow and red).

The procedure is rather difficult to apply

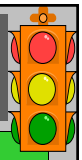
MANUAL HANDLING OF LOADS : PROPOSAL OF FINAL ASSESSMENT BY SYNTHETIC INDEX

$$\frac{\text{Actual load or force (1)}}{\text{Recommended load or force}} = \text{Handling index}$$

(1) lift or pull or push or carry

MANUAL HANDLING (all action such as lifting, push/pull, carry):

HANDLING INDEX AND ITS CONSEQUENCES



Handling index < 0.85
Condition acceptable: no further actions

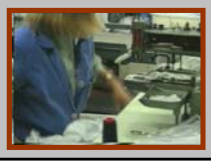
Handling index 0.85 - 1.00
Risk of disease or injury cannot be neglected: it is suggested to redesign the task

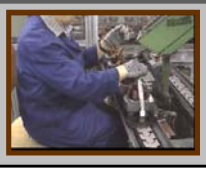
Handling index >1.00 = RISK!!
Primary prevention
Priority to higher index situations
Health surveillance
Education and training

ISO 11228-3

Handling of low loads at high frequency

Devoted to repetitive movements of upper limbs





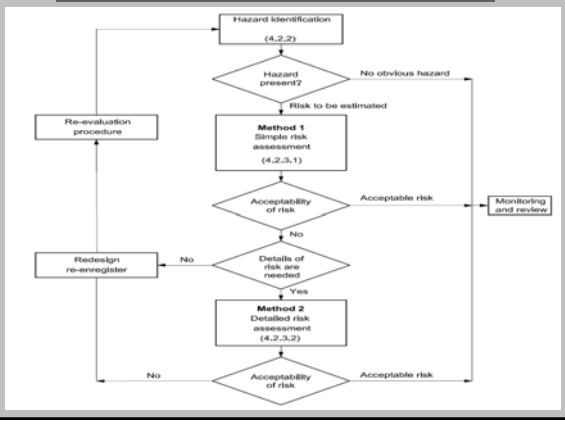
REFERENCE MODEL IN ISO 11228-3

Exposure Assessment of Upper Limb Repetitive Movements: A Consensus Document

Developed by the Technical Committee on Musculoskeletal Disorders of the International Ergonomics Association (IEA) and endorsed by the International Commission on Occupational Health (ICOH)

COLOMBINI D, OCCHIPINTI E, DELLEMAN N, FALLENTIN M, KILBOM A, GRIECO A: Exposure assessment of upper limb repetitive movements: a Consensus Document. In W.Karwowski (Ed): International Encyclopaedia of Ergonomics and Human Factors. London:Taylor and Francis, 2001:52-66.

ISO 11228-3: RISK ASSESSMENT PROCEDURE



ISO 11228-3

Method 1

Simple risk assessment

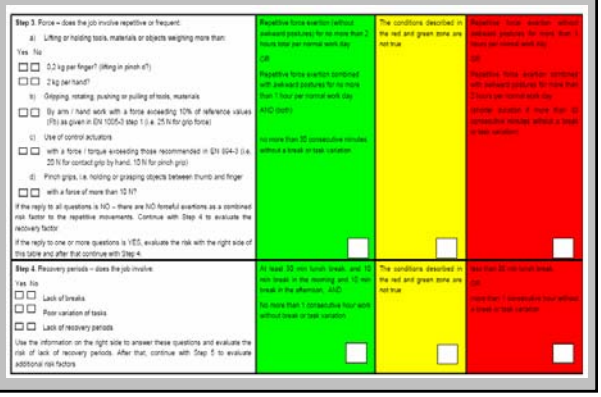
The procedure and checklist model in Annex B is preferred to carry out the simple risk assessment.

As a secondary choice, other simple methods and checklists reported in Annex A could be used.

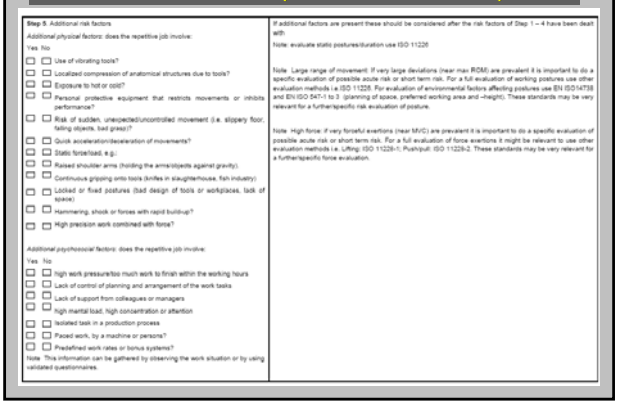
Risk estimation by simple risk assessment should allow the classification of the risk by the 3-zone model (green; yellow; red)

ISO 11228-3- ANNEX B- CHECKLIST (preferred)- METHOD 1 REPETITIVENESS AND POSTURES

ISO 11228-3- ANNEX B- CHECKLIST (preferred)-METHOD 1 FORCE AND RECOVERY PERIODS



ISO 11228-3- ANNEX B- CHECKLIST (preferred) - METHOD 1
ADDITIONAL FACTORS (INCLUDING PSYCHOSOCIAL)



ISO 11228-3- ANNEX A
OTHER TOOLS USEFUL FOR METHOD 1

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 *	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 *	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 *	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) hand/work 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 *	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 *	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

* Method/tool useful for the purposes of Method 1

ISO 11228-3

Method 2
Detailed risk assessment

If the risk estimated by Method 1 is in the 'yellow' or 'red' zone, or if the job is composed by two or more repetitive tasks (multitask job), it is recommended to perform a more detailed risk assessment.

For the purposes of a detailed risk assessment the

OCRA method

is preferred.

ISO 11228-3 - ANNEX A : Why the OCRA method

The following considerations are the basis for the choice of the OCRA method as the reference method for a detailed risk assessment.

- It provides a detailed analysis of all the main mechanical and organizational risk factors for UL WMSDs.
- It uses a common language with respect to traditional methods of task analysis (Predetermined Time Systems).
- It considers all the repetitive tasks involved in a complex (or rotating) job and estimates the overall worker's risk level.
- The OCRA index resulted, in many epidemiological surveys, to be well related with health effects (like occurrence of UL-WMSDs) and so it is a good predictor of the collective risk at a given OCRA level.

ISO 11228-3

Method 2
Detailed risk assessment

Other detailed risk assessment methods are available which can be used for a detailed risk assessment.

Annex D gives basic information about the other detailed risk assessment methods selected

(Strain Index; HAL-TLV-ACGIH)

together with some remarks about their current applicative limits.

ISO 11228-3

Whichever method is used for detailed risk assessment, it should allow to classify the risk by the 3-zone model (green; yellow; red) and to address the consequent action to be taken according to criteria given in Table 1.

Table 1 — Method 2: Final assessment criteria

AREA	RISK LEVEL	CONSEQUENCES
GREEN	NO RISK	Acceptable, no consequences.
YELLOW	VERY LOW RISK	Advisable to set up improvements with regard to structural risk factors (posture, force, technical actions, etc.) or to suggest other organizational measures.
RED	RISK	Redesign of tasks and workplaces according to priorities is recommended.

ISO 11228-3- MAIN TEXT AND ANNEX C

FULL DETAILS OF OCRA METHOD

ISO 11228-3
FACTORS CONSIDERED IN RISK ASSESSMENT

DURATION

FREQUENCY OF ACTIONS

ADDITIONAL FACTORS

USE OF FORCE

AWKWARD POSTURES AND MOVEMENTS

LACK OF RECOVERY PERIODS

OCRA INDEX

ATA

(NUMBER OF TECHNICAL ACTIONS ACTUALLY CARRIED OUT IN THE SHIFT)

RTA

(REFERENCE NUMBER OF TECHNICAL ACTIONS IN THE SHIFT)

ISO 11228-3- ANNEX C
OCRA Method: Final assessment criteria

ZONE	OCRA VALUES	RISK LEVEL	CONSEQUENCES
GREEN	≤ 2.2	NO RISK. UL-WMSDs (PA) forecast is not significantly different from the one expected in the reference population.	Acceptable. No consequences
YELLOW	2.3 - 3.5	VERY LOW RISK. UL-WMSDs (PA) forecast is higher than previous but lower than twice the one expected in the reference population.	Advisable to set up improvements with regard to structural risk factors (posture, force, technical actions, etc.) or to suggest other organizational measures.
RED	> 3.5	RISK. UL-WMSDs (PA) forecast is higher than twice the one expected in the reference population. The higher the index, the higher the risk.	Redesign of tasks and workplace according to priorities is recommended.

It should be underlined that the OCRA index "critical values" reported in Table C.5 should be used as a help to better frame the risk assessment and guide any consequent preventative actions more effectively, rather than rigid numbers splitting results between "risk" or "no risk".

ISO 11228-3- ANNEX D

BASIC INFORMATION ON OTHER METHODS FOR A DETAILED RISK ASSESSMENT

- *STRAIN INDEX*
- *HAL/ACGIH TLV*

ISO 11228-3 – REFERENCES AND WEBSITES

IN THE LIST OF REFERENCES A LINK IS PROVIDED TO THE FOLLOWING WEBSITES:

FOR OCRA:

www.epmresearch.org

FOR STRAIN INDEX:

http://ergocenter.srph.tamhsc.edu/winsi/

FOR HAL/ACGIH TLV:

http://umrerc.engin.umich.edu/jobdatabase/RERC2/HAL/ApplyingTLV.htm

PERSPECTIVES

STRAIN INDEX

In recent papers Authors give practical suggestions on how to apply the Strain Index method especially for jobs where multiple forces/tasks are developed.

Users of ISO 11228-3 are addressed to this and similar papers for a better knowledge on Strain index method application especially for multiple tasks.

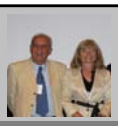
HAL-AICGH-TLV

In one 2005 paper from the "Michigan Group" that inspired the HAL/ACGIH TLV procedure the authors observed that even at "acceptable" levels of hand activity, many workers will still experience symptoms and/or upper extremity musculoskeletal disorders.

Similar findings (the action limit could be not considered as a "safe" limit) were addressed in other papers and some authors proposed to lower the Action Limits (for instance to a peak force of maximum 3-4 for an HAL of 1) for a broader prevention of UL WMSDs.

Users of ISO 11228-3 are addressed to those and similar papers when using the HAL/ACGIH TLV method and interpret the corresponding results.

OCRA



OCRA INDEX method could result rather difficult and time consuming particularly when complex or multiple tasks should be analysed.

⇩

It is suggested to use the OCRA Checklist method,

much easier for risk assessment purposes, since it is based on the same general framework, criteria and definition of the "Consensus Document" assumed as a reference in the standard

OCRA

Updates on OCRA (Index and Checklist)

Multitask Analysis

1. A "traditional" procedure has been proposed, whose results could be defined as "time weighted average", It seems to be appropriate when considering rotations among tasks that are performed very frequently, for instance almost once every hour (or for shorter periods)
2. A new procedure, based on a more realistic concept that the most stressful task is the minimum starting point. It is more appropriate when rotation among repetitive tasks is less frequent (i.e. once every 1.5 or more hours).

The new procedure is actually esperimentally used also for evaluating multiple repetitive tasks with long term rotations (week; moonth; year).

www.epmresearch.org

IN THE WEBSITE SOFTWARE AND TOOLS FOR USING OCRA METHODS (OCRA INDEX AND OCRA CHECKLIST) ALSO FOR MULTITASK ANALYSIS ARE FREELY AVAILABLE

ISO CD 12259 (Technical Report)

Ergonomics – Application document for standards on manual handling (ISO 11228 – 1,2,3) and working postures (ISO 11226).

The ISO (and CEN) groups are now going to produce "technical documents" that should facilitate the practical application of the ISO 11228 (and EN 1005) series

The ISO application document will contain the following:

- Detailed definition of field of application of different standards;
- Key enters (simple parametric hazard identification) to different standards;
- Updates of classification systems in part 1 (lifting) and 2 (push/pull);
- Updates of the main selected methods used in the standards with particular reference to multitask analysis of lifting and repetitive tasks;
- Reference to websites relevant for applying the standards.

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