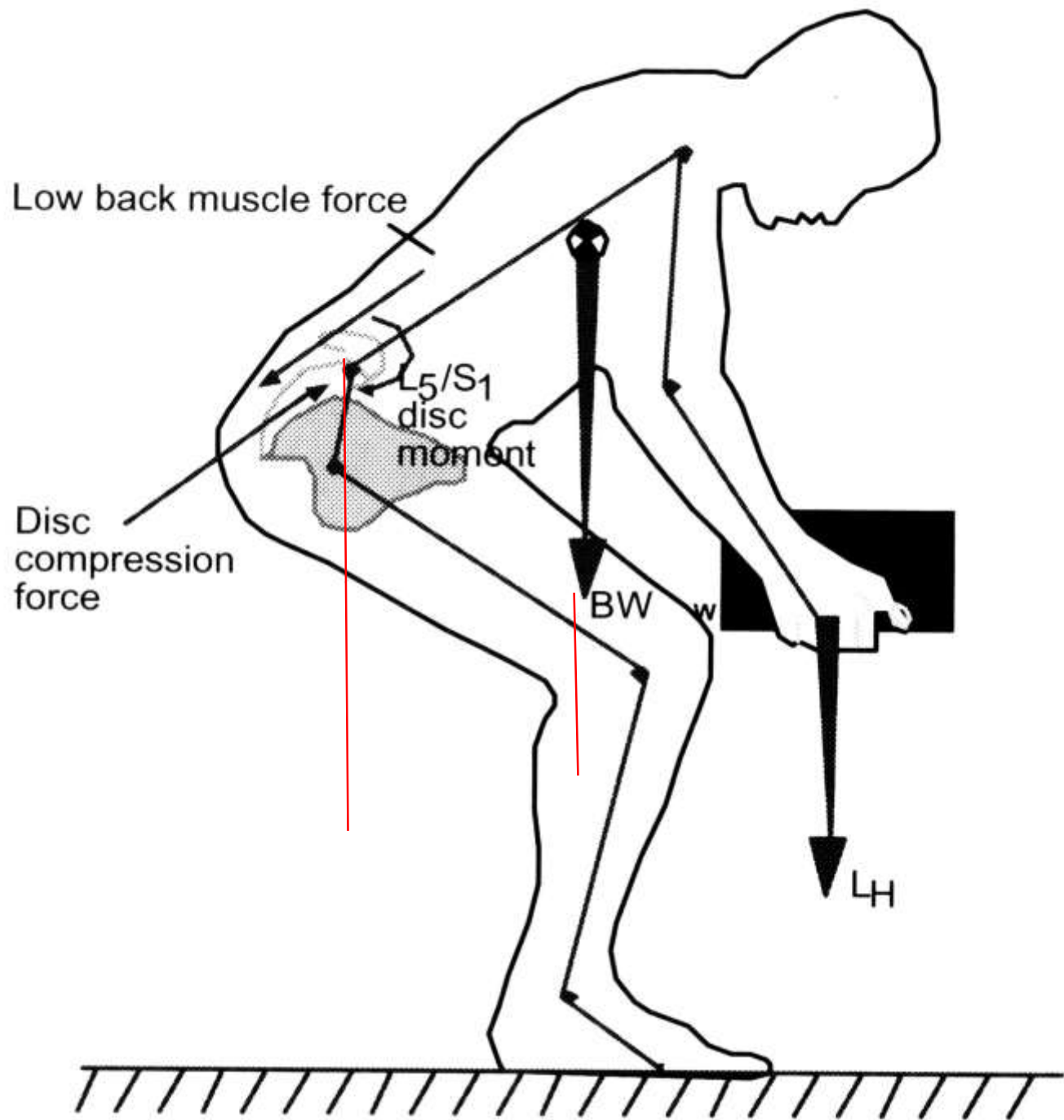


Unità didattica 5:

La movimentazione manuale dei carichi

La valutazione delle posture incongrue nei luoghi di lavoro e la riprogettazione dei luoghi di lavoro



Allegato XXXIII

- La prevenzione dovrà considerare in modo integrato l'insieme degli elementi di riferimento e dei fattori individuali di rischio riportato nel presente allegato

1. Caratteristiche del carico.

La movimentazione manuale di un carico può costituire un rischio di patologie da sovraccarico biomeccanico, in particolare dorso-lombari nei seguenti casi:

- il carico è troppo pesante;
- è ingombrante o difficile da afferrare;
- è in equilibrio instabile o il suo contenuto rischia di spostarsi;
- è collocato in una posizione tale per cui deve essere tenuto o maneggiato a una certa distanza dal tronco o con una torsione o inclinazione del tronco;
- può, a motivo della struttura esterna e/o della consistenza, comportare lesioni per il lavoratore, in particolare in caso di urto.

2. Sforzo fisico richiesto.

Lo sforzo fisico può presentare rischi di patologie da sovraccarico biomeccanico, in particolare dorso-lombari nei seguenti casi:

- è eccessivo;
- può essere effettuato soltanto con un movimento di torsione del tronco;
- può comportare un movimento brusco del carico;
- è compiuto col corpo in posizione instabile.

3. Caratteristiche dell'ambiente di lavoro.

Le caratteristiche dell'ambiente di lavoro possono aumentare le possibilità di rischio di patologie da sovraccarico biomeccanico, in particolare dorso-lombari nei seguenti casi:

- lo spazio libero, in particolare verticale, è insufficiente per lo svolgimento dell'attività richiesta;
- il pavimento è ineguale, quindi presenta rischi di inciampo o è scivoloso
- il posto o l'ambiente di lavoro non consentono al lavoratore la movimentazione manuale di carichi a un'altezza di sicurezza o in buona posizione;
- il pavimento o il piano di lavoro presenta dislivelli che implicano la manipolazione del carico a livelli diversi;
- il pavimento o il punto di appoggio sono instabili;
- la temperatura, l'umidità o la ventilazione sono inadeguate.

4. Esigenze connesse all'attività.

L'attività può comportare un rischio di patologie da sovraccarico biomeccanico, in particolare dorso-lombari se comporta una o più delle seguenti esigenze:

- sforzi fisici che sollecitano in particolare la colonna vertebrale, troppo frequenti o troppo prolungati;
- pause e periodi di recupero fisiologico insufficienti;
- distanze troppo grandi di sollevamento, di abbassamento o di trasporto;
- un ritmo imposto da un processo che non può essere modulato dal lavoratore.

RIFERIMENTI A NORME TECNICHE

- Le norme tecniche della serie ISO 11228 (parti 1-2-3) relative alle attività di movimentazione manuale sono da considerarsi tra quelle previste all'articolo *168 ndr* comma 3.

**APPLICATIONS MANUAL
FOR THE REVISED NIOSH LIFTING EQUATION**

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January 1994

Table 1
Horizontal Multiplier

H	HM	H	HM
in		cm	
≤10	1.00	≤25	1.00
11	.91	28	.89
12	.83	30	.83
13	.77	32	.78
14	.71	34	.74
15	.67	36	.69
16	.63	38	.66
17	.59	40	.63
18	.56	42	.60
19	.53	44	.57
20	.50	46	.54
21	.48	48	.52
22	.46	50	.50
23	.44	52	.48
24	.42	54	.46
25	.40	56	.45
>25	.00	58	.43
		60	.42
		63	.40
		>63	.00

Table 2
Vertical Multiplier

V	VM	V	VM
in		cm	
0	.78	0	.78
5	.81	10	.81
10	.85	20	.84
15	.89	30	.87
20	.93	40	.90
25	.96	50	.93
30	1.00	60	.96
35	.96	70	.99
40	.93	80	.99
45	.89	90	.96
50	.85	100	.93
55	.81	110	.90
60	.78	120	.87
65	.74	130	.84
70	.70	140	.81
>70	.00	150	.78
		160	.75
		170	.72
		175	.70
		>175	.00

Table 3
Distance Multiplier

D	DM	D	DM
in		cm	
≤10	1.00	≤25	1.00
15	.94	40	.93
20	.91	55	.90
25	.89	70	.88
30	.88	85	.87
35	.87	100	.87
40	.87	115	.86
45	.86	130	.86
50	.86	145	.85
55	.85	160	.85
60	.85	175	.85
70	.85	>175	.00
>70	.00		

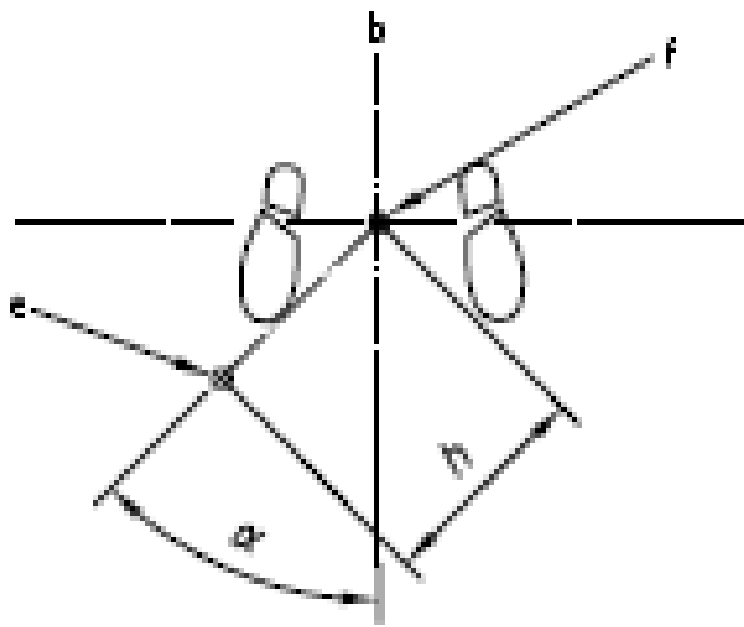
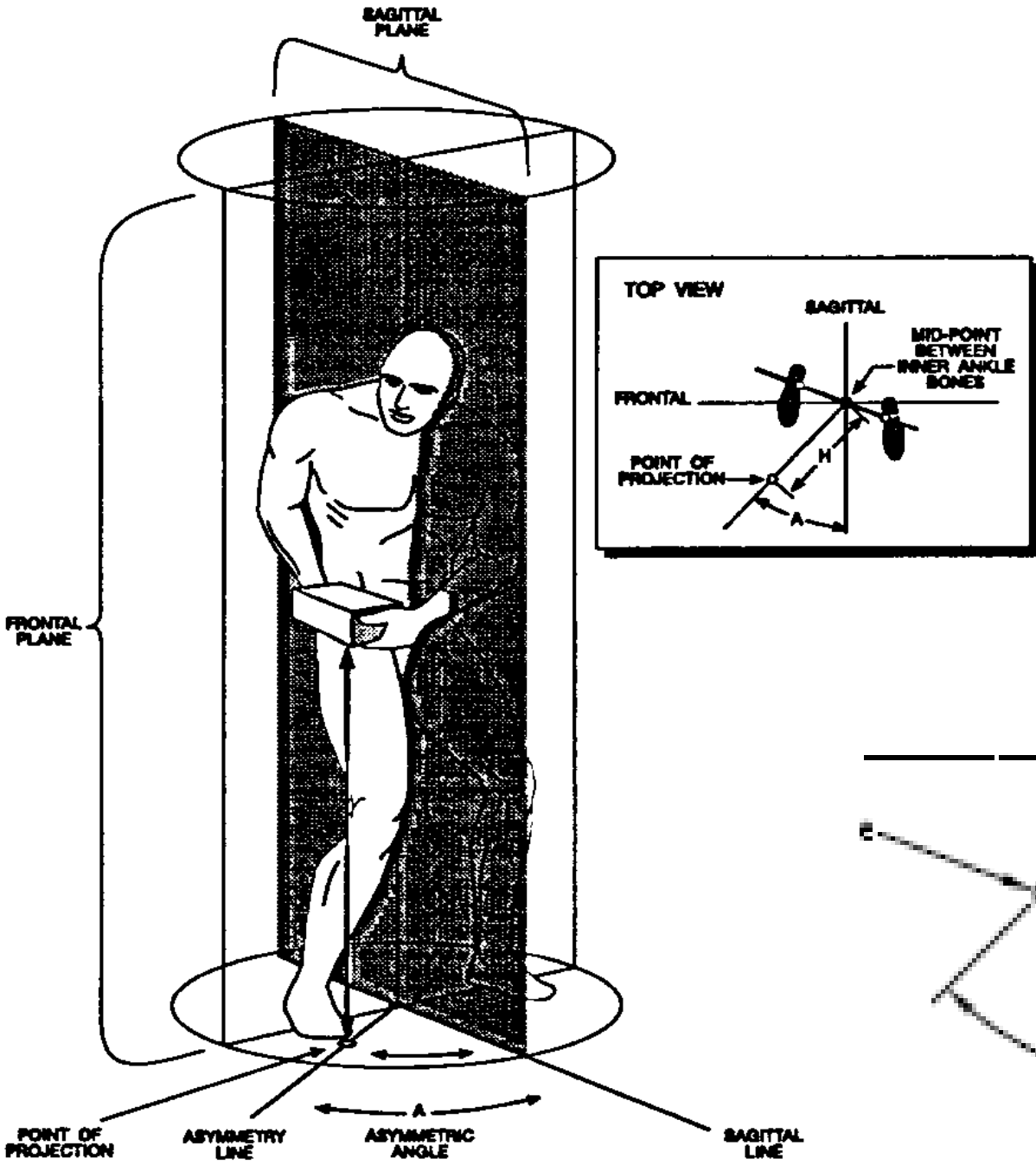


Table 4
Asymmetric Multiplier

A	AM
deg	
0	1.00
15	.95
30	.90
45	.86
60	.81
75	.76
90	.71
105	.66
120	.62
135	.57
>135	.00

Table 5
Frequency Multiplier Table (FM)

Frequency Lifts/min (F) ‡	Work Duration					
	≤ 1 Hour		>1 but ≤ 2 Hours		>2 but ≤ 8 Hours	
	V < 30†	V ≥ 30	V < 30	V ≥ 30	V < 30	V ≥ 30
≤0.2	1.00	1.00	.95	.95	.85	.85
0.5	.97	.97	.92	.92	.81	.81
1	.94	.94	.88	.88	.75	.75
2	.91	.91	.84	.84	.65	.65
3	.88	.88	.79	.79	.55	.55
4	.84	.84	.72	.72	.45	.45
5	.80	.80	.60	.60	.35	.35
6	.75	.75	.50	.50	.27	.27
7	.70	.70	.42	.42	.22	.22
8	.60	.60	.35	.35	.18	.18
9	.52	.52	.30	.30	.00	.15
10	.45	.45	.26	.26	.00	.13
11	.41	.41	.00	.23	.00	.00
12	.37	.37	.00	.21	.00	.00
13	.00	.34	.00	.00	.00	.00
14	.00	.31	.00	.00	.00	.00
15	.00	.28	.00	.00	.00	.00
>15	.00	.00	.00	.00	.00	.00

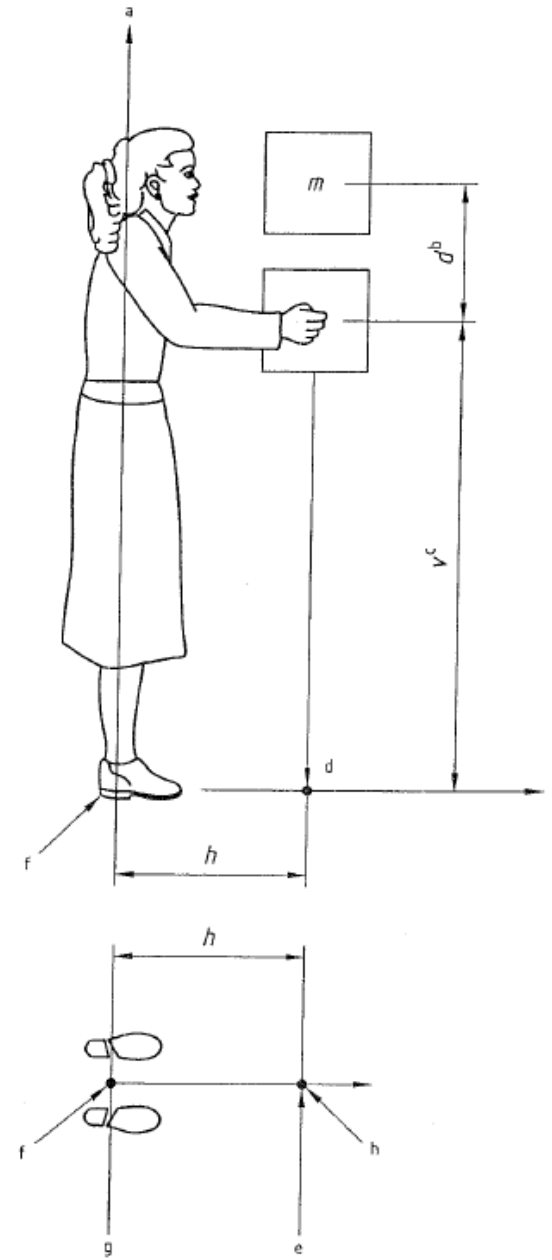
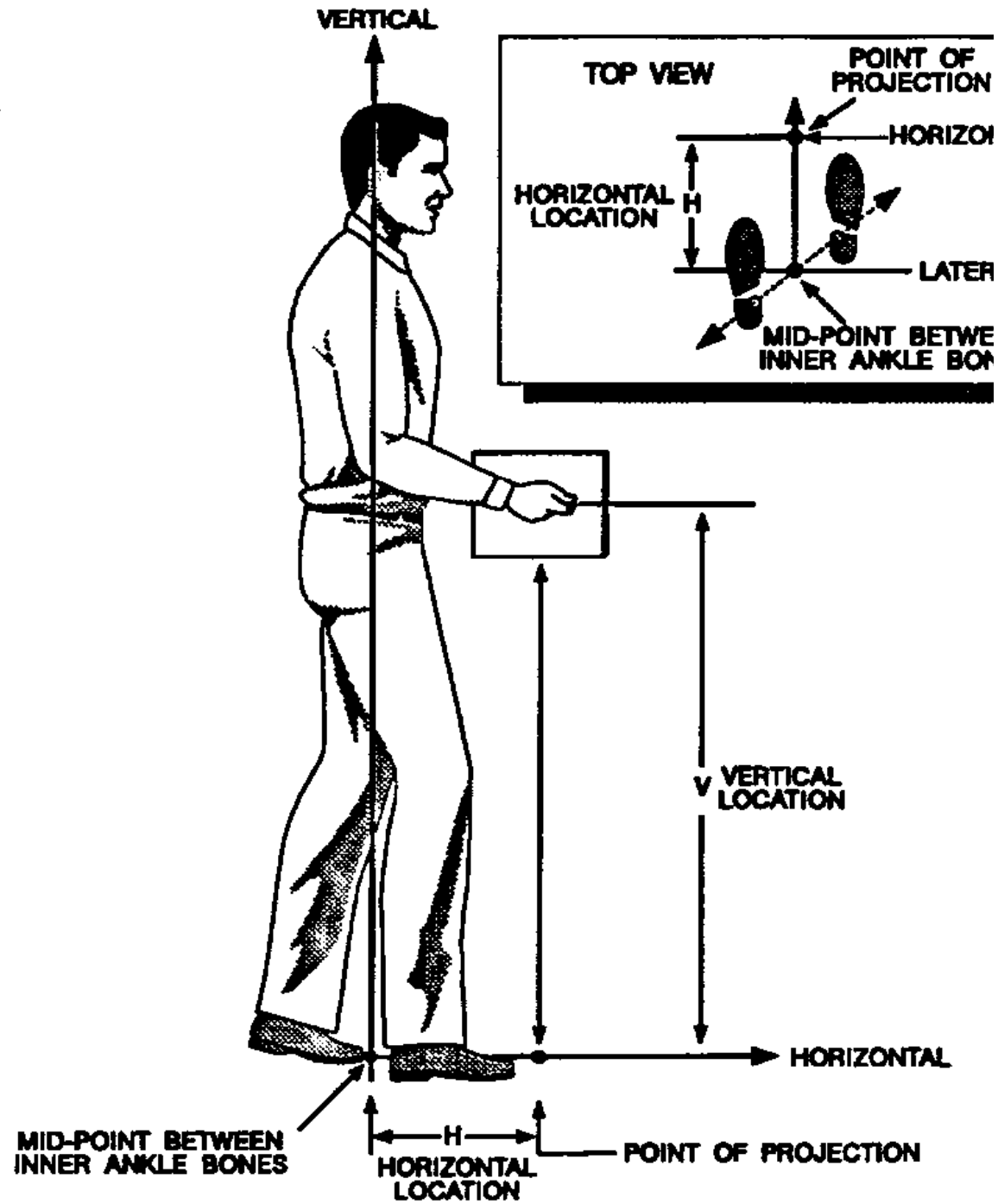
- 1. Short-duration** defines lifting tasks that have a work duration of *one hour or less*, followed by a recovery time equal to 1.2 times the work time [i.e., at least a 1.2 recovery-time to work-time ratio (RT/WT)].
- 2. Moderate-duration** defines lifting tasks that have a duration of *more than one hour, but not more than two hours*, followed by a recovery period of at least 0.3 times the work time [i.e., at least a 0.3 recovery-time to work-time ratio (RT/WT)].
- 3. Long-duration** defines lifting tasks that have a duration of *between two and eight hours*, with standard industrial rest allowances (e.g., morning, lunch, and afternoon rest breaks).

Table 7
Coupling Multiplier

Coupling Type	Coupling Multiplier	
	V < 30 inches (75 cm)	V ≥ 30 inches (75 cm)
Good	1.00	1.00
Fair	0.95	1.00
Poor	0.90	0.90

- 1. An optimal handle design has .75 - 1.5 inches (1.9 to 3.8 cm) diameter, \geq 4.5 inches (11.5 cm) length, 2 inches (5 cm) clearance, cylindrical shape, and a smooth, non-slip surface.**
- 3. An optimal container design has \leq 16 inches (40 cm) frontal length, \leq 12 inches (30 cm) height, and a smooth non-slip surface.**
- 5. A container is considered less than optimal if it has a frontal length $>$ 16 inches (40 cm), height $>$ 12 inches (30 cm), rough or slippery surfaces, sharp edges, asymmetric center of mass, unstable contents, or requires the use of gloves. A loose object is**

		METRIC	U.S. CUSTOMARY
Load Constant	LC	23 kg	51 lb
Horizontal Multiplier	HM	(25/H)	(10/H)
Vertical Multiplier	VM	1-(.003 V-75)	1-(.0075 V-30)
Distance Multiplier	DM	.82 + (4.5/D)	.82 + (1.8/D)
Asymmetric Multiplier	AM	1-(.0032A)	1-(.0032A)
Frequency Multiplier	FM	From Table 5	From Table 5
Coupling Multiplier	CM	From Table 7	From Table 7



- | | | | |
|---|---|---|-------------------------------------|
| a | Vertical | e | Horizontal |
| b | Vertical travel displacement | f | Mid-point between inner ankle bones |
| c | Vertical location | g | Lateral |
| d | Projection from centre of gravity of load | h | Centre of load |

JOB ANALYSIS WORKSHEET

DEPARTMENT Manufacturing
JOB TITLE Punch Press Operator
ANALYST'S NAME _____
DATE _____

JOB DESCRIPTION
Loading supply stock onto
punch press machine
 Example 1

STEP 1. Measure and record task variables

Object Weight (lbs)		Hand Location (in)				Vertical Distance (in)	Asymmetric Angle (degrees)		Frequency Rate lifts/min	Duration (HRS)	Object Coupling
		Origin		Dest.			Origin	Destination			
L (AVG.)	L (Max)	H	V	H	V	D	A	A	F	C	
44	44	23	15	23	63	48	0	0	<.2	<1	Fair

STEP 2. Determine the multipliers and compute the RWL's

$$RWL = LC \cdot HM \cdot VM \cdot DM \cdot AM \cdot FM \cdot CM$$

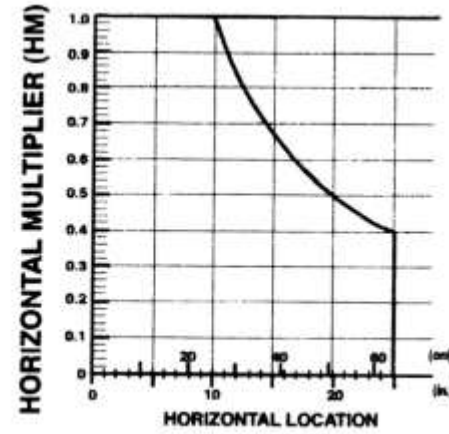
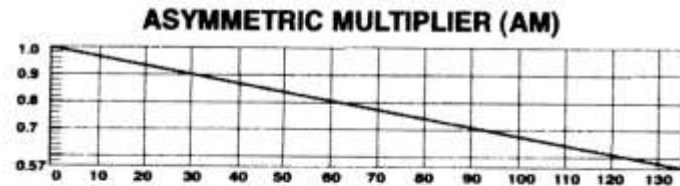
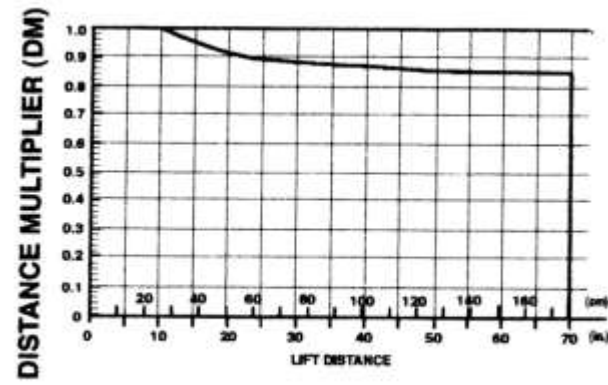
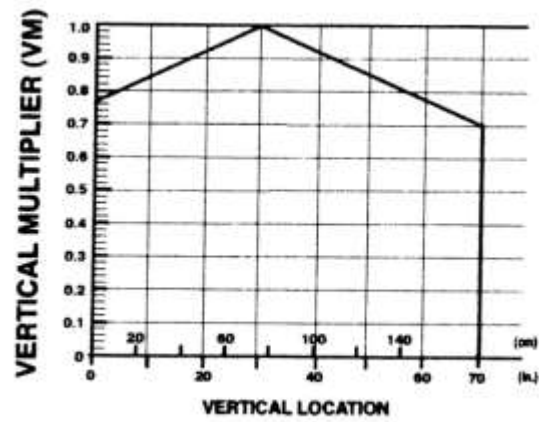
ORIGIN $RWL = 51 \cdot .44 \cdot .89 \cdot .86 \cdot 1.0 \cdot 1.0 \cdot .95 = 16.3 \text{ Lbs}$

DESTINATION $RWL = 51 \cdot .44 \cdot .75 \cdot .86 \cdot 1.0 \cdot 1.0 \cdot 1.0 = 14.5 \text{ Lbs}$

STEP 3. Compute the LIFTING INDEX

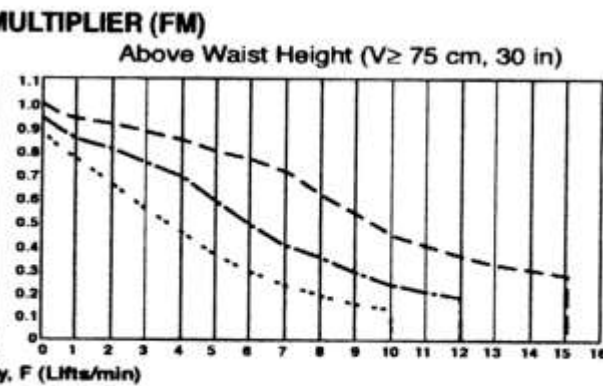
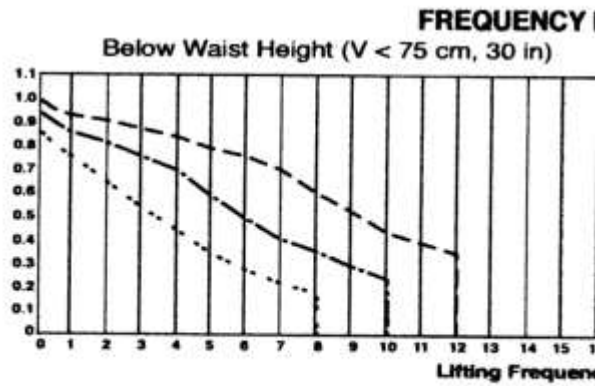
ORIGIN LIFTING INDEX = $\frac{\text{OBJECT WEIGHT (L)}}{RWL} = \frac{44}{16.3} = 2.7$

DESTINATION LIFTING INDEX = $\frac{\text{OBJECT WEIGHT (L)}}{RWL} = \frac{44}{14.5} = 3.0$



COUPLING MULTIPLIER (CM)

Couplings	V < 75 cm (30 in)	V > 75 cm (30 in)
Good	1.00	1.00
Fair	.95	1.00
Poor	.90	.90



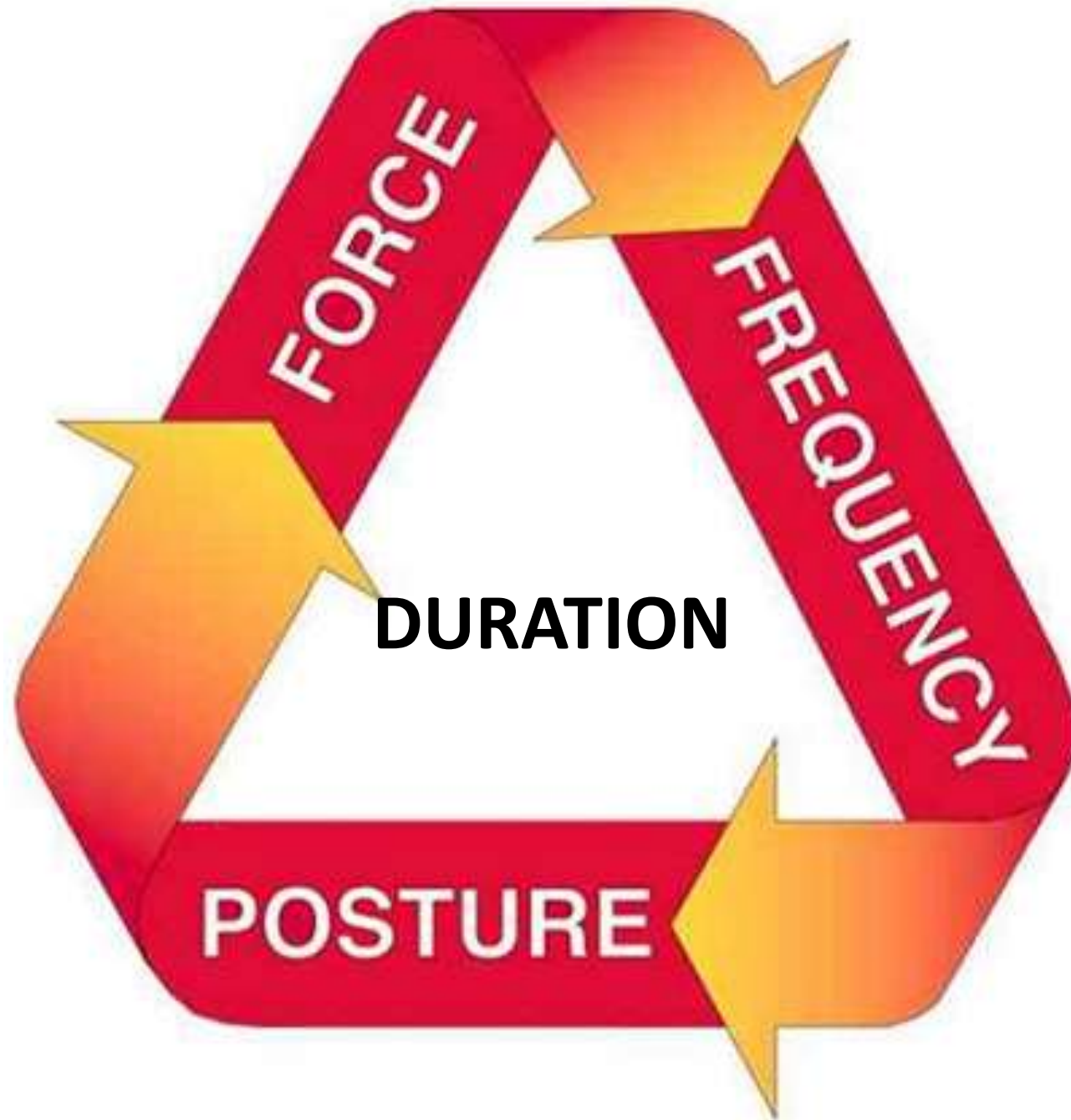
--- 1 hr TOP LINE
 — 1 to 2 hrs MIDDLE LINE
 - - - 2 to 8 hrs BOTTOM LINE

NIOSH equation does not apply

- ◆ **Lifting/lowering with one hand**
- ◆ **Lifting/lowering for over 8 hours**
- ◆ **Lifting/lowering while seated or kneeling**
- ◆ **Lifting/lowering in a restricted work space**
- ◆ **Lifting/lowering unstable objects**

NIOSH Does not

- ◆ **Lifting/lowering while carrying, pushing or pulling**
- ◆ **Lifting/lowering with wheelbarrows or shovels**
- ◆ **Lifting/lowering with *high speed* motion (faster than about 30 inches/second)**
- ◆ **Lifting/lowering with unreasonable foot/floor coupling (< 0.4 coefficient of friction between the sole and the floor)**
- ◆ **Lifting/lowering in an unfavorable environment (i.e., temperature significantly outside 66-79° F (19-26° C) range; relative humidity outside 35-50% range)**



Il Technical Report ISO/TR 12295

e la movimentazione manuale dei carichi

**TECHNICAL
REPORT**

**ISO/TR
12295**

First edition
2014-04-01

DML
Dot. DANIELLO

**Ergonomics — Application document
for International Standards on manual
handling (ISO 11228-1, ISO 11228-2
and ISO 11228-3) and evaluation of
static working postures (ISO 11226)**

*Ergonomie — Document pour l'application des Normes
Internationales sur la manutention manuelle (ISO 11228-1, ISO
11228-2 et ISO 11228-3) et l'évaluation des positions statiques de
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Technical Report

- A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.
- ISO/TR 12295 was prepared by Technical Committee ISO/TC 159, Ergonomics, Subcommittee SC 3, Anthropometry and biomechanics
- This information is fully consistent with the methods proposed in the standards, and does not introduce any change to the application of the mathematical risk level calculations defined in the existing standards.

scope

- This Technical Report serves as an application guide that offers a simple risk assessment methodology for small and medium enterprises and for non professional activities. For expert users, more detailed assessment methodologies are presented in the annexes.
- It is emphasized that the quick assessment method is best completed using a **partecipatory apporach**.

a dual scope

- To identify situations in which apply the ISO 11228
- Provide a “quick assessment” to identify activities that are acceptable, critical or not acceptable

FIRST LEVEL

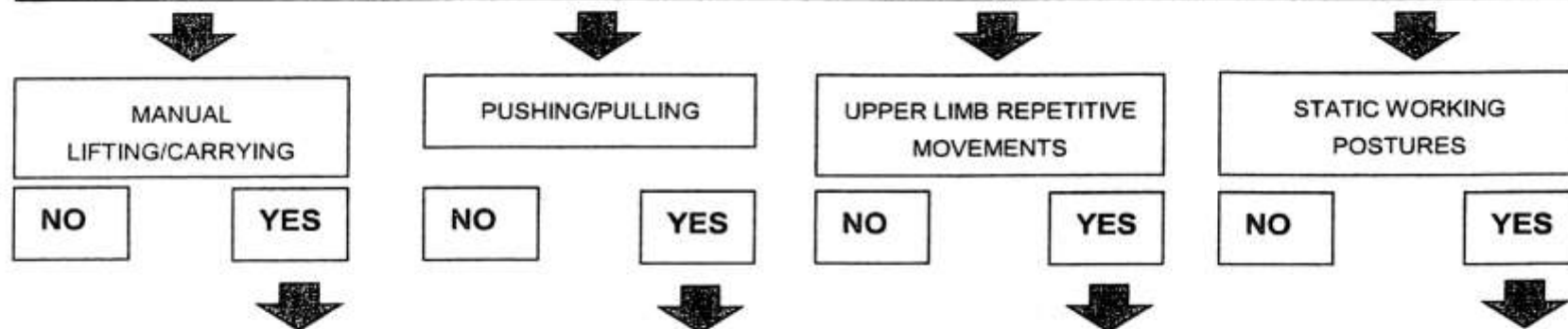
“Key Questions” will direct you to the relevant standard or standards that are appropriate for your job conditions. “Key Questions” are designed to identify if hazards are present and whether a further analysis (using relevant standards) is necessary

Key Question: is there manual lifting/lowering or carrying of an object of 3 Kg or more present ?

FIRST LEVEL: Key Questions

The "Key Questions" are designed to assess if there is any relevance of the basic conditions of the job to the specific standards. If there is a relevance, then the user is directed to the applicable "Quick Assessment" questions that will give an approximated indication of the magnitude of the potential hazard, either low/no risk or the presence of risk conditions. If hazards are indicated then the user is directed to the appropriate standard.

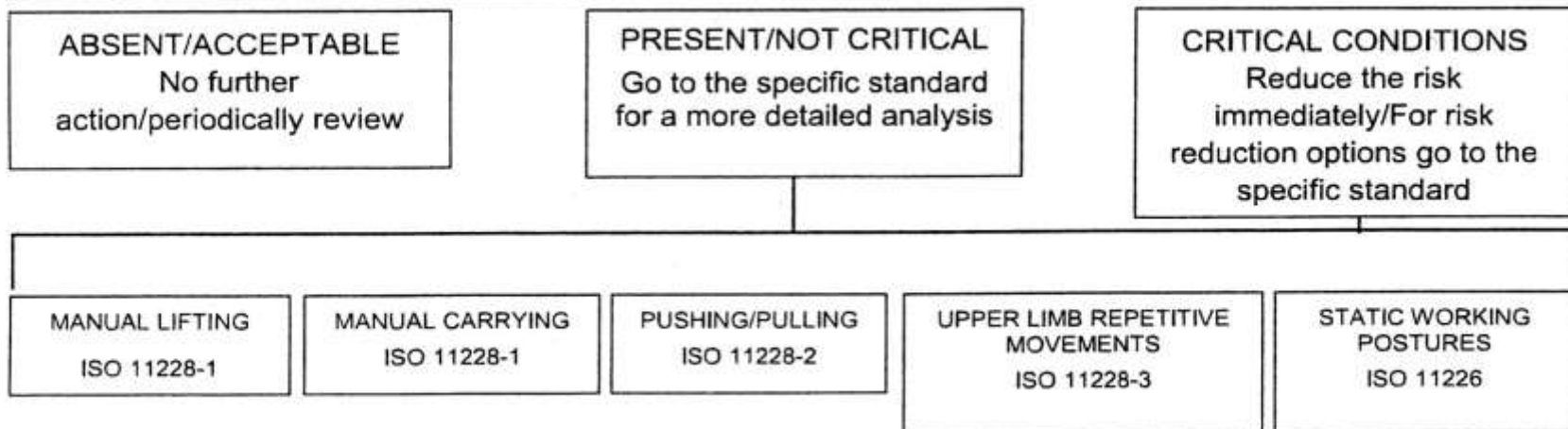
Note Lifting and lowering are treated identically in the risk assessments.



SECOND LEVEL: Quick Assessment

The "Quick Assessment" aims to identify (without calculation) through the use of pre-defined scenarios, the presence of two extreme exposure conditions:

- absence of significant risk or presence of acceptable conditions;
- critical conditions (presence of significant and unacceptable risk).



SECOND LEVEL

Quick Assessment aims to identify, without the need for calculation, the presence of two opposite exposure conditions:

- the absence of risk or acceptable risk;
- the presence of a relevant risk (or the presence of extremely hazardous risk factors that are not acceptable), also labeled as critical conditions (critical code).

preliminary additional aspects

- A preliminary check of some adverse environmental, object and organizational conditions is highly recommended since those conditions could represent an additional risk in manual handling

Is the working environment unfavourable for manual lifting and carrying?		
Presence of extreme (low or high) temperature	NO	YES
Presence of slippery, uneven, unstable floor	NO	YES
Presence of insufficient space for lifting and carrying	NO	YES
Are there unfavourable object characteristics for manual lifting and carrying?		
The size of object reduces the operator's view and hinder movement	NO	YES
The centre of gravity of the load is not stable (example: liquids, items moving around inside of object)	NO	YES
The object shape/configuration presents sharp edges, surfaces or protrusions	NO	YES
The contact surfaces are too cold or too hot	NO	YES
Does the task(s) with manual lifting or carrying last more than 8 hours a day?	NO	YES
<p>If all of the questions are answered "NO", then continue the "Quick Assessment". If at least one of the questions is answered "YES", then APPLY The standard ISO 11228-1. The consequent specific additional risks HAVE TO be carefully considered to MINIMIZE THESE RISKS.</p>		

QUICK ASSESSMENT

Lifting acceptable condition

3 TO 5 kg	Asymmetry (e.g. body rotation, trunk twisting) is absent	NO	YES
	Load is maintained close to the body	NO	YES
	Load vertical displacement is between hips and shoulders	NO	YES
	Maximum frequency: less than 5 lifts per minute	NO	YES
5,1 TO 10 kg	Asymmetry (e.g. body rotation, trunk twisting) is absent	NO	YES
	Load is maintained close to the body	NO	YES
	Load vertical displacement is between hips and shoulder	NO	YES
	Maximum frequency: less than 1 lift per minute	NO	YES
MORE THAN 10 kg	Loads of more than 10 kg are absent	NO	YES
<p>If all of the questions are answered "YES", then the examined task is in green area (ACCEPTABLE) and it is not necessary to continue the risk evaluation. If at least one of the questions is answered "NO", then evaluate the task(s) by ISO 11228-1.</p>			

If all of the questions are answered YES ...
it is not necessary to continue the risk evaluation

the examined task is

ACCEPTABLE

If at least one of the questions is answered “YES”,
then **APPLY** The standard ISO 11228-1

QA: Carrying acceptable condition

Recommended Cumulative Mass (total load (in kg) carried during the given durations for the specified distance below): is the cumulative mass carried LESS than recommended values considering the distance (more/less than 10 meters) and duration (1 minute; 1 hour; 8 hours) ?				
Duration	Distance ≤ 10 m per action	Distance > 10 m per action		
8 hrs	10000 kg	6000 kg	NO	YES
1 h	1500 kg	750 kg	NO	YES
1 min	30 kg	15 kg	NO	YES
	Awkward postures during the carrying are not present		NO	YES
<p>If all of the questions are answered "YES", then the examined task is in green area (ACCEPTABLE) and it is not necessary to continue the risk evaluation. If at least one of the questions is answered "NO", then evaluate the task(s) by ISO 11228-1.</p>				

...it is not necessary to
continue the risk evaluation
the examined task is
ACCEPTABLE

LIFT/LOWER critical condition

If one or more of the following conditions is present, consider risk as HIGH and it is necessary to proceed with task re-design.

CRITICAL CONDITION: presence of lifting/carrying task lay-out and frequency conditions exceeding the maximum suggested

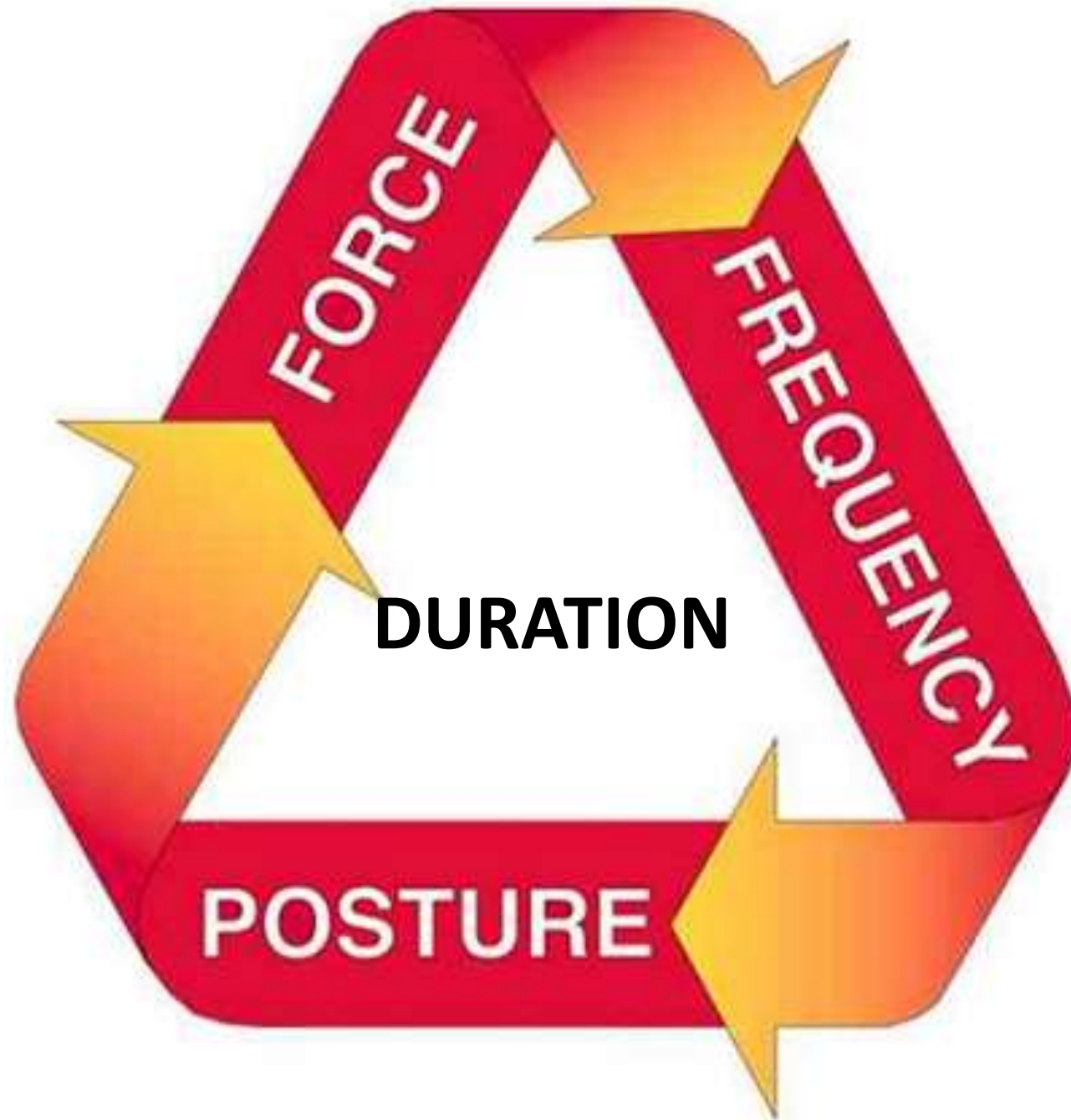
VERTICAL LOCATION	The hand location at the beginning/end of the lift is higher than 175 cm or lower than 0 cm.	NO	YES
VERTICAL DISPLACEMENT	The vertical distance between the origin and the destination of the lifted object is more than 175 cm	NO	YES
HORIZONTAL DISTANCE	The horizontal distance between the body and load is greater than full arm reach	NO	YES
ASYMMETRY	Extreme body twisting without moving the feet	NO	YES
FREQUENCY	More than 15 lifts per min of SHORT DURATION (manual handling lasting no more than 60 min consecutively in the shift, followed by at least 60 minutes of break-light task)	NO	YES
	More than 12 lifts per min of MEDIUM DURATION (manual handling lasting no more than 120 min consecutively in the shift, followed by at least 30 minutes of break--light task)	NO	YES
	More than 8 lift per min of LONG DURATION (manual handling lasting more than 120 min consecutively in the shift)	NO	YES

Critical condition

CRITICAL CONDITION for lifting/carrying: presence of loads exceeding the following limits			
Males (18-45 years)	25 kg	NO	YES
Females (18-45 years)	20 kg	NO	YES
Males (<18 or >45 years)	20 kg	NO	YES
Females (<18 or >45 years)	15 kg	NO	YES
CRITICAL CONDITION FOR CARRYING: presence of cumulative carried mass greater than those indicated			
Carrying distance 20 m or more in 8 hours / Carrying distance per action 20 m or more	6000 kg in 8 hours	NO	YES
Carrying distance less than 20 m in 8 hours / Carrying distance per action less than 20 m	10000 kg in 8 hours	NO	YES
<p>If at least one of the conditions have a "YES" response then a critical condition is present. If a critical condition is present then apply ISO 11228-1 for identifying urgent corrective actions.</p>			

If at least one have a YES

APPLY ISO 11228-1 for identifying URGENT corrective actions



CLI

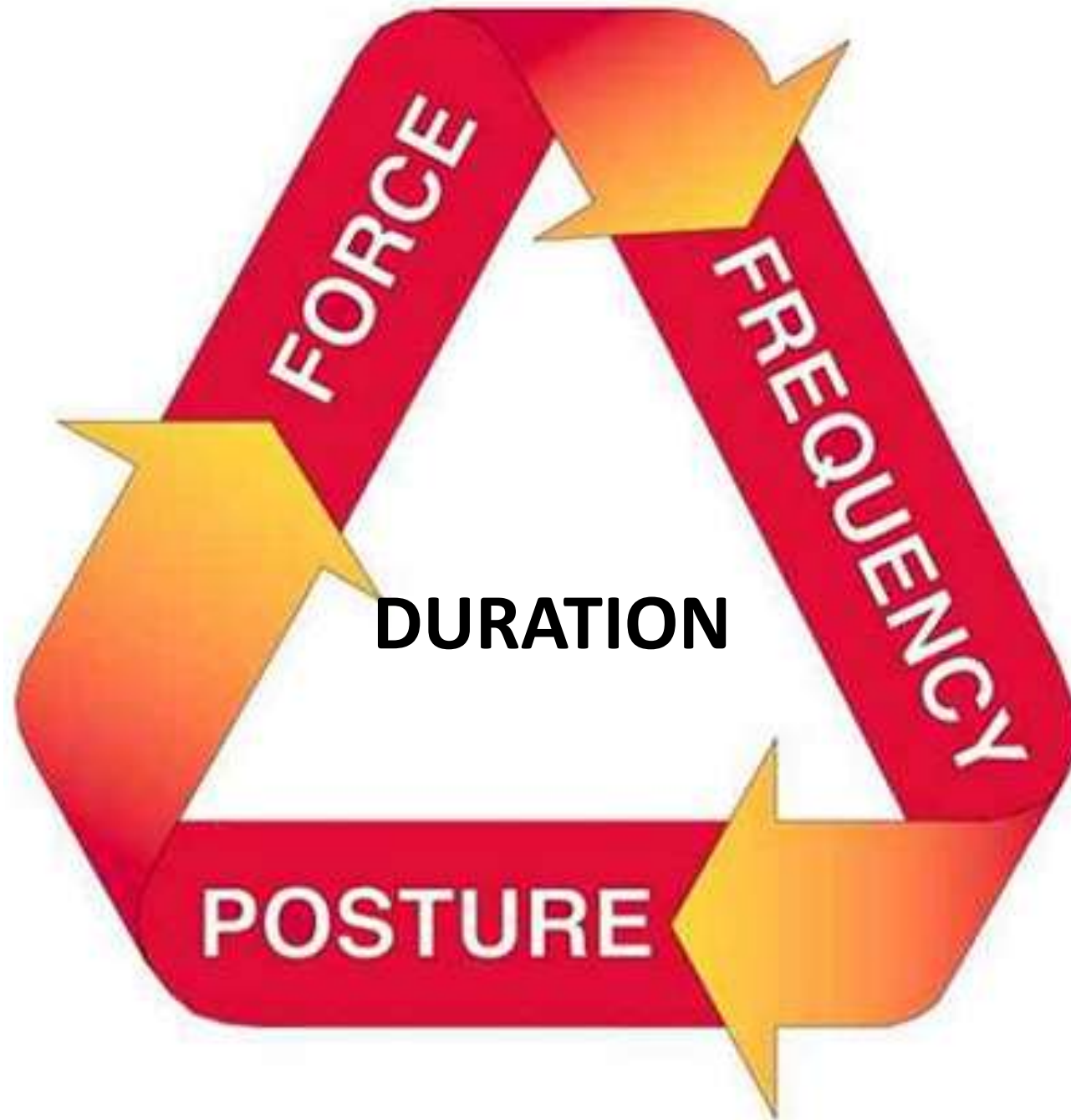
The new method is based on the concept that the Composite Lifting Index (CLI), which represents the collective demands of the job, is equal to the sum of the largest Single Task Lifting Index (STLI) and the incremental increases in the CLI as each subsequent task is added. The incremental increase in the CLI for a specific task is defined as the difference between the Lifting Index for that task at the cumulative frequency and the Lifting Index for that task at its actual frequency. For example, consider

$$CU = LI_{A,1} + (LI_{B,2} - LI_{B,1})$$

$$CU = STLI_1 + \sum \Delta LI$$

$$\begin{aligned}
 \sum \Delta LI &= (FILI_2 \times \left(\frac{1}{FM_{1,2}} - \frac{1}{FM_1} \right)) \\
 &+ (FILI_3 \times \left(\frac{1}{FM_{1,2,3}} - \frac{1}{FM_{1,2}} \right)) \\
 &+ (FILI_4 \times \left(\frac{1}{FM_{1,2,3,4}} - \frac{1}{FM_{1,2,3}} \right))
 \end{aligned}$$

Task Number	1	2	3
Load Weight (L)	30	20	10
Task Frequency (F)	1	2	4
FIRWL	20	20	15
FM	.94	.91	.84
STRWL	18.8	18.2	12.6
FILI	1.5	1.0	.67
STLI	1.6	1.1	.8
New Task Number	1	2	3



ISO/TC 159/SC 3

Secretariat: JISC

Voting begins on:
2003-01-30

Voting terminates on:
2003-03-30

Ergonomics — Manual handling —

**Part 1:
Lifting and carrying**

Ergonomie — Manutention manuelle —

Partie 1: Manutention verticale et manutention horizontale

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NATIONAL REGULATIONS.

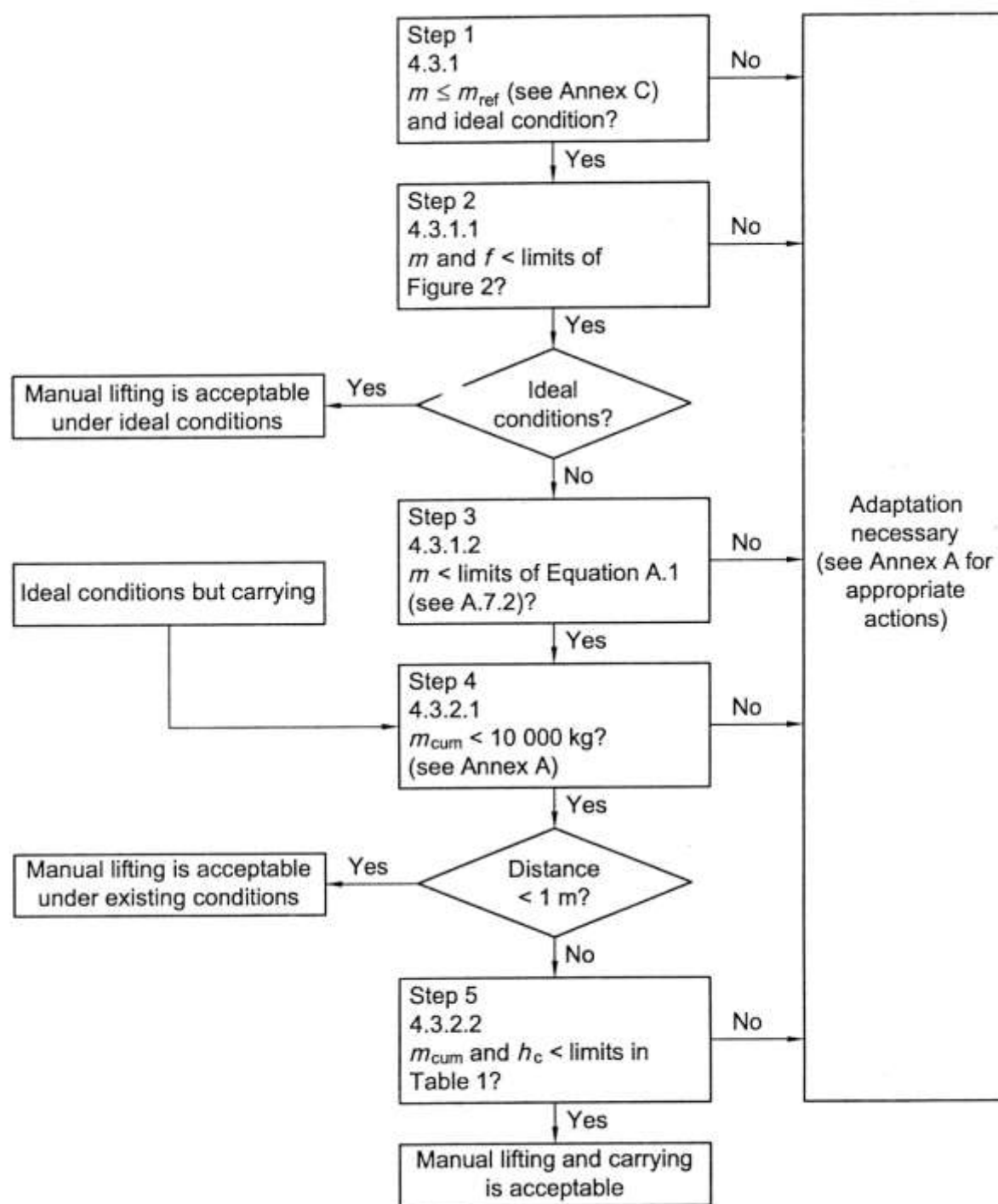


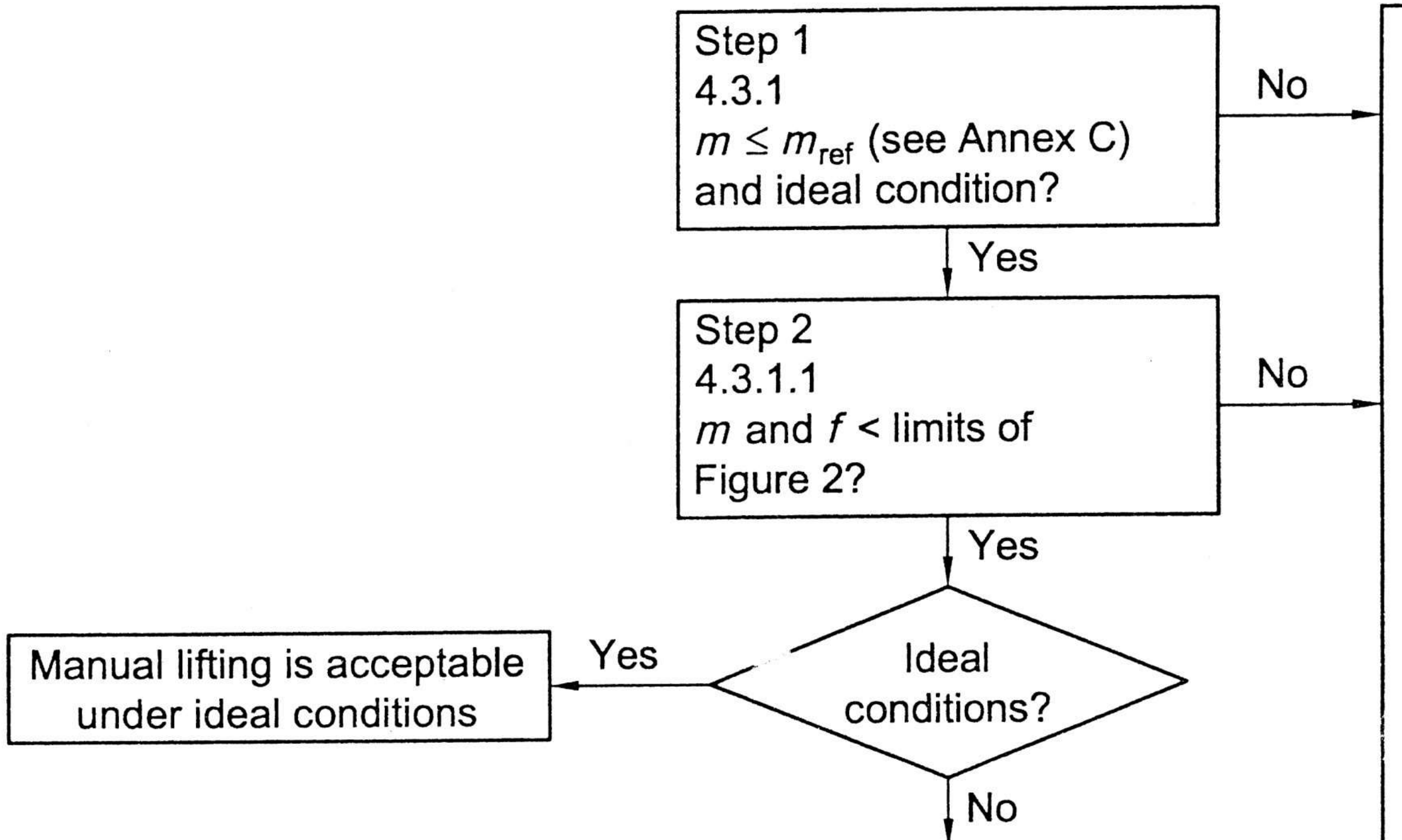
Reference number
ISO/FDIS 11228-1:2003(E)

ISO 14121, EN 1005-2 e ISO/IEC Guide 51

4 risk assessment stages

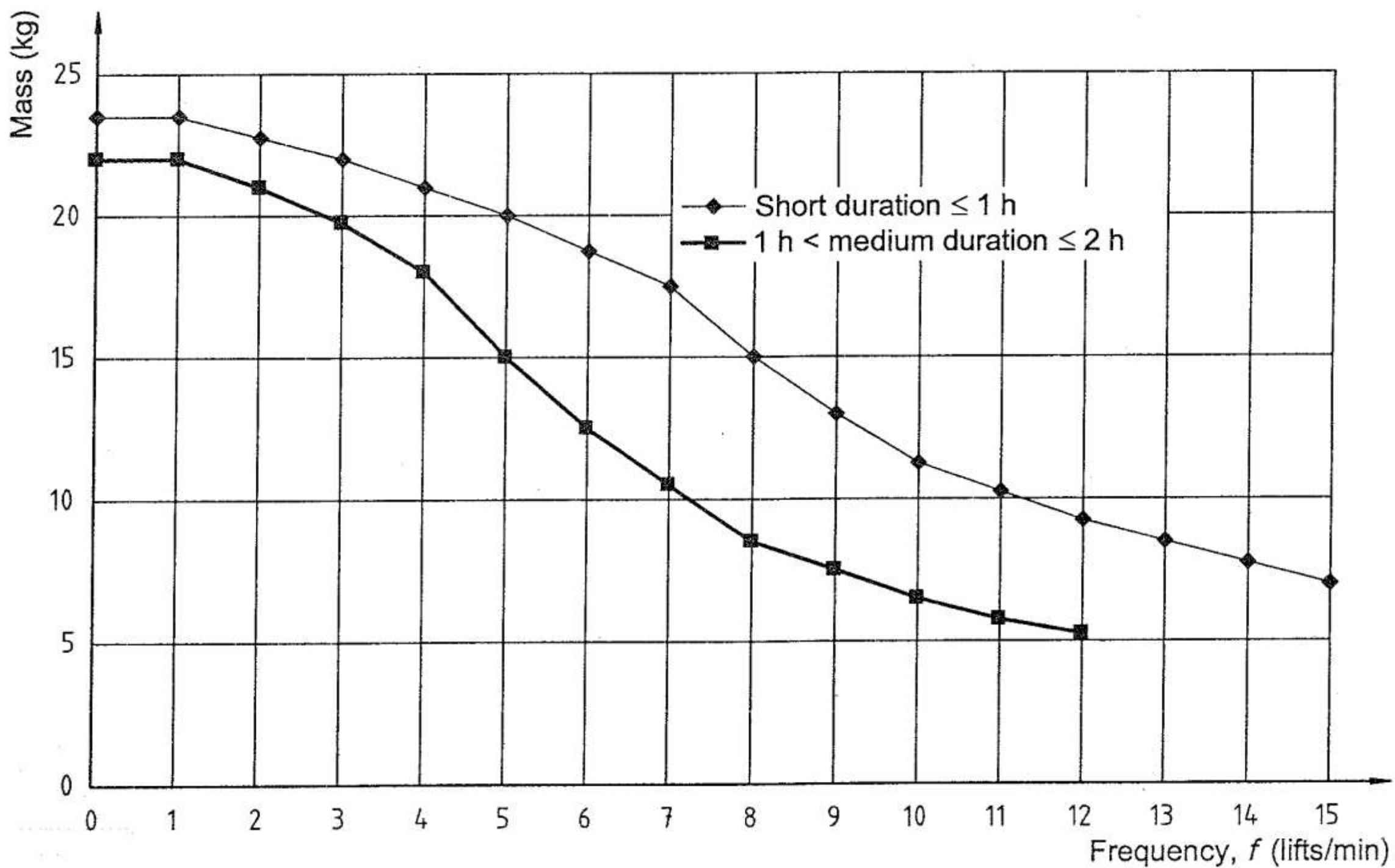
- Riconoscimento del pericolo (peril): TR entry level
- Identificazione del pericolo (hazard)
- **Stima del rischio (estimation)**
- **Valutazione del rischio (assessment)**





STEP 1. Attività occasionale in condizioni ideali DETERMINARE LA MASSA

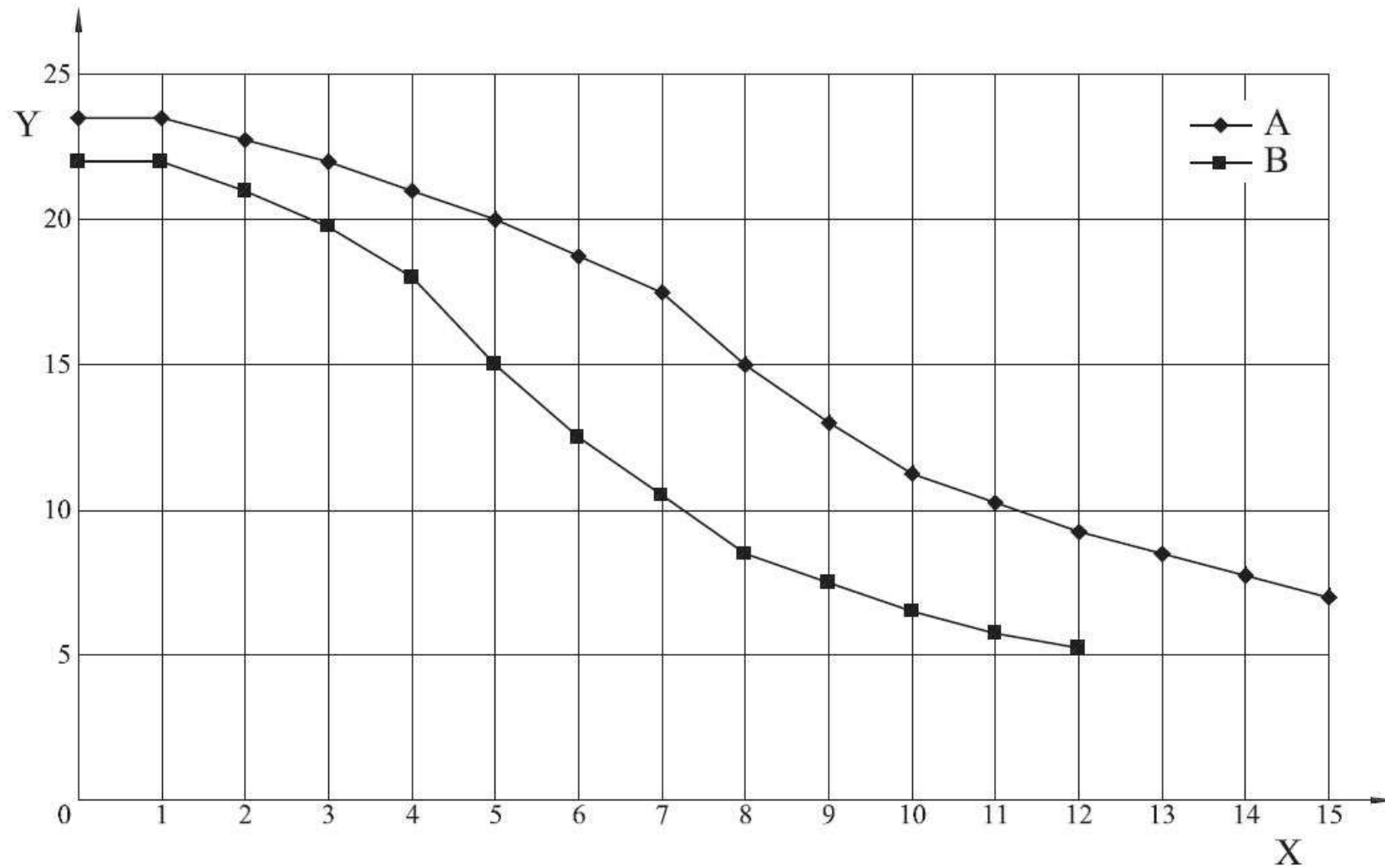
1. Standing simmetrical and upright
2. Horizontal distance between centre of mass of the object and c of m. of the worker < 0.25 m
3. Height of the grip less than 0.25 m above knuckle
 - $f < 1/5$ min (not repetitive handling)
 - Si raccomanda di non superare i limiti posti dalla tabella C1



Frequenza massima di sollevamento manuale in condizioni ideali correlata alla massa dell'oggetto per due diverse durate di sollevamento, corrispondente al prospetto A.1

Legenda

- X Frequenza f (sollevamenti/min)
- Y Massa (kg)
- A Durata breve ≤ 1 h
- B 1 h < durata media ≤ 2 h



$$RWL \leq LC \times HM \times VM \times DM \times AM \times FM \times CM$$

$$m \leq m_{ref} \times h_M \times v_M \times d_M \times a_M \times f_M \times c_M$$

Massa di riferimento (m_{ref}) per popolazioni differenti

Campo di applicazione	m_{ref} kg	Percentuale di popolazione di utilizzatori protetta			Gruppo di popolazione	
		F ed M ^{a)}	F	M		
Utilizzo non professionale	5	Dati non disponibili			Bambini e anziani	Popolazione totale
	10	99	99	99	Popolazione domestica generale	
Utilizzo professionale	15	95	90	99	Popolazione lavorativa generale, inclusiva di giovani e anziani	Popolazione lavorativa generale
	20					
	23					
	25	85	70	95	Popolazione lavorativa adulta	
	30	Vedere Nota			Popolazione lavorativa specializzata	Popolazione lavorativa specializzata in circostanze particolari
35						
40						

Nota Circostanze particolari. Mentre si dovrebbe fare ogni tentativo per evitare attività di movimentazione manuale o per ridurre il più possibile il livello dei rischi, potrebbero verificarsi circostanze eccezionali a seguito delle quali la massa di riferimento potrebbe essere maggiore di 25 kg (per esempio dove i progressi tecnologici o gli interventi non sono sufficientemente avanzati). In presenza di tali circostanze eccezionali, si deve prestare maggiore attenzione e considerazione all'istruzione e alla formazione dell'individuo (per esempio, conoscenze specializzate concernenti identificazione e riduzione del rischio), ma anche alle condizioni di lavoro prevalenti e alle capacità dei singoli individui.

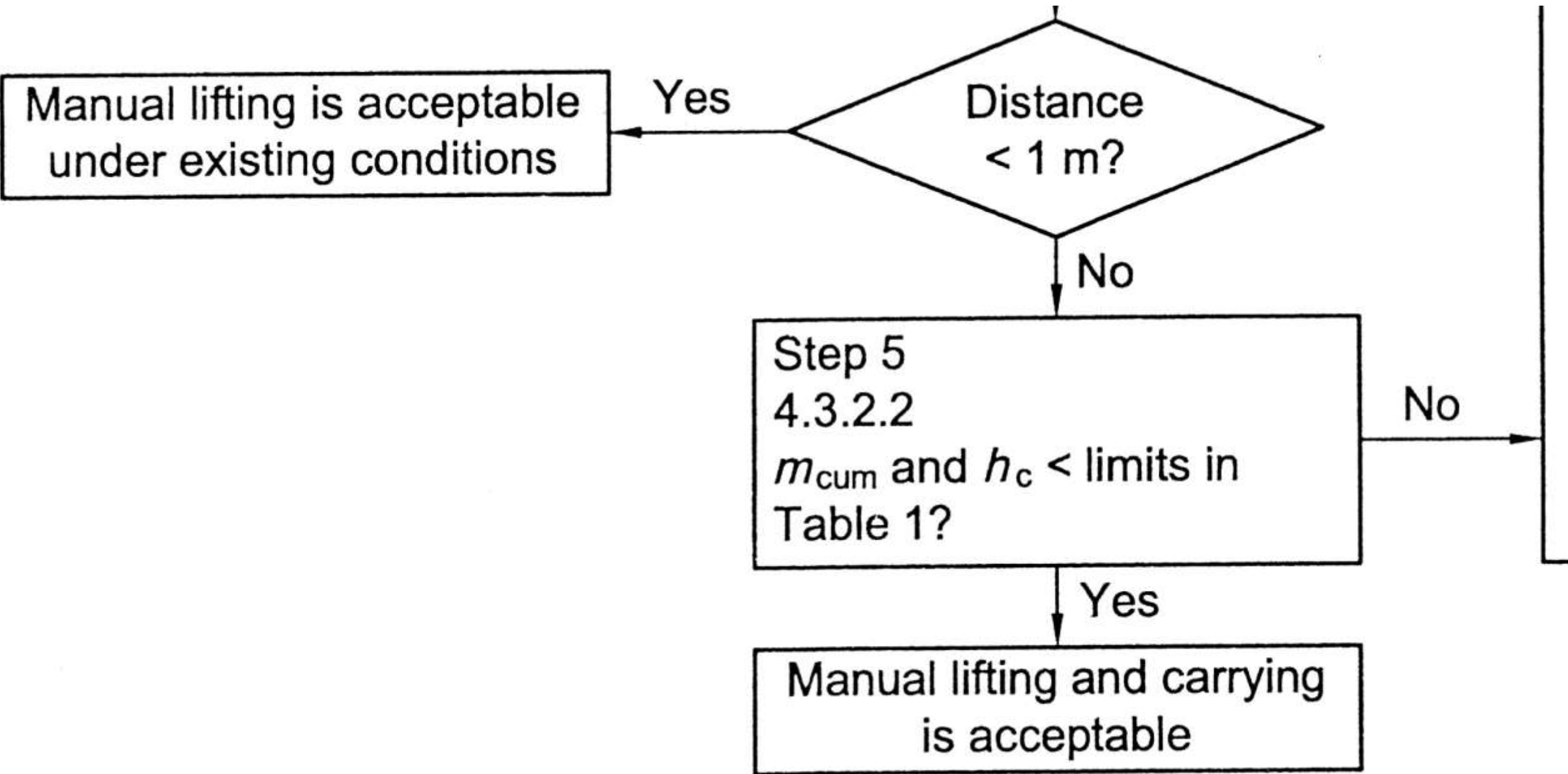
a) F: femmine, M: maschi.

Differenza di genere

- L'art. 28, primo comma, del D.Lgs. 81/2008, che tratta dell'“*oggetto della valutazione dei rischi*”, afferma che detta valutazione dei rischi “*deve riguardare tutti i rischi ... nonché quelli connessi alle differenze di genere ...*”.

Working population by gender and age	Reference mass (m_{ref})
Men (18–45 years old)	25 kg
Women (18–45 years old)	20 kg
Men (<18 or > 45 years old)	20 kg
Women (<18 or > 45 years old)	15 kg

NOTE A value of 23 kg is the reference mass used in the Lifting Equation by the National Institute of Occupational Safety and Health (NIOSH) of the US, and is the source of the lifting analysis method used in ISO 11228-1. The use of 23 kg as the reference mass accommodates at least 99 % of male healthy workers and at least 75 % of female healthy workers at LI = 1,0.



Massa cumulativa in funzione della distanza percorsa

prospetto 1

Limiti raccomandati per la massa cumulativa correlati alla distanza di trasporto (per la popolazione lavorativa generale)

Distanza di trasporto m	Frequenza di trasporto f_{max} min ⁻¹	Massa cumulativa m_{max}			Esempi di prodotto $m \times f$
		kg/min	kg/h	kg/8 h	
20	1	15	750	6 000	5 kg × 3 volte/min 15 kg × 1 volta/min 25 kg × 0,5 volte/min
10	2	30	1 500	10 000	5 kg × 6 volte/min 15 kg × 2 volte/min 25 kg × 1 volta/min
4	4	60	3 000	10 000	5 kg × 12 volte/min 15 kg × 4 volte/min 25 kg × 1 volta/min
2	5	75	4 500	10 000	5 kg × 15 volte/min 15 kg × 5 volte/min 25 kg × 1 volta/min
1	8	120	7 200	10 000	5 kg × 15 volte/min 15 kg × 8 volte/min 25 kg × 1 volta/min

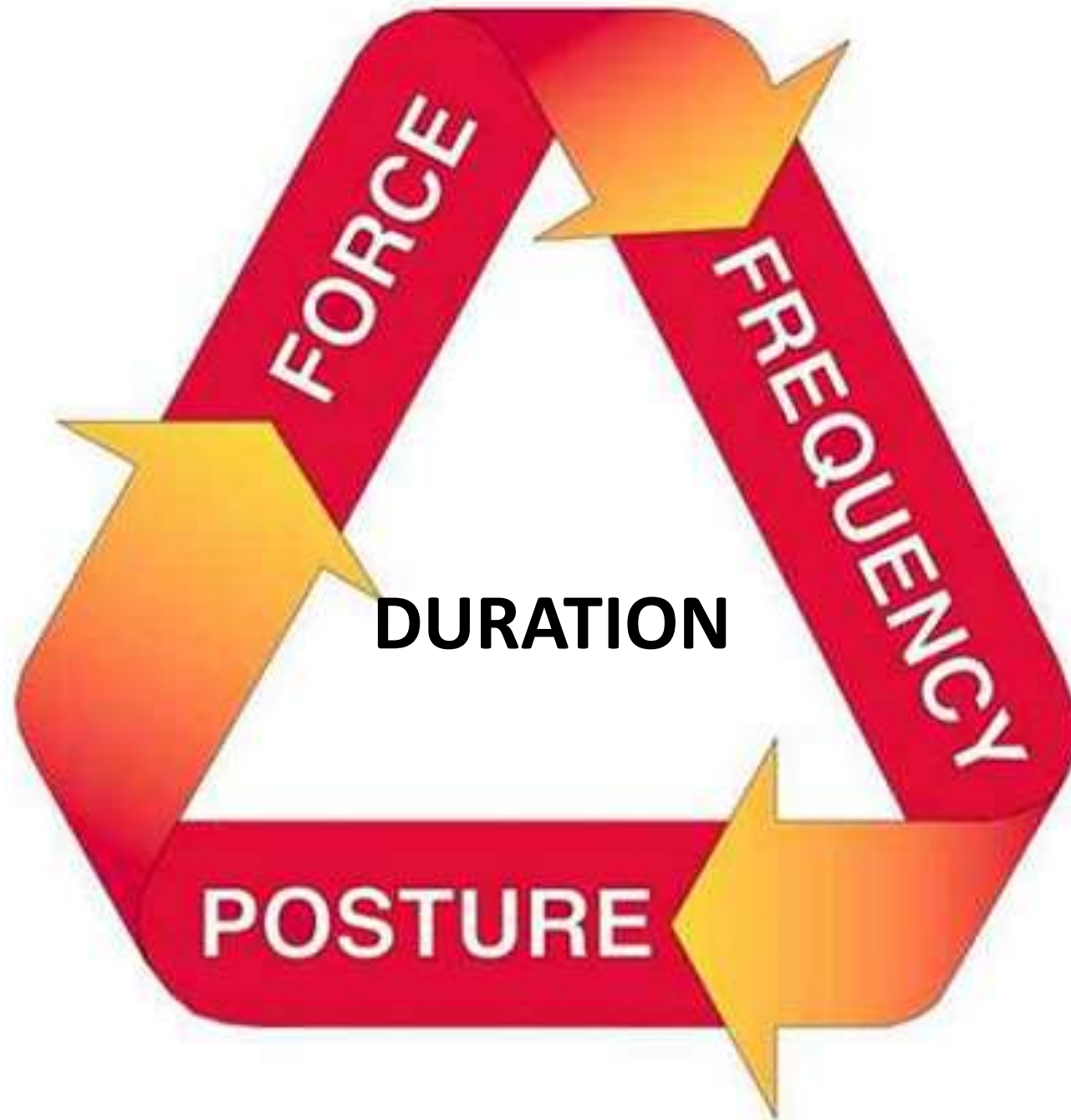
Nota 1 Nel calcolo della massa cumulativa, è stata utilizzata una massa di riferimento di 15 kg e una frequenza di trasporto di 15 volte/min per la popolazione lavorativa generale.

Nota 2 La massa cumulativa totale di sollevamento e trasporto manuale non dovrebbe mai superare i 10 000 kg/giornalieri, a prescindere dalla durata giornaliera del lavoro.

Nota 3 23 kg sono inclusi nella massa da 25 kg.

cumulative mass

- Under unfavourable environmental conditions, or lifting from/to low levels or when the arm are lifted above the shoulders the limits should be reduced at list by one-third



Annex A (informative)

Application information for ISO 11228-1

1. reference masses to be used when considering gender and age;
2. classification of the results of risk assessment, introducing the concept of the Lifting Index (LI);
3. demonstration (by an example) of a task evaluation that emphasizes the need to address work organization;
4. an approach (derived from the standard) for the analysis of manual lifts operated by several (2 or more) workers.

Notes advances the standard

5. an approach for simple lifts carried with one upper limb;
6. evaluation of variable lifting tasks (when different masses are lifted while holding different body postures (by taking into account various load placement positions) with examples for the calculation of Variable Lifting Index (VLI).

$$2- LI = mA/mR$$

- acceptable condition, if Lifting index ≤ 1 ;
- not recommended condition, if Lifting index > 1 .

Lifting Index Value	Exposure level	Interpretation	Consequences
LI ≤ 1,0	Acceptable	Exposure is acceptable for most members of reference working population.	Acceptable: no consequences
1,0 < LI ≤ 2,0	Risk present	A part of adult industrial working population could be exposed to a moderate risk level	Redesign tasks and workplaces according to priorities
2,0 < LI ≤ 3,0	Risk present; high level	An increased part of adult industrial working population could be exposed to a significant risk level.	Redesign tasks and workplaces as soon as possible
LI > 3,0	Risk present; very high level	<p>Absolutely not suitable for most working population.</p> <p>Consider only for exceptional circumstances 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).</p>	Redesign tasks and workplaces immediately

3. Lifting by 2 or 3 operators

$$m_R = m_{\text{ref}} \times h_M \times v_M \times d_M \times a_M \times f_M \times c_M \times p_M$$

- $p_M = 0.67$ for 2 persons lifting actions
- $p_M = 0.5$ for 3 persons lifting actions

$$LI = \frac{m_A}{m_R} \times \frac{1}{2} \times \frac{2}{3} \text{ FOR 2 PERSONS}$$

$$LI = \frac{m_A}{m_R} \times \frac{1}{3} \times \frac{1}{2} \text{ FOR 3 PERSONS}$$

4. Lifting by one arm only

- $mR = m_{ref} \times h_M \times v_M \times d_M \times a_M \times f_M \times c_M \times p_M \times o_M$
- $o_M = 0.6$

Carrying limits in other than "ideal conditions":

- The recommended limits for cumulative mass (RecCuM) to be carried per day and cumulative mass (mCuM) related to distance carried (steps 4 and 5 in the risk estimation step model on 11228-1:2003 assume ideal conditions

"ideal conditions":

- smooth, non-slippery walking surface in good repair;
- no steps or climbing;
- good coupling for the load carriage;
- no obstructions to movement;
- good environmental conditions (temperature, humidity in moderate range);
- no obstructions to vision.

no ideal conditions

- Worker safety should not be compromised. Acute hazards, such as trip or fall hazards, must be eliminated or controlled.
- cumulative mass limits should be **reduced by 33%**, if:
 1. loads are awkward or difficult to handle;
 2. environmental conditions are hot or cold;
 3. there are a significant number of stair steps to make while carrying;

discussione