MMC

Movimentazione manuale dei carichi

UNI ISO 11228-1:2022

Certifico S.r.l. IT EN | Rev. 0.0 2022

ID 16255 | 31.03.2022

0. Premessa

Documento di approfondimento sui limiti per la movimentazione manuale dei carichi in accordo alla norma tecnica UNI ISO 11228-1:2022. La norma specifica i limiti raccomandati per il sollevamento, l'abbassamento e il trasporto manuale, tenuto conto della intensità, della frequenza e della durata del compito lavorativo.

La norma, inoltre, fornisce i requisiti e le raccomandazioni relative alla analisi di molteplici variabili del compito lavorativo, consentendo di valutare i rischi per la salute dei lavoratori. L'analisi si applica alla movimentazione manuale di oggetti con massa di 3 kg o superiore e a una velocità di trasporto moderata, cioè compresa tra 0,5 m/s e 1,0 m/s, lungo una superficie orizzontale.

La UNI ISO 11228-1:2022 basa la sua analisi su una giornata lavorativa di 8 ore, ma considera anche tempi di lavoro più lunghi, fino a 12 ore. La norma tratta anche di combinazioni di compiti di sollevamento, abbassamento e trasporto nello stesso turno di lavoro.

La norma non considera il mantenimento di oggetti (senza trasporto), il traino e la spinta di oggetti o la movimentazione manuale da seduti. Il traino e la spinta di oggetti sono analizzati in altre parti della serie ISO 11228. Inoltre, la norma non considera la movimentazione manuale di persone o animali, non tratta il sollevamento manuale di oggetti laddove si usino apparecchiature di ausilio al sollevamento, come gli esoscheletri e non prende in considerazione le necessità di donne in gravidanza o di persone con disabilità.

ISO 11228-1:2021 "Ergonomics - Manual handling - Part 1: Lifting, lowering and carrying"

Data entrata in vigore: 05 ottobre 2021

Recepita in Italia con la UNI ISO 11228-1:2022 "Ergonomia - Movimentazione manuale - Parte 1: Sollevamento, abbassamento e trasporto" entrata in vigore il 24 marzo 2022.

Novità Edizione 2022:

- revisione dello scopo per includere l'abbassamento;
- ampliamento della stima del rischio;
- ampliamento degli Allegati A, B e C;
- aggiunta dell'Allegato D Indice di sollevamento
- aggiunta dell'allegato E Modello semplificato per il calcolo RML e L1
- aggiunta dell'Allegato F Sollevamento manuale Multi-task
- aggiunta dell'Allegato G Esempi di movimentazione manuale di oggetti
- aggiunta dell'Allegato H Trasporto
- aggiunta dell'Allegato I Esposizione e rischio: la Tabella D.1

La valutazione dei rischi derivanti dalla movimentazione manuale dei carichi è un obbligo del Datore in Lavoro secondo l'art. 168 del D.Lgs. 81/08.

Art. 168 **- Obblighi del datore di lavoro**

1. Il datore di lavoro adotta le misure organizzative necessarie e ricorre ai mezzi appropriati, in particolare attrezzature meccaniche, per evitare la necessità di una movimentazione manuale dei carichi da parte dei lavoratori.

2. Qualora non sia possibile evitare la movimentazione manuale dei carichi ad opera dei lavoratori, il datore di lavoro adotta le misure organizzative necessarie, ricorre ai mezzi appropriati e fornisce ai lavoratori stessi i mezzi adeguati, allo scopo di ridurre il rischio che comporta la movimentazione manuale di detti carichi, tenendo conto dell'allegato XXXIII, ed in particolare:

a) organizza i posti di lavoro in modo che detta movimentazione assicuri condizioni di sicurezza e salute;

b) valuta, se possibile anche in fase di progettazione, le condizioni di sicurezza e di salute connesse al lavoro in questione tenendo conto dell'allegato XXXIII;
c) evita o riduce i rischi, particolarmente di patologie dorso-lombari, adottando le misure adeguate, tenendo conto in particolare dei fattori individuali di rischio, delle caratteristiche dell'ambiente di lavoro e delle esigenze che tale attività comporta, in base all'allegato XXXIII;
d) sottopone i lavoratori alla sorveglianza sanitaria di cui all'articolo 41, sulla base della valutazione del rischio e dei fattori individuali di rischio di cui all'allegato XXXIII.

3. Le norme tecniche costituiscono criteri di riferimento per le finalità del presente articolo e dell'allegato XXXIII, ove applicabili. Negli altri casi si può fare riferimento alle buone prassi e alle linee guida.

Allegato XXXIII **Movimentazione Manuale dei Carichi**

La prevenzione del rischio di patologie da sovraccarico biomeccanico, in particolare dorso-lombari, connesse alle attività lavorative di movimentazione manuale dei carichi dovrà considerare, in modo integrato, il complesso degli elementi di riferimento e dei fattori individuali di rischio riportati nel presente allegato.

Elementi di riferimento

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.

5. Fattori individuali di rischio

Fatto salvo quanto previsto dalla normativa vigente in tema di tutela e sostegno della maternità e di protezione dei giovani sul lavoro, il lavoratore può correre un rischio nei seguenti casi:
- inidoneità fisica a svolgere il compito in questione tenuto altresì conto delle differenze di genere e di età;
- indumenti, calzature o altri effetti personali inadeguati portati dal lavoratore;
- insufficienza o inadeguatezza delle conoscenze o della formazione o dell'addestramento

6. Riferimenti a norme tecniche

Le norme tecniche della serie ISO 11228 (parti 1-2-3) relative alle attività di movimentazione manuale (sollevamento, trasporto, traino, spinta, movimentazione di carichi leggeri ad alta frequenza) sono da considerarsi tra quelle previste all'articolo 168, comma 3.

Il presente documento è una traduzione non ufficiale in lingua italiana di parti della norma UNI ISO 11228-1:2022 - Traduzione non ufficiale IT.

1. Valutazione del rischio (modello a fasi)

Il modello descrive le fasi della valutazione del rischio analizzando la movimentazione dei carichi dall'inizio dell'attività.

La prima considerazione da fare è sul peso del carico da movimentare, il modello della norma è applicabile solo se il carico supera i 3 Kg. Il passaggio successivo, invece, si basa sull'analisi del superamento dei limiti consigliati per la movimentazione (fase 1) (l'utente dovrà apportare delle modifiche alla movimentazione in caso di superamento dei limiti).

In caso di movimentazione ripetitiva, la valutazione può essere fatta usando la procedura di valutazione rapida (fase 2). A seconda del risultato ottenuto dalla fase 2, l'attività:

- dovrà essere sottoposta a delle modifiche per il miglioramento delle condizioni di sicurezza (allegato A della UNI ISO 11228-1:2022);
- sarà ritenuta accettabile;
- dovrà essere sottoposta ad una valutazione più dettagliata (fase 3).

La fase 3 deve essere usata per la valutazione di attività che si svolgono utilizzando posture non ideali. La condizione di riferimento della postura per il sollevamento e l'abbassamento durante la movimentazione manuale è determinata da:

- una posizione eretta e simmetrica del tronco (nessuna torsione o flessione laterale);
- un'inclinazione del tronco sagittale non superiore a 15° dalla verticale (inclinazione minima osservabile dall'occhio umano), in modo da assecondare la naturale postura della schiena;
- altezza della presa tra la nocca ed il gomito per il sollevamento o tra la nocca e la spalla per il trasporto.

Le fasi 4 e 5 sono necessarie per un'ulteriore valutazione dell'attività basata sulla massa cumulativa sollevata e trasportata.

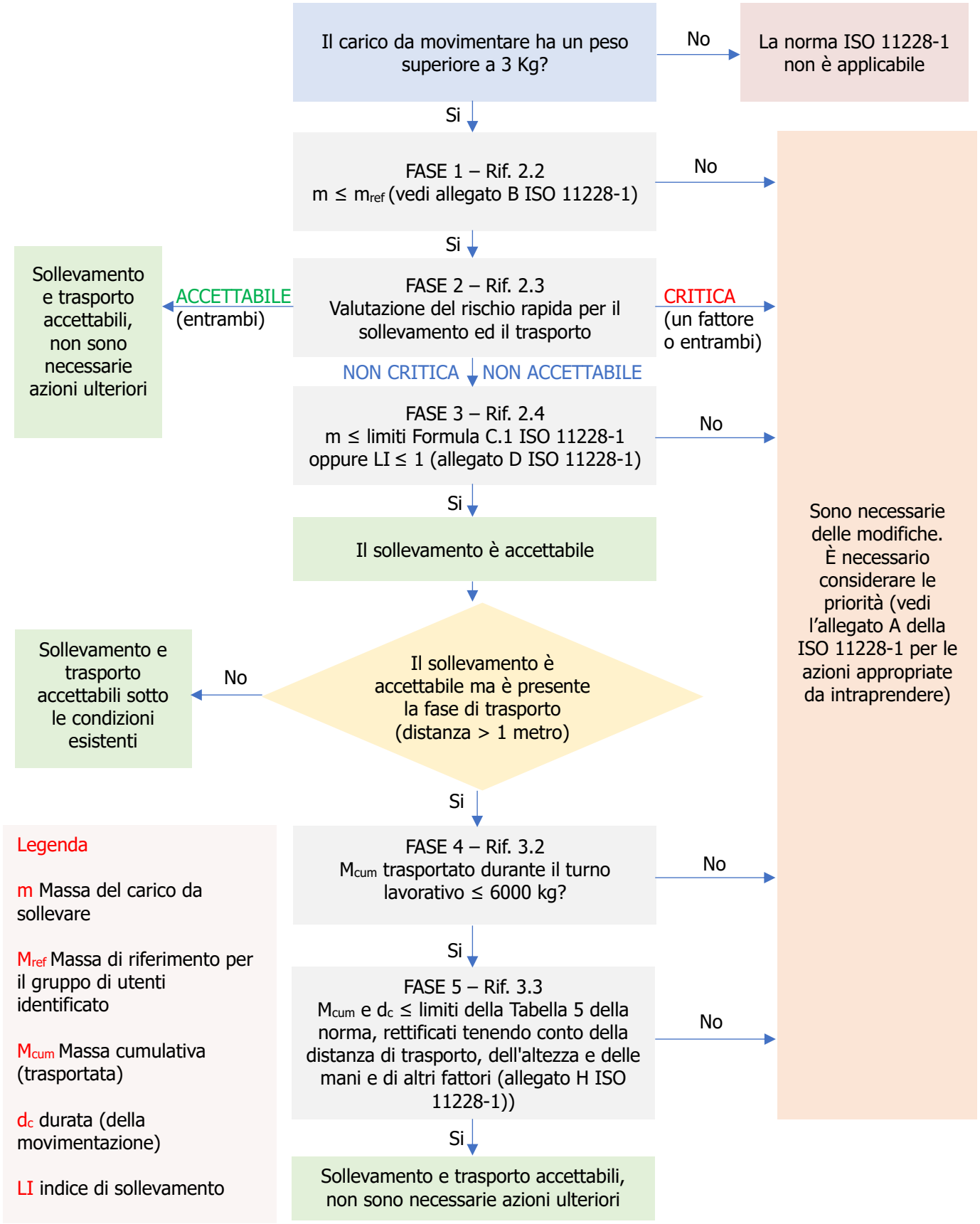


Figura 1 – Modello a fasi

2. Limite consigliato per il sollevamento, l'abbassamento ed il trasporto manuali

2.1 Peso del carico

Ogni volta che un oggetto di peso pari o superiore a 3 kg viene sollevato o trasportato, deve essere eseguita una valutazione del rischio, a cominciare dallo screening iniziale, fase 1. Si noti che, in tutta la norma ISO 11228-1, ogni volta che viene utilizzato il termine "sollevamento" è implicito un atto di "abbassamento".

2.2 FASE 1

Un primo screening sul sollevamento e sul trasporto non ripetitivo (eseguito nelle condizioni di riferimento del luogo di lavoro) richiede la determinazione della massa dell'oggetto (fase 1). Il limite consigliato per la massa del carico, denominato massa di riferimento, m_{ref}, e basato sulle caratteristiche della popolazione, è individuabile nell'allegato B della norma. Per avere delle indicazioni generali e ulteriori informazioni relative alla fase 1, si può consultare l'allegato A della norma.

2.3 FASE 2 Valutazione rapida del sollevamento e del trasporto ripetitivi

Lo screening delle attività ripetitive di sollevamento e trasporto di oggetti di peso pari o superiore a 3 kg viene eseguito utilizzando una procedura di valutazione rapida.

La procedura di valutazione rapida mira ad individuare, senza necessità di calcolo, la presenza di due condizioni di esposizione opposte:

- condizione accettabile, in cui non è stato identificato un rischio inaccettabile;
- condizione critica, in cui è stato identificato un rischio inaccettabile.

Quando una di queste condizioni è soddisfatta, non è necessario eseguire una valutazione più dettagliata del livello di esposizione. Al contrario, mentre non è necessario considerare ulteriori modifiche (rischio accettabile, rif Tabella 1 e Tabella 2), le modifiche devono essere apportate immediatamente (consultare l'allegato A per indicazioni) a causa della presenza di una condizione critica (vedi tabella 3). In entrambi i casi, si farà riferimento anche alla tabella 4 per identificare la presenza di qualsiasi ambiente di lavoro non idoneo all'attività o circostanze oggettive che possano favorire l'aumento del rischio (fattori aggiuntivi).

Quando nessuna delle due condizioni estreme è soddisfatta, è necessario condurre un'ulteriore valutazione del rischio con i metodi illustrati dalla norma (vedere 2.4).

La tabella 1 e la tabella 2 sono utilizzate per stabilire se la condizione di rischio è accettabile. Se tutte le condizioni elencate sono presenti (sì per ogni condizione), il compito esaminato è accettabile e non è necessaria una valutazione del rischio. In caso di risposta negativa, si deve utilizzare la tabella 3 per confermare l'eventuale presenza di criticità. Se una di queste condizioni è soddisfatta (una risposta affermativa), il compito non deve essere svolto prima vengano apportate le modifiche necessarie.

In entrambi i casi, la tabella 4 deve essere utilizzata sistematicamente anche per identificare la presenza di eventuali caratteristiche svantaggiose dell'ambiente di lavoro o dell'oggetto, che potenzialmente possono aumentare ulteriormente il rischio. Questi fattori possono essere correlati all'ambiente di lavoro o alle caratteristiche dell'oggetto e devono essere analizzati per contribuire alla riduzione il rischio.

Sollevamento ed abbassamento			
Da 3 kg a 5 kg	Assenza di asimmetria (ad esempio, rotazione del corpo, torsione del tronco)	No	Si
	Il carico è mantenuto vicino al corpo (ad esempio dove lo spazio tra il corpo e l'oggetto è minimo)	No	Si
	Lo spostamento verticale del carico è tra fianchi e spalle	No	Si
	Frequenza massima: meno di cinque alzate al minuto	No	Si
> 5 kg a 10 kg	Assenza di asimmetria (ad esempio, rotazione del corpo, torsione del tronco)	No	Si
	Il carico è mantenuto vicino al corpo (ad esempio dove lo spazio tra il corpo e l'oggetto è minimo)	No	Si
	Lo spostamento verticale del carico è tra fianchi e spalle	No	Si
	Frequenza massima: meno di un'alzata al minuto	No	Si
Più di 10 kg	Sono assenti carichi superiori a 10 kg	No	Si
Se tutte le domande ricevono risposta affermativa, il sollevamento esaminato è accettabile e non è necessario continuare la valutazione del rischio, salvo applicare la tabella 4 per analizzare altri fattori. In caso di risposta negativa ad almeno una delle domande, la valutazione prosegue (tabella 3 e tabella 4).			

Tabella 1 - Sollevamento e abbassamento - Valutazione rapida - Condizione accettabile

Trasporto				
Calcolare la massa cumulativa (kg totali trasportati durante le durate indicate per la distanza indicata). La massa cumulativa trasportata è inferiore o uguale ai valori di massa cumulativa raccomandati considerando le distanze (±5 m) e la durata (1 min; 1 h; 4 h; 8 h)?				
Durata	Distanza da 1 m a ≤ 5 m per attività	Distanza da > 5 m a 10 m per attività	Valutazione	
Da 6 h a 8 h	4800 kg	3600 kg	No	Si
4 h	4000 kg	3000 kg	No	Si
1 h	2000 kg	1500 kg	No	Si
1 min	60 kg	45 kg	No	Si
Condizioni accettabili per il trasporto: trasportare con due mani al massimo per una distanza di 10 m, prelevando e deponendo l'oggetto in altezza, dove l'altezza di prelievo e deposito varia da 0,75 m a 1,10 m, considerando il ciclo completo compreso il ritorno al punto di partenza a mani vuote percorrendo la stessa distanza. L'attività di trasporto viene eseguita in un ambiente interno confortevole, su un pavimento duro, piano, antiscivolo, senza ostacoli e in uno spazio di lavoro che consente la libertà di movimento e postura del corpo. Non ci sono ostacoli all'attività. Non sono necessarie posture scomode durante il trasporto.			No	Si
Se tutte le domande ricevono risposta affermativa, il sollevamento esaminato è accettabile e non è necessario continuare la valutazione del rischio, salvo applicare la tabella 4 per analizzare altri fattori. In caso di risposta negativa ad almeno una delle domande, la valutazione prosegue (tabella 3 e tabella 4).				

Tabella 2 - Trasporto - Valutazione rapida - Condizione accettabile

Condizione critica per il sollevamento: disposizione dell'attività e condizioni di frequenza eccedenti il limite massimo suggerito			
Posizione verticale	La posizione della mano all'inizio e alla fine del sollevamento è superiore a 175 cm o inferiore alla superficie dove poggiano i piedi	No	Si
Spostamento verticale	La distanza verticale tra la posizione iniziale e la destinazione dell'oggetto sollevato è superiore a 175 cm	No	Si
Distanza orizzontale	La distanza orizzontale tra il corpo e il carico è maggiore della portata massima del braccio (> 63 cm)	No	Si
Asimmetria	Estrema torsione del corpo (su entrambi i lati di oltre 45°) senza muovere i piedi	No	Si
Frequenza di sollevamento	Più di 15 sollevamenti al minuto di breve durata (movimentazione manuale di durata non superiore a 60 min consecutivi durante il turno, seguiti da almeno 60 min di recupero)	No	Si
	Più di 12 sollevamenti al minuto di media durata (movimentazione manuale della durata non superiore a 120 min consecutivi durante il turno, seguiti da almeno 30 minuti di recupero)	No	Si
	Più di 10 sollevamenti al minuto di lunga durata (movimentazione manuale di durata superiore a 120 min consecutivi durante il turno)	No	Si
Condizione critica per il sollevamento o il trasporto: presenza di carichi eccedenti i seguenti limiti (vedi Tabella B.2 della ISO 11228-1:2022 per maggiori informazioni)			
Femmine (da 20 a 45 anni)	20 kg	No	Si
Femmine (< 20 o > 45 anni)	15 kg	No	Si
Maschi (da 20 a 45 anni)	25 kg	No	Si
Maschi (< 20 o > 45 anni)	20 kg	No	Si
Condizione critica per il trasporto: presenza di massa trasportata cumulata superiore a quelle indicate anche con condizioni accettabili per il trasporto			
Distanza di trasporto (per azione) da 1 m a 5 m in un tempo compreso tra 6 h e 8 h?	6000 kg in un tempo compreso tra 6 h e 8 h	No	Si
Distanza di trasporto (per azione) da 5 m a 10 m in un tempo compreso tra 6 h e 8 h?	3600 kg in un tempo compreso tra 6 h e 8 h	No	Si
Distanza di trasporto (per azione) da 10 m a 20 m in un tempo compreso tra 6 h e 8 h?	1200 kg in un tempo compreso tra 6 h e 8 h	No	Si
Distanza di trasporto (per azione) più di 20 metri	La distanza di trasporto è generalmente superiore a 20 m	No	Si
Se almeno una delle condizioni ha una risposta affermativa, considerare il rischio come alto ed è presente una condizione critica. Procedere con la riprogettazione dell'attività e continuare con la Tabella 4 per identificare ulteriori fattori da considerare, quindi continuare con l'allegato A per l'individuazione di azioni correttive urgenti.			

Tabella 3 - Sollevamento o trasporto - Valutazione rapida - Condizione critica

L'ambiente di lavoro è sfavorevole al sollevamento ed al trasporto?		
Presenza di stress termico estremo (basso o alto) (es. temperatura, umidità, movimento dell'aria)	No	Si
Presenza di pavimento scivoloso, irregolare, instabile	No	Si
Presenza di spazio insufficiente per il sollevamento e il trasporto	No	Si
Ci sono caratteristiche dell'oggetto sfavorevoli al sollevamento ed al trasporto?		
Le dimensioni dell'oggetto riducono la visuale del lavoratore e ostacolano i movimenti	No	Si
Il baricentro del carico non è stabile (ad es. liquidi, oggetti che si muovono all'interno dell'oggetto)	No	Si
La forma o configurazione dell'oggetto presenta spigoli vivi, superfici o sporgenze	No	Si
Le superfici di contatto sono troppo fredde o troppo calde	No	Si
Appigli o agganci impropri	No	Si
Le attività di sollevamento o trasporto durano più di 8 ore al giorno?	No	Si
Se almeno una delle domande ha una risposta affermativa, la condizione specificata deve essere affrontata e i rischi ridotti al minimo.		

Tabella 4 - Sollevamento e trasporto - Ulteriori fattori da considerare

2.4 FASE 3 Limiti consigliati per massa, frequenza e posizione dell'oggetto

Quando nessuna delle due condizioni identificate nella fase 2 è soddisfatta, è necessario condurre una valutazione del rischio (fase 3) per determinare i limiti consigliati per l'attività.

Per determinare il limite di massa raccomandato (RML; allegato C) tenendo conto della postura di lavoro, posizione dell'oggetto e frequenza e durata del sollevamento, utilizzare le formule da (C.1) a (C.5). Queste formule tengono conto delle variabili dell'attività (caratteristiche dell'attività). Deve essere calcolato, inoltre, un indice di sollevamento (LI; allegato D) per ottenere ulteriori informazioni sull'esposizione al rischio. Chi effettua l'analisi prima controlla se l'RML per il sollevamento viene superato e, in tal caso, verifica se LI supera i limiti (Tabella D.1). Se entrambi vengono superati, l'attività deve essere adattata modificando la massa, la frequenza di sollevamento, la durata del sollevamento o la posizione dell'oggetto.

La tabella D.1 fornisce l'interpretazione dei risultati e delle conseguenti misure. L'allegato E riporta un modello semplificato per il calcolo di RML e LI. L'allegato F riporta le procedure per l'analisi dei sollevamenti manuali multipli (compiti di sollevamento compositi, variabili e sequenziali), l'allegato G riporta esempi di analisi di semplici compiti di sollevamento. L'allegato I riporta una breve rassegna della letteratura pertinente in merito all'interpretazione dell'indice di sollevamento ed è la base per la tabella D.1.

3 Massa cumulativa del trasporto

3.1 Generale

Per un oggetto da trasportare una volta per una distanza modesta (uno o due passi o inferiore a 1 m), devono essere considerati solo i limiti per il sollevamento come indicato nelle FASI 1, 2, 3.

Per un'analisi della massa cumulativa giornaliera per il trasporto (fase 4), devono essere utilizzati inizialmente i limiti raccomandati ai capitoli 2.2 e 2.3. Completata l'analisi inziale, devono essere applicati i limiti indicati al capitolo 3.2 per la condizione di trasporto di riferimento.

Per la massa cumulativa di trasporto in relazione a distanza, modelli temporali e altri fattori di influenza, far riferimento al capitolo 3.3 (fase 5).

3.2 FASE 4 Limite consigliato per la massa cumulativa giornaliera

La massa cumulativa in un determinato periodo è calcolata come prodotto di massa e frequenza di trasporto.

Questi due valori sono limitati nelle fasi 1, 2 e 3. In questo modo la massa di riferimento non può superare al massimo 25 kg (cioè la massa deve diminuire a partire da 25 kg all'aumentare della frequenza) e la

frequenza di trasporto non deve mai superare un valore massimo pari a 15 volte al minuto (cioè la frequenza deve diminuire a partire da 15 volte al minuto all'aumentare della massa trasportata).

Le condizioni ideali di riferimento consistono nel trasportare l'oggetto con due mani al massimo per una distanza di 2 m, prelevando e deponendo l'oggetto in altezza, dove l'altezza del punto di prelievo e di deposito varia da 0,75 m a 1,10 m, considerando il ciclo completo compreso il ritorno al punto di partenza a mani vuote percorrendo la stessa distanza. L'attività di trasporto viene eseguita in un ambiente interno confortevole, su un pavimento duro, piano, antiscivolo, senza ostacoli e in uno spazio di lavoro che consenta la libertà di movimento e postura del corpo. Non sono necessarie posture scomode durante il trasporto.

Le condizioni di riferimento riguardanti la distanza da percorrere, il ritorno al punto di partenza e le condizioni ambientali e dello spazio di lavoro devono essere idonee al trasporto sulle spalle o sul collo. L'altezza di prelievo e deposito dell'oggetto è circa all'altezza della spalla (da 125 cm a 155 cm). In alternativa, queste azioni vengono eseguite da un collega, per esempio un collega che carica un carico sulla spalla di un altro lavoratore che poi lo trasporta.

Con le condizioni di riferimento citate, il limite raccomandato per la massa cumulativa di trasporto è di 6000 kg ogni 8 ore.

3.3 FASE 5 Limite raccomandato per la massa cumulativa di trasporto in relazione ai modelli temporali, alla distanza e ad altri fattori

Per il trasporto nelle condizioni di riferimento indicate, i limiti raccomandati per la massa cumulativa considerando i diversi scenari di durata del trasporto sono indicati nella Tabella 5.

Distanza di trasporto> 1 m e ≤ 2 m	Kg per minuto	Kg per 1 ora	Kg per 2 ore	Kg per 3 ore	Kg per 4 ore	Kg per 5 ore	Kg per 6 ore fino a 8 ore
Limiti consigliati per massa cumulativa per il trasporto manuale	75	2500	3400	4200	5000	5600	6000

Tabella 5 - Limiti raccomandati nelle condizioni di riferimento di trasporto per la massa cumulativa in relazione alla durata del trasporto durante il turno (per la popolazione lavorativa in generale)

Per valutare la massa cumulativa trasportata, deve essere considerata la durata delle attività di trasporto in un periodo di tempo. La tabella 5 fornisce i valori limite raccomandati della massa cumulativa in base al tempo dedicato alla movimentazione manuale (compresi i carichi che vengono sia sollevati che poi trasportati) nel turno e rappresenta il prodotto della movimentazione di diverse masse possibili a frequenze diverse. Ad esempio, il limite di a una massa cumulativa di 75 kg per un singolo minuto può essere raggiunto con una massa di 12,5 kg × 6 volte/min.

Quando le condizioni di trasporto differiscono dalla condizione di riferimento, i limiti raccomandati nella tabella 5 devono essere regolati applicando rapporti di correzione (moltiplicatori) nel calcolo. I moltiplicatori rappresentano condizioni reali dell'attività osservata (ad es. distanza di trasporto, altezza del punto di prelievo o deposito e altre condizioni pertinenti). I moltiplicatori sono forniti nell'allegato H della norma.

4 Riduzione del rischio

La riduzione del rischio può essere ottenuta minimizzando o escludendo i rischi derivanti dall'attività, dall'oggetto, dal luogo di lavoro, dall'organizzazione del lavoro o dalle condizioni ambientali; degli esempi sono forniti da A.3 a A.5 della norma.

4.1 Considerazioni aggiuntive

La sorveglianza sanitaria dovrebbe essere fornita dal datore di lavoro per quanto riguarda i rischi legati al lavoro stesso.

La sorveglianza sanitaria è di natura preventiva e dovrebbe garantire, prima di iniziare il lavoro e poi su base continuativa, che il rapporto tra lo stato di salute della persona e le condizioni di lavoro siano soddisfacenti.

In particolare, la sorveglianza sanitaria mira a:

- identificare eventuali condizioni di salute negative in una fase sufficientemente precoce da impedirne il peggioramento;
- individuare le persone che necessitano di misure di tutela maggiori rispetto a quelle adottate per altri lavoratori;
- contribuire, sulla base di un riscontro appropriato, al miglioramento dell'accuratezza delle informazioni collettive e delle valutazioni dei rischi individuali;
- monitorare le misure preventive per garantirne l'adeguamento continuo;
- raccogliere dati sull'esposizione o sugli infortuni al fine di confrontare diversi gruppi di lavoratori e diversi scenari;
- raccogliere dati sulle assenze causate da disturbi specifici per stimare il costo della non prevenzione.

La sorveglianza sanitaria relativa alla movimentazione manuale dovrebbe essere focalizzata sia sulla colonna vertebrale che su altre parti del corpo, soprattutto considerando il coinvolgimento delle spalle e degli arti superiori.

Salute mentale personale (es. depressione) e fattori psicosociali legati al lavoro (es. soddisfazione sul lavoro, supporto alla supervisione) dovrebbero essere presi in considerazione anche nella sorveglianza sanitaria per una prevenzione completa di lesioni o disturbi muscolo-scheletrici sul luogo di lavoro.

I mezzi tecnici o meccanici per ridurre il rischio dovrebbero essere forniti e integrati con le informazioni e un'adeguata formazione su come utilizzare in modo appropriato gli ausili manuali per la movimentazione dei materiali (vedere A.6). Tutti i lavoratori dovrebbero ricevere informazioni sui rischi legati al lavoro, sui loro rischi e su come fare per ridurre al minimo l'esposizione in modo sicuro.

Annex A - Ergonomics approach to the design of lifting and carrying tasks

A.1 General

Scientific knowledge stresses the importance of an ergonomic approach in removing or reducing the risk of manual-handling-related injury. Ergonomics focuses on the design of work and its accommodation of human needs and physical and mental capabilities.

In seeking to avoid injury from manual handling, it is pertinent to ask whether manual handling which is hazardous or presents a risk of injury can be eliminated altogether. Those designing new systems of work, or installing new plants, should consider introducing an integrated handling system that, where appropriate, fully utilizes powered or mechanical handling rather than a manual system. It should, however, be remembered that the introduction of automation or mechanization can create different risks. Mechanization, for example, by the introduction of a lift truck, hoist, trolley, sack truck, chute or pallet inverter, needs to be well maintained and a defect-reporting and -correction system should be implemented. All handling aids should be compatible with the rest of the work system, effective, appropriately designed and easily operated. Training concerning handling aids should cover their appropriate usage, and knowledge of safe storage and procedures to be used in the event of breakdown. Training should also include techniques on appropriate body positioning when using the equipment. Operating instructions and safety concerns should be clearly placed on the equipment.

If manual handling cannot be avoided, technical aids should be available. Handling devices such as hand-held straps, slide mats, hooks or suction pads can simplify the problem of handling an object.

A.2 Design of the work: task, workplace and work organization

A.2.1 Task

Stress levels on the back increase substantially as the distance between the object and the body increases. Therefore, in the planning of tasks it is relevant to avoid long reaching, twisting, stooping, bending and awkward movements or postures. Being able to gain secure and close footing to the object is central to designing for good posture. Often obstacles that prevent this can be avoided; a common example is long reaches across to an object from the far side of a pallet, which can be resolved by the use of pallet-rotating equipment. Another example where awkward postures are seen and alternatives are achievable is retrieving objects from the rear of deep shelves or racks less stressfully by installing rollers. The best height for storage is between the mid-thigh and chest height of the workers involved, with lighter items being stored above or below this region.

A good grip is essential for avoiding accidents with respect to handling and is often determined by the characteristics of the object. This means that the object should normally be equipped with suitable handles, cut-outs or finger slots. Objects with large dimensions should have two handles. The handles should be of sufficient dimensions and should be placed so that the centre of gravity falls at the midpoint of the line between the two handles.

A.2.2 Workplace

The work area should be designed to minimize the amount of manual effort, thus reducing the need for twisting, bending, reaching and carrying. The distance that both typical and infrequently handled objects have to be moved should be taken into account, together with the heights between which objects can be transferred.

Gangways and other working areas should be large enough to allow adequate room to manoeuvre. Sufficient space is a prerequisite for efficiently carrying out work in appropriate working postures. Also, the use of suitable mechanical devices often requires more room than manual lifting.

A person carrying an object should have a clear view ahead, unobstructed by the object. Lifting and carrying on stairways and on ladders should be avoided.

It is important to provide adequate space around the object and in the gangways, as well as sufficient headroom to avoid stooping postures while handling an object.

Floor or ground surfaces should be level, well maintained, not slippery and clear of obstacles to avoid potential slipping or tripping accidents. The presence of steps, steep slopes and ladders can increase the risk of injury by adding to the complexity of movement when handling objects. Debris and materials (e.g. used wrapping materials) can also pose tripping and slipping hazards and should be cleared.

A.2.3 Work organization

The amount of work undertaken in fixed postures is also an important consideration. Recommendations on this issue are made in ISO 11226. The frequency of handling an object can influence the risk of injury. Particular care is necessary where the handler cannot control or vary the rate of work. Consideration should, therefore, be given to whether there are adequate opportunities for rest (i.e. momentary pauses or breaks from work) or recovery (i.e. changing to another task which uses a different set of muscles). Job enrichment, job enlargement and job rotation have a key role to play in countering potential fatigue and maintaining levels of safe production output, though this issue is complicated by a large variation in individual susceptibility to fatigue.

Handling by two or more people can render possible an operation that is beyond the capability of one person or reduce the risk of injury to a single person. The object that a team can handle safely is less than the sum of the masses that the team members can cope with individually. Additional difficulties can arise if team members impede each other's vision or movement and if the object offers insufficient suitable handholds.

When engineering or other controls do not provide adequate protection, personal protective equipment should be used only as a last resort. Advance planning is especially important in dealing with hazardous materials or other potentially dangerous loads. It can be necessary to give special attention to handling methods and provision made for dealing with an emergency, including emergency equipment and clear instructions. Where the wearing of personal protective equipment cannot be avoided, its implications for the risk of manual handling injury should be taken into consideration. For example, gloves can impair manual dexterity; other clothing, such as uniforms, can inhibit free movement during manual handling. Personal protective equipment, such as gloves, aprons, overalls, gaiters or safety footwear, should be well fitting. Footwear should provide adequate support, be stable, have a non-slip base, have anti-fatigue qualities and provide proper protection.

A.3 Design of the object

The object to be handled can constitute a hazard because of its mass or resistance to movement, size, shape, rigidity or the absence of handgrips. In determining if a load represents a risk, proper account shall also be made of the circumstances in which the load is handled. For example, postural recommendations, frequency and duration of handling, workplace design and aspects of work organization, such as incentive schemes and piecework, should be considered.

The shape of an object affects the way in which it can be held. In general, if any dimension of the object exceeds about shoulder width or if it is not a compact object, its handling is likely to pose an increased risk of injury. This is especially the case where this size is exceeded in more than one dimension. The risk is further increased if the object does not possess convenient handholds.

If the centre of gravity of the object is not positioned centrally within the object, an inappropriate handling style can result. Sometimes, as with a sealed and unmarked carton, an offset centre of gravity is not visibly apparent. In these circumstances, the risk of injury is increased since the handler can unwittingly hold the object with its centre of gravity further from the body than is necessary.

Consideration should be given to using pack filling for objects liable to shift when being handled. Equally, greater care is needed when handling objects which are inherently difficult to grasp. In addition, there can be physical or chemical hazards which should also be indicated, for example the object can have sharp edges, be too hot or too cold to touch, or contain materials or substances which can be hazardous if spilled.

A.4 Design of the working environment

General environmental conditions, including illumination, noise and climate, should be within tolerable levels. It is recommended to apply ISO 7730 for thermal comfort requirements. Extra care should be taken if work has to be done at extremes of temperature. For example, high temperatures or humidity can cause rapid

fatigue; work at low temperatures can require gloves to prevent numbness of the hands but can also lead to a loss of manual dexterity. Air circulation (indoor and outdoor) is also a factor that influences body temperature. Rapid air circulation cools the body and should be avoided as far as possible. In very hot climates or working conditions, rapid air circulation can be desirable. It is important that there should be sufficient light to enable the workers to see clearly what they are doing and also prevent poor working postures. High noise levels can lead to reduced vigilance. For outdoor work, account needs to be taken of the effects of changing weather conditions. Extra care is needed in strong winds or where gusts are likely, for example around buildings. Assistance or mechanical devices can be especially necessary when carrying large sheets or bulky objects in such conditions.

Reference conditions for manual materials handling include the following criteria:

- moderate ambient thermal environment;
- two-handed operation only;
- unrestricted standing posture;
- handling by one person only;
- smooth lifting;
- good coupling between the hands and the objects handled;
- good coupling between the feet and the floor;
- manual handling activities, other than lifting, are minimal;
- the objects to be lifted are not cold, hot or contaminated;
- vertical displacement of the load is less than or equal to 0,25 m and does not occur below knuckle or above shoulder height;
- the trunk is upright and not rotated;
- the load is kept close to the body;
- the load is carried less than 20 m.

A.5 Individual considerations

Manual handling injuries are associated with the nature of the operations, the way they are organized and variations among individual physical capabilities. It is a fact that the ability to lift and carry does vary among individuals.

In general, the lifting strength for women as a group is up to two-thirds that of men. However, the range of strength and ability among individuals is large and means that some women can deal safely with heavier objects than some men. In those cases where neither manual lifting nor carrying can be eliminated in the short term, special demands on the physical capability of the worker, regardless of gender, can be necessary.

Young and old workers can have particular needs. For example, younger people are likely to be less skilled. Older people are more susceptible to sudden strains due to a decreasing elasticity of parts of the musculoskeletal system. With age, there is a reduction in physical capability, which becomes more significant after the age of 45.

There is good evidence that an individual with a medical history of a back disorder is more susceptible to recurrent episodes of back pain. Workers with a history of back disorders should be assessed and monitored. Eventually, it can become necessary to make modifications to prevent further recurrence of back problems.

Workers who suffer from spinal pathologies (Table A.1), both malformative and degenerative in nature, both work-related and not work-related, that are influenced by biomechanical overload, should be exposed to a lower level of manual handling than the general healthy population.

To accommodate these workers in workplaces, the reference masses given in Table B.1 which are protective for almost 99 % of the population (10 kg or 15 kg) can be used for calculating the appropriate RML and LI. This results in lifting conditions where the RML is not exceeded or the LI is less than or equal to 1.

In particular, also considering the type and severity of spinal pathologies reported in Table A.1:

- for males with pathologies of medium severity, the RML and the LI are calculated using 15 kg as the reference mass;

- for females with medium to severe pathologies and males with severe pathologies, the RML and the LI are calculated using a reference mass of 10 kg;

Loads shall only be lifted vertically between the height of the knees and the shoulders, and the frequency and duration of time assigned to lifting in the shift shall be limited.

It is important to recognize that these provisions for defining "acceptable" weights for lifting, by subjects with spinal pathologies, be used with caution and using a practical approach, possibly involving physician monitoring where appropriate. They are based on research-derived conclusions. However, the effectiveness of individual measures to restrict exposure to risk on a case-by-case basis is required in the field (through close follow-up of individual health and working conditions).

"Moderate" pathologies Significant scoliosis (20° Cobb with torsion 2; 30° Cobb with torsion 1+) Baastrup syndrome Scheuermann disease (with structured curving of the spine) Klippel-Feil syndrome (even with only one synostosis) Cervical and/or dorsal hernia Grade 1 spondylolisthesis, spondylolysis Sacralization (fully or partially fused or articulated) Spinal canal stenosis without neurological signs Severe lumbar disk disease (spondylodiscopathy) Inverted lumbar lordosis with disc disease Slight vertebral instability (10 % or 15 % in the presence of certain pathologies) Lumbar protrusion with dural sac impingement Surgically reduced lumbar disc herniation without adverse outcomes
"Severe" pathologies Herniated disc Surgically reduced lumbar disc herniation with adverse outcomes Spinal canal stenosis with root or dural sac impairment Grade 2 spondylolisthesis (>25 % slippage) Klippel-Feil syndrome (cervical or dorsal synostosis with vertebral instability) Significant scoliosis (at least COBB 30° and torsion 2) Scheuermann disease with approximately 40° structured curving of the spine and lumbar disc disease Severe vertebral instability (i.e. spondylolisthesis, Klippel-Feil syndrome, disc disease, fractures with vertebral slippage of 25 %) Degenerative or newly formed lesions of the bones and joints (e.g. severe osteoporosis, vertebral angioma) Systemic disease with severe spinal impairment

Table A.1 — Classification of moderate and severe spinal pathologies

A.6 Information and training

As a complement to a safe system of work, effective training has an important part to play in preventing and reducing manual handling injuries. To be effective, training shall be work-related and reinforced at regular intervals.

Elements within a training program can include:

- how to recognize potentially hazardous handling operations, how to advocate improvements, how to deal with unfamiliar handling operations;
- the appropriate use of handling aids and personal protective equipment;
- ergonomic principles of task, object and working environment design;
- safe handling techniques, including practical training elements.

Additional elements to be included within a training program are anatomy and physiology of the back, body mechanics and proper lifting techniques, and exercises to stretch and strengthen the back muscles.

A good technique is one where the person is balanced, in complete control throughout the task, and uses the minimum amount of effort to achieve, where possible, a smooth, uninterrupted movement. When lifting or carrying the object, it should be kept as close to the body as possible and both hands should be used. When applying effort, jerky or twisting movements and stooped postures should be avoided.

Annex B - Reference mass determination

B.1 Reference mass determination (step 1)

Step 1 of the determination of the RML for manual handling involves an initial screening of an object's mass. To determine if the mass is at or below a recommended limit for the population in question, the actual weight being handled (or planned to be handled) can be compared to a reference mass, mref, for that population. Table B.1 gives the reference masses, taking into consideration different populations.

Field of application	m_{ref}	Percentage of user population protected			Population group	
	kg	F and M	F	M		
Non-occupational use	5	Data not available			Children and the elderly	Total population
	10	99	99	99	General domestic population	
Professional use	15	95	90	99	General working population	Working population
	20	90 to 95	85	99		
	23	90	75	99	Adult working population	
	25	85	70 to 75	95 to 99		

Table B.1 - Reference mass, mr_{ef}, for different populations

B.2 Special considerations

In order to lower the risk for people at work, particularly those with less physical capability, the recommended limit for mass should not exceed 15 kg. This increases the level of health protection afforded to the working population by up to 95 %. In this instance, a reference mass of 15 kg instead of 25 kg should be used in Formula (C.1) (see C.1.3.3).

As workplaces are expected to be accessible to everyone within the working population, exceeding the recommended limit mass of 25 kg should be regarded as an exception. When exceeding the recommended limits, working conditions must remain safe. In these cases, it is especially important that workers are well trained and instructed for these specific tasks.

B.3 Age and gender considerations

In circumstances where age and gender need to be more specifically considered (beyond the intent of Table B.1) in the general healthy working population, the reference masses in Table B.2 can be adopted.

Working population by gender and age	Reference mass m_{ref}
Females (aged 20 to 45)	20 kg
Females (aged < 20 or > 45)	15 kg
Males (aged 20 to 45)	25 kg
Males (aged < 20 or > 45)	20 kg
NOTE Table B.2 is included in step 1.	

Table B.2 - Suggested reference masses, mref, considering gender and age, in the general healthy working population

Annex C Assessment method for recommended limits for mass, frequency and object position

C.1 Assessment method for recommended limits for mass, frequency and object position

C.1.1 Recommended mass limit

The RML is the mass of a load that nearly all people in a specific population of people can handle over a substantial period of time without an increased risk of developing lifting-related lower back pain.

The formula used to derive the RML [Formula (C.1)] is a product of multipliers assigned to various conditions (variables) present in the handling task. Formula (C.1) and the multipliers are described in detail in this annex.

C.1.2 Non-repetitive lifting tasks

The mass of an object or the working postures used to manipulate the load in non-repetitive lifting tasks can lead to health risks. Masses which are higher than the reference mass (Annex B), and unfavourable postures like a bent or twisted trunk or a far reach, should be avoided.

To estimate the influence of an unfavourable posture, use a frequency multiplier of "1" in the riskassessment model formula [Formula (C.1)]. The horizontal multiplier indicates the severity of a possible far reach; vertical, distance and asymmetry multipliers show the negative influence of a twisted or bent trunk.

C.1.3 Repetitive lifting tasks

C.1.3.1 Assumptions

The recommended limits are derived from a model assuming that:

- they are only valid for smooth lifting with no sudden acceleration effects (i.e. jerking);
- they cannot be used for tasks where the worker is partly supported (e.g. one foot not on the floor);
- the width of the object 0,75 m or less;
- they are only valid for unrestricted lifting postures;
- they are only valid when good coupling exists (i.e. hand holds are secure and shoe or floor slip potential is low);
- they are only valid under favourable conditions (see Table 4 for details).

C.1.3.2 Primary task variables

The primary task variables include the following information (see also Table C.1):

- RML;
- object mass, m, in kilograms;
- horizontal distance, h, in metres, measured from the mid-point of the line joining the ankles to the centre of gravity of the object grasped.

NOTE The location of the centre of mass of the object is approximately the vertical projection of the midpoint of the line between the hands at the grasping location in a two-handed operation or by the vertical projection of the hand grasping the object in a one-handed operation. The location of the centre of the mass of the worker is approximately the midpoint of the line between the inner points of the ankles.

- vertical location, v, in metres, determined by measuring the distance from the floor to the point at which the hands grasp the object;
- vertical travel displacement, d, in metres, from origin to destination of lift;
- frequency of lifting, f, expressed as average number of lifts per minute;
- duration of lifting, in hours or, alternatively, in minutes;
- angle of asymmetry, α, in degrees;

- quality of gripping, c;
- one-handed operation, o;
- two-persons operation, p;
- extended (more than 8 h) manual handling time, e, in hours.

C.1.3.3 Recommended mass limit formula and multipliers

The first step towards the assessment of the acceptability (safety) of a lifting task is to compare the mass of the object being handled, m, with the RML.

If m ≤ RML, it is a recommended condition.

If m > RML, it is not a recommended condition. In these cases, calculate an LI (Annex D), assess the level of exposure and establish priorities according to Table D.1.

The RML is derived using Formula (C.1) which considers the impact of each task variable. These are represented in the formula by "multipliers" (M) as follows:

$$RML = m_{ref} \times h_M \times v_M \times d_M \times a_M \times f_M \times c_M \times [o_M \times p_M \times \varepsilon_M] \quad (C.1)$$

where

m is the lifted object mass;
m_{ref} is the reference mass for the identified user population group (Tables B.1 and B.2);
h_M is the horizontal distance multiplier, derived from Formula (C.2);
v_M is the vertical location multiplier, derived from Formula (C.3);
d_M is the vertical-displacement multiplier, derived from Formula (C.4);
a_M is the asymmetry multiplier, derived from Formula (C.5) (see also Figure C.1);
f_M is the frequency multiplier (see Table C.2);
c_M is the coupling multiplier for the quality of gripping (see Table C.3);
o_M is the one-handed operation additional multiplier, to be used for lifts performed with only one hand; if true, o_M = 0,6; otherwise, o_M = 1,0 (see also C.1.4);
p_M is the two or more person additional multiplier to be used when two or more persons perform the same lift; if true, pM = 0,85; otherwise, pM = 1,0 (see also C.1.5);
e_M is the extended time additional multiplier to be used when manual handling is performed for more than 8 h per shift; if true, see C.1.6 and Table C.5; otherwise, e_M = 1,0.

See Table C.1 for an illustration of the factors and multipliers.

The multipliers for Formula (C.1) are obtained from Formulae (C.2) to (C.5) and Tables C.2 to C.5. If a multiplier in Formulae (C.2) to (C.5) exceeds a value of 1, its value should be taken as 1.

$$h_M = 0{,}25 / h \quad (C.2)$$

If h < 0,25, then h_M = 1.
If h > 0,63, then h_M = 0.

$$v_M = 1 - 0{,}3 \times 0{,}75 - v \quad (C.3)$$

If v > 1,75, then v_M = 0.
If v < 0, then v_M = 0.

$$d_M = 0{,}82 + 0{,}045 / d \quad (C.4)$$

If d > 1,75, then d_M = 0.
If d < 0,25, then d_M = 1.

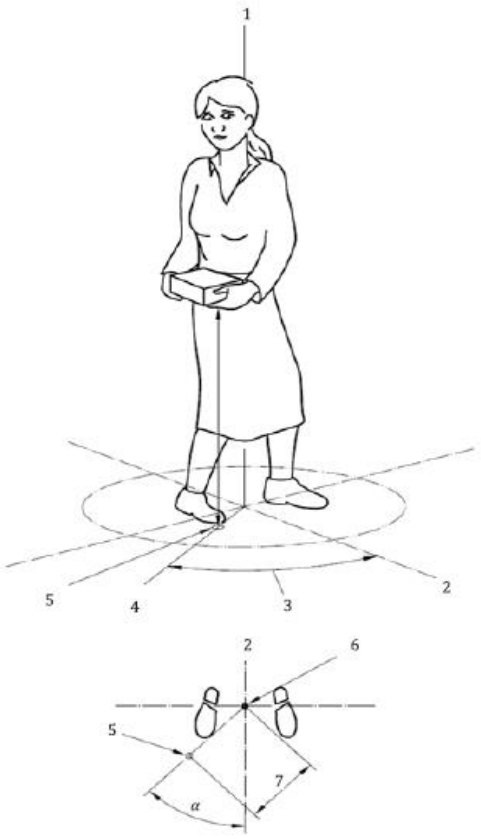
$a_M = 1 - 0{,}003\ 2 \times a$ (C.5)

If $a > 135$, then $a_M = 0$.

Additional multipliers concerning frequency, one-handed lifting, team lifting and extended handling time are provided in C1.4 to C1.6.

Task variable symbol	Task variable		Task variable description
m_{ref}	Reference mass		Maximum recommended mass under reference conditions for manual handling
v_M	Vertical multiplier		Distance of the hands from the floor at the start or end of lifting (A)
d_M	Distance multiplier		Vertical distance of the load between the beginning and the end of lifting (B)
h_M	Horizontal multiplier		Maximum distance between the load and the body during lifting (H)
a_M	Asymmetry multiplier		Angular measure of displacement of the load from the mid-sagittal plane (angle α)
c_M	Coupling multiplier		Assessment of grip of the object (from Table C.3)
f_M	Frequency multiplier		Frequency of lifts per minute and duration (from Tables C.2 and C. 4)
o_M	One-hand multiplier		Lifting by only one hand (from C.1.4)
p_M	Team lifting multiplier		Lifting by two or more operators (from C.1.5)
e_M	Extended time multiplier		Manual handling lasting more than 8 h per shift (from C.1.6 and Table C.5)

Table C.1 - Main task variables in the RML formula



Key

1 vertical
2 mid-sagittal plane
3 asymmetry angle (α)
4 asymmetry line along the plane of asymmetry
5 projection from centre of gravity of load
6 mid-point between inner ankle bones
7 horizontal distance (from 6 to 5)

Figure C.1 — Angle of asymmetry

The RML formula needs to be calculated for the start-point of each task. If there is a definite precision placement involved at the end then end-point calculations will possibly be necessary. In these cases, the lower RML value (between the start and end points) should be used in the analysis and for the computation of the LI (Annex D). If the item is thrown or dropped into place without undue stress on the body in the extended position, then calculating the end-point value is not strictly necessary.

C.1.3.4 Asymmetry multiplier

To decide if an asymmetry multiplier < 1 should be assigned, observe the "primary" working positionof the worker both at the origin and the destination of the lift. If the mid-sagittal plane coincides with the plane of asymmetry both at the origin and at the destination (the object is always in front of the body in the primary position and the worker uses their feet to change the primary position from origin to destination), then there is no asymmetry (αM = 1). If the worker cannot use their feet to change the primary position (for lack of adequate space or for high frequencies), then consider the angle of asymmetry both at origin and destination.

C.1.3.5 Frequency multiplier

The appropriate frequency multiplier, fM, is determined first by considering the continuous duration of the repetitive lifting task and then considering the duration of the recovery period that immediately follows the repetitive lifting task. The recovery period is defined as the duration of light physical work following a period of continuous lifting. Examples of light work include activities such as sitting at a desk, monitoring operations and light assembly work. Manual handling activities other than lifting (i.e. whole body pushing and pulling) should not be considered as recovery periods.

The categories of continuous, repetitive lifting tasks, their durations and the required duration of the recovery period that is to immediately follow the lifting task are provided in Table C.2.

It is critical to note that the combination of the work period and the recovery period shall be jointly considered to be a work-recovery cycle, wherein the recovery period provides sufficient opportunity for the worker to recover following a continuous period of lifting-related work. Accordingly, if two successive work periods are separated by a recovery period of inadequate duration, then the worker cannot adequately recover and the entire period (the two work periods plus the recovery period) shall be treated as if it were a single, continuous work period. The impact of such circumstances is to make the resultant work period substantially longer, resulting in the value for the frequency multiplier, fM, being lowered.

The value of fM is then determined from Table C.3 The use of Table C.3 requires three components of information:

- the frequency of lifting (number of lifts per minute);
- the duration, tL, of the continuous, repetitive lifting task (note that the determination of the frequency multiplier is based on the three duration categories: <1 h, 1 h to 2 h and > 2 h);
- the vertical location, v, of the hands on the object to be lifted at the beginning of the lift.

C.1.3.6 Coupling multiplier

Coupling, or the quality of gripping (Table C.4), is defined as follows:

- Good: if the object can be grasped by wrapping the hand comfortably around the object or handles or hand-hold cut-outs of the object, or the object itself, without significant deviations from the neutral wrist posture. An optimal handle design has a diameter of 1,9 cm to 3,8 cm, a length of ≥ 11,5 cm, a cylindrical shape and a smooth, non-slip surface.
- Fair: if the object has handles or cutouts that do not fulfil the criteria of good quality of gripping or if the object itself can be grasped with a grip in which the hand can be flexed by about 90°.
- Poor: if the criteria of good or fair quality of gripping are not fulfilled or the object is bulky, hard to handle or has sharp edges.

Categories	Duration, t	Required recovery period
Short duration	t ≤ 1 h	100 % of duration of the continuous, repetitive lifting task
Medium duration	1 h < t ≤ 2 h	30 % of duration of the continuous, repetitive lifting task
Long duration	2 h < t ≤ 8 h	No amount is specified; normal morning, afternoon and lunch breaks are presumed
NOTE For respective frequency multipliers see Table C.3.		

Table C.2 - Continuous lifting tasks and their required recovery periods

Frequency of lifting Number of lifts per minute	Values of fM					
	$t_L \leq 1$ h		1 h < $t_L \leq 2$ h		2 h < $t_L \leq 8$ h	
≤ 0,2	1,00	1,00	0,95	0,95	0,85	0,85
0,5	0,97	0,97	0,92	0,92	0,81	0,81
1	0,94	0,94	0,88	0,88	0,75	0,75
2	0,91	0,91	0,84	0,84	0,65	0,65
3	0,88	0,88	0,79	0,79	0,55	0,55
4	0,84	0,84	0,72	0,72	0,45	0,45
5	0,80	0,80	0,60	0,60	0,35	0,35
6	0,75	0,75	0,50	0,50	0,27	0,27
7	0,70	0,70	0,42	0,42	0,22	0,22
8	0,60	0,60	0,35	0,35	0,18	0,18
9	0,52	0,52	0,30	0,30	0,00	0,15
10	0,45	0,45	0,26	0,26	0,00	0,13
11	0,41	0,41	0,00	0,23	0,00	0,00
12	0,37	0,37	0,00	0,21	0,00	0,00
13	0,00	0,34	0,00	0,00	0,00	0,00
14	0,00	0,31	0,00	0,00	0,00	0,00
15	0,00	0,28	0,00	0,00	0,00	0,00
> 15	0,00	0,00	0,00	0,00	0,00	0,00

Table C.3 - Values of frequency multiplier, f_M, of Formula (C.1)

Quality of gripping	Values of c_M	
	h < 0,75 m	h ≥ 0,75 m
Good	1,00	1,00
Fair	0,95	1,00
Poor	0,90	0,90

Table C.4 - Coupling multiplier (c_M) for the quality of gripping

C.1.4 Lifting one-handed

When the lifting is performed one-handed, add the one-hand multiplier (oM) to Formula (C.1) tocalculate the RML.

$o_M = 0,6$

C.1.5 Lifting by two or three people

When the lifting action is performed by two or three people, the RML for each person should be derived by using the true lifted mass, m_A, dividing by two or three (according to the number of people lifting) and adding the persons multiplier, p_M, to Formula (C.1). Adding this multiplier allows the RML for each person in a lifting team to be calculated. $p_M = 0,85$.

C.1.6 Handling for more than 8 h per shift

When manual handling activities are performed for more than 8 hours per shift, another multiplier, e_M, should be added to Formula (C.1) using the information provided in Table C.5.

Hours (with MMH) in the shift	≤ 8	8 to 9	9 to 10	10 to 11	11 to 12
eM (extended time multiplier)	1	0,97	0,93	0,89	0,85
NOTE Only apply to RML calculation when the frequency is ≥ 0,2 lifts per minute and a long duration scenario is present (from Table C.2).					

Table C.5 - Extended time multiplier, e_M, for manual handling tasks lasting more than 8 h per shift

LI value	Exposure level/risk implication	Recommended actions[a]
LI ≤ 1,0	Very low	None in general for the healthy working population.
1,0 < LI ≤ 1,5	Low	In particular pay attention to low frequency/high load conditions and to extreme or static postures. Include all factors in redesigning tasks or workstations and consider efforts to lower the LI values < 1,0.
1,5 < LI ≤ 2,0	Moderate	Redesign tasks and workplaces according to priorities to reduce the LI, followed by analysis of results to confirm effectiveness.
2,0 < LI ≤ 3,0	High	Changes to the task to reduce the LI are a high priority.
LI > 3,0	Very high	Changes to the task to reduce the LI are needed immediately.
For any level of risk or exposure	Identify any workers who have special needs or vulnerabilities in lifting tasks and assign or design the work accordingly. Training workers on safe manual handling methods and recognizing material handling hazards is beneficial. Limiting the weight to be lifted to less than the reference mass may also be considered.	
a To be used in conjunction with considerations outlined in the Introduction and Annex A regarding general use of ergonomics principles and approaches that should be used at all workplaces.		

Table D.1 - Interpretation of LI (m_A/RML) values

Annex D Lifting index

D.1 Calculating the lifting index and its derivatives

The LI is the ratio of the object mass (m) to the RML for a particular lifting condition [see Formula (D.1)]. It provides an indication of the level of exposure to overall physical demands for repetitive lifting activities. It can be used to compare risks across different lifting tasks.

LI = m/RML (D.1)

If LI ≤ 1, it is an acceptable condition.
If LI > 1, assess the level of exposure and establish priorities (see Table D.1).

The above equation for the LI is derived to include three additional metrics: the composite lifting index (CLI), the sequential lifting index (SLI) and the variable lifting index (VLI) (see Annex F for detailed calculation methods).

D.2 Interpretation of the LI and its derivatives

The LI and its derivatives (CLI, SLI and VLI) indicate the level of exposure to overall physical demands for repetitive lifting activities. Table D.1 provides information on exposure levels related to different LI values, as well as their interpretation (based on current scientific literature) and some possible recommended actions. See Annex I for a discussion on exposure and risk. Depending on task specifics, the analyst can supplement the lifting analysis with additional analyses for low back loading. This can be desirable where extreme postures or movements are used in the lifting tasks, or for establishing metabolic demands of all of the tasks involved.

Annex F Multi-task manual lifting

F.1 General aspects

Jobs which involve single-task lifting are different from multi-task lifting jobs. The task variables in single-task lifting jobs do not vary significantly from task to task or from lift to lift, whereas in multitask lifting jobs they do.

Multi-task lifting jobs are more difficult to analyse than single task jobs, as each task needs to be analysedseparately and as a group. The method used to study tasks as a group shall avoid averaging out good and bad task variables and other potential inaccuracies. There are additional analysis complications if the multi-task job involves the lifting of a large variety of objects or if there is a sequential handling of objects due to job rotation or other variations in work patterns.

The following criteria are to be used when defining task characteristics for the purpose of analysing lifting tasks:

- Single (or mono) tasks are defined as tasks involving the lifting of only one kind of object (with the same load) using always the same postures (body geometry) in the same layout at origin and destination. In this case, or if only one lift is of interest, the traditional LI calculation can be used (Annex D). Although this type of lifting task is not common, it is the basis for the calculations and procedures used for more complicated and variable lifting or lowering tasks.
- Multiple composite tasks are defined as tasks involving lifting objects (generally of the same kind and mass) and collecting and positioning them from or to various different heights, depths or both. Object location is one of the variables considered in the analysis of a lifting task. Practically each individual location of the object's placement is a new task variant and is considered to be a subtaskin this type of analysis. In this case, the composite lifting index (CLI) calculation is applied. No more than 10 subtasks should be used in this calculation (Figure F.2). The variable lifting index (VLI) is suggested for assessing jobs with more than 10 subtasks.
- Multiple variable tasks are defined as lifting tasks in which both the locations and load mass vary in different lifts performed by the worker(s) within (or during) the same period of time (Figure F.3). The VLI is suggested for assessing these complex types of lifting tasks.
- A sequential task (Figure F.4, Table F.1) is defined as a job in which the worker rotates between two or more mono tasks, composite tasks and/or variable tasks during a work shift (each task lasting no less than 30 min consecutively). For these work scenarios, the sequential lifting index (SLI) calculation can be used.

Figure F.1 gives criteria for the use of the different approaches outlined here when analysing different handling tasks.

NOTE The interpretation criteria for LI reported in Table D.1 are also valid for interpreting CLI, VLI and SLI results.

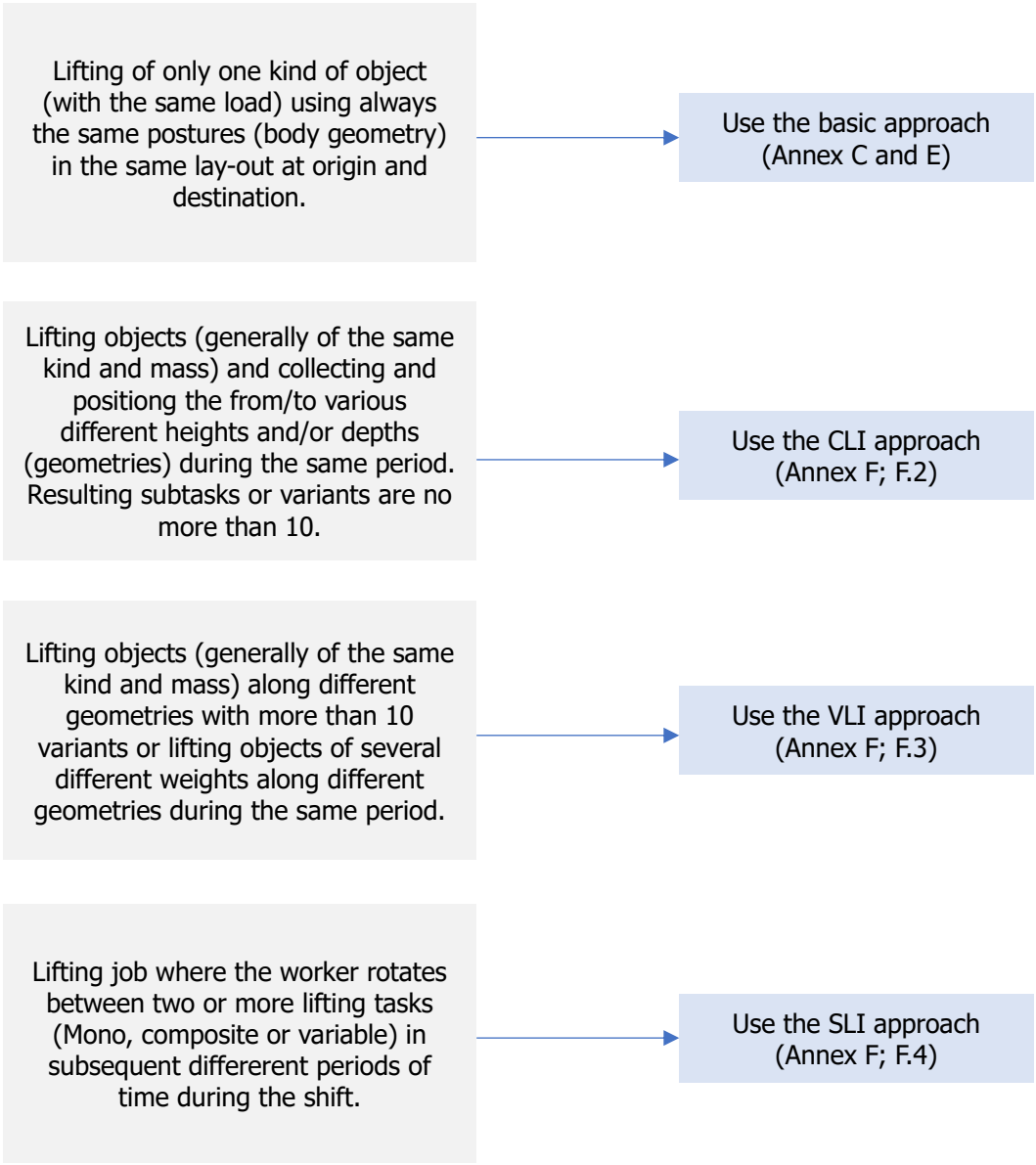
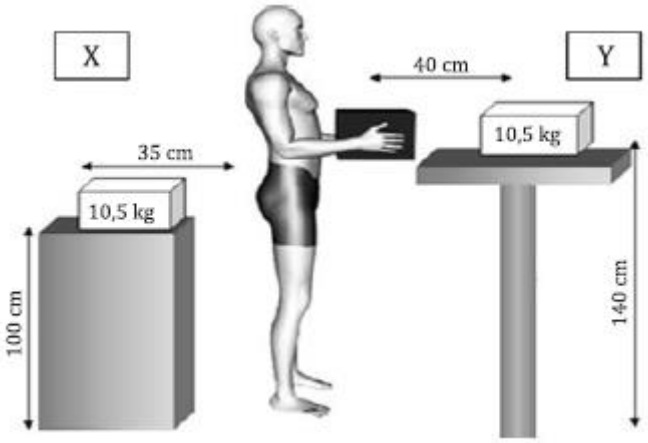
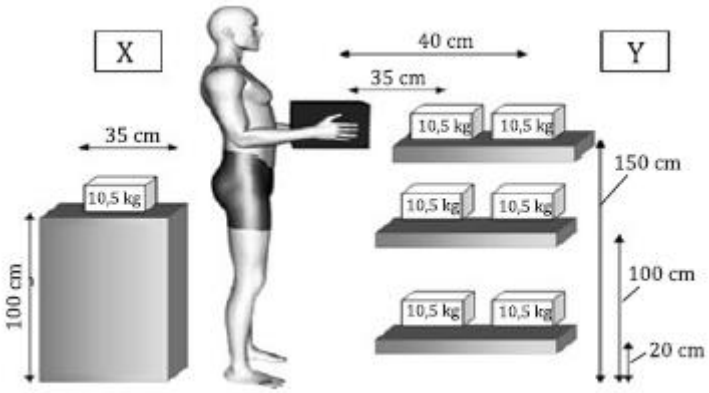


Figure F.1 - Different types of lifting tasks and consequent computation approaches



a) Single task

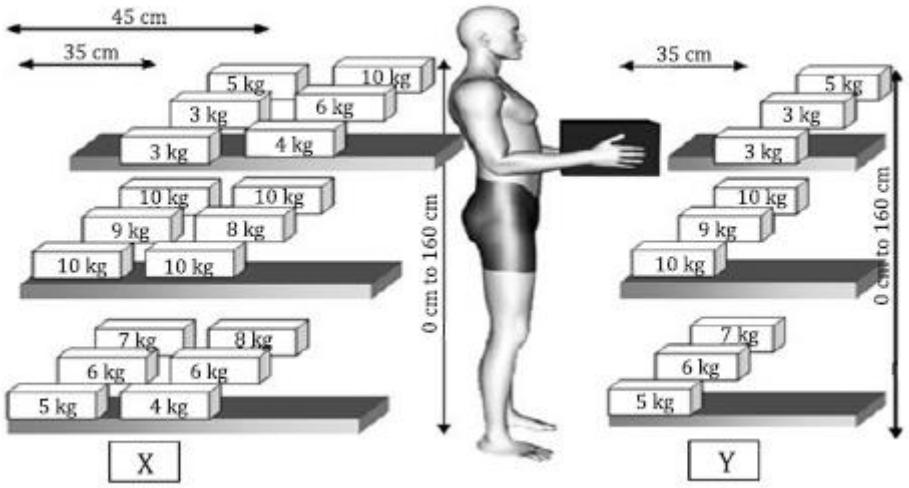


b) Composite task

Key

x origin
y destination

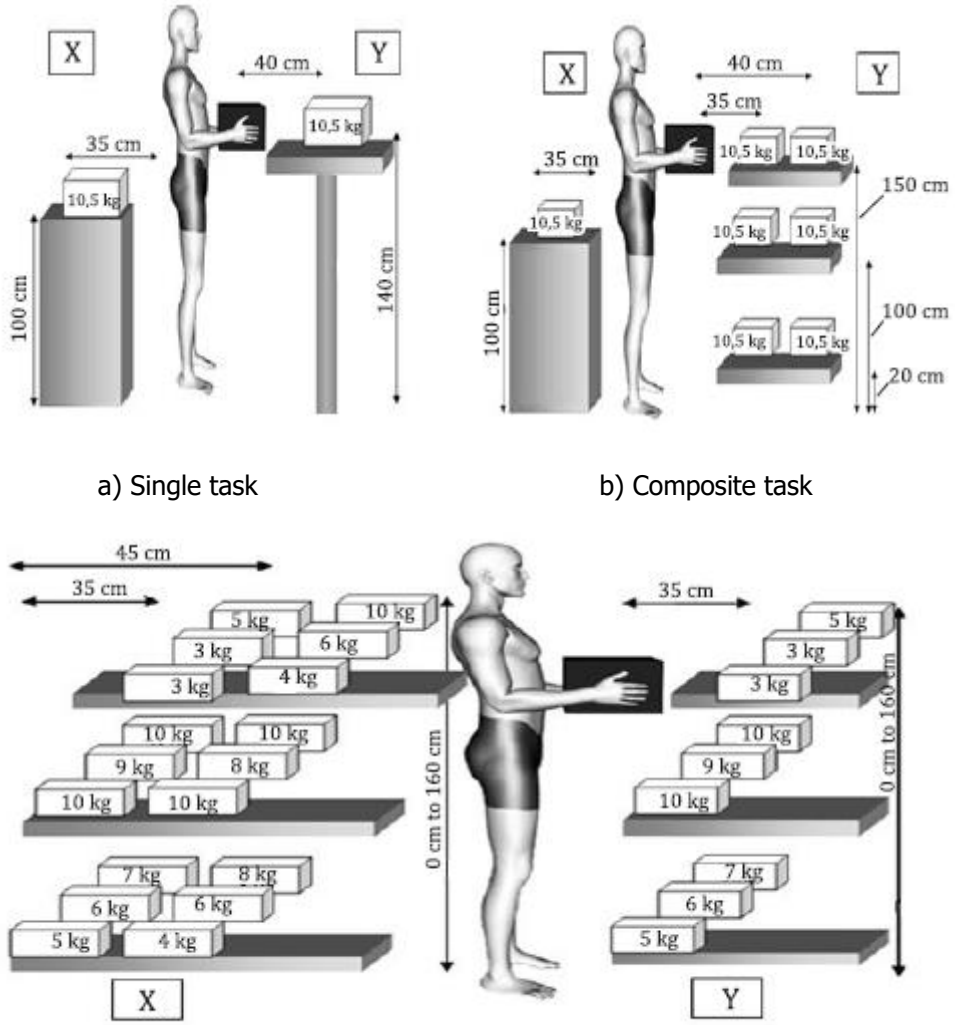
Figure F.2 - Single and composite tasks



Key

x origin
y destination

Figure F.3 - Variable task



a) Single task

b) Composite task

c) Variable task

Key

x origin
y destination

Figure F.4 - Sequential task as a combination of a single, composite and variable task

Single task	Composite task	Break	Composite task	Variable task	Lunch	Variable task	Break	Composite task	Single task
45 min	75 min	10 min	45 min	65 min	65 min	125 min	10 min	60 min	45 min

Table F.1 - Sequential task: example of duration and distribution of tasks of Figure F.4 in a 480-min shift

F.2 Composite lifting tasks and CLI

Where composite lifting tasks are performed, i.e. tasks where the weights are the same but they are moved to several different locations (e.g. height, depth) (Figure F.2) or where few different weights are moved over a variety of heights, depths or both, every variant of location is defined as a subtask. In such cases, it is recommended that the CLI is calculated using Formula (F.1), which represents the collective demand for that task or job. It is equal to the sum of the largest single (sub)task lifting index (STLI) and the incremental increase in the CLI as each subsequent subtask is added. The incremental increase in the CLI for a specific subtask is defined as the difference between the STLI of that subtask at the cumulative frequency for all the subtasks and the STLI of the same subtask at its own actual frequency.

$CLI = LI_1 + \Sigma\Delta LI_n$ (F.1)

where

$\Sigma\Delta LI_n = (FILI_2X\ (1/FM_{1,2} - 1/FM_1)) + (FILI_3X\ (1/FM_{1,2,3} - 1/FM_{1,2})) + (FILI_4X\ (1/FM_{1,2,3,4} - 1/FM_{1,2,3})) + (FILI_nX\ (1/FM_{1,2,3,4,\ldots,n} - 1/FM_{1,2,3,\ldots,(n-1)}))$

NOTE 1 The numbers in subscript refer to the new LI task in order of relevance.

NOTE 2 The FM values are determined from the frequency Table C.3.

Steps for the CLI calculation:

- Calculate the frequency-independent recommended mass limit (FIRML), i.e. the RML without considering the frequency/duration multiplier, and the single task recommended mass limit (STRML) for each subtask as in single task analysis.
- Calculate consequently the frequency-independent lift index (FILI) and single task lift index (STLI) for each subtask.
- Renumber the subtasks in order of decreasing STLI values.
- Calculate the composite lifting index (CLI) for the overall lifting task or job.

Subtasks are defined in relation to variants of weight and geometries (e.g. vertical height, horizontal distance). Consider a task where a worker removes objects of the same weight from three shelves of different heights and places them on a conveyer belt of constant height. At each of the three shelf heights, there are two different distances from the body. Therefore, there are six subtasks (three heights × two horizontal distances) which are treated like six single tasks. Each single task shall first be evaluated separately and then the CLI is estimated.

To accurately calculate the CLI, there shall not be more than 10 subtasks, since the overall frequency has to be divided by the number of subtasks. If there are more than 10 subtasks, the final result can be unreliable. In cases where the number of subtasks exceeds 10, it is recommended that the simplified procedures of the variable lifting task are used to calculate the VLI.

F.3 Variable lifting tasks and VLI

F.3.1 General

A variable task is defined as a lifting task in which both the geometry and load mass vary in different lifts performed by the worker(s) during the same period of time.

Examples of this category of task can include lifting in warehouse operations, baggage handling and small lot material delivery in assembly line manufacturing operations.

The variables that increase the number of subtasks in composite or variable tasks can be large and lead to long analysis times and errors. The original formula for composite lifting tasks discourages the use of more than 10 variables (subtasks). Hence, simplifications are needed for allowing analysis of such complex lifting tasks.

The concept for the VLI is similar to that of the composite lift index (CLI). However, in the VLI calculation, individual lifting tasks (subtasks) are grouped together into defined frequency-independent lift index (FILI) categories. These FILI categories are then treated as if they were individual lifts in the CLI calculation. Although as many as nine FILI categories can be used, it is suggested that six categories be used for ease of use.

F.3.2 Calculating VLI

The following general procedure for calculating VLI is suggested.

Whatever the number of potential individual lifting tasks in the job, compress them into a structurethat considers up to a maximum of 30 subtasks (and corresponding FILI and STLI) for different loads (weight categories) and geometries using the following approach:

- Aggregate up to five object (weight) categories.
- Classify the vertical location into two categories (good; bad).
- Classify the horizontal location into up to three categories (near; medium; far).
- Assess the presence or absence of asymmetry for each weight category (by threshold value for all the lifts in the category).
- Classify the daily duration of lifting as in Table C.2.
- Determine or estimate the frequency of lifts for each subtask and FILI. Determine the frequency multipliers (fM) as in Table C.3.
- Consider both vertical displacement (DM) and coupling (CM) as a constant.

In the end it is possible to calculate individual FILI and STLI for up to 30 subtasks.

The resulting FILIs are then fitted into six FILI categories.

The average values for each FILI category and the corresponding frequency of lifts in each category are then used as input into the CLI to obtain the VLI for a variable lifting task. The procedure maintains the original criteria reported in Annex C via simplifications in data collection.

F.3.3 Calculating CLI (for a composite task with more than 10 subtasks) and VLI for variable tasks

The procedure is based on a systematic assessment of the job using existing job and task data (for durations, weights, workstation design and overall and partial frequencies) or probability distribution data (for geometries and sub partial frequencies). The assessment requires knowledge of the total duration of the lifting tasks during the work shift, number and weight of the different objects lifted, for the job.

a) Identify the mass (from 3 kg up to maximum, by increments of 1 kg) and the number of objects lifted in a shift. The recorded weight of the masses is aggregated into a maximum of five weight categories by dividing the span of weight values (i.e. maximum value – minimum value) by five to determine the minimum and maximum for each category. A representative average (by frequency) mass is selected for each category.

From the data collected (e.g. number of workers involved in the task(s), net duration of lifting in the shift, total number of objects lifted during a shift, number of objects within each mass category lifted during a shift), one can determine the net manual handling duration, the overall lifting frequency (per worker) and the lifting frequency per each mass category.

b) Simplify the geometry variables according to these criteria:

- Vertical location (height of hands at lifting origin or destination). This variable is reduced to 2 areas:

- - ideal area (good): hands are between 51 cm and 125 cm vertical height. The vertical multiplier, v_M, is equal to 1;
- - non-ideal areas (low or high): hands are at or below 50 cm or above 125 cm (up to 175 cm) vertical height. The vertical multiplier, v_M, is equal to 0,78.

In cases where the vertical height exceeds the maximum recommended vertical height (>175 cm), the lift is considered unsafe.

- Horizontal location (maximum hand grasp point away from the body during lifting). The horizontal distances are simplified into 3 areas:

-- near: horizontal distance is within 25 cm to 40 cm. The representative horizontal multiplier, h_M, is equal to 0,71 (for a representative value of 35 cm);

-- mid: horizontal distance is within 41 cm to 50 cm. The representative horizontal multiplier, h_M, is equal to 0,56 (for a representative value of 45 cm);
-- far: horizontal distance is within 51 cm to 63 cm. The representative horizontal multiplier, h_M, is equal to 0,40 (for a representative value of 63 cm).

In cases where the horizontal distances exceed the maximum recommended value (>63 cm), the lifts are considered unsafe (no calculation is possible).

- Asymmetry (angular displacement of loads off to the side of the body): asymmetry is considered collectively for each weight category. An asymmetry multiplier, a_M, of 0,81 is assigned to all the subtasks in a weight category if asymmetry of 45° or more is observed for over 50 % of lifting actions in that category. Otherwise, the asymmetry multiplier is set to 1.

- Vertical travel distance (vertical distance between the height of hands at origin and at destination): the contribution of this factor has been considered as non-influent. The corresponding multiplier, d_M, has thus been taken as a constant, equal to 1. Even if the vertical distance multiplier, d_M, is set as a constant, the height of the hands at both the origin and destination of the lift should always be measured and considered.

- Coupling (quality or type of grip): the contribution of this factor has also been defined as constant.

Experience has taught that ideal couplings are very rare, so the corresponding multiplier, c_M, is defined as a constant equal to 0,90.

By adopting these simplifications and procedures, it is possible to analyse a variable lifting task scenario and produce up to (and no more than) 30 sets of FILI and STLI values, one for each of 30 different subtasks (five weight categories × two vertical location × three horizontal areas × one asymmetry condition) (Figure F.5).

For each of these subtasks, an individual frequency of lifting is calculated or estimated by a statistical approach and the subsequent frequency multiplier, fM, is derived from Table C.3.

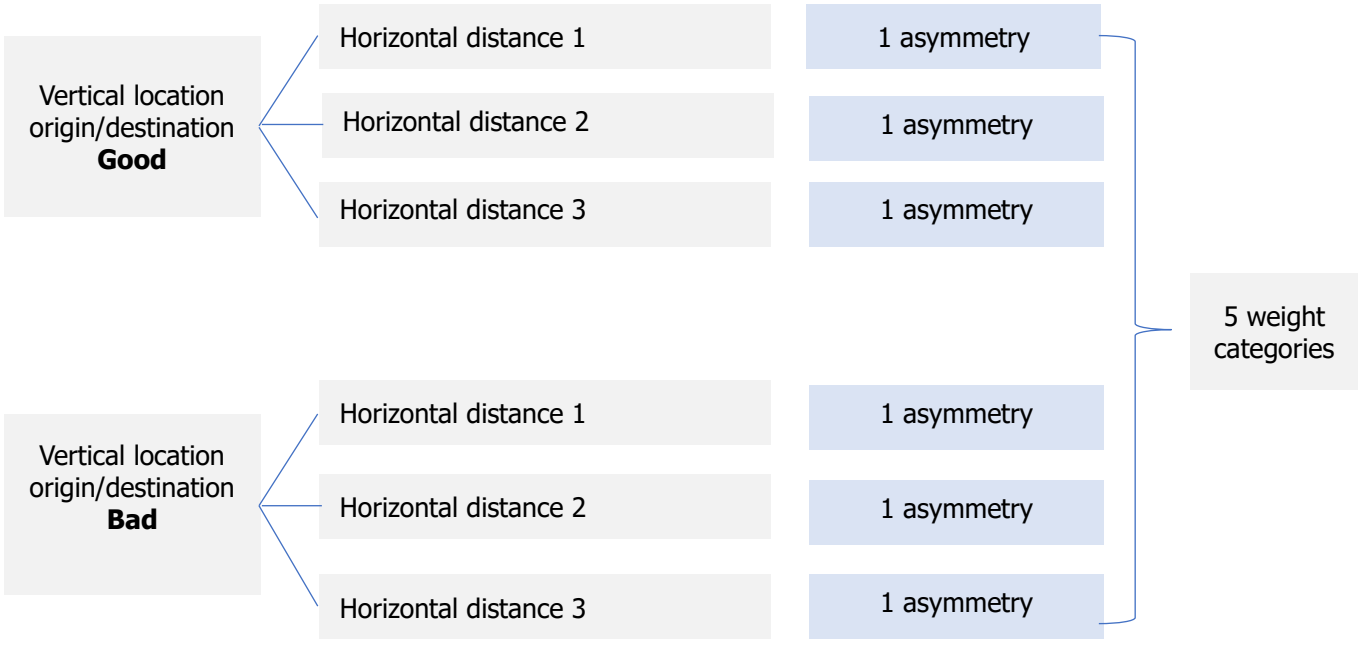


Figure F.5 - The result of the adopted simplifications: a maximum of 30 potential subtasks

c) Aggregate the resulting LI and calculate the final VLI (or CLI with more than 10 subtasks). 30 subtasks with corresponding FILI and STLI is still too many. For correctly applying the variable task analysis, it is necessary to further reduce and group the number of subtasks to six LI categories (each with a representative FILI and STLI value) and then to apply the traditional CLI formula.

To this end:

- the entire set of FILI values are assigned into six LI categories;
- the LI categories are defined by assigning the FILI values according to "sextiles" of the corresponding FILI distribution (16,66th, 33,33th, 50th, 66,66th and 83,33th percentiles values);
- consequently, the cumulative frequency of lifting for each of those six LI categories is also determined;
- once the LI categories have been aggregated, a representative FILI and STLI value is chosen within each category and the categories are reordered (mean value for categories 2 to 6; highest value for the first category).

The final VLI can then be calculated using Formula (F.2), similar to the traditional CLI formula applied to the six LI categories.

$$VLI = STLI_1 + \Sigma\Delta LI_n \quad (F.2)$$

$$\Sigma\Delta LI = (FILI_2 X\ (1/FM_{1,2} - 1/FM_1)) + (FILI_3 X\ (1/FM_{1,2,3} - 1/FM_{1,2})) + (FILI_4 X\ (1/FM_{1,2,3,4} - 1/FM_{1,2,3})) + (FILI_5 X\ (1/FM_{1,2,3,4,5} - 1/FM_{1,2,3,4})) + (FILI_6 X\ (1/FM_{1,2,3,4,5,6} - 1/FM_{1,2,3,4,5}))$$

The VLI calculation is very difficult to complete manually and is best completed using dedicated

software. Free downloadable software is available at various websites [59].

F.4 Sequential lifting tasks and SLI

When a job is characterized by several different lifting tasks (mono, composite, variable) in a shift,and workers rotate between a series of single or multiple lifting task rotation slots during a work shift, a clear multitask job is presented. In this case, the recommended method to assess the risk is the sequential lifting task technique[18],[51]. The SLI allows the calculation of the final LI for multitaskjobs, considering the sequence of lifting tasks, the different intrinsic duration of each task and the total duration of exposure to manual handling during the shift.

The main steps for obtaining the SLI are:

a) Step 1: define the tasks present in the shift and their time sequence.
b) Step 2: define the duration and time distribution of the lifting tasks present in the shift.
c) Step 3: for each lifting task, as per the procedures previously given for CLI and VLI calculation, describe the number of objects lifted and geometry of the objects per shift.
d) Step 4: for each task, calculate the respective STLI by considering both intrinsic duration (LI intr) and total duration (all lifting tasks) (LI max) scenarios.
e) Step 5: use Formula (F.3) to obtain the SLI.

The SLI calculation is:

$$SLI = LI_1intr + (LI1max - LI_1intr) \times K$$

where

LI_1intr is the STLI of the most stressful task considering its continuous duration;
LI_1max is the STLI of the most stressful task considering overall duration of all lifting tasks;
$K = ((LI_1max \times FT1)+(LI_2max \times FT2)+....+ (LI_nmax \times FT_n))/ LI_1max$;
FT_j is the time (in min) in task j during the shift/480 min (i.e. 60 min × 8 h)

The SLI approach can be used for analysing lifting tasks that vary along periods longer than a day (a week, a month or also a year). In such cases, the approach should be properly adjusted considering the effective and proportional duration of each rotating task within the whole considered period as well as the duration of tasks not involving manual handling activities.

Annex H Carrying

H.1 Reference conditions for carrying limits

The recommended limits for cumulative mass per day and cumulative mass related to distance (steps 4 and 5 in Figure 1 and 4.2.2.1 and 4.2.2.2) assume reference conditions.

Reference conditions include the following:

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

Worker safety should not be compromised. Acute hazards, such as trip or fall hazards, shall be eliminated or controlled.

H.2 Correction ratios and multipliers for carrying conditions other than reference conditions

When carrying tasks are performed in conditions other than reference conditions, the threshold values supplied in Table 5 shall be reduced. Correction ratios and multipliers have been established for the influencing factors below that are beyond the reference conditions. These make it possible to adjust the threshold values supplied in Table 5 to non-reference conditions. These correction ratios are presented as multipliers.

- Where there is more than one influencing factor, only the two most unfavourable multipliers (lowest values) shall be used.
- Where carrying is performed with only one hand, the recommended limits for cumulative mass in Table 5 shall first be multiplied by 0,6, and then two of the most unfavourable multipliers (lowest numbers) shall be applied.

Regarding the carrying durations and the load limits in Table 5, the kg per time interval represents the total amount of mass carried within that duration regardless of the number of trips. The amount of mass carried per trip and the number of trips can vary. Given that, in most cases, a carry also involves a lift, the lifted mass is subject to lifting or lowering assessment.

Consider the average or modal carrying distance and apply the multipliers in Table H.1 accordingly.

Carrying distance	CR or multiplier
1 m to 2 m	1
> 2 m to 5 m	0,8
> 5 m to 10 m	0,6
> 10 m to 20 m	0,2

Table H.1 - Carrying distance correction ratios or multipliers

Carrying distances > 20 m are considered to be unacceptable.

When carrying at low or high levels the recommended limits for cumulative mass for carrying in Table 5 shall be reduced according to Table H.2.

Vertical hand position during carrying	CR or multiplier
Conditions with hand position: > 75 cm to 110 cm	1
Conditions with hand position: 40 cm to 75 cm or > 110 cm to 140 cm	0,8[a]
Exceptional conditions > 140 cm to < 40 cm	0,4[a]
a Does not apply to shoulder carries where the weight of the load is borne by the shoulder and not by the hands.	

Table H.2 - Correction ratios or multipliers for the height at which the carrying (not lifting or lowering) effort is applied (handhold height)

Pick-up, set-down or carrying with hands below 40 cm or beyond 175 cm is considered to be unacceptable.

The conditions considered to be risk-generating are: an object without hand-grips or with unsuitable hand-grips, twisting the trunk, having to reach in > 0,40 m (horizontally), or out of the reach span, one or more postural or body position constraints, unstable object, visibility hindered by the object (see Table H.3).

Conditions in which the tasks are performed	CR or multiplier
No risk-generating factor	1
One risk-generating factor	0,8
Two or more risk-generating factors	0,7

The following additional risk factors should also be considered in the general assessment of the task:

- ambient noise, noisy conditions;
- poor atmospheric conditions such as dust, fumes or smoke in the air;
- poor or damaged walking surfaces;
- physical obstacles in the carry path;
- limited head room;
- limited or constrained manoeuvre room;
- strict task pacing;
- multiple tasks being performed;
- quality requirements.

The information presented in this annex has been drawn from studies presented in the French standard NF X35-109 and from German studies on carrying.

H.3 Example — Carrying a part from a machine to a shipping container

The operation is performed once a minute using two hands where there are two good handles, 7 h per day and the activity conditions are as follows:

- the part weighs 12 kg;
- machine-to-container distance is 10 m;
- the operative picks and carries the part up at a height of 1,15 m;
- the part is set down at an off-ground height of 0,45 m;
- the horizontal reach-in to set-down is 0,60 m.

In order to use Table 5, the kg per duration shall be calculated. Given that the mass is 12 kg, the work time duration is 7 h per day and the operation is performed once per minute, the cumulative mass is:

12 kg × 1/min × 60 min/h × 7 h = 5 040 kg/7 h

Consider the correction multipliers from the tables above:

- carry distance is 10 m, from Table H.1 the correction multiplier is 0,6;
- carry height is 1,15 m, from Table H.2 the correction multiplier is 0,8;
- the reach-in or horizontal reach for the set down is 0,6 m, from Table H.3 the correction multiplier is 0,8.

Among the multipliers, the two most severe multipliers are 0,6 and 0,8. Therefore, these two numbers are used for calculation of the recommended limit for cumulative mass. The acceptable cumulative mass for 7 h (from Table 5) is 6 000 kg. The resulting recommended cumulative mass for 7 h and with the given conditions is:

6000 kg × 0,6 × 0,8 = 2880 kg

The task of carrying a total of 5 040 kg/7 h is not recommended since 2 880 kg is the maximum cumulative mass acceptable in this condition. A number of job changes can eliminate the need for the correction multipliers, such as reducing the carry distance to less than 2 m, changing the carry height and reducing the horizontal reach-in distance. This can bring the acceptable weight to handle closer to the actual weight being carried. However, there is a need to reconsider the job and task organization as suggested in Annex A to reduce the weight to within an acceptable limit.

Consider the same carrying condition but with a reduced duration (e.g. a carry of 12 kg where the carry is performed for 4 h).

In this example, the cumulative mass is:

12 kg × 1/min × 60 min/h × 4 h = 2880 kg

This is below the limit of 5 000 kg/4 h in Table 5. With the multipliers added, the actual recommended limit is: 5000 kg × 0,6 × 0,8 kg = 2400 kg.

The actual accumulated weight is only 480 kg greater than the recommended accumulated carrying under these conditions. Modifications to the task itself (in order to reduce the conditions that canincrease risk of injury) eliminate or reduce the multipliers and change the weight recommendations for the new conditions.

Fonti:
UNI ISO 11228-1:2022
D.Lgs. 81/08

Collegati
UNI ISO 11228-1:2022 - MMC / Sollevamento, abbassamento e trasporto
ISO 11228-1:2021
Decreto Legislativo 9 aprile 2008 n. 81
Analisi normativa rischio MMC: ISO 11228 e il Metodo NIOSH
Valutazione rischio MMC ripetitivi ISO 11228-3 OCRA | Semplice
Valutazione rischio MMC ripetitivi ISO 11228-3 OCRA | Dettagliata
Rischio MMC e ISO/TR 12295:2014

Matrice Revisioni

Rev.	Data	Oggetto
0.0	31.03.2022	---

Note Documento e legali
Certifico Srl - IT / EN | Rev. 0.0 2022
©Copia autorizzata Abbonati
ID 16255 | 31.03.2022
Permalink: https://www.certifico.com/id/16255
Policy