Ergonomics

NIOSH Lifting Equation (Single Tasks)

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ERGONOMICS PLUS

About

The NIOSH Lifting Equation is a tool used by occupational health and safety professionals to assess the manual material handling risks associated with lifting and lowering tasks in the workplace.

NIOSH Lifting Equation Outputs

Recommended Weight Limit (RWL)

Answers, "Is this weight too heavy for the task?"

Lifting Index (LI)

Answers, "How significant is the risk?"

NIOSH Lifting Equation Outputs

Lifting Index (LI)

Answers, "How significant is the risk?"

> 1.0 High Risk

< 1.0 Nominal Risk

The goal is to design a job / task to be < 1.0!

NIOSH Lifting Equation

RWL = LC (51) x HM x VM x DM x AM x FM x CM

Task variables needed to calculate the RWL:

- H = Horizontal location of the object relative to the body
- V = Vertical location of the object relative to the floor
- D = Distance the object is moved vertically
- A = Asymmetry angle or twisting requirement
- F = Frequency and duration of lifting activity
- C = Coupling or quality of the workers grip on the object

(M stands for Multiplier)

NIOSH Lifting Equation Outputs

Lifting Index (LI) = RWL ÷ Weight

Additional task variables needed to calculate the LI:

- Average weight of the objects lifted
- Maximum weight of the objects lifted

NIOSH Lifting Equation Outputs

The RWL and LI can be used to guide lifting task design in the following ways:

1) The individual multipliers that determine the RWL can be used to identify specific weaknesses in the design.
2) The LI can be used to estimate the relative physical stress and injury risk for a task or job. The higher the LI value, the smaller the percentage of workers capable of safely performing these job demands. Thus, injury risk of two or more job designs could be compared.
3) The LI can also be used to prioritize ergonomic redesign efforts. Jobs can be ranked by LI and a control strategy can be implemented based on a priority order of the jobs or individual lifting tasks.

Additional Outputs

Frequency Independent Recommended Weight Limit (FIRWL)

Uses a Frequency Multiplier (FM) of 1.

Frequency Independent Lifting Index (FILI)

= Weight ÷ FIRWL

Using the NIOSH Lifting Equation

Step 1 – Measure and Record Task Variables

Step 2 – Enter Data, Calculate RWL & LI

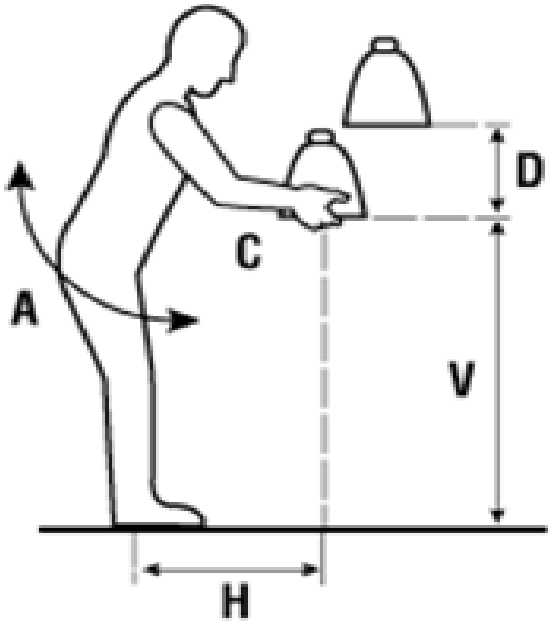
Data Collection Sheet

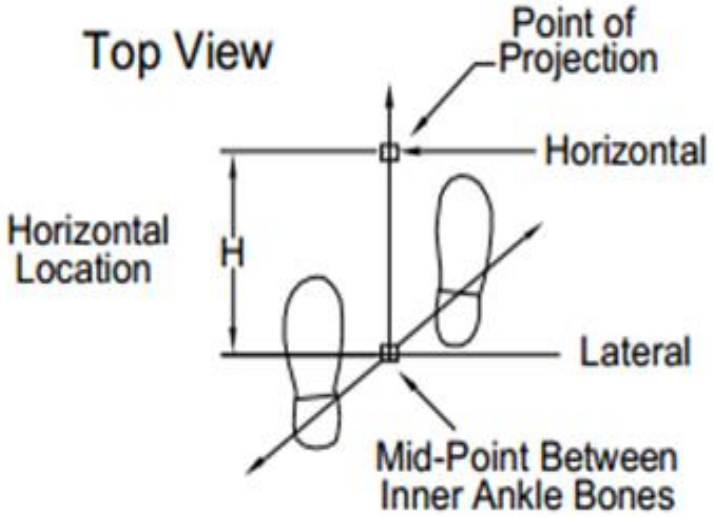
Department: Job:

Lifting Task	NIOSH Lifting Variables								
	H Horizontal Location (10-25")	**V** Vertical Location (0-70")	**D** Travel Distance (10-70")	**A** Angle of Asymmetry (0° - 135°)	**C** Coupling (1=good, 2=fair, 3=poor)	**F** Frequency (0.2 - 15 lifts/min)	**L** Ave. Load Lifted (lbs.)	**L** Max. Load Lifted (lbs.)	**Dur** Duration (1, 2, 8 hours)

Horizontal Location of the Hands (H)

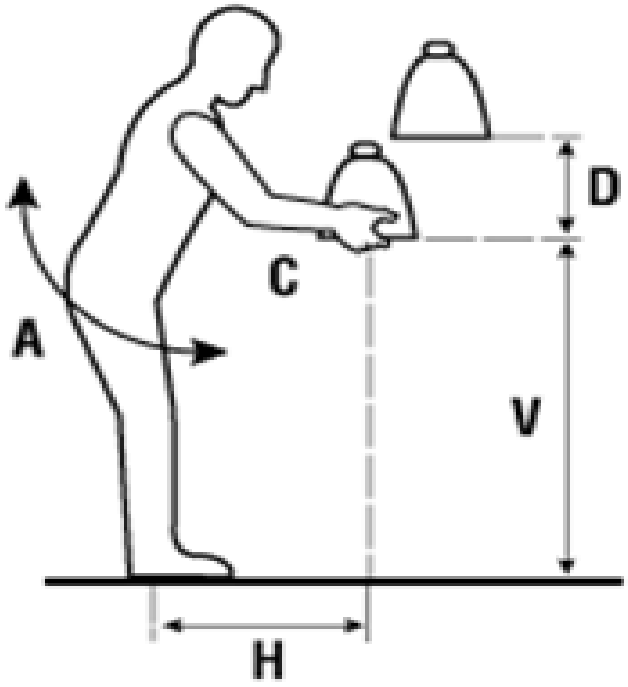
Horizontal Location of the Hands (H) – Measure and record the horizontal location of the hands at both the start (origin) and end (destination) of the lifting task. The horizontal location is measured as the distance (inches) between the employee's ankles to a point projected on the floor directly below the mid-point of the hands grasping the object as pictured below:





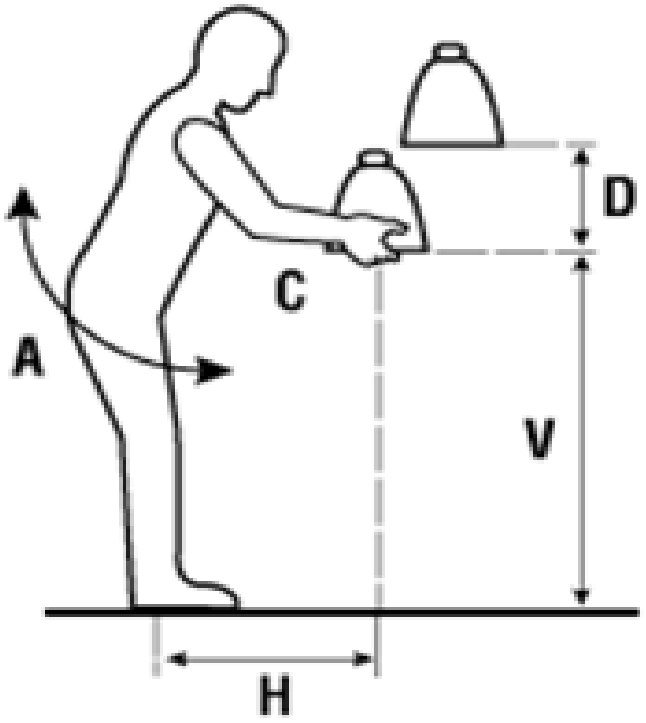
Vertical Location of the Hands (V)

Vertical Location of the Hands (V) – Measure and record the vertical location of the hands above the floor at the start (origin) and end (destination) of the lifting task. The vertical location is measured from the floor to the vertical mid-point between the two hands as shown below. The middle knuckle can be used to define the mid-point.



Vertical Travel Distance (D)

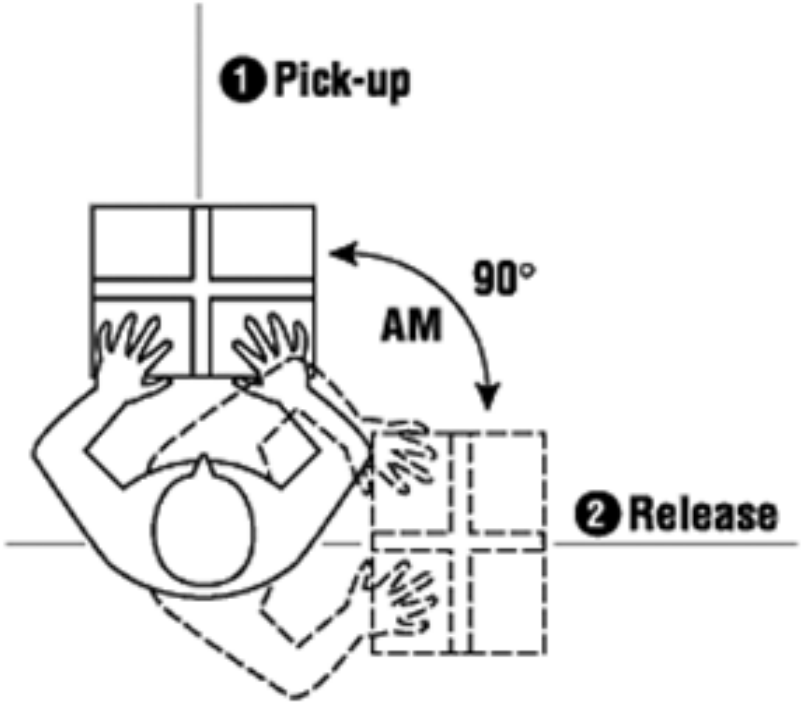
Vertical Travel Distance (D) – The vertical travel distance of a lift is determined by subtracting the vertical location (V) at the start of the lift from the vertical location (V) at the end of the lift. For a lowering task, subtract the V location at the end from the V location at the start.



Asymmetric Angle (A)

Asymmetric Angle (A) – Measure the degree to which the body is required to twist or turn during the lifting task. The asymmetric angle is the amount (in degrees) of trunk and shoulder rotation required by the lifting task.

Note: Sometimes the twisting is not caused by the physical aspects of the job design, but rather by the employee using poor body mechanics. If this is the case, no twisting (0 degrees) is required by the job. If twisting is required by the design of the job, determine the number of degrees the back and body trunk must twist or rotate to accomplish the lift. (i.e. 90° as pictured below)



Coupling (C)

Coupling (C) – Determine the classification of the quality of the coupling between the worker's hands and the object as good, fair, or poor (1, 2, or 3). A good coupling will reduce the maximum grasp forces required and increase the acceptable weight for lifting, while a poor coupling will generally require higher maximum grasp forces and decrease the acceptable weight for lifting.

1 = Good - Optimal design containers with handles of optimal design, or irregular objects where the hand can be easily wrapped around the object.

2 = Fair - Optimal design containers with handles of less than optimal design, optimal design containers with no handles or cut-outs, or irregular objects where the hand can be flexed about 90°.

3 = Poor - Less than optimal design container with no handles or cut-outs, or irregular objects that are hard to handle and/or bulky (e.g. bags that sag in the middle).

Frequency (F)

Frequency (F) - Determine the appropriate lifting frequency of lifting tasks by using the average number of lifts per minute during an average 15 minute sampling period. For example, count the total number of lifts in a typical 15 minute period of time and divide that total number by 15.

Minimum = 0.2 lifts/minute
Maximum is 15 lifts/minute.

Load (L)

Load (L) – Determine the weight of the object lifted. If necessary, use a scale to determine the exact weight. If the weight of the load varies from lift to lift, you should record the average and maximum weights lifted.

Duration (D)

Duration (Dur) – Determine the lifting duration as classified into one of three categories: Enter 1 for short-duration, 2 for moderate-duration and 8 for long-duration as follows:

1 = Short - lifting ≤ 1 hour with recovery time ≥ 1.2 X work time

2 = Moderate - lifting between 1 and 2 hours with recovery time ≥ 0.3 X lifting time

8 = Long - lifting between 2 and 8 hours with standard industrial rest allowances

Enter Data, Calculate RWL and LI

Department: 250

Job: *Unload product boxes from conveyor and place onto cart*

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	NIOSH Lifting Variables								
Lifting Task	**H** Horizontal Location (10-25")	**V** Vertical Location (0-70")	**D** Travel Distance (10-70")	**A** Angle of Asymmetry (0° - 135°)	**C** Coupling (1=good, 2=fair, 3=poor)	**F** Frequency (0.2 - 15 lifts/min)	**L** Ave. Load Lifted (lbs.)	**L** Max. Load Lifted (lbs.)	**Dur** Duration (1, 2, 8 hours)
Origin - Lift product box from conveyor	15	38	6	0	1	2	24	24	8
Destination - Place product box onto cart	20	32	6	30	1	2	24	24	8

Enter Data, Calculate RWL and LI

Origin

Analyst: Mark Middlesworth **Task:** Dept. 250 - Unload Origin

Inputs:		Multipliers:	
Horizontal Location (min. 10", max. 25")	15	HM	0.67
Vertical Location (min. 0", max. 70")	38	VM	0.94
Travel Distance (min 10", max. 70")	6	DM	1.00
Angle of Asymmetry (min. 0, max. 135)	0	AM	1.00
Coupling (1=good | 2=fair | 3=poor)	1	CM	1.00
Frequency (min. 0.2 lifts/min.)	2	FM	0.65
Avg. Load (lbs.)	24		
Max Load (lbs.)	24		
Duration (hours) (enter 1, 2 or 8)	8		

Results

Recommended Weight Limit (in pounds):

RWL = **20.77**

FIRWL = **31.96**

Lifting Index:

LI = **1.16**

FILI = **0.75**

Recommendations:

Engineering or Ergonomic Intervention Should Be Implemented

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Enter Data, Calculate RWL and LI

Destination

Analyst: Mark Middlesworth **Task:** Dept. 250 Assembly Ln Utility - Dest.

Inputs:		Multipliers:	
Horizontal Location (min. 10", max. 25")	20	HM	0.50
Vertical Location (min. 0", max. 70")	32	VM	0.99
Travel Distance (min 10", max. 70")	6	DM	1.00
Angle of Asymmetry (min. 0, max. 135)	30	AM	0.90
Coupling (1=good | 2=fair | 3=poor)	1	CM	1.00
Frequency (min. 0.2 lifts/min.)	2	FM	0.65
Avg. Load (lbs.)	24		
Max Load (lbs.)	24		
Duration (hours) (enter 1, 2 or 8)	8		

Results

Recommended Weight Limit (in pounds):

RWL = **14.76**

FIRWL = **22.71**

Lifting Index:

LI = **1.63**

FILI = **1.06**

Recommendations:

Engineering or Ergonomic Intervention Should Be Implemented

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Example

Origin

Destination

Data Collection Worksheet

Department: 253

Job: *Unload parts from storage rack and place on cart*

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Lifting Task	NIOSH Lifting Variables								
	H Horizontal Location (10-25")	**V** Vertical Location (0-70")	**D** Travel Distance (10-70")	**A** Angle of Asymmetry (0° - 135°)	**C** Coupling (1=good, 2=fair, 3=poor)	**F** Frequency (0.2 - 15 lifts/min)	**L** Ave. Load Lifted (lbs.)	**L** Max. Load Lifted (lbs.)	**Dur** Duration (1, 2, 8 hours)
Origin - Lift product container from rack	15	11	29	10	1	1	12.5	26	2
Destination - Place container on cart	20	32	6	0	1	1	12.5	26	2

Enter Data, Calculate RWL and LI

Origin

Analyst: Mark Middlesworth **Task:** Dept. 253 Assembly Line Utility - origin

Inputs:		Multipliers:	
Horizontal Location (min. 10", max. 25")	15	HM	0.67
Vertical Location (min. 0", max. 70")	11	VM	0.86
Travel Distance (min 10", max. 70")	29	DM	0.88
Angle of Asymmetry (min. 0, max. 135)	10	AM	0.97
Coupling (1=good | 2=fair | 3=poor)	1	CM	1.00
Frequency (min. 0.2 lifts/min.)	2	FM	0.84
Avg. Load (lbs.)	12.5		
Max Load (lbs.)	26		
Duration (hours) (enter 1, 2 or 8)	2		

Results

Recommended Weight Limit (in pounds):

RWL = 20.91

FIRWL = 24.89

Lifting Index:

LI = 0.60

FILI = 1.04

Recommendations:

Nominal Risk

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Enter Data, Calculate RWL and LI

Destination

Analyst: Mark Middlesworth **Task:** Dept. 253 Assembly Ln Assembly - Dest

Inputs:		Multipliers:	
Horizontal Location (min. 10", max. 25")	12	HM	0.83
Vertical Location (min. 0", max. 70")	40	VM	0.93
Travel Distance (min 10", max. 70")	29	DM	0.88
Angle of Asymmetry (min. 0, max. 135)	0	AM	1.00
Coupling (1=good | 2=fair | 3=poor)	1	CM	1.00
Frequency (min. 0.2 lifts/min.)	2	FM	0.84
Avg. Load (lbs.)	12.5		
Max Load (lbs.)	26		
Duration (hours) (enter 1, 2 or 8)	2		

Results

Recommended Weight Limit (in pounds):

RWL = **29.13**

FIRWL = **34.68**

Lifting Index:

LI = **0.43**

FILI = **0.75**

Recommendations:

Nominal Risk

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Learn more about
The NIOSH Lifting Equation (Single Tasks)

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