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# Manual Lifting:
# The NIOSH Work Practices Guide for Manual Lifting
# Determining Acceptable Weights of Lift

-- Effective from March 1981 to July 1994 --

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In the past, efforts to control back injuries largely focused on the limited recommendations to "lift with your legs, and not your back," and "keep your back straight." Comparatively little attention was given to available research related to acceptable weights of lift until 1981, when the National Institute for Occupational Safety and Health (NIOSH) published a landmark technical report entitled *Work Practices Guide for Manual Lifting.*

The NIOSH *Guide* presents us with one unified set of manual lifting recommendations based on the convergence of medical, scientific, and engineering points of view. Such convergence, bolstered by post-publication studies that have further validated the guide, has established the 1981 NIOSH *Work Practices Guide for Manual Lifting* as the preeminent ergonomic authority for the determination of acceptable weights of manual lift.

Unlike the arbitrary and largely ineffective recommendations of the past, the NIOSH *Guide* can assist in determining which lifts are "safe" (that is, which lifts are associated with an acceptable risk) and which lifts are "unsafe" (that is, which lifts are associated with an unacceptable risk). With the help of the NIOSH *Guide*, employers can inventory lifting tasks assigned to their employees and then implement reasonable steps to control lifting related back injuries. Using the same guidelines, manufacturers can recognize the risk of back injury associated with their products and then design their products to eliminate such risk or properly label their products to warn and instruct about proper methods of lift.

In 1985, NIOSH convened an *ad hoc* committee of experts to revise and expand the NIOSH equation for the design and evaluation of manual lifting tasks. According to NIOSH, the revised equation "...reflects new findings and provides methods for evaluating asymmetrical lifts, lifts of objects with less than optimal hand-container couplings, and also provides guidelines for a larger range of work durations and lifting frequencies than the 1981 equation."

The revised equation was developed in 1991 and published in July 1993. There is little doubt that future field studies will validate the 1991 equation as the 1981 equation has been validated in the past.

## JOB RISK FACTORS

Many aspects of the physical act of lifting a load have been identified as potentially hazardous to a person's musculoskeletal system. Job risk factors defined by the *Guide* include:

1. Weight - force required.
2. Location/Site - load center of gravity with respect to the worker.
3. Frequency/duration/pace - temporal aspects of the task in terms of repetitiveness of handling.
4. Stability - Consistency in location of load center of gravity as in handling bulky or liquid materials.
5. Coupling - texture, handle size and location, shape, etc.

6. Workplace geometry - spatial aspects of the task in terms of movement distance, direction, obstacles, postural constraints, etc.

7. Environment - factors such as temperature, humidity, illumination, noise, vibration, frictional stability of the foot, etc.

The first three "job risk factors" have received sufficient attention in lifting injury research to form a mathematical basis for guidance. These three comprise the "lifting task variables." Properly applied, these variables can form the basis for establishing acceptable versus unacceptable lifting task limits. This will be explained by example on pages 3 and 4.

Before limits are determined, however, there is an important caveat which must be understood. Lifting limits based on the "lifting task variables" are valid only in the absence of extraneous risks defined by job risk factors 4 through 7. The *Guide* assumes "ideal" lifting conditions including a stable load, a smooth two-handed symmetrical lift with a natural and comfortable grip or handhold (called a "good coupling") on an object of moderate width. The *Guide* also calls for a natural, unrestricted lifting posture, good footing, a favorable ambient environment (moderate temperature and humidity, good lighting, absence of high noise or vibration, etc.), absence of twisting during the lifting process, and a minimum of other manual activities associated with the lifting task (such as pushing, pulling, carrying, holding, etc.).

Thus, a lifting task that might be acceptable for a given weight under favorable conditions could be unacceptable under actual conditions found in some workplaces. Conditions that would lower an otherwise acceptable (limit for) weight of lift would include elements of the lifting task involving twisting motions, a restrictive lifting posture, the carrying of objects on stairs or over obstacles, slippery footing, or hot environments.

**TASK EVALUATION**

A simple algebraic formula is provided in the NIOSH *Guide* for evaluating specified manual lifting tasks based on the "lifting task variables." Two limits are defined by the *Guide* for each particular task. These are the Action Limit (AL) and the Maximum Permissible Limit (MPL). Depending on these limits, every task will fall into one of the following three distinct categories.

1. Tasks That Are Below the Action Limit. Such tasks represent a nominal risk to most workers. More than 99% of male workers and over 75% of female workers have the strength to lift this much weight.

2. Tasks that are above the Action Limit. These tasks present an unacceptable risk to most workers without administrative or engineering controls. (Engineering controls are always preferred.)

Where engineering controls are difficult to achieve, management may chose to utilize administrative controls to protect workers. Administrative controls include action taken by management to match job requirements to individual worker capabilities through carefully administered worker strength and aerobic capacity testing, and training programs that teach workers the use of techniques that minimize physical stress and the basic manual lifting concepts necessary to determine the difference between a safe and an unsafe lift.

3. Tasks That Are Above the Maximum Permissible Limit. These tasks are so hazardous that nearly all workers would be at an unacceptably high risk of injury during the performance of such tasks. Therefore, in order to be acceptable, these tasks must be redesigned to incorporate engineering controls. Fewer that 25% of male workers and less than 1% of female workers have the strength to lift this much weight.

Engineering controls include efforts to reduce container size, reduce unit weight, and enhance container or unit handholds and mechanical "couplings," such as the use of handles or other features that eliminate hand grip discomfort and increase hand grip strength. Engineering controls also include the provision of walking and working surfaces that are slip resistant and free of obstacles, the provision of adequate lighting, and attention given to workstation design to minimize required bending, reaching, twisting, and carrying. A most important engineering control activity involves the consideration of mechanical handling alternatives to manual handling. This would include design features that provide appropriate mechanical lift points and provision for the use of hooks, bars, jacks, carts, dollies, hand trucks, lift trucks, conveyors, and hoists.

Calculating Limits: In order to calculate the AL and the MPL, it is only necessary to know the weight of the object being lifted, location of the load in relation to the worker, distance and frequency of lift, and duration of the lifting activity.

In terms of U.S. Customary Units, the equations are:

**AL** (lb)=90(6/H)(1-.01|V-30|)(.7+3/D)(1-/$F_{max}$) and
**MPL** (lb) = 3(AL)

Where:

H = Horizontal location of the hands at origin of lift measured forward of the body centerline or midpoint between ankles (inches). The minimum value to be used is 6".

V = Vertical location of hands at origin of lift measured from floor level (inches).

D = Vertical travel distance from origin to destination of lift (inches). The minimum value to be used is 10".

F = Frequency of lifting. The average number of lifts per minute. For frequencies below .2, this value is set to zero.

$F_{max}$ = maximum frequency which can be sustained (from table of values contained in the *Guide*)

A similar equation for determining AL and MPL in terms of metric units is found in the *Guide*.

The following examples will illustrate how the lifting task variables (H, V, D, and F) are used in the algebraic equation that expresses the NIOSH Guideline Limits through the use of multiplicative factor weighting. A knowledge of high school algebra is assumed.

Example 1: Cartons weighing 30 lbs are to be picked up from the floor and placed on a roller conveyor 24" above floor level. Hand holds are located 18" above the floor and 12" forward of the midpoint of the worker's ankles. The average frequency of lifting is .2 lifts per minute and the task duration is more than an hour. Note: The table value for $F_{max}$ for this task (found on page 127 of the 1981 *Guide*) is 12.

**AL** (lb)= 90(6/H)(1-.01|V-30|)(.7+3/D)(1-F/$F_{max}$)

**H Factor** = (6/H) = (6/12) = .50

**V Factor** = (1-.01|V-30|) = (1-.01|18-30|) =.88

**D Factor** = (.7+3/D) = (.7+3/24) = .825

**F Factor** = (1-F/$F_{max}$) = (1-.2/12) = .983

**AL** = 90(.50)(.88)(.825)(.983) = 32 lbs

**MPL** = 3(AL) = 3(32) = 96 lbs

Conclusion: The weight lifted is below the AL. This task represents an acceptable risk for most workers.

Example 2: A box of tools weighing 35 lbs is to be lifted (occasionally) from the floor to a cart that is 48" high. The handle of the box is 6" high. Due to the width of the box, the worker must reach 24" in front of his or her ankles to grasp the handle.

**AL** (lb)= 90(6/H)(1-.01|V-30|)(.7+3/D)(1-F/$F_{max}$)

**H Factor** = (6/H) = (6/24) = .25

**V Factor** = (1-.01|V-30|) = (1-.01|6-30|) = .76

**D Factor** = (.7+3/D) = (.7+3/48)= .7625

**F Factor** = (1-F/$F_{max}$) = (1-0/$F_{max}$) = 1.0

**AL** = 90(.25)(.76)(.7625)(1.0) = 13 lbs

**MPL** = 3(AL) = 3(13) = 39 lbs

Conclusion: The weight of the box is far above the Action Limit. This is a hazardous task representing an unacceptable risk of injury for most workers.

**SUMMARY**

Workers generally do not have the information that is required in order to judge which lifting tasks are acceptable (low-risk) and which are unacceptable (high-risk). Therefore, it is impractical to tell workers to "ask for help when you feel you need it." Likewise, instructing workers to "keep your back straight" and "lift with your legs and not your back" is of little value when they are confronted with material handling and lifting tasks that are not free from high-risk factors such as twisting, bending, reaching, unstable footing, or excessive weight.

The NIOSH *Work Practices Guide for Manual Lifting* is a tool that can be used by employers and manufacturers to help meet their responsibilities for providing workplaces and products that are reasonably free from recognized hazards that are likely to cause serious physical harm.

For further information about the control of manual lifting hazards associated with the handling of excessive weight, request the following Nelson & Associates fact sheets:

"Manual Lifting: Historical Sources of Current Standards Regarding Acceptable Weights of Lift"

"Manual Lifting: The Revised NIOSH Lifting Equation for Evaluating Acceptable Weights for Manual Lifting (Effective July 1994)"

"Manual Lifting: Training Programs in Manual Materials Handling"

"Manual Lifting: Product Design and Labeling"