

Express Parcel Handling Analysis

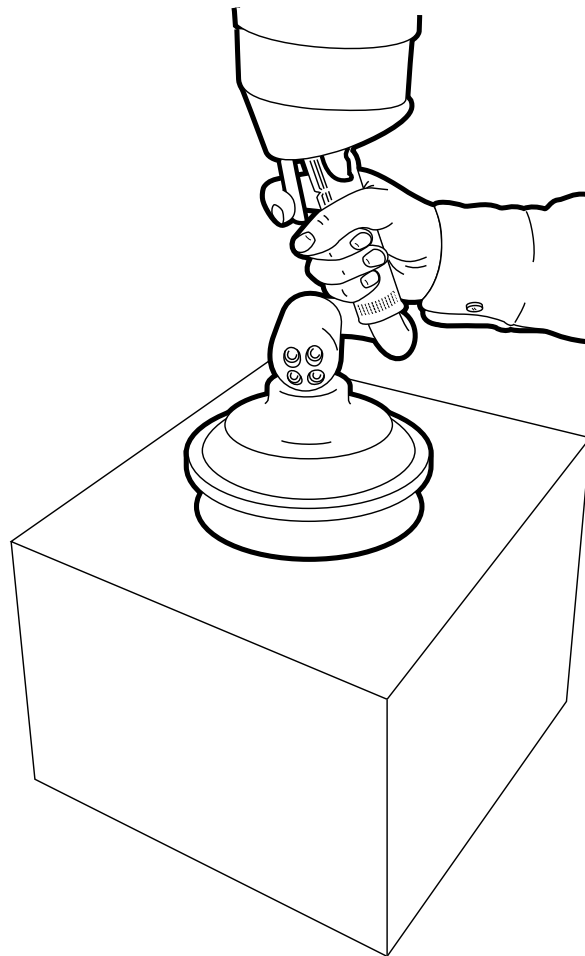
Ergonomics and productivity analysis by Xdin for Vaculex

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Analysis used in this report

NIOSH - back problems

MTM-1 - productivity study

RULA - repetitive strain injuries

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Express Parcel Handling Analysis

“Musculoskeletal disorders (MSD) cover a broad range of health problems. The main groups are back pain/injuries and Work Related Upper Limb Disorders, commonly known as “repetitive strain injuries”. Lower limbs can also be affected. Lifting, poor posture and repetitive movements are among the causes. Some types of disorders are associated with particular tasks or occupations.

MSD are commonly reported work related health problem by European workers: 30% complain of backache; 17% complain of muscular pains in their arms and legs; 45% report working in painful or tiring positions; 33% are required to handle heavy loads in their work.”

– European Agency for Safety and Health at Work
<http://europe.osha.eu.int/>

Background

Vaculex engaged an independent company, Xdin, to make an ergonomic and productivity study of existing manual lifts in comparison with lifts using the Vaculex TP. We wanted to see how much the TP could decrease the risk for injury. We also wanted to know if the TP was able to maintain the productivity level or even better, increase productivity. To make the study credible, we made an analysis of an actual situation at TNT Sweden and their depot in Solentuna. The analysis consists of different lifting combinations common in the parcel handling.

We also made general studies in addition to the TNT specific analysis. The general studies was carried out with a NIOSH (back problems) analysis and a MTM-1 study

(productivity study). We wanted to demonstrate different material handling scenarios and prove what recovery Vaculex TL contributes with as a lifting aid.

Analysis methods

The software Jack®

Jack is a computer program with manikins that simulate human work. The operator makes a stress analysis and strength measurements on the manikin. The digital human beings have 68 joints and 135 degrees of freedom. The software includes different modules for the analyzing of stress, load and productivity. A total of 12 modules can be used to investigate a specific work task.

We made three different analyses:

NIOSH - back problem

MTM-1 - productivity study

RULA - repetitive strain injuries

NIOSH Analysis

NIOSH (National Institute for Occupational Safety and Health, USA) – lifting equation, is the most widely used method to analyze the lower back. NIOSH – lifting equation, was developed by a committee of experts who evaluated research findings from a wide range of worker performance studies.

NIOSH – lifting equation, is built on stress statistics, medical measurements of different lifting tasks and how different lifts give different compression in the spine. The lifting guideline reflects biomechanical, psychophysical and metabolic (energy) data.

“Scientific Support Documentation for the Revised 1991 NIOSH Lifting Equation, Technical Contract Reports, May 8, 1991”

The result of a NIOSH lifting analysis is a lift index - LI. The LI term provides a relative estimate of the level of physical stress associated with a specific manual lifting task. LI is the ratio of the actual weight of the load and the recommended weight limit. A low LI is desirable and a high LI indicates high risk for back injuries in a foreseeable future of time. Xdin has used this method to help Vaculex determine lift stress in several different lift tasks.

MTM-1 Analysis

MTM-1 is a method that analyses manual work time and determines how work changes influence productivity. MTM-1 is a time standard and MTM stands for methods-time measurement. The number stands for how much the method has been simplified to make it easier to work with. 1 means no simplification at all and 5 stands for high simplification.

The Predetermined Time Analysis tool is based on nearly 50 years of research on methods-time measurement systems.

“Delmar W. Karger and Franklin H. Bayha, Engineered Work Measurement: The Principles, Techniques, and Data of Methods-Time Measurement. Background and Foundations of Work Measurement and Methods. 4th edition, (1987)”

To evaluate how much working with a Vaculex lifting tool influence the productivity in comparison to manual lifting, Xdin used the MTM-1 (the most precise level) tool in the computer program Jack® to evaluate different lifting tasks.

RULA Analysis

This analysis was made only to the TNT specific scenarios.

If the work routine is altered, it is important to look at other areas of the work that can have negative influence on the human body. One of these areas is static load and posture load.

A tool for evaluating posture has been developed by Dr. Lynn McAtamneys and Dr. Nigel Corletts at the University of Nottingham (1993). The tool is called Rapid Upper Limb Assessment (RULA) and builds on stress statistics from injury databases.

This ergonomic technique evaluates people’s exposure to postures, forces and muscle activities that have been shown to contribute to Repetitive Strain Injuries (RSIs). This tool does not provide specific data on injury or stress risk but is very good at comparing different ways of working. Xdin used RULA to investigate if the static load would increase in the upper body when workers go from manual lifting to lifting with Vaculex TP.

General studies

The following general studies are a selection of the most common manual lifts within parcel handling. The vertical axis states what LI (Lift Index) a specific lift gives during a specific frequency – the horizontal axis.

LI=1 means that 5% of the population get permanent injuries within a short period of time (normally 2 years). 75% of the female population and 99% of the male population have most likely the muscle strength to manage the specific lift manually.

LI=3 means that 95% of the population get permanent injuries within a short period of time (normally 2 years). 1% of the female population and 25% of the male population have most likely the muscle strength to manage the specific lift manually.

NIOSH

Lifting from pallet to table with twist

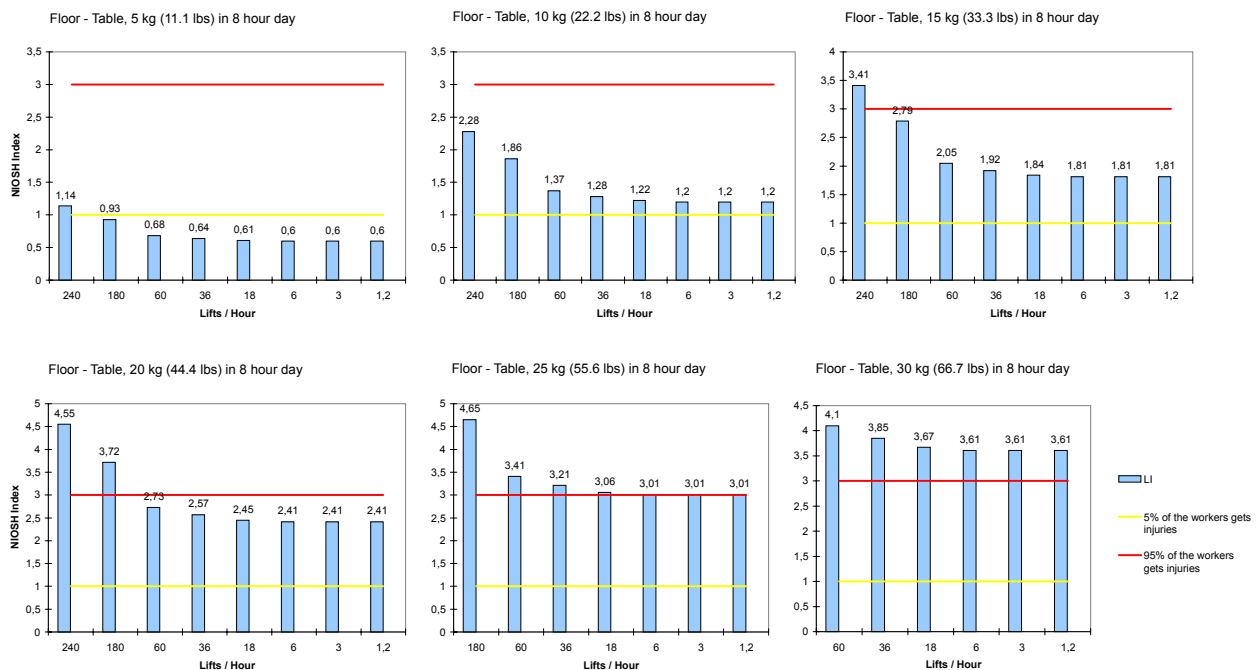


How should LI values be interpreted?

It is desirable to design the job to fit in the lift index < 1 (green colour).

A lift index > 3 (red colour) should receive immediate attention and values between 1 and 3 (yellow colour) should be noticed and kept under surveillance.

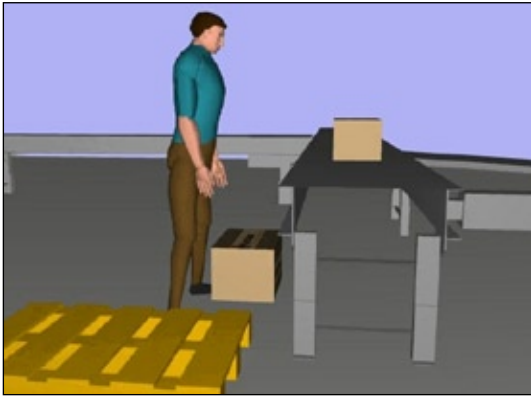
Lift Index



General studies

NIOSH

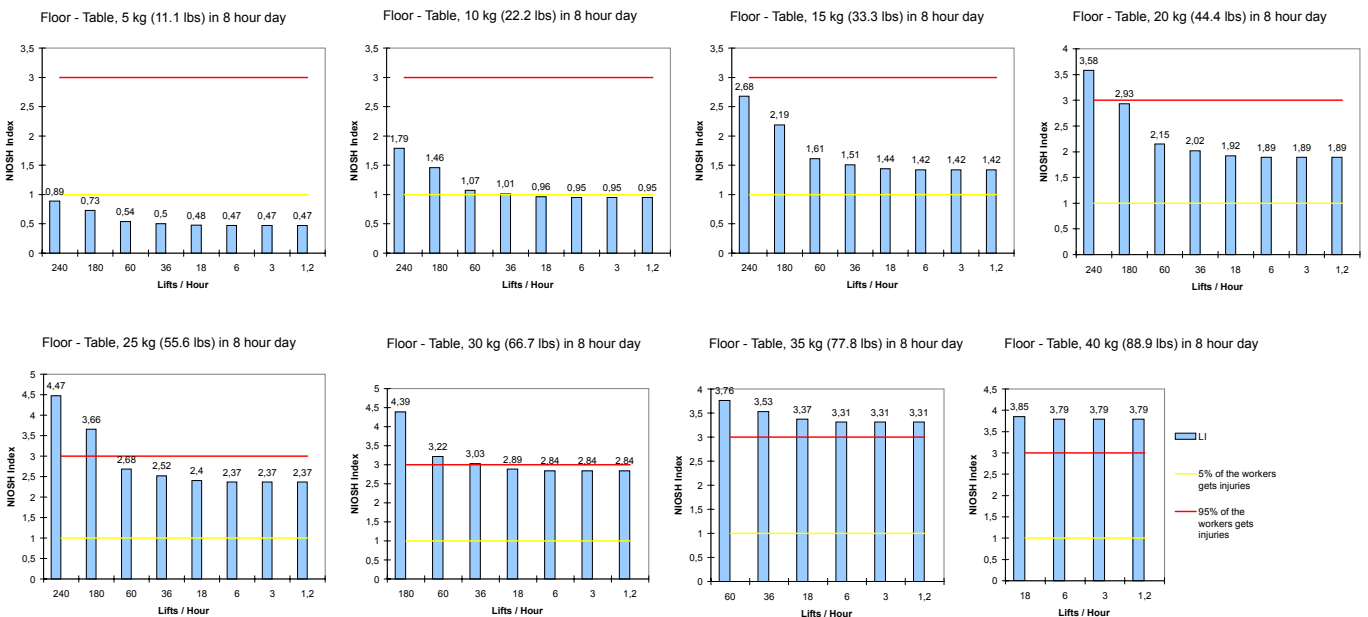
Lifting from pallets to table without twist



How should LI values be interpreted?

It is desirable to design the job to fit in the lift index <1 (green colour).
 A lift index >3 (red colour) should receive immediate attention and values between 1 and 3 (yellow colour) should be noticed and kept under surveillance.

Lift Index



General studies

NIOSH

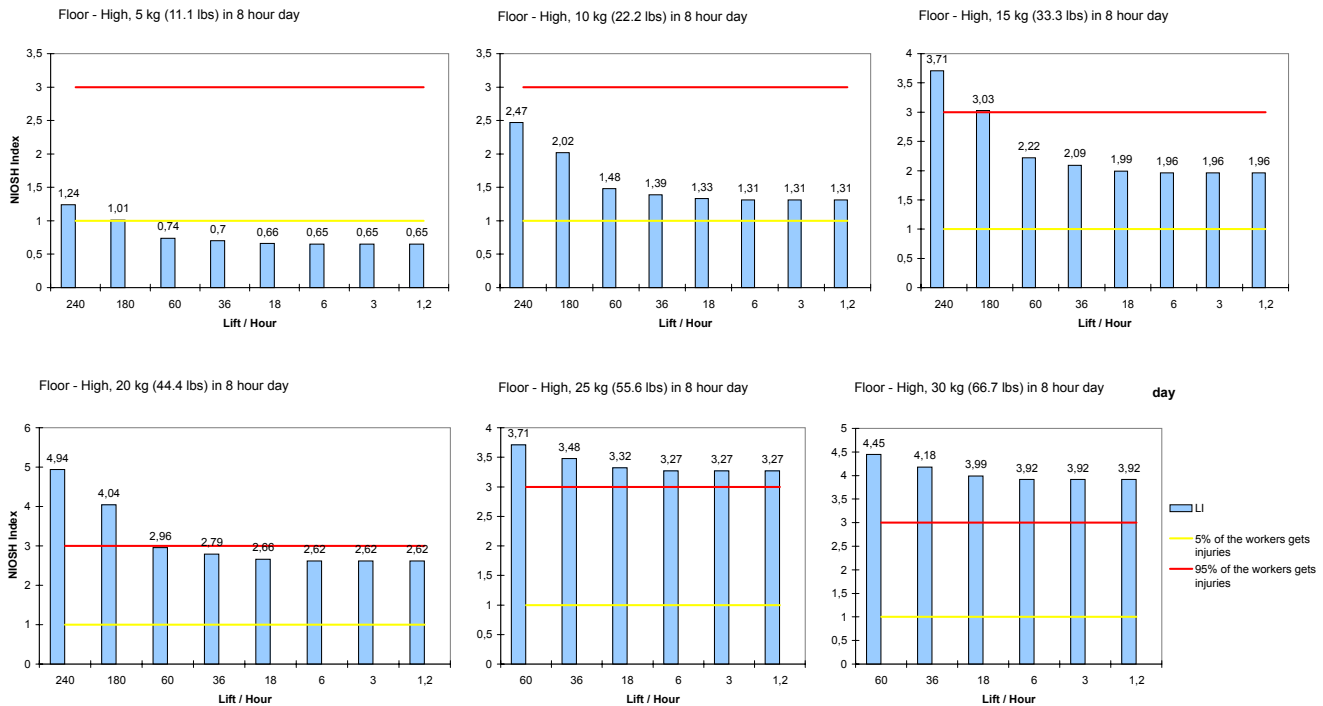
Lifting from pallet to heights with twist



How should LI values be interpreted?

It is desirable to design the job to fit in the lift index < 1 (green colour).
 A lift index > 3 (red colour) should receive immediate attention and values between 1 and 3 (yellow colour) should be noticed and kept under surveillance.

Lift Index



General studies

NIOSH

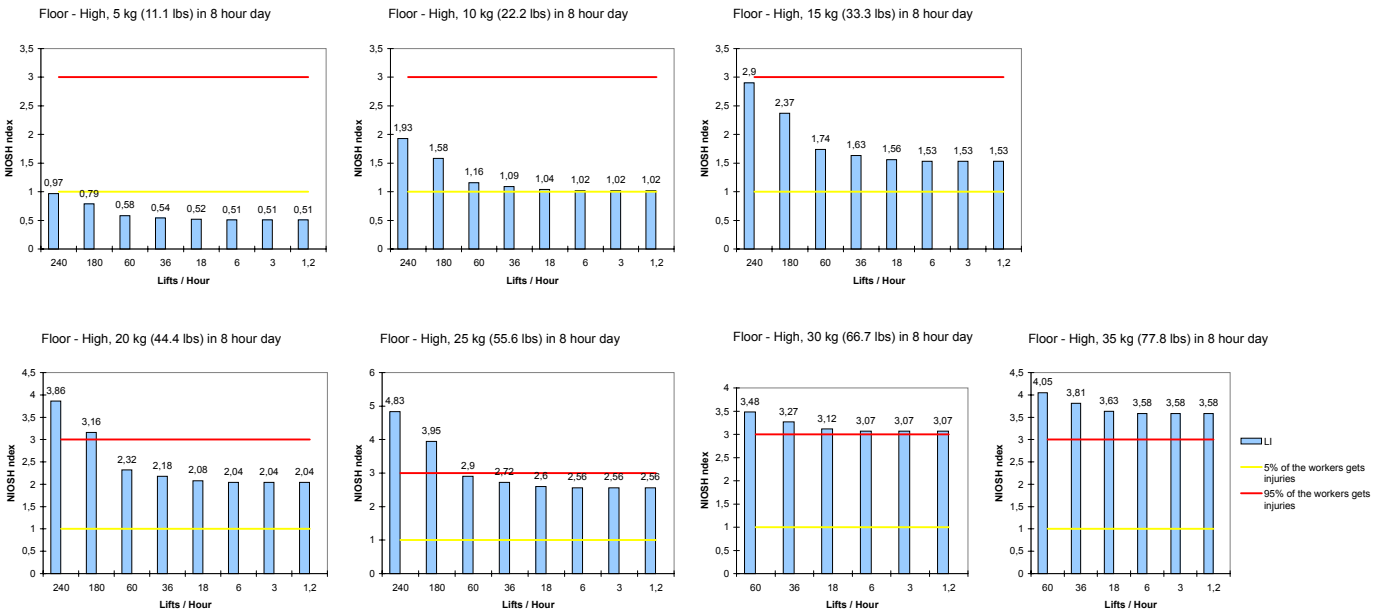
Lifting from pallet to heights without twist



How should LI values be interpreted?

It is desirable to design the job to fit in the lift index < 1 (green colour).
 A lift index > 3 (red colour) should receive immediate attention and values between 1 and 3 (yellow colour) should be noticed and kept under surveillance.

Lift Index



General studies

NIOSH

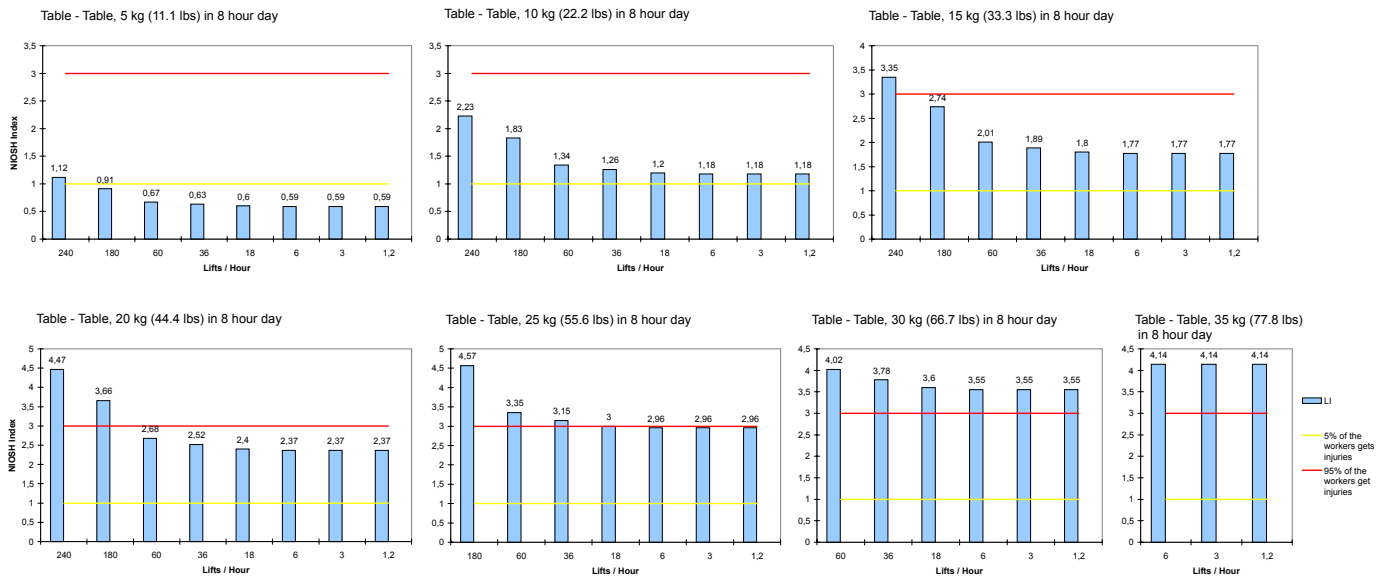
Lifting from table to table with twist



How should LI values be interpreted?

It is desirable to design the job to fit in the lift index < 1 (green colour).
 A lift index > 3 (red colour) should receive immediate attention and values between 1 and 3 (yellow colour) should be noticed and kept under surveillance.

Lift Index



General studies

NIOSH

Lifting from table to heights with twist



How should LI values be interpreted?

It is desirable to design the job to fit in the lift index <1 (green colour).
 A lift index >3 (red colour) should receive immediate attention and values between 1 and 3 (yellow colour) should be noticed and kept under surveillance.

Lift Index

Table - high, 5 kg (11.1 lbs) in 8 hour day

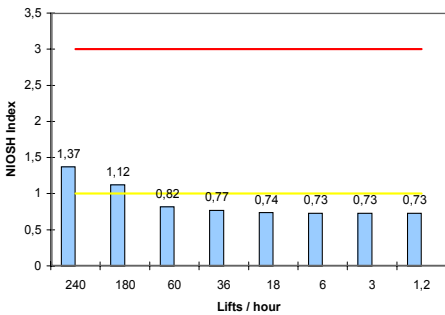


Table - high, 10 kg (22.2 lbs) in 8 hour day

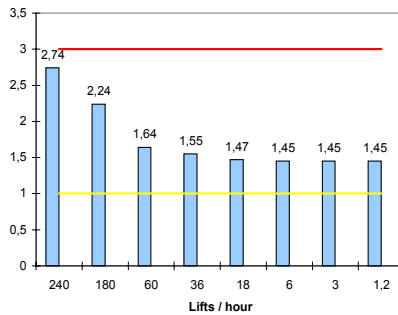


Table - high, 15 kg (33.3 lbs) in 8 hour day

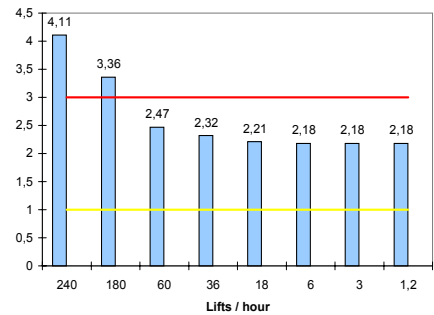


Table - high, 20 kg (44.4 lbs) in 8 hour day

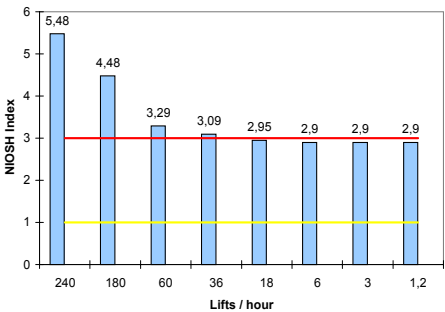


Table - high, 25 kg (55.6 lbs) in 8 hour day

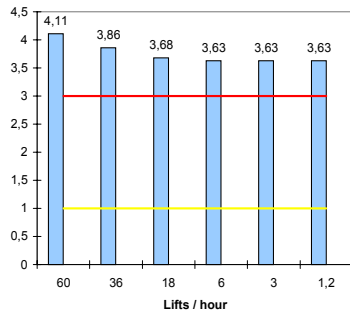
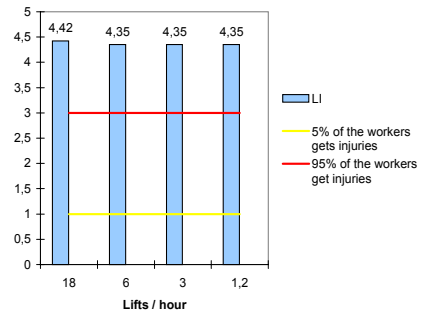


Table - high, 30 kg (66.7 lbs) in 8 hour day



Legend:
 LI (blue bar)
 5% of the workers gets injuries (yellow line)
 95% of the workers get injuries (red line)

General studies

MTM-1

Basic conditions

The evaluation builds on lifts made from a 90 cm (35.4") high conveyer belt with about 200 cm (78.7") walking distance to a transportation cage where parcels are positioned in the levels 30 cm (11.8"), 95 cm (37.4") and 160 cm (63") above the floor.

The operator is a 187 cm (73.6") tall male in fit condition

Parcel handling from conveyer belt

1. A 5 kg (11.1 lbs), 10 kg (22.2 lbs), 15 kg (33.3 lbs), 20 kg (44.4 lbs) and 30 kg (66.7 lbs) parcel is positioned in a cage **30 cm (11.8")** above the floor in the middle of the cage.
2. A 5 kg (11.1 lbs), 10 kg (22.2 lbs), 15 kg (33.3 lbs), 20 kg (44.4 lbs) and 30 kg (66.7 lbs) parcel is positioned in a cage **95 cm (37.4")** above the floor in the middle of the cage.
3. A 5 kg (11.1 lbs), 10 kg (22.2 lbs), 15 kg (33.3 lbs), 20 kg (44.4 lbs) and 30 kg (66.7 lbs) parcel positioned in a cage **160 cm (63")** above the floor in the middle of the cage.

Parcels with a weight of 15 kg (33.3 lbs) or more are pulled to the operator before lifting to get a better lift position at the conveyer belt.

	Manual 5 Kg (11.1 lbs)	Vaculex 5 Kg (11.1 lbs)	Manual 10 Kg (22.2 lbs)	Vaculex 10 Kg (22.2 lbs)	Manual 15 Kg (33.3 lbs)	Vaculex 15 Kg (33.3 lbs)	Manual 20 Kg (44.4 lbs)	Vaculex 20 Kg (44.4 lbs)	Manual 30 Kg (66.7 lbs)	Vaculex 30 Kg (66.7 lbs)
30 cm	13,7	13,4	13,8	13,8	15,09	14,2	16,3	14,5	17,2	15,5
95 cm	12,4	12,5	12,6	12,9	13,49	13,3	14,3	13,6	15,6	14,6
160 cm	12,5	12,1	12,7	12,5	13,79	12,9	14,9	13,2	16	14,2

	Difference in %	Difference in %	Difference in %	Difference in %	Difference in %
30 cm	2%	0%	6%	11%	10%
95 cm	-1%	-2%	1%	5%	6%
160 cm	3%	2%	6%	11%	11%

CONCLUSION

Working with Vaculex TP will increase productivity when working with higher weights if the operator has to position the parcel in the cage. If the positioning is extended from the body, working with Vaculex TP will increase productivity even more.

This means that if the operator needs to optimize the cage's unutilized space, the work time will take longer when manually adjusting the parcels than what the analysis shows. This applies also when lifting with Vaculex TP, but the work-time will decrease considerably when handling heavier loads (>15kg (33.3 lbs)).

TNT Analysis

NIOSH

Basic Condition

To make the result as reliable as possible, we assumed that the operator is a tall and fit male and the cardboard box in very good condition with external handholds. The working-hour is also rather short. In other words, in reality the conditions are worse.

1. Operator
 - 187 cm (73.6") tall male in fit condition
2. Parcels
 - 75 % between 3-12kg (6.6 – 26.4 lbs)
 - 15 % over 20kg (44.4 lbs)
 - 10 % less than 3kg (6.6 lbs)
3. Frequency
 - 15 seconds on average.
5. Positioning and lifting heights
 - From belt conveyer to cage or pallets or vice versa with 180% turning/twist.
 - Lifting heights from 90 cm (35.4"), belt conveyer to cage or pallets at 10 cm-180 cm (3.9'- 70.9") or vice versa.

Results

Manual work				
	To floor	To middle	To high	Mixed
Working-hours				
1	2.9	2.7	2.9	2.9
2	3.1	2.9	3.1	3.1
3	3.8	3.6	3.8	3.8
4	3.8	3.6	3.8	3.8
>4	3.8	3.6	3.8	3.8

Manual lifts reach the LI (Lifting Index) level 3 almost all of the time. This means that more than 95% of the workers are in the risk zone.

With Vaculex TP				
	To floor	To middle	To high	Mixed
Working-hours				
1	1,646	1,54	1,612	1,643
2	1,8	1,679	1,764	1,794
3	2,381	2,227	2,321	2,361
4	2,381	2,227	2,321	2,361
>4	2,381		2,321	2,361

With Vaculex TP we decreased the risk for injuries by 41% in total. The reason for having LI (Lifting Index) 1.5 – 2.3 is the high frequency of twist. Even without any load, twist is injurious. It's very hard to avoid twist in this type of work.

How should LI values be interpreted?

It is desirable to design the job to fit in the lift index <1 (green colour). A lift index >3 (red colour) should receive immediate attention and values between 1 and 3 (yellow colour) should be noticed and kept under surveillance.

TNT Analysis

CONCLUSION

With a NIOSH analysis it was apparent that the risks for injuries are high for almost all types of commonly performed lifts within manual parcel handling. The risk for injuries accelerates when we exceed the weight of 10 kg (22.2 lbs).

With a NIOSH analysis we proved that TNT would decrease the risk for injuries by 41 % with the conditions described above.

Even if you don't lift anything, frequently twisting or bending the lower back increases the risk for back injury. When lifting with one hand at the time, 50% with the left hand and 50% with the right hand, the total day frequency and stress will be lower and the injury risk decreases. Lifting with one hand at the time is possible if a lifting aid is used.

TNT Analysis

MTM-1

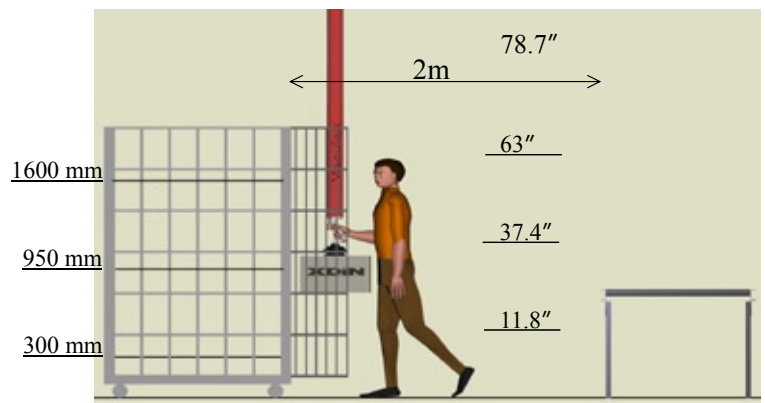
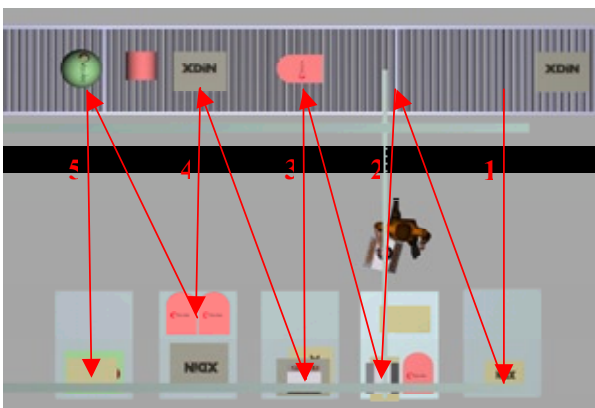
Conditions

The evaluation builds on lifts made from a 90 cm (35.4") high conveyor belt with about 200 cm (78.7") walking distance to a transportation cage where parcels are positioned in the levels 30 cm (11.8"), 95 cm (37.4") and 160 cm (63") above the floor.

The operator is a 187 cm (73.6") tall male in fit condition

Parcel handling from conveyor belt

1. A 4 kg (8.9 lbs) parcel positioned in a cage 30 cm (11.8") above the floor and inner part of cage.
2. A 7 kg (15.6 lbs) parcel positioned in a cage 95 cm (37.4") above the floor and inner part of cage.
3. A 8 kg (17.8 lbs) parcel positioned with a twist in a cage 160 cm (63") above the floor and inner part of cage.
4. A 20 kg (44.4 lbs) parcel positioned in a cage 95 cm (37.4") above the floor and near part of cage.
5. A 10 kg (22.2 lbs) parcel positioned in a cage 160 cm (63") above the floor and inner part of cage.



TNT Analysis

Results

Manual lifting

Number of subtasks: 65		
Number of elements: 44		
Task motion type	Total number	Time - sec
Reach	10	3,639 (6,613)
Move	14	13,96
Grasp	10	2,68 (2,752)
Release	10	0,36 (0,72)
Walk	9	36,471
Stand	5	7,81
Bend	1	1,044
Twist	6	7,365
Skilled Worker		
Total Time: 1 min 13,3 sec		

Lifting with Vaculex TP

Number of subtasks: 56		
Number of elements: 45		
Task motion type	Total number	Time - sec
Reach	1	1,102
Move	21	16,113
Grasp	8	2,02
Lift	5	3,8
Walk	9	30,325
Twist	12	8,04
Skilled Worker		
Total Time: 1 min 1,4 sec		

CONCLUSION

With The MTM-1 analysis we proved that TNT would increase productivity with 16% with the conditions above. The time period includes re-grasping parcels when higher weights are moved and walking with fewer loads.

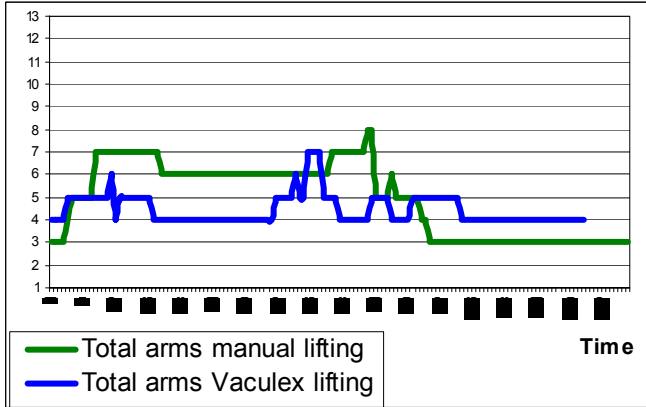
TNT Analysis

RULA

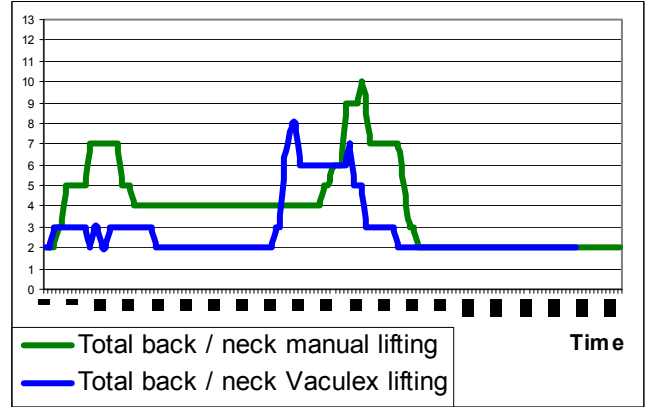
Conditions

The same conditions and scenario as for the MTM-1 analysis.

Results



This diagram shows how the upper body's stress changes over time. Value 4 or less is acceptable. The range is between 1-13. A higher value indicates a higher risk for injuries.



This diagram shows how stress changes in the neck and trunk. Value 3 or less is acceptable.

