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Title:	Ergonomic Efforts to Reduce Isolator Worker Injuries
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Form 836 (7/06)

Ergonomic Efforts To Reduce Isolator Worker Injuries

Abstract:

Many worker injuries occur in isolator/glovebox work. This talk will discuss design criteria of the isolator as well as employee biomechanics while working in a glovebox/isolator to help reduce the risk of employee injury. In addition, exercises also will be demonstrated which can also benefit the employees.

Ergonomic Efforts to Reduce Isolator Worker Injuries

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ISPE NJ CHAPTER DAY June 17th,2009

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Workplace safety

- Reduce employees pain and suffering
- Help avoid direct cost of workplace injuries
- Save on indirect cost

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Cost of Injuries

2006
48.6 Billion direct cost
over 240 billion indirect and direct cost

Every **$1** of direct cost leads to **$2 - $5** of indirect cost

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Direct Costs

Payment to medical care providers

Payments to injured workers

Examples:

Carpal Tunnel syndrome - $8000

Low back injury - $18,000

Indirect costs

- **Lost productivity**
- **Overtime**
- **Training and replacement**
- **Administrative overhead**
- **Value of staff time involved in accident investigation and recordkeeping**
- Any product damage

Increased insurance premiums

SHUT DOWN - BREACH

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Sprains and Strains

The leading nature of injury or illness in **EVERY** major industry sector

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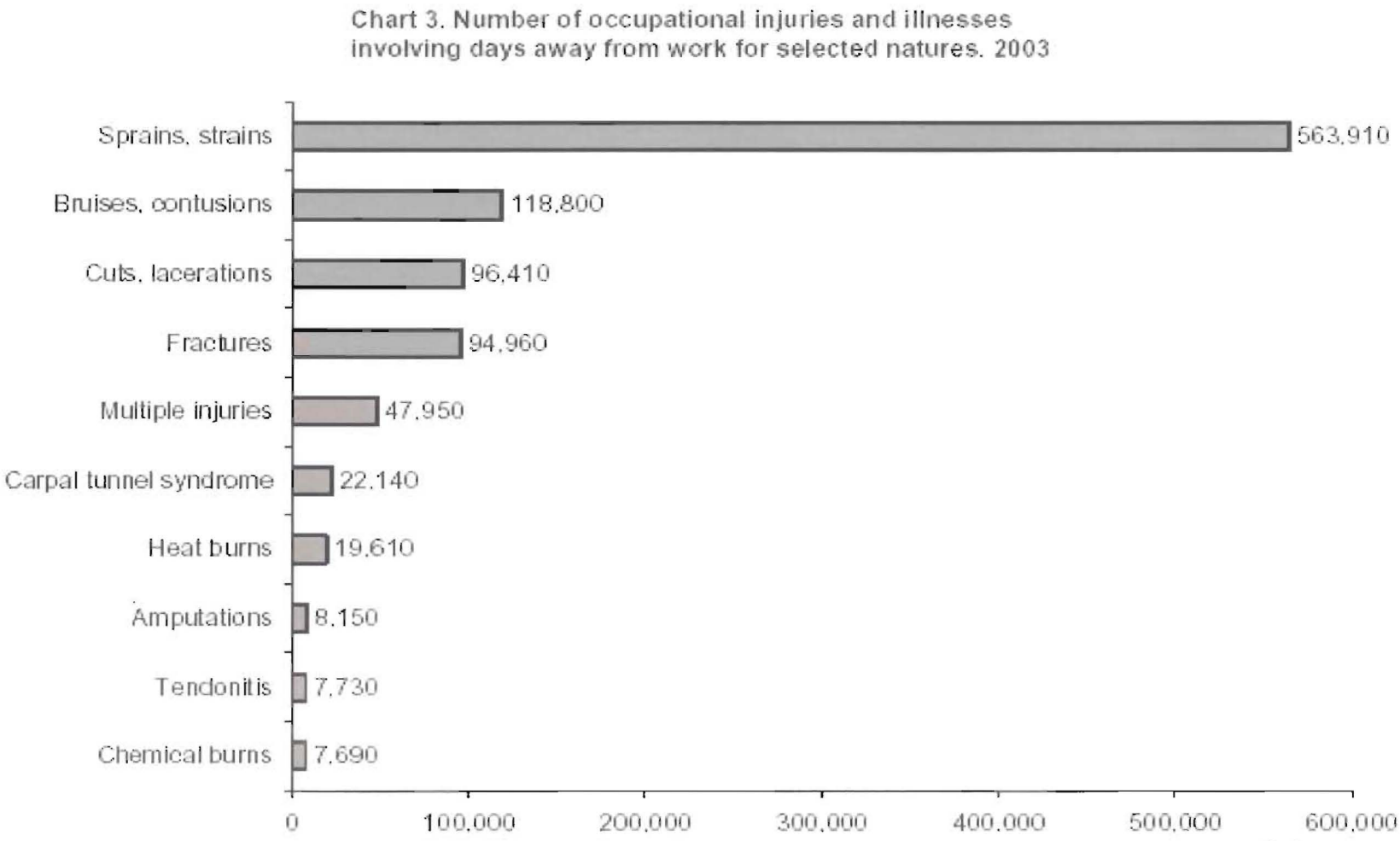
Sprains and Strains



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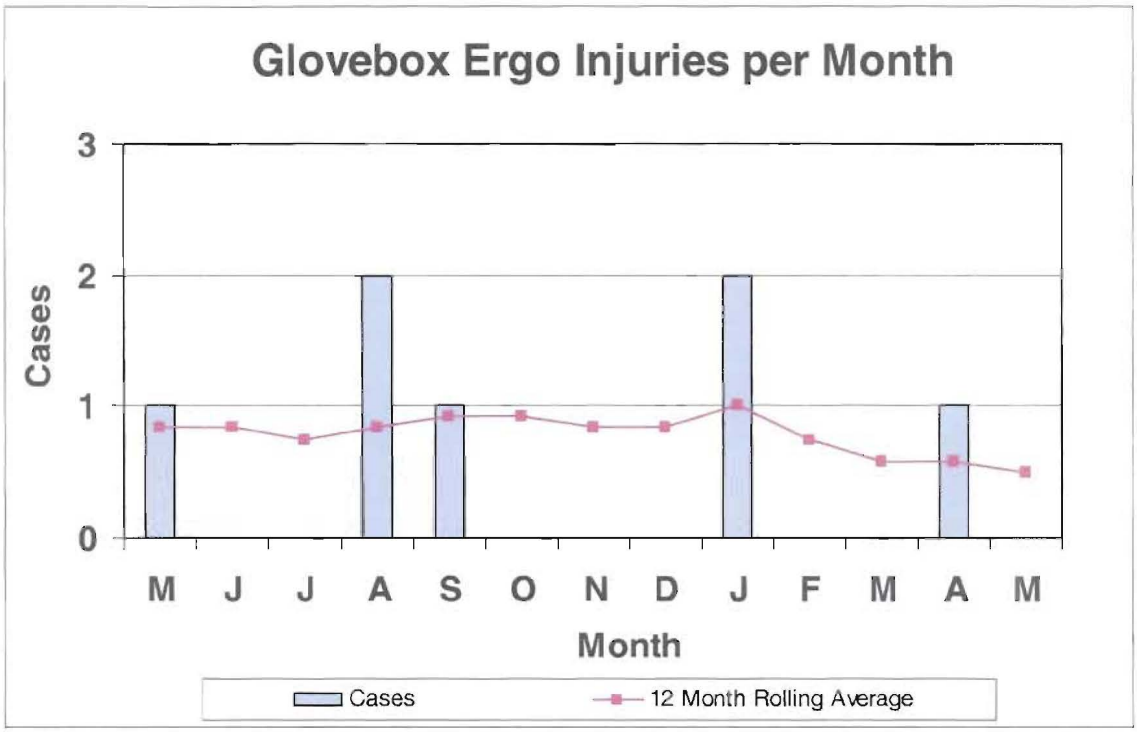
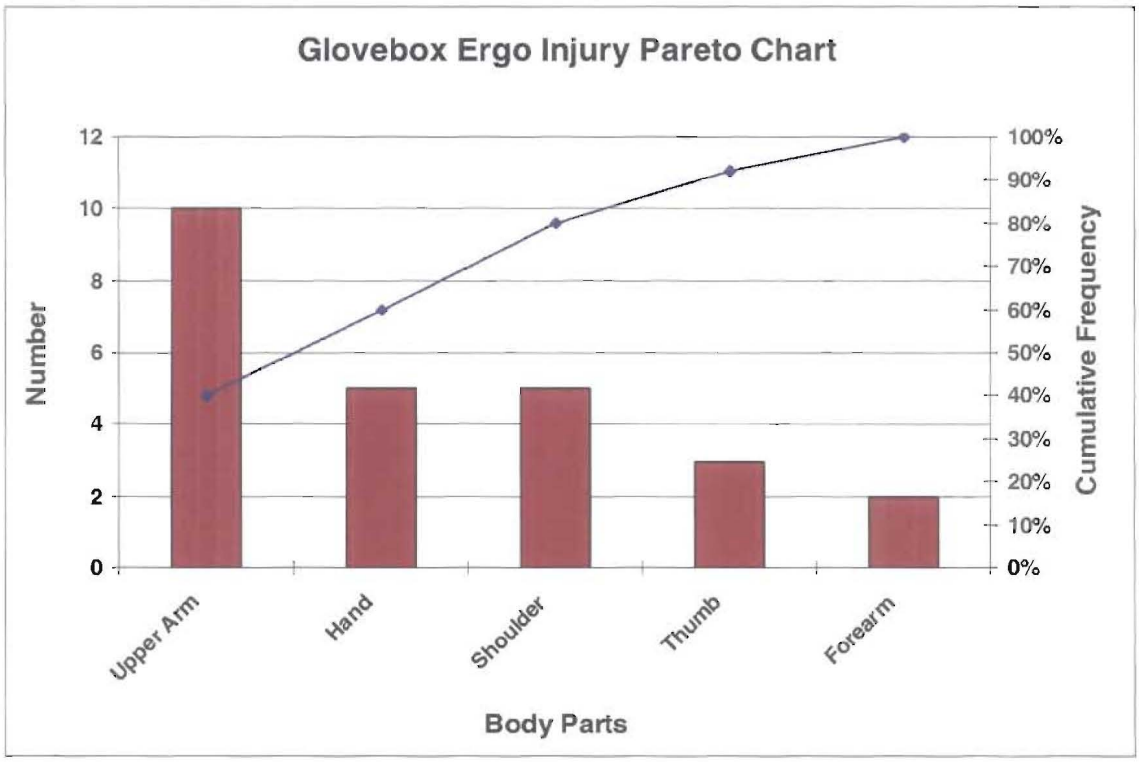
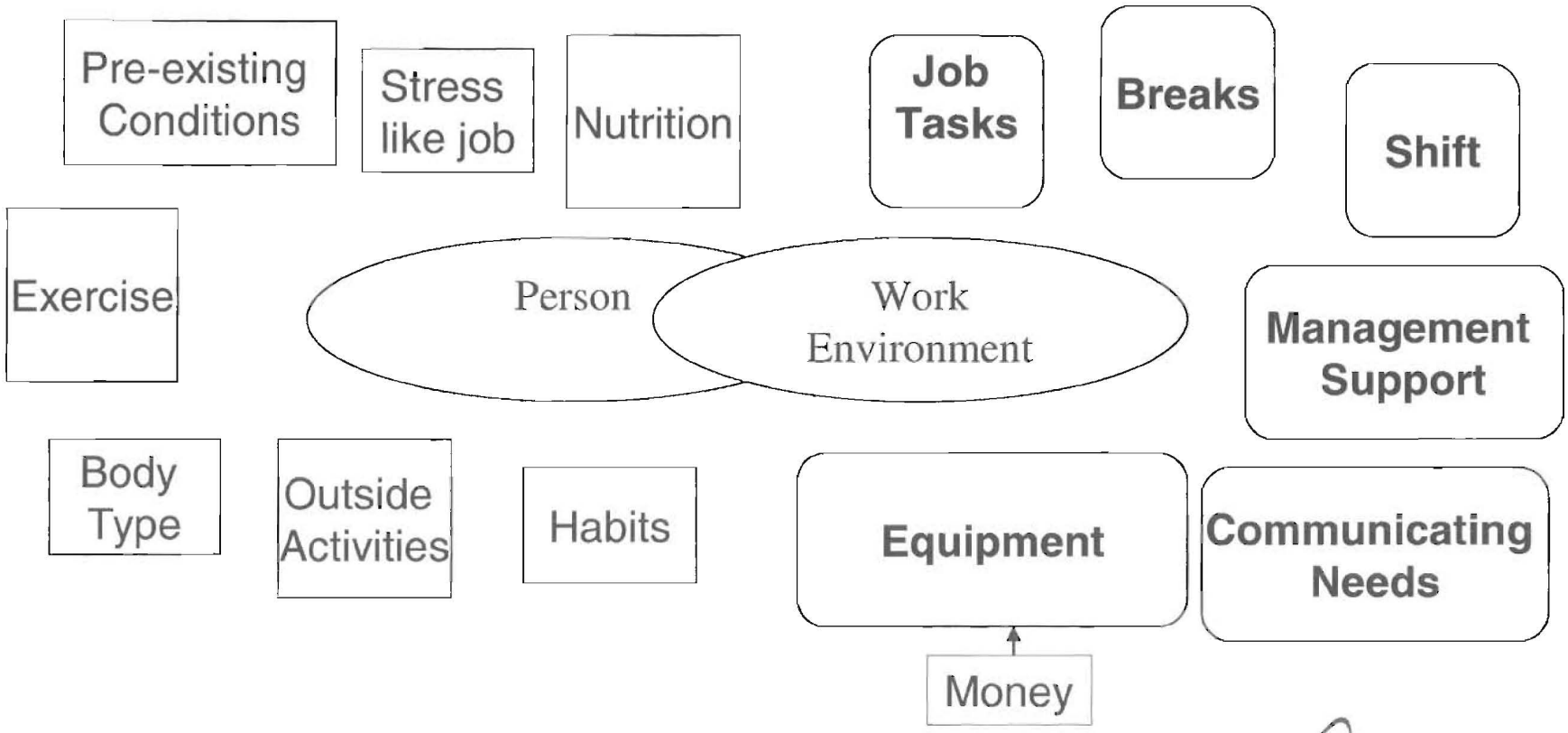

Glovebox Ergo Injuries per Month
Cases
3
2
1
0
M J J A S O N D J F M A M
Month
Cases
12 Month Rolling Average


Glovebox Ergo Injury Pareto Chart
Number
12
10
8
6
4
2
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Cumulative Frequency
Upper Arm
Hand
Shoulder
Thumb
Forearm
Body Parts

LANL: Glovebox Injury Table

Body Part	Recordable/First Aid	Lost Days/Restricted
Shoulder	5	7
Hand/wrist	2	4
Thumb	1	2
Forearm/elbow	9	5
Undetermined	0	1

Who is going to get hurt??



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Human Factors

- Human factors are a very important consideration in the design and use of Isolatores
- Human factors such as statistical human dimensional data and performance capabilities are utilized in Isolator design to improve operator performance, to improve safety, and to reduce operator fatigue and possible injury
- The following are recommendations for use in Isolator design

Designing

Human Factors involvement

Understand the process

Mock-up of the new isolators

Test

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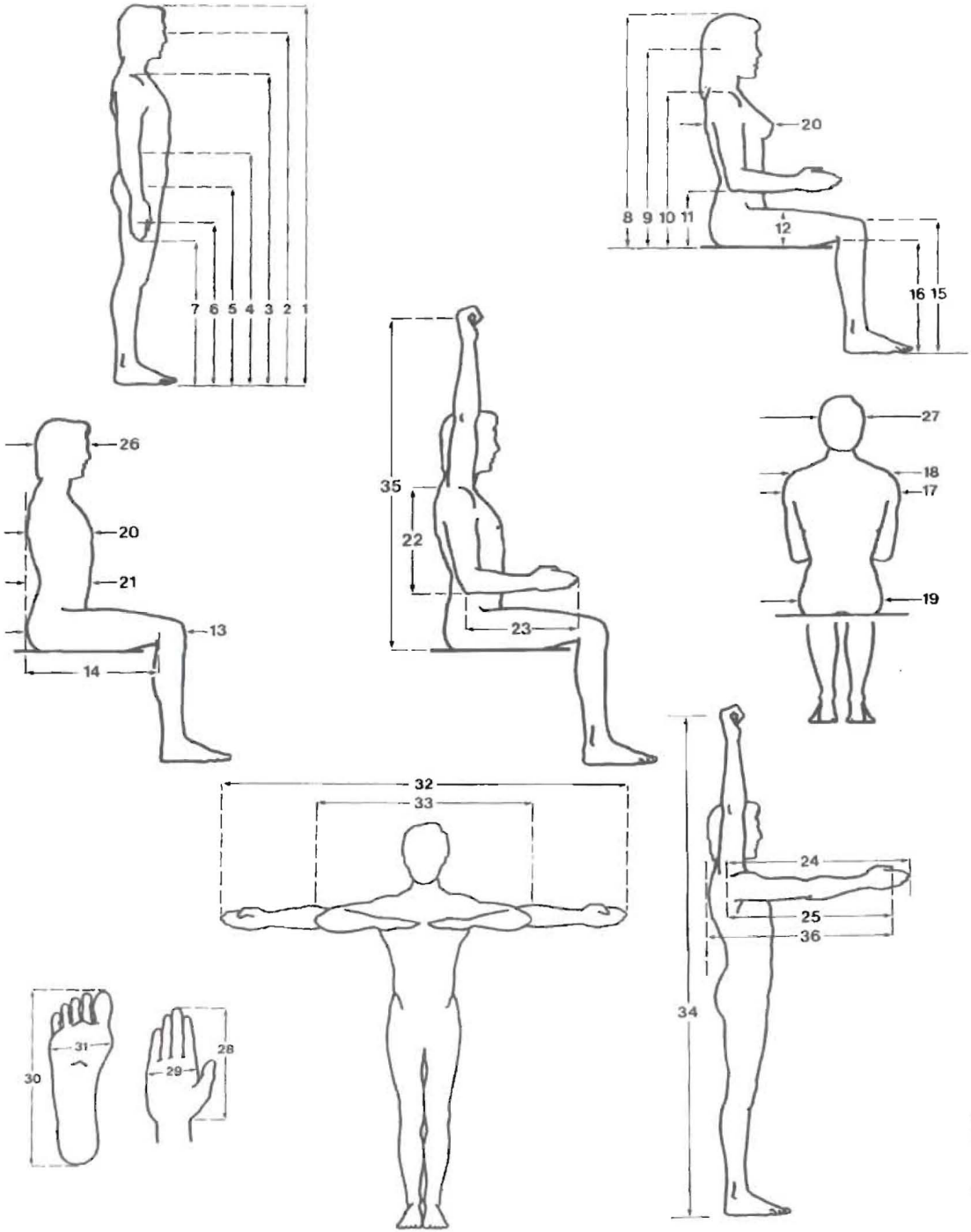
Human Factors - Anthropometry

- Define who users will be in terms of gender anthropometric design range (size)
- Design to fit a user population ranging from the 5th percentile female through 95th percentile male, unless otherwise specified
- Design around the task to be performed



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Anthropometric DATA

Measures - Inches	Males				Females			
	5th	50th	95th	1 S.D.	5th	50th	95th	1 S.D.
1. Stature	64.6	69.1	73.6	2.8	59.8	64.0	68.1	2.5
2. Eye Height	62.8	67.3	71.9	2.8	55.9	60.0	64.2	2.5
3. Shoulder Height	52.4	56.7	61.0	2.6	48.2	52.2	56.1	2.4
4. Elbow Height	40.2	43.5	46.9	2.1	37.2	40.2	43.1	1.9
5. Hip Height	32.9	36.0	39.2	2.0	29.9	32.9	35.8	1.8
6. Knuckle Height	27.6	30.1	32.7	1.6	26.4	28.7	31.1	1.5
7. Fingertip Height	23.4	26.0	28.5	1.5	22.2	24.8	27.4	1.6
8. Sitting Height	33.7	36.0	38.4	1.4	31.5	33.9	36.2	1.4
9. Sitting Eye Height	29.1	31.5	33.9	1.4	27.2	29.5	31.9	1.4
10. Sitting Shoulder Height	21.5	23.6	25.8	1.3	20.1	22.2	24.4	1.3
11. Sitting Elbow Height	7.7	9.6	11.6	1.2	7.3	9.3	11.2	1.1
12. Thigh Thickness	5.3	6.3	7.3	0.6	4.9	6.1	7.3	0.7
13. Tailbone-Knee Length	21.7	23.6	25.6	1.2	20.7	22.6	24.6	1.2
14. Tailbone-Popliteal Length	17.5	19.7	21.9	1.3	17.3	19.3	21.3	1.2
15. Knee Height	19.5	21.7	23.8	1.3	18.1	19.9	21.7	1.1
16. Popliteal height	15.6	17.5	19.5	1.1	14.2	15.9	17.7	1.1
17. Shoulder Breadth (bideltoid)	16.7	18.5	20.3	1.1	14.2	15.7	17.3	1.0
18. Shoulder Breadth (biacromial)	14.4	15.7	17.1	0.8	13.0	14.2	15.4	0.7
19. Hip Breadth	12.2	14.2	16.1	1.2	12.2	14.8	17.3	1.5
20. Chest (Bust) Depth	8.7	10.0	11.4	0.9	8.3	10.0	11.8	1.1
21. Abdominal Depth	8.7	10.8	13.0	1.3	8.3	10.2	12.2	1.2
22. Shoulder-Elbow Length	13.0	14.4	15.7	0.8	12.0	13.2	14.4	0.7
23. Elbow-Fingertip Length	17.5	18.9	20.3	0.8	15.7	17.1	18.5	0.8
24. Upper Limb Length	28.7	31.1	33.5	1.4	25.8	28.1	30.5	1.4
25. Shoulder-Grip Length	24.2	26.4	28.5	1.3	22.0	24.0	26.0	1.2
26. Head Length	7.1	7.7	8.3	0.3	6.5	7.1	7.7	0.3
27. Head Breadth	5.7	6.1	6.5	0.2	5.3	5.7	6.1	0.2
28. Hand Length	6.9	7.5	8.1	0.4	6.3	6.9	7.5	0.4
29. Hand Breadth	3.1	3.5	3.9	0.2	2.6	3.0	3.3	0.2
30. Foot Length	9.4	10.4	11.4	0.6	8.7	9.4	10.2	0.5
31. Foot Breadth	3.5	3.9	4.3	0.2	3.1	3.5	3.9	0.2
32. Span	65.7	71.3	76.8	3.3	59.3	64.0	68.7	2.9
33. Elbow Span	34.4	37.6	40.7	1.9	31.1	33.9	36.6	1.7
34. Vertical Grip Reach (Standing)	76.8	81.9	87.0	3.1	71.1	75.8	80.5	2.9
35. Vertical Grip Reach (Sitting)	45.5	49.4	53.3	2.4	42.1	45.7	49.2	2.2
36. Forward Grip Reach	28.5	30.9	33.3	1.4	25.8	28.0	30.1	1.3
37. Body Weight *(in pounds)*	121.0	171.6	224.4	30.8	90.2	143.0	195.8	33.0

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Human Factors - Anthropometry

- Perform majority of tasks within a normal work envelope, 11 to 13 inches, with a maximum of 18 to 20 inches
- Isolator overall depth dimensions: Single-sided access 24 to 26 inches, Double-sided access 48 to 52 inches
- Ideal working position should be dependent on tasks: consider if tasks are considered precision tasks or more gross motor skill tasks.

Human Factors - Gloveports

- Spacing between horizontal centerlines of a working pair of glove rings should be nominal 16.5 inches (range from 15 to 18 inches)

Human Factors - Gloveports

- Oval-shaped or large-diameter rings provide increased functional reach capability and accommodate a greater range of heights of personnel
- Centerline height for standing workers should normally be 48 inches (range from 48 to 52 inches) from finish floor; provide multi-adjustable footstools to accommodate range of workers

Injuries: Rotator cuff injuries

- Rotator Cuff Muscles (Supraspinatus)

- High risk of injury because of altered muscle length and extreme ROM needed to perform isolator work

Gloveport Height

Problem?

- Isolator ports too high
- Neck extension can cause headaches, and neck tension
- Shoulder 70-110

Solution?

• Portable platform allows for a neutral posture

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Depth of Box

- Over-lengthening of midback

- Stress on shoulder and neck

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Reach Distance

- Using tools for reaching (left) helps you to maintain your body in a more neutral posture.

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Ergonomics – Avoid Breaches

Crease

Wear

Breach

Poor Ergonomics

Injury Risk

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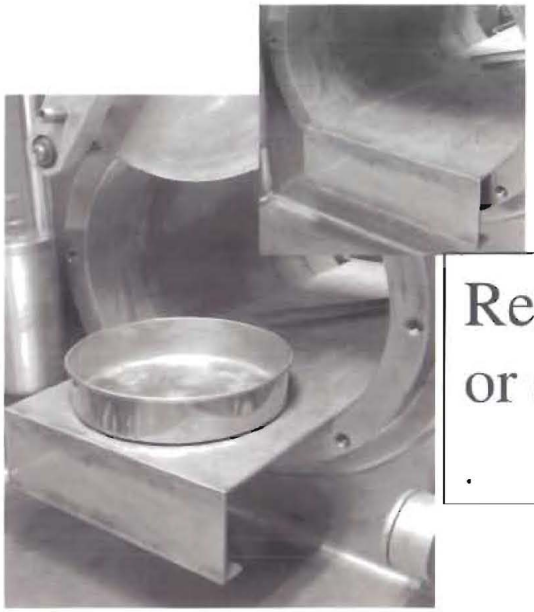
Solution



Retractable shelf for airlock or entry ports

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Elbow and Wrist Injuries

- Lateral Epicondylitis: Inflammation of the tendon along the outside of the elbow

- Tendonitis in wrist and thumb

Isolator Design:

Relationship between gloveport height

And

Bottom of the box

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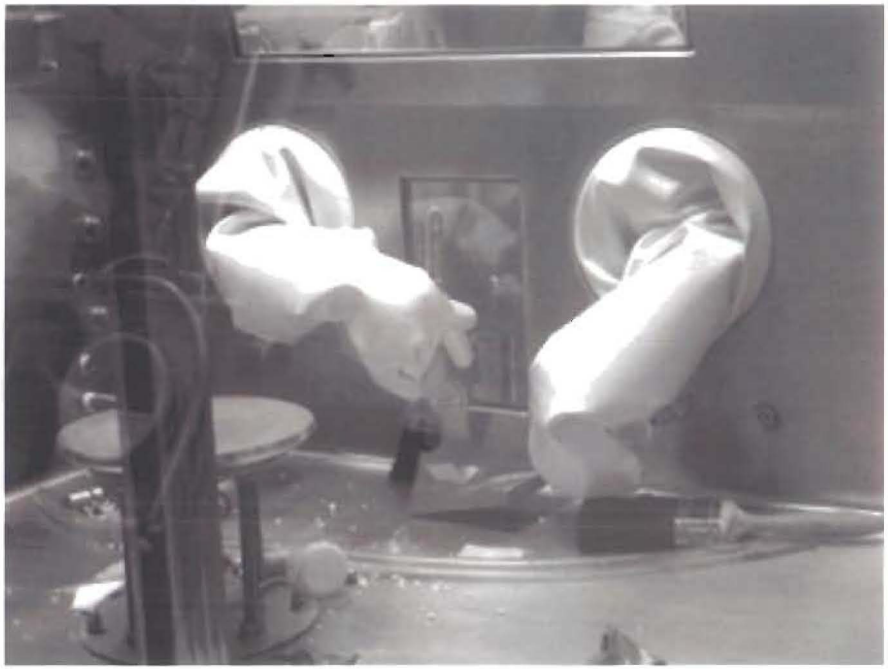
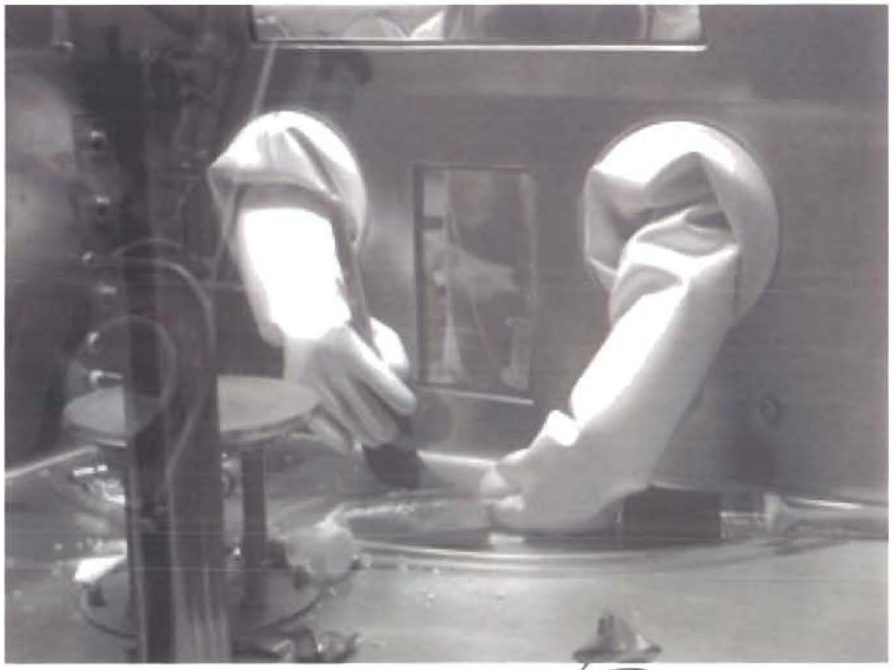
Height of Box/Cleaning up



- Wrists in awkward positions

Wrist Injuries



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Technique while working

Good!

Bad!

Worse!

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Hand Position

Thumb up!

or

Palm up!

Isolator Design

Functional Work Space:

Directly in front of Gloveport

Very Important with entry ports

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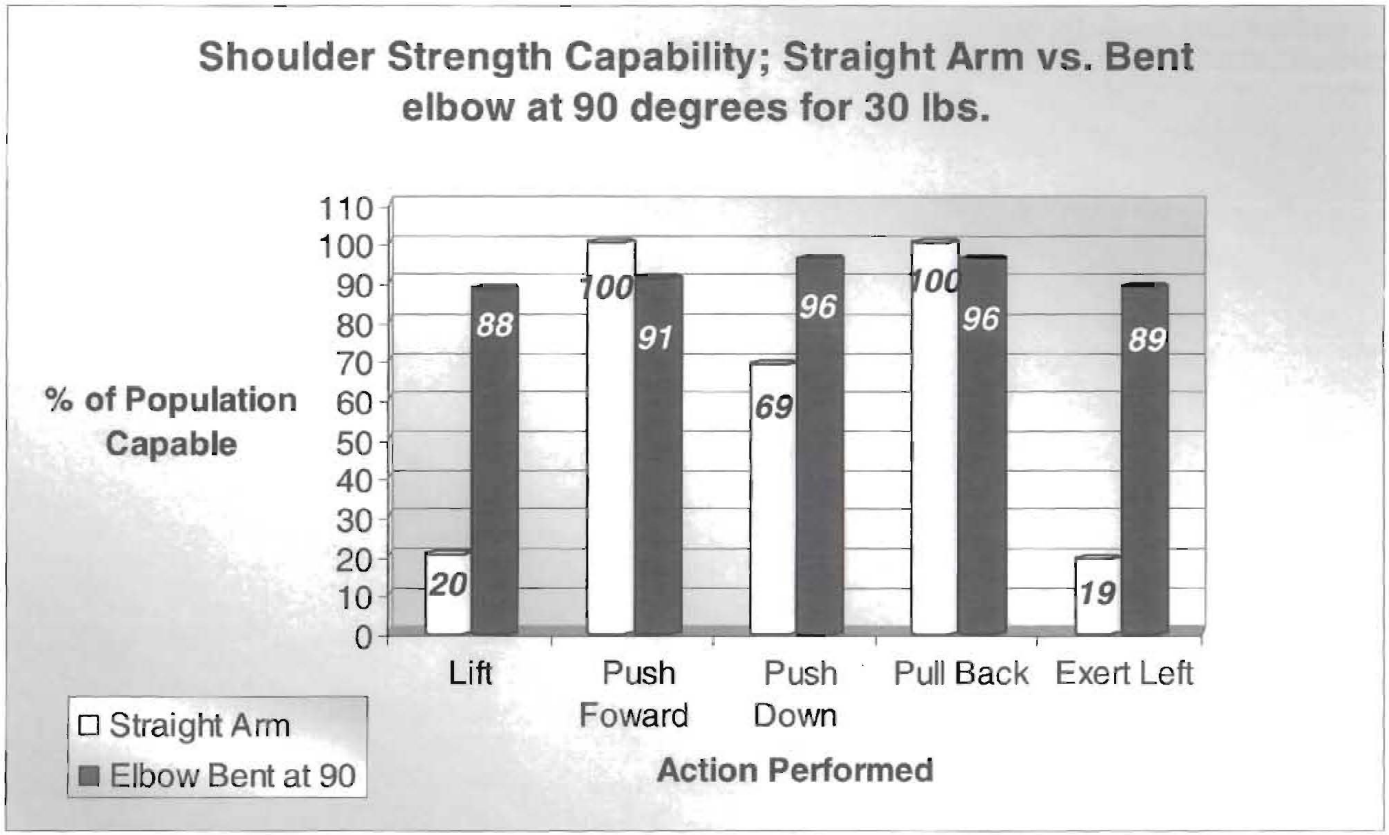
Human Factors – weight limits

- Objects that need to be moved manually should not exceed the weight of 15 lbs.

- For greater than 15 lbs., the task should be analyzed to determine for lifting assists.

Shoulder Strength for 30 lbs



~ Straight arm decreases significantly

~ Bent elbow- also decreases

~Notice that Exertion to the Left and Lift have the lowest percent of the population capable

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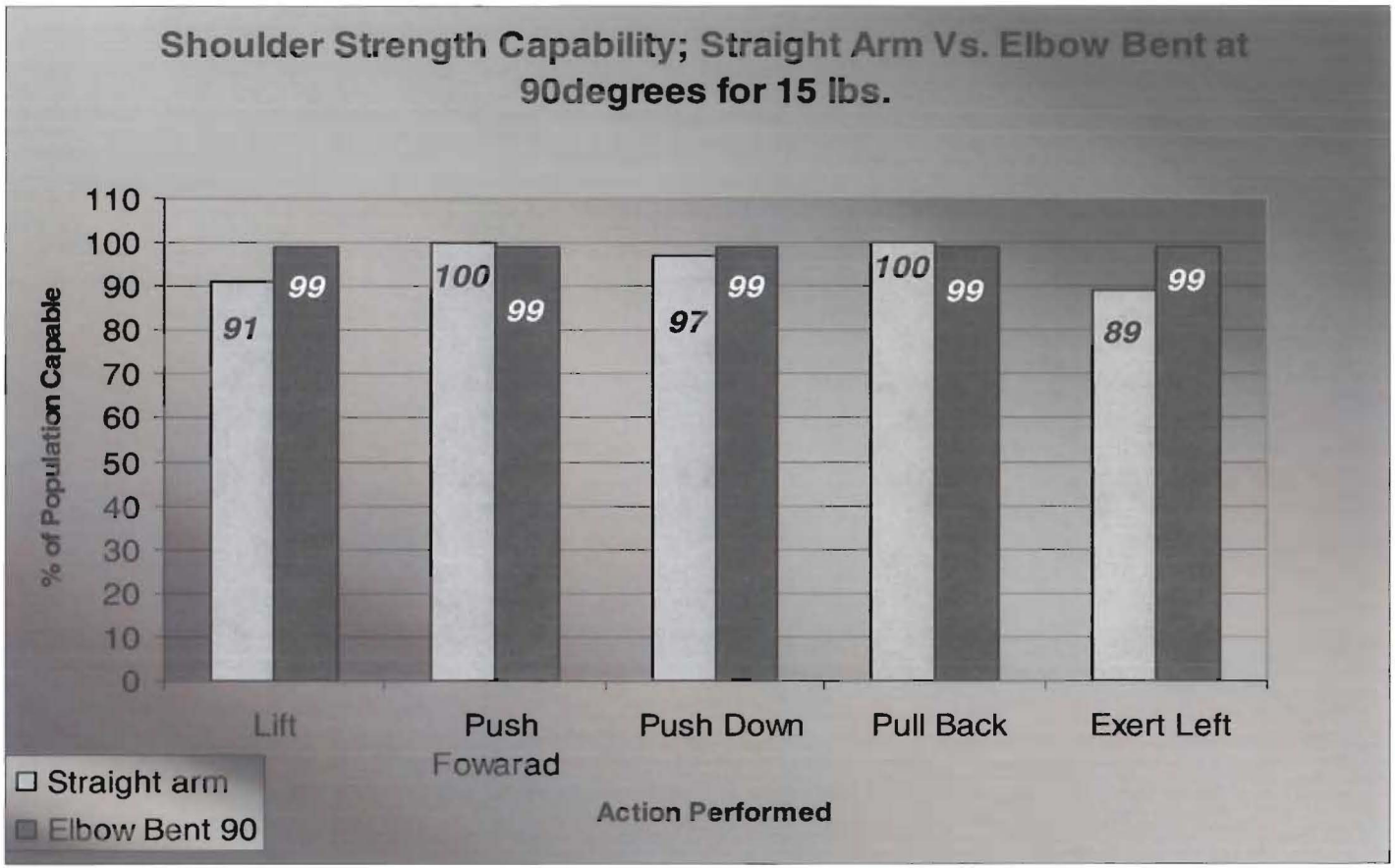
Shoulder Strength for 15 lbs



~ 15 lbs seems to be a reasonable weight

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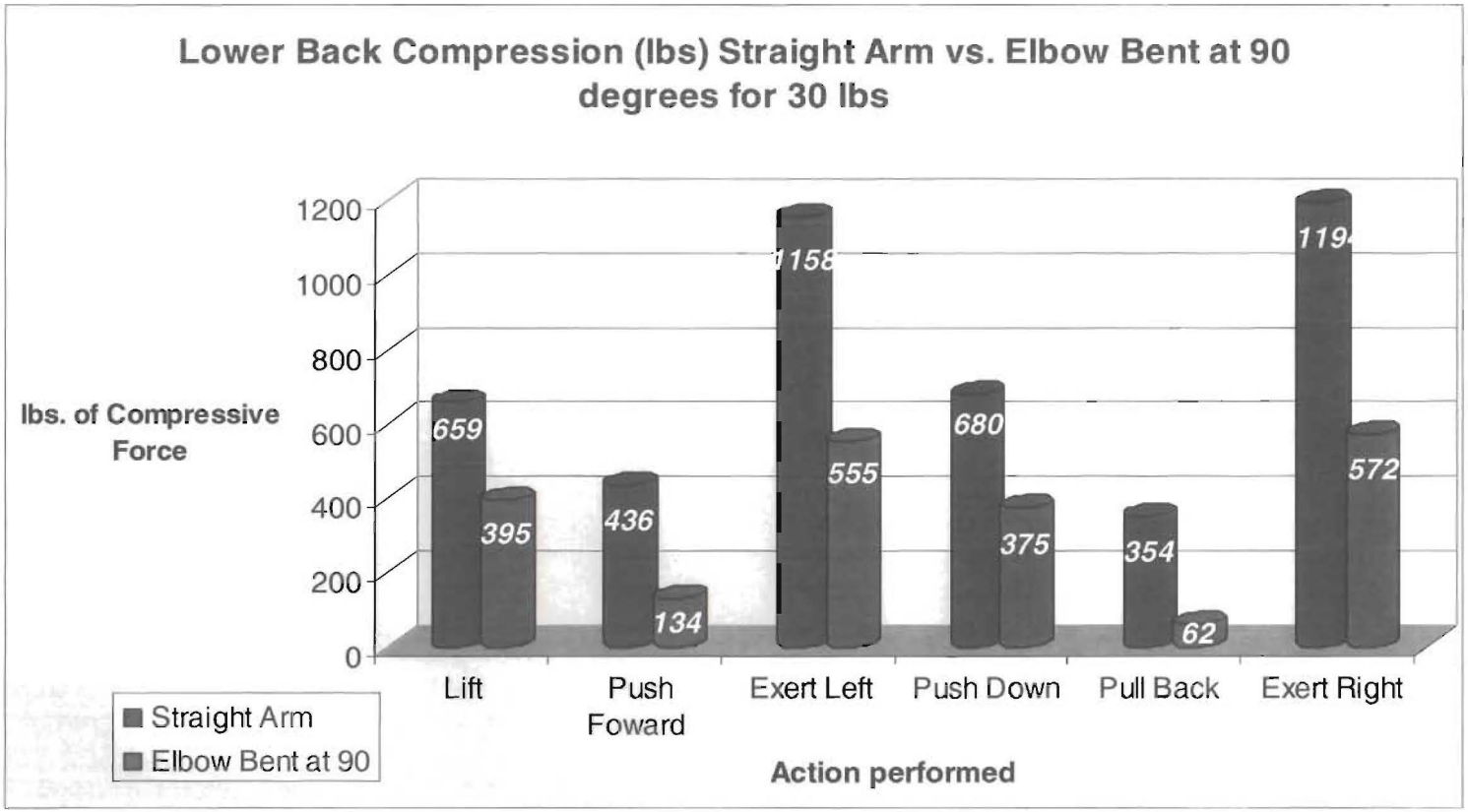
Lower Back Compression for 30 lbs



~ Great difference in the Straight Arm

~ Only minimal difference in Bent Elbow

~ Exertion to the Left and Right almost double

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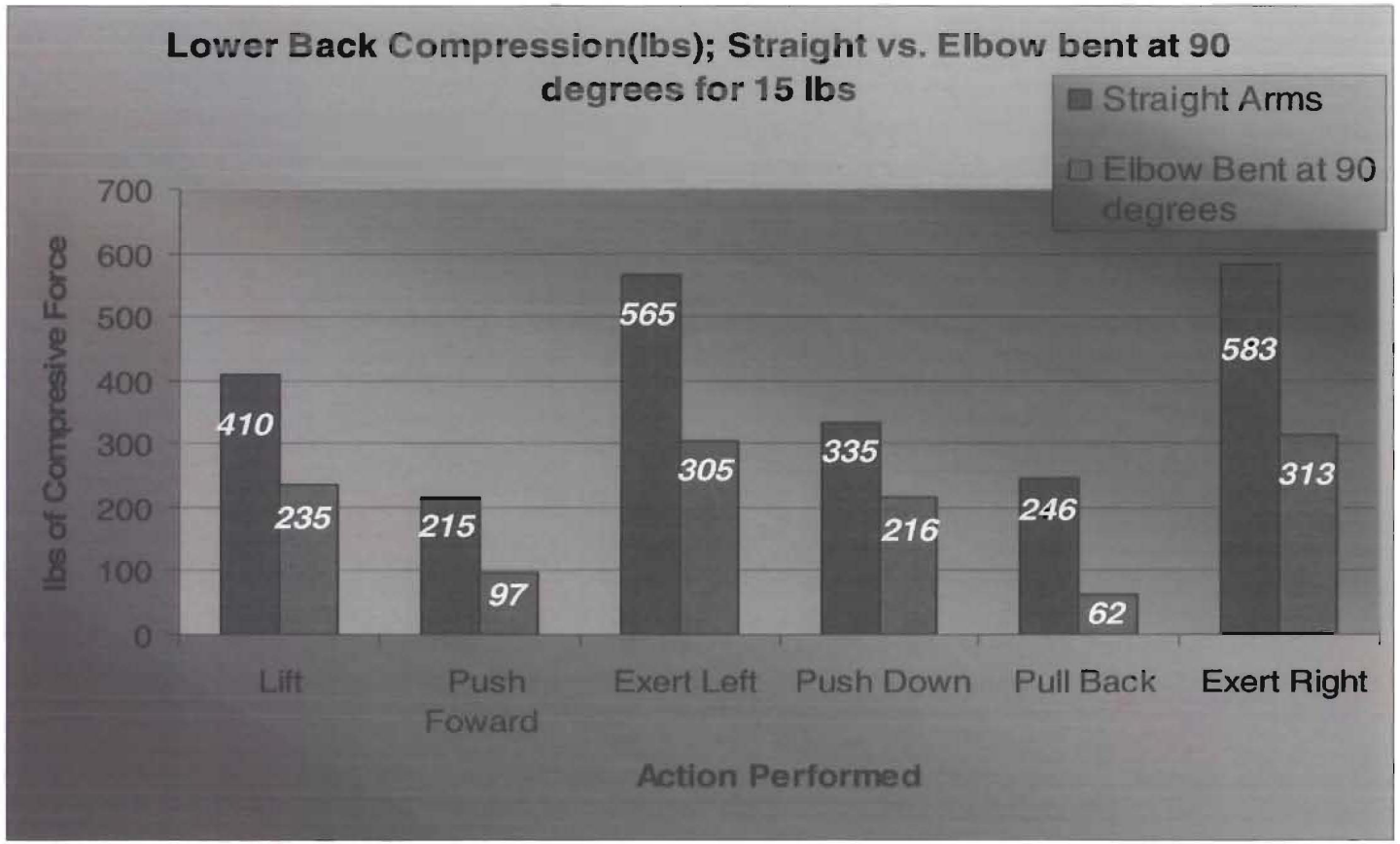
Lower Back Compression for 15lbs



~ Low compressive force on the lower back

~ Extreme difference between Straight Arm and Bent Elbow

~ Exertion to the Right and Left highest

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Human Factors - Biomechanical Considerations

- Do not require workers to stoop/stretch for long periods; workstations should be comfortable
- Employ rubber cushions on standing surfaces to soften surface and reduce leg/back fatigue

Human Factors - Biomechanical Considerations

Minimize manual handling errors by utilizing accessories such as conveyors, racks, air pumps for liquids, trays, containers, hoists, etc.

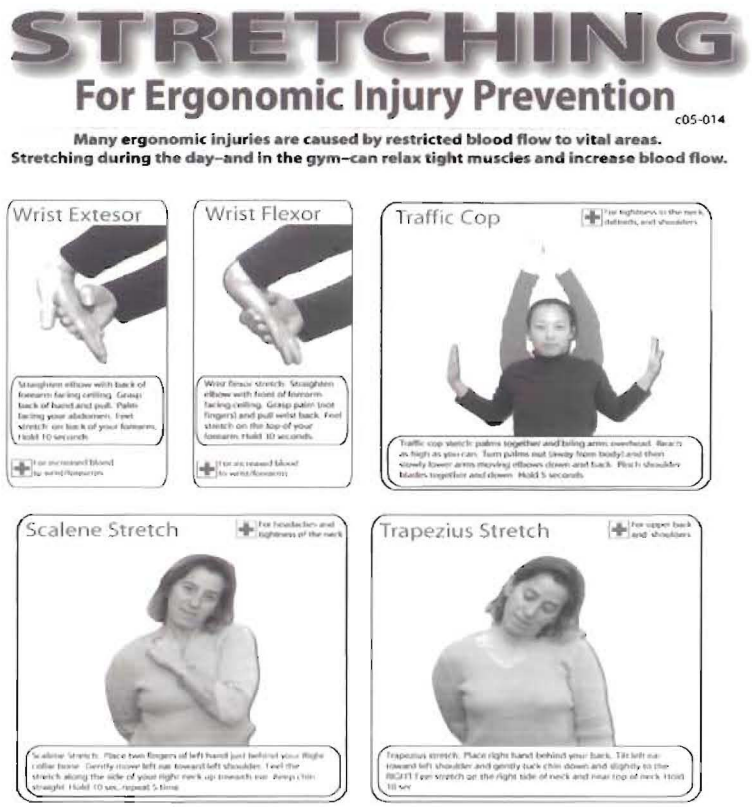
Human Factors - Gloves

- In operations where using thick or inflexible gloves is necessary, tasks should require only crude manipulations
- Use gloves with a "grasp" design to reduce fatigue by allowing the hands to reach in their normal relaxed position
- Improve contact friction with textured finger surfaces

Exercises

- Warm up using a UBE
- Stretching the forearm muscles to reduce risk of elbow injuries
- Strengthen the rotator cuff muscles

Stretching Forearms



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Shoulder exercise poster

Shoulders

Ergonomic Injury Prevention

c05-013

Ergonomic shoulder injuries often involve the rhomboid or the rotator cuff. By strenghtening the surrounding muscles, having good posture, and using good workstation design, shoulder pain can be reversed.

Rhomboid

Lower Rhomboid:
Turn wrist so thumb is toward ceiling. Pull back with elbows close to body, pinch shoulder blades together

Upper Rhomboid:
Turn wrist so palm is facing floor. Pull back keeping elbows out to the side. Make sure wrist stays neutral/straight.

Rotation

Internal rotation:
Keep elbow locked into side. Pull handle toward your belly button, release slowly. Be careful not to move wrist.

External Rotation: Keep elbow locked into side. Pull handle AWAY from body. Keep wrist straight/neutral.

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Summary

- Understand the injuries caused by isolators
- Identify improper techniques and movements
- Ways to improve the isolators and exercises to help mitigate the problems

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Happy Isolator Workers

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Acknowledgments

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Questions?

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