# Jackson Strength System

## User Instructions


Lafayette Instrument

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## Contents



## Consent Form

The undersigned hereby certifies that he/she has read and understands the instructions for use explained within this manual. The undersigned further certifies that he/she understands the potential for injury to individuals tested in an improper manner. The undersigned agrees to use this product only for its designed purposes in accordance with the instructions described herein.

Signed: ______________________________

Dated: ______________________________

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# *Safety Precautions*

## To the Purchaser of the Jackson Strength Evaluation System

This manual must be provided to the operator of the Jackson Strength Evaluation System prior to use. The operator must read, understand, and follow the instructions for use given herein, and must understand the potential risk of testing subjects if these procedures are not followed.

## To the Operator of the Jackson Strength Evaluation System

Prior to using the Jackson Strength Evaluation System, you are required to sign the consent form at the beginning of this manual. Your signature on the consent form indicates that you have read and understand these instructions for use, including the following warnings.

## Warnings

Improper use of this product increases the risk of severe injuries to a test subject. Specifically, misuse of this product can result in musculoskeletal injury. Operators of this unit are forbidden to use this product for any use other than its designed use as instructed herein. Equipment must be used according to manufacturer's instructions only. Read this entire document before testing any subject. **Notice:** This device uses a Lithium-Ion battery as a power source. It is recommended that the battery be charged at least once every six months. Failure to periodically charge the battery may result in battery damage or device malfunction.

Individuals with prior back or hernia problems must not be subjected to this equipment without prior doctor approval. Individuals with heart or respiratory ailments or high blood pressure must not be subjected to this equipment without prior doctor approval.

Before any test, brief the subject on the methods used and the various safety precautions that should be observed. The test subject must be given detailed instruction as to proper use before beginning any test. Instruct the test subject not to use equipment in any manner not provided for in this manual.

These instructions for use cannot be modified without Lafayette Instrument's prior approval. An employer cannot design its own test format without prior Lafayette Instrument approval.

The test unit and load cell must be inspected and re-certified on an annual basis to ensure that they have not been unsafely altered. Unsafe alterations could cause erroneous readings, increasing the risk of physical injury.

If you have any question regarding appropriate use, operation, or maintenance of this equipment, call (765) 423-1505.

# Introduction

Lafayette Instrument Company and all associated with the design and development of the Jackson Strength Evaluation System thank you for selecting this system. It is our goal that the system serves you safely, economically, and reliably. These User Instructions have been created to aid you in the proper use of your system. We also thank those whose research has made the field of strength testing a safer and more precise science. For those with a greater interest in this field, a comprehensive list of background references is provided in the back of this manual.

## How to Use this Manual

This manual is divided into several sections. These sections provide the following information:

**Introduction:** Gives an overview of the three types of strength testing, common strength test applications, and a brief discussion of the development of the Jackson Strength Evaluation System.

**Testing Instructions:** Explains isometric test principles, gives recommended strength tests and test procedures, and shows how to perform strength tests.

**Test Result Evaluation Instructions:** Provides general guidelines for interpreting strength test scores.

**References:** Provides a list of reference material on the body of work done in the field of strength testing.


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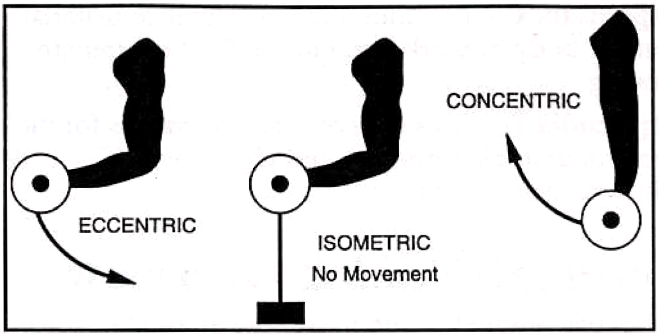



**Types of Strength Testing**

## Strength Testing Overview

Muscular strength is the maximum amount of force that a muscle group can exert. The objective of a strength test is to find the individual's capacity to generate maximum force.

Muscle contractions can be either dynamic or static. Static contractions do not involve movement and are called Isometric. Dynamic contractions involve movement, either eccentric or concentric (Figure 1), The dynamic forms include isotonic and isokinetic. Isotonic contractions involve moving a weight against gravity. Lifting the weight uses a concentric contraction while lowering the weight uses an eccentric contaction. Isokinetic contractions involve muscle contractions at a fixed speed. Although isometric tests are described in this manual, the following paragraphs provide a brief discussion of all methods used to evaluate muscular strength.

**Isometric Strength Testing**

Isometric strength is the maximum force that a muscle group can exert without movement. Tests of isometric strength are easy to perform as they require only a single, maximal contraction.

Isometric strength testing is inexpensive and flexible. By creating the proper test environment, many different types of strength can be evaluated. The National Institute for Occupational Safety and Health (NIOSH) preemployment test manual (1977) illustrates several different test positions. The major disadvantage of isometric testing is that only one joint angle is tested at at time. If different joint angles need to be tested, the process must be repeated.

**Isotonic Strength Testing**

Isotonic strength is measured by determining the maximum force that a muscle group can exert with a single contraction. Isotonic strength tests measure the maximum weight that can be lifted with a single repetition. The major disadvantage of isotonic testing is the need for a maximum lift effort which can increase fatigue and increase the risk of injury.

**Isokinetic Strength Testing**

Isokinetic methods measure peak torque through a defined range of motion while keeping the speed of movement constant. The major advantage of isokinetic tests is that the muscle's strength is evaluated throughout the entire range of motion. The isokinetic method is an excellent method of evaluating strength, but due to the expense it is typically limited to specialized environments such as medical centers, NASA, or the U.S. Olympic Testing Center.

**Strength Test Applications**

Strength testing is most commonly used for:

- Preemployment testing
- Evaluating and rehabilitating patients
- Evaluating and training athletes
- Evaluating physical fitness

**Preemployment Testing**

Strength tests are used to screen job applicants for physically demanding jobs. Over the past 30 years, employment testing has received considerable attention from legal, medical, and exercise physiology scholars. (Refer to References section at the end of this manual for comprehensive coverage of this topic.) This attention has caused employers to institute preemployment strength tests in the interest of increased worker safety, reduced litigation, and increased worker productivity.

*Worker Safety* - Strength tests may be used to select job applicants who have sufficient strength to meet the demands of the job. Injury rate is related to strength. A worker's likelihood of sustaining a musculoskeletal injury increases when job lifting requirements approach or exceed the worker's strength capacity. When strength capacity is too low, back problems are more likely. Back injuries are a major and pervasive industrial medical problem, and are the most common reason for decreased work capacity and reduced leisure time activity for Americans below the age of 45.

*Legal Requirements* - Strength tests may be used as part of a physical abilities test. Title VII of the 1964 Civil Rights Act prohibits employment discrimination based on race, color, religion, sex, or national origin. The Americans with Disabilities Act prohibits employment discrimination against handicapped Americans. With the increased interest of women seeking jobs traditionally held by men, the litigation of cases concerning physical fitness requirements of many jobs has increased. This has been especially true for public safety jobs, namely firefighters, police officers, and correctional officers.

It is illegal to make an employee decision based on gender. Since, compared to men, women have less weight and a higher percentage of body fat, they have less muscular strength and a lower aerobic capacity. Because of these physiological differences, women are less able to perform physically demanding work tasks. While gender is not a valid criterion for job employment, an adequate physical ability to perform the job is. This has led to the development of physical abilities tests for selecting workers for physically demanding jobs.

*Worker Productivity* - Hiring physically fit workers not only decreases the risk of iniury, but can also enhance work productivity. Thus, strength testing for physically demanding jobs can reduce hiring costs.

**Physical Therapy and Rehabilitation**
Strength training and testing are used by physical therapists to rehabilitate patients. The rehabilitative process uses strength development programs to regain lost strength, and strength testing is a major part of the program. The general process is:

1. Strength tests are used to define the initial level of strength of the involved limb. Often, the strength of the non-involved limb is determined to establish a final goal.
2. The initial strength test data is used to prescribe a strength development program.
3. Periodic and systematic reevaluation of the involved limb's strength monitors progress.

**Athletics**
A major factor in the scientific training of athletes is strength training. In the athletic setting, strength tests may be used to:

1. Evaluate an athlete's initial strength and identify areas of weakness.
2. Design an athlete's individual training program based on the diagnosed weaknesses.
3. Evaluate the effects and quality of the training program by administering the same test at the end of the program

## *The Jackson Strength Evaluation System*

The Jackson Strength Evaluation System evolved from preemployment research conducted at the University of Houston from 1979 to 1984. Testing equipment derived from the initial work was suitable for research but not for general use. In 1981, Lafayette Instrument Company began to design isometric test equipment to be used for preemployment testing. The resulting Jackson Strength Evaluation System meets all criteria for such use, since it:

- Is dependable and accurate
- Meets the published standards for preemployment isometric strength testing
- Has the capacity to measure the strength of major muscle groups of humans
- Has the capacity to standardize test procedures in terms of test position and length of the test trial
- Provides an auditory stimulus to start and stop the test
- Is durable and transportable
- Is easy to use, so that personnel who are not experienced in strength testing can be easily trained to administer the tests at an employment office


**The Jackson Strength Evaluation System Components**

- A load cell with a 1000 lb capacity. The load cell is mounted on the platform test devices.
- A handheld tablet with LEval application that measures peak and average force exerted.
- A platform, chain system, and lift bar used to measure the strength of major muscle groups

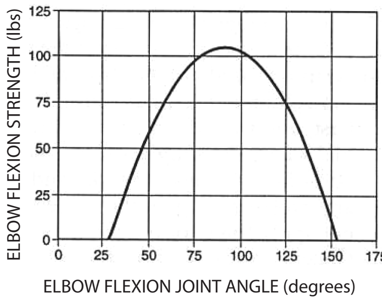
## *System Setup Procedure*

Setting up the Jackson Strength Evaluation System consists of:

1. Assembling the lifting platform, bar, and chain
2. Connecting to LEval application

## Isometric Test Principles

The peak force produced by a muscle group varies depending on the joint angle where force is applied. The chart at the right shows the force production for isometric elbow flexion. A muscle can exert its maximum force when fully stretched (i.e., 160 degrees), but the angle of pull is mechanically poor, resulting in a low force output. It also shows that the peak force application for arm flexion is at about 90 degrees. Research conducted at NASA/Johnson Space Center with healthy subjects showed that the force produced at various angles on the force production curve were highly correlated. This showed that just one angle was needed to evaluate the strength for the total curve. A basic principle of isometric strength testing is to select one joint angle and test all subjects in the same position. Typically, the peak is used.




**Force Production for Isometric Elbow Flexion**

Isometric testing involves placing an individual in a standard position that allows the subject to exert maximum force without producing movement. The photo at the right shows the test position for the arm lift strength test and illustrates the principle of isometric strength testing. The subject stands with his/her elbows at 90 degrees flexion, holding a bar in his/her hands. A chain system is attached to the bar. An electronic load cell is attached to the chain system and the base. When the subject exerts force, there is no movement, but the load cell measures the force exerted by the subject.


**Test Position for the Isometric Arm Strength**

Isometric testing is a flexible method of evaluating strength. All one needs is to create the equipment to standardize the subject's test position (e.g., hand grip and a cable or chain system), and place a load cell in such a position that it will record force. These systems use load cells to measure strength at several different angles. See the NIOSH test manual (1977) for extensive coverage of different test positions used for assessing the strength of workers.

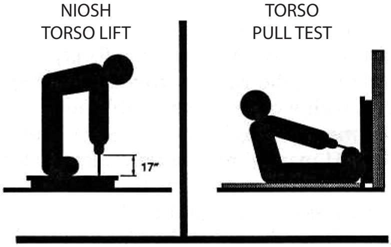
## Torso Lift vs Torso Pull

There are many different isometric tests. The National Institute for Occupational Safety and Health (NIOSH), the Federal governmental agency concerned with worker safety, published *Preemployment Strength Testing* (1977). The authors of the NIOSH manual recommend that the torso lift test be used to screen workers for physically demanding tasks. Although the NIOSH torso test is safe, research conducted at the University of Houston has led to the development of a new test, the torso pull. This test reduces the low back compression forces associated with back testing below that of the NIOSH recommended test.

The torso lift test recommended by NIOSH to screen applicants for physically demanding jobs requires the subject to be in a standing position. The NIOSH test duplicates the position that individuals assume when lifting an object. A major causal factor of low back problems is the compression forces placed on the spine during lifting. There are several factors that increase low back compression forces. Among them are the size of the object, the vertical distance the object is held away from the body, and the number of times the object is lifted. Additionally, the weight of the object and the weight of the subject affect low back compression forces. As the weight of the load and the subject increase, low back compression forces also increase.

The research conducted at the University of Houston was done to develop a torso strength test that minimizes the low back compression forces. The focus of this research was to change the test by having the subject assume a sitting position.

The NIOSH torso lift test is administered in a standing position with the legs straight or slightly bent. The lift bar is 17 inches from the floor. Many individuals are reluctant to be tested in the NIOSH position because they have been taught to bend their knees and lift with the legs. The recommended torso pull test rotates the test position 90 degrees, placing the subject in a sitting position. The figure below compares these two positions. The torso lift test requires the subject to lift; in contrast, the torso pull test requires the subject, while in the sitting position, to pull. Except for being rotated 90 degrees, the subject is in the same general position; thus the two tests use the same muscle groups to generate force.




**The NIOSH (1977) Torso Lift Test and the Torso Pull Test**
**Developed at the University of Houston**

# Test Procedures

**WARNING:** Do not administer a strength test using only the General Procedure information shown here. Use the specific testing instructions given for each use.

## General Procedures

These general test procedures are recommended when using the Jackson Strength System.

1. Hold the tablet in such a position that the subject cannot read his/her score.
2. Use a 3-second trial. Set the Prep time setting to 1 second and the Test time to 2 seconds.
3. For each test, give the subject 3 trials: One warm-up trial at 50% effort and two trials at voluntary maximum effort.
   - First you will administer a “warm-up” trial where the subject exerts force at 50% effort. Observe the trial and correct any problems, e.g., if the subject did not apply force for the full 3 seconds.
   - Once the subject understands what to do, you will administer two trials for score. The trials should be at maximum voluntary effort.
4. To ensure a maximum voluntary effort:
   - Do not test the person in the presence of others.
   - Do not give the subject any form of external motivation.
   - Do not give the subject their score at the completion of the trial. If scores are to be given to the subject, they should be given after all testing is completed.

## Instructions to Test Subjects

Prior to administering the first test, give the following instructions:

> *"We are going to measure the maximum strength of your hands, arms, shoulders, and torso with isometric tests. This means you will be exerting force, but there will not be any movement. We will measure your maximum force with this apparatus. For each test, please follow these instructions."*
>
> *"The test will be demonstrated to you. If you do not understand what to do, ask questions."*
>
> *"For each test, we will give you three attempts. The first attempt will not count; we want you to try at only half (50%) effort. This attempt is a warm-up, and will help you figure out if you understand what to do. If you do not fully understand what to do, let me know."*
>
> *"Next, you will be given two attempts on each test. Try your best on both attempts."*
>
> *"When a test is to be given, I will ask you if you are ready. Shortly after the command 'ready,' you will hear a beep. This first beep is the signal to exert maximum force. Three seconds later you will hear a second beep. Stop your force application on this second beep. You should apply a constant, maximum effort during this three second period."*
>
> *"Always stop a test if I tell you to, even if there is no apparent reason to do so. Also, if you feel pain or discomfort, stop exerting force immediately. But do not change your specified position or the muscle groups used during the test, even if you believe that you could apply a greater force and/or reduce discomfort with such changes."*
>
> *"Now let me show you."* [tap ▶ icon in LEval application] *"Exert force on this beep, then relax after the final beep."*
>
> *"Are there any questions?"*

## Preparation Checklist for Running a Strength Test

**WARNING:** Read the entire manual before testing any subject. Before any test, brief the subject on the methods being used and the various safety precautions that should be observed. These precautions include the following:

1. The subject must put his/her body and the test fixtures in the correct position before the test is initiated, but must not apply any force to the load cell (i.e., chain) until the initiate "beep" is heard.
2. The subject must apply a constant force, free from "jerking."
3. The subject must apply continuous force until the "multiple beep" stop signal is heard.
4. If at any time during the test the subject feels pain or discomfort, the subject must stop the test immediately.
5. The subject must never change their specified position or the muscle groups used during the test, even if he/she believes that he/she could apply a stronger force and/or reduce discomfort with such changes.
6. The subject must always stop a test on demand from the examiner, even if there is no apparent reason to do so.
7. The examiner is never obligated to perform initial or additional tests on a subject that may have a high risk of injury or on a subject that refuses to conform to any of the previous rules.

## Arm Lift Test Procedure

The photo at the right shows the arm lift test position. Use the following procedures to get the subject into position:

1. Demonstrate the test position to the subject and then have the subject assume the test position.
2. In proper position, the subject stands on the platform with arms at his/her side and elbows at 90 degrees in the test position. To set the height of the lift bar:
   - Unsnap the bar from the chain.
   - Raise the chain to the desired height.
   - Snap the lift bar back onto the chain at the proper link.
   - The unused portion of the chain should hang beneath the bar.
3. Have the subject hold the handle with the palms up. Allow the subject to assume a hand placement width that is comfortable, about shoulder width apart. The chain should be at a right angle to the base. Move the subject forward or backward to obtain a right angle between the chain and the base.
4. The purpose of this test is to measure the lifting strength of the arms. The subject is not allowed to lean back or use his/her legs (e.g., bending the knees and generating force with the legs). The force is correctly exerted by lifting with the arms at the elbow joint.


**Test Position for the Arm Lift Test**

When the subject is in the correct position, give the following instructions to the subject:

*"The purpose of this test is to measure the strength of your arms. In this position, lift up with your arms. Do not lean back, rather, lift up. Are there any questions?"*

1. Make sure the subject is in the proper position, and then say, *"Now let's try your first attempt at half effort. Ready?"*
2. Tap the icon in the LEval application, and when the final beep has sounded, ask, *"Do you have any questions?"*
3. Answer any questions and then ask, *"Ready for your maximum attempt?"*
4. Tap the icon in the LEval application; after the final beep, the application will allow you to record the displayed scores by tapping the icon.
5. Administer the two trials for score and record the subject's score from the test results display.
6. Do not announce the score to the subject. The subjects's score is the average of the two maximum voluntary effort trials.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## Shoulder Lift Test Procedure

The photo at right shows the shoulder lift test position. Use the following procedures to get the subject into position:

1. Demonstrate the test position to the subject and then have the subject assume the test position.
2. Use the same bar setting for the shoulder lift test that was used for the arm lift test.
3. To assume the correct position, have the subject move forward until the bar touches his/her body. The chain should be at a right angle to the base.
4. With the palms facing the rear, have the subject grab the bar so that the insides of his/her hands are on the inside of the black handle. In this position, the elbows are pointing out, away from the body.
5. The purpose of this test is to measure the lifting strength of the shoulders. The subject is not allowed to lean back or use his/her legs (e.g., bending the knees and generating force with the legs). The force is correctly exerted by lifting up with the shoulders while the elbows point outward.


**Test Position for the Shoulder Lift Test**

When the subject is in the correct position, give the following instructions to the subject:

*"The purpose of this test is to measure the strength of your shoulders. Do not lean back, rather, lift up. Are there any questions?"*

1. Make sure the subject is in the proper position, and then say, *"Now let's try your first attempt at half effort. Ready?"*
2. Push the ▶ icon in the LEval application, and when the final beep has sounded, ask, *"Do you have any questions?"*
3. Answer any questions and then ask, *"Ready for your maximum attempt?"*
4. Tap the ▶ icon in the LEval application; after the final beep, the application will allow you to record the displayed scores by tapping the 💾 icon.
5. Administer the two trials for score and record the subject's score from the test results display.
6. Do not announce the score to the subject. The subject's score is the average of the two maximum voluntary effort trials.

## Torso Pull Test Procedure

The photo below shows the torso pull test position. Use the following procedures to get the subject into position:

1. Demonstrate the test position to the subject, and then have the subject assume the test position.
2. Attach the lift bar to a chain link that places the bar 17 inches from the base of the platform. Use the same chain setting for all subjects.
3. Place the platform against the wall with the chain system at the bottom of the platform.
4. Have the subject sit on the floor with his/her feet against the platform and legs straight.
5. Have the subject bend at the waist and grip the handle with the palms facing down. The hands should be about shoulder width apart and the arms should be straight.
6. In the test position, the subject exerts force by pulling and leaning back. The subject should not jerk but apply force in a continuous manner.

When the subject is in the correct position, give the following instructions to the subject:

> *"The purpose of this test is to measure your capacity to pull back. Grip the bar with your palms facing down. From this position lean back and pull. Apply a steady, forceful effort. Are there any questions?"*

1. Make sure the subject is in the proper position, and then say, *"Now let's try your first attempt at half effort. Ready?"*
2. Tap the icon in the LEval application, and when the final beep has sounded, ask, *"Do you have any questions?"*
3. Answer any questions and then ask, *"Ready for your maximum attempt?"*
4. Tap the icon in the LEval application; after the final beep, the application will allow you to record the displayed scores by tapping the icon.
5. Administer the two trials for score and record the subject's score from the test results display.
6. Do not announce the score to the subject. The subjects's score is the average of the two maximum voluntary effort trials.

**Test Position for the Torso Pull Test**

*System shown with platform stands sold separately*

## Quality Control Checks

Not following the outlined test procedures can adversely affect test results. Provided next are methods you can take to ensure that proper test procedures are being followed.

### Compare Peak and Average Scores

The tablet display provides a peak and average reading. The peak score should not be more than 15 lbs (6.8 kg) higher than the average reading. If the peak value is that much greater than the average score, the most likely reason is that the subject stopped exerting force before the final beep. If this happens, re-administer the trial after reminding the subject to administer force until the final beep sounds.

### Extreme Scores

The table below gives expected test score ranges for men and women. Roughly 95% of all scores should fall within the ranges. If a high proportion (> 10%) of the people you test fall outside the ranges, it is probably due to one of two reasons:

1. The tests are not being administered properly.
2. The group being tested is not typical of the general adult population, i.e., extremely weak or strong.

**Test Score Ranges**

| Strength Test | Males | Females |
|---|---|---|
| Grip Strength* | 60-156 lbs | 28-98 lbs |
| Arm Lift | 40-130 lbs | 15-80 lbs |
| Shoulder Lift | 60-200 lbs | 25-110 lbs |
| Torso Pull | 100-400 lbs | 40-250 lbs |
| Leg Lift | 200-700 lbs | 100-500 lbs |

* Grip measured with Lafayette Hand Dynamometer

# Test Result Evaluation Instructions

This section provides methods for interpreting isometric strength scores. Provided are three different ways to evaluate performance. First, normative data for different groups of adults are listed. Second, standards for adult men and women, adjusted for body weight, are described. Finally, methods used to define the level of strength needed to perform physically demanding industrial tasks are illustrated.

## Normative Data

Several studies have been completed to develop preemployment strength tests. These studies produced data on college students and several different groups of workers. The following table gives the normative male and female data from these studies. Provided are the means, standard deviations, and sample sizes. The test protocols changed over the years, so the same tests were not administered to all groups.

The following tables are normative strength data for the isometric strength tests. Provided are means and standard deviations for samples of male and female college students and industrial workers. The samples include those tested when participating in preemployment research completed at the University of Houston (college students and workers), and college students enrolled in the physical fitness course required of all students.

**Means, standard deviations, and sample sizes for isometric strength tests administered to male industrial workers and college students**

| Strength Test | Male Industrial Workers | | | Male College Students | | |
|---|---|---|---|---|---|---|
| | N | MEAN | SD | N | MEAN | SD |
| Grip | 1178 | 111.5 | 23.2 | 311 | 95.9 | 25.6 |
| Arm Lift | 1424 | 89.6 | 19.0 | 971 | 72.4 | 22.2 |
| Shoulder Lift | 407 | 128.7 | 25.7 | 659 | 102.9 | 32.4 |
| Leg Lift | 246 | 247.9 | 63.4 | 122 | 213.1 | 73.8 |
| Torso Pull | 382 | 244.7 | 38.1 | 598 | 225.6 | 57.3 |

**Means, standard deviations, and sample sizes for isometric strength tests administered to female industrial workers and college students**

| Strength Test | Female Industrial Workers | | | Female College Students | | |
|---|---|---|---|---|---|---|
| | N | MEAN | SD | N | MEAN | SD |
| Grip | 106 | 74.4 | 18.2 | 299 | 60.5 | 16.1 |
| Arm Lift | 204 | 52.6 | 13.6 | 1143 | 37.7 | 16.4 |
| Shoulder Lift | 115 | 70.1 | 19.2 | 844 | 51.7 | 19.3 |
| Leg Lift | 98 | 137.3 | 55.1 | 147 | 113.5 | 38.6 |
| Torso Pull | 48 | 161.1 | 41.4 | 805 | 119.0 | 40.1 |

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## Adjusted for Body Weight

Strength is related to body weight. Heavier individuals tend to be stronger than those who weigh less. This can be traced to the fact that a body's fat-free weight component consists largely of muscle mass and bone. Since the percentage of body fat of women is 8% higher than that of men, the weight-strength relationships for men and women differ somewhat.

Regression analysis defines the linear relationship between strength and body weight. The table below presents the regression equations for calculating the average isometric strength for a given body weight.

**Regression equations that define the relationship between isometric strength and body weight**

| N | Gender | Test | Equation | R | SEE |
|---:|---|---|---|---:|---:|
| 388 | Female | Grip | G = 35.40 + (0.20 x Wt) | 0.34 | 16.7 |
| 1320 | Male | Grip | G = 60.80 + (0.26 x Wt) | 0.34 | 22.6 |
| 521 | Female | Arm Lift | AL = 22.91 + (0.15 x Wt) | 0.34 | 13.2 |
| 1485 | Male | Arm Lift | AL = 43.88 + (0.23 x Wt) | 0.37 | 18.8 |
| 133 | Female | Shoulder Lift | SL = 34.45 + (0.20 x Wt) | 0.39 | 16.0 |
| 165 | Male | Shoulder Lift | SL = 46.66 + (0.38 x Wt) | 0.55 | 22.3 |
| 175 | Female | Torso Pull | TP = 76.79 + (0.46 x Wt) | 0.32 | 0.32 |
| 357 | Male | Torso Pull | TP = 167.69 + (0.48 x Wt) | 0.36 | 0.36 |

**NOTE:** N = Sample Size
R = Correlation
SEE = Standard Error of Estimate

Using the standard error of estimate from the regression analysis, low and high strength levels were calculated. The table on the following page gives male and female strength standards adjusted for body weight.

Provided are low, average, and high levels of strength for weight categories. These strength levels are defined as:

- Low: 15th percentile
- Average: 50th percentile
- High: 85th percentile

**Low, Average, and High levels of isometric strength for levels of body weight contrasted by gender**

**WOMEN**

| Weight | Grip | | | Arm Lift | | | Shoulder Lift | | | Torso Pull | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low | Avg | Hi | Low | Avg | Hi | Low | Avg | Hi | Low | Avg | Hi |
| 90-99 | 38 | 54 | 71 | 24 | 37 | 50 | 37 | 53 | 69 | 79 | 120 | 162 |
| 100-109 | 40 | 56 | 73 | 25 | 39 | 52 | 39 | 55 | 71 | 83 | 125 | 166 |
| 110-119 | 42 | 58 | 75 | 27 | 40 | 53 | 41 | 57 | 73 | 88 | 129 | 171 |
| 120-129 | 44 | 60 | 77 | 28 | 42 | 55 | 43 | 59 | 75 | 92 | 134 | 176 |
| 130-139 | 46 | 62 | 79 | 30 | 43 | 56 | 45 | 61 | 77 | 97 | 139 | 180 |
| 140-149 | 48 | 64 | 81 | 31 | 45 | 58 | 47 | 63 | 79 | 102 | 143 | 185 |
| 150-159 | 50 | 66 | 83 | 33 | 46 | 59 | 49 | 65 | 81 | 106 | 148 | 189 |
| 160-169 | 52 | 68 | 85 | 34 | 48 | 61 | 51 | 67 | 83 | 111 | 152 | 194 |
| 170-179 | 54 | 70 | 87 | 36 | 49 | 62 | 53 | 69 | 85 | 115 | 157 | 199 |
| 180-189 | 56 | 72 | 89 | 37 | 51 | 64 | 55 | 71 | 87 | 120 | 162 | 203 |
| 190-199 | 58 | 74 | 91 | 39 | 52 | 65 | 57 | 73 | 89 | 125 | 166 | 208 |
| 200-209 | 60 | 76 | 93 | 40 | 54 | 67 | 59 | 75 | 91 | 129 | 171 | 212 |

**MEN**

| Weight | Grip | | | Arm Lift | | | Shoulder Lift | | | Torso Pull | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low | Avg | Hi | Low | Avg | Hi | Low | Avg | Hi | Low | Avg | Hi |
| 110-119 | 68 | 91 | 113 | 51 | 70 | 98 | 68 | 90 | 112 | 182 | 223 | 264 |
| 120-129 | 71 | 93 | 116 | 54 | 73 | 91 | 72 | 94 | 116 | 186 | 227 | 269 |
| 130-139 | 73 | 96 | 118 | 56 | 75 | 94 | 75 | 98 | 120 | 191 | 232 | 273 |
| 140-149 | 76 | 98 | 121 | 58 | 77 | 96 | 79 | 102 | 124 | 196 | 237 | 278 |
| 150-159 | 78 | 101 | 124 | 61 | 79 | 98 | 83 | 105 | 128 | 201 | 242 | 283 |
| 160-169 | 81 | 104 | 126 | 63 | 82 | 101 | 87 | 109 | 131 | 206 | 247 | 288 |
| 170-179 | 84 | 106 | 129 | 65 | 84 | 103 | 91 | 113 | 135 | 210 | 251 | 293 |
| 180-189 | 86 | 109 | 131 | 68 | 86 | 105 | 91 | 117 | 139 | 215 | 256 | 297 |
| 190-199 | 89 | 111 | 134 | 70 | 89 | 107 | 98 | 121 | 143 | 220 | 261 | 302 |
| 200-209 | 91 | 114 | 137 | 72 | 91 | 110 | 102 | 124 | 147 | 225 | 266 | 307 |
| 210-219 | 94 | 117 | 139 | 74 | 93 | 112 | 106 | 128 | 150 | 230 | 271 | 312 |
| 220-229 | 97 | 119 | 142 | 77 | 96 | 114 | 110 | 132 | 154 | 234 | 275 | 317 |
| 230-239 | 102 | 124 | 147 | 81 | 100 | 119 | 117 | 140 | 162 | 244 | 285 | 326 |

**NOTE:** A percentile reflects the percentage of subjects who can be expected to score below the given value. For example, 15% of the group tested scored below given for the 15th percentile.

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## Standards for Physically Demanding Job Tasks

Many physically demanding jobs are strength dependent. Strength tests are used to select and match workers to physically demanding work tasks. Numerous studies show that isometric strength tests predict one's capacity to perform physically demanding job tasks. Refer to the References section at the end of this manual for a comprehensive review of this literature.

Research conducted at the University of Houston found that the isometric strength test presented in this manual validly predicts the ability to perform physically demanding job tasks. The table below summarizes the results. Given are the validity coefficients (i.e., product-moment correlations) between the isometric tests and work sample tests that simulated the job. These correlations are high, showing that the successful completion of the work task depended upon the subject's strength. The strength tests used were sums of several tests. With correlations this high, it is possible to develop equations to estimate the level of strength needed to perform the work task.

**Correlations between isometric strength tests and work sample tests for preemployment research completed at the University of Houston**

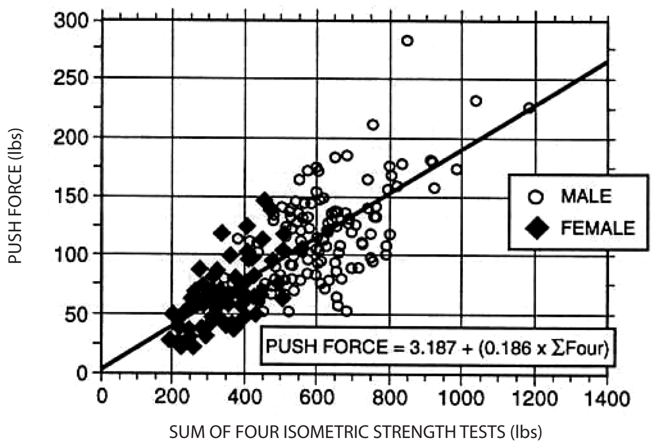
| Reference | Work Sample Test | Correlation |
|---|---|---|
| Jackson et al. 1991 | Shoveling Coal | 0.71 |
| Jackson et al. 1991 | 50 lb Bag Carry | 0.63 |
| Jackson & Osburn 1983 | 70 lb Block Carry | 0.87 |
| Jackson & Osburn 1983 | Roof Bolting in a Coal Mine | 0.91 |
| Jackson 1986 | Push Force | 0.86 |
| Jackson et al. 1993 | Push Force | 0.78 |
| Jackson 1986 | Pull Force | 0.78 |
| Jackson et al. 1993 | Pull Force | 0.67 |
| Laughery & Jackson | Lifting Force | 0.93 |
| Jackson et al. 1992 | Refinery Valve-Turning Endurace | 0.83 |
| Jackson et al. 1993 | Box Transport Endurance | 0.76 |
| Jackson et al. 1991 | Moving Document Bags | 0.70 |
| Jackson et al. 1994 | Patient Lift Force | 0.86 |

Provided next are examples of methods used to establish the level of strength needed for physically demanding work tasks. Since the correlations and test distributions vary, each work task has a unique equation.

## Defining Push Force

The capacity to generate push force is a requirement of freight handlers. The chart below presents a scattergram and simple linear regression equation that defines the relationship between the sum of four isometric strength tests and the capacity to generate force. Push force was measured with a work sample test that simulated the action required by freight handlers to move containers full of freight. As a part of the task analysis, the force required to move containers full of freight was measured with the Jackson Strength Evaluation System load cell. By knowing the amount of force required to move the freight container, it was possible to define the level of strength needed by the worker. To illustrate, if 100 lbs of force is required to move the container, workers with strength scores greater than about 450 lbs would be expected to have sufficient strength to complete the task.

**A Scattergram Showing the Relationship Between the Sum of Four Isometric Strength Tests and the Capacity to Generate Push Force**





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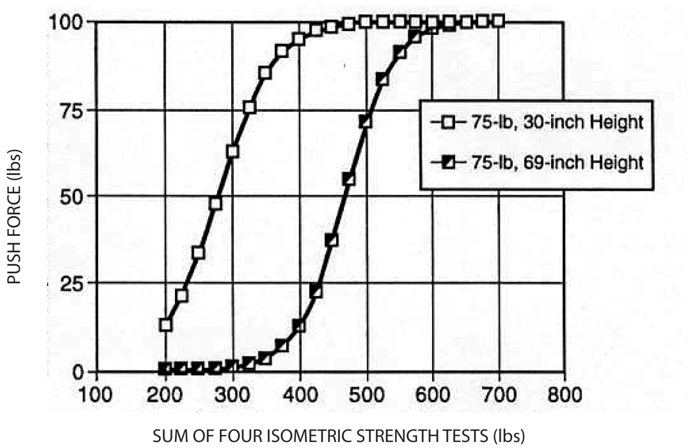
## Defining Lifting Capacity

Many industrial tasks require a worker to lift objects (e.g., boxes) specified heights. This is a major work task of freight handlers. The chart below gives probability curves that define the level of strength needed to lift a 75 lb box to heights of 30 and 69 inches. The curves were developed through logistic regression analysis. Refer to the References section at the end of the manual for a more detailed discussion of this approach.

Logistic analysis provides an estimate of the probability that someone with a given level of isometric strength will be strong enough to complete the lift. Lifting a 75 lb box to a 30 inch height is a much easier task than the higher lift. The curves show that someone with 400 lbs of isometric strength will likely (p = 98%) be able to lift the 75 lb box to a 30 inch height. This would be similar to lifting a box from the floor to the bed of a truck. In contrast, if the task required the worker to lift the box to the higher level it would be very difficult for most with 400 lbs of strength to complete the high lift compared to the low lift. The strength test provided the data to confirm and quantify this obvious relationship.

**Logistic Curves that Define the Probability that Someone Will be Able to Lift a 75 lb Box to Heights of 30 and 65 inches**



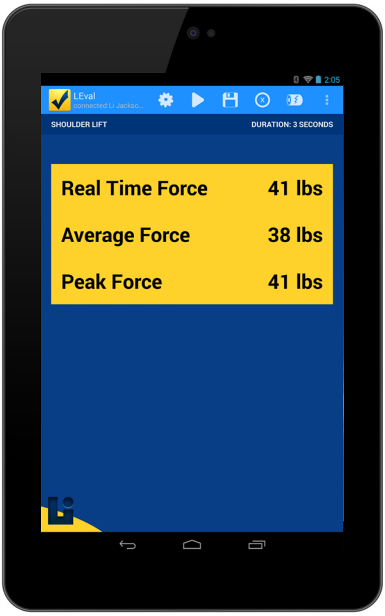
## *LEval Application*

The Lafayette Jackson Strength System utilizes the Lafayette LEval tablet application*. The application may be downloaded**, for free, via the Google Play store from any Android device.

The Jackson System pairs directly to the Android device via bluetooth, and all test administration is done from within the application.

LEval allows quick and consistent management of large groups of subjects and saving of subject results in a local database for future study. A subject's data can be easily viewed in both raw and printable chart form. Collected data can be used to generate specific norms for all user data or at an organization level.

More specific usage details are available in the LEval application's Help Menu. The Help Menu is accessed by tapping the pulldown menu icon on the upper right hand corner of the application and selecting "Help" from the menu.




* *Only available for the Android operating system*

** *Internet access is required for initially downloading the application, as well as retrieving any additional updates that are pushed through the Google Play store. Internet access is not required for day-to-day usage or pairing with the Jackson Strength System.*

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This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

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- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

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