Instructions for Use Manual

Jackson Strength Evaluation System

Model # 32628

Lafayette Instrument

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 shown on the following page. 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 other than its designed use as instructed herein.

Equipment must be used according to manufacturer's instructions only. Read the entire document before testing any subject.

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 insure 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 1-800-428-7545.

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: ______________________________

Table of Contents

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 serve you safely, economically, and reliably. These Instructions For Use 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.

System Components – Shows what models are needed to perform strength tests, the accessory that may be purchased, introductory system control and display information, and an explanation of how to operate the system.

Setup Instructions – Shows how to assemble a load cell, how to assemble the lifting platform, bar and chain, how to install a load cell in the platform, how to connect and adjust the eye bolt spacing on the load cell, and how to connect a 12 volt 500 mA center positive power supply to the control unit.

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.

Operating Instructions – Explains how to operate the control unit, showing Standard Read mode. Also shows how to review test parameters.

Calibration Instructions – Lists equipment required to perform a calibration check.

Appendix A – Shows how to program different protocols (series of tests).

Appendix B – Shows how to select and modify test parameters.

Appendix C – Provides a list of reference material on the body of work done in the field of strength testing.

Appendix D – Lists the specification values for the control unit, platform, bar and chain, hand dynamometer, and load cells.

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 contraction. 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 a time. If different joint angles need to be tested, the process must be repeated.

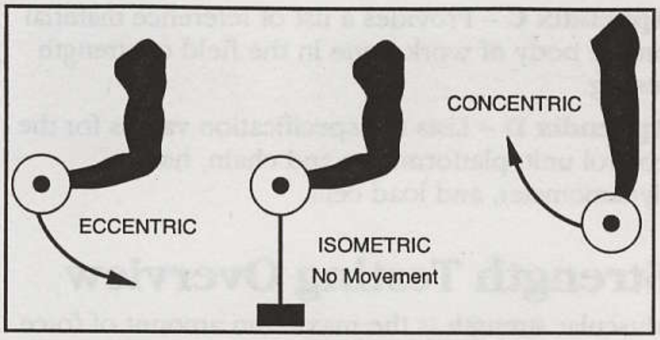


Figure 1. Types of Strength Testing

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, 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 Appendix C for a listing of reference material providing 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 injury, 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 has several components. These are:

1. A load cell with a 1000-pound capacity (Figure 2). The load cell is mounted on either the grip or platform test devices, and is electronically connected to the control unit.
2. A control unit that measures peak and average force (in pounds) exerted on the load cell (Figure 2). The control unit records the force applied to the load cell.
3. A unit for measuring grip strength (Figure 3).
4. A platform, cable and chain system, and lift bar used to measure the strength of major muscle groups (Figure 3).

Figure 2. Control Unit and Load Cell

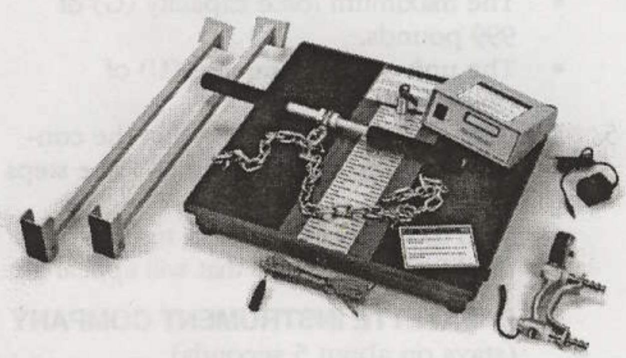


Figure 3. Grip (Hand Dynamometer) Unit and Platform, Cable-Chain, and Lift Bar

Summary of Equipment Operating Procedures

Provided in this section are step by step procedures for operating the Jackson Strength Evaluation System.

1. The Jackson Strength Evaluation System consists of: a wooden platform; a chain; a handle; a hand dynamometer; and a control unit.
2. When you receive the Jackson Strength Evaluation System, the load cell will most likely be attached to the platform. If this is not the case, see the System Setup Procedure on page 7 for securing the load cell to the platform unit. Attach the chain to the cable loop located on the base of the platform.
3. In order to measure strength, the load cell must be attached to the control unit. The load cell is calibrated for a unique control unit. The white tag attached to the cable of the load cell gives the identification number. The system has the capacity to support two load cells. The load cells are attached to the rear of the control unit at Transducer "A" and "B." If only one load cell is used, Transducer "A" should be used. The appropriate transducer is marked on the white tag.
4. The control unit has the capacity to change test parameters, but it comes from the factory with default settings, which are:
   - A 3-second trial consisting of a prep (P) time of 1 second and test time (T) of 2 seconds.
   - The maximum force capacity (G) of 999 pounds.
   - The unit of measurement (U) of pounds (lbs).
5. The first step is to be certain that the control unit is at the default settings. The steps to follow are:
   - With the load cell attached, turn on the machine. The screens that will appear are:

     LAFAYETTE INSTRUMENT COMPANY
     (stays on about 5 seconds)

     JACKSON STRENGTH EVALUATION SYSTEM (stays on about 5 seconds)
   - The following screen appears:

     MONITOR-> • 0 lbs
     Init Param Zero Mode
   - Push button #2, which is below "Param," and a screen appears with the parameters. The screen that appears should read:

     P: 1 T: 2 G: 999 U: lbs
     More> Curs List OK
     - If this screen appears, the unit is set properly for testing. Push button #4, which is under "OK," and the previous screen will appear.
6. If the default settings do not appear, steps need to be taken to set the default setting. Assume the test time (T) is not 2, but 5. The screen would be:

   P: 1 T: 5 G: 999 U: lbs
   More> Curs List OK
   - The following steps must be taken to program the unit:

     Note: For further explanation of how to program the unit (selecting and changing parameters), refer to the Operating Instructions, pages 25 – 29.

     Push button #2, which is below "Curs." The "P:1, T:5, G:999, U: lbs" line appears with a blinking black square on the "P." If "P:1" is to be changed, push button #2, which is below "Sel." This selects that parameter to be changed. However, since Prep (P) time should be 1, it is correct. What needs to be changed is "T:5." Push button #1, which is below ">>>," and this moves the blinking box over the "T." Push button #2, which is below "Sel," and the window that appears is:

     T: TEST TIME = 5 secs
     >>> <<< Cancel OK

Pushing button #1, which is below ">>>," increases the time. Pushing button #2, which is below "<<<," decreases the time. Since we want Test Time to be "2", not "5", push button #2 three times and the correct screen appears:

T: TEST TIME = 2 secs
>>> <<< Cancel OK

Push button #4, which is below "OK," and the following screen will appear:

P: 1 T: 5 G: 999 U: lbs
More> Curs List OK

Push button #4 ("OK") again and the following screen appears:

MONITOR-> • 0 lbs
Init Param Zero Mode

7. The unit must be "zeroed" before testing. If "0 lbs" does not appear on this screen (e.g., 9 lbs), push button #3, which is below "Zero," and the unit will be zeroed, i.e., 0 lbs will appear.
8. Once the unit is zeroed and the default settings are set, the unit is ready for testing. The following screen should be present to initiate (Init) a test trial:

MONITOR-> • 0 lbs
Init Param Zero Mode

To start a trial, push button #1, which is located below "Init," and a short "beep" will be heard. This is the stimulus for the subject to exert force. Three seconds after the "initiate beep," a second "flutter beep" will be heard. This is the signal of the end of the trial.

9. Assume the subject exerted 79 pounds of peak force and 75 pounds of average force. The following screen would appear:

P: - 79b A: - 75b
Reset — — —

10. Push button #1, which is under "Reset." This resets the equipment and you are ready to administer the next trial. The screen that should now appear is:

MONITOR-> • 0 lbs
Init Param Zero Mode

The Jackson Strength Evaluation System has the capacity to use two load cells. To expedite testing, the two platforms can be used. In this test situation, one platform is used to test arm and shoulder lift and the second load cell is used to test torso pull. Provided next are the steps to follow when using two load cells. If you are just using one load cell, you can skip these steps.

1. Each load cell is calibrated for a specific port. Be certain the load cell is attached to the correct port. Turn on the unit. After 10 seconds, the following screen appears:

MONITOR-> • 0 lbs
Init Param Zero Mode

2. Press button #2, which is below "Param." Press button #2 again (below "Curs") to activate the cursor. In the correct mode, you will see a blinking black rectangle on the "P."
3. Press button #1 six times. This moves the cursor to flash on the displayed "C." Press button #2, which is below "Sel," and the following screen appears:

C: INPUT CHANNEL = A
CH.A Ch.B. Concl OK

4. Press button #2, which is below "CH.B." The screen changes to read: "**C:INPUT CHANNEL = B.**"
   - Press button #4, which is below "OK," to accept the current INPUT CHANNEL selection.
   - Press button #4 ("OK") again to return to the MONITOR MODE, which displays:

MONITOR-> • 0 lbs
Init Param Zero Mode

5. If "0 lbs" does not appear on the screen, push button #3 to zero the unit.
6. Initiate the test by pushing button #1, which is below "Init"; force is recorded using CHANNEL B.
7. In order to change back to CHANNEL A from B, steps 1-5 must be repeated. At step 4, to change from INPUT CHANNEL B to A, press button #1, which is below "CH.A." The screen changes to read: "C: INPUT CHANNEL = A." Then push button #4 (OK) twice and the load cell attached to CHANNEL A is now the "live" test channel.

Model Description

At the heart of the Jackson Strength Evaluation System is the electronic control unit. A complete 32628 system consists of, at a minimum, a model 32628CTL, 32628PBC, J00105, and a 32528LC. The following test components may be ordered, as determined by your testing needs:

- Model 32628CTL: the electronic control unit and a matched load cell (Figure 4A).
- Model 32628PBC: the lifting platform, bar and chain (for use with all lift tasks) (Figure 4B).
- Model J00105: the hand dynamometer fixture (does not include separate load cell) (Figure 4C).
- Model 32528LC: Load cell only, with cable and connector (Figure 4C).

Figure 4A. Electronic Control Unit with Matched Load Cell

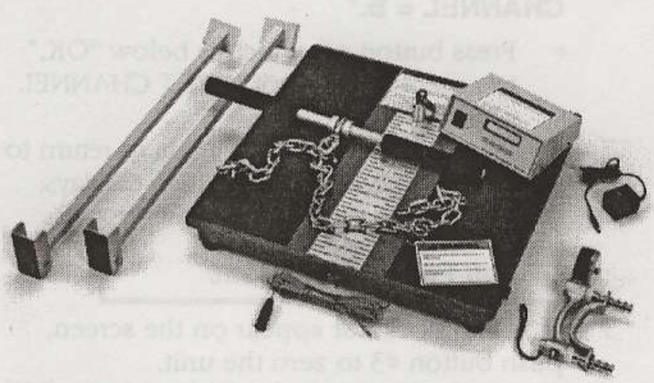


Figure 4B. Lifting Bar and Chain with Hand Dynamometer

Figure 4C. Load Cell with Cable and Connector

Accessory

The following accessory is available for use with the Jackson Strength Evaluation System:

- Model 32629: Lafayette calibration check kit, includes stand, and NIST-certified weights (Figure 5).

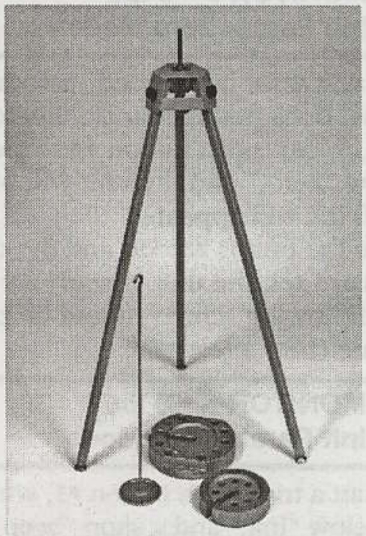


Figure 5. Calibration Check Kit

System Setup Procedure

Setting up the Jackson Strength Evaluation System consists of:

1. Assembling the lifting platform, bar and chain (Figure 6).
2. Installing a matched load cell onto the platform (Figures 7a – 7g).
3. Connecting the control unit (Figure 8).

Install a load cell in the platform using the following procedure:

1. Remove the panel below the platform (Figure 7a).
2. Loosen "J" bolt on the platform (Figure 7b).
3. Adjust eye bolts in the load cell (Figure 7c).
4. Attach the load cell (Figure 7d).
5. Tighten the "J" bolt (Figure 7e).
6. Lay the platform flat and test the installation (Figure 7f).
7. Install the panel below the platform (Figure 7g).

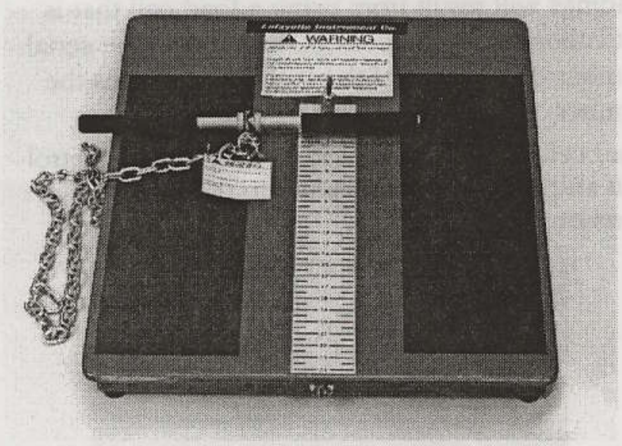


Figure 6. Assembling the Lifting Platform and the Bar and Chain

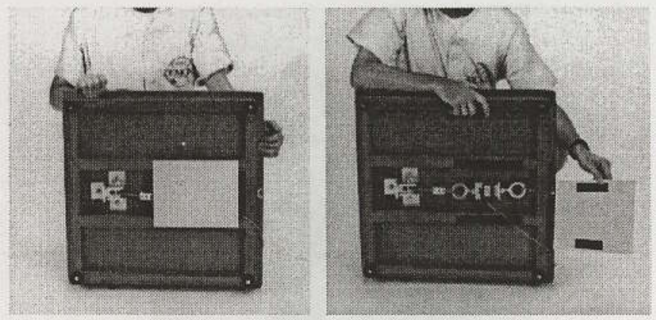


Figure 7a. Remove the Panel Below the Platform

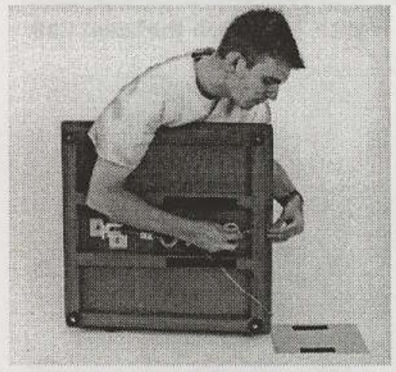


Figure 7b. Loosen the "J" Bolt on the Platform

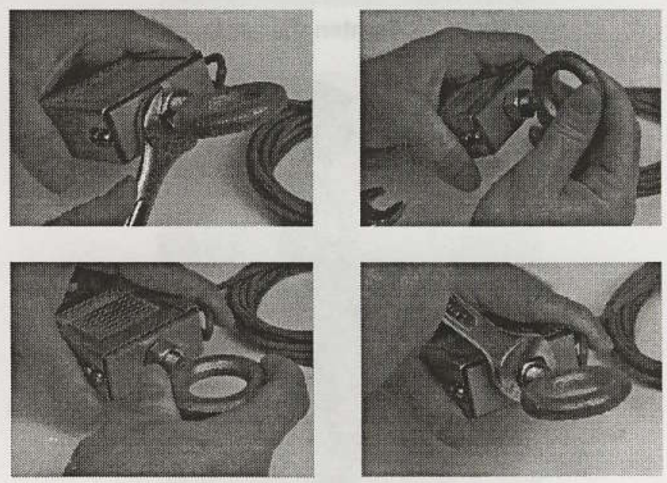


Figure 7c. Adjust the Eye Bolts in the Load Cell

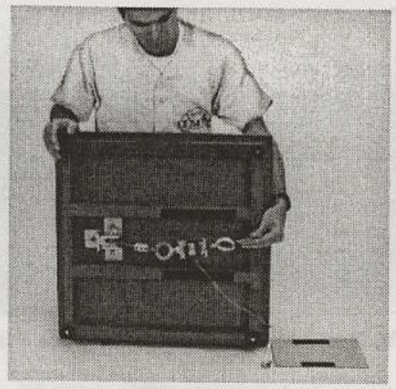


Figure 7d. Attach the Load Cell

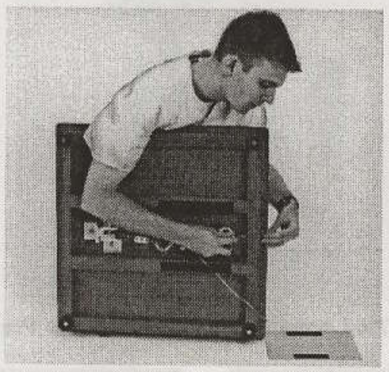


Figure 7e. Tighten the "J" Bolt

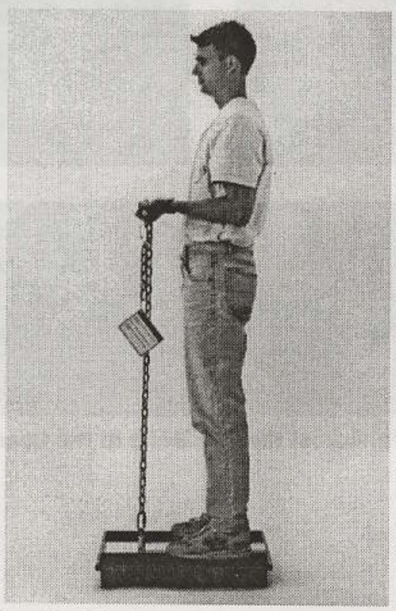


Figure 7f. Lay the Platform Flat and Test the Installation

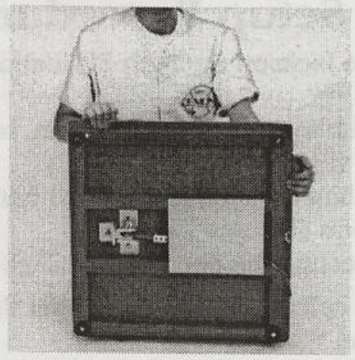


Figure 7g. Install the Panel Below Platform

Load Cell Adjustment Procedure

Load cells are calibrated to control units. (They are also serialized with the same number). Improper readings will result from using a load cell that is not calibrated to the control. Insure that the serial number on the side of the load cell matches the number on the control unit.

Load cells must remain with the serialized control unit and should be connected to their respective ports on the control.

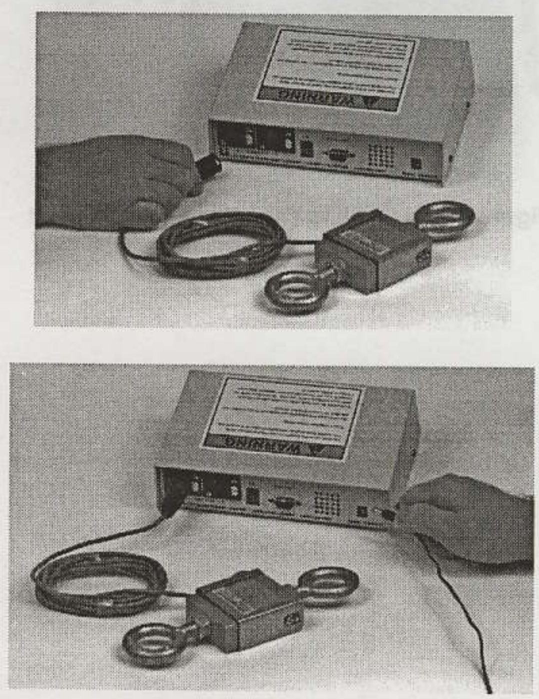


Figure 8. Connecting the Load Cells and DC Power Supply to the Control Unit

Isometric Test Principles

The peak force produced by a muscle group varies depending on the joint angle where force is applied. Figure 9 shows the force production for isometric elbow flexion. A muscle can exert its maximum force when fully stretched (i.e., 160°), but the angle of pull is mechanically poor, resulting in a low force output. Figure 9 shows that the peak force application for arm flexion is at about 90°. 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.

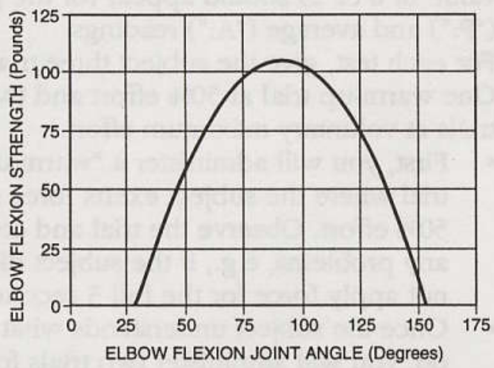


Figure 9. Force Production for Isometric Elbow Flexion

Isometric testing involves placing an individual in a standard position that allows the subject to exert maximum force without producing movement. Figure 10 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° flexion, holding a bar in his/her hands. A chain and cable unit is attached to the bar. An electronic load cell is attached to the chain and cable unit and the base. When the subject exerts force, there is no movement, but the load cell measures the force exerted by the subject.

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 cable-chain units), 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.

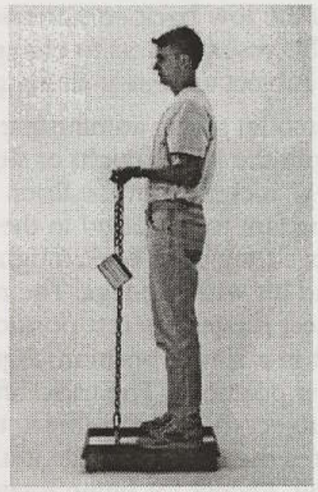


Figure 10. Test Position for the Isometric Arm Strength Test

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 lifted, the horizontal 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°, placing the subject in a sitting position. Figure 11 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°, the subject is in the same general position; thus, the two tests use the same muscle groups to generate force.

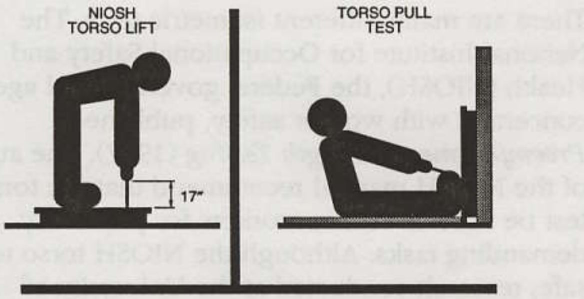


Figure 11. The NIOSH (1977) Torso Lift Test and the Torso Pull Test Developed at the University of Houston

Recommended Tests and Test Procedures

While it is possible to test isometric strength in many different ways, Lafayette Instruments recommends four tests. These are:

- grip strength
- arm lift
- shoulder lift
- torso pull

Provided in this section are the general procedures for administering each of these four tests. Following the general instructions are specific instructions for each of the four tests.

⚠ 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 Evaluation System:

1. At the start of the test session, ensure that the load cell is properly attached. Turn on the Jackson Strength Evaluation System at least 10 minutes prior to testing.
2. Place the recording unit on a table and set it in such a position that the subject cannot read their score from the recording unit.
3. Use a 3-second trial. Set the Prep time setting to "1 secs" and the test-time setting to "2 secs." (If necessary, refer to the Parameter setting section in the Operating Instructions.)
4. With the load cell lying on a table, press the initiate button. Do this several times. A value of 0 (± 2) should appear for the peak ("P:") and average ("A:") readings.
5. For each test, give the subject three 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.
6. To insure 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.
7. Depending upon the test being administered, the platform unit must be turned over to attach the load cell unit. Attach one end of the load cell to the hook on the platform and the other end on the cable/chain unit. (If necessary, refer to the Setup Instructions for more specific guidance.).

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 as your score will be the average of the two measurements."

"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. [Push the Initiate button.] *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 believe that he/she could apply a greater 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.

Grip Strength Test Procedure

The grip strength test measures the grip of both hands. The right and left grip strength tests can be administered with the Jackson Strength Evaluation System or the JAMAR Hand Dynamometer.

Jackson Grip Strength Test

When using the Jackson Strength Evaluation System to measure grip strength, it is recommended that two load cells be used. This eliminates the time consuming procedure of moving the load cell from the grip test unit to the platform for the arm lift, shoulder lift, and torso pull tests.

Figure 12 shows the grip test position. Use the following procedure to set up the equipment and to get the subject into the test position:

1. Attach the load cell to the grip test unit by removing the two large, black screw-knobs, placing the load cell in position, and replacing and tightening the screw-knobs.
2. Set the grip handle in the proper position. A centimeter scale is on the inside of the handle of the grip test unit. A black knob on the inside of the grip unit adjusts the grip spacing. Set the bottom of the handle at 2.5 centimeters when testing adults.
3. Place the grip apparatus on a table.
4. Demonstrate the test position to the subject, and then have the subject assume the test position.
5. Have the subject sit on a chair facing the table. The chair must be placed close enough to the table so that the subject can rest his/her hands on the table.
6. Have the subject decide which hand to use first. With the palm facing up, have the subject hold the grip handle. The unit should rest comfortably in the hand with the fingers wrapped around the handle.
7. Have the subject slightly bend at the elbow the arm being used. Have the subject place the hand not being used on top of the table, but not in contact with the test apparatus.

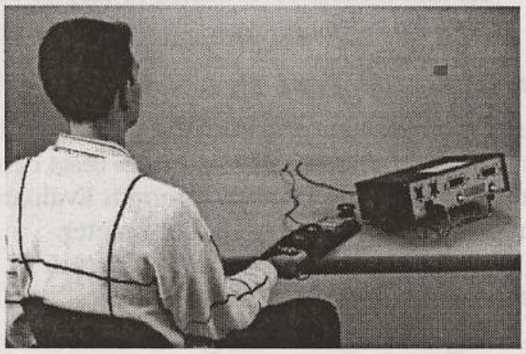


Figure 12. Test Position for the Grip Strength Test Using the Jackson Strength Evaluation System

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 grip. In this position, apply force by gripping the handle. You can move the grip unit on the table, but do not use your other hand. 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 Initiate button, and when the final beep has sounded, ask, *"Do you have any questions?"*
3. Answer any questions and then ask, *"Ready for your first maximum attempt?"*
4. Push button "1", and after the final beep, record the score on the Average display.
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 for this hand is the average of the two maximum voluntary effort trials.
7. Go back to step 1 above, and have the subject repeat the test, using the other hand. The subject's score is the average of the scores for each hand.

JAMAR Grip Strength Test

The JAMAR hand dynamometer uses a hydraulic gauge with a peak-hold needle to record the highest strength effort. The JAMAR displays grip strength in both pounds and kilograms. When recording scores, always read the "Pounds" scale. Figure 13 shows the grip test position. Use the following procedure to set up the equipment and to get the subject into the test position:

1. Set the grip handle in the proper position. The adjustable handle allows for five settings; use settings "2" or "3". The distance between the outer sides of the grip handles when the unit is sent from the factory is about 2 ¼ to 2 ½ inches.
2. Demonstrate the test position to the subject, and then have the subject assume the test position.

3. In proper position, the subject stands comfortably with the shoulder adducted and neutrally rotated, the elbows at a right angle (90° flexion), and the forearm and wrist in neutral position.
4. Have the subject decide which hand to use first. With the palm facing up, have the subject hold the grip handle. The unit should rest comfortable in the hand with the fingers wrapped around the handle.

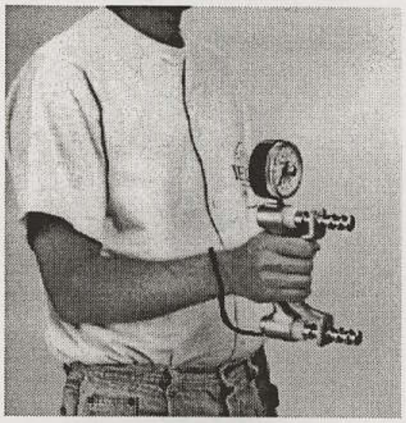


Figure 13. Test Position for the Grip Strength Test Using the JAMAR Hand Dynamometer

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 grip. In this position, apply force by gripping the handle with a single, 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. After the attempt at half effort, reset the peak-hold needle to zero, and ask, *"Do you have any questions?"*
3. Answer any questions and then ask, *"Ready for your first maximum attempt?"*
4. After the maximum attempt, record the score (in pounds) from the peak-hold needle. Reset the peak-hold needle.
5. Administer the two trials for score and record the subject's score (in pounds) for each from the peak-hold needle.
6. Do not announce the score to the subject. The subject's score for this hand is the average of the two maximum voluntary effort trials.
7. Go back to step 1 above, and have the subject repeat the test, using the other hand. The subject's score is the average of the scores for each hand.

Arm Lift Test Procedure

Figure 14 shows the arm lift test position. Use the following procedures to get the subject into the test 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 a right angle (90° flexion). Find the cable/chain attachment that places the elbows at 90° 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 cable should be at a right angle to the base. Move the subject forward or backward to obtain a right angle between the cable 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.

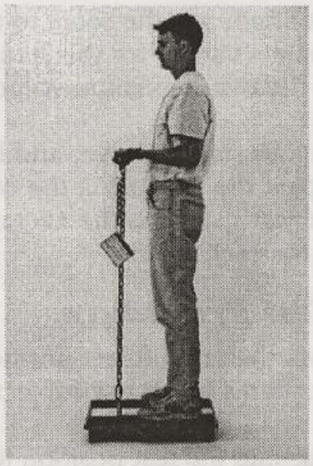


Figure 14. Test Position for the Arm Lift Test

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. Push the Initiate button, and when the final beep has sounded, ask, *"Do you have any questions?"*
3. Answer any questions and then ask, *"Ready for your first maximum attempt?"*
4. Push the Initiate button, and after the final beep, record the score on the Average display.
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.

Shoulder Lift Test Procedure

Figure 15 shows the shoulder lift test position. Use the following procedure to get the subject into the test 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 cable 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.

Figure 15. Test Position for the Shoulder Lift Test

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

"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 Initiate button, and when the final beep has sounded, ask, *"Do you have any questions?"*
3. Answer any questions and then ask, *"Ready for your first maximum attempt?"*
4. Push the Initiate button, and after the final beep, record the score on the Average display.
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

Figure 16 shows the torso pull test position. Use the following procedures to get the subject into the test 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 cable-chain unit 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.

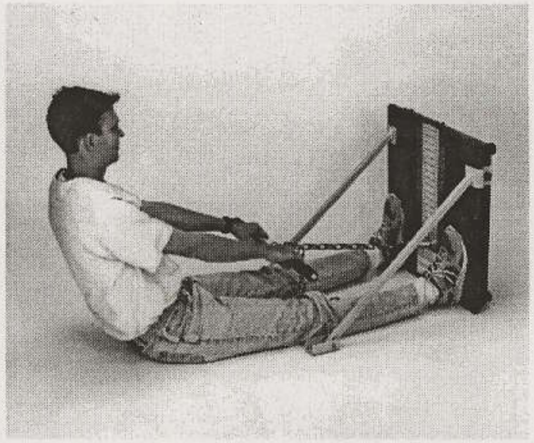


Figure 16. Test Position for the Torso Pull Test

When the subject is in the correct test 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. Push the Initiate button, and when the final beep has sounded, ask, *"Do you have any questions?"*
3. Answer any questions and then ask, *"Ready for your first maximum attempt?"*
4. Push the Initiate button, and after the final beep, record the score on the Average display.
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.

Quality Control Checks

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

Compare Peak and Average Scores

The unit provides a peak and average reading. The peak score should not be more than 15 pounds higher than the average reading. If the peak value is 15 pounds higher 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

Table 1 gives expected test score ranges for men and women. About 95% of all scores should fall within these ranges. If a high proportion (> 10%) of the people you test fall outside these 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.

STRENGTH TEST	MALES	FEMALES
Grip Strength	60-156 lbs.	28-98 lbs.
Arm Lift	45-128 lbs.	17-73 lbs.
Shoulder Lift	64-172 lbs.	30-98 lbs.
Torso Pull	120-370 lbs.	50-240 lbs.

Table 1. Test Score Ranges

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. Table 2 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.

These normative data show two general trends. First, the strength scores vary by the physical demands of the job. For example, the strength of coal miners tended to be higher than all other groups. College students tended to have the lowest strength scores. Second, the strength of females is lower than males. These gender differences are well documented in the literature and can be traced to body size and body composition differences. Men not only weigh more than women, but also have a lower percentage of body fat. Because of these physiological differences, men have a higher level of fat-free weight, the body's force producing component. Depending upon the sample and tests, research shows that women have from about 40-60% of men's strength. In the most extensive sample of industrial workers, the percentage of female to male strength was: arm lift, 51%; torso lift, 49%; and leg lift, 44%.

GROUP	GRIP			ARM LIFT			SHOULDER LIFT			TORSO PULL		
	M	SD	N	M	SD	N	M	SD	N	M	SD	N
FREIGHT WORKERS												
Females				48	11	56	65	17	56	152	30	56
Males				88	18	10	121	23	101	231	49	101
GAS CONSTRUCTION WORKERS												
Females	80	23	18	58	16	18				179	53	18
Males	111	23	234	89	20	234				240	57	234
GAS CUSTOMER SERVICE WORKERS												
Females	71	19	34	49	13	34				165	33	34
Males	109	23	212	78	19	212				212	52	212
STATE TROOPERS												
Females	71	16	17	53	10	17				184	23	17
Males	114	25	161	98	18	161				270	49	161
COLLEGE STUDENTS												
Females	60	16	299	42	13	376	63	18	77	143	36	490
Males	95.9	25.6	311	77.8	2	375	11	31	64	226	58	465
REFINERY WORKERS												
Females	76.8	13	14	54	12	14				170	48	14
Males	118	23	75	91	16	75				231	50	75
CONSTRUCTION WORKERS												
Females	88	9	6	76	5.7	6				202	21	6
Males	104	16	235	84	12	235				256	31	237
COAL MINERS												
Males	125	17	98	96	13	98						

NOTE: *Blank cells indicate that subjects were not tested.*
All test results are expressed in pounds.

Table 2. Isometric strength test means (M), standard deviations (SD), and sample sizes (N) of college students and occupational groups

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 about 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. Table 3 presents the regression equations for calculating the average isometric strength for a given 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	41.6
357	Male	Torso Pull	TP = 167.69 + (0.48 x Wt.)	0.36	41.1

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

Table 3. Regression equations that define the relationship between isometric strength and body weight

Using the standard error of estimate (SEE) from the regression analysis, low and high strength levels were calculated. Table 4 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

WEIGHT	GRIP			ARM LIFT			SHOULDER LIFT			TORSO PULL		
	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High
WOMEN												
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												
110-119	68	91	113	51	70	89	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	94	117	139	215	256	297
190-199	89	111	134	70	89	107	98	121	143	220	261	302
200-199	91	114	137	72	91	110	102	124	147	225	266	307
210-209	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
240-249	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 the score given for the 15th percentile.*

Table 4. Low, average, and high levels of isometric strength for levels of body weight contrasted by gender

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 Appendix C 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. Table 5 summarizes these 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.

REFERENCE	WORK SAMPLE TEST	CORRELATION
Jackson et al. 1991	Shoveling Coal	0.71
Jackson et al. 1991	50-pound Bag Carry	0.63
Jackson & Osburn 1983	70-pound 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 Endurance	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

Table 5. Correlations between isometric strength tests and work sample tests for preemployment research completed at the University of Houston

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. Figure 17 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 pounds of force is required to move the container, workers with strength scores greater than about 450 pounds would be expected to have sufficient strength to complete the task.

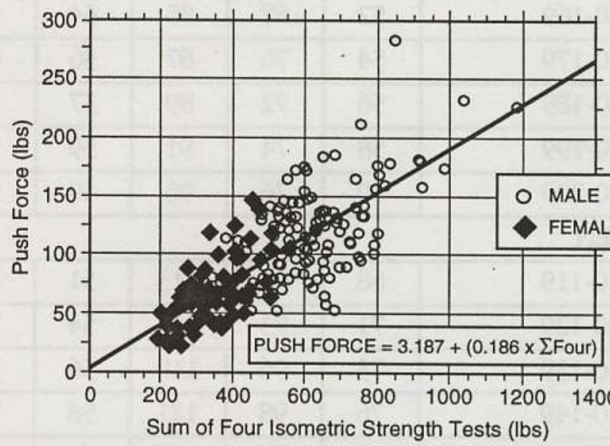


Figure 17. A Scattergram Showing the Relationship Between the Sum of Four Isometric Strength Tests and the Capacity to Generate Push Force

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. Figure 18 gives probability curves that define the level of strength needed to lift a 75-pound box to heights of 30 and 69 inches. The curves were developed through logistic regression analysis. Refer to Appendix C for references on 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 lift. Lifting a 75-pound box to a 30-inch height is a much easier task than the higher lift. The curves show that someone with 400 pounds of isometric strength will likely (p = 98%) be able to lift the 75-pound 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 pounds of strength to complete the task. Only about 15% of those with this level of strength would be expected to complete the high lift. Obviously, it takes a stronger worker to complete the high lift compared to the low lift. The strength test provided the data to confirm and quantify this obvious relationship.

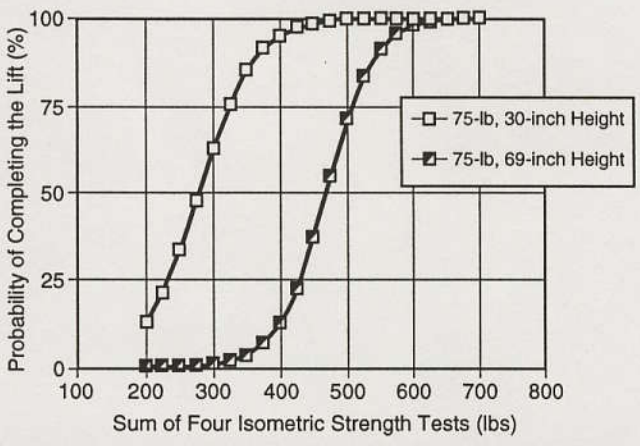


Figure 18. Logistic Curves that Define the Probability that Someone with the Defined Level of Isometric Strength Will be Able to Lift a 75-pound Box to Heights of 30 and 69 Inches

⚠ WARNING: *Do not use this section of the manual to test individuals. This material is provided for familiarity and informational purposes only. Actual testing instructions are given earlier in this manual.*

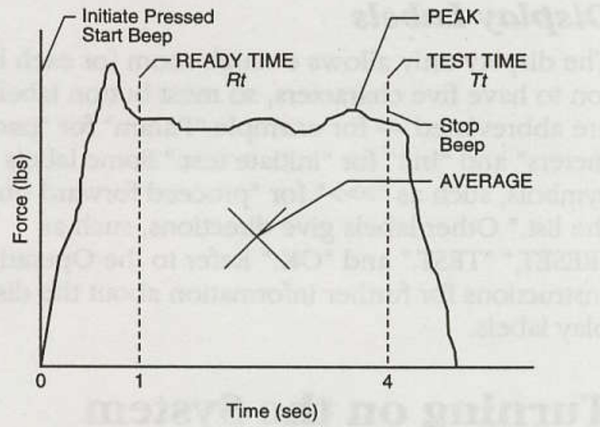
Abbreviations and Definitions

The following is a short list of commonly used terms and abbreviations in this manual. It is not intended to be an exhaustive list. For additional terms, refer to the Index.

- **Average data** — Mean pounds of force over the time period the unit measured the force application during a strength test.
- **Curs** — Cursor. Mode used to change parameters in the control unit.
- **Warning** — The warning beep that sounds when the amount of force on the load cell exceeds the limit set by the operator.
- **Init** — Initiate. Begin a strength test.
- Mode — Operating mode of the control unit.
- **Parameters** — Any variable that limits testing.
- **Peak data** — Maximum pounds of force applied during a strength test.
- **Prep time** — Prep time is the length of time when the unit does not measure force at the start of the test.
- **Test-time** — Test-time is the length of time the unit measures force.
- **Zero** — To set the unit values to zero before beginning a test.

System Controls and Displays

The Jackson Strength Evaluation System is used to measure the strength of a subject by measuring the force exerted by the individual on an electronic force transducer. The resultant force is displayed on the control unit. The force is given in two quantities: PEAK and AVERAGE force as measured in pounds. Two time periods, "READY TIME" and "TEST TIME," are used to calculate the forces displayed and for determining the length of a particular test. The following graph depicts a typical test and shows how each of the components on the control are used or determined.



Where:

$$AVERAGE = \frac{1}{Tt - Rt} \int_{Rt}^{Tt} FORCE(t)\, dt$$

Figure 19. Test Time

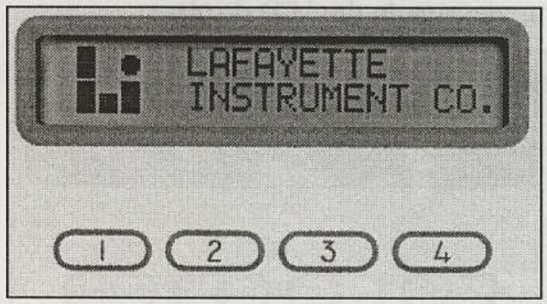


Figure 20. System Controls and Displays

Control Unit Displays

The Jackson Strength Evaluation System provides user data through the LCD display. The display, while cryptic, provides mode and test results information, and allows the user to program test protocols (series of tests). The two lines of the LCD give the following information:

- The top line of characters shows the current mode of the system and displays test result data.
- The bottom line of the LCD display assigns labels to the number keys below the display (1, 2, 3, 4).

Display Labels

The display only allows enough room for each button to have five characters, so most button labels are abbreviated — for example "Param" for "parameters" and "Init" for "initiate test." Some labels use symbols, such as ">>>" for "proceed forward on the list." Other labels give directions, such as "RESET," "TEST," and "OK." Refer to the Operating Instructions for further information about the display labels.

Turning on the System

After the load cell is connected to the box, the Jackson Strength Evaluation System is ready to be powered up. Press the power switch to the ON position. The first thing you will notice is the following message in the LCD display:

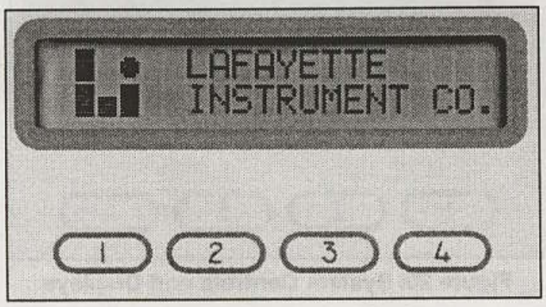


Figure 21. Power on Display

This is followed 5 seconds later by the name of the product:

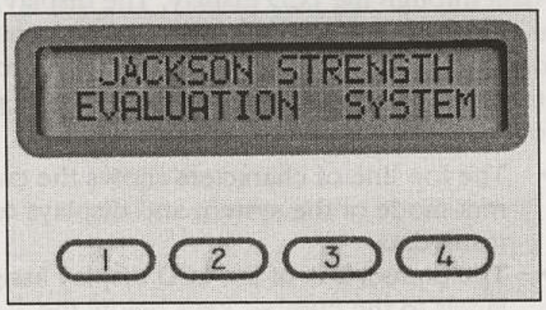


Figure 22. Power on Display — Product Name

After another 5 seconds, you enter the "Ready" mode of the Jackson Strength Evaluation System, as shown in Figure 23.

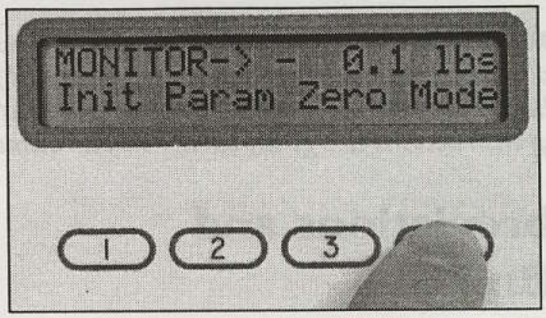


Figure 23. Ready Mode

Selecting Modes

The operation of the "Mode" button is shown in Figure 23 above.

Notice above that the "Mode" button is present in "Ready." When in "Ready", it is also automatically in "Standard." Press the "Mode" button to enter "Mode Select" (Figure 24).

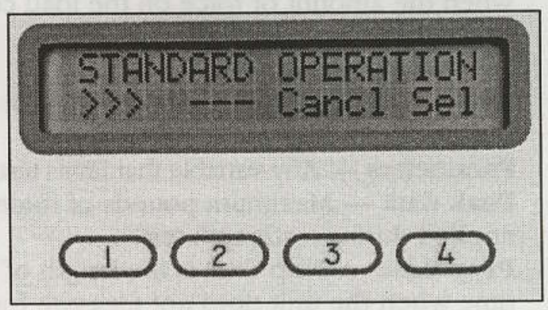


Figure 24. Mode Select

There are 3 possible modes of operation. As you press the ">>>" and ">>>" buttons, you will move through each possible mode. The 3 modes are:

- Standard Operation
- Protocol Operation
- Protocol Management

The "Standard Operation" mode is discussed below. A discussion of the "Protocol Operation" and "Protocol Management" modes are given in Appendix A. Once you have selected the appropriate mode on the display, pressing the "OK" button begins execution of that mode at the respective "entry/exit" mode. Pressing the "Cancl" button will return you to the previous mode of operation, ignoring the current displayed selection.

NOTE: *If you do not press a button and the input does not change within seconds, the control unit will enter the "power saver mode." Press any of the number keys to return to the display.*

Standard Operation Mode

You will notice that the force reading (0.0 lbs) on the upper line of the display is the actual force currently being applied to the load cell. This is to ensure that the starting force is always at zero before a test is initiated. Thus, it is "Ready." In this mode, the second line of text contains the abbreviations for the other possible functions immediately above their corresponding buttons. The buttons in this mode have the following functions:

- #1: Init: Initiate a strength test
- #2: Param: View or modify the current device parameters
- #3: Zero: Take the current force on the load cell and zero display
- #4: Mode: Switch to the mode selection menu

The first function you will need to know about is button #2, "Param."

Parameters (Param)

Before a test is initiated (especially immediately after power up), the user may wish to review or change the current device parameters. The "parameters" are any variables that limit testing. The "Parameter Review" mode may be reached by pressing the "Param" button. The LCD now displays the first "page" of parameter abbreviations, shown in Figure 25. (**NOTE:** *The parameters currently set on your device may be different than the examples shown. The different parameter modes will be fully explained later.*)

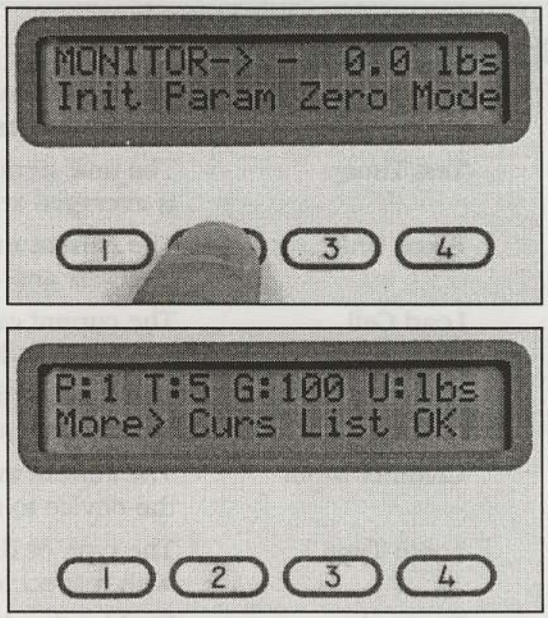


Figure 25. Parameter Review Mode, Page 1

After the user presses the "More>" button, the second "page" of parameters appears:

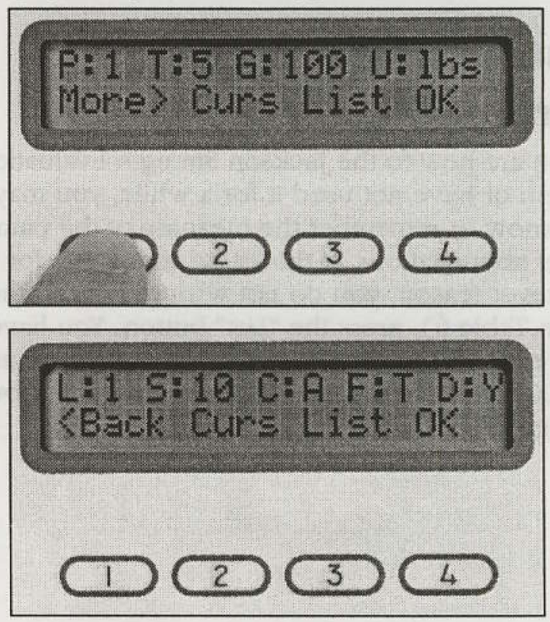


Figure 26. Parameter Review Mode, Page 2

Notice that the "More>" button has changed to "<Back." If the "<Back" button is pressed, the display will toggle back to Figure 25. The letter on the immediate left of each colon is the parameter abbreviation. The number or letter on the immediate right of each colon is the parameter's current value. Table 6 briefly explains each parameter's function and possible values. A more detailed explanation of each parameter is presented in Appendix B.

Abbreviation	Name	Function	Possible Values
P:	Prep Time	The initial few seconds of data that are ignored during a test	0 - 2 seconds
T:	Test Time	The time period in which the data is averaged and peak is detected	1 - 9 seconds
U:	Force Unit	The current unit of force used in goal sets and test results	Lbs.: English pounds kgs.: Metric kilograms
L:	Load Cell	The current calibration setting used in calculation of load force	# 1 - 4
S:	Sample Rate	The number of data samples per second obtained by the device	10, 20, and 40/sec
C:	Channel Input	The current input channel used by the device to measure the force	Chan. A or Chan. B
F:	Force Type	The type or direction of the force with respect to the load cell	T: Tension C: Compression
D:	Decimal Tenths	Enables the displaying of decimal tenths of pounds or kilograms	Y: Yes (enable 1/10ths) N: No (disable 1/10ths)

Table 6. Jackson Strength Evaluation System Device Parameters

Listing and Selecting a Parameter

If you are new to the Jackson Strength Evaluation System or have not used it for a while, you may not know or remember the meaning of the parameter abbreviations. If this is the case (and, for whatever reason, you do not wish to refer to the list in Table 6), press the "List" button. You have now entered the "Parameter List Select" mode and the LCD will display the labels and buttons shown in Figure 27.

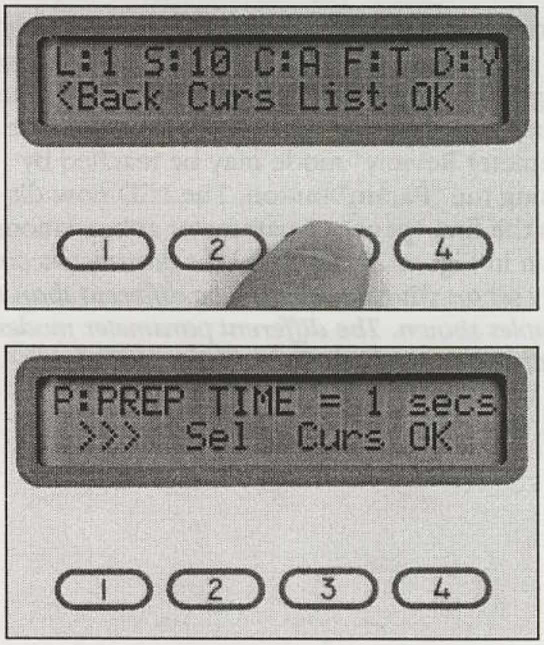


Figure 27. Parameter List Select Mode

Notice that the abbreviation, the full parameter name, and the current set value are displayed. You can now press the ">>>" (next on list) button and continue through all 9 parameters. Table 7 shows example text of the top line of the display as you progress through the list. When you reach the end of the list, the device starts again at the beginning of the parameter list.

P: PREP TIME = 2 secs
T: TEST TIME = 5 secs
U: FORCE UNIT = lbs
L: LOAD CELL = #1
S: SAMPLE RATE = 10/s
C: CHANNEL INPUT = A
F: FORCE TYPE = TENS
D: DEC . 1/10s = YES

Table 7. "Parameter List Select" Text

Using the Cursor to Select a Parameter

The "Curs" button shown in Figures 27 through 29 stands for "Parameter Cursor Select" mode.

If you press the "Curs" button in either Parameter List Select or Parameter Review mode, you will enter the "Parameter Cursor Select" mode. The displayed characters are shown in Figure 28. Note the blinking cursor on the "P" for "Prep Time." (Also note that in all further illustrations, the underlined italic character indicates that a blinking cursor is located at this position.)

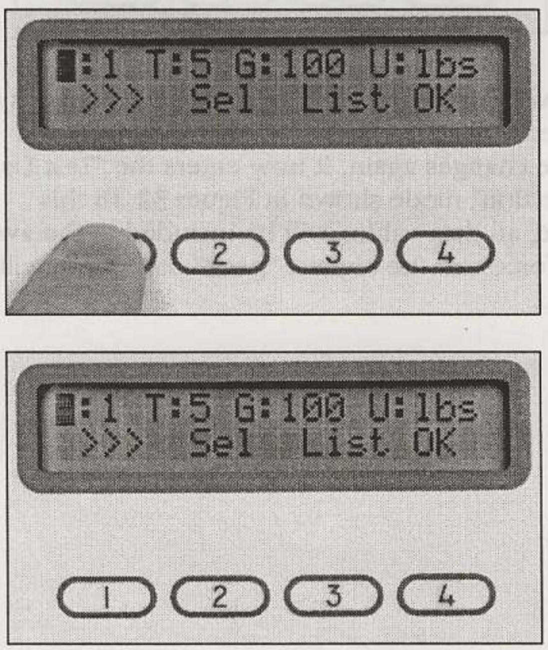


Figure 28. Parameter Cursor Select Mode

As you push the ">>>" button, the cursor moves to the "T," "G," and the "U." As you press again, you will switch to the next Parameter List "page", starting with the cursor on the "L" (as shown in Figure 29).

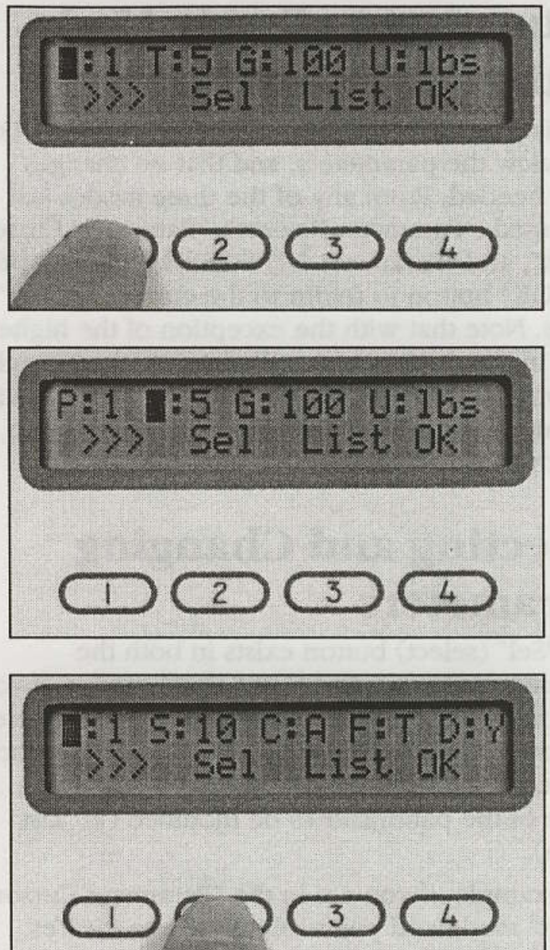


Figure 29. Moving the Cursor through the Parameter List

Again, as you push the ">>>", the cursor moves to the "S", "C", "F", and "D." As you press again, you will return to the first "page" of the parameter list. If you are in the "Parameter Cursor Select" mode and you forget the meaning of a particular abbreviation, press the "List" button to enter the "Parameter List Select" mode. The full name and value of the parameter will now appear. Pushing the "Curs" button will move the cursor back to the same point in the parameter list where it was before you pressed the "List" button (assuming the cursor was not moved in the "Parameter List Select" mode).

You can easily toggle back and forth from "Parameter Cursor Select" to "Parameter List Select" modes. However, you can not go directly back to "Parameter Review" once you have entered either of these two modes. You can only enter "Parameter Review" from the prior "Ready" mode by pressing the "Param" button. The next section will explain how to get back to current "Ready" mode.

Returning to Ready Mode with "OK"

At this point, we will assume that you wished only to review the parameters, and that no changes were needed. From any of the three modes just discussed ("Parameter Review", "Parameter Cursor Select", and "Parameter List Select"), you may press the "OK" button to return to the current "Ready" mode. Note that with the exception of the highest level in the device modes, button #4 (the far right button) will always take you back to some previous mode. In this case, it takes you back to the "Ready" mode (Figure 30).

Selecting and Changing Parameters

The "Sel" (select) button exists in both the "Parameter Cursor" and "List Select" modes. If you find that you do indeed need to alter a parameter for your current test, use the ">>>" button to locate the cursor on (in "Cursor" mode) or display the name of the parameter to be modified (in "List" mode).

For example, if you are in the "Parameter Cursor Select" mode and you wish to change the Test Time from the current 5 seconds to the new time of 7 seconds, you can simply press the ">>>" button until the blinking cursor is over the "T." At this point you can press "Sel" to enter the "Modification" mode for that parameter. The same thing can be done while in the "Parameter List Select" mode, except that you press the ">>>" button until the correct parameter label appears (T:TEST TIME). At that point, you press "Sel."

NOTE: *All parameter and modification modes are explained in detail in Appendix B.*

Using the Unit to Perform Tests

When you are ready to run a test, the display will appear as shown in Figure 30.

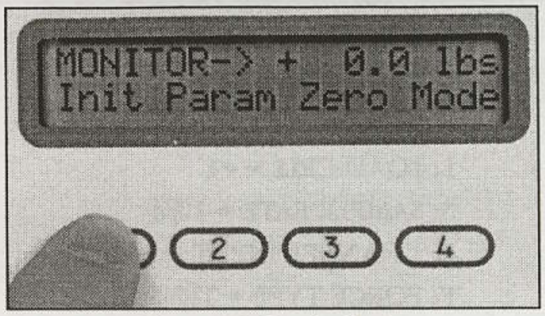


Figure 30. Ready Mode

When you press the "Init" button, you will notice that the display and the current mode have both changed. Figure 31 shows the display in "Prep Data Collection" mode. (Since this display typically appears for only 1 second, it may only appear briefly before changing). During this mode, peak values are ignored and no data values are included in the average strength measurement.

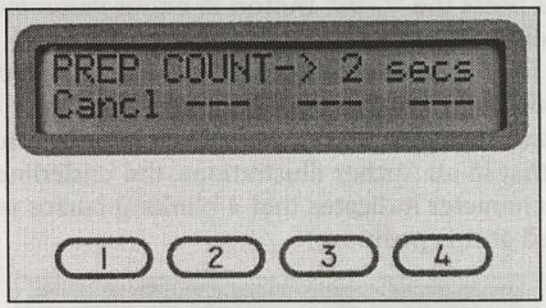


Figure 31. Prep Data Collection Mode

You will notice the that the number of seconds displayed will count down automatically until the mode changes again. It now enters the "Test Data Collection" mode shown in Figure 32. In this mode, all data values will be included in the average force and the highest "peak" data value will be saved.

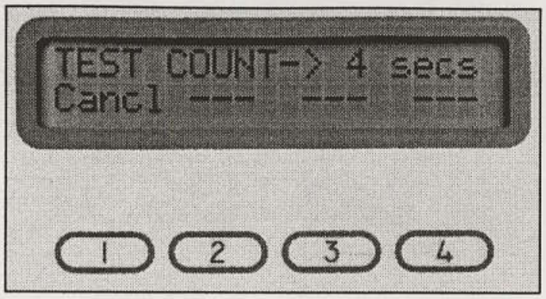


Figure 32. Test Data Collection Mode

If you have set your Prep Time parameter to zero, there will be no "Prep Data Collection" mode. The device will start with the "Test Data Collection" mode and count down until the test period is completed. In both of these modes, there is only one active button. If (for whatever reason) the test must be aborted, press the "Cancl" button. This will sound the "Stop" beeper signal and will return you to your current "Ready" mode.

Upon completion of a successful test, the "Stop" signal is emitted and the results of the test are displayed. This mode is very appropriately called the "Test Results" mode. A sample display is shown in Figure 33.

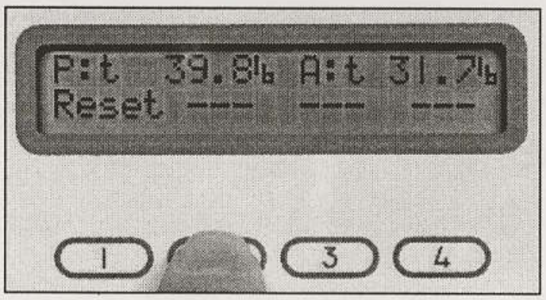


Figure 33. Test Results Mode

In this particular mode, the "P:" indicates the "peak" value detected during the "Test Data Collection" mode. The "A:" indicates the average data value during the same mode.

After the values have been recorded, press the "Reset" key to return to the current "Ready" mode for another test.

Calibration Instructions

NOTE: *If calibration of the unit is required, contact Lafayette Instrument Company for instructions on how to send the unit in for calibration.*

Equipment Required

Calibration checks require the following equipment:

1. calibration fixture to suspend weights and load cell
2. certified weights, accurate to 0.5 pounds
3. ⅝″ wrench to adjust eye bolt spacing on load cells

NOTE: *A calibration check kit, model 32629, is available from Lafayette Instrument Company. The calibration check kit includes a calibration fixture, a weight hanger, and slotted weights certified by National Institute of Standards and Technology (NIST). Call Lafayette Instrument Company for current pricing and availability.*

The operation of the "Mode" button is shown in Figure A-1 below.

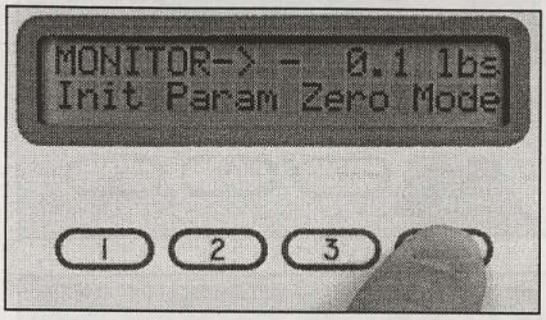


Figure A-1. Ready Mode

Notice above that the "Mode" button is present in the "Ready" mode. You are currently in the "Standard Ready" mode. Press the "Mode" button and you will enter the "Mode Select" mode. Figure A-2 shows how the display will look when entering from the "Standard Ready" mode.

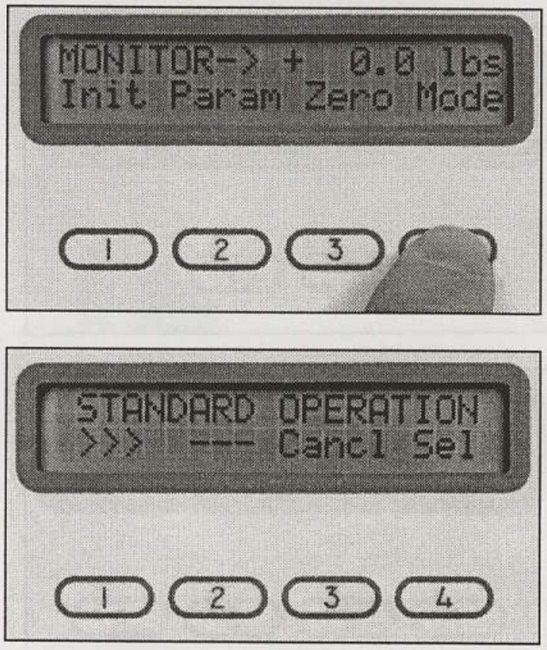


Figure A-2. Selecting Modes

As discussed in the main body of the manual, the three possible modes of operation are:

- Standard Operation
- Protocol Operation
- Protocol Management

You are already familiar with the "Standard Operation" mode. A discussion of the "Protocol Operation" and "Protocol Management" modes follows. Once you have selected the appropriate mode on the display, pressing the "OK" button begins execution of that mode at the respective "entry/exit" mode. Pressing the "Cancl" button will return you to the previous mode of operation and ignore the currently displayed selection.

Modes of Operation: Standard and Protocol

Instructions in other parts of this manual have dealt exclusively with running a strength test from the "Standard Ready" mode. Running a test from this mode makes sense under the following circumstances:

1. You are new to the Jackson Strength Evaluation System and wish to keep it simple.
2. You are running only one or two different tests on many subjects.
3. You are running the same exact test many times in a row.
4. You are "experimenting" with various parameters, load cells, etc., before you do actual testing.

Now imagine the following scenario: You have 100 subjects to test and none of your subjects can be away from their jobs for more than 30 minutes. Therefore, you decide to bring in one subject at a time until all subjects are tested. You will be required to administer (to all 100 subjects) four different tests, each test with its own different parameter settings. Two different load cells will be used during all the tests. Imagine the hassle of re-programming the parameters four times per subject and the possibility of re-programming incorrectly (which could lead to erroneous data or even physical injury to the subject). These suppositions are the "down" side of this scenario. The "up" side is that the same tests with the same parameter settings and load cell combinations will be done on all the subjects.

The solution to this scenario is the Jackson Strength Evaluation System "Protocol Operation" mode. This operation mode permits the user to select from up to four different "protocols" (groups or series of tests), with up to eight different tests per protocol. All of the parameters are pre-selected for each test, making complete test changes as easy as pushing a single button. The various protocols, tests, and parameters for this mode are programmed into memory, where they remain intact, even when the power is off or the batteries are depleted or missing. The programming mode for the "Protocol Operation" mode is called the "Protocol Management" mode.

Protocol Management Mode

Before we can run a "protocol" type test, we must program the protocol into the memory of the Jackson Strength Evaluation System. As was previously mentioned, the Jackson Strength Evaluation System will store a maximum of 4 protocols with a maximum of 8 tests per protocol. If you have a new Jackson Strength Evaluation System, it will come to you with one programmed protocol. That protocol will include one test. (**NOTE:** *If you have made special arrangements with Lafayette Instrument Company, your required protocols may already be programmed. Even so, it is still important to learn the programming procedure of the Jackson Strength Evaluation System.*)

For now, it will be assumed that your device is new and has not been pre-programmed. From the "Mode Select" mode, press ">>>" until you see "Protocol Management" displayed. Press "Sel" and a display similar to Figure A-3 will appear.

This mode is the entry/exit point of the "Protocol Management" mode and will be referred to as the "Protocol Main" mode. From this mode the user can do the following:

- Add or delete a protocol from memory (via "P+:P-")
- Edit an existing protocol (via "Edit")

The number after the # sign ("1" in this case) indicates the current selected protocol whose name follows the colon ("GROUP1" in this case). The protocol name is always 6 characters or less in length. The "—" button would be a ">>>" button if there is more than one protocol in memory. Since there is only one protocol, this is not a choice.

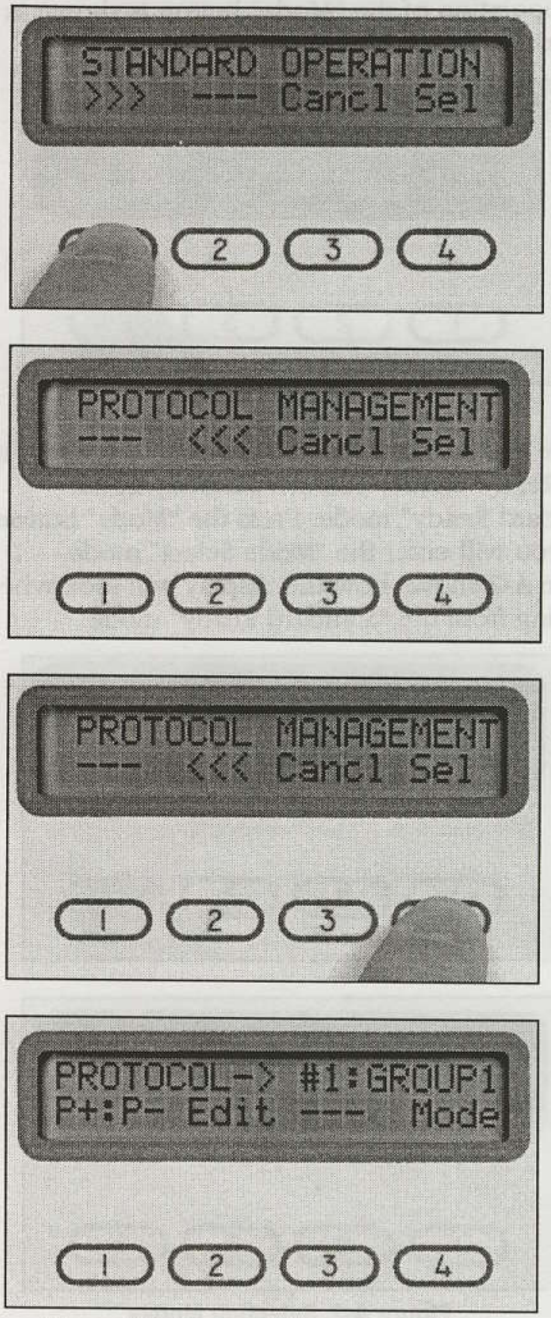


Figure A-3. Protocol Management Mode

Adding and Deleting Protocols with "P+:P-"

As an exercise, we will examine the process of adding a protocol and then deleting that same protocol. To begin, it is important to understand the basic rules in setting up a protocol addition or deletion:

1. When deleting a protocol, use the ">>>" button to select the protocol to be deleted before pressing the "P+:P-" button.
2. When adding a new protocol, the currently selected protocol will be used as source information and will be "copied" again into memory at the desired location.
3. If you wish to add a protocol and the goal is to "insert" a protocol into the current list, use the ">>>" button to select the protocol immediately before which the new protocol will be placed. For example, you have 2 protocols in memory with the names "TAC" and "TOE" respectively. You wish to add a new protocol (called "TIC") to the beginning of the list. To accomplish this, select the "TAC" protocol before pressing the "P+:P-" button. The contents of "TAC" will be "copied" into memory again at a location that will be edited later.
4. If you wish to add a protocol and the goal is to "append" a protocol to the end of the current list, select the protocol you wish to have recopied at the end of the list before pressing the "P+:P-." The selected protocol will be copied into memory at the end of the list and edited later. (**NOTE:** *When copying a protocol, always select the protocol that is most similar to the new final protocol. This will save time and effort.*)

At this point in the example, we will make the following assumptions:

1. There is only one protocol in memory.
2. Initially we will "append" a new protocol to the current list.
3. We will then "delete" that newly created protocol from the list.
4. Finally, we will "insert" a new protocol at the beginning of the list.

The fact that we only have one protocol in memory prevents us from making a selection on which protocol to copy. Therefore, press the "P+:P-" button; the display should be similar to Figure A-4. This mode is called the "Protocol Add/Delete" mode.

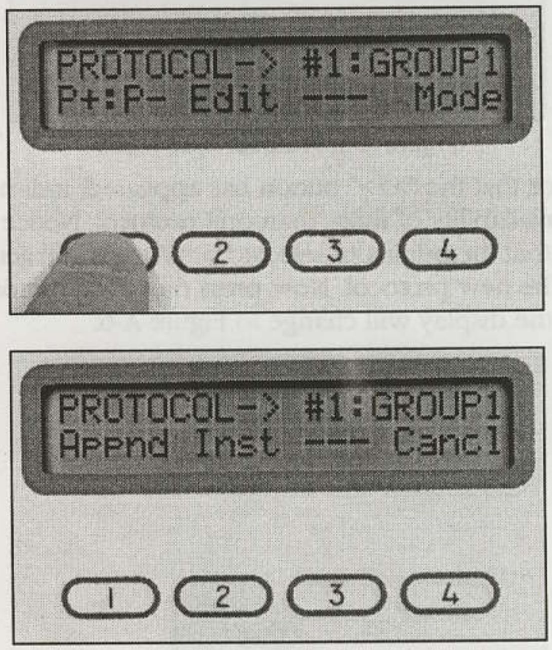


Figure A-4. Protocol Add/Delete Mode

The two new buttons are Append ("Appnd") and Insert ("Inst"). The "---" button is actually an invalid Delete ("Del") button. The "Del" button is not an option here because you must always have at least one protocol in memory. But our goal is to a append a new protocol. Therefore, you should press the "Appnd" button. After a short delay, you return to the "Protocol Main" mode with the display showing the information in Figure A-5.

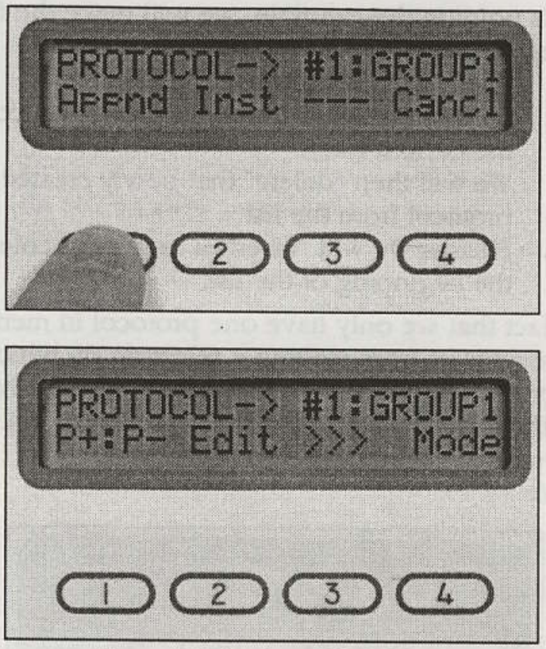


Figure A-5. Protocol Main Mode

Notice that the ">>>" button has appeared, indicating the availability of more than one protocol. Notice also that the originally selected protocol is still active, not the new protocol. Now press the ">>>" button and the display will change to Figure A-6.

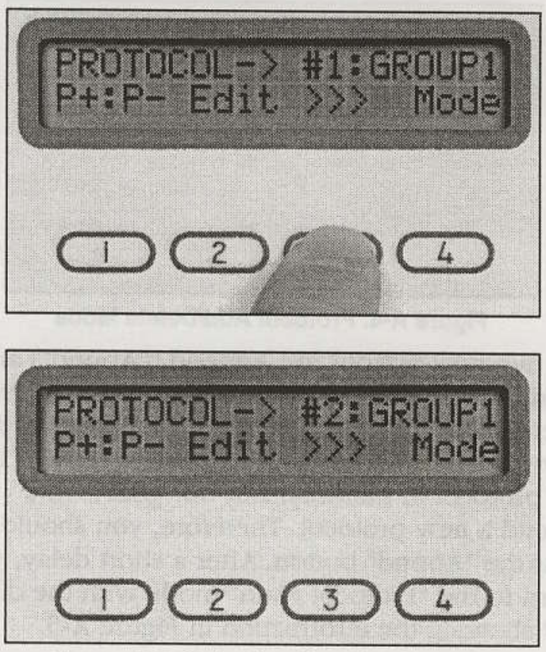


Figure A-6. Selecting Another Protocol

The only thing that changes is the index number of the protocol. We would expect this, since all information of the previously selected protocol was copied over to the new protocol, including the protocol name. Now we are going to delete this new protocol. With the #2 protocol selected, press the "P+:P-" button and the display will show Figure A-7. Notice that the "Del" label is now visible, indicating more than one protocol in memory.

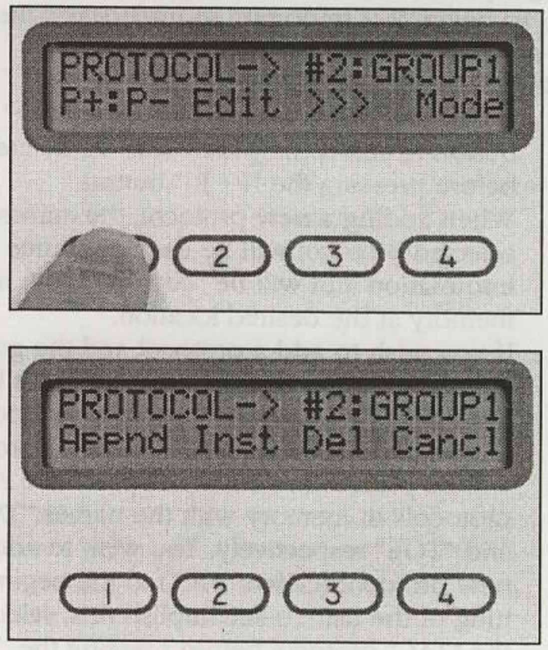


Figure A-7. Deleting a Protocol

Press the "Del" button and the display now changes to Figure A-8. Note that the display is identical to the last display shown in Figure A-3.

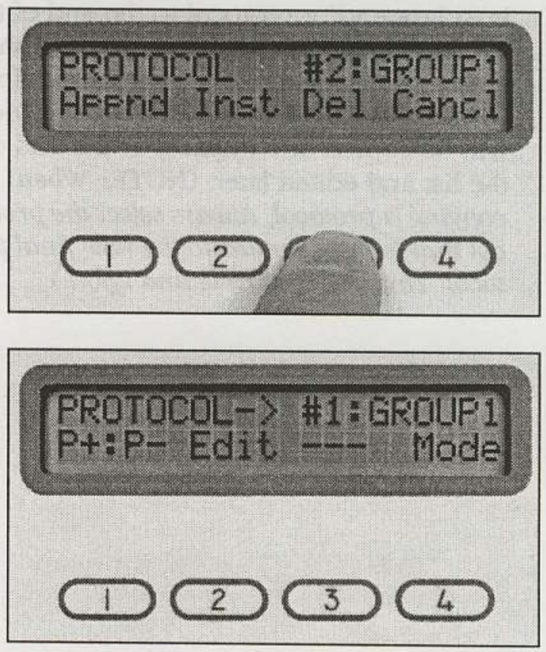


Figure A-8. Protocol Management Mode

A basic rule about deleting a protocol is that you always return to the "Protocol Main" mode with the first protocol in memory as the newly selected protocol. Since we have only one protocol in memory, we cannot select another protocol and therefore there is no ">>>" label.

Now we will insert a new protocol at the beginning of the list. Press the "P+:P-" button to re-enter the "Protocol Add/Delete" mode (shown in Figure A-4) and then press the "Inst" (insert) button. You will notice that you are now back to the same situation that you were in when you "appended" a new protocol (see Figure A-6). You now have 2 copies of the "GROUP1" protocol in memory. In this particular case, the outcomes of an insert or an append operation are identical. This is always the case when there is only one protocol in memory. But this is the only time they give similar results. We will keep this new protocol in memory for now.

Editing a Protocol with "Edit"

While in the "Protocol Main" mode, press the "Edit" button. The display in Figure A-9 will now appear. You are now in the "Protocol Edit" mode.

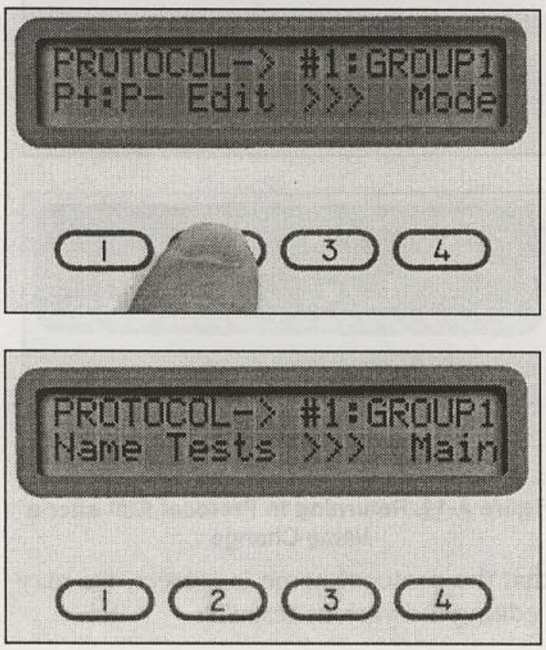


Figure A-9. Protocol Edit Mode

Notice that this mode has the same text as the "Protocol Main" mode and that you can still select (">>>") from different protocols within this mode. The "Tests" buttons will be discussed shortly. For now we will turn our attention to the "Name" button.

Editing a Protocol Name

Each protocol should have its own "unique" identifier or name. The Jackson Strength Evaluation System supports 6 character "names" for each of the protocols. In this example, the name of protocol #1 is "GROUP1." Suppose that we want to change that name to something more descriptive like "STKBAS" (short for "stock base"). From the "Protocol Edit" mode (Figure A-9), press the "Name" button. The new display information is shown in Figure A-10. The mode is referred to as the "Protocol Name" mode.

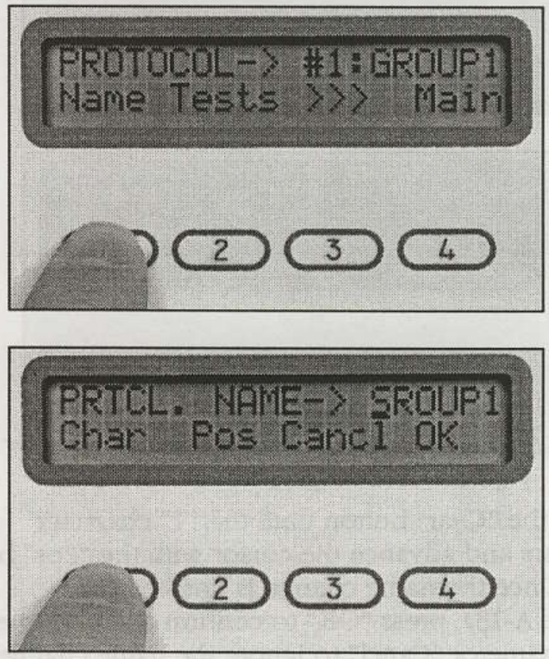


Figure A-10. Protocol Name Mode

Notice that the blinking cursor has appeared at the first character location of the protocol name. The "Char" (character) button changes the character at the position marked by the cursor. The list of characters available is shown in Figure A-11. Once the end of the list has been reached, it returns to the beginning of the list. Note that lower case alphabet characters are not available.

(space)!"#%&'()*+,-
./0123456789:;<=>
?@ABCDEFGHIJKLMNOP
QRSTUVWXYZ[Y]^_'

Figure A-11. Characters Available to Name Protocols

Since our goal is to change the current name to "STKBAS", go through the character list by pressing the "Char" button until the "S" character appears at the first position. Once you have reached "S", press the "Pos" (position) button once to move the cursor to the next character position. The display should appear similar to that in Figure A-12.

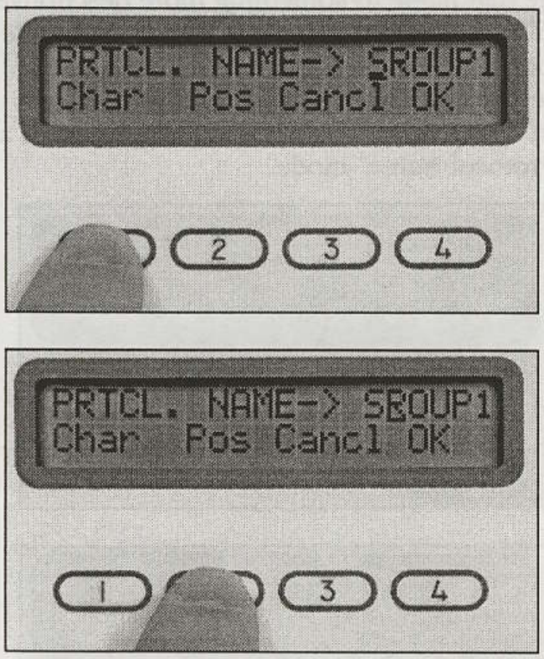


Figure A-12. Changing the Protocol Name

Press the "Char" button until the "T" character appears and advance the cursor with the "Pos" button. Once the name change is finished (as in Figure A-13), press "OK" to confirm and save the new name or "Cancl" to ignore the name change. Both of these keys will return you to the "Protocol Edit" mode (Figure A-14).

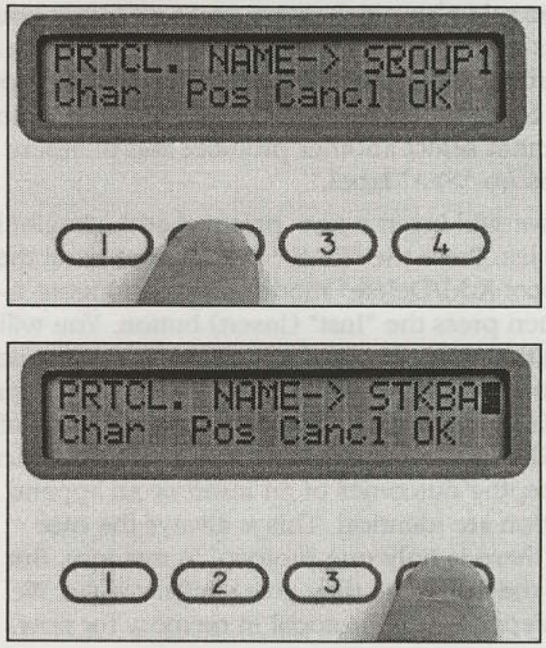


Figure A-13. Finishing a Protocol Name Change

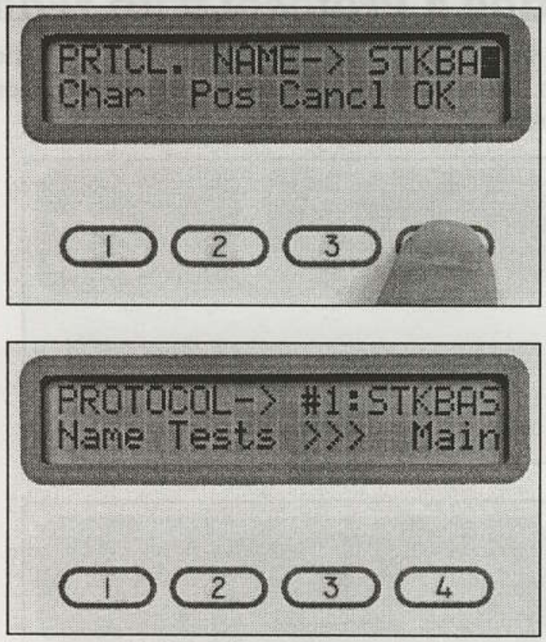


Figure A-14. Returning to Protocol Edit after a Name Change

Now that the protocol name is correct, we may begin editing the various tests.

Editing Protocol Tests

While in the "Protocol Edit" mode, press the "Tests" button. This will transfer the device to the "Test Main" mode. Figure A-15 illustrates display information consistent with the example we have been using so far.

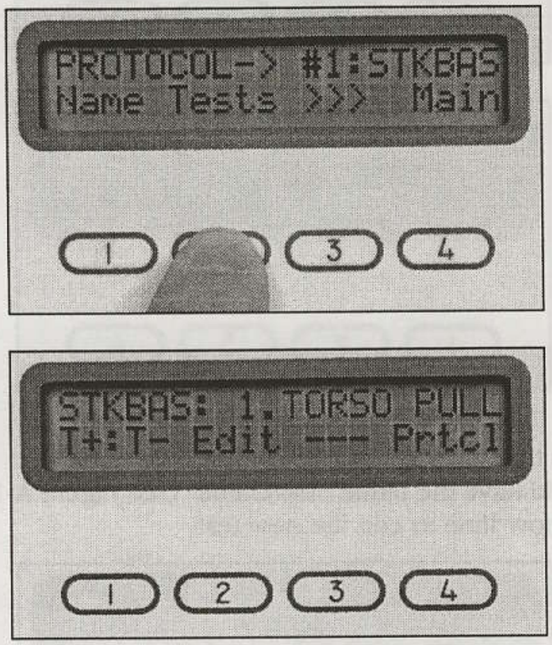


Figure A-15. Test Main Mode, Test #1

Notice that the name of the protocol is shown on the left side of the top line of the display. Other information on the top line includes the test index ("4") and the test name ("TORSO PULL"). The appearance of the ">>>" (select) button indicates that there is more than one test associated with this protocol. The "—" button would indicate that there is currently only one test for this protocol. For our example, we will assume more than one test is in memory. Pressing the ">>>" button switches the focus to the next test (see Figure A-16). When the final test is reached, the ">>>" button will return back to the first test of the protocol.

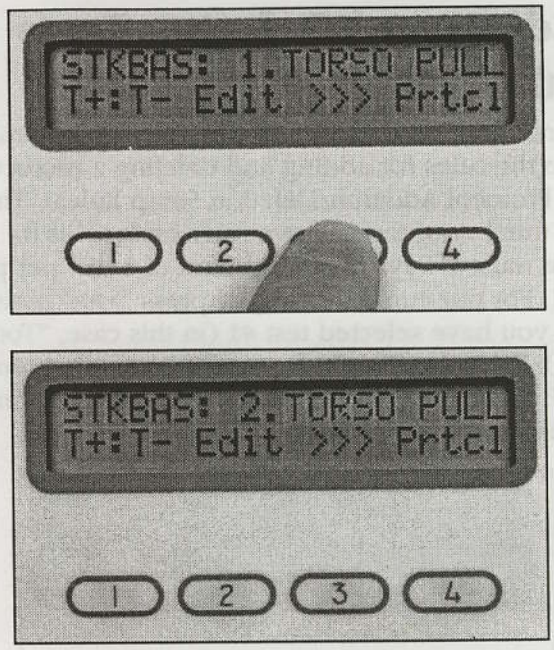


Figure A-16. Test Main Mode, Test #2

For our current example, we will assume that we have 2 tests in memory. Our goals for editing the tests of this protocol will be the following:

1. Append a new test to the list (make it a copy of the first test).
2. Designate the new test as "Shoulder Lift."
3. Change the parameters to correspond with the new "Shoulder Lift" test.

Adding and Deleting Tests with "T+:T-"

The rules for adding and deleting a test are identical to the rules for adding and deleting a protocol (see Protocol Addition/Deletion Setup Rules). The total number of tests allowed per protocol is 8. There must always be a minimum of 1 test per protocol. For our current example, press ">>>" button until you have selected test #1 (in this case, "Torso Pull"). Press the "T+:T-" button. You will then enter the "Test Add/Delete" mode. This display information is shown in Figure A-17.

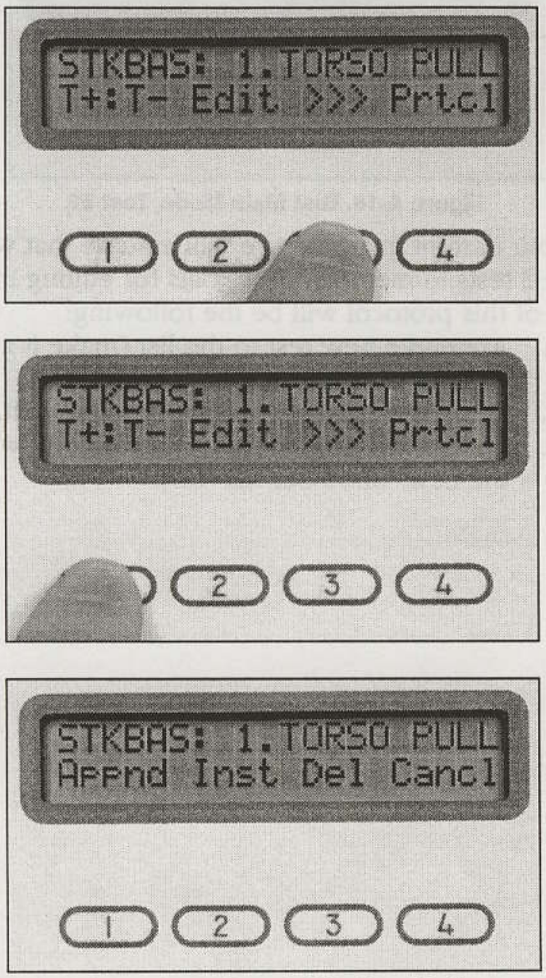


Figure A-17. Test Add/Delete Mode

Now press the "Appnd" (append) button to copy information to a new test at the end of the list. Keep in mind that the only thing different about these two tests will be their index numbers.

After you have appended the new test, the device will return to the "Test Main" mode (as shown in Figure A-18).

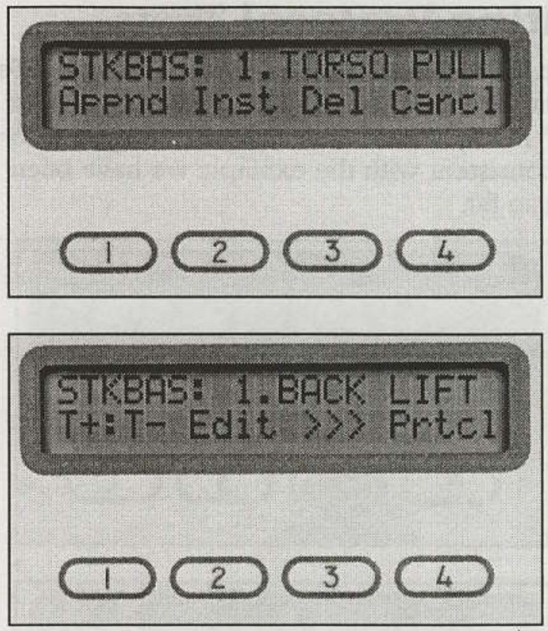


Figure A-18. Test Main Mode

Press the ">>>" button until you reach test #3. It should have the name "Torso Pull" (see Figure A-19). It is now time to edit the new test.

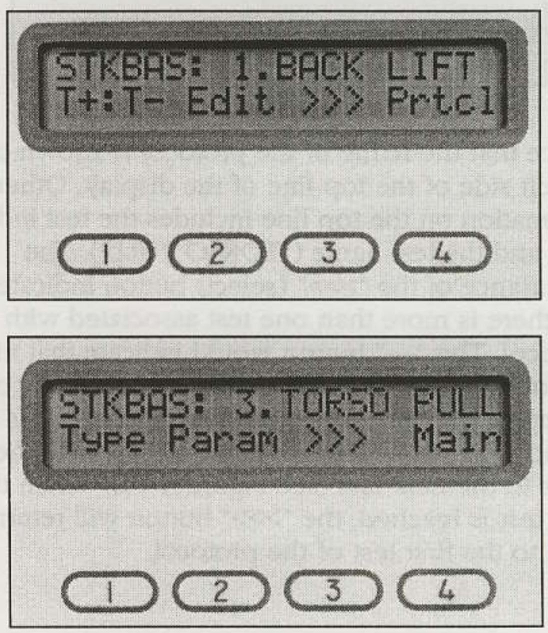


Figure A-19. Test Main Mode, Test #3

Editing a Test with "Edit"

As you may have already noticed, the "Edit" button is part of the "Test Main" mode as well as the "Protocol Main" mode. Pressing the "Edit" button while in the "Test Main" mode will transfer you to the "Test Edit" mode (as shown in Figure A-20).

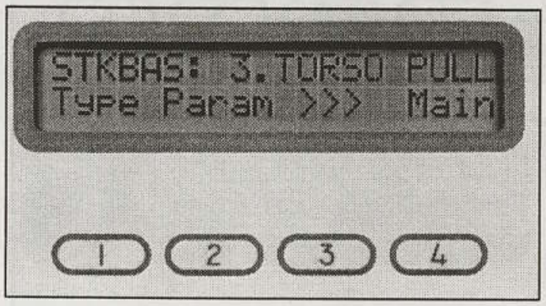


Figure A-20. Test Edit Mode

Like the "Protocol Edit" mode, the ">>>" button is still present, allowing you to edit other tests. For now, we will concentrate on editing test #3. Our first step will be to change the name of the test.

Changing a Test Name

When we change the name of a protocol, we can enter any name we wish (using the provided character set). The names of the individual tests, however, are not "made up" (in most cases) by the user. For safety reasons, the only tests that should be run on the Jackson Strength Evaluation System are those tests that are approved by Lafayette Instrument Company and associates. The names of these "approved" tests are included with the device. The current approved tests are:

- Hand Grip
- Arm Lift
- Shoulder Lift
- Torso Pull

⚠ **WARNING:** *For personal safety and liability reasons, NEVER run any strength tests on the Jackson Strength Evaluation System that are not specifically designated in this manual.*

The Jackson Strength Evaluation System is capable of storing up to 10 different test names. This allows for future expansion as new approved protocols become available. When such new protocols are available, Lafayette Instrument Company will notify you by mail and offer an upgrade to your current system.

Since our goal is to change the test name (or type) to "Hand Grip", press the "Type" button and the device will change to the "Test Type" mode as shown in Figure A-21.

Figure A-21. Test Type Mode

The absence of the "<<<" button suggests that "Hand Grip" is the last name on the list. Press the ">>>" until the correct name appears. Notice that the only thing that changes is the test name. The protocol name and the test index remain the same. With the "Shoulder Lift" test selected, the display should be similar to Figure A-22.

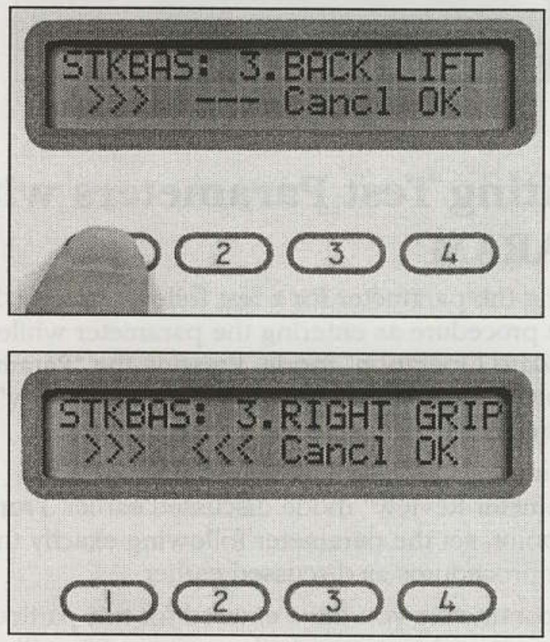


Figure A-22. Test Type Mode

Pressing either "Cancl" or "OK" will return you to the previous mode ("Test Edit"), but only "OK" will save the changes you have made. Assuming you have pressed "OK", the new display information is shown in Figure A-23.

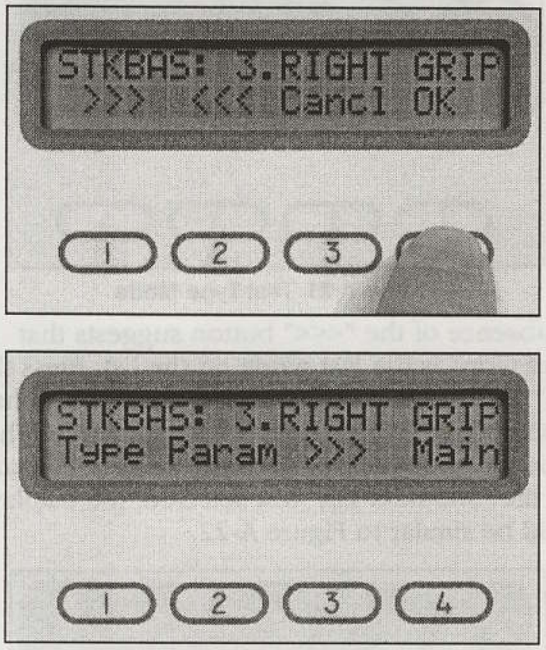


Figure A-23. Test Edit Mode

Editing Test Parameters with "PARAM"

Editing the parameter for a test follows exactly the same procedure as entering the parameter while in "Standard Operation" mode. Pressing the "Param" button changes the mode to "Parameter Review" (Figure A-24).

This mode is functionally identical to the "Parameter Review" mode discussed earlier. From this point, set the parameter following exactly the same procedures as discussed earlier.

The parameters you have entered for this particular test are stored in non-volatile memory. We will discuss the usage of these tests and protocols shortly. For now, use the techniques you have learned to edit test #1 ("Torso Pull"). If you have problems, review the above instructions.

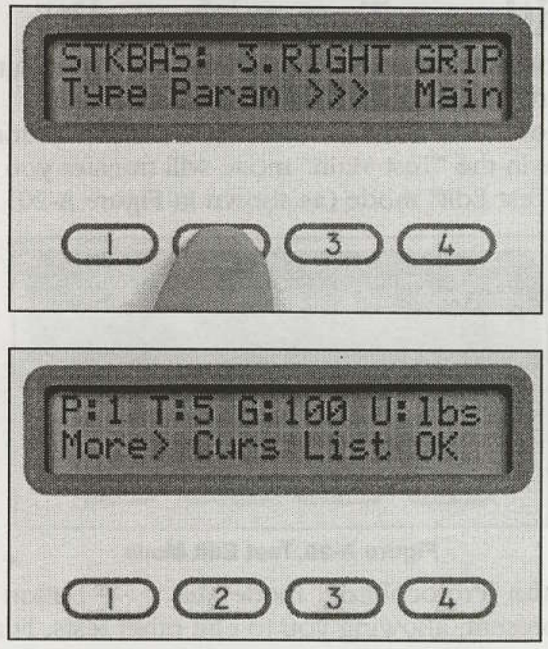


Figure A-24. Parameter Review Mode

Once you have finished all editing tasks, press the far right button until you return to the "Mode Select" mode (see Figure A-25).

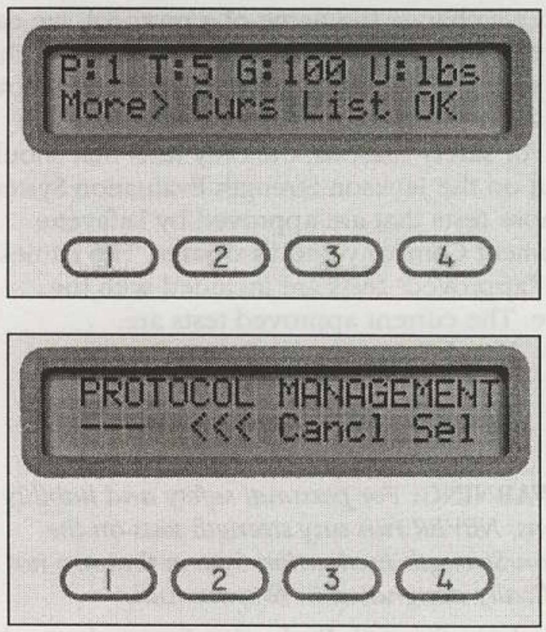


Figure A-25. Mode Select

We will now test the newly created protocol in the "Protocol Operation" mode.

Protocol Operation Mode

Once in the "Mode Select" mode, press the "<<<" (in this case) to change the mode select text to "PROTOCOL OPERATION" (see Figure A-26).

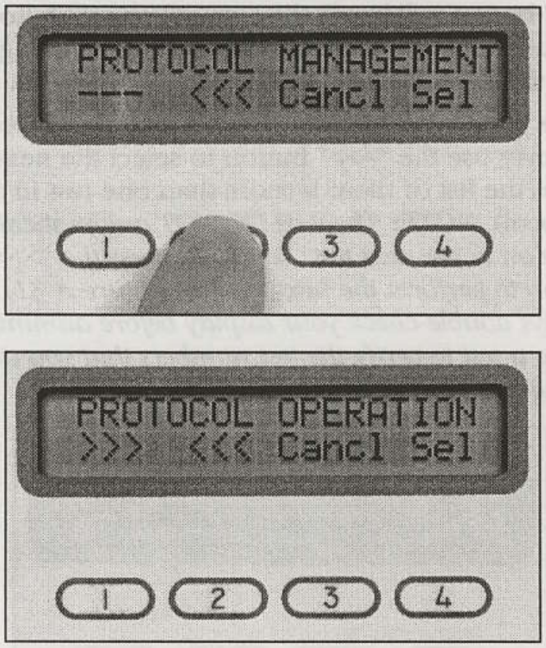


Figure A-26. Protocol Operation Mode

At this point, press the "Sel" button and you will enter the "Protocol Select" mode (see Figure A-27).

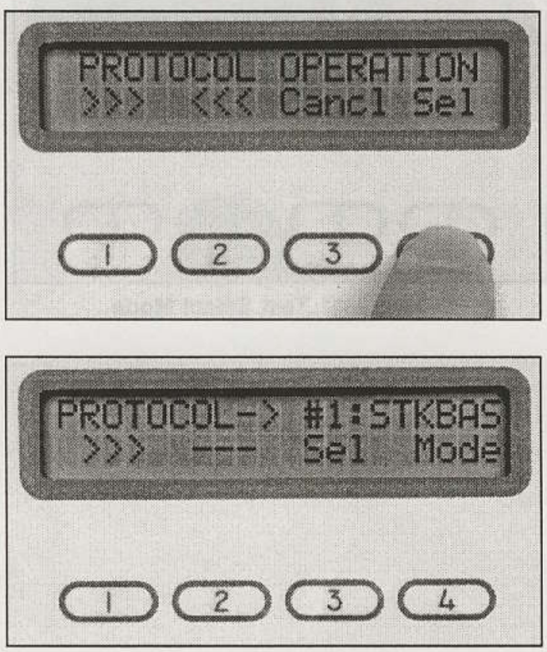


Figure A-27. Protocol Select Mode

The first protocol ("STKBAS") is now available for selection. We will continue using this protocol by pressing the "Sel" (select) button. You will then enter the "Test Select" mode (see Figure A-28).

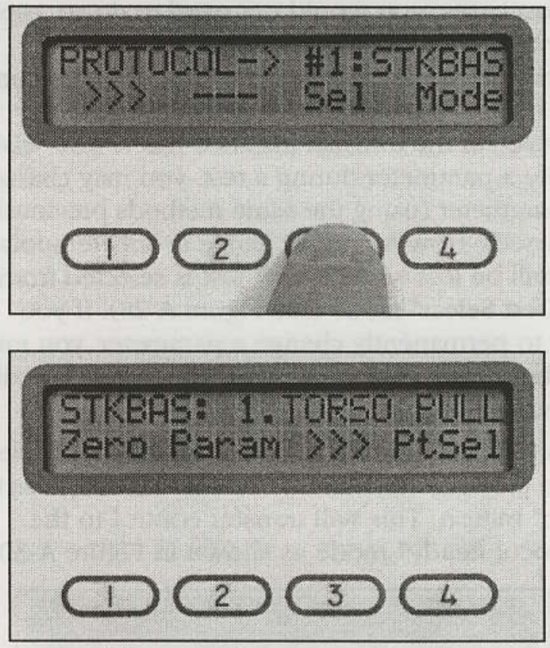


Figure A-28. Test Select Mode

Notice that the "Param" button has appeared. Press it now and the display should appear similar to Figure A-29.

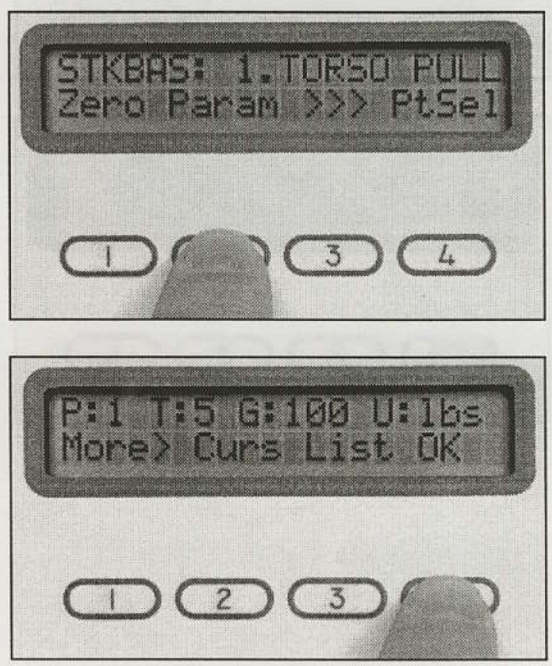


Figure A-29. Selecting Parameters

The same group of parameters will always come up whenever "1. TORSO PULL" is selected. But what happens if you modify one of these "preset" parameters at this point?

In most cases, you would not need to do so, especially since the whole idea of the "Protocol Operation" mode is to eliminate the need for constant manual parameter changes between tests. However, in the unusual instance where you wish to modify a parameter during a test, you may change the parameter (using the same methods previously discussed). However, this change is only temporary and will be lost when a new test is selected from the "Test Select" mode (see Figure A-28). If you want to permanently change a parameter, you must use the "Protocol Management" mode that was discussed earlier.

Press the "OK" button to return to the "Test Select" mode (see Figure A-28). From this mode, press the "Zero" button. This will transfer control to the "Protocol Ready" mode as shown in Figure A-30.

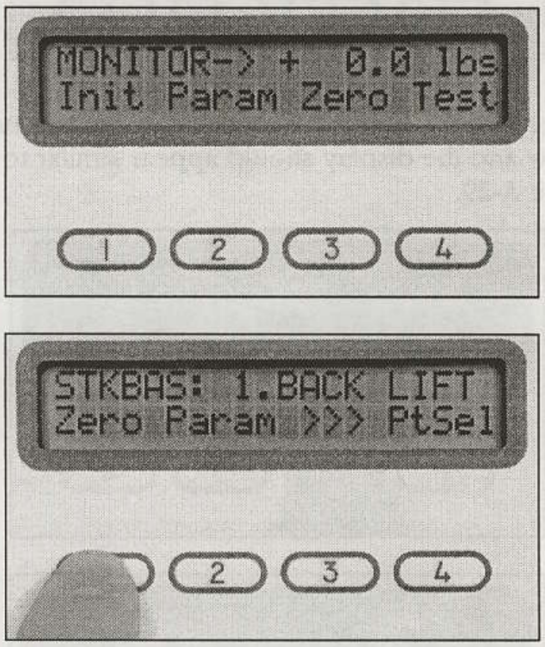


Figure A-30. Protocol Ready Mode

This mode functions similarly to the "Standard Ready" mode that we have previously discussed. The only difference is the "Test" button instead of the "Mode" button. Pressing the "Test" button will return you to the "Test Select" mode. Pressing the "Init" button will begin the test, which will follow the same path during test operation, concluding with the "Test Results" mode (see Figure A-30).

Once you have returned to the "Test Select" mode, you may use the ">>>" button to select the next test in the list (if there is more than one test in the protocol). **NOTE:** *The tests DO NOT automatically move on to the next test. You must press the ">>>" button to perform the next test (see Figure A-31). Always double-check your display before administering a test to verify the test numbers that you are giving.*

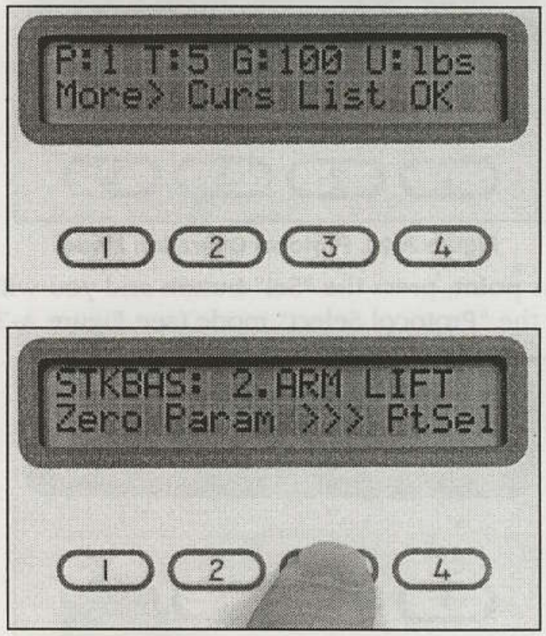


Figure A-31. Test Select Mode

Prep Time and Test Time Modification

Prep Time is defined as "the amount of timed data at the beginning of a test that is ignored in both averaging and peak detection of the device." The basic purpose of this "data omission" is two fold:

1. Eliminate the early "ascending" data values from the averaging data group.
2. Eliminate the initial "peak spike" data from the peak detection data group.

The elimination of this data helps to gauge a more accurate strength measurement, unbiased by the first few seconds of data. Note that while this data is ignored during averaging and peak detection analysis, the force values are supplied to the communications port in real time, allowing an external computer to save and analyze the real time data.

The LCD display for the "Prep Time Modification" mode appears in Figure B-1. In this example, we will assume that the current value is one second. Once again we see the button, which in this mode means "forward to the next highest value," similar to its meaning in the parameter select modes. Notice too the ">>>" button, which in this mode means "backward to the next lowest value."

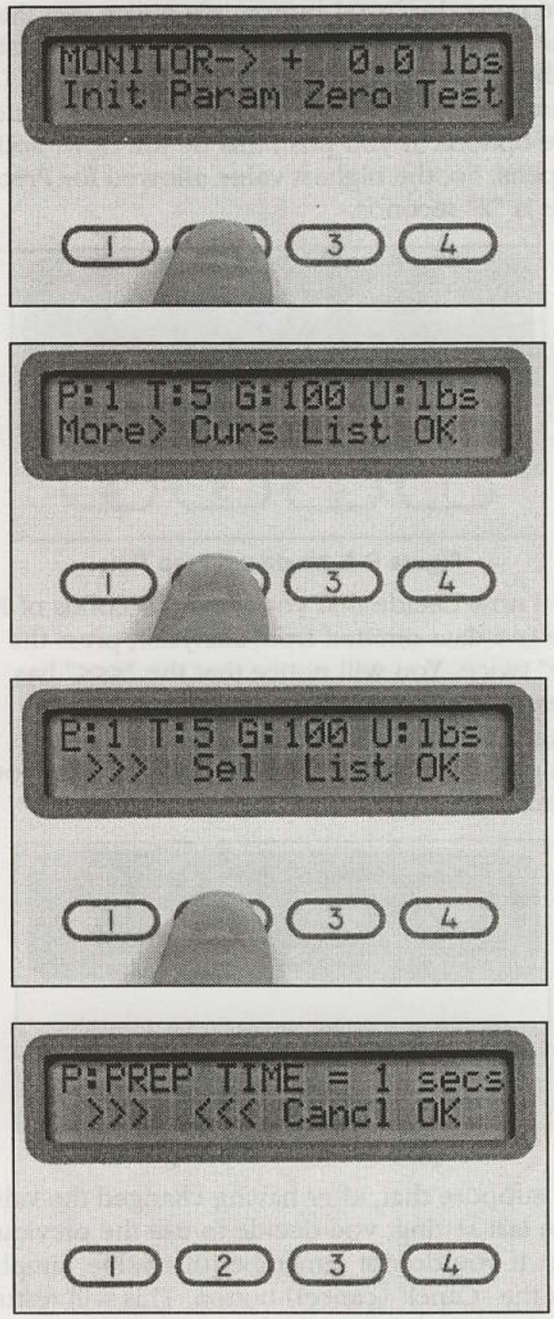


Figure B-1. Prep Time Modification Mode

If we press the ">>>" button, we notice that the value changes to two seconds. However, the label for the ">>>" button has now changed to "---" (see Figure B-2). This 3-dash line means there are no more options. If you push this button now, nothing happens. So, the highest value allowed for Prep Time is "2" seconds.

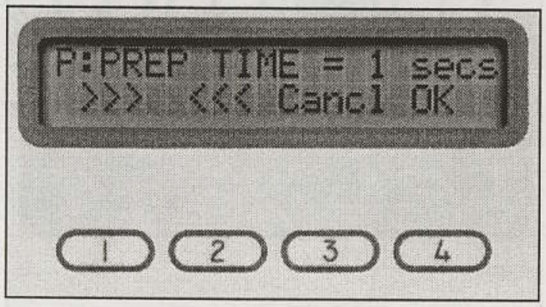


Figure B-2. Maximum Prep Time

If you now decide that you want 0 seconds of Prep Time (no data omitted from analysis), press the ">>>" twice. You will notice that the "<<<" has appeared again and the ">>>" label has now changed to "---" (see Figure B-3). This prevents you from going lower than zero seconds (which would not make sense anyway).

Figure B-3. Minimum Prep Time

Now suppose that, after having changed the value of the last setting, you decide to use the previous value. If you do not remember that value, simply press the "Cancl" (cancel) button. This will restore the last valid setting and take you back to the "Parameter Select" mode from which you entered the "Prep Time Modification" mode. If, on the other hand, you are happy with the new value, press "OK." This will modify the current device parameter and will also return you to the previous parameter select mode.

Test Time is defined as "the amount of timed data of a test that is averaged and from which a peak value is detected." Setting the Test Time is identical to the Prep Time, except that the "Test Time Modification" mode has different limits. The lower limit is one second, and the upper limit is nine seconds. The ">>>" and ">>>" buttons will behave accordingly during any time selection in this mode. The function of the "Cancl" and "OK" buttons is identical to the "Prep Time Modification" mode. In fact, the "Cancl" and "OK" will always have the same constant functionality in all nice parameter modification modes.

Force Unit Modification

Four of the nine possible parameters are "binary"; that is, they have only two possible values, making these the easiest and most intuitive to change. The Force Unit modification is the first of these binary parameters. Since there are only two choices, each of the two available buttons can designate a choice. Figure B-4 shows the display in the "Force Unit Modification" mode.

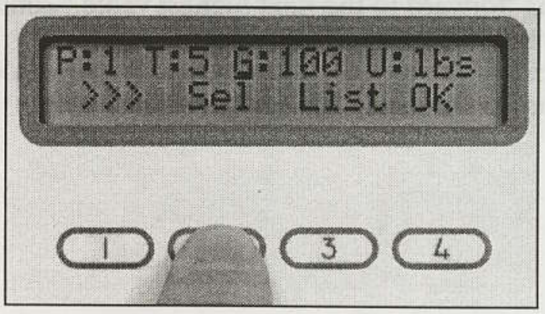


Figure B-4. Force Unit Modification Mode

Selection here is very easy. If you want pounds, press the "Lbs" (pounds) button. If you want kilograms, press the "Kgs" (kilograms) button. "Cancl" or "OK" buttons may be pressed, as usual, to exit.

Load Cell Modification

The Jackson Strength Evaluation System is designed to internally maintain up to four possible load cell calibration values. This allows for the use of multiple load cells that either have vastly different sensitivities, or that are built into fixtures that are used for limited types of tests. Each purchased load cell should have an index number and should have been calibrated with your device by Lafayette Instrument Company. Only load cells that have been calibrated and recorded into the Jackson Strength Evaluation System can be used (for more information, call the Lafayette Instrument Company). Figure B-5 shows the display in a possible "Load Cell Modification" mode.

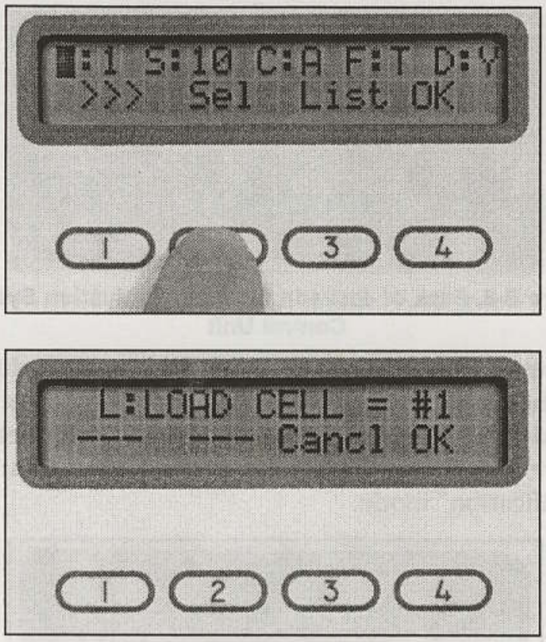


Figure B-5. Load Cell Modification Mode, No Values in Memory

Note that in this case, there is no way to select a different load cell calibration. Since there are no other value options in memory, you have no choice. In this case, "Cancl" and "OK" perform exactly the same. However, suppose that you have gone through the correct procedures and have three load cells, and that all three have calibration values in memory. Let's also assume that you are currently using load cell #1. The display would look more like Figure B-6.

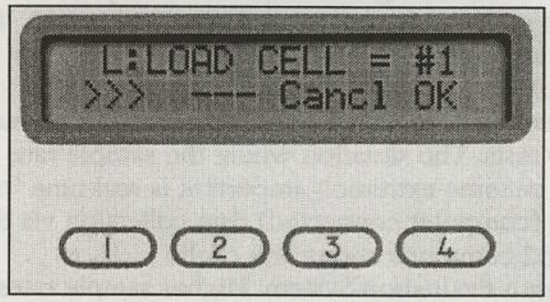


Figure B-6. Load Cell Modification Mode, Values in Memory

Notice that the ">>>" button is present. This implies that you do have other calibration values to choose from. You don't know how many until you continue to press the ">>>" and find that it changes to "---." You are now at the limit. The "<<<" has also appeared, permitting you to move backward through the selections.

WARNING: *Always make sure that you are using the correct load cell with the corresponding calibration value. Failure to do so will lead to erroneous data and the risk of physical injury.*

Sample Rate Modification

The "Sample Rate Modification" mode is probably the most ambiguous of the 9 parameter settings. The number of data points read per second does affect the accuracy of the detected peak. It may also slightly affect the accuracy of the overall average, especially if the force is very "jerky" or unstable. In both of these cases, a higher sample rate would theoretically be better than a lower sample rate. However, higher sample rates may also be more susceptible to "external electrical noise", that may affect the accuracy. For the most part, any sample rate setting will provide quality performance for normal "off line" (no computer connection) tests. The situation where the sample rate may become extremely important is real-time "on line" (computer connected) data collection via the RS-232 communications link of the Jackson Strength Evaluation System. Higher sample rates will be able to better detect individual peaks and make "tremor" analysis more accurate. On the other hand, lower sample rates produce smaller data files, and are adequate where very precise readings are not required. There are three available sample rates: 10, 20, and 40 samples per second. In order to best balance out the above effects on data accuracy, 20 samples per second is recommended for most "off line" testing. The display for "Sample Rate Modification" mode is shown in Figure B-7.

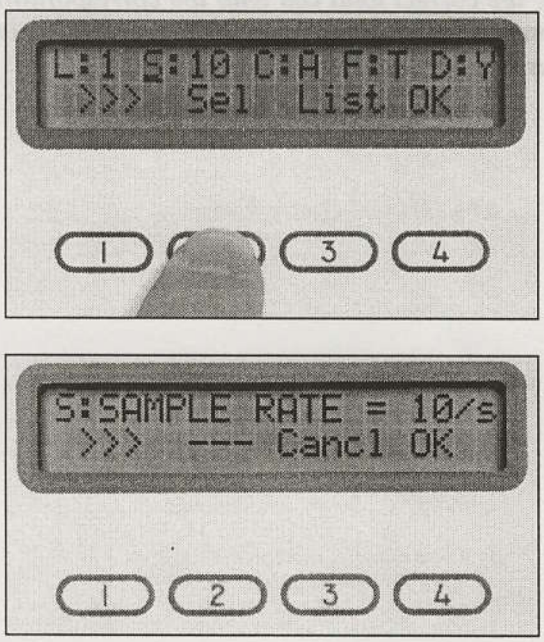


Figure B-7. Sample Rate Modification Mode

You are now familiar with the ">>>" and "<<<" buttons. In the "Sample Rate Modification" mode, 10/s is the lowest value, while 40/s is the highest. Each button will be disabled ("---") when its respective limit has been reached. Use "Cancl" or "OK" to exit. Note that the selected sample rate effects both "Prep" and "Test" data collection as well as the sample rate of all "Ready" modes.

Input Channel Modification

While examining the back of the Jackson Strength Evaluation System controller, you will note that there are two 5-pin connectors marked "A" and "B" (see Figure B-8). This allows you to connect two load cells to the controller at the same time.

Figure B-8. Back of Jackson Strength Evaluation System Control Unit

However, only one of the load cells is active during the actual testing of the device. You can set the "valid input channel" by modifying this parameter. Figure B-9 shows the display in the "Input Channel Modification" mode.

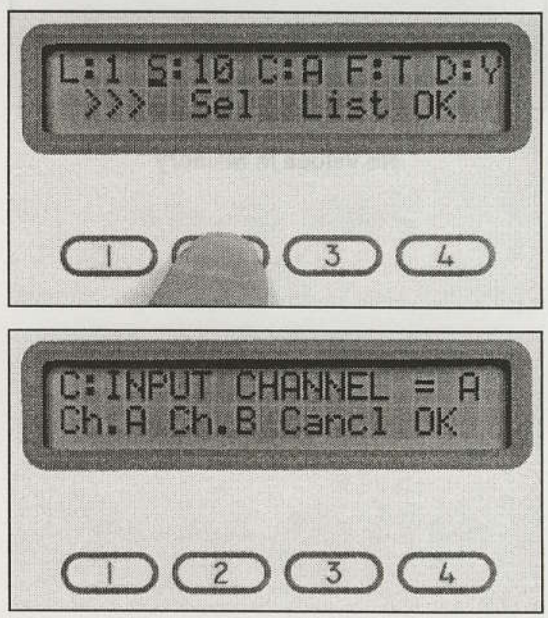


Figure B-9. Input Channel Modification Mode

If you wish to use the load cell in the "A" input channel, select "Ch.A." Select "Ch.B" for input channel "B." Press "Cancl" or "OK" to exit.

WARNING: *In nearly all cases, you will be required to change the load cell parameter if you change the input channel. Failure to do so will lead to erroneous data and the risk of physical injury. Also, be aware that if you are running on batteries only, two load cells connected to the device at the same time will greatly diminish battery life. When using two load cells, you should run the Jackson Strength Evaluation System controller off wall current. If wall current is unavailable, connect only one load cell to the controller at a time.*

Force Type Modification

The "Force Type" parameter designates which force is to be considered the "positive" force in a given test. For example, if this parameter is set for "Tension", a "pulling" force on the load cell will generate values that are internally read and externally displayed as positive (+).

Referring to Figure B-10, note the "+" sign at the beginning of the force reading. The "+" or "-" sign also appears on test results.

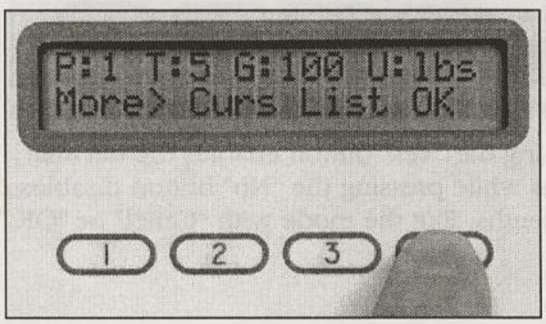


Figure B-10. Force Type shown on Ready Mode display

Now, if you "push" (compress) the load cell while in "tension" mode, the sign changes to negative ("-"), implying that a negative or (in this case) an "inappropriate" force is being detected. It is important that the desired "target force" always read as "positive" because peak forces are detected and displayed only for the highest "positive" force.

Figure B-11 shows the display in the "Force Type Modification" mode.

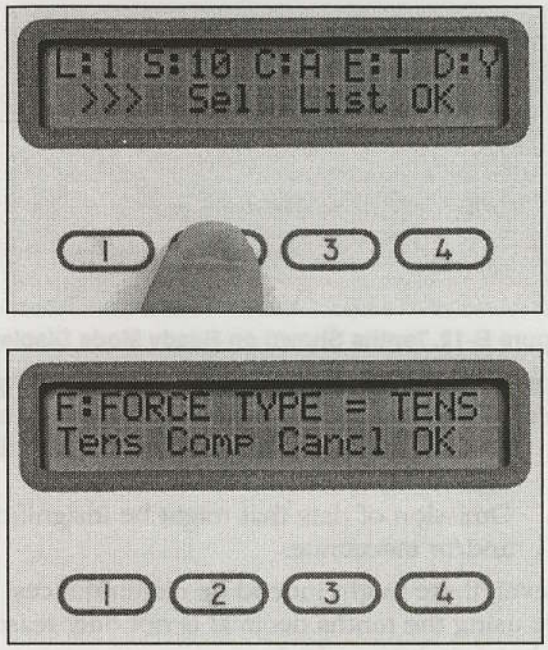


Figure B-11. Force Type Modification Mode

Pressing the "Tens" (tension) button will set the parameter for positive tension forces while the "Comp" (compression) button will support negative compression forces. Use the "Cancl" and "OK" buttons to exit.

WARNING: *Failure to have the correct force type setting will result in erroneous peak data. It may also increase the risk of physical injury.*

Decimal Tenths Modification

The Jackson Strength Evaluation System controller has the capability of displaying tenths of pounds (see Figure B-12) or tenths of kilograms. Of course, during many kinds of strength testing, force values well into the hundreds of pounds are possible, possibly rendering tenths insignificant. What's more, while the individual "single pound" accuracy on these "heavy duty" load cells might be very good, the tenths of pounds might be "choppy" and unreliable due to limitations of the load cell and controller.

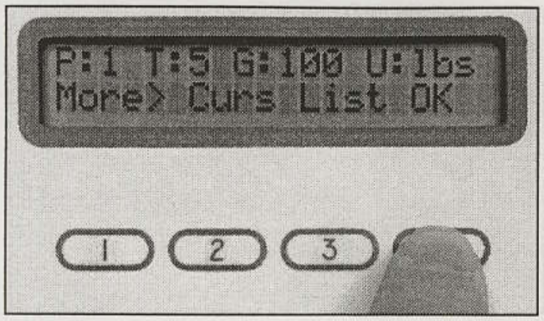


Figure B-12. Tenths Shown on Ready Mode Display

During testing with large force loads, eliminating the tenths decimal has the following advantages:

1. Cleaner displays with fewer significant figures to worry about.
2. Omission of data that might be insignificant and/or inaccurate.

However, there might indeed be circumstances where using the tenths decimal is not only reasonable, but may be required:

1. The load cell is highly sensitive, designed for lower force loads (less than 50 lbs) and would provide a reasonably accurate tenths decimal.
2. The average force measurements across the population in a particular test are small (less than 50 lbs).
3. Data communications on the RS-232 may require the tenth level accuracy for fine tremor detection, frequency, or some other form of high-resolution analysis.

Figure B-13 shows the display for the "Decimal Tenths Modification" mode.

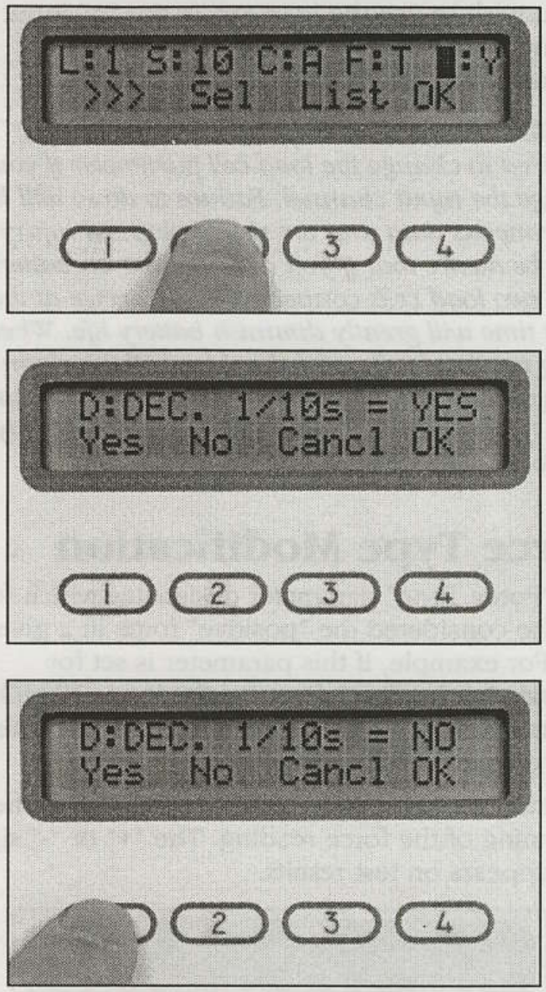


Figure B-13. Decimal Tenths Modification Mode

Pressing the "Yes" button enables the decimal tenths while pressing the "No" button disables decimal tenths. Exit the mode with "Cancl" or "OK."

Arnold, J. D., Rauschenberger, J. M., Soubel, W. G., & Guion, R. M. (1982). Validation and utility of a strength test for selecting steelworkers. *Journal of Applied Psychology*, 67, 588-604.

Arvey, R. D., & Faley, R. H. (1988). *Fairness in Selecting Employees* (2 ed.). Reading, MA: Addison-Wesley Publishing Co.

Arvey, R. D., Nutting, S. M., & Landon, T. E. (1992). Validation strategies for physical ability testing in police and fire settings. *Public Personnel Management*, 21, 301-312.

Ayoub, M. A. (1982). Control of manual lifting hazards: III. Preemployment screening. *Journal of Occupational Medicine*, 24, 751-761.

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32628CTL

Electrical

Wall Mount Power Supply	120 VAC, 60 HZ, 12V 500 mA center positive 240 VAC, 50 Hz, 12V 500 mA center positive
Battery	4 - 1.5V Alkaline C-cell
Display Accuracy	.1 lbs .2 kgs
Processor Accuracy	8-bit
Typical System Accuracy	.51% 20% F.S.
Sample Rate	Selectable 10, 20, 40 samples/sec

Operating Conditions

0 to 70 degrees C

-32 to 148 degrees F

10% to 90% RH

Controls Output

Rocker switch ON/OFF with international nomenclature

Push buttons

20x2 Character Lilquid Crystal Display

Transducers A+B selectable

I/O for future use

RS-232 Serial communication port for future use

Standard Test Results: Peak and Mean

Selectable Test and Prep Time

Pre-Set and Configurable Test Protocols

32628PBC

Weight:	Platform	16.2 lbs
	Bar	2 lbs
	Chain	3 lbs
	Stand	3.9 lbs

32528LC

Capacity:	1000 lbs
Weight	1.6 lbs